POULTRY LITTER COMPOST PRODUCTION, A MEANS OF DISTRIBUTING EXCESS NUTRIENTS[1]

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ABSTRACT

Alternate technologies of compost manufacture from poultry litter (manure) were studied as a means of producing a value added product for the landscape and nursery industry. Static pile and turned windrow technologies were investigated on a commercial scale with the composting of nearly 1,000 tons of material. The major difference between the technologies is the amount of energy and labor required. Static pile systems require less energy but more time than windrow turned systems. There was no process advantage found for passively aerated static piles over static piles but costs of passive aeration for pipes and labor was higher than for static piles. Machine turned windrows completed active temperature production within 100 days while portions of both the static and passively aerated piles continued to actively compost past 300 days. Process operational costs and compost quality were similar among the compost methods studied. Production operational cost is driven by the cost of compost ingredients and accounted for 60 to 70 percent of the cost in the pilot study. Ingredients were poultry litter, wood chips and sawdust. Screened compost was produced at an operational cost of $30 while unscreened compost could be produced for $20 per ton of compost. A production scheme where poultry litter is static pile composted on farms for later transport to regional processing centers appears feasible. This two part composting procedure will eliminate the transport of raw litter and improve poultry biosecurity. Most likely, a private compost business would provide the expertise, on-farm compost procedures and operate the regional facility.

INTRODUCTION

Estimates of poultry litter (manure) production on the Delmarva Peninsula indicate some areas of potential nutrient excess in conflict with Tributary Strategy goals of reduced nutrient input (Brodie and Lawrrence, 1996). Solutions to the problem of excess manure nutrients include the transport of treated manure to areas where it can be assimilated as a soil amendment or fertilizer in an environmentally neutral manner. One opportunity is to develop compost products desired by the nursery industry. Nursery needs are continually increasing and represent a vast potential market for the movement of poultry litter away from the concentrated poultry rearing areas (Bissman and Wheeley, 1997). But can compost from poultry litter be produced in sufficient quantity and quality at low enough cost to satisfy the demands of this market?

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Can poultry litter be partially composted on-farm for later transport to a central facility for further processing? Several cooperative arrangements have been proposed between farmers and composters that can move compost products to market (Brodie, 1996). One proposal was the partial composting of litter on-farm with later transport to a central composting facility for finishing, blending and sale. This paper reports on a study at a large scale compost production site that compared static piles, passively aerated piles and mechanically turned windrows in an effort to establish an economic and compost quality comparison between the methods. The static piles were managed as would be expected on farms and then blended to simulate the activities as would be expected at a central finishing facility.

METHOD

The composting of poultry litter was demonstrated at the New Earth Services composting facility near Hurlock, Maryland. Approximately 520 tons of ingredients were composted in mechanically turned windrows in 1995 and approximately 300 tons of ingredients were composted in static, passively aerated and mechanically turned windrows in 1996 (Table I).

Compost ingredients consisted of poultry (broiler) litter, chipped wood and sawdust. Multiple samples of each ingredient were mixed to produce a composite sample for laboratory analysis. All analysis was performed by the University of Maryland Soils Testing Laboratory using standard methods. Table II is a summary of the average ingredient properties. Analysis results were utilized to develop compost recipes which provided the desired C:N ratio and moisture content (Brodie, 1994).

Sawdust and wood chips represent a large portion of the cost of compost ingredients. It is anticipated that farmers will attempt to minimize cost and therefore use lesser quantities of wood product than is normally recommended. Recommended C:N ratios for compost mixes range from 25 to 35 (Rynk, 1992). In this demonstration the C:N ratios were depressed to 15 to simulate what might happen on farms (Table II).

Windrow compost mixed in December, 1995 (pile 6 in Table I) was measured as truckloads. Weigh tickets from county operated scales were used to determine the mix ratios. The mixed compost was formed into three windrows each with a triangular cross section of ten feet wide by five feet high and four hundred feet in length. A total of 528 tons of ingredients were used. The mix ratio was approximately 30 percent poultry litter; 35 percent wood chips; and 35 percent sawdust by volume.

