PHILIPPINE AGRICULTURAL ENGINEERING STANDARD PAES 414-2:2002
Agricultural Structures - Waste Management Structures
Part 2: Agricultural solid waste - Composting

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of the AFMA Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA).

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997 – Rules for the Structure and Drafting of International Standards. It specifies the general requirements for waste management structures – agricultural solid waste - composting.

The word "shall" is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.

In the preparation of this standard, the following references were considered:

Agricultural Waste Management Field Handbook. United States Department of Agriculture. July 1996.

Crites, R. and G. Tchobanoglous. Small and Decentralized Wastewater Management Systems. WCB McGraw-Hill, 1998.

Draft Guidelines for Aerobic Composting Facilities and Compost Use. Ministry of Environment. Ontario, May 1998.

Livestock Waste Facilities Handbook, MWPS-18.

R.A. No. 9003, Ecological Solid Waste Management Act of 2000.

Agricultural Structures - Waste Management Structures
Part 2 – Agricultural Solid Waste - Composting

1 Scope

This standard specifies the minimum requirements for composting agricultural solid waste management. It does not include hazardous solid waste.

2 Reference

The following normative document contains provisions which through reference in this text constitute provisions of this National Standard:

PAES 414-1:2002 Agricultural Structures – Waste Management Structures: Part 1 – Agricultural Liquid Waste

PD 1152 Provisions of the Environmental Code on Solid and Liquid Waste Disposal

RA 9003 Ecological Solid Waste Management Act of 2000

Rules and Regulations of National Pollution Commission, 1978

3 Definition

For the purpose of this standard, the following definitions shall apply:

3.1
agricultural solid waste
wastes resulting from the production and processing of crops and animals or agricultural products, including manures with at least 20% solids, pruning and crop residues wherever produced

3.2
bulking agent
any item used to improve the compost structure and to increase porosity to allow internal air movement

3.3
C:N ratio
weight ratio of carbon to nitrogen

3.4
compost mix
mixture of an organic waste with amendment(s) or bulking agent(s) in the proper proportions to promote aerobic microbial activity and growth and to achieve optimum temperatures

3.5
composting
controlled decomposition of organic matter by micro-organisms, mainly bacteria and fungi, into a humus-like product

3.6
composting amendment
any item added to the compost mixture that alters the moisture content, C:N ratio, or pH

3.7
curing
process where fungi digest the carbons not degraded during composting and further stabilize the nutrients

3.8
disposal site
site where solid waste is finally discharged and deposited

3.9
hazardous waste
solid waste or combination of solid waste which because of its quantity, concentration, or physical, chemical or infectious characteristics may: cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness

3.10
leachate
shall refer to the liquid produced when waste undergo decomposition, and when water percolate through solid waste undergoing decomposition; contaminated liquid that contains dissolved and suspended materials

3.11
storage
interim containment of solid waste after generation and prior to collection for ultimate recovery or disposal

3.12
windrow composting
involves the arrangement of compost mix in long, narrow piles or windrows that are periodically turned to maintain aerobic conditions

4 Location

4.1 The location of solid waste disposal sites shall conform with the existing zoning, land use standards and regulations set by Department of Environment and Natural Resources (AO 34 and 35) and other national policies such as Ecological Solid Waste Management Act of 2000 (RA 9003) and Environmental Code on Solid and Liquid Waste Disposal (PD 1152).

4.2 Solid waste disposal sites should be located so that the prevailing winds tend to disperse and transport the odor away from residences.

4.3 The site should be hidden from public view with landscaping.

4.4 It should be located in soils with at least 15% clay. If it is located in other soil types, provision for soil sealant should be made.

5 Types

5.1 Storage

5.2 Composting

5.2.1 Windrow composting

5.2.2 Aerated static pile

5.2.3 In-vessel system

6 Functional requirements

6.1 Storage

6.1.1 Factors to consider in the design of storage facilities for solids shall include type, number and size of animals, number of days storage desired, and the amount of biodegradable waste generated in processing plants for animals, fruit and vegetables.

6.1.2 There shall be provision of properly designed containers or receptacles in selected collection points for the temporary storage of solid waste while awaiting collection and transfer to processing sites or to final disposal sites.

6.1.3 For solid manure storage, it should be located for year-round access so manure can be spread when field, weather, and regulations permit.

