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ECONOMIC ANALYSIS OF ALTERNATIVE POULTRY LITTER COMPOST SYSTEMS

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Economic Analysis of Alternative Poultry Litter Compost Systems

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Introduction

Poultry is the number one agricultural industry in North Carolina. In 1989, the total gross North Carolina farm income from poultry was $1.568 billion. Of this amount, broilers and turkeys accounted for $848 million and $407 million, respectively. Over 4,200 farmers are currently engaged in poultry and egg production and an additional 17,000 people are employed by poultry processors. Nationally, North Carolina ranked fourth in broiler production in 1989 with 523 million birds produced, and first in turkey production, with 52.2 million turkeys raised (North Carolina Agricultural Statistics, 1989).

The majority of broilers and turkeys grown in North Carolina are raised in confinement housing. Different bedding materials including wood shavings, sawdust and peanut hulls are used to absorb moisture in these houses. After every 1 to 5 flocks, the litter (bedding and manure) is removed from the confinement houses and replaced with fresh bedding. This litter is rich in nutrients and can be used as an organic fertilizer on cropland or as a feed ingredient for ruminants. However, because broiler and turkey production is concentrated near processing facilities, the quantity of litter produced may exceed the agricultural demand in these areas. Because of this excess, there has been growing concern about potential environmental pollution from the nitrates and heavy metals in the litter. So there is a need to develop alternative uses for poultry litter. Some options that have been discussed include:

- composting the litter and using the material in the horticulture industry,

- composting and drying the litter for reuse as bedding material,
- composting the litter and utilizing it as a fertilizer.

To effect the transport of litter outside concentrated production areas there must be economic incentives; therefore, entrepreneurs should have production, marketing and financial information to make informed decisions. The purpose of this study is to evaluate the economic feasibility of alternative poultry litter compost systems. Cost models are presented for six alternative compost systems of different sizes and capacities. All capital and production estimates are included so that input and cost information can be updated and used to evaluate current or future investment or production decisions.

Enterprise budgets for four fish byproducts composting systems were recently developed as part of a feasibility study conducted by the Mid-Coast Compost Consortium (Brinton and Seekins, 1988). These budgets were helpful for this study, but they used different equipment components in the composting process and they did not include detailed estimates of annual fixed costs, hourly variable costs, or the labor and power inputs required for each system. Lack of this type of information makes it difficult to update cost information.

The overall objective of this study was to develop the resources and costs required for each composting system. Specific objectives were to:

1. design representative on-farm and off-farm composting systems (land requirements and improvements, buildings and facilities, equipment and machinery, labor and power inputs, and annual input and output capacities);

2. estimate the total capital investment cost for each compost system and the annual fixed (ownership) costs and variable (operating) costs for each equipment component; and
3. develop production budgets for each compost system and estimate the production costs per unit of output.

Organization of the Report

The methodology used to develop the compost systems is discussed in the following section. Assumptions and input price estimates are presented in the fourth section and the results are summarized in the fifth section. Conclusions are presented in the final section. Detailed operating budgets, labor and power inputs, and site plans for each model are presented in the appendices.

Methodology

The compost systems were either patterned after existing commercial operations or the economic-engineering approach was used to synthesize the building, equipment, labor and cost relationships where the "best proven practice" was included in each model. The first two systems were designed to be used on existing poultry farms, while the last four prototypes were developed for off-farm commercial businesses. Each compost model includes: (1) land requirements (2) the production cycle or compost turning schedule; (3) a schematic drawing of the physical layout to include buildings, retention pond, and composting and storage areas; (4) a list of machinery and equipment; (5) annual labor and equipment requirements; and (6) annual production budgets. Summaries of the physical characteristics, capital requirements, and cost estimates are presented in the text, while detailed production and budget

information is displayed in the appendices. The systems were designed to produce a horticulturally acceptable grade of compost, assuming appropriate inputs of raw material and management.