Compost was mixed in October 1996 to allow time and motion study and development of a cost of the compost using different production techniques. The production techniques consisted of static with and without a compost cover; passively aerated static with and without a compost cover; and mechanically turned windrow. Compost ingredients were delivered to the compost site by truck. Ingredients were moved to the mixing area by tractor bucket loader. Volume ratios for mixing were measured by the bucketful. Ingredients were proportionately stacked in a windrow that was then mixed by two passes of the compost windrow turning machine. Mixed materials were then stacked as static piles or as turned windrows using the bucket loader.

Four static piles (piles 1,2,3,4 in table I) were constructed with base dimensions approximately fifteen feet by forty feet and a seven to eight foot height with 100 cubic yards of ingredients. The cross sectional shape was triangular. The piles were placed on a sixteen inch deep bed of wood chips placed on the ground to improve aeration capacity. Each static pile bed utilized an additional 36 cubic yards of wood chips most of which were reclaimed at the finish of the compost process and could be utilized in the production of new compost.

Two static piles (pile 2 and 4 in Table I) were covered with a six inch deep layer of previously made compost to act as an insulating blanket and odor control biofilter. Two static passively aerated static piles (piles 3 and 4 in Table I) were constructed on a wood chip bed which contained a twelve inch diameter perforated pipe under the center of the pile and extended the entire pile length. The pipe was laid in one continuous forty foot length in the center of the bed. The pipe was fitted with three rows of one inch diameter holes on one foot spacing to allow air transport into the bottom center of the compost pile.. Static and passively aerated piles were made with 23 percent

Table I. Demonstration piles of poultry litter compost

compost pile		process	process dates	ingredient volume cu yds
1		static	10/12/96 - 9/27/97	
	a	turned once		50
	b	turned three times		50
2		static with compost cover	10/16/96 - 9/27/97	
	a	turned once		50
	b	turned three times		50
3		static passively aerated	10/25/96 - 9/27/97	
	a	turned once		50
	b	turned three times		50
4		static passively aerated with cover	10/28/96 - 9/27/97	
	a	turned once		50
	b	turned three times		50
5		mechanically turned windrow	10/29/96 - 05/12/97	100
6		mechanically turned windrow	12/08/95 - 05/01/96	1,700

poultry litter; 39 percent wood chips; and 38 percent sawdust by volume (3:5:5 in Table II). Static piles were then subdivided such that half the pile was turned once and half the pile was turned three times during the period of composting. Turning was accomplished using a bucket loader in a manner that the wood chip bed and aeration pipe were undisturbed during the process.

Two turned windrows were constructed with a triangular cross section of ten feet wide and five feet high with a combined total length of one hundred feet (pile 5 in Table I). These windrows were not placed on a wood chip bed. Turned windrows were made with approximately 25 percent poultry litter; 37 percent wood chips; and 38 percent sawdust (2:3:3 in Table II).

No water was added to the ingredients during initial mixing or subsequent turning. It was assumed that farmers would not be equipped to provide water. The resulting mixes had moisture contents of 40 to 45 percent which is below the desired moisture level of 50 to 60 percent.

This project is considered a demonstration of compost production and the data generated are specific to the individual compost piles monitored. The inference of trends may be considered subjective in that there was insufficient replication of ingredient mixes and pile configurations to allow statistically meaningful measurement. However, because the demonstration was conducted on a commercial site using methods and employees normal to large scale composting, it is assumed that the experience is realistic.

RESULTS AND DISCUSSION

Ingredient mixing

The mixing of materials for the production of compost must be accomplished in a manner that approximates the desired proportions of the various ingredients. Although simple in concept the task is not so simple in practice at compost sites not equipped with expensive material metering equipment. The ingredients for windrow compost produced in 1995-96 arrived at the site in December. The 27 trailer loads of poultry litter, wood chips and sawdust were each weighed and then deposited in parallel rows such that removing material from the rows in equidistant proportions would approximate the ratio of the ingredients required of the compost recipe. Although expressed in the affirmative, the concept was not understood by the bucket loader operator as was evidenced by exhaustion of