6.1.4 There shall be provision to prevent surface runoff water from entering the storage.

6.1.5 Construction

6.1.5.1 Floor shall be concreted and shall have a slope of 2% to one or both sides with openings on the low side to a gutter or surface drain.

6.1.5.2 Floor drains shall be provided with removable grills. Underground non-corrosive pipe with a diameter of 150 mm shall be installed to carry the liquids away.

6.1.5.3 Walls shall be concrete.

6.1.5.4 Access for unloading and hauling equipment shall be provided.

6.1.5.5 Entrance shall be provided with ramps so that surface water does not drain into the storage. Ramp slope should be 20:1 – 10:1.

6.2 Composting

6.2.1 Feedstock quality

Feedstock shall be organic and biodegradable. It shall not contain contaminants or foreign matter or hazardous waste.

6.2.2 Composting time

Composting time varies with C:N ratio, moisture content, climate, type of operation, management, and the types of wastes and amendments being composted. Typical composting time is shown in Table 1.

Table 1 – Typical composting time

Method	Composting time
Windrow	4 months
Aerated static pile	4 weeks
In-vessel	7 – 30 days

6.2.3 C:N ratio

The C:N ratio of the compost mix should be maintained for most compost operations between 25:1 and 40:1. The C:N ratio for the compost mix is calculated from the C:N ratios of the waste, bulking agents, and amendments. Table 2 shows typical carbon to nitrogen ratios of common composting materials.

Table 2 - Typical carbon to nitrogen ratios of common composting materials

Material	C:N ratios
Cattle manure (with straw)	25–30
Cattle feedlot	13
Corn & sorghum stover	60–100
Cucumber	20
Dairy manure	10–18
Garden wastes	20–60
Grain rice	36
Grass clippings	12–25
Green leaves	30–60
Horse	19
Lamb	10
Pig manure	5–8
Potato tops	25
Poultry manure (fresh)	6–10

Table 2 – *continuation…*

Material	C:N ratios
Poultry manure (henhouse litter)	12–18
Residue of mushroom culture	40
Rice straw	48–115
Saw dust	300–723
Seaweed	19
Soybean residues	20–40
Straw	40–80
Sugar cane (trash)	50
Tomato leaves	13
Tomatoes	25–30
Veal	2
Watermelon	20
Water hyacinth	20-30
Weeds	19
Wood chips	100–441

6.2.4 pH

The pH varies throughout the compost mixture and during the various phases of the composting process. The recommended pH in the compost mixture should be 5.5 – 8.0. Optimum pH control should be accomplished by adding alkaline or acidic materials to the initial mixture.

6.2.5 Aerobic conditions

The composting mass shall be provided with adequate ventilation. At least 5% oxygen shall be provided.

6.2.6 Temperature control

6.2.6.1 If waste is composted inside a fully enclosed vessel, the waste shall be maintained at a minimum temperature of 55^{o}C on at least three different days.

6.2.6.2 If waste is composted in windrows or in a vessel that is not fully enclosed, the waste shall be maintained at a minimum temperature of 55^{o}C on at least 15 different days. The windrows shall be turned at least five times after the temperature first reaches 55^{o}C and the temperature must reach at least 55^{o}C after the fifth turning.

6.2.6.3 If waste is composted using the static pile method, the waste shall be maintained at a minimum temperature of 55^{o}C on at least 15 different days. The pile shall be covered with an insulating material such as cured compost.

6.2.6.4 Temperature shall be measured at a depth of one meter from the surface of the composting mass and shall be measured at a sufficient number of points.

6.2.7 Moisture

Moisture content should be maintained 50% - 60% to nourish the composting bacteria.

6.2.8 Particle size

Particle size shall be 5 mm – 50 mm. For very dense compost materials, a bulking agent or amendment shall be incorporated and shall be mixed or ground to the required size before being added to the compost pile.

