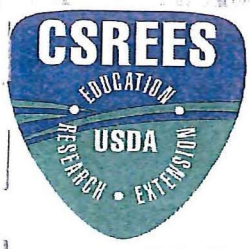
Animal Waste Management Systems Workshop

March 1, 2008

Department of Agriculture Dededo Breeding Station



Deep-Litter Hog Pen

&

Composting

UNIVERSITY OF GUAM NF 08-02
GUAM COOPERATIVE EXTENSION NEW FARMER PUBLICATION

Portable Deep Litter Hog Pens

Mark Acosta, Extension Associate, Mike Morta and JoAnna Delfin, Extension Assistants, L. Robert Barber, Extension Agricultural Economist

The portable hog pen was designed to help island communities by promoting the beneficial uses of pig manure while protecting our limited water resources from these potential waste products. This animal waste management system can be used by both farmers and home gardeners/subsistence producers alike. It is a very low-cost way to begin hog production.

What is a Portable Deep Litter Hog Pen?

A portable hog pen is a bottomless pen that is filled with dry litter such as, dried grass, leaves, palm fronds and other high carbon content materials. The design of the pen must be strong enough to keep the hogs from escaping, yet light enough to move all with an eye to keeping the costs down. The actual design is dependent on availability of materials. Two common products on our island which meet these criteria are canopies and chain link fencing.

Waste in a Portable Deep Litter Hog Pen:

Serious contamination of ground and surface water by hog production systems can be prevented by reducing the amount of run-off and leaching associated with nutrients from pig waste. Portable hog pens are designed to protect our limited island water resources by capturing and utilizing these waste materials.

Adding dry-litter (carbon materials) such as dried leaves and grass aids in the absorption of liquid hog waste. The hogs' in the pen results in their hooves breaking down their solid waste and mixing it with the dry-litter. As dry-litter is added every few days the litter absorbs the liquid waste and mixes and blends with the dry waste below with a clean layer of dry litter on top thus, keeping the hogs in a relatively clean environment. Leaching into the ground water is prevented by the absorption of waste liquids and the prevention of (rain or cleaning) water from carrying the waste out of the pen. A significant benefit to the producer and his/her neighbors is the reduction in odor from the hog wastes due to its dry nature.

Advantages of Deep Litter Portable Pens:

- Dramatically reduces odor
- Conserves Water - No pen wash-down or discharge of effluent
- Low levels of labor/management to operate
- Small land area required
- Low capital and operating costs
- Organic fertilizer by-product compost

Disadvantages of Deep Litter Portable Pens:

- Requires a consistent supply of carbon materials
- May be only applicable for small scale operations
- Requires relocation every 1-3 months
- Difficult to use on steep or rough terrain

Composting the Litter

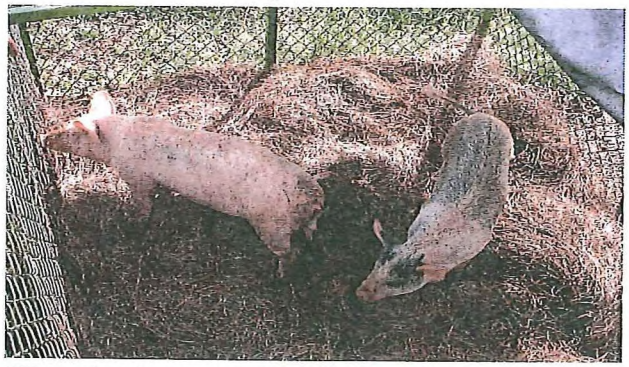
Composting is a key component in the Portable Deep Litter Hog Pen's waste management system. After one to three months or so in on location the pen is moved and the litter material is composted. Composting serves two purposes in the system. First it breaks down the manure and high carbon litter material, providing a high nutrient soil amendment. Second the high temperature of a correctly managed compost pile will kill bacteria and other potential pathogens in the hog waste. For information on

 Funding for this publication was provided by USDA WSARE Cooperative Agreement Number: 2003-47001-01599 and USDA-NRCS Conservation Innovation Grant #63-3A75-5-172. 2006. Dr. Lee S. Yudin Director UOG-CES

composting systems contact your local Cooperative Extension Office, Department of Agriculture or the USDA Natural Resource Conservation

Choosing a Location:
Site selection must be taken into consideration before using a portable hog pen. The location should be level and ideally in a shaded area for hog protection. It should be located in a place where the dry-litter and composting bins are easily accessible. It is important that the hog pen be at least 50 feet away from rivers or flowing water.

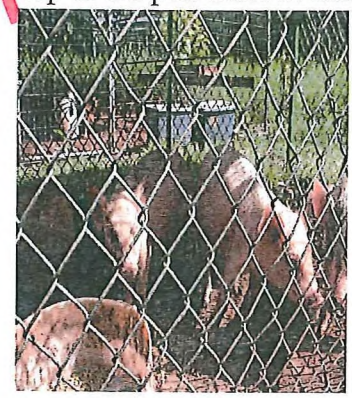
Hogs in the Pen:
After the hogs have been situated in the portable deep litter pens, they will need shade, water, and feed. One of the reasons for selecting the canopy pen was that it is an inexpensive way to provide shade for the hogs. Another reason for this system is to keep the dry litter from getting wet.



Water is given to the hogs by an automated watering system. This system provides clean and potable drinking water to the hogs at all times. It is also important, because the water is on-demand and does not saturate the dry litter. This form of watering reduces the amount of contamination of the drinking water from surrounding manure, urine, and soil.

55 Gallon Drum with valve On-demand Water Nipple

Feeders for the pens should be mounted onto the cyclone fence and above the ground. Conventional methods of feeders are cut barrels or trays. However, these types of feeder may become contaminated similar to the water. Mounted troughs are ideal for the portable deep litter hog pens because the feeder is elevated, just enough for the hogs to feed and not get into and contaminate the food. The troughs have an opening on the top, making feeding less labor intensive. The feed can be poured directly from the top of the pen without entering.



Cut barrel feeders

Mounted trough

If you have questions/concerns, please contact your local Cooperative Extension Service at (671) 735-2080, Natural Resources Conservation Services at (671) 472-7569, or Department of Agriculture at (671) 735-3942.

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Portable Dry-Litter Hog Pens

Prepared by:
Mark Acosta & L. Robert Barber
For:
Guam Cooperative Extension Service
&
Guam Department of Agriculture

Animal Waste Management Systems Workshop
March 1, 2008

Dept. of Agriculture, Dededo Breeding Facility

Dry-Litter Hog Pen

- Designed to help island communities
- Promotes beneficial uses of pig manure
- Protects our island resources.
- Can be used by farmers and home gardeners/subsistence producers.

What is a Portable Deep-Litter Hog Pen

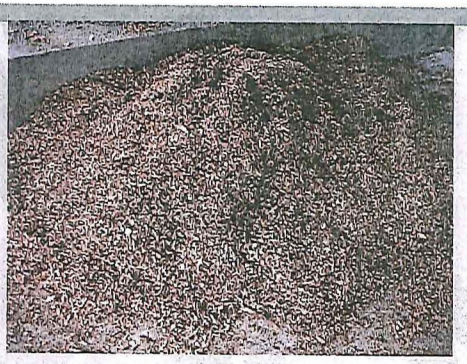
- A bottomless pen that is filled with dry litter
- Must be strong enough to keep the hogs from escaping; The actual design is dependent on availability of materials.

Waste in a Portable Deep Litter Hog Pen:

- Serious contamination of ground and surface water
- The pens are designed to protect our island's limited water resources

Adding Dry-Litter

- Adding dry-litter (carbon materials) such as dried leaves and grass aids in the absorption of liquid hog waste.
- The hogs' in the pen use their hooves to break down solid waste.
- Dry-litter is added every few days the and the litter absorbs the liquid waste.
- Leaching is prevented by the absorption of waste liquids.



Advantages

- Dramatically reduces odor
- Conserves Water
- Low levels of labor/management to operate
- Small land area required
- Low capital and operating costs
- Method of weed control
- Organic fertilizer by-product compost

Disadvantages

- Consistent supply of carbon materials
- Only applicable for small scale operations
- Requires relocation every 1-3 months
- Difficult to use on steep or rough terrain

Composting

- Key component in the Portable Deep Litter Hog Pen's waste management system.
- After one to three months or so in on location the pen is moved and the litter material is composted.
- Composting serves two purposes in the system.
  - Breaks down carbon material.
  - Kills bacteria and other potential pathogens in the hog waste.

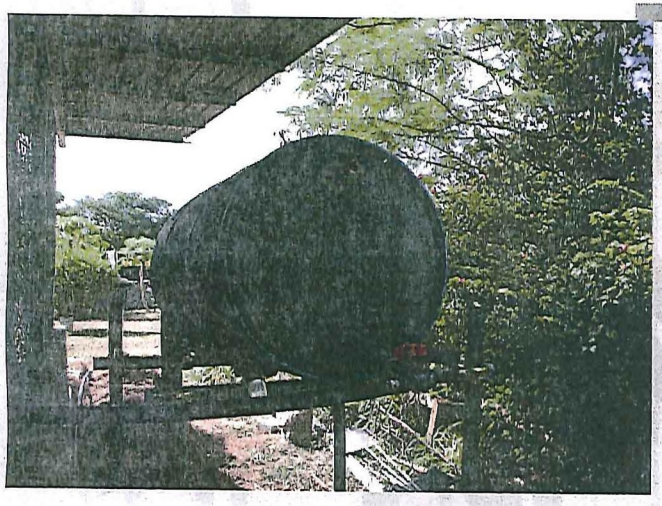
Choosing a Location:

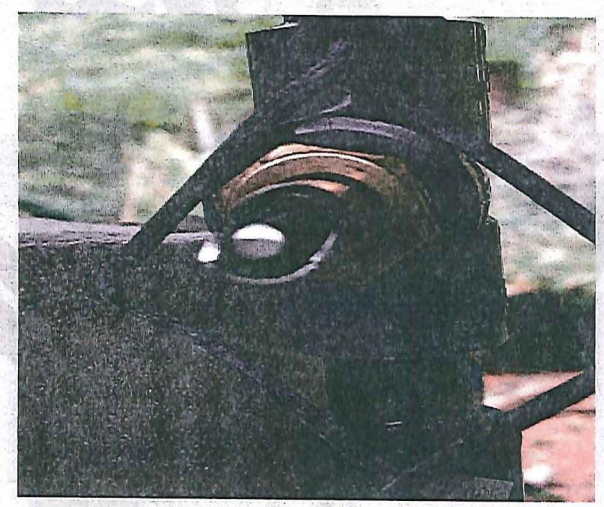
- The location should be level
- Ideally in a shaded area.
- Easy access to dry-litter.
- Be at least 50 feet away from rivers or flowing water.

Hogs in the Pen

- Hogs need shade, water, and feed.
- Using the canopy for the pen is an inexpensive way to provide shade.
- Keep the dry litter from getting wet.

Water for the Hogs

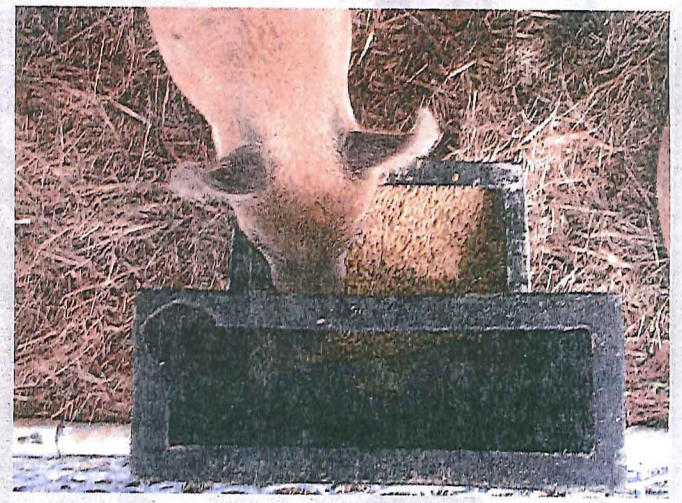




- Automated watering system
- This system provides clean and potable drinking water
- Water is on-demand
- Reduces the amount of contamination

Feeding the Hogs

- Mounted onto the cyclone fence and above the ground
- Cut barrels or trays
- Mounted troughs are ideal
- Openings on the top of the trough is less-labor intensive and prevents contamination



UNIVERSITY OF GUAM NF 08-03

Constructing Portable Deep Litter Hog Pens

GUAM COOPERATIVE EXTENSION NEW FARMER PUBLICATION

Mark Acosta, Extension Associate, Mike Morta and JoAnna Delfin, Extension Assistants, L. Robert Barber, Extension Agricultural Economist

Constructing the Pen: This publication describes Before you begin construction on your hog pen first be sure to have on hand the tools that you anticipate needing to build the pen.

