NRCS

# INOCULATED DEEP LITTER SYSTEM

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Figure 1 – IDLS Piggery, Kurtistown, Big Island, Hawaii – 30-feet x 60-feet Building

## INTRODUCTION

There are various alternatives for managing agricultural animal waste from confined facilities.

**Conventional.** Conventional methods consist of transferring waste to a storage facility until such time as it might be applied to crop or pasture-land. Instead of applying the waste directly to the land, it could be transferred to a treatment facility, such as an anaerobic or aerobic digester. Nonetheless, this method generates a substantial amount of liquid manure due to the wash-down process of cleaning the concrete pens. This method has been used more on large operations.

**Modified Dry Litter.** A recent innovation developed in Hawaii that has been effective for smaller operations is the Modified Dry Litter (MDL) waste management system (**Appendix A**). A thin layer (2") of dry litter is placed on the pen's concrete floor. The floor is sloped toward a "gutter" so that waste (litter and manure) migrates toward the gutter and is collected and placed in an adjacent series of compost bins where it is treated and eventually taken out to be applied to crop land.

**Inoculated Deep Litter System.** Most recently, a method known as the Inoculated Deep Litter System (IDLS), was incorporated into a piggery installed on the Big Island in Kurtistown, Hawaii, and became operational in August 2009. This method incorporates some of the concepts of the MDL system.

The Waste Management Plan for this facility was developed in April 2007, by Buddy Perry, Soil Conservationist with the Puna Soil & Water Conservation District. Mr. Perry is now a Soil Conservationist with the Natural Resources Conservation Service in the Hilo Field Office.

The University of Hawaii: Manoa - College of Tropical Agriculture & Human Resources, Sustainable Agriculture Research & Education, Farm Pilot Project Coordination, Hawaii County Research & Development, and the Big Island Resource Conservation & Development Program provided assistance for this project.

It is based upon principles explored on a fact finding trip in 2008 to Korea, by Mike Duponte, Dwight Sato, David Ikeda, & David Matsuura of the University of Hawaii. This piggery uses a dry deep litter system.

**DESCRIPTION**

**Structure.** The building is a 30 feet wide by 60 feet long (**Figure 1**). The pens are 36-inches deep (**Figure 2**). They are filled with a layering of cinder-charcoal mix and litter with the finished product of saw dust-wood chip mixture (**Figure 3**).

There are several structural differences in this building when compared to a conventional wash-down facility. This facility has a reinforced concrete floor and a hollow tile (cement block) wall to contain the bedding (logs, woodchips and IMO treatment). A conventional facility also has a reinforced concrete floor but not the hollow tile containment.

This particular structure cost about $50,000 ($28/square foot) - turnkey. This includes the completed structure, nipple watering system, and the litter with the IMO. One major potential savings in this system is that it would not need a waste storage facility and the capability and space to spread the manure.

**Layering**. Since this is an aerobic process, air must be present within the litter. The initial IDLS piggery had native soil as the foundation. The Hawaii Department of Health was concerned about contamination of the ground water and required an impermeable layer which consists of a 4" thick concrete floor. An impervious flexible membrane, such as a 60-mil High Density Polyethylene liner attached to the walls, could probably be used instead of the concrete floor.

Because the concrete floor prevented air exchange with the soil, a venting system was devised. Standard 4-inch diameter drain pipe on about five-foot centers was laid on the concrete floor and vented to the side of the building. The first layer, consisting of a mixture of cinder and charcoal six-

inches thick, was placed around and on the drain pipe. A layer of wooden posts, four to six inches in diameter and about eight-inches thick is placed on this. The third layer consists of short pieces of wood logs about eight-inches thick laid on the posts. The final layer is a sawdust/wood chip mixture about 12 inches thick. Each layer is inoculated with the Indigenous Microorganism (IMO) developed on-farm and lactic acid is initially sprayed on the top surface until the IMO's take effect. IMO's are added only once for the life of the practice,

**Indigenous Microorganisms.** The addition of IMO is necessary because the litter most likely does not have a predominance of the necessary microorganisms necessary for the decomposition of the manure. It is a naturally occurring microorganism, cultivated on-farm using a process developed by Master Cho Han of Korea (**Appendix B**). The process is inexpensive to replicate and is considered safe from a biological standpoint, provided standard sanitation procedures are followed, as these organisms are natural and indigenous to the area.