Composting is an aerobic process. Incidental odors may be emitted if the process is mismanaged or if the poultry litter and bulking agent are improperly mixed. However, under proper management, nuisance odors can be minimized. In addition, each system was designed to minimize water runoff. The quality of local water sources will not be adversely affected if the operator selects an appropriate site and properly manages the runoff. Unsuitable locations include sites on light or sandy soil. If the operator has any questions concerning the suitability of a potential site, he or she should contact a county agent of the Cooperative Extension Service for further assistance.

Data for this study were obtained from existing commercial composting operations and from suppliers of composting facilities and equipment. Commercial operators also provided the technical coefficients such as the labor and time requirements for each composting procedure used to calculate the cost estimates. Whenever possible, machinery and equipment costs were collected from a number of vendors for comparison. The primary goals that were followed while designing these systems were: (1) to minimize the initial investment and production costs and (2) to maintain the quality of the output.

Assumptions and Input Price Estimates

The physical plant and equipment mix can greatly affect investment costs and the cost per salable unit of output. In this study, the major items an operator might need were included, but overhead items such as office and machinery storage buildings, office supplies, legal and accounting services,

telephone expenses, and marketing costs were omitted. In some cases these costs could be minor. However, in other situations these costs could be significant. Marketing costs, for example, typically represent a large percentage of any operating budget. Marketing costs for compost operations may be substantial because the entrepreneur will either have to develop a market niche or gain entry into an existing market by displacing competing products such as peat moss, pine bark, and composted cattle manure. Many of these cost estimates were not included because of a lack of primary data. Managers of commercial composting facilities, for example, either could not or would not discuss their marketing costs, and attempts to estimate these expenses proved futile. Entrepreneurs should be aware of the costs excluded in this study and adjust their estimates accordingly.

The purchase price, annual fixed costs and hourly variable cost estimates for all the components used in this study, i.e., land and improvements, buildings, and machinery and equipment, are summarized in Table 1. It was assumed that land could be purchased at an average price of $1,200 per acre and land improvements such as grading, roads and a retention pond could be constructed for $5,000 per acre. Land charges were based on the estimated cost of farm land in North Carolina for 1989 (Neuman). New buildings and facilities were budgeted for each system, and new machinery and equipment prices were used unless otherwise noted. In addition, it was assumed that:

1. The two on-farm compost systems produced output of identical quality, while the four off-farm commercial models yielded output of identical quality. However,

Table 1. Summary of fixed and variable costs

Item	Size	Purchase Price	Salvage Value	Years of Life	Annual Fixed Costs					Total Variable Costs[a]
					Depri-ciation	Interest	Insu-rance	Taxes	Total	
Land	Acre	$ 1,200	$ --		0	156	0	12	168	$ 0
Improvements	Acre	5,000	0	20	250	325	25	20	620	50[b]
Buildings:[b]										
Open-Sided Compost Bldg.	81'x300'	147,326	0	20	7,366	9,576	737	589	18,268	2,946[b]
IPS Compost Facility	--	1,200,000	0	20	60,000	78,000	6,000	4,800	148,800	36,000[b]
Screening & Bagging Facility	50'x100'	30,300	0	20	1,515	1,970	152	121	3,758	758[b]
Asphalt Pavement	Sq Ft	1.67	0	20	0.084	0.109	0.008	0.007	0.208	0.017[b]
Machinery & Equipment:										
Tractor, Gas, Used	60 HP	7,500	1,155	10	634	563	43	35	1,275	5.24
Tractor, Diesel	100 HP	30,000	4,620	10	2,538	2,250	173	138	5,099	6.65
Front-End Loader,SP[c], Diesel	62 HP	25,000	3,875	10	2,113	1,877	144	116	4,250	3.86
Front-End Loader, SP[c], Diesel	160 HP	60,000	9,300	10	5,070	4,504	346	277	10,197	10.85
Truck, Dump Bed, Used	2 Ton	10,000	670	10	933	694	54	43	1,724	11.01
Windrower, PTd	--	35,000	2,205	10	3,280	2,418	186	149	6,033	4.00
Windrower, SP[c], Diesel	100 HP	120,000	18,600	10	10,140	9,009	693	554	20,396	8.95
Windrower, SP[c], Diesel	300 HP	96,000	14,880	10	8,112	7,207	554	444	16,317	18.52
Box Manure Spreader,PT[d]	269 Cu Ft	4,500	261	10	424	309	24	19	776	0.41
Box Manure Spreader,PT[d]	332 Cu Ft	10,841	629	10	1,021	746	57	46	1,870	1.00
Bagging Machine	20 Bags/Minb	48,000	4,800	10	4,320	3,432	264	211	8,227	1.52
Separator Screens	26.7 Cu Ft/Hr	9,000	900	10	810	644	50	40	1,544	0.33
Fork Lift	3000-LB Lift	5,695	560	10	514	406	31	25	976	2.18
Water Pump[e]	2 HP	1,300	130	10	117	93	7	6	223	0.07
Blowers, 15 5/8" Radial Arms	3 HP	871	87	10	78	62	5	4	194	0.07
Thermometers, Industrial	6 Ft	60	0	10	6.00	3.90	0.30	0.24	10.44	---
Pallets, Wooden	45"x48"	4.60	0	5	1.00	0.32	0.02	0.02	1.36	---