6.2.9 Construction

6.2.9.1 Windrow composting

6.2.9.1.1 Windrows should be 1 m – 2 m high and 2 m – 5 m wide at the base (Figure 1).

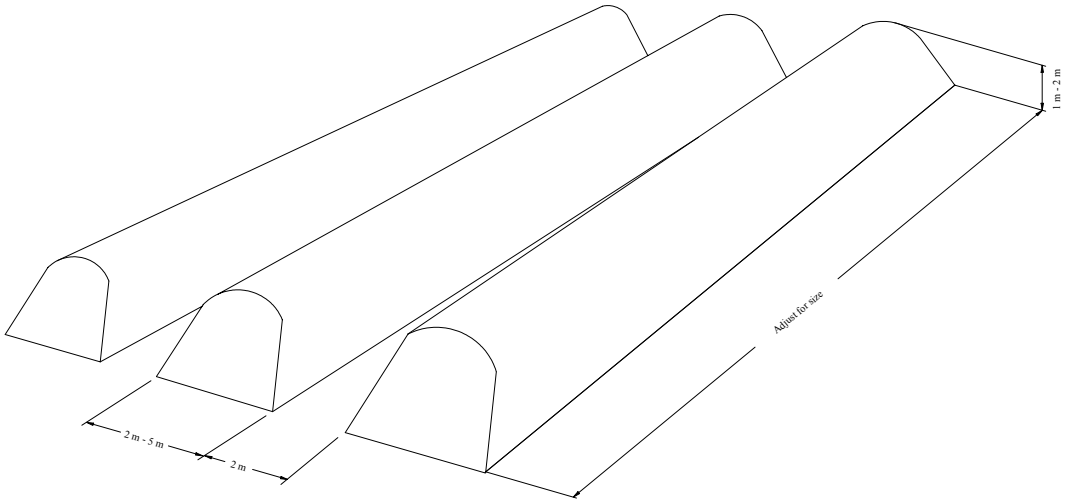


Figure 1 – Typical windrow composting

6.2.9.1.2 Ventilation should be achieved through natural ventilation with mechanical mixing of the piles.

6.2.9.2 Aerated static pile

6.2.9.2.1 In aerated static piles, the material shall be aerated by a system of perforated pipes placed in the layers of compost pile (Figures 2 and 3). Forcing air through may not be necessary with small compost piles that are highly porous or with a mix that is stacked in layers with highly porous materials.