Tools
Pipe cutter or chopsaw
Pliers and wire cutter
Tape Measure
Wrench Set
Bolt cutter or Hacksaw

The material list includes:

No.	Item	Price
1	1 5/8" 8x10 Canopy Set	$125.00
4	1 5/8" Slip Tee Fittings	$12.00
4 8	1 5/8 " 4 way 90 degree corner fittings or 1 5/8" Rail end clamps	$12.00
6	10 foot 1 5/8" pipes	
6	1 5/8" tension bands	$1.00
2	4' Tension bars	$3.00
1	50' roll, 4' Cyclone Fencing	$125.00
1	Package of Steel Fencing Ties	$16.50

Door

No.	Item	Price
2	2 foot long 1 5/8" pipe	$5.00
2	4 foot long 1 5/8" pipe	$10.00
4	1 5/8" rail end clamps	$2.00
2	4' tension bars	$3.00
6	1 5/8" tension bands	$1.00
2	1 5/8" male door hinges	$2.00
2	1 5/8" female door hinges	$3.00
1	1 5/8" door lock clasp	$7.00

***Prices given are only an estimate and may vary**

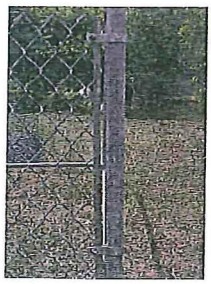
Construction Steps:

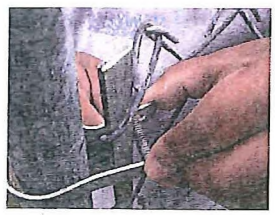
Hog Pen

1. Assemble 8' X 10' canopy with slip-tees on each 10' pipe
2. Assemble base fittings using either corner fittings or rail end clamps with slip-tees on each 10' pipe

3. Add additional pipes into both slip-tees
4. Cut 2 tension bars with bolt cutter or hacksaw into 4' pieces

5. Run one tension bar through cyclone fence
6. Place three tension bands on the top, middle, and bottom of the corner pipe adjacent to the door.
7. Tighten tension bar and bands together with nuts and bolts





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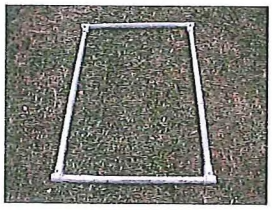
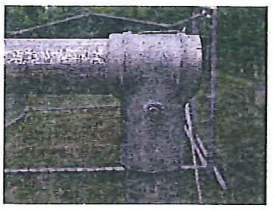
8. Wrap and tie cyclone fence to each pipe until the fence reaches the opposite adjacent side of the door.
9. Cut cyclone fence and repeat steps 5-7.
10. Secure canopy tarp with bungee cords.

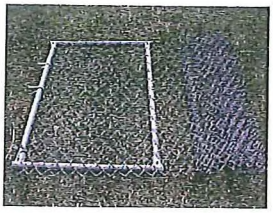
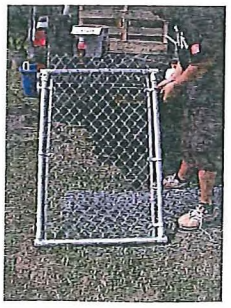

Hog Pen Door:

1. Cut two 2'and 4' pipes
2. Connect pipes with rail end clamps

3. Tighten each corner with nuts and bolts
4. Cut two tension bars with bolt cutter or hacksaw into 4' pieces


5. Cut cyclone fence to fit door
6. Run each tension bar through left and right side of the fence

7. Place three tension bands on the top, middle, and bottom of both corner pipes
8. Tighten tension bar ands together with nuts and bolts


9. Place hinges onto one side of the door and secure onto frame with nuts and bolts
10. Place door lock on opposite side of the door and secure with nuts and bolts




If you have questions or concerns, please contact your local Cooperative Extension Agent at (671) 735-2080.

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Cooperative Extension Service
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Animal Waste Management
April 2004
AWM-2

A Portable Dry-Litter Pig Pen

Glen Fukumoto[1] and Jim Wimberly[2]
[1]Department of Human Nutrition, Food and Animal Sciences; [2](formerly) Foundation for Organic Resources Management

Water, too often taken for granted, is of critical importance in island ecosystems. Water bodies, such as streams and coastal ocean areas, as well as underground drinking water sources, need to be protected from the many pressures and contaminations created by increasing human and livestock populations. The goal of the small-scale swine waste management system described here is to help island communities by developing beneficial uses of pig manure while protecting water resources from being polluted by the nutrients in pig wastes that may run off or leach from pig pens. The system is applicable for backyard or small-farm pig husbandry, where allowable under local zoning regulations, in Hawaii and other regions of the Pacific.

This portable dry-litter (PDL) pen system was introduced by the authors in American Samoa in 2002. It is easy to install, and it helps recycle plant residues by transforming them into nutrient-rich compost. The pigs are provided a bedding of compostable material such as yard trimmings, crop residues, or shredded municipal green-waste from tree trimming. The bedding helps to absorb pig waste liquids, while the action of the pigs' hooves and rooting helps to break down the solid pig waste and mix it with the bedding. No wash water is used. Bedding material is added on a regular basis to keep the animals in a relatively clean environment. For each pen cycle of 4–6 months, up to four animals may be raised until the desired market or slaughter weight is achieved. After each cycle, the pen is moved to a new site, and the process can start again.

This pen system was developed using materials that were available from hardware suppliers in American Samoa. The rigid, galvanized fence panels used are products of the Behlen Manufacturing Co., Columbus, Nebraska, USA; they may not be availabile everywhere. Such panels are suggested because of their rigidity and durability, but other fencing materials may be substituted.

Materials and tools needed

- ☐ four 8-ft pen side fence panels*
- ☐ fencing for floor (8 ft x 8 ft)**
- ☐ four 6-ft T-posts
- ☐ one corrugated galvanized roof panel (10 ft long)
- ☐ one 2 x 4-inch piece of lumber (10 ft long)
- ☐ coil of tie wire
- ☐ post pounder
- ☐ drill and ¼-inch bit
- ☐ hacksaw or heavy-duty wire cutter
- ☐ pliers

*Behlen Mfg. Co. makes various sizes of fencing panels in 16-ft lengths. Panels for pig enclosures usually have the horizontal wires closer together at the bottom; Behlen markets a 42-inch "Combo" panel and a 34-inch "Hog" panel in this style. The panels shown in the photographs are 60-inch "Security" panels with a uniform mesh grid.

**The floor fencing does not need to be rigid or heavy gauge. Pigs usually stop rooting once they encounter a barrier, and the floor is designed to keep them from digging under the side panels and to prevent them from making depressions in the soil that might collect water. Light fencing materials (such as chicken-wire) used for the pen floor may need to be replaced with each pen cycle. Behlen markets a "Handy Panel" with a grid of about 6 x 8 inch mesh, which at 4 x 8 ft would be a convenient dimension; regular construction reinforcing wire used in poured concrete slabs will work as well.

Ideal location for a PDL pen

The location of a PDL pen is important from both an operations and management standpoint. Choose a site that is level and shaded so that the pigs are protected

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from the sun. If possible, the site should be close to or within the area from which the bedding materials are obtained and also where the compost will be applied. This makes it easier to collect the bedding materials and distribute the compost. Make sure the PDL pen site is set back far enough from any streams and well heads—normally 50 feet from streams and up to 1000 feet from wells (allowable set-back distances will vary according to local environmental protection regulations).

Building the pen

1. Use the hacksaw or wire cutter to cut the side-panel fencing to 8-ft lengths.
2. Lay the floor wire on the ground chosen for the pen site.
3. Drive the first T-post into the ground at one corner of the floor wire.
4. Attach one fence panel to the T-post with tie wire.
5. Determine the location of the next T-post, drive it, and attach the fence panel to it.
6. Repeat steps 4 and 5 for the remaining T-posts and fence panels.
7. Square up all four sides as you work with each panel; tying the floor wire to the side panels will add greater security from escape.
8. Drill holes near the ends of the 2x4 and wire it to the T-posts on one side of the pen.
9. Drill or punch holes in the corners of the roofing material; attach one edge to the 2x4 and tie the corners of the opposite side directly to the side panels. The roof provides shade and protection from rain.
9. Cover the entire pen floor with 6–8 inches of dry bedding material.
10. Access the pen through a corner opposite the roof.

How the PDL pen works

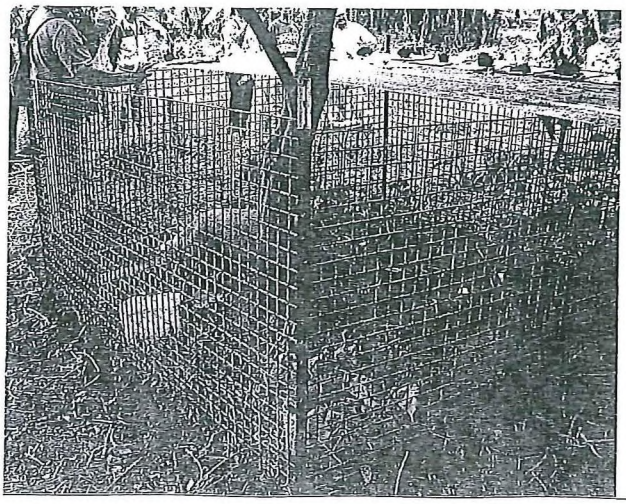
Once the pen is built and the bedding has been added, it is ready to house pigs. The 8-ft square pen area (64 square feet) will accommodate up to four weaned pigs, figuring on at least 15 square feet per pig. The pigs will root through the dry litter material looking for bugs and worms, but the wire floor will prevent them from digging themselves out of the pen and escaping. The wire base also helps to prevent the pigs from creating depressions in the soil that can collect water and breed mosquitoes.

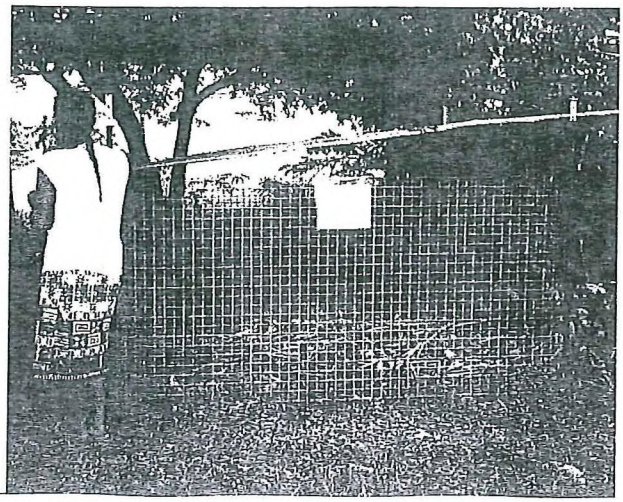
At least twice a week, add new, dry litter to the pen to cover any exposed pig manure. The pigs will use one corner or end of the pen as a dunging area rather than excreting wastes everywhere in the pen. Over time, as more dry litter is added, the material in the pen will build up, and the floor of the pen will rise. With the active stomping and rooting of normal pig behavior, the material becomes a mixture of pig waste and green-waste that will begin to compost.

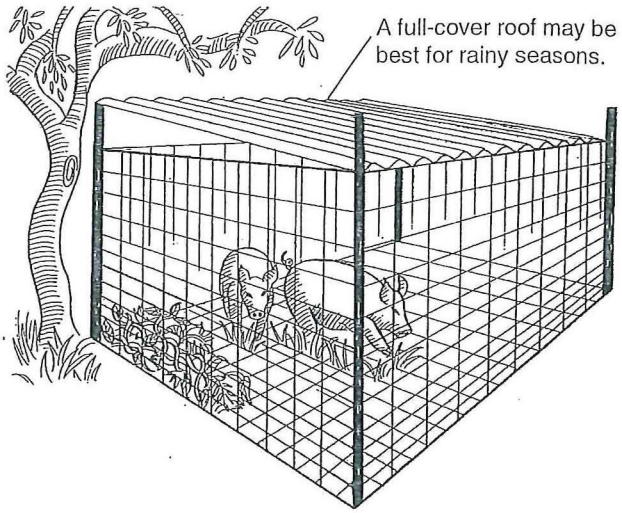
The PDL pen cycle

Pigs can be kept in the PDL pen for from 4 to 6 months. Once the pigs are slaughtered, the pen cycle is complete. The cycle should not be longer than six months. The pen should be moved, and the mixture of manure

Portable dry-litter pig pens in American Samoa.







and bedding material should be piled and composted.