[a] DJ0 Total annual repair and maintenance cost for land improvements and buildings. Total variable cost (fuel, lubricants and repair cost) per hour for machinery and equipment.
[b] Repair and maintenance costs were calculated at 1% of purchase price for land improvements, 2% for open sided composting buildings, 3% for the IPS composting facility, 2.5% for the bagging and screening facility and 1% for the asphalt pavement.
[c] SP = Self-Propelled
[d] PT = Pull-Type
[e] Variable cost estimates per KWH

the off-farm models produced a higher quality product than the on-farm systems.

2. All systems lost 10.2 percent of the input volume as a result of the composting process and handling operations.

3. The total costs of the assets required for each system were charged to the system regardless of whether the system was used to full capacity.

Other assumptions that affect the cost and income of each system are discussed in the following sections.

Fixed Costs

Annual fixed costs include depreciation, interest, insurance and taxes. Depreciation was calculated by dividing the purchase price less the salvage value by the projected years of useful life. Interest cost for land was estimated by multiplying the initial purchase price by 13 percent per year. The interest cost for improvements, buildings, and machinery and equipment was calculated by multiplying the average value of each component by 13 percent. Insurance was not assessed on land. An insurance rate of 1 percent was charged for improvements, buildings, and machinery and equipment. These values were estimated by multiplying the average value by the insurance rate. Taxes were estimated at the rate of 1 percent per year for land and 0.8 percent for improvements, buildings, and machinery and equipment (Farm Enterprise Budget Guidelines). The tax charge for land was calculated by multiplying the initial land value by the land tax rate while taxes for the other components were estimated by multiplying 0.4 percent by the respective average values.

Variable Costs

Variable costs include all the costs that vary with the volume of output. For example, the number of bags needed depends on the volume of output as well as the percentage of output management wants to sell bagged instead of bulk. Variable costs were estimated based on plant capacity, production schedules and an assumed marketing mix of 80 percent of the output sold bulk and 20 percent sold bagged for off-farm commercial operations. On-farm systems were assumed to sell all their final product in bulk form. Variable costs were divided into materials, machinery and equipment, labor and interest on operating capital.

Materials. Material cost estimates included poultry litter, sawdust, delivery fees, and plastic bags for commercial off-farm facilities. It was assumed on-farm compost systems used the litter produced as a byproduct of the poultry operation and were charged an opportunity cost of $5 per ton. Off-farm facilities were charged $7 per ton of litter -- $5 per ton for the litter plus a delivery fee of $2 per ton. Sawdust, which was used as a bulking agent, was budgeted at a rate of $8.35 per ton and delivered at a fee of $5 per ton. Plastic bags with a volume of two-cubic feet cost $0.21 each.