Table II. Average compost ingredient and initial mix properties

parameter	units	poultry litter	wood chips	sawdust	3:5:5 volume mix calculated	2:3:3 volume mix calculated
moisture	% wet weight	40	29	61	42	42
nitrogen	mg/kg dry weight	59,000	3,000	3,200	18,900	20,100
ammonium nitrogen	"	13,000	0	0	3,500	3,800
phosphorous	"	22,000	550	0	6,400	6,800
potassium	"	34,000	1040	530	10,010	10,800
calcium	"	19,000	1100	0	5,800	6,200
carbon	"	385,000	127,900	492,000	275,000	279,200
magnesium	"	12,000	1370	560	4,100	4,400
sulfur	"	10,000	180	1,010	3,200	3,400
volatile solids	"	787,000	380,000	969,000	616,500	621,600
manganese	"	500	80	38	185	194
zinc	"	540	50	6	178	188
copper	"	850	14	3	248	266
C:N	ratio	7	44	153	15	14

the poultry litter pile while having excess wood products. After the error was discovered the remaining wood product was then distributed on the three windrows of mixed materials that had been made. It is important that operators be trained in the concept of ratios and that they understand the needs of the recipe mixing process.

The ingredient mixing for the 1996-97 compost trials of static, passively aerated static and windrow turned piles was accomplished under direct supervision which provided the desired proportions of ingredients in October 1966. The materials were measured by volume through counting the bucketfuls of each ingredient used. Ingredients were proportionally placed in a windrow that was then mixed using the windrow turning machine. The mixed ingredients were then placed in the respective piles or windrows. Each pile contained approximately 100 cubic yards of ingredients which when mixed reduced to 84 cubic yards. The reduction in volume is a result of a filling of voids between large particles with smaller particles of different materials. The percentage change in volume is dependent on the physical properties of the particular materials used.

The operator of a bucket loader cannot achieve a consistent bucket volume of different types of ingredients or of the same ingredient when the resource pile changes shape. During this demonstration an overflowing bucket of sawdust was common while only about two-thirds of the bucket was filled with poultry litter. The operator may not be able to see the amount of bucket fill and may not be able to judge the quantities moved. Ingredient quantity deficiencies were corrected by adjusting the required number of bucket fills to make up for the lack of volume placed in the bucket. However, if the bucket operator fails to occasionally stop and observe the bucket capacity being moved the desired recipe may not be achieved.

Composting process

The windrows constructed in December of 1995 were turned using the compost turning machine on a schedule determined by the site operator. Temperatures, oxygen concentration and turning event data were not sufficiently recorded by the operator to allow a description of the compost process for these windrows. Piles and windrows constructed in October of 1996 were monitored for temperature, oxygen concentration and physical appearance with enough regularity to describe the process.

Compost oxygen concentration was less than one percent in all piles and windrows for all depths in the mass for several months after construction. The consistency of this low reading discouraged the operator from taking

regular measurement resulting in a lack of oxygen data for the entire project. Sporadic measurements indicated an increase of oxygen concentration to three to four percent within eighteen inches of the pile surface but less at deeper regions. For the static piles this low oxygen concentration was independent of whether the pile was passively aerated or covered with compost. However, after pile turning higher oxygen concentrations could be measured directly over the aeration pipe.

The lack of oxygen concentration would normally be indicative of anaerobic processes accompanied by cold temperatures, water saturated mass, blackness of the material and offensive odor. Machine turned windrows did not have these characteristics. Inspection of turned portions of the static piles showed some blackness of the mass but no major regions of water saturation. The only odor present was ammonia which was anticipated because of the low C:N ratio used in the mix recipe. There was no foul odor as is usually associated with anaerobic processes.

Compost temperature was rigorously measured by the operator with a long stem dial thermometer. Measuring temperature is more rewarding than measuring oxygen in that the numbers change and trends can be noticed. Therefore, temperature monitoring is more acceptable to site operators than oxygen monitoring even though oxygen monitoring can be used to predict a problem while temperature indicates that a problem may have already occurred.

Temperature histories for each treatment are shown in Figure 1. Each pile and windrow was monitored in six locations and the temperatures are shown as the mean for the pile on the day of record. The temperatures of the different treatments were different in timing and degree. All temperatures averaged more than 55°C for five or more consecutive days at some time during the process.