The pen should be moved after each cycle to prevent concentration and build-up of nutrients from the waste in the soil beneath the pen. Moving the pen allows the site to recover.

To move the pen, remove the 2x4 and roofing material. Scoop out the manure and green-waste mixture to a nearby site prepared for composting. Move the wire base and place it in the new pen location.

If setting up the new pen just next to where it was previously, leave two posts and one side of the pen standing. Remove the other two T-posts and three fence panels. Set up the posts and panels on the opposite side of the standing fence panel. Reattach the 2x4 piece of lumber and roofing material. The pen has thus been moved to a new site and is ready to begin the next pen cycle. This system can be used in four-cycle rotations as shown in the diagram on page 4.

The manure and green-waste mixture

After completion of each pen cycle, the mixture of pig manure and green-waste is ready for composting. For details on the composting process, read CTAHR's publication HG-41, *Backyard Composting: Recycling a Natural Product* (see *References*). Following are some basic instructions.

The compost pile should be about as high as its diameter, but usually not more than 3–4 ft high. The pile should be protected from heavy rain and kept moist but not wet.

The interior of the pile should heat up to the point where it is uncomfortable to put your hand into it; this means the decomposition process is proceeding. As the interior of the pile cools, turn it with a spading fork, pitchfork, or shovel so that the parts on the outside are moved to the center of the pile; it should heat up again. Once the pile no longer heats up, the compost process has run out of "fuel."

"Finished" compost is brown and crumbly, and the plant materials that went into it should no longer be recognizable. If this is not the case, screen out the fine material to use as fertilizer and save the coarse material for the next compost cycle, or use it as mulch.

The finished compost is relatively free of disease pathogens if the pile got hot enough. Avoid adding fresh manure to the pile while it is composting, because this may add pathogens that will not be killed in the heating process. Finished compost can be used in the garden or crop field or sold to neighbors and other farmers.

See ADAP publication 2003-3, *Treatment, Storage and Use of Swine Waste Solids*, for ideas on composting swine waste solids. See CTAHR publication AWM-1, *Composted Animal Manures: Precautions and Processing*, for more information about animal waste management.

Benefits of the PDL pen system

Advantages of the PDL pen system include:

- uses no water for pen cleaning
- discharges no effluent from the pen when properly managed
- low construction cost compared to concrete, cinderblock, or wooden structures
- requires minimal effort or cost to operate and maintain
- produces a beneficial organic fertilizer byproduct to improve the soil and aid crop growth
- requires only a small land area
- reduces fly and mosquito breeding.

Considerations about the PDL pen system

Here are some things to keep in mind when using a PDL pen system to manage the solid and liquid swine wastes:

- You need a consistent supply of bedding material. A mixture of different materials is preferable. Do not use poisonous plants. Avoid adding weed seeds unless you know how to manage the composting process effectively so that seeds are killed.

- This system is best for small-scale operations.
- It requires relocation after each 4–6-month cycle.
- Flat land is best; it cannot be used on steep or rough terrain.
- It should not be placed over or near groundwater recharge areas (wells, streams, springs) or within a natural drainage area (ditch, stream channel).
- Composting is required to produce a fertilizer that can be used without "burning" sensitive crops.
- The composting process should reach temperatures between 130 and 155°F for a couple of weeks to destroy disease organisms in the manure, and weed seeds.
- Local regulations on sites, set-backs, and other guidelines for piggery operations should be followed.

Benefits of using compost include:

- increased soil fertility, aeration, and water-holding capacity
- increased soil organic matter content and microbial activity
- increased soil resistance to erosion
- suppressed levels of plant pathogens and soil nematodes.

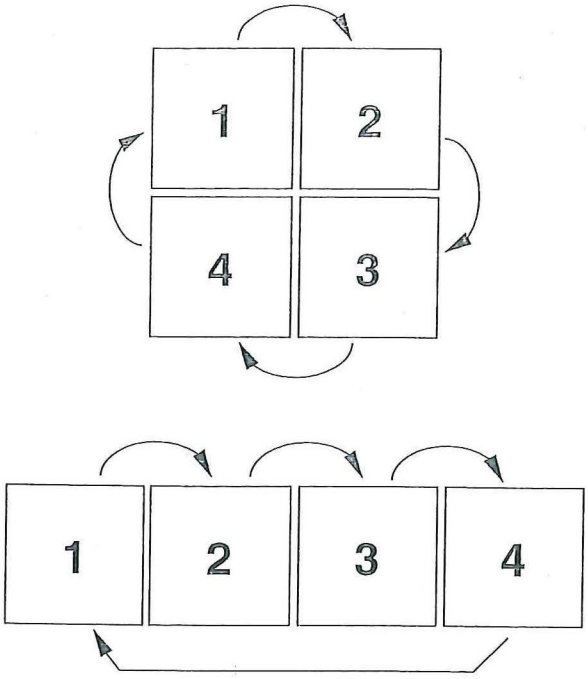
Summary

The portable dry-litter pen system is a practical option for small-scale piggery operations. It adapts the concept of the dry-litter waste management system developed for commercial swine operations in Hawaii, combining it with rotational grazing and cropping strategies and the goal of recycling through composting. The system is relatively inexpensive and adaptable to locations with limited land area. No water is used for pen cleaning, thus reducing the threat of pollution of groundwater supplies and surface water bodies.

Acknowledgment

Thanks to Carla D'Angelo for her artistic rendition of the PDL pen system and to Luisa Castro for content research and technical editing. Funds supporting this work were provided through the U.S. Department of Agriculture, Cooperative State Research, Education and Extension Service Grant 2001-51130-11413.

Two examples of a four-cycle PDL pen rotation.



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Applying knowledge to improve water quality

Southwest States & Pacific Islands Regional Water Program

A Partnership of USDA CSREES & Land Grant Colleges and Universities

Winter 2007
RWQ005

Small Scale Animal Waste Management

By Carl I. Evensen and Glen K. Fukumoto

Management of livestock wastes is a serious concern for the American-affiliated Pacific Islands due to limited land for disposal and the need to protect fragile environments from contamination by nutrients and pathogens. Most animal waste management practices in the continental US are not appropriate for the small scale and limited resources of Pacific Island farms.

Coordinated activities to solve these problems are supported by the Southwest States and Pacific Islands Regional Water Program. Our objectives are to protect stream, coastal and groundwater resources through promotion of waste management practices which are culturally acceptable and economically feasible. Water Quality Coordinators in each of the islands support research and extension to develop and promote promising practices.

Problems

Serious contamination of surface and groundwater with pig waste occurs throughout the American Pacific Islands. Often manures are discharged directly without treatment. These wastes can leach to groundwater on porous soils (such as in the Northern Marianas Islands) or contaminate streams through direct discharge.

Pig effluent discharge into a stream in American Samoa.

Portable Pen

An example of a practice being promoted is a portable dry-litter system which eliminates discharges into waterways and integrates composting. A pen is constructed of 8-foot lengths of fence panels, filled with about 6 inches of carbon-based bedding material, such as coconut husks or wood chips, and holds up to 4 weaned pigs for 4 to 6 months. New bedding is added weekly.

Portable dry litter pen.

Advantages

- No pen washdown or discharge of effluent
- Low level of management to operate
- Small "footprint" or land area required
- Low capital and operating costs
- Organic fertilizer by-product

Disadvantages

- Consistent supply of carbon materials is required
- Applicable only for very small scale operations
- Requires relocation every 6 months
- Cannot be used on steep or rough terrain
- Not recommended for use over groundwater recharge areas

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The Overstory #50

Animal Tractor Systems

Author:
Andy Lee

Contents:

Introduction

When planned and managed properly, animals can be key components in sustainable farming systems, enhancing important cycles of nature such as nutrient cycling and balancing of insect populations. A well-designed system with animals can also greatly reduce the human labor required to care for the animals and to prepare and maintain crop areas.

Animal tractor systems are a sustainable, cost-effective, and humane way to integrate animals into an agricultural system. Although the term "tractor" can be confusing, animal tractor systems do not involve draft animals.

Animal tractors are shelter-pen systems where animals such as chickens, turkeys, geese, ducks, pigs, or goats become integral parts of agricultural environments. In animal tractor systems, the animals are managed for productivity of eggs, milk, or meat. At the same time, the scratching, pecking, tilling, and manure spreading behavior of animals is used to prepare, clean, or maintain planting areas.

In this issue of The Overstory, special guest author Andy Lee shares his extensive personal experience working with animals including chickens, pigs, turkeys, and goats in effective animal tractor systems. He describes animal tractors for many purposes, including market garden operations, orchard settings, pond preparation, land clearing, and pasture improvement/diversification.

Animal Tractors

The key to creating an effective animal tractor system is to integrate the needs, behaviors, and products of the animals with the farm system as a whole. An animal tractor locates animals where its food is abundant, where the animal enjoys relative

freedom, and where the natural behaviors of the animal are put to best use. By having an animal in the right location, the need to be fed, watered, and cared for by humans is minimized.

Animal tractors bring into harmony the relationships between farmers, the agroecosystem, and animals. The animal provides a handy tillage tool with its continual scratching, pecking, or rooting behavior. It becomes a biomass recycler, consuming excess weeds, grasses, insects, etc. The manure returns to the earth as fertility for the crops.

Orchard maintenance

Animal tractor systems can be very effective for ground cover maintenance, and work well with orchard or tree crops. In an orchard animal tractor system, the animals are rotated through the orchard, either in movable pens or in a series of fixed paddocks. When at the proper density, the animals clean the area between and under the trees of grasses, weeds, and weed seeds, scavenge wastes and windfall fruits, and eat insects and their larvae. At the same time, the animals add their manure to help fertilize the crops. When the pen area has been cleared and fertilized by the animals, they are moved on to the next section of orchard.

With the appropriate combination of animals and crop trees, this system has been effective with chickens, guinea fowl, turkey, pheasant, quail, sheep, and pigs. On a healthy mixed diet from the orchard, animals tend to have less disease problems.

Lighter animals such as chickens or other poultry can be rotated permanently through an orchard system. More intensive animal tractor systems, for example with pigs, can be very useful in orchard establishment as well as for seasonal maintenance. The system can be further adapted to be more productive by mixing tree species that provide additional food for the animals; for example papaya, banana, and inga (ice cream bean).

Market gardens

Poultry such as chickens and turkeys are excellent for preparing and fertilizing garden areas. In such systems, the poultry are confined to an area in sufficient density to remove virtually all green matter, fallen fruit, insects, etc. When an area is grazed clean, the animals are moved to a fresh area.

In our case, we use turkeys to fertilize and prepare our market gardens. At the end of each garden season in the Fall we herd turkeys into our enclosed gardens to graze. They eat crop residue and weeds right down to bare ground in no time. Then we harvest the turkeys for the holidays and unroll round bales of hay to mulch the gardens for the winter. The following spring we transplant our garden crops right into the mulch.

To establish a new garden site we use a tractor-powered spading machine to work up the plot. In following years we rely solely upon the turkeys for clean up and fertilizing, and the mulch for soil stability and weed control. Underneath the mulch the soil stays wonderfully loose, sopping up rain and providing a great habitat for soil dwellers and plant roots. Our yields are always well above national averages, and our soil gets richer year by year.

Portable tractor systems are also very effective with chickens. For household production, 120 sq. foot (11 sq. meter) pasture pens are just fine for up to 30 layers or 80 broilers. On a commercial scale, such small pens are too costly and labor intensive for the number of birds each can house. We use a portable ranging system, where we house the birds at night and enclose them in a 1700 sq. foot (160 sq. meter) area during the day inside a portable electric netting. This way we can double or even triple the number of birds per shelter, and still be able to move them easily on a daily or weekly basis.