**OPERATION**

The piggery has been operating since August 2009. There have been no incidents during that time. Even though it has not yet been utilized to full capacity, there is no accumulation of manure, flies are not present to speak of, and the smell is virtually non-existent. The key is to keep the bedding relatively dry.

Figure 2 – Individual Pen before Addition of Litter – 12’ Wide x 24’ Long x3’ Deep

This system has been operating in Korea and elsewhere for at least 12 years with no need to clean or replace the bedding or inoculate with additional IMO.

Bedding needs to be added periodically. For pens with pigs that are 40-100 lb body weight, 3 cubic yards per pen need to be added every 6 months (or 1/2 cubic yard every month). For pens with pigs that are 100-220 lb body wt, 6-7 cubic yards of sawdust needs to be added every 6 months per pen (or 1 to 1-1/2 cubic yards every month).

**Capacity.** The IDLS piggery is designed to allow the animals more space than some conventional systems. Each 12’ x 24’ pen can accommodate 17 market size (220#) hogs or about one animal per 17 square feet. Each pen can accommodate six breeding sows. Conventional systems usually have up to twice the density. For various reasons, breeding boars should limited to one animal per pen.

Figure 3 – Four of the Five Pens Filled with Litter, 12'x24' each, Located in a30'x60' Building

**System.** The IDLS piggery involves several concepts beyond simple construction. Building orientation (N-S), ventilation, regulated sunlight, and addition of the IMO and lactic acid are also components of the system. The payback is healthier animals that are less susceptible to disease and personal injury as well as higher average-daily weight gain. **Animal health and comfort is a major consideration in this system**.

**CONCLUSION**

The Waste Management Plan for this facility was developed in April 2007, by Buddy Perry, while he was a Soil Conservationist with the Puna Soil & Water Conservation District. He is now a Soil Conservationist with the Natural Resources Conservation Service in the Hilo Field Office.

The Hawaii Department of Health issued a permit to build the demonstration project in Kurtistown, Hawaii. The piggery was constructed and has been operational since August 2009.

The initial cost of the IDLS would probably be less than the conventional system due to the elimination of the need for storage of waste or the need for land area for application of the nutrients. The cost of IDLS would be similar to the MDL system described elsewhere in this document.

It is very likely that the IDLS could be a preferred method to raise hogs on the scale customarily encountered in the Pacific Island Area, particularly in the areas of high rainfall. It will be totally dependent upon basic operation skills of the farmer as well as making the initial investment to pay for the structure.

There is a real interest in this method, particularly if the agency can assist in its' implementation. Please notice the sketch (**Appendix C**) for the planned expansion of this concept at the Kang Piggery in Kurtistown.

From a technical standpoint, the IDLS will meet conservation concerns of improving air and water quality, reducing water use, and improving the living conditions of the animals.

The process most closely mimics the existing standard for Composting Facility (317).

NRCS supports the implementation of this system and is working to adapt it for inclusion into our Field Office Technical Guide.

APPENDIX - A

# A Modified Dry Litter Waste Management System – The Kealia Farms Model

New animal waste management systems are helping hog producers in Hawaii deal with the costly and potentially polluting aspect of hog farming. Among new systems, the Modified Dry Litter Waste Management System has a definite advantage. This model, unlike traditional water-based waste management systems, does not use water to wash down the pens and transport animal waste to a storage lagoon, which can be a major pathway for surface and groundwater pollution.

An interagency team convened by the Hawaii Association of Conservation Districts and supported by a 319 grant, developed a Hawaiian style waste management system by modifying the dry litter waste management systems currently being tested in other land- limited countries, for example, the Netherlands and Japan. In this system, the hogs are housed in sloping pens and dry litter or bedding is used to help push the waste down slope into a composting or storage pit. Various slope ratios and types of dry litter help determine the effectiveness of the system and the quality of the composted product.

## How the system works

The Kealia Farm's model significantly improves the original dry litter waste management system by incorporating pen sizes with slopes ranging from 15 to 1 to 20 to 1. The optimal pen size for these slope ratios are 8 feet by 16 feet, which is typical of pen designs used in the United States (but smaller than a typical pen in Japan and the Netherlands).

Wood chips and grass cuttings were used as litter; both are excellent bedding materials for the hogs and keep the pens dry, but the Kealia and Masazu Farms (in Kona District, Hawaii) achieved their best results using macadamia nut (Macadamia integrefolia) husks. The hogs crush the bedding materials and the manure with their hooves; the mix dries and begins to decompose (compost), and it eventually moves down slope into a composting or storage pit, where high temperatures finish the job.