In general:

* piles with compost cover (2 and 4) had lower temperatures than uncovered piles (1 and 3)

* static piles that were turned three times (1b,2b,3b and 4b) had higher average temperatures than piles that were turned only once (1a,2a,3a and 4a) but the latter piles had the higher peak temperatures which occurred after turning

* passively aerated static pile (3) showed little difference in temperature as compared to static pile (1)

* all static piles (1,2,3 and 4) reached temperatures higher than the machine turned pile (5)

* the machine turned pile (5) cooled to ambient after 100 days of processing indicating a completed process

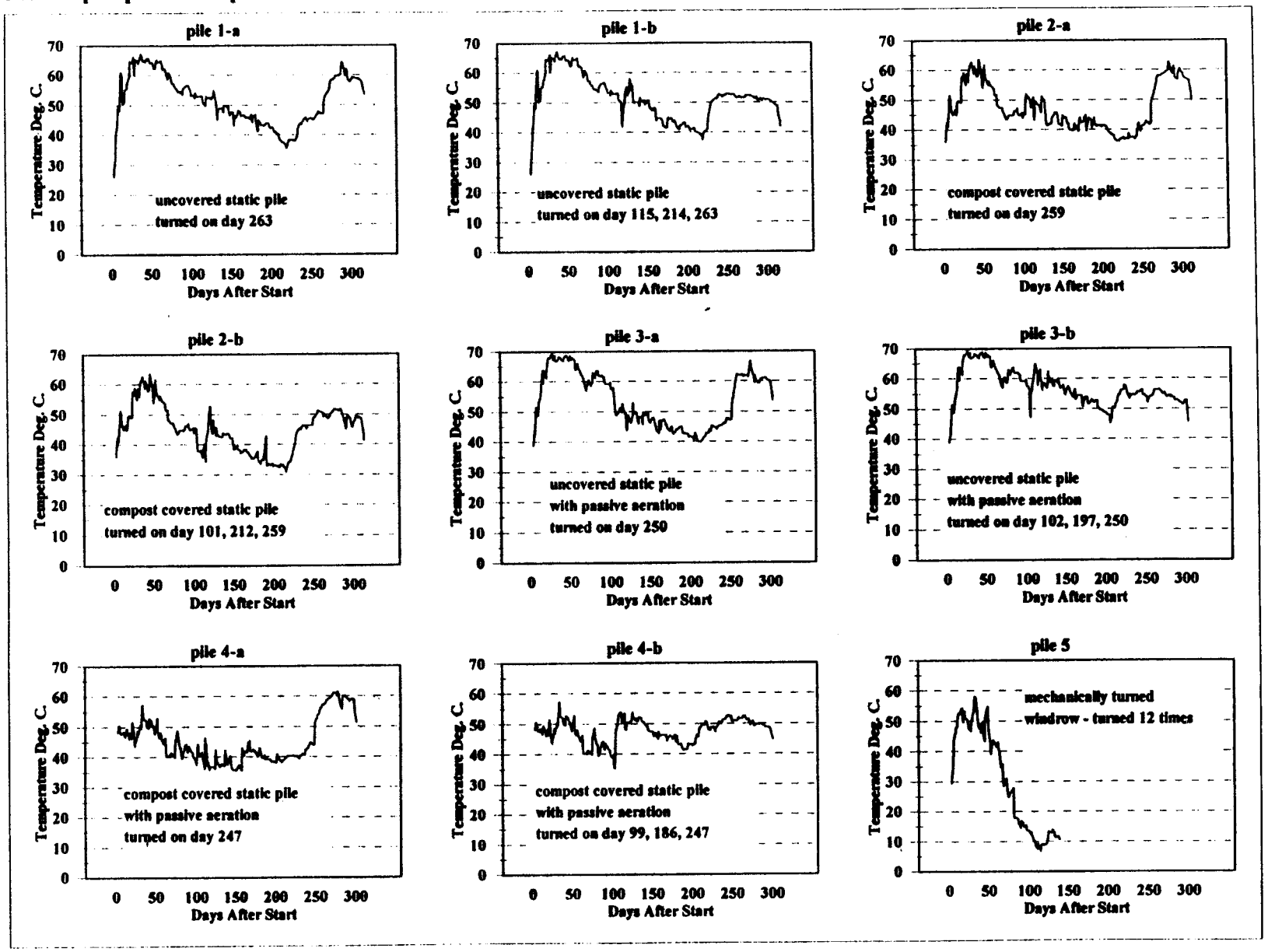
* all static piles (1,2,3 and 4) after 290 days of processing had temperatures above 50°C

* all static piles had temperatures on the side exposed to the winter sun consistently higher than temperatures on the shadow side

Reasons for the process differences can be postulated based on the temperature information and other observations during and after the turning of the piles.