Preparing pasture

Removing deep rooted woody weeds requires the power of a pig tractor. A pig tractor works much the same as poultry tractors. Instead of scratching, it is the rooting behavior of the pigs which is used. Pig tractors can be used to prepare land for permanent tree

crops or rotated seasonally to clean up crop wastes or fallen fruits.

My father used pigs to root out a pasture in a cut over wood lot on our farm in Southwest Missouri. To encourage the pigs to root at the stumps, he dug holes around the roots of oak and hickory and filled them with shell corn. He then turned in the hogs.

In a few months the stumps were rooted out and the ground was completely churned up. After taking out the stumps, the bare ground was disc harrowed and planted to permanent pasture with scattered trees. The whole process took about a year, but the results were excellent. I returned to my father's farm forty years later, and found the pasture is still thriving, with cattle grazing amongst the trees that offer shelter and shade.

Pond preparation

Another application for the pig tractor is in pond preparation. In this case the wallowing and rooting behavior of the pigs, along with their manure and trampled crop residue combine to make a watertight pond bottom.

In my family's case, we have had very good results turning boggy garden areas into ponds. First, we turn feeder pigs into the garden and let them eat crop residue and weeds. The pigs love to wallow and root in the boggy areas. After the area is thoroughly worked over by the pigs, we use a grader to scoop out the pond. We then return the pigs to wallow some more.

The combination of compaction and gleying (similar to gluing) of manure and plant residue creates a perfect pond bottom that holds water for years. Any time the pond starts to leak, we'd just put a pig or two in there for a few days. Ponds usually leak at the water level, and that's where the pigs do the most good. Half in and half out of the water they lay there for hours just slicking the pond side to a impermeable surface, fixing leaks we can't see.

Pasture improvement and diversification

Animal tractors can be used very effectively to revitalize and diversify pasture. Using pig and chicken tractors in mobile enclosures can greatly enhance the pasture.

We use beef cattle followed by a chicken tractor to improve our pasture. We only raise a few cattle inside portable electric sheep netting (7000 sq. ft or 650 sq meters). We stock the enclosures so that the cattle daily chew the grass down low enough for the chickens to graze on it. The chickens follow the beef by a week. The time between gives the manure pats time to dry out, for seeds to germinate, and for parasites to become larvae. The chickens scratch the cow pats completely apart, spreading the fertility of the cow pat over a much larger area and eliminating the large cow-pats found in conventionally grazed fields. At the same time, the chickens sanitize the pasture by eating weed seeds and grain that passed through the cows, and eating the parasite larvae. This breaks up the parasite cycle and makes it safe to graze the cattle across the field in controlled rotations without concern for reinfecting them with stomach parasites.

We also use pig tractors in our permanent pasture. Each tractor occupies 130 sq. feet (12 sq. meters), and is roofed and enclosed on one end with sheet metal roofing to shelter the pigs. The pig tractor is on wheels so we can move it easily each morning when we do chores. Leaving the pigs at any one place for just one day churns up a small area of pasture. As soon as we move the pig tractor to its next spot we throw grass and clover seed on the rooted up area to diversify the pasture vegetation.

Land preparation

Various animals can be used to prepare land, depending on the condition of the vegetation. For lightly vegetated land prone to erosion, a movable poultry tractor works well to quickly remove the tops of weeds and lay down a light coat of manure, in preparation for planting permanent ground covers such as grass, legumes or other protective plants.

Where vegetation is too rough for poultry, pigs, goats or cattle can be used to prepare land for production. For example, on parts of our land crowded with red cedar and black locust sprouts, Virginia creeper, honeysuckle and multi-flora rose, we use goats to clean up the vegetation (Boar meat goats). We use the goats to prepare the land ahead of the chickens, again relying on the poultry to spread the manure and break up parasite cycles.

Conclusion

Here at Good Earth Farm in Central Virginia, USA, our livestock and poultry are reclaiming a 40-acre Shenandoah Valley farm. The results we are seeing are gratifying, especially knowing that we have not spent any money on fertilizer, and in all likelihood we'll never have to, as long as we keep rotating the animals to where they are needed.

The livestock and poultry are also our cash income, to pay for the land and house, and to keep us clothed. Without them we would both have to work off the farm to make ends meet. Instead, we live the kind of life we have always dreamed about, and look forward to sharing our knowledge with others who are ready to learn.

About the Author

Andy Lee is a well known speaker and small farm advocate, and the author of _Backyard Market Gardening_. He and his wife Patricia Foreman authored _Chicken Tractor, The Permaculture Guide to Happy Hens and Healthy Soils_. Their books are available at Good Earth Publications Company, which publishes books on self-reliant living and sustainable small-scale agriculture. Good Earth Farm School has workshops and apprenticeships in free range poultry, organic market gardening and applied permaculture. You can reach them at:

Andy Lee Good Earth Publications Good Earth Farm and Farm School 1702 Mountain View Road Buena Vista, VA 24416, USA phone & fax: (540) 261-8775 E-mail: goodearth@rockbridge.net Web site: <http://www.goodearthpub.com>

References

Andy Lee's _Chicken Tractor, The Permaculture Guide to Happy Hens and Healthy Soils_ is a thorough reference and a wonderful read. Available at: <http://www.goodearthpub.com/gefpubs.html#bestsellers>

Bill Mollison's _Permaculture: A Practical Guide for a Sustainable Future,_ covers many systems which integrate animals. Available at: <http://www.goodearthpub.com/gefpubs.html#permaculture>

Rosemary Morrow presents a good introduction to animal tractors in her book, _Earth User's Guide to Permaculture_ Available at: <http://www.goodearthpub.com/gefpubs.html#permaculture>

Web Links and Periodicals

Chicken and duck tractor examples with photos: <http://www-pals.gsu.edu/~biojdsx/fowl/tractor.htm> <http://www.gsu.edu/%7Ebiojdsx/fowl/tempfenc.htm>

Pastured poultry resources: <http://metalab.unc.edu/farming-connection/grazing/pastpoul/resource.htm>

Subscriber lists are also available at: <http://groups.yahoo.com/group/PasturePoultry> and <http://groups.yahoo.com/group/PasturedPigs>

If you know of other web links related to traditional agroforestry systems please share them with us by writing to <overstory@agroforester.com>.

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The Overstory #37--Trees/Livestock Examples
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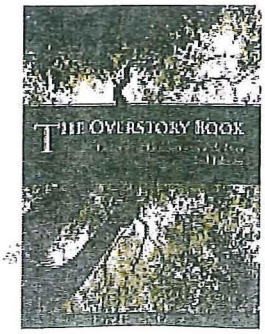

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Site comments and suggestions

Page Last Updated: September 17, 2007

WATER-SAVING DEVICES AND PRACTICES FOR PIGGERY FARMS TO IMPROVE WATER QUALITY

Manuel V. Duguies, D.V.M.
Guam Cooperative Extension

Introduction

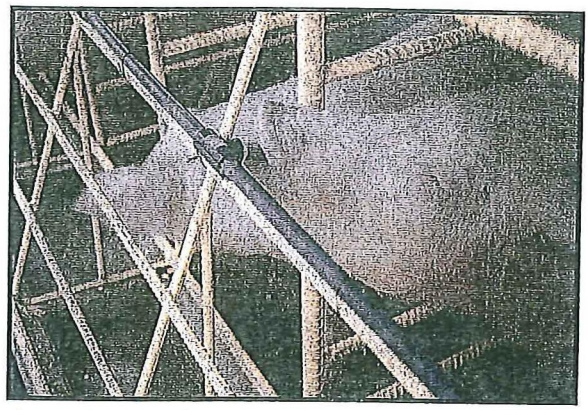
Clean and potable drinking water for swine is often not a priority in the daily operations of most piggery farms on Guam. However, water is very important to the animals' bodies as it serves in a number of life-sustaining functions. Water is a much needed nutrient. It is also the cheapest and the most readily available.

Because water becomes inexpensive, very little attention is given to the amount used in drinking water, pen cleaning and bathing hogs. As a result, the extravagance and excessive use of water creates resource and environmental concerns.

This informational brochure provides helpful suggestions on the efficient use of water for (1) drinking and (2) bathing/cleaning purposes for piggery farms.

Drinking Water

Open-water troughs are the most common form of water supplies for drinking among livestock and poultry farms on Guam. They can be in the form of 55 gallon drums cut into various sizes

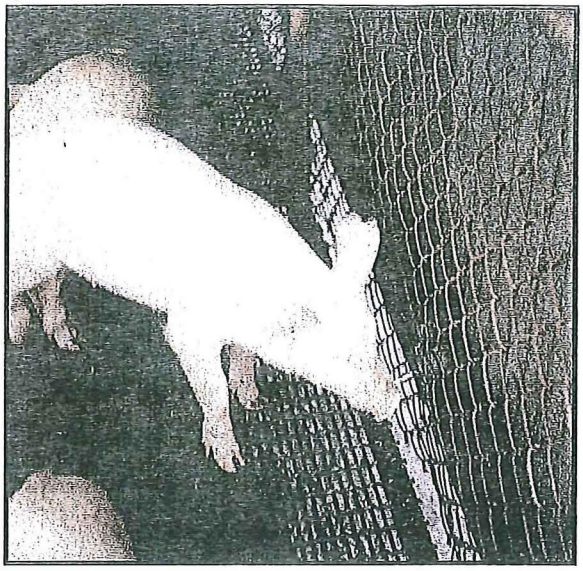


A sow drinking from a nipple waterer. PVC water line is installed along the gestating stalls.

and shapes, plastic pails, galvanized pans, built-in watering area in the pens, used rubber tires cut in halves, and others. These open troughs are normally filled up to an average of five gallons, more than the average daily water requirement of non-pregnant breeders, which is two-three gallons per day. For nursing sows, the water placed in these trough is not enough for their daily drinking water, which would be five to eight gallons for milk production. Open water troughs are also used for group penned weaners, growers and fatteners.

A lot of problems can occur with this type of watering system. Some of these problems are:

1. Contamination of the drinking



A weaner drinking from the nipple.

water from manure, urine and dirt from the surroundings which can rapidly spread diseases and parasites.

2. Animals can be out of water for long periods because the water has spilled. Long periods of thirst can cause fights and irritation among animals.

3. It takes time and labor to fill up and clean the troughs. Sometimes the troughs are not cleaned at all.

All these problems lead to water wastage, dirty drinking water, lowered animal productivity, stress, and inefficient use of time. The time use to fill up and clean troughs can be used in observing heat detection, piglet care and pen cleaning.

Through the use of automatic watering systems, such as nipple waterers and cup drinkers, the swine herd can always have access to clean and potable water 24 hours a day. These nipple waterers come in various brands, shapes and sizes to fit the different age groups in swine. As early as two-week-old piglets can drink from these nipples. Nipples are easy to install and connect to galvanized iron or PVC water pipes. Such watering systems are durable and increase productivity and efficiency on the farm. Water wastage is minimized.

Breeders and fatteners in groups need one nipple for every three to six heads while weaners and growers need one nipple for every six to twelve heads. Individual gestating stalls and farrowing crates should have one nipple per unit.

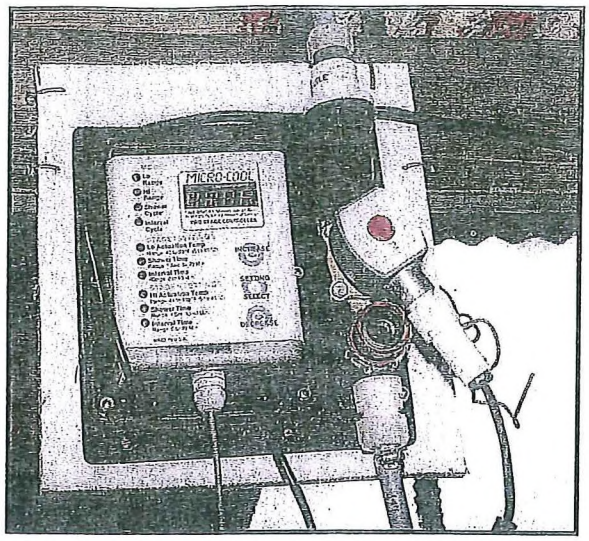
Water for Bathing and Cleaning

Another major activity and consideration in the use of water in piggery farms is bathing the animals using a water hose, which is usually done once or twice a day. Although this serves to clean and cool the animals, it is not the most efficient way of cooling them. Water usage is very high and the volume of slurry (waste water, dirt and manure) released into the environment is increased tremendously. The animals only get the cooling effect during the actual bath. The rest of the day will be hot unless bathing is frequent or the animals have access to a pool of water to wallow. Even in farms with lots of shades and trees, the temperature inside the building can get very hot and uncomfortable for the breeders and fatteners, creating a stressful condition to the animals.