Temperatures in the composting pit range on average from 140 to 150 F. When the team analyzed the cooked, or composted, product, it contained 2.6 percent nitrogen, 0.6 percent phosphorus, and 2.6 percent potassium with a carbon to nitrogen ratio of 13:1 making it a good medium for organic farming. A typical pen operated under this system can convert about 30 cubic yards of green waste into 20 cubic yards of valuable compost annually.

## Healthy hogs

As the green waste is excellent bedding for the hogs and keeps the pens dry except where the hogs are watered, the modified dry litter waste management system also

produced healthy hogs. In fact, feeder hogs produced under the modified dry litter waste management system easily matched and exceeded the industry's national production standard. Feeder hogs in the modified dry litter pens averaged a daily weight gain of 1.20 to 1.69 pounds; the national standard is an average daily weight gain of 1.25 pounds. During the trials, small feeder hogs entered the system weighing an average of 22.0 lbs. A typical system has 16 pens. Each pen can be stocked with 30 wean-offs at the beginning of the growth cycle, then each group can be subdivided as they reach heavier weights to prevent overcrowding.

### Environmental and other assets

Because it does not rely on wash downs to move the waste out of the pen and subsequently to a lagoon or storage tank, the modified dry litter waste management system eliminates one of the major potential sources of contaminated runoff on the farm. And it has other attractive benefits: lower water bills and labor costs to the farm because pen washing is virtually eliminated.

Odor production is practically nonexistent. Hydrogen sulfide levels recorded throughout the production and storage areas were considerably less than the conventional wash down or scrapper system. The dry litter waste management facility produced 10.7 parts per billion hydrogen sulfide levels and 5.0 parts per billion in the production and storage area. The control or conventional wash-down facility had measurements of 54.3 parts per billion and an average of 104.5 parts per billion at the effluent entry to the waste lagoon. The modified dry litter waste management system succeeds in turning a potentially polluting waste product into a lucrative income stream. A yard of compost imported from the mainland United States normally sells for about $100 per cubic yard including freight costs. The organic farmer on the island of Hawaii can obtain similar material at farms with the modified dry litter waste management system at approximately one-third that price. Therefore, each pen can produce about $660 of compost annually.

### Expanding benefits

The prospects are bright that as more farmers learn about the system, other hog farms in Hawaii will install modified dry litter waste management systems. The technology is scheduled to be exported to the rest of the Pacific Basin Islands supported by additional section 319 funding.

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# APPENDIX - B

**How to make Indigenous Microorganisms – By the Numbers**

The NRCS National Engineering Handbook-Part 637, Composting-Subpart 637.0206-Pathogens, mentions that pathogens can be destroyed as a result of competition with indigenous microorganisms (IMO). In order to ensure that a sufficient amount of IMO's are present, they must be cultivated.

The following is a process for "cultivating" microorganisms to obtain a desirable concentration of IMO's, for use in the piggery.

1. Prepare enough hard-cooked rice to fill a 1'x1'x4" high clean wooden box at least half way. Hard-cooked rice is rice cooked with a little less water.
2. Cover the box with parchment paper and secure it with a large rubber band. Protect the contents with a stiff wire screen or Plexiglas cover. Rodents and contaminants (including water) need to be excluded from the container. Partially bury (2") the container outside in a shaded area (not roofed) and cover with leaves. This interface with the soil allows IMO's from the soil to enter the box. In about a week there will be a fair amount of white mycelia growth (fungi). If it is a color other than white, then it is contaminated with less effective fungi. This is known as IMO #1.
3. Mix IMO #1 with brown sugar on a 1:1 ratio and place in a clean clay pot. Cover and let set for seven days in a cool shaded area– This is known as IMO #2.
4. The process for making IMO #3 is little more involved (See references). IMO #2 is mixed with specific amounts of Water, Oriental Durable Nutrient, Mineral A, Brown Rice Vinegar, Fermented Plant Juice, and Wheat Mill Run. 65-70% moisture. Ferment. This is known as IMO #3. It can be used as potting "soil". It can be diluted with water and sprayed on organic material in order to initiate the composting process.
5. IMO #4 is made by mixing equal amounts of IMO #3 with soil. The soil should be from the cropped area and an undisturbed area on the farm. IMO #4 is added to the piggery litter to assist in the decomposition of the pig manure.