The compost cover on static piles was reasoned to collect odor and ammonia which may be released from the composting mass, to act as an insulating blanket to promote heat retention and to provide a barrier to fly attraction to the raw poultry litter in the mix. It appears that the cover did not have an exceptionally beneficial effect on temperature retention and may have been responsible for reduced temperature by dampening the air flow through the pile. Small flies or gnats were present at all piles and it could not be differentiated if the cover provided any insect advantage. None of the static piles developed obnoxious odor. Therefore, it can be suggested that the effort and cost of placing a compost cover on static piles is unwarranted when using the combination of ingredients provided in this demonstration.

Figure 1. compost process temperatures



The use of a single large pipe for passive aeration appears to have allowed slightly increased temperatures in piles without a compost cover and in covered piles that had been turned and in the process lost the compost cover. Oxygen concentrations when measured were not different between passively aerated and static piles. All of the uncovered piles reached temperatures above 60°C independent of passive aeration. It appears that the sixteen inch depth of wood chips was a sufficient base for air movement without the pipe.

The number of times the pile was turned effected the maximum temperature reached and the timing of the occurrence. All static piles which were turned once after 250 to 260 days sustained temperatures of between 50 and 70°C for four to five weeks after turning. This was independent of compost cover or passive aeration. All static piles which were turned three times in 250 days showed an elevated temperature after each turning but only the passively aerated pile without a compost cover sustained temperatures above 60°C for an extended period of time after turning. This elevated temperature is an important aspect of the process because the previously unturned static piles were producing a dense crop of weeds on the surface which added available nutrients and energy when mixed with the internal compost mass. The elevated temperature is necessary to destroy the weed seeds. It appears that with these recipes sufficient process heat can be generated with a single late turning of a static pile.

During the first turning of piles turned three times the compost was inspected for odor, color and moisture. Generally ammonia was released during turning but no other objectionable odor was noted. Moisture was 50 to 60 percent as determined by the hand squeeze method. The wettest regions were in a twelve inch layer approximately sixteen inches below the outside surface. This was probably a combination of rain infiltration combined with internal vapor condensation as the vapor migrated toward the colder outside regions of the pile. Compost covered piles were wetter than piles not covered. Passively aerated piles were drier in the center than non aerated piles. Some regions of black material were present in all piles but were not accompanied with odor. The chip bed was dry and light colored in passively aerated piles while non aerated pile chip beds were dark and moist but not saturated. These conditions were less noticeable at subsequent turnings.

During the turning of piles turned only once after 260 days of process there was little difference in appearance between the compost piles. Ammonia was released but not objectionable odor. Moisture was still high with laboratory samples ranging from 32 to 50 percent water.

After 320 days all static piles were cooling but had not reached ambient temperature. The material from all piles was combined into a windrow and machine turned twice in two weeks. The temperatures climbed in all windrows to 50°C that lasted for several days then declined. Ammonia release was no longer evident. The static pile compost was ready for screening 350 days after initial pile construction. During this period excessive rainfall increased the moisture content of all the compost to between 40 and 45 percent.

The machine turned windrow was turned twelve times in 120 days after which the process was considered complete. During the process period temperatures of greater than 50°C were not sustained throughout the mass for periods of more than several days. The turning process in mid winter may have excessively cooled the composting mass. In addition, the small windrow shape required for mechanical turning provided a large windrow surface to mass ratio that easily lost heat to the cold winter atmosphere. The low profile shape and the broad surface area allowed these windrows to capture rainwater that may have reduced porosity needed for air exchange in the mass. A temperature history for similar windrows operated during the summer would most likely show higher compost temperature than experienced with this demonstration.

The demonstration experience indicates that a combination of static and machine turned compost processing is suitable for poultry litter combinations with wood chips and sawdust at less than optimal C:N ratios. Winter and wet season composting in uncovered unturned deep static piles on wood chip beds that are converted to machine turned windrows in warmer and dryer months can be recommended.