Research and studies show that intermittent mist-like and sprinkle types of showers give a better lasting cooling effect than a water hose. Water lines can be installed on top of gestating stalls and farrowing crates. Holes can be drilled in the water line just above the shoulder area of breeders. The control valve will be at the end of the line for easy opening and closing. Because this type of system is manually operated, it is ideal for farms whose owners are always present or staying on the farm. Valves can be opened every twenty to thirty minutes for three to five minutes, depending on the day's temperature. This way, the breeders are always cooled throughout the day.

Spray and drip-cool systems which are electronically operated are also available. Water is turned on and off at a desired frequency and duration and the amount of water released is controlled as well. Such systems have controls where you can set the temperature to which the system will activate, how frequently the water mist or drip will flow, and the duration of water flow to the animals. It is costly but it works even if nobody is on the farm. In this system, one breeder uses only one gallon of water for a three-minute flow every fifteen minutes during a four-hour time period compared to the water hose method which uses ten gallons or more per breeder at one time. In the mist/spray method, the animals' environment is kept cool most of the day at a very minimal usage of water and volume of slurry is much reduced.

The drip-cool line goes around the gestating stalls.

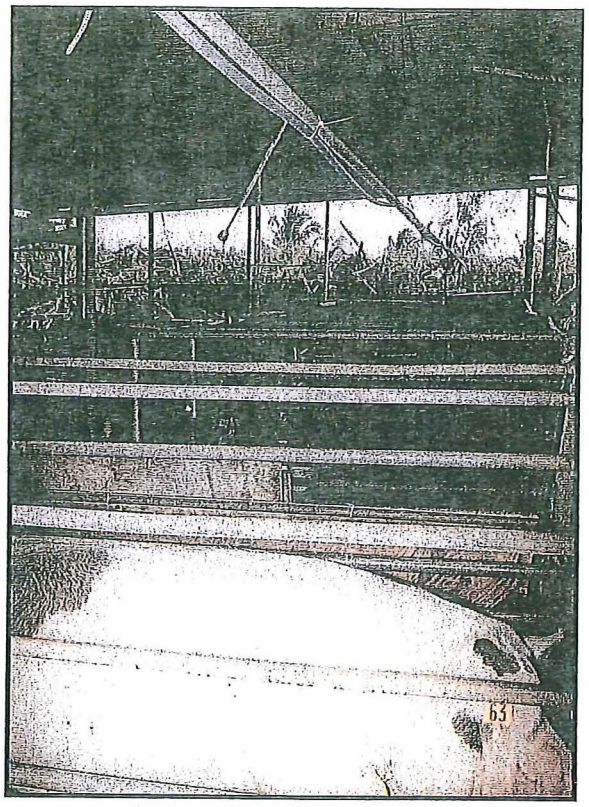


The drip-cool controller enables the hog producer to set the system in terms of frequency and duration of water flow and the temperature range wherein the system will activate.

With a cool environment, heat stress is minimized and breeders attain higher pregnancy rates, more milk production for nursing sows, and better quality piglets.

Farms which have the automatic watering system and mist/sprinkle type of shower can reduce their cleaning and flushing of pens. Producers can practice a wet and dry cleaning method

of pens. Wet cleaning is flushing the pens with water through the use of the standard water hose. Dry cleaning



Water drips intermittently at the shoulder area of breeders.

simply means using the shovel or stickbroom to remove the manure from the pens to the gutter. These cleaning methods can be done on an alternating basis of wet and dry cleaning on the farm.

Conclusion

Swine require adequate amounts of clean, fresh water at all times for a higher level of productivity and better health. High temperatures and humidity stress the animals. The practice of one water-hose bath a day is not enough to cool the animals and the premises.

A system of free-choice water supply is highly recommended through the use of automatic watering devices and drip/mist cooling system. These practices reduces the amount of slurry that will eventually affect our environment. The cost involved in these watering systems will eventually pay off in terms of higher production on the farm. A number of piggery farms on Guam has installed water nipples.

These water-saving and cooling devices can be ordered from livestock suppliers in Hawaii and the US mainland. Some local feed dealers can order them for you. Contact your Livestock Extension Agent for more information and visits to demonstration farms on these devices.

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Cooperative Extension Service
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Animal Waste Management
Apr. 2005
AWM-3

Composted Swine Manure for Vegetable Crop Application

Halina M. Zaleski[1] and Daniel G. Paquin[2]
Departments of [1]Human Nutrition, Food and Animal Sciences, [2]Molecular Biosciences and Bioengineering

Swine waste or crop fertilizer?

One way to manage swine waste is to spread it on agricultural land, but few swine producers have enough land to which to apply all the waste generated by their operation. Crop producers wishing to use swine waste on their land must address issues such as the cost of transporting liquid waste and the limits on waste use imposed by food safety certification requirements. Composting can help address these concerns. Processing the liquid waste by composting it eliminates the need to transport and apply liquids. Food safety certification for vegetable crops does not allow use of raw manure but does allow the use of properly composted livestock waste. Composting thus has the potential to allow the recycling of swine waste nutrients in a sustainable and environmentally friendly manner.

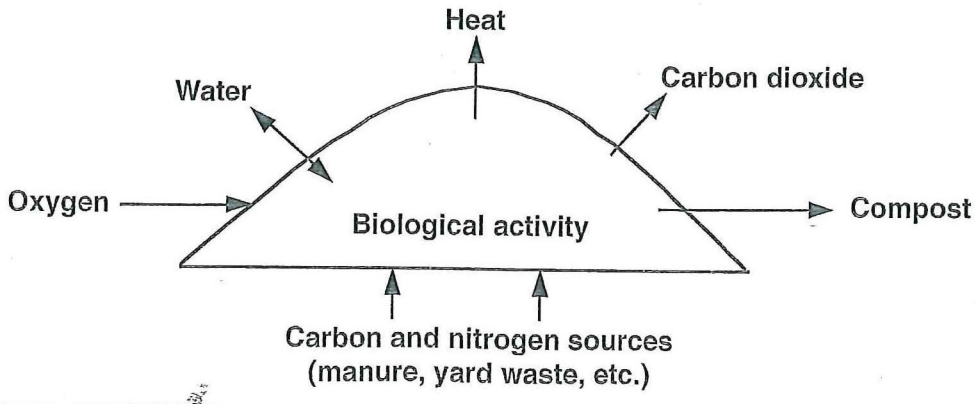
What is composting?

Composting is the biological breakdown of organic matter. It starts with a mixture of materials such as manure, food processing or yard wastes, or waste silage, which decompose in the presence of oxygen. Properly done, with a suitable mixture of carbon and nitrogen source materials and adequate moisture and aeration, composting forms a rich, humus-like material valued for its soil-conditioning qualities. Temperatures in the pile above 130°F, generated by microbiological activity, will kill many disease organisms.

Compost is known to increase nutrient retention and soil water-holding capacity and improve soil structure. Compost added to the soil provides organic matter, macronutrients (N, P, and K), and micronutrients.

A demonstration of composting in Hawai'i

The development and implementation of best nutrient management practices appropriate to Hawai'i farms is important to protect our waters. Our swine waste composting project was designed to demonstrate this alternative livestock waste management practice, using the facilities of the largest swine production operation in the Waimanalo Stream watershed, by diverting some waste from their anaerobic lagoon to composting.



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Composting was followed by a demonstration of land application of compost at agronomic rates on an adjoining vegetable farm using radishes and corn as test crops. The location for the project was selected because Waimanalo Stream on O'ahu, among others in Hawai'i, has been identified as an impaired water body.

Making compost

Two composting piles were made at the Waimanalo swine farm. A sheet of high-density polyethylene was used to line the composting area, and the edges of the liner were raised over a 3-inch diameter PVC pipe to create a berm. Leachate and excess runoff drained from the liner through a screen and were collected in a 45-gallon plastic drum set in the ground below the level of the composting area. Leachate collected in the drum was pumped back to the existing waste collection system.

About 2.7 tons of coarse (drum-chipped) tree trimmings formed each pile (11 ft long x 10 ft wide). We calculated that adding enough nitrogen to obtain a carbon to nitrogen (C:N) ratio of 30:1 would require 2700 gallons of the swine waste effluent. To avoid applying excessive liquid resulting in runoff, we applied approximately 750 gallons of swine effluent to each pile.

The piles differed in the manner of aeration. The static (unturned) pile was aerated through a perforated 4-inch pipe under the pile; a household vacuum cleaner was used to push air through the pipe. A front-end loader was used to mix and aerate the active (turned) pile.

Composting results

Five essential components are needed for composting: the proper decomposing organisms, and the water, carbon, nitrogen, and oxygen needed by the organisms. We assessed our experiment in relation to these components.

Decomposing organisms produce heat by their activity. This heat in turn energizes them, and the whole process goes faster if adequate food sources are present. Using a thermometer to take pile temperature, the level of composting activity was easily determined.

Water should keep a compost pile moist but not too wet. During the first two months of composting, the piles tended to be too dry. This was followed by a very rainy period, which resulted in wet piles, cooler than optimal temperatures, and a slower composting process.

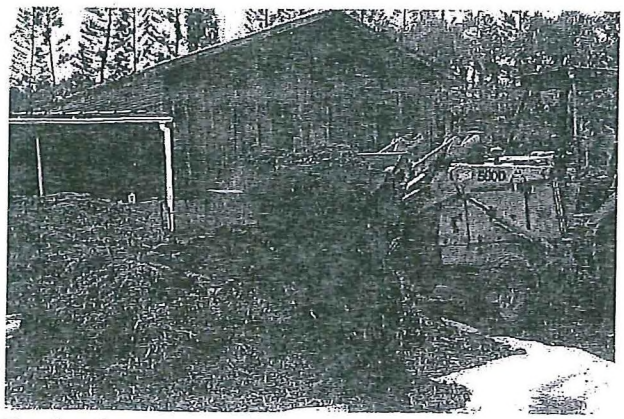
Carbon (C) is abundant in most organic materials and is used as food by decomposing organisms to create energy. The coarsely chopped tree trimmings were high in carbon but had little nitrogen compared with grass clippings, green leaves, or animal manure. The coarseness (up to 8 inches long) of the material kept the piles fluffy and allowed natural air flow through the compost but necessitated longer composting times.

Nitrogen (N) is required by decomposers. The low nitrogen content of the swine effluent made it impossible to apply nitrogen in the amounts needed by decomposers. The low amount of effluent (nitrogen source) increased the C:N ratio well above the optimum 20–30 parts carbon for each part nitrogen and slowed the composting process.

Oxygen is essential to most decomposers. After turning, the turned pile's temperature increased dramatically due to the increased aeration. With the unturned, blower-aerated pile, the anticipated composting process was limited, as indicated by low pile temperatures. When the blower was turned off, the pile temperature greatly increased, suggesting that the added air might be cooling and drying the pile too much.

Safety

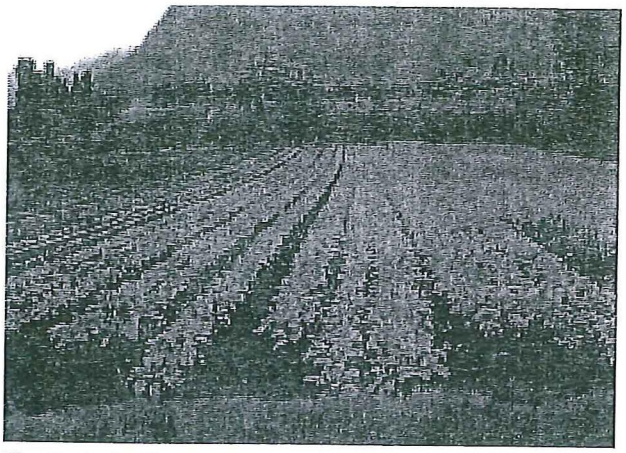
Safety of the composted product is important when applying it to vegetables, such as radishes, that are normally eaten raw. Both compost piles reached a temperature higher than 130°F for more than the 3 days needed to destroy disease organisms. Compost from both piles was negative when tested for salmonella bacteria, confirming its suitability for application on land used to grow vegetables.



Turning the compost pile.

