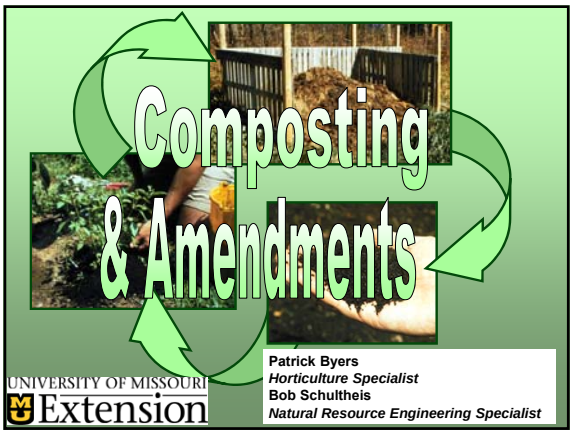


Upcoming Programs of Interest

- Webster County Gardening Workshops, 6:30-8:30, Marshfield
- Blackberry Workshops, 1-4pm;
  - 4/25/18, 6/27/18; Southwest Research Center, Mount Vernon
  - 4/26/18; Farmington
- Elderberry Conference, June 14-16, Jefferson City and Columbia
- Missouri Tomato School, June 28-29, Jackson
- Garlic Festival, Sept 21, 6-8pm, Botanical Center, Springfield
- Great Plains Growers Conference, Jan 10-12 2019, St Joseph
- Missouri Blueberry School, March 2018

Outline

- Composting
- Vermicomposting
- Bokashi composting
- Compost tea
- Soil amendments

UNIVERSITY OF MISSOURI Extension

What is composting?

Using the natural process of decay to change organic wastes into a valuable humus-like material called compost

Benefits of compost
Promotes soil health

- Supplies organic matter to soil
- Attracts earthworms
- Stimulates beneficial soil microorganisms
- Increases soil water holding capacity
- Increases soil nutrient retention

Benefits of compost
Promotes soil health

- Improves soil tilth and friability
- Improves soil drainage
- Loosens heavy clay soils
- Suppresses soil-borne plant pathogens (diseases)

Benefits of compost
Plant nutrients

Compost is not a fertilizer, but does contain plant nutrients

- Nitrogen and phosphorus are mostly in organic forms
  - Released slowly to plants
  - Not readily leached from the topsoil
- Compost contains many trace nutrients that are essential for plant growth

Composting -

Speeding up the natural decay process

A compost pile or bin allows you to control

- Air (oxygen)
- Water
- Food, and
- Temperature

By managing these factors you can speed up the otherwise slow natural decay process

What do you need to make compost?

- Decomposers – Your composting work crew. These are the microbes (mainly bacteria and fungi) that do all the work for you.
- Food for the decomposers The organic materials to be composted
- The right amount of air, water, and warmth to keep the work crew happy

Where do the decomposers come from?

If you build it, they will come…

- Soil
- Leaves
- Food scraps
- Manure, and
- Finished compost

Each of these will add microorganisms to the compost pile

One teaspoon of good garden soil to which compost has been added contains

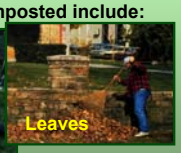
- 100 million bacteria
- 800 feet of fungal threads

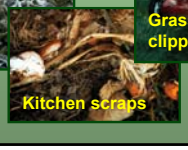
Numerous additives and starters are available but are not needed for good or rapid composting

What is the best food for your decomposers?

All organic materials will compost, but not all should be added to a backyard compost pile

Organic wastes that should be composted include:





Also
- Used potting soil
- Manure
- Sawdust
- Hair

Materials to avoid…

Avoid organic materials that could cause problems during or after composting
- Oil, fat, grease, meat, fish or dairy products, unwashed egg shells (tend to attract pests, vermin)
- Hard to kill weeds (bindweed, bermudagrass, nutsedge) and weeds that have gone to seed (could infest garden area when compost is used).

Materials to avoid…

Cat or dog waste
(attracts pests, could spread disease)

Diseased or insect ridden plants
(could infect or attack garden plants when compost is used)

Materials to avoid…

- Lime (increases compost pH and promotes ammonia odor problems)
- Wood ash, add sparingly to the pile (will add some potash to compost but will increase pH and ammonia odor problems)

Is shredding necessary?