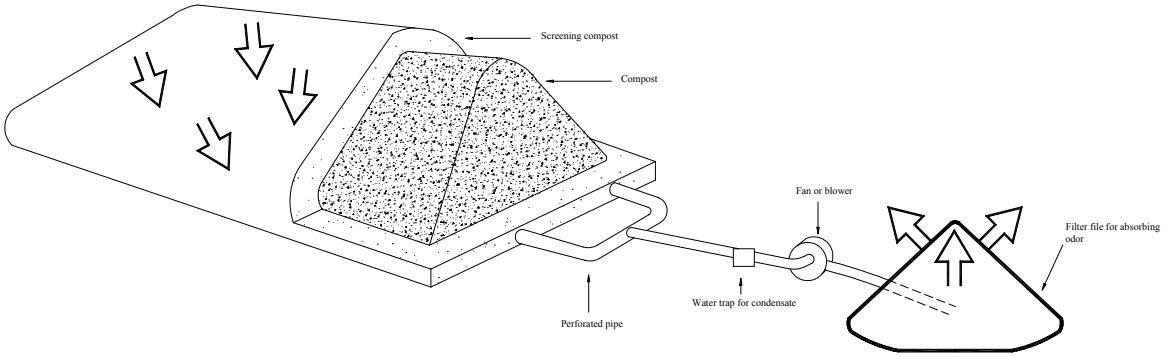


Figure 2 – Typical static pile composting

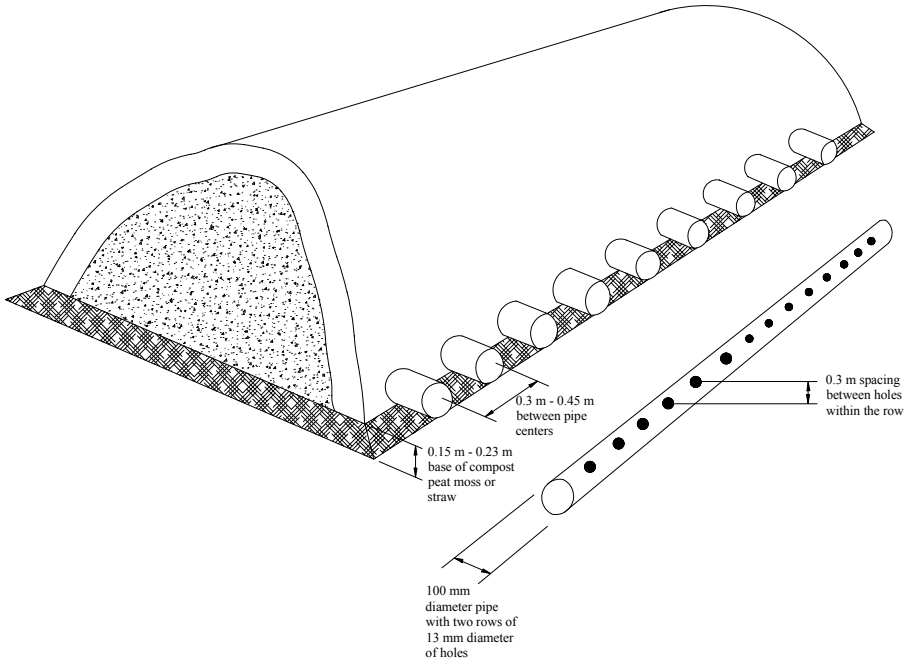


Figure 3 – Typical duct placement for static pile composting

6.2.9.2.2 The exterior of the pile should be insulated with finished compost or other material.

6.2.9.2.3 The dimension of the static pile should be based on the blower's capacity and the stacking characteristics of the waste.

6.2.9.2.4 The compost mixture height generally ranges from 2.4 m – 4.5 m and the width should be twice the depth.

6.2.9.2.5 Individual piles should be spaced about a half the distance of the height.

6.2.9.3 In-vessel system

In-vessel reactor should be enclosed in a building or a closed reactor to control temperature, moisture and odor and may involve the addition of a controlled amount of air over a specific detention time.

6.2.10 Curing

The pile shall be cured when turning no longer results in an increase in temperature. The pile shall not be disturbed for 1 month – 2 months. After curing, the compost should be screened, if necessary, to remove any non-biodegradable compounds and should be analyzed to determine nutrient value.

6.2.11 Compost quality

Compost products shall conform with the standards for organic fertilizers set by the Department of Agriculture.