Applying compost to cropland

Frequent rains delayed land application of the compost and crop planting. Compost and soil samples were analyzed for nutrients at the UH-CTAHR Agricultural Diagnostic Service Center. Because soil phosphorus was adequate, compost application rates were based on estimated crop phosphorus removal. Compost was applied at 10 tons of compost per acre, or about ½ pound per square foot, and tilled into the soil. Compost application was compared with the farmer's standard commercial fertilizer application. The field was made into beds with each bed planted with two rows of radishes and one row of corn between them. The crops were irrigated following normal farm practice.



The test planting.

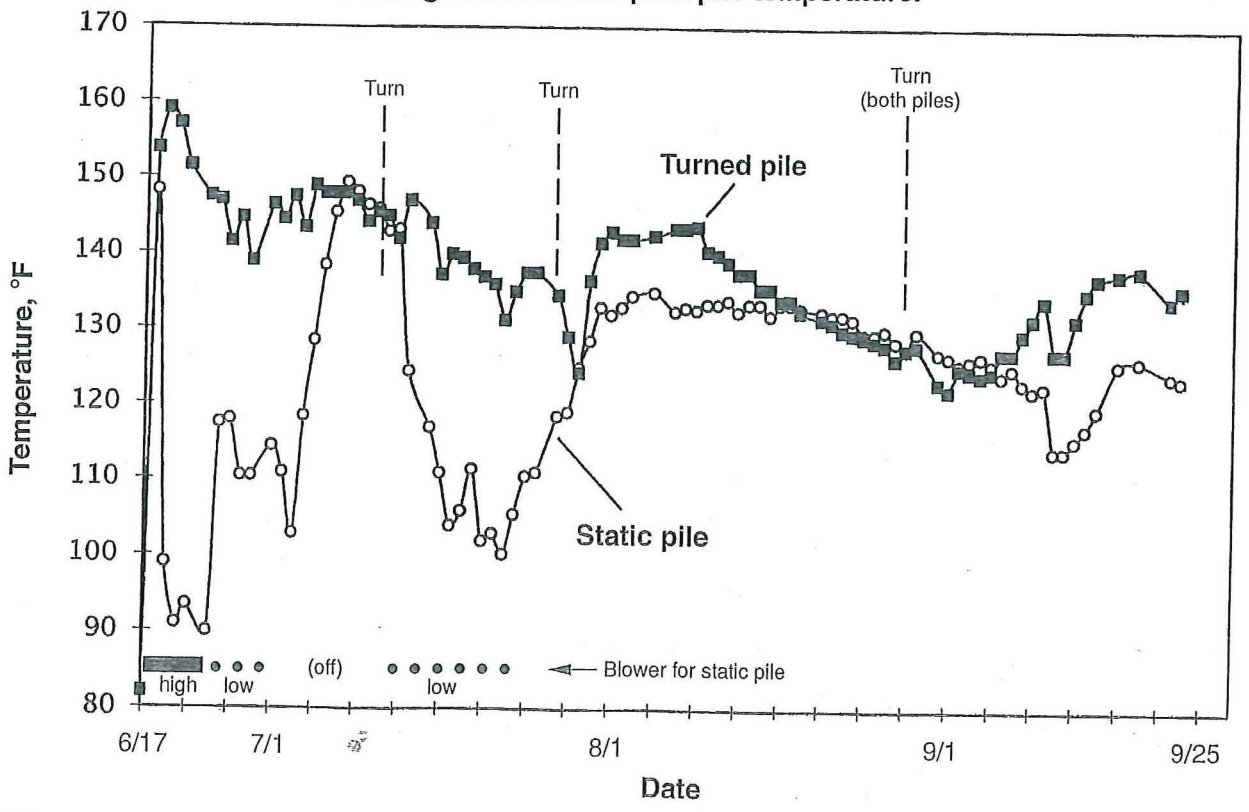
Cropping results

Soil nutrients and the yield response of radishes and corn to the compost were evaluated.

Pre-plant soil tests showed sufficient soil phosphorus for the crops to be grown. By having the soil test results, the farmer was able to save money by not applying inorganic phosphorus.

Radishes grown with compost had a greater total yield but a lower saleable yield because of cracking. High

Average internal compost pile temperature.



rainfall and planting of a susceptible variety contributed to the cracking problem.

Corn grown with compost had 20% higher mean cob weight and total yield per acre than corn without compost.

Postharvest soil tests showed final soil nutrient levels (except magnesium) were lower in composted rows than in rows treated with inorganic fertilizer, possibly due to increased plant nutrient uptake.

Summary and recommendations

- Turned-windrow composting performed much better than static piles.
- The compost was easy to handle and did not require specialized equipment. Operating costs were low, making composting affordable for a small-scale swine producer.
- Assessing moisture with a hay moisture tester in addition to measuring temperature would provide better monitoring of the composting process.
- Composting time could be reduced by using finer tree trimmings and by applying more swine effluent to the compost pile.
- Composting under a roof or cover would protect the piles from rainfall but would greatly increase start-up costs, so composting may be better suited for leeward-area swine farms receiving less rainfall.
- Where the soil is suitable, making the compost pile on compacted soil would reduce costs compared to using a plastic liner.
- There was very little unpleasant odor except during effluent addition. The compost produced had an earthy odor and texture and was judged to be a marketable product.
- Ensuring three days of internal pile temperature over 130°F destroyed disease-causing organisms such as salmonella.
- Soil testing can assist farmers in reducing fertilizer costs.
- Applying compost is recommended for farmers growing corn.
- When designing livestock waste management systems, the products should be tested to ensure suitability for land application and to determine crop response.

UNIVERSITY OF GUAM & GUAM DEPARTMENT OF AGRICULTURE NF 06-18

GUAM COOPERATIVE EXTENSION

COMPOST

NEW FARMER PUBLICATION

Conservation Practices

Mark Acosta, & Ilene Iriarte, Extension Associates, L. Robert Barber, Extension Agricultural Economist

What is Composting?

A controlled breakdown of organic material through an aerobic (with oxygen) process driven by bacteria, protozoa, fungi, worms, and other organisms. The end result is a dark, crumbly decomposed organic matter. Organic material holds water, nutrients, and other enzymes which are used by the plants.

Finished Compost

Reasons for Composting

In our landfill green wastes take up to 50 – 80% of the space. Composting is an environmentally sensitive method to dispose of yard clippings. When added to the soil, compost improves the soil structure, helps conserve water, provides nutrients to the plants and helps reduce soil erosion.

What can be Composted?

Many different kinds of organic materials can be composted. They range from yard waste to kitchen wastes. Two general categories of materials are known as greens and browns. Fresh grass clippings, green garden plant waste, vegetable scarps, coffee grounds, chicken, pig, and cow manure, are high in nitrogen and are known as greens. Twigs, branches, fallen leaves, shredded news papers, napkins, cardboard, bark, and wood chips contain high amounts of carbon are generally known as browns, all make wonderful compost materials. Materials with high nitrogen decompose much faster than materials with high carbon.

Organic materials that are not recommended for composting are meats, bones, fatty foods, pet litter, dead animals, and human/pet manure.

Just keep in mind that when adding animal manure to your compost pile, the temperature should be above 133°F for at least 15 days to decrease the risk of pathogens in your compost.

Carbon: Nitrogen Ratio:

The carbon to nitrogen ratio (C: N) is an important concept in composting. If there is too much carbon present it dramatically slows down the composting process. If too much nitrogen is present the compost will heat up so fast that the nitrogen will be lost in the atmosphere in a form called ammonia which causes odor problems. The recommended C: N is 1 part of nitrogen to 3 parts of carbon (25% nitrogen and 75% carbon). Understanding the C: N will help you produce compost efficiently.

Components of Composting

To have a successful compost pile there are a number of components that are needed.

Browns: Acts like a drying agent, and provides air spaces and comprises the bulk of the pile.

Greens: Have high moisture content and are a food source for microorganisms. It helps with reproduction and growth. Without greens you will have no heat coming from your compost pile.

Oxygen: Is needed for the organisms to survive. A lack of oxygen (anaerobic process) can produce a rotten odor from anaerobic organism growth.

Water: The compost pile needs to be moist. The level of moisture should be like a sponge that has been squeezed out.

Surface Area: The greater the surface area of the compost particles the faster the microorganisms can breakdown the organic material. To increase the surface area of your material cut them into pieces, especially big branches.

Temperature: How hot your compost pile gets depends on the size of your compost, the amount of water, oxygen, and nitrogen. The compost pile should

 Funding for this publication was provided by a USDA WSARE New Farmer grant through University of Hawaii and a USDA NRCS Conservation Innovation Grant. 2005-06. Dr. Jeff D. T. Barcinas Director UOG-CES

be large enough (recommended minimum size is 3'x3'x3') to generate heat in the middle of the pile. The most effective temperature range is 122°F - 140°F. This temperature should be maintained for several weeks. Temperatures greater than 149°F may kill many of the organisms that are involved in the composting process. When your compost pile reaches 140°F it is recommended that you turn the compost. Your temperature should rise again after you turn it. When the temperature drops then your compost is probably finished.

How to Turn Your Compost Pile:
Heat is generated in the middle of compost piles and the top and sides of the pile remain cool. Take organic matter from the top and sides and move them to the middle, and the material in the middle gets moved to the sides or top. If you are using a two or three-bin compost unit the organic matter should be transferred to the second bin. Turning your compost pile releases heat and adds oxygen for the microorganisms.

Layering Your Compost:
Start your pile with a layer of browns about 4" – 6" thick. Next add a layer of greens which should be half the thickness of the browns. If the layers are dry add water just to moisten the organic material. Continue this process until the bin is full.

In the tropics during dry season create a saucer at the center of the pile to catch rainfall. In the rainy season it is recommended to mound the center of the pile so rains can runoff and if possible cover the pile with a tarp. Refrain from letting the tarp touch the pile because it can restrict the oxygen from entering the pile.

You should be checking the moisture of the compost pile regularly. The pile should feel moist but you shouldn't be able to squeeze water out of it.

Common Problems:

Problem	Causes	Solution
Ammonia Odor	Too much nitrogen	Add carbon to balance
Rotten Odor	Too much moisture (anaerobic) Compacted Food on top of pile	Mix in dry material Cover pile when it rains Turn pile (aerate) Bury food
Pests: Flies, rats, insects, etc.	Food remains of meat and fat	Avoid meat and fatty foods in compost
Nothing Happened	Little moisture Dry & Small Pile Poor aeration Not enough greens	Add water Make a bigger pile Turn pile Mix in green material
High Temperatures above 150°F	Inadequate aeration Too much nitrogen Large pile	Aerate compost (turn) Mix in carbon Reduce compost size

Composting Methods:
There are basically two types of composting methods. The first one is called active composting or fast composting. This method is very labor intensive and requires a lot of turning. Compost can be produced in two months or less using this method. A recommended compost bin for this method would be a three-bin compost unit. The steps in creating a fast compost system is a layering of browns and greens as described previously. It is recommended to turn your compost every three to five days. If your organic material is dark, and crumbly and it doesn't look anything like what you started with then your organic material has turned into compost.

The second type of composting method is called passive composting or slow composting. This method has the least labor and time put into it. This method is perfect for homeowners who don't have a lot of organic material to compost. It can take anywhere from six months to a couple of years to create compost. The bins that are recommended for this type of composting are wire bin, or a trash can with holes all around it for aeration. Lift the bin at least a foot off the ground for aeration. Start your compost pile with browns hen greens. Turn your pile occasionally to provide aeration to avoid the organic matter from going anaerobic (breaking down without oxygen). If you smell a rotten odor then your compost pile is breaking down anaerobicly.

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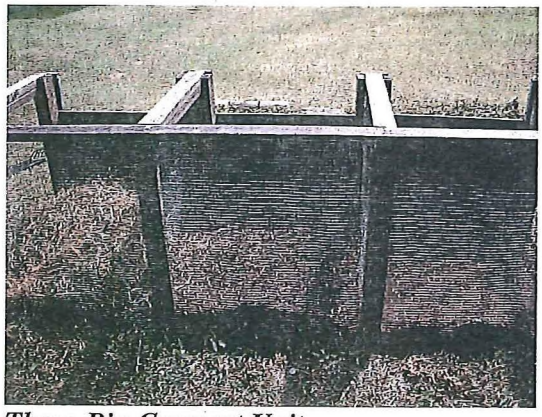
Types of Compost Bins:
Compost bins can be constructed in many different ways using a variety of materials to reduce labor it should be designed to facilitate turning. The bins should be suited for the needs and abilities the person utilizing it.