Have greater surface area per unit volume

Allows microbes to get at more of the food

Chipping or shredding coarse materials (twigs, stems) will speed up the rate at which they decompose

Is shredding necessary?

but…

Smaller particles will also decrease airflow into the pile
- May lead to anaerobic conditions
- Pile may need to be turned more often

More about food for your decomposers

Your compost workers will thrive if you give them a balanced diet.

- Composting will be most rapid if the decomposers are fed a mix of carbon-rich and nitrogen-rich materials.
- Carbon-rich organic wastes are known as "browns"
- Nitrogen-rich organic wastes are known as "greens"

Browns

High carbon materials such as

- Leaves (30-80:1)
- Straw (40-100:1)
- Paper (150-200:1)
- Sawdust (100-500:1)
- Animal bedding mixed with manure (30-80:1)

Greens

High nitrogen materials such as

- Vegetable scraps (12-20:1)
- Coffee grounds (20:1)
- Grass clippings (12-25:1)
- Manure
  - Cow (20:1)
  - Horse (25:1)
  - Poultry (10:1), with litter (13-18:1)
  - Hog (5-7:1)

Browns	Greens
• Decay very slowly	• Decay rapidly
• Coarse browns can keep pile aerated	• Poor aeration – may have foul odors if composted alone
• Tend to accumulate in the fall	• Tend to accumulate in spring and summer
• Tie up nitrogen in soil if not fully composted	• Supply nitrogen for composting
• May need to stockpile until can mix with greens	• Best composting if mixed with browns

C:N ratio for best composting – 10:1 to 20:1

Building the Compost Pile

- Start with a layer of browns on the bottom
- Layer browns and greens – equal amounts will approximate the proper C:N ratio
- Leave a depression in the top of the pile

Browns and Greens!

Aerobic composting

- Composting with decomposers that need air (oxygen)
- The fastest way to make high quality compost
- Produces no foul odors
- Aerobic decomposers produce heat

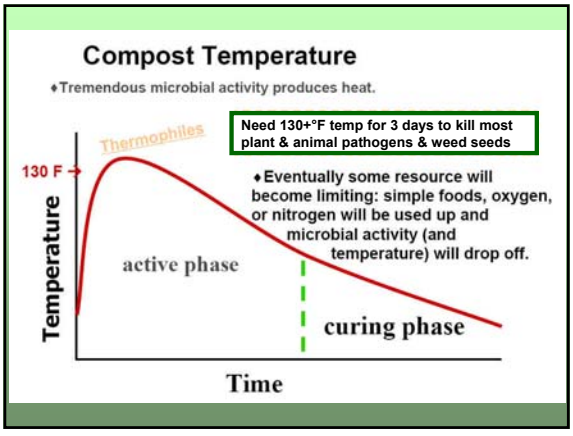
Heat is Generated During Aerobic Composting

Aerobic composting and temperature

- Active composting occurs in the temperature range of 55°F to 155°F
- Pile temperature may increase above 140°F but this is too hot for most bacteria and decomposition will slow until temperature decreases again.
- A thermometer is a nice tool but is not essential for good composting

Does my compost pile have to get hot?

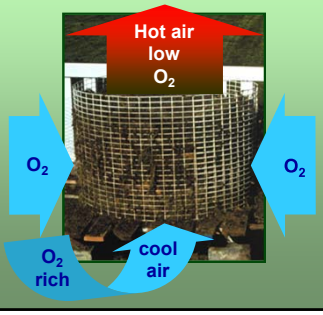
- Good compost can be made in a pile that never gets hot, but…
  - Decay will be slower and it will take longer to make compost
  - Not enough air, to little or too much water, or too many browns in the mix could all keep a pile from heating.
- High pile temperature provides the benefits of
  - The most rapid composting
  - Killing pathogenic (disease-causing) organisms
  - Killing weed seeds



Getting air to your decomposers

Warm air rising through the pile draws fresh air in from bottom and sides

Wind can stimulate aeration

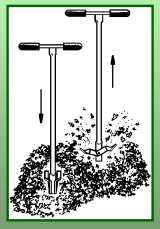


Pile aeration
Depends upon adequate porosity

- Porosity is the air-filled space between particles
- "Browns" help to maintain good porosity in the pile
- A compacted pile has lost porosity; can be increased by turning
- Aeration can be increased by inserting sticks, cornstalks, or perforated pipes into or under the pile