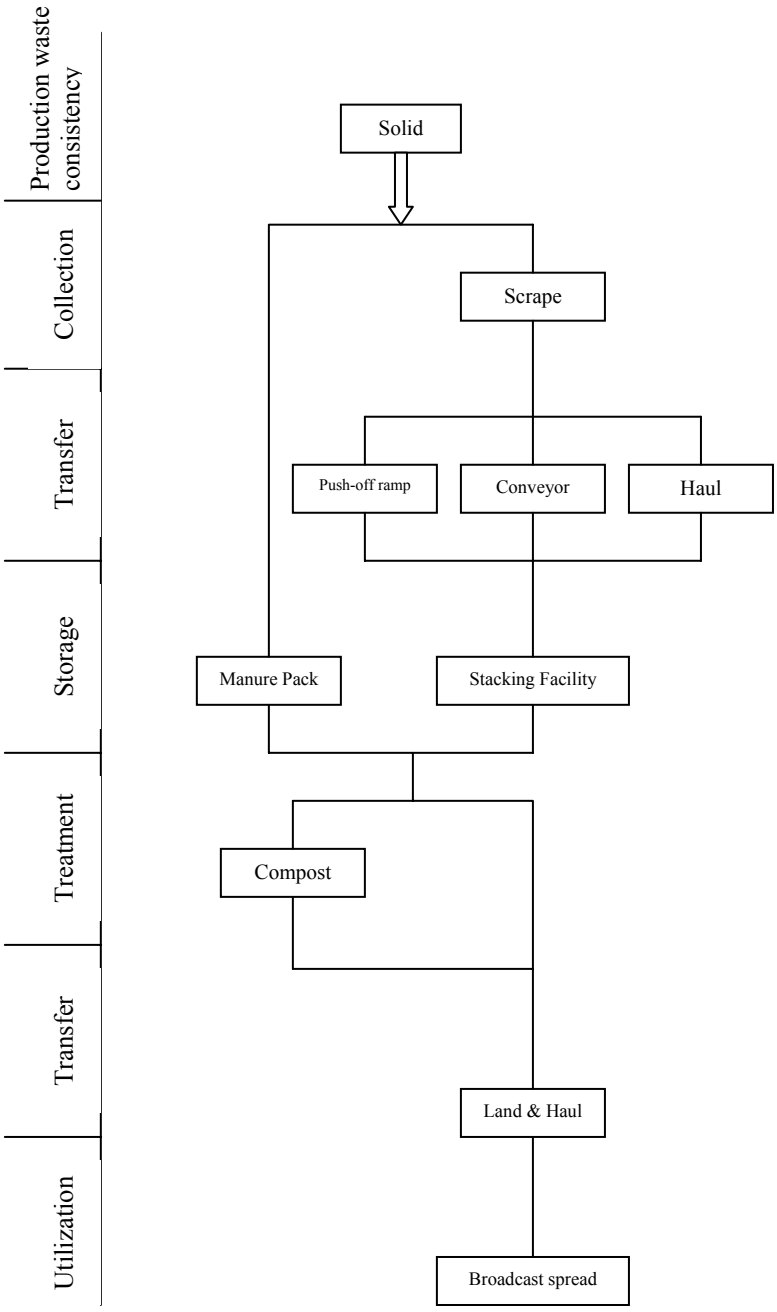
6.2.12 Disposal

6.2.12.1 Compost which fails to meet quality requirements shall be disposed at an approved waste disposal site.

6.2.12.2 Leachate from storage and composting shall be treated as liquid waste. Refer to **PAES 414-1:2002**.

Annex A
(informative)

Typical components of solid waste management



Annex B
(informative)

Daily manure production

Animal	Size	Total manure production			Water	Density	TS	VS	BOD_5
	kg	kg/day	m^3/day	L/day	%	kg/m^3	kg/day	kg/day	kg/day
Dairy cattle	66.96	5.36	0.01	5.68	87.30	977.46	0.71	0.58	0.12
	111.61	8.93	0.01	9.08	87.30	977.46	1.16	0.94	0.19
	223.21	18.30	0.02	18.93	87.30	977.46	2.32	1.92	0.38
	446.43	36.61	0.04	37.48	87.30	977.46	4.64	3.84	0.76
	625.00	51.34	0.05	52.62	87.30	977.46	6.52	5.36	1.06
Beef cattle	223.21	13.39	0.01	14.38	88.40	945.93	1.56	1.34	0.36
	334.82	20.09	0.02	21.20	88.40	945.93	2.32	1.96	0.54
	446.43	26.79	0.03	28.39	88.40	945.93	3.08	2.68	0.71
	558.04	33.48	0.03	35.58	88.40	945.93	3.88	3.30	0.89
Swine									
Nursery pig	15.63	1.03	0.001	1.02	90.80	945.93	0.09	0.08	0.03
Growing pig	29.02	1.88	0.002	1.82	90.80	945.93	0.17	0.14	0.06
Finishing pig	66.96	4.38	0.005	4.28	90.80	945.93	0.40	0.32	0.13
	89.29	5.80	0.006	5.68	90.80	945.93	0.54	0.43	0.17
Gestate sow	122.77	3.97	0.004	4.16	90.80	945.93	0.37	0.29	0.12
Sow and litter	167.41	14.73	0.015	15.14	90.80	945.93	1.34	1.07	0.45
Boar	156.25	4.91	0.005	5.30	90.80	945.93	0.45	0.38	0.16
Sheep	44.64	1.79	0.002	1.74	75.00	1024.76	0.45	0.38	0.04
Poultry									
Layers	1.79	0.09	0.0001	0.10	74.80	945.93	0.02	0.02	0.01
Broilers	0.89	0.06	0.00087	0.07	74.80	945.93	0.02	0.01	0.00
Horse	446.43	20.09	0.021	21.31	79.50	945.93	4.20	3.35	-

Annex C
(informative)

Fruit and vegetable waste characterization

Fruit/vegetable	Moisture content	Total solids	Volatile solids	Fixed solids
Banana, fresh	84.0	16.0	13.9	2.1
Broccoli, leaf	86.5	13.5		
Cabbage, leaf	90.4	9.6	8.6	1.0
Cabbage core	89.7	10.3		
Carrot, top	84.0	16.0	13.6	2.4
Carrot root	87.4	12.6	11.3	1.3
Cassava, root	67.6	32.4	31.1	1.3
Corn, sweet, top	79.8	20.2	19.0	1.2
Lettuce, top	94.6	5.4	4.5	0.9
Onion, top, mature	8.6	91.4	84.7	6.7
Orange, flesh	87.2	12.8	12.2	0.6
Orange pulp	84.0	16.0	15.0	1.0
Potato, top, mature	12.8	87.2	71.5	15.7
Squash	91.3	8.7	7.9	0.8
Tomato, fresh	94.2	5.8	5.2	0.6
Tomato solid waste	88.9	11.1	10.2	0.9