Machinery and Equipment. Variable machinery and equipment costs include fuel, lubricants, and repair expenses that are incurred as each item is used. Fuel and repair costs were estimated using Budget Planner, a microcomputer software program developed at North Carolina State University (Hoag, et al.). A price of $0.85 per gallon was used for gas and $0.70 for diesel fuel (Farm Enterprise Budget Guidelines). Lubricant costs were assumed to be 15 percent of fuel costs. Electrical power equipment was charged a rate of $0.07 per

kilowatt-hour. These costs were charged to each piece of machinery and equipment based on the number of hours used for each system. The amount of time each component was used is listed under the "Power" column in the labor and power input tables developed for each compost system. The labor and input tables are included in the appendices.

Hourly Labor. The basic hourly wage was budgeted at $6 per hour. Required payroll expenses such as FICA tax and Workman's Compensation were included in general overhead. Total estimated man-hours required to complete each operation are listed under the "Labor" column in the labor and power input tables. The difference between the "Labor" and "Power" estimates for a particular operation represents the amount of time needed to get ready to do the job, repair and maintain the equipment, and any work breaks taken during the job. A "gear-up" factor[1] of 1.2 was use to account for these additional labor costs. This factor should be adjusted to represent an individual business situation more appropriately.

Operating Capital. An interest rate of 6.5 percent was charged on the total estimated operating capital for each system. This rate was computed at 13 percent on an annual basis for six months.

General Overhead

Fixed annual expenses not discussed in the section on fixed costs were included as general overhead items. These costs include licenses, employer's

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[1]Gear-up factors are used to account for the time required to "get ready" to perform a specific task and "clean up" after the job has been completed. Examples include: attaching equipment to tractors, travel to and from the job site, repairing and servicing machinery and equipment, and other overhead labor chargeable to the job but not "spent on the job." The 1.2 factor should be adjusted to represent an individual business situation more appropriately.

share of the FICA tax, workman's compensation, health and unemployment insurance, general repairs and maintenance, and management salary. General repairs and maintenance expenses consist of repairs and upkeep for land improvements, buildings and grounds. These costs were computed at a rate of 1 percent of the purchase price for land improvements, 2 percent for open-sided composting buildings, 3 percent for the International Process Systems[2] facility, 2.5 percent for bagging and screening facilities, and 1 percent for asphalt surfaces. It was assumed off-farm commercial operations would require a full-time manager to supervise employees, monitor production schedules, and develop and implement marketing plans. This individual was paid an annual salary of $30,000. Interest on general overhead was also computed at an annual rate of 13 percent for six months.

Results

Table 2 summarizes the significant physical characteristics and capital requirements for each of the compost systems analyzed in this study. Fixed and variable cost estimates for each system operating at 50 percent of its total capacity are listed in Table 3, while the cost estimates for each system operating at full capacity are shown in Table 4.[3,4] In general, the initial investment requirements and fixed and variable cost estimates were lower for the two on-farm operations than for the four off-farm enterprises. This was

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[2]International Process Systems is the brand name of a commercial composting facility. This system is discussed in detail in the following sections.

[3]Detailed capital requirements, labor and equipment requirements, and production budgets are presented in the appendices.

[4]When appropriate, the fixed cost estimates, such as the employer's share of the FICA tax, were adjusted to reflect the 50 percent change in output for each compost system.