Pile aeration
Getting air to your work force

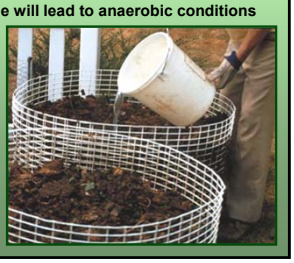
- Turning the pile mixes fresh air into the pile



- Turning tools can make the job easier

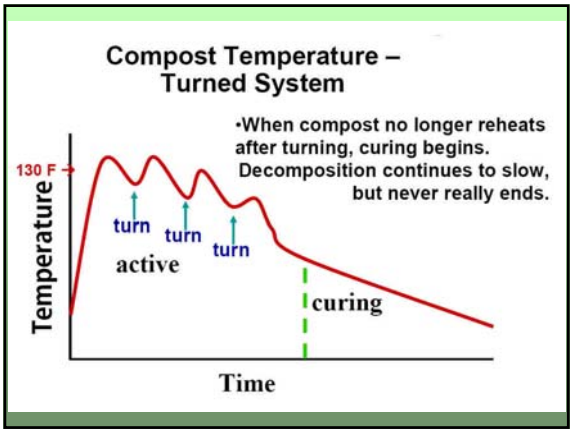
Water

- Rapid decomposition requires optimum water content
  - If too dry, bacterial activity will slow or cease
  - If too wet, loss of air in the pile will lead to anaerobic conditions
- Pile water content should be at 40-60%
- As wet as a wrung-out sponge
- If too dry, add water as you turn the pile
- If too wet, add browns and/or turn the pile



Taking care of your compost pile

- The most rapid composting is achieved by
  - Adding mixed browns + greens
  - Regularly turning (mixing) the compost pile
  - Controlling water content
- When pile no longer heats after mixing, allow it to cure (stand without mixing) for at least 4 weeks before using the compost



Making compost the fast way (Instructions for active composters)

- Turn the pile every 5 to 7 days,
  - move outer material to the pile center
  - add water if needed
- During the first few weeks, temp should reach 140°F
- After about 4 weeks, less heat will be produced and compost will maintain lower temp (100°F)

Making compost the fast way (Instructions for active composters)

- After about 4 more weeks, the pile will no longer heat after turning and volume will be about one third of original.
- Allow the pile to cure (stand without turning) for 4 more weeks before using the compost

When is compost finished?

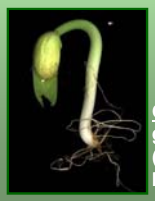
Compost is mature when

- The color is dark brown
- It is crumbly, loose, and humus-like
- It has an earthy smell
- It contains no readily recognizable feedstock
- The pile has shrunk to about 1/3 of its original volume

Sift out oversized pieces for more composting

Simple tests for finished compost

Bag test: sealing compost in a plastic bag for several days should produce no foul odor



Germination test: will seeds germinate in the compost? (good test to use if compost will be part of a potting mix)

Where should I put my compost pile?

- Shaded area will help prevent drying out in summer
- Avoid areas that will interfere with lawn and garden activities
- Adequate work area around the pile
- Area for storage
- Water available

Considerations for locating the compost pile

- Good drainage
- Away from any wells
- Near where finished compost will be used
- Be a good neighbor
  - Make your composting area attractive, or
  - Keep it out of your neighbors' view

Composting options

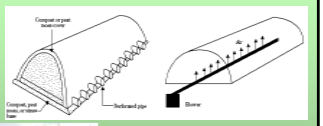
- Pile
- One-bin
- Multi-bin
- Wire collector
- Tumbler
- Trench

Pile composting

- Passive
  - Most inexpensive
  - Minimal management
  - Inconsistent results

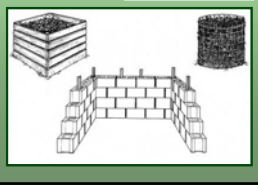
Pile composting

- Aerated
  - Scaleable
  - Turned every 1-14 days
  - Can be expensive



Bin construction

- Ideal size is approximately a 3-foot cube
  - Promotes good air movement
  - Retains sufficient heat to maintain warm temps
  - Piles larger than 5 x 5 x 5 feet are difficult to turn and tend to become anaerobic in the center



One-bin composter

- Most popular
- Inexpensive
- Easily movable
- Has a lid
- Some have bottoms
- Is scavenger-resistant
- Holds heat well
- Easy to access finished product
- Often made of recycled plastic