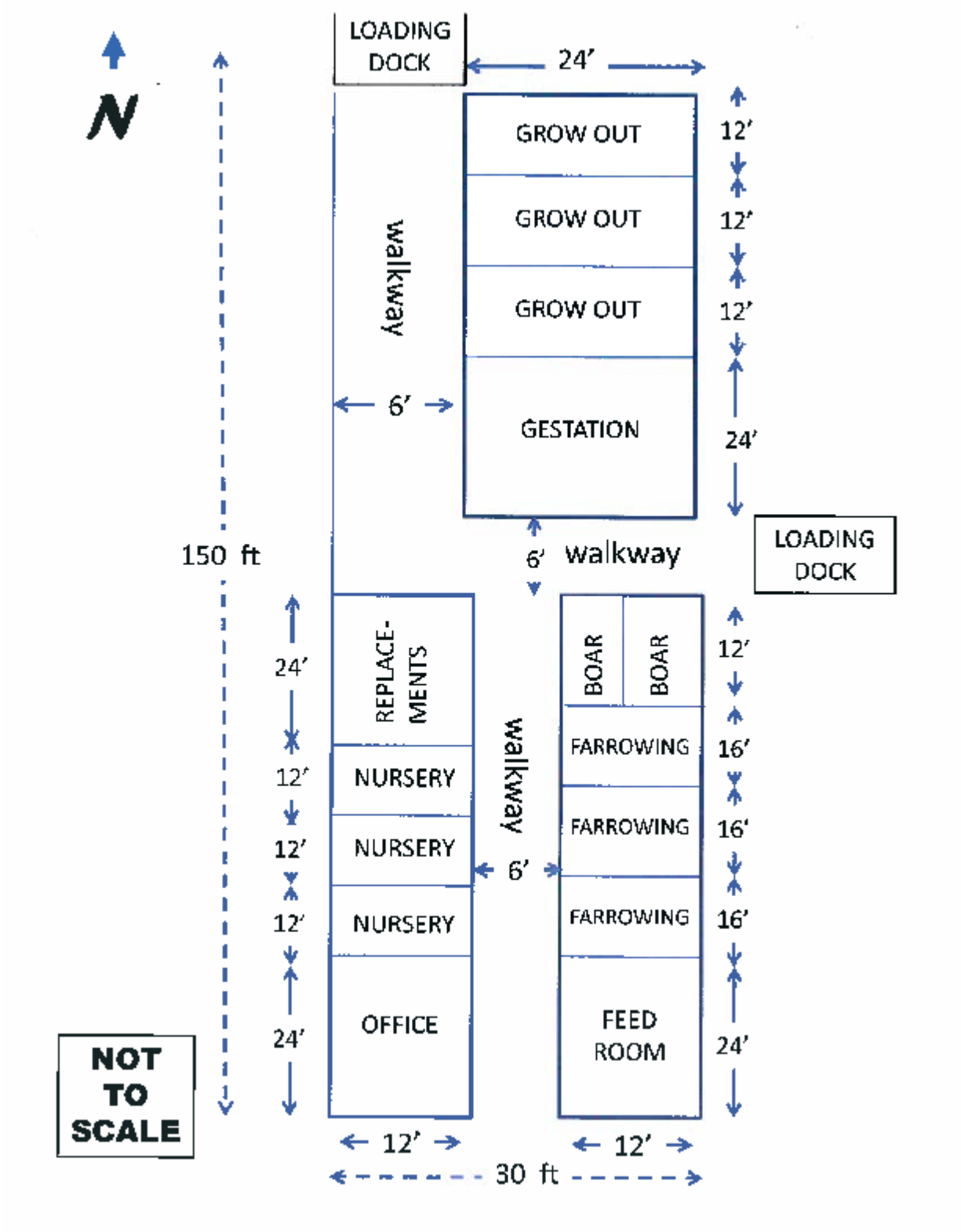
References:

Hoon Park, Michael W. Duponte, "How to Cultivate Indigenous Microorganisms"; University of Hawaii, Cooperative Extension Service, August 2008

David Ikeda, Chapter 2 (DVD), How to Collect Microbes; Integrated Pest Management, Big Island Swine Day and Tour, August 13, 2009, Kurtistown, Hawaii

National Engineering Handbook, Part 637-Composting, Subpart 637.0206-Pathogens

# APPENDIX - C




Layout of a Planned 30' Wide x 150' Long Expansion