Table 2. Summary of physical characteristics and capital requirements by compost system[a]

	On-Farm		Off-Farm			
Item	1	2	3	4	5	6
Physical Characteristics:						
Acres Required	7.2	5.2	10.1	9.5	2.5	10.9
Annual Input Capacity	10,000	10,000	40,000	40,000	40,000	40,000
Estimated Annual Output (tons)	8,980	8,980	35,920	35,920	35,920	35,920
Projected Bulk Sales (tons)	8,980	8,980	28,736	28,736	28,736	28,736
Projected Bagged Sales (tons)	---	---	7,184	7,184	7,184	7,184
Projected Bagged Sales (2 Cu Ft Bags)	---	---	194,000	194,000	194,000	194,000
Projected Labor Requirements (Man-Hours):	1,383.6	1,195.6	4,656.1	5,226.5	3,588.4	4,166.0
Capital Investments:						
Land & Improvements	$ 44,640	$ 32,240	$62,620	$ 58,900	$ 15,500	$ 67,580
Buildings	0	0	1,208,908	513,932	1,230,300	687,880
Machinery & Equipment	112,471	148,900	316,576	340,576	142,335	311,160
Total	$157,381	$181,140	$1,588,104	$913,408	$1,388,135	$1,066,620
Capital Investment per Ton of Output	$ 17.526	$ 20.171	$44.212	$ 25.429	$ 38.645	$ 29.694

[a]Assuming each system operates at 100 percent capacity

Table 3. Summary of annual fixed and variable cost estimates by composst system for 50 percent operating capacity

	On-Farm		Off-Farm			
Item	1	2	3	4	5	6
Annual Fixed Costs:						
Land & Improvements	$ 5,673	$ 4,097	$ 7,958	$ 7,487	$ 1,969	$ 8,588
Buildings	0	0	149,902	63,728	152,558	85,298
Machinery & Equipment	18,123	25,431	57,692	61,771	25,066	56,871
General Overhead	2,293	1,702	53,188	42,879	59,214	62,574
Interest, General Overhead, Insurance & Taxes	241	228	4,408	3,345	4,656	4,713
Total Fixed Cost	$26,330	$31,458	$273,148	$179,210	$243,463	$218,044
Annual Variable Costs:						
Materials	$39,612	$39,612	$204,820	$204,820	$204,820	$204,820
Machinery & Equipment	6,059	4,162	15,381	15,558	5,772	11,874
Labor	4,151	3,586	13,968	15,680	10,765	12,498
Interest on Operating Capital	3,239	3,078	15,221	15,344	14,388	14,898
Total Variable Cost	$53,061	$50,438	$249,390	$251,402	$235,745	$244,090
Total Annual Cost	$79,391	$81,896	$522,538	$430,612	$479,208	$462,134
Costs for Bulk Product:						
Fixed Cost per Ton	$ 5.864	$ 7.006	$13.916	$8.686	$12.264	$10.848
Variable Cost per Ton	11.818	11.233	12.404	12.516	11.661	12.109
Total Cost per Ton	$17.682	$18.239	$26.320	$21.202	$23.925	$22.957
Costs for Bagged Product:						
Fixed Cost per Bag	---	---	$0.755	$0.561	$0.693	$0.641
Variable Cost per Bag	---	---	0.734	0.738	0.698	0.723
Total Cost per Bag	---	---	$1.489	$1.299	$1.391	$1.364

Table 4. Summary of annual fixed and variable cost estimates by compost system for 100 percent operating capacity

Item	On-Farm 1	On-Farm 2	Off-Farm 3	Off-Farm 4	Off-Farm 5	Off-Farm 6
Annual Fixed Costs:						
Land & Improvements	$ 5,673	$ 4,097	$ 7,958	$ 7,487	$ 1,969	$ 8,588
Buildings	0	0	149,902	63,728	152,558	85,298
Machinery & Equipment	18,123	25,431	57,692	61,771	25,066	56,871
General Overhead	4,200	3,120	71,273	50,656	83,325	72,183
Interest on General Overhead, Insurance & Taxes	365	320	5,584	3,851	6,223	5,337
Total Fixed Cost	$28,361	$32,968	$292,409	$187,493	$269,141	$228,277
Annual Variable Costs:						
Materials	$79,225	$79,225	$409,640	$409,640	$409,640	$409,640
Machinery & Equipment	12,118	8,323	30,762	31,117	11,544	23,749
Labor	8,302	7,171	27,937	31,359	21,530	24,996
Interest on Operating Capital	6,477	6,157	30,442	30,688	28,776	29,795
Total Variable Cost	$106,122	$100,876	$498,780	$502,804	$471,490	$488,180
Total Annual Cost	$134,483	$133,844	$791,189	$690,297	$740,631	$716,457
Costs for Bulk Product:						
Fixed Cost per Ton	$ 3.158	$ 3.671	$ 7.494	$ 4.574	$ 6.847	$ 5.709
Variable Cost per Ton	11.818	11.233	12.404	12.516	11.661	12.109
Total Cost per Ton	$14.976	$14.904	$19.898	$17.090	$18.508	$17.818
Costs for Bagged Product:						
Fixed Cost per Bag	---	---	$0.397	$0.289	$0.373	$0.331
Variable Cost per Bag	---	---	0.734	0.738	0.703	0.723
Total Cost per Bag	---	---	$1.131	$1.027	$1.076	$1.054