The Earth Machine Bin

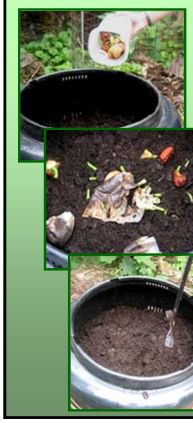


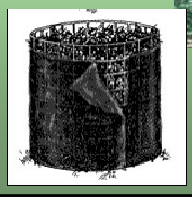
Photo credit: www.earthmachine.com/

Multi-bin composter

- For households with significant waste
- Move materials between bins as batches finish
- For the "serious" composter

Wire collector composter

- Quick to build
- Inexpensive
- Little heating takes place
- Susceptible to scavengers
- Can be covered with lid
- Easy to access – remove the wire!



Tumbler composter

- Small
- Can be expensive
- Very fast – 3 weeks!
- Many choices

Photo credit: www.envirocyclesystems.com

Homemade tumbler composter

Trench composting

- Dig trench or hole ~ 1 ft deep
- Add wastes + garden soil
- Cover with soil
- Easy
- Protects from pests
- Improves garden soil

Compost troubleshooting
Odors

Odors are one of the most frequent but easily avoidable composting problems.

- Rotten odor
  - Putrid smell or rotten egg smell
  - Usually results from anaerobic conditions
  - Excess moisture, compaction
  - Turn pile, add dry porous material (browns), cover kitchen scraps
- Ammonia odor
  - Too much nitrogen (greens)
  - Add high carbon material (browns), turn pile

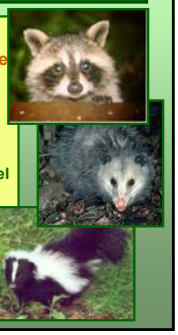
Compost troubleshooting
Temperature

Low pile temperature
- Pile too small, cold weather, too dry, poor aeration, or lacks nitrogen
- Make pile bigger or insulate sides, add water, turn the pile, add greens or manure

High pile temperature
- Pile too large, insufficient ventilation
- Reduce pile size, turn

Compost troubleshooting

Pests: raccoons, rats, insects
- Presence of meat scraps or fatty food waste rotten odors
- Remove meats and fatty foods, cover with sawdust or leaves, turn the pile
- Compost in an animal-proof bin
  - Covered bin, trash can bin, cone bin, or barrel bin
  - Wire mesh sides and floor (1/4 – 1/2 in openings)
- Use worm composting (vermicomposting) for food scraps



Using finished compost

- Soil amendment
  - Be sure that compost is mature, has an earthy smell (no ammonia or rotten smell), looks dark and crumbly with no recognizable feedstock
  - Compost improves soil health when mixed in the top 4 to 6 inches (work in no more than a 2" layer of compost)
    - Will improve water and nutrient retention of sandy soils
    - Will loosen compacted clay soils and make them more friable

Using finished compost

- Lawn topdressing
  - Be sure compost is very mature to avoid harming the lawn
  - Use fine (screened) compost, ¼" depth raked over lawn
  - Best if lawn is cored before applying compost
  - Retains moisture, supplies slow release nutrients, prevents soil compaction
- Potting mix
  - Compost must be very mature to avoid injury to plants
  - Use fine-textured compost
  - Mix no more than 1/3 compost by volume

Vermicomposting

- Harness the digestive power of worms
- Useful for year-round composting of kitchen waste
- Can be done indoors
- What do you need?
  - a container
  - bedding
  - water
  - worms
  - nonfatty kitchen scraps

Vermicomposting

- The container
  - 8-12" deep
  - 1 sq ft per pound of kitchen waste/week
  - Adequate drainage is needed
  - Provide a lid to conserve moisture
  - Provide darkness
  - Place over a pan or tray to catch leachate

Vermicomposting

- The bedding
  - Shredded paper is often used
- Moisten bedding before placing the container; fill container 2/3 full
- Keep bedding moist with mist if needed

Vermicomposting

- The worms
  - Use redworms (*Eisenia foetida*)
  - Best to purchase healthy worms from a supplier
  - Redworms prefer temperatures between 55 and 77 degrees Fahrenheit
  - One pound of redworms will easily take care of each half-pound of scraps produced per day

Vermicomposting

- Harvesting worm castings
  - Use a light to drive worms to the bottom of bin, and remove castings from top with sieve
  - Move worms/castings to the side, add fresh bedding and food, and sieve castings