A three-bin compost unit is designed so that the first bin is used for fresh organic matter or for storing organic matter, the second bin is for active composting, and the third bin is for finished compost. This type of compost unit is recommended for farmers or people with a lot of organic material.



Three-Bin Compost Unit

Other types of compost bins are two-bin compost unit, circular wire bin, and purchased composting systems. Purchased composting systems can be trash cans with holes all over the bin, rotating drums, and many other styles.

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Composting & Other Soil Building Techniques

Prepared by:

L. Robert Barber, & Ilene Iriarte

For:

Guam Cooperative Extension Service & Guam Department of Agriculture

Funding provided by:

United States Department of Agriculture Natural Resources Conservation Service, Western Region Sustainable Agriculture Research and Education, Administration for Native Americans,, & Sanctuary Incorporated

Building the Soil by Increasing Organic Matter

- Mulching
  - Yard and farm waste around plants
- Green Manures and Cover Crops
  - Sun Hemp, Perennial Peanut, Sweet Potato
- Direct addition of Animal Manures and Crop Residues
- Composting – Primary topic of today's lecture.

Introduction to Composting

- What is composting?
  - Composting is the "breakdown" of organic material derived from living animals and plants.
  - The "Breakdown" is an aerobic (oxygen) process, by which bacteria, fungi, insects and animals decompose organic matter.

Reasons for Composting

- Waste Management
  - Reduce waste/ Land fill issues
  - Reuse organic material
- Soil and Water Conservation
- Increases agricultural productivity
  - Soil amendment
    - Improves soil quality
- Reduced production cost so increased revenues
- Helps bind nutrients and release slowly

Disadvantages

- Time/Labor
- Improper Management:
  - Disease from animal manure
  - Point-source
  - Odor

What can be composted?

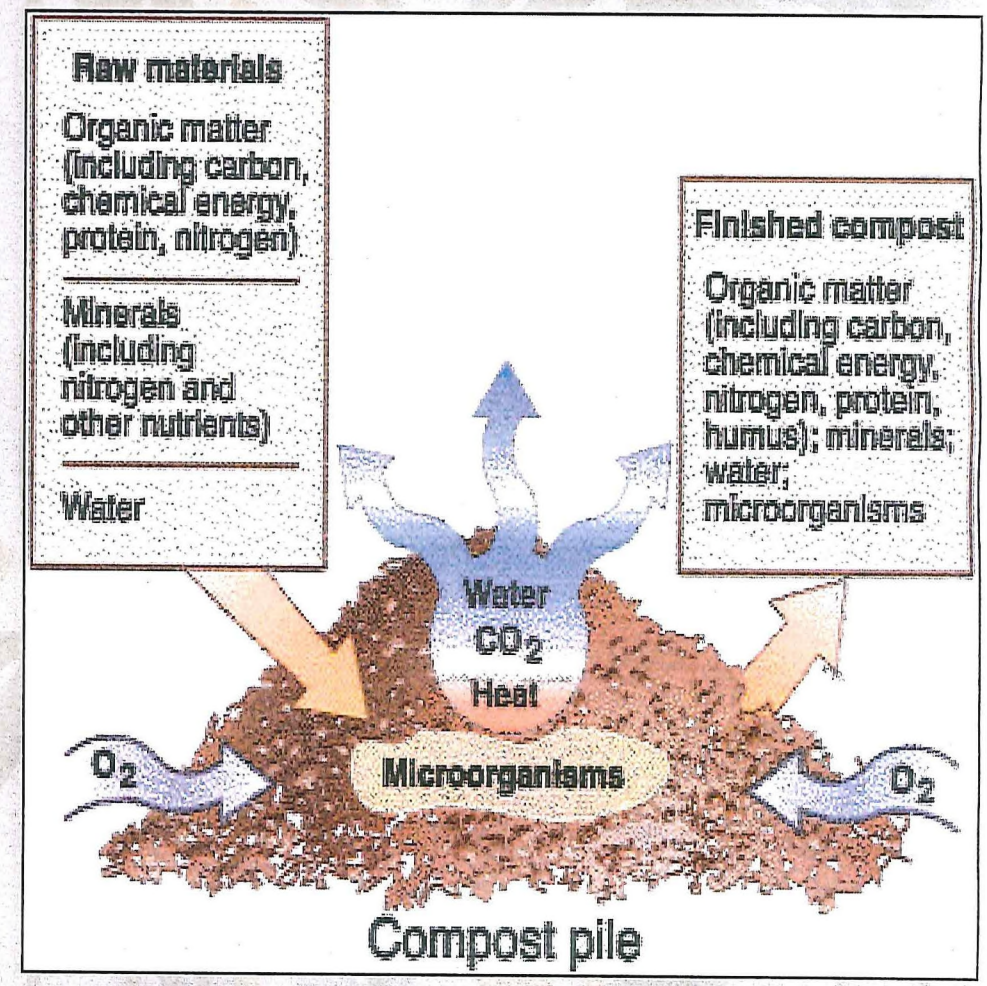
- Yard debris
  - fallen leaves, grass clippings, tree branches
  - cardboard, shredded paper, etc.
- Kitchen Waste
  - Vegetable and fruit peelings, coffee grounds, crushed eggshells, tea bags
- Manure

What not to compost

- Meat/Bones
- Fatty foods
- Pet litter/manure
- Human manure
- Dead Animals

Components of Composting

- Microorganisms
- Water
- Oxygen
- Carbon (browns)
- Nitrogen (greens)
- Surface area
- Temperature
- Time



Picture From MU Guide

Components of Composting

- Microorganisms:
  - Decompose organic material
- Water:
  - Needed for microbial activity
  - Compost should be moist
- Oxygen:
  - Microbes need oxygen
  - Prevent odor problems

Conditions that promote Composting

- Surface Area:
  - Increased material surface area allows the microbes to decompose compost materials faster
  - Increase surface area by tearing, shredding, chopping compost material
- Temperature:
  - Idle range is from 122°F-140°F
- Time:
  - It can take a month to a year or more to produce compost

Components of Composting

- Browns (carbon source):
  - Provides air space
  - Acts like a drying agent
  - Types of materials rich in carbon:
    - Woodchips/Branches
    - Brown leaves
    - Shredded Paper
    - Cardboard

Components of Composting

- Greens (nitrogen source):
  - Microorganism Food Source
    - Reproduction and Growth
  - High moisture content
  - Materials Rich in Nitrogen:
    - Animal Manure
    - Green Vegetation
      - Grass Clippings
    - Kitchen Waste

Brown to Green Ratio

- Recommended Brown: Green ratio
  - 3: 1 (3 parts of Brown for every 1 part of green)
- Too much carbon (from browns) slows down the decomposition process
- Too much nitrogen (from greens) can be lost as ammonia (smell) or by leaching into the aquifer

Building the Pile

- The first layer should be the browns
- Second layer consists of greens
- In dry season create a saucer in the middle of the pile to capture water
- In rainy season
  - mound the pile
  - Place a tarp over the compost bin, but make sure it's not touching the compos
- Over time mix the layers together (turning)
  - adds oxygen

Managing Compost Pile

- Water periodically:
  - moist but not saturated
  - If conditions are too wet, anaerobic microorganisms (those that can live without oxygen) take over the composting process
  - Turning the pile speeds up the process

Common problems

Problem	Causes	Solution
Ammonia Odor	Too much nitrogen	Add browns to balance
Rotten Odor	Too much moisture Compacted Food on top of pile	Mix in dry material Cover pile when it rains Turn pile (aerate) Bury food
Pests: Flies, Rats, Insects, etc.	Food remains of meat and fat	Avoid meat and fatty foods in compost
Nothing Happened	Too much moisture Too dry, or too Small of a Pile	Turn pile, add dry material, add water, make a bigger pile, mix in green material
High Temperatures above 150°F	Inadequate aeration Too much nitrogen	Aerate compost Mix in carbon Reduce compost size

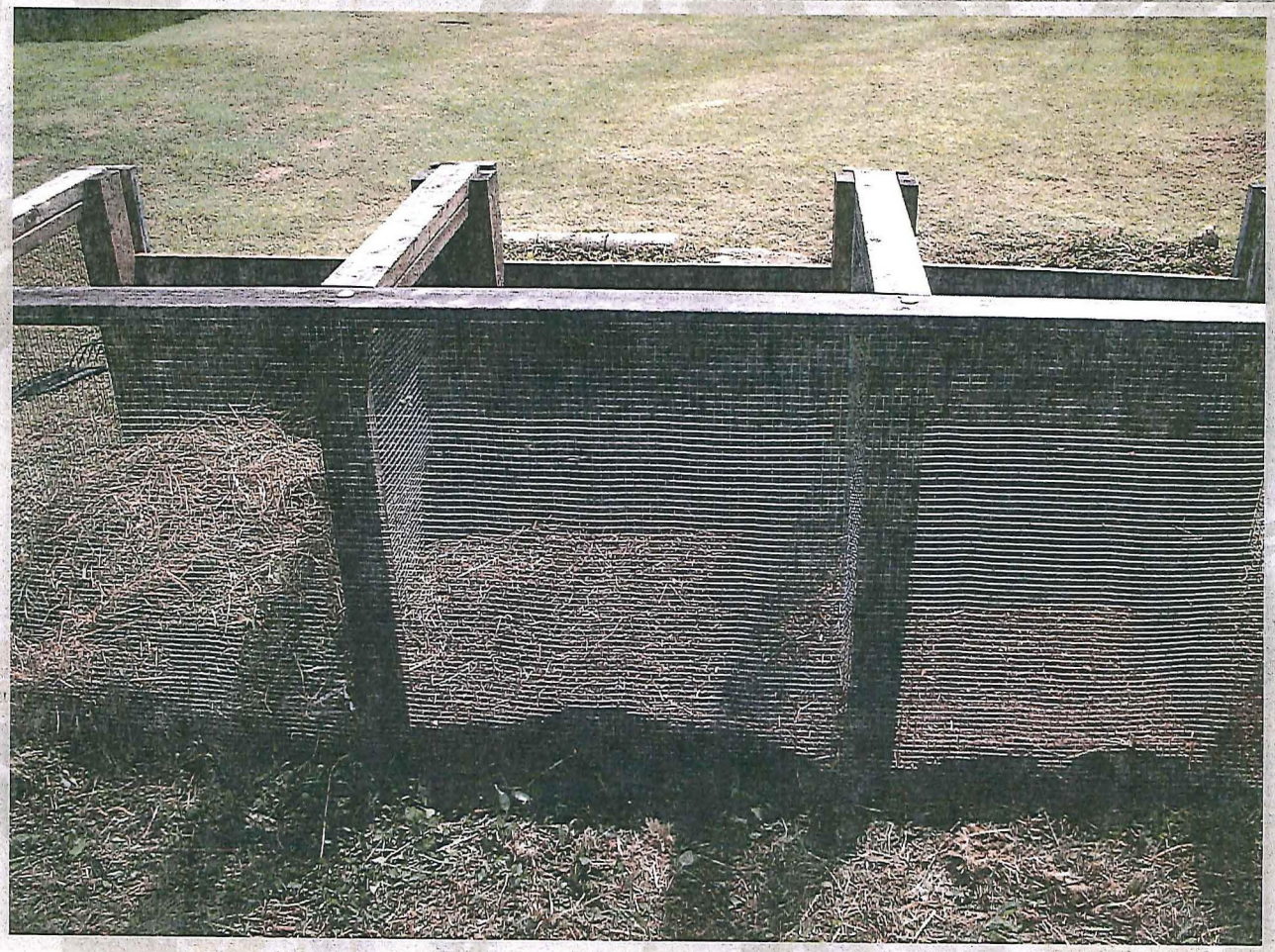
Composting Methods

- Fast or Active Methods:
  - Labor Intensive
  - Turn compost every 3 – 5 days
  - Produced in two months or less
  - Three-bin method is recommended
- Passive or slow composting:
  - Low labor and longer time
  - Six months – couple of years
  - Large piles or wire bin or trash can with holes