expected because the off-farm systems process a larger volume of poultry litter and all of these models utilize either a physical structure or an asphalt surface during the composting procedure. Furthermore, all of the off-farm enterprises require screening and bagging facilities and additional operations to prepare 20 percent of the output for the wholesale market.

Because the on-farm and off-farm systems were designed for either a private poultry operation or a commercial enterprise, they are presented and examined according to their intended use. The two on-farm models are analyzed first and the four off-farm prototypes are evaluated next.

On-Farm Systems

The on-farm systems were designed for poultry operators interested in composting the litter produced by their own operations. Each model has an annual input capacity of 10,000 tons -- 6,500 tons of poultry litter and 3,500 tons of sawdust -- and an estimated output of 8,980 tons of finished product (Table 2).

System 1 requires a total of 7.2 acres of land, while System 2 needs a total of 5.2 acres. Compost piles for each model were formed with a box manure spreader on the bare ground; therefore the sites must be level, hard-packed and offer good drainage.[5] The piles for both systems are formed with a box manure spreader, but the first model uses a self-propelled front-end loader to turn the windrows, while a mechanical compost pile turner, i.e., a windrower, pulled by a 60 hp tractor is used in the second prototype. Each windrow in

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[5]Establishing compost piles on bare ground presents problems because piles must be moved and/or turned on a regular schedule regardless of the weather. However, asphalt surfaces were not constructed for these models because of the prohibitive cost -- asphalt pavement costs an estimated $1.67 per square foot.

System 1 is turned 10 times over a 16-week period and the piles in System 2 are rotated 18 times over a 10-week period.

System 1 requires more time and land for the composting process than System 2 because of the different procedures used to turn the windrows. Since the material in the first system is turned with a front-end loader, little oxygen reaches the interior of the pile and the composting process occurs rather slowly. The windrower, on the other hand, incorporates oxygen and shreds the material as it rotates the piles. Therefore the composting process for the second model is completed in less time. More land is required for System 1 because additional space is needed to maneuver the front-end loader between the windrows.

The initial capital investment for System 2 was $23,759 higher than that for System 1 primarily because of the additional machinery and equipment required to rotate the windrows (Table 2). The $35,000 for the windrower and the $7,500 for the 60 hp tractor more than offset the second system's lower investment expenses for land, land improvements, and a 269 cu. ft. capacity manure spreader was used instead of the 332 cu. ft. capacity manure spreader used in the first prototype.

The additional machinery and equipment purchases also resulted in higher fixed cost estimates for System 2 relative to those for System 1. The fixed costs for machinery and equipment were $25,431 for the second model compared to $18,123 for the first model, while the total annual fixed costs for System 2 were $31,458 when operating at 50 percent capacity versus $26,330 for System 1 (Table 3), and $32,968 for System 2 when operating at full capacity versus $28,361 for System 1 (Table 4). However, purchasing the additional pieces of equipment did contribute to a reduction in the fixed and variable

labor costs for the second system relative to those for the first system. Using the windrower to turn the compost piles decreased the labor requirements for System 2 an estimated 334 man-hours per year at full capacity. Although this decrease was partially offset by an extra 145 man-hours per year needed to create windrows because a smaller capacity manure spreader was used, there was a net decrease of 189 man-hours per year for the second model compared to the first model. Hence, annual fixed labor expenses (FICA tax, workman's compensation, etc.) for System 2 were $1,080 less than those for System 1, and annual variable labor expenses were $1,131 lower when each system was operated at 100 percent capacity and $591 and $565 lower, respectively, at 50 percent capacity.