Bokashi Composting

- **"fermented organic matter"**
- **Two stage process**
  - **anaerobic fermentation in a closed container with Effective Microorganisms (Bokashi Mix) added.**
  - **aerobic decomposition in the soil or in compost pile.**
- **Useful way to compost kitchen scraps and other materials**
- **Do inside or outside**
- **Can use meat scraps, cheese, bones**

Bokashi Composting

- **Use a Bokashi host medium - a mixture of Effective Microorganisms (EM), wheat bran and molasses**
- **1 tbsp per cup of scraps is usual**

Bokashi Composting

- Stage 1
  - Use a container with a lid that excludes air
  - Mix the host medium with food scraps and press out any air
  - Remove leachate as needed
  - This stage takes 2-3 weeks

Bokashi Composting

- Stage 2
  - Stage 1 anaerobic fermentation produces a mixture of lactic acid, yeast, and phototrophic bacteria, along with "pickled" organic matter. Bury this in the soil or add to a compost heap

Compost Tea

- The liquid portion of compost soaked ("steeped") in water
  - Use high quality compost
  - Use non-chlorinated water

Compost Tea

- Non-aerated tea
  - 1 part compost, 3-10 parts water
  - Occasional stirring
  - 1-3 weeks

Compost Tea

- Aerated tea
  - 1 part compost, 10-50 parts water
  - Air injection or constant circulation for 6-24 hours
  - Often made with additives (molasses, yeast extract, algal powder, kelp) to increase microbial biomass

Benefits of Compost Tea

- Foliar fertilizer – inconsistent results
- Soil fertilizer – yes and no
- Disease suppression – yes and no
  - Foliar
  - Soil-borne
- Residue decomposition - maybe
- Enhanced soil biology - perhaps

NOP Compost Tea Task Force Recommendations (April, 2004)

- Use drinkable water
- Sanitize equipment before use
- Use NOP-compliant compost (both plant and manure-based composts)
- No restriction:
  - Compost tea without additives
  - Compost extract (steeped for < 1 hr)
  - Compost tea with additives IF production system (compost + additives + equipment) makes tea that meets EPA water quality guidelines for E. coli and enterococci in two pre-tests
- 90/120 day pre-harvest restriction:
  - Untested compost tea with additives
  - Soil applications of raw manure extract/tea or compost leachate
- Prohibited:
  - Foliar applications of raw manure extract/tea or compost leachate
  - Use of compost teas for edible sprout production

Soil Amendments

- A soil amendment is any material added to a soil to improve its physical properties (water retention, permeability, water infiltration, drainage, aeration and structure); chemical properties (nutrients, pH) and biological activity. The goal is to provide a better environment for roots.
- Considerations
  - how long the amendment will last in the soil
  - soil texture
  - soil salinity and plant sensitivities to salts
  - salt content and pH of the amendment

Green Manures

- Green manure crops
  - Crops that are grown and incorporated into the soil to improve soil fertility
  - Protection
  - Used for winter growth or in rotation
  - Nutrient (nitrogen) scavengers
  - Plow early in spring so it won't steal moisture or nutrients
  - Cover completely for decomposition

Animal Manures

- What does manure supply?
  - Nutrients: N, P, K, secondary and micronutrients
  - Organic matter
- Nitrogen availability
  - about 30% to 50% of the organic nitrogen becomes available the first year.
  - Thereafter, the amount gradually decreases; 25% the second year
  - 12.5% the third year, and so forth.
- How much to apply? – depends on the plant needs
- Apply in advance of plant needs
- Fresh manure poses food safety issues

Animal Manures

- What affects the amount of nutrients in manure?
  - Type of animal.
  - Type and amount of bedding used.
  - Manure moisture content.
  - Time and method of storage.
- Don't use dog or cat manure

Table 1. Nutrient content of manures commonly used in Kentucky. (All values on an "as-is" moisture basis.)