Compost yield and quality

The dry mass and volume of the ingredients are reduced through composting as a result of the conversion of carbon to carbon dioxide and the reduction of particle size through microbial degradation. The wet mass may not

show a significant reduction because although water is lost to evaporation, water may be gained through rainfall infiltration on compost processed on sites open to the elements. As compost activity and temperature declines at the end of the process there is less air movement through the mass and the compost develops sponge like characteristics with respect to water retention from rainfall.

It is very difficult to measure compost volume and mass reduction on a commercial scale production facility because all of the product cannot be weighed or measured in known volume containers. Additionally, the bulk density and the volume of the compost changes every time it is stacked or unstacked. Therefore, bulk densities of representative samples and volumetric estimates of non uniform piles and windrows must be accepted as indicative of compost yield from a known quantity of ingredients.

Screening compost is necessary for some markets to assure a desired particle size range and remove unwanted wood chips. The effectiveness of a screen is reduced as the moisture content of the compost is increased. Ideal compost moisture for screening is in the 30 to 40 percent water range. Wetter compost forms balls that roll off the screen with the rejects and may clog the screen mesh resulting in less screened compost and more rejected material than with dry composts. The rejected material is not thrown away but is recycled through the compost process with new mixes in place of some of the wood or sawdust. Although the recycled material may reduce some of the new wood product input, the cost of lost saleable product and of the additional processing of already composted material may exceed the value of the new wood not purchased.

The compost of 1995-1996 produced in machine turned windrows started in December as 528 tons and 1,724 cubic yards of material as delivered to the site. By April 1996 the measured windrows held an estimated 800 cubic yards of compost or about 47 percent of the volume of the initial ingredients. The compost had a moisture content of 48 percent water which was too high for effective commercial screening.

The compost of 1996-97 produced in static piles started in October as 192 tons and 400 cubic yards of ingredient material not including the wood chip bed. Mixing the materials reduced the volume to 336 cubic yards divided equally among four piles. By September of 1997 after the piles had been separated from the wood chip bed and shaped to windrows for curing, the measured windrows contained approximately 67 percent of the volume of the initial ingredients. After commercial screening with a 3/4 inch mesh at about 40 percent moisture the compost yield was 33 percent of the volume and 50 percent of the dry weight of the initial ingredients.

The compost of 1996-97 produced in machine turned windrows started in October as 49 tons and 100 cubic yards of ingredients. Mixing the materials reduced the volume to 84 cubic yards. By June 1996 the measured windrows contained approximately 59 percent of the volume of the initial ingredients. Hand screening several samples through a 1/2 inch mesh at approximately 48 percent moisture the compost yield was 39 percent of the volume and 50 percent of the dry weight of the ingredients.

Screened compost can be bagged and sold at higher market value than unscreened compost that is sold in bulk. The rejects from the screen consist of wood and clumps of wet compost that are recycled into a new ingredient mix in place of purchased wood chips. Used in this manner the rejects have economic value. The chip bed retrieved after moving the static piles can also be used in the ingredient mix but not as a new bed. The purpose of the bed is to allow air flow under the pile and used chips are contaminated with small wet particles which reduces the porosity of the bed. Chips for bedding must be clean and uniform and are more expensive to procure than the tree trimmings or chipped pallets used in the ingredient mix.

Compost chemical content

The chemistry of compost is highly dependent on the chemistry of the ingredients used in the initial mix. During composting dry mass is lost through release of carbon dioxide, ammonia and other compounds to the atmosphere. Other elements that are not part of these gaseous products are retained and their concentrations increased in the finished compost. Table III lists the chemical concentrations found in composite samples of the final composts.

Table III. Chemical concentrations in poultry litter compost

constituent	units	turned windrows Dec95	turned windrows Oct96	combined static piles Oct96
H_2O	% wet wt	41	22	42
N	mg/kg dry wt	16,000	10,100	12,600
P	"	27,000	10,500	11,400
K	"	14,000	6,800	8,300
Ca	"	16,000	16,500	20,200
Mg	"	7,000	4,900	4,800
S	"	na	3,100	2,600
Mn	"	490	300	398
Zn	"	550	240	286
Cu	"	300	230	282
conductivity	mmhos/cm	na	5.5	9.26
percent of initial mix by dry weight				
poultry litter	%	45	30	28
sawdust	"	23	20	21
wood chips	"	32	50	51
percent of initial mix by volume				
poultry litter	%	30	25	23
sawdust	"	35	37	38
wood chips	"	35	38	39