Variable cost savings were also realized for System 2 as a result of using machinery and equipment to turn the windrows that not only had lower projected hourly operating costs but also reduced the number of hours needed to complete this operation. When running at full capacity, the front-end loader in System 1 is used 530 hours per year to turn windrows and costs $12.59 per hour to operate, while the windrower and 60 hp tractor used in the second prototype are operated 252 hours per year and costs $4 and $5.24 per hour, respectively. Therefore, the variable cost for this operation was $4,344 per year lower for System 2. This decrease was offset somewhat by the increased expense associated with using the 100 hp tractor and lower capacity manure spreader an additional 121 hours to create the windrows. However, the total variable cost of machinery and equipment was $3,795 lower for System 2 than for System 1, while total annual variable costs were $5,246 lower.

On a unit basis, the total fixed cost for System 1 was $1.14 per ton of final product lower than that for System 2 when operating at 50 percent

capacity, $5.86 per ton compared to $7 per ton, while the total variable cost was $0.59 per ton higher, $11.82 per ton versus $11.23 per ton (Table 3). Consequently, the total annual cost per ton of output for the first on-farm model was $0.56 higher than that for the second on-farm prototype, $17.68 per ton compared to $18.24 per ton, and the total difference between these two systems was $2,505 per year.

At full operating capacity, the fixed cost for the first model was $0.51 per ton of output lower than that for the second design, $3.16 per ton versus $3.67 per ton (Table 4). Of course, the variable expenses per unit of output and the cost differential between the two models did not change as a result of doubling the production. The total annual cost for System 1 was $0.08 per ton higher than that for System 2, $14.98 per ton compared to $14.90 per ton, and the total difference between the two models was $639 per year.

Off-Farm Systems

The off-farm commercial enterprises were designed to accommodate an annual input capacity of 40,000 tons -- 26,000 tons of poultry litter and 14,000 tons of sawdust -- and produce an annual output of 35,920 tons. After completion of the composting process for each system, the bulk product is stockpiled in a central storage area, while the material destined for the commercial market is run through a screener to remove foreign matter and then bagged.

System 3 represents a typical large commercial operation and requires about nine weeks to complete a two-phase composting process. Windrows are initially formed and turned in open-sided buildings that have paved,

reinforced floors to help control the moisture content of the compost piles.[6] This phase takes five weeks and the piles are turned a total of 11 times with a self-propelled windrower to incorporate oxygen and shred the material. During the second phase, the manure is removed from the buildings and formed into windrows in the open on bare ground. The windrows are rotated an additional six times during the four weeks needed to complete this phase.

The composting process for the fourth prototype is similar to the previous model in that windrows are constructed and periodically rotated with a self-propelled windrower. However, the compost piles are constructed on an asphalt surface instead of inside buildings or on the bare ground. The asphalt pavement ensures year-round operation, but the lack of overhead protection could cause some management problems in controlling the moisture content of the compost piles. Sixteen weeks are required to complete this composting procedure. The windrows are turned a total of 17 times in this system: three times per week for the first three weeks, two times per week for the next three weeks, and once per week for two more weeks.

The fifth design was patterned after the International Process System (IPS) (Kuter) compost facility, which uses in-vessel composting to process the raw product. This modular building includes a forced aeration structure with an agitator and four horizonal composting bays, a staging and mixing area, and a receiving pit for the finished product. Poultry litter and sawdust are deposited and mixed in the staging