		N	P_2O_5	K_2O	Moisture (%)
Solid Manures (lb/ton)					
Beef		11	7	10	80
Dairy		11	9	12	80
Swine		9	9	8	82
Broiler	(fresh)	55	55	45	20
	(stockpiled)	40	80	35	20
	(cake)	60	70	40	30
	(pullet)	40	68	40	25
	(breeder)	35	55	30	40
Layer		30	40	30	40
Liquid Manures (lb/1,000 gal)					
Holding Pit	Swine	36	27	22	96
	Dairy	31	15	19	94
Lagoon	Swine	4	2	4	99
	Dairy	4	2	3	98

Worm Castings

- Worm castings have excellent aeration, porosity, structure, drainage, and moisture-holding capacity; use as a growth medium
- Good source of plant nutrients

Sphagnum Peat Moss, Coir

- Absorbs water up to 20 times its dry weight; the absorbed water is then slowly released to plant roots.
- Aerates and lightens heavier soils such as clay.
- Adds mass to sandy soils to reduce the leaching of nutrients.
- Is peat harvest sustainable?

Compost

- Plant based compost
  - Generally safe to use
  - Often more expensive
- Animal based compost
  - Can be high in salts
  - Microbial contamination issues if not completely composted
  - Herbicide contamination issues
- Mushroom compost
  - Can be high in salts
- One cubic yard of compost will cover about 100 square feet of garden to a depth of about 2 inches.

Biochar

- A charcoal byproduct created by burning woody products at slow and low heat in the absence of air
- Biochar can increase soil retention of nutrients
- Biochar can help to improve water quality by causing more nutrients to stay in the soil instead of leaching into groundwater or surface waters.
- Biochar is of interest as a way to sequester carbon in the soil
- Characteristics of biochar vary with the source organic matter
- Discussion on best rates

Wood Ash

- A byproduct created by burning woody products
- Good source of potash; 3-10%K
- Can rapidly raise soil pH; don't apply to high pH soils (> 6.5)
- 20 pounds per 1000 square feet usual rate; soil test regularly

Lime and Sulfur

- Useful to modify soil pH (lime to raise, sulfur to lower) into best range
- Apply based on a soil test
- Available in powder or pelletized form

Amendments In Summary

- Soil test every 2-3 years to monitor progress
- Build soil organic matter with regular additions of organic amendments
- Reduce or eliminate tillage
- Keep the soil covered
- Plant cover crops between crop cycles

Reading List

- **Teaming with Microbes** by Lowenfels and Lewis
- **Soil Biology Primer** by Elaine Ingham
- **Holistic Management** by Allan Savory
- **The One Straw Revolution** by Masanobu Fukuoka
- **The Worst Hard Times** by Timothy Egan
- **Collapse** by Jared Diamond
- **Dirt-The Erosion of Civilization** by David Montgomery

Composting Resources

- **G6956 Making and Using Compost**
  extension.missouri.edu/p/G6956
  G6957 How to Build a Compost Bin
  extension.missouri.edu/publications/DisplayPub.aspx?P=G6957
- **G6958 Grass Clippings, Compost and Mulch: FAQs**
  extension.missouri.edu/p/G6958
  Compost Analysis (MU Extension)
  soilplantlab.missouri.edu/soil/compost.aspx
- **Worm Composting (MO Dept. of Natural Resources)**
  www.dnr.mo.gov/env/swmp/worms/wormlist.htm
- **MP906 Community Gardening Toolkit (MU Extension)**
  extension.missouri.edu/p/MP906
  Webster County Extension Center
  extension.missouri.edu/webster

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For More Information

UNIVERSITY OF MISSOURI Extension

Webster County Extension Center
800 S. Marshall St.
Marshfield, MO 65706
Voice: 417-859-2044
Fax: 417-468-2086
E-mail: schultheisr@missouri.edu
byerspl@Missouri.edu
Web: extension.missouri.edu/webster

Portions of this presentation adapted from information provided by:
- Penn State Cooperative Extension and PA DEP
- Bob Neier, KSU Extension horticulture agent

Program Complaint Information
To file a program complaint you may contact any of the following:

University of Missouri
- **MU Extension AA/EEO Office**
  109 F. Whitten Hall, Columbia, MO 65211
- **MU Human Resources Office**
  130 Heinkel Bldg, Columbia, MO 65211

USDA
- **Office of Civil Rights, Director**
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-9410

"Equal opportunity is and shall be provided to all participants in Extension programs and activities, and for all employees and applicants for employment on the basis of their demonstrated ability and competence without discrimination on the basis of their race, color, religion, sex, sexual orientation, national origin, age, disability, or status as a Vietnam-era veteran. This policy shall not be interpreted in such a manner as to violate the legal rights of religious organizations or military organizations associated with the armed forces of the United States of America."

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