NOTES: na means not available
-- Dec95 windrow was started in December of 1995 and finished in May 1996
-- Oct96 windrow was started in October of 1996 and finished in April 1997
-- Oct96 static piles were started in October 1996, mixed in windrows in August 1997 and finished in October 1997

All composts had elevated electrical conductivity above 5 mmhos/cm (a measure of soluble salts). Utilization of the compost in nursery potting mixes requires electrical conductivity between 2 and 3.6 mmhos/cm. Other applications such as field nursery and landscaping where the compost is mixed with soil are more tolerant of the salt levels in the compost because of the mass dilution and eventual salt leaching.

All of the methods of composting demonstrated in this project produced compost of similar quality when similar ingredient recipes were used. Even the December 1995 compost that used different proportions of ingredients and was mixed and managed with uncertainty produced a product similar to the October 1996 compost. Differences in chemical data may be a result of mixing and sampling variations. It can be concluded that with the materials and methods used, the compost process is very forgiving if the basic conditions of porosity, nutrient and moisture balance are established.

Production costs

Time and motion were measured during the mixing, pile building and turning processes (Table IV). The total time required was proportional to the number of steps required. Windrows for machine turning were made almost twice as rapidly as static piles and slightly less than three times faster than passively aerated static piles covered with compost. However, the times recorded are dependent on the configuration of the site and distances between locations of materials moved as well as the skill of the operator and the capacity of the bucket.

Table IV. Times for processing compost at the demonstration site

operation	static pile	static pile compost covered	passively aerated pile compost covered	passively aerated pile	machine turned windrow
making compost mixes and piles		100 cubic yards of ingredients			
lay pipe - minutes	0	0	15	15	0
place chip bed - minutes	24	24	24	24	0
get ingredients - minutes	55	55	55	55	55
mixing with turner - minutes	10	10	10	10	10
place mix in pile - minutes	40	40	40	40	0
cover with compost - minutes	0	12	0	12	0
total time - minutes	129	141	144	156	65
time - minutes/cubic yard	1.3	1.4	1.4	1.6	0.7
cubic yards/hour	47	43	42	38	92
turning piles minutes/event	20	20	20	20	6
making curing windrows minutes/pile	40	40	40	40	30
turning curing windrows minutes/event					35
screening cubic yards/minute					1.1

The time and motion information was used to develop the operational costs for producing compost to compare the use of static piles and turned windrows. A summary is shown in Table V. The comparison only includes the actual machine and labor time and space costs based on 100 cubic yards of material mixed. This operational cost is somewhat independent of the total mass and was not considered responsive to economies of scale. The additional costs of machine maintenance and ownership, profit return to management, and other overhead items associated with the business were not included in this comparison. These additional costs are responsive to economies of scale and their analysis is beyond the scope of this project.

The processes used for static pile 1a were compared with the machine turned windrow. The use of compost covers, passive aeration and multiple turnings for the static pile were considered of no advantage for improving process time or compost quality. The machine turned windrow required slightly more operational cost than the static pile because of the number of turnings required of the process. However, the static piles required more ingredient cost because of the wood chip bed even when given credit for use of recycled chips. Screening adds operational cost but also reduces finished compost volume by half or more. Although the screen rejects are given credit for being recycled the loss of finished compost exceeds the value of new ingredients. A complicating factor not included here is the value of the screened compost as compared to the unscreened compost. In this example, screened compost would have to be sold for slightly less than twice the price of unscreened compost to make up for the cost of screening.

The cost of ingredients represented 60 to 70 percent of the cost of producing compost in this demonstration. The charge for wood chips and sawdust was equal at $10 per ton. However, depending on the supply of wood residuals there are periods of the year when sawdust or chips may arrive at the site for more or less than $10. In the spring of 1998 the cost of available wood products reached $20 per ton. Wood is usually not available in rural areas of Maryland because residuals from tree trimming, land clearing and other operations are rarely moved from the place of origination and may be left to rot or are burned. The project utilized wood chips that were generated in the metropolitan region approximately 90 miles from the compost site. Looking for wood is a constant exercise of compost management.