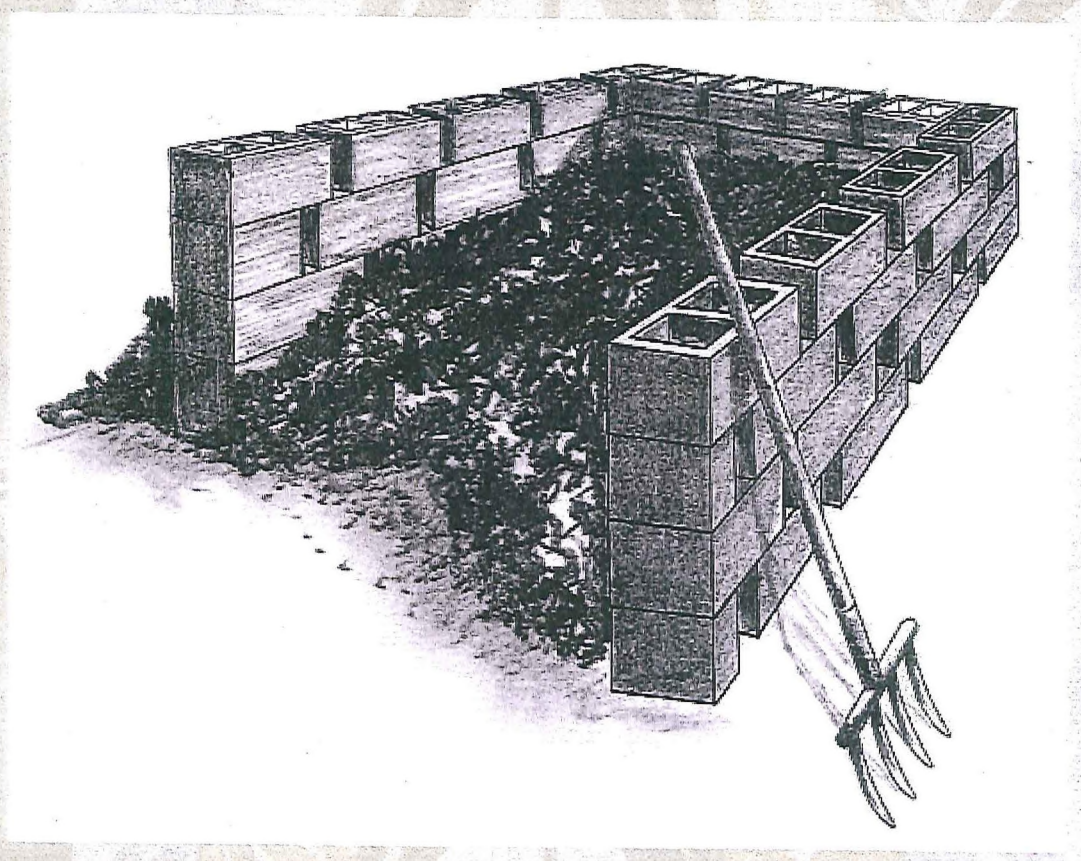
Compost Bins

- Compost bins can be constructed in many different ways using a variety of materials.
- Bins should be well suited for the needs and ability of the consumer
- Bins should be designed to facilitate turning

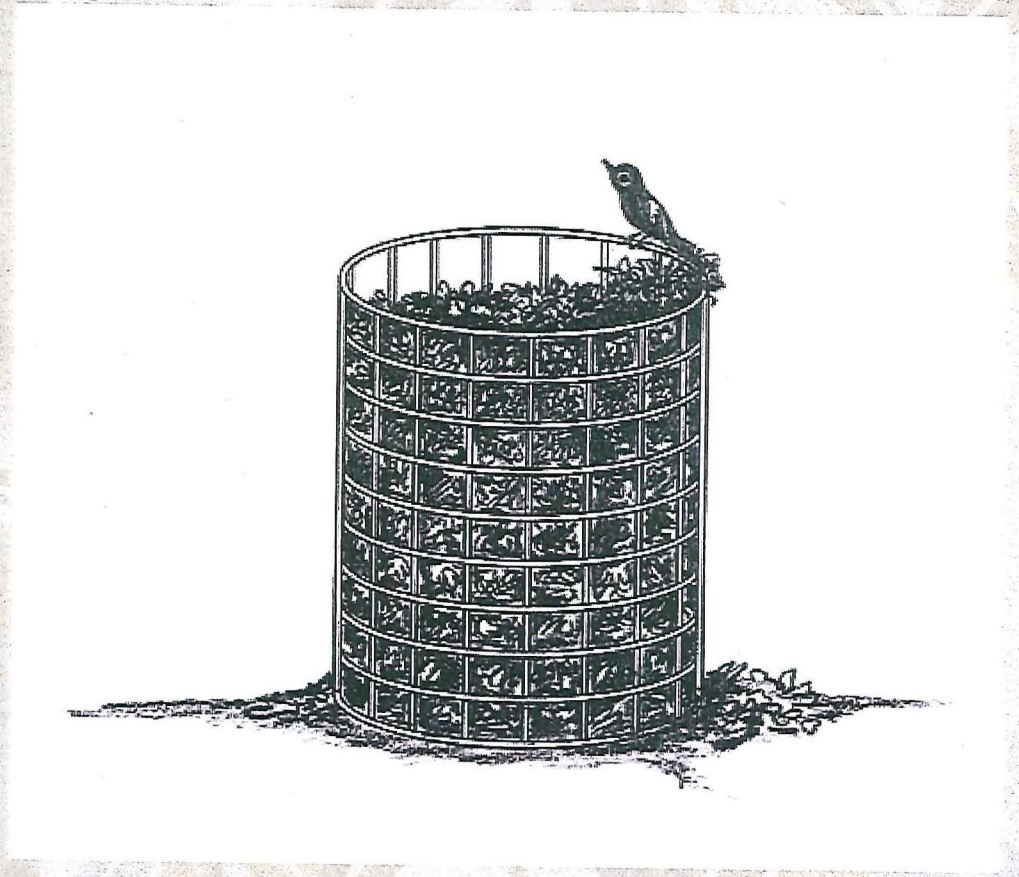
Three Bin



Concrete block bins

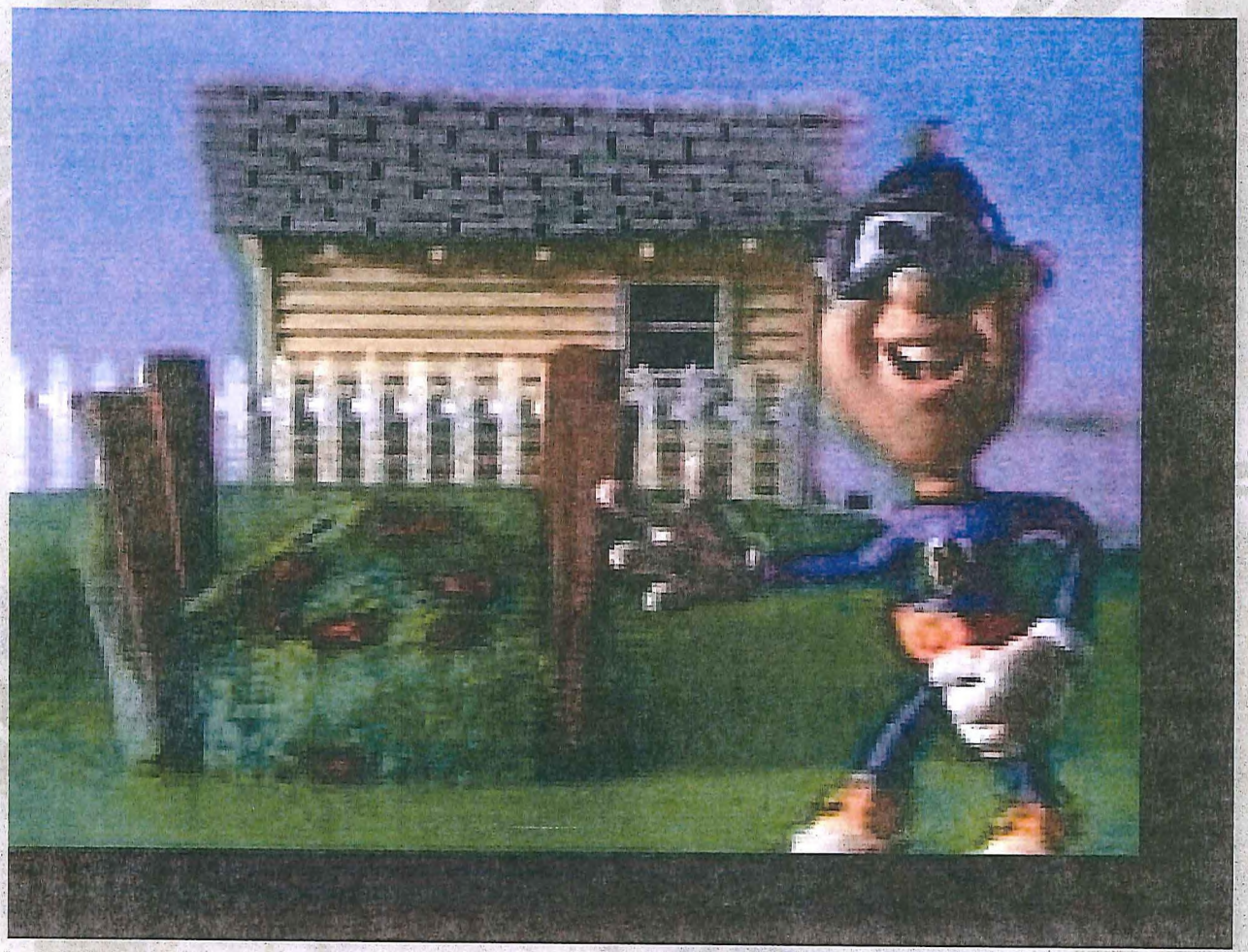


Wire Bin



Purchased Composting Systems

Have fun composting!!



Planting Guide

1

Starting in a container (with drainage holes) of well moistened, sterile seed-starting mix, make shallow furrows about ¼" deep. Sow seeds by dropping them along the bottom of the furrows ½" apart. (Spacing depends on plant. The hole should be 1-4 times the diameter of the seed.)

2

Gently pinch together soil to cover each furrow, covering seeds ¼" deep. Water gently with diluted fertilizer solution or water. Put container in a place that doesn't get full sun. As soon as seeds begin germinating and stems start to show above the soil, it's important to provide more light.

3

Day 4-7: Seedlings will have germinated depending of the species. (Some seeds may take longer to germinate.) First to appear are "baby" or "cotyledon" leaves. (Fertilize with recommended rate of complete water soluble fertilizer, such as Miracle-Gro®).

4

Seedlings are still tiny with just cotyledon leaves, but growing well. Note the nice green color of the baby leaves. This indicates that plants are getting enough bright light and nutrients to thrive.

5

Day 10-12: The first set of "true" leaves begin to appear above the cotyledons. (Note: Time varies with plant species.)

6

Once the true leaves have emerged, it's time to transplant seedlings to larger individual containers.

Plant Nutrients

Table 1. Nutrients essential for plant growth

Nutrients from air & water	Nutrients from soil, lime and commercial fertilizers		
	primary nutrients	secondary nutrients	micronutrients
carbon (C)	nitrogen (N)	calcium (Ca)	boron (B)
hydrogen (H)	phosphorus (P)	magnesium (Mg)	chlorine (Cl)
oxygen (O)	potassium (K)	sulfur (S)	copper (Cu)
			iron (Fe)
			manganese (Mn)
			molybdenum (Mo)
			zinc (Zn)

Nitrogen's Role

Of the three major nutrients, plants require nitrogen in the largest amounts. Nitrogen promotes rapid growth, increases leaf size and quality, hastens crop maturity, and promotes fruit and seed development. Because nitrogen is a constituent of amino acids, which are required to synthesize proteins and other related compounds, it plays a role in almost all plant metabolic processes.

Phosphorus' Role

1) Enhances seed germination and early growth
2) Stimulates blooming
3) Enhances bud set
4) Aids in seed formation

Potassium's Role

Potassium has many functions in plant growth. It

1) is essential for photosynthesis,
2) activates enzymes to metabolize carbohydrates for the manufacture of amino acids and proteins,
3) facilitates cell division and growth by helping to move starches and sugars between plant parts,
4) adds stalk and stem stiffness,
5) increases disease resistance,
6) increases drought tolerance,
7) regulates opening and closing of stomates,
8) gives plumpness to grain and seed,
9) improves firmness, texture, size and color of fruit crops, and
10) increases the oil content of oil crops.