Table V. Compost production cost summary

type of compost (100 cubic yard batches)		screened		unscreened	
		static pile	machine windrow	static pile	machine windrow
required time days		350	185	350	185
litter processed tons		13	14	13	14
compost produced tons		22	26	44	39
compost produced cubic yards		34	39	67	59
ingredient cost					
litter	$	130	142	131	142
sawdust	$	149	147	151	147
chips in mix	$	200	197	203	197
chip bed	$	284	0	284	0
chips recycled value	$	(320)	(102)	(144)	0
net cost of ingredients	$	444	384	624	486
operations cost					
loader use	$	80	51	48	33
turner use	$	15	92	15	92
screen use	$	65	57	0	0
energy cost	$	24	28	14	21
site rent	$	11	7	11	7
sample analysis cost	$	40	40	40	40
record keeping cost	$	50	53	50	53
total cost of operations	$	235	275	127	194
total cost of ingredients and operations	$	729	712	802	733
cost of compost production $ per unit of finished compost					
$ per ton		33	28	18	19
$ per cubic yard		22	18	12	12
cost of processing $ per ton of litter used		56	50	61	52

NOTE: Costs are based on a $ per unit time charge for labor, equipment and space and do not consider aspects of ownership and profit which may be affected by the volume of material processed. Compost cost is very sensitive to material yield. The windrow turning machine was used to mix ingredients for the static pile.

The cost of poultry litter was also $10 per ton. Farmers consider poultry litter a tradable fertilizer commodity rather than a waste product. Unlike urban compost operations that can collect tipping fees for incoming wastes, poultry litter composters have to buy the waste. This condition may change if and when government places restrictions on the land application of poultry litter. Use restrictions will reduce the value of the litter and improve the economic situation for composters.

Compost production scenarios

Problems with developing a business to compost poultry litter include but are not limited to the logistics and cost of obtaining ingredient material, actual and perceived environmental impacts of large processing sites and biosecurity. The poultry industry is very concerned about the potential spread of bird disease through the movement of litter carrying trucks moving between farms. All activities must be accomplished with biosecurity in the forefront if composting is to become a viable business.

It is evident from the demonstration project that an advisable scenario would be to mix and static pile compost poultry litter on the farm which produced the litter. After 200 or more days the static pile would be turned. After

an additional 30 days the compost could be removed to a regional processing facility for blending with compost from other farms, curing, screening and preparation for sale.

This scenario could be accomplished by a compost company utilizing trucks, bucket loaders and portable ingredient mixing equipment. Farm to farm traffic could be minimized and biosecurity measures could be controlled by the compost company. Only composted poultry litter would be removed from the farm and the regional processing facility would handle only composted products which would minimize environmental and biosecurity impact.

The production costs developed in this study require adjustment to account for the conditions of the on-farm composting agreements. Adjustments would be based on whether the farmer or the compost contractor is responsible for supplying ingredients, equipment, manpower, and transportation.

SUMMARY

The composting of approximately 2,200 cubic yards of materials from 1995 to 1997 on a commercial scale demonstrated the production of poultry litter compost using turned windrows and static piles. The compost produced had similar qualities regardless of the technology applied when similar ingredient mixes were used. A static pile consisting of poultry litter, wood chips and sawdust with an initial mixture moisture content of 42% placed on a wood chip bed produced desirable process temperature with one turning after 260 days. Process variations including covering the static pile with a layer of mature compost, installing pipes for passive aeration and earlier and more frequent turning did not appear to significantly improve the process. Machine turned windrow processing allowed the production of compost in less than half the time required of static pile composting. The volume of compost produced before screening ranged from 50 to 67 percent of the volume of the initial ingredients. Screening reduced the compost yield to 30 to 40 percent of the ingredient volume. Screen rejects are recycled through new compost. The operational cost of static and turned windrows was similar on a per unit of compost produced basis which averaged $20 per cubic yard of compost screened and $12 per cubic yard unscreened. Ingredients accounted for 60 to 70 percent of the production cost. A combination of on-farm static pile composting and regional center processing for marketing may be a commercially viable enterprise. Good quality compost can be produced for field nursery and landscape use with static piles and/or machine turned windrows at a cost that can be marginally covered by the sale of the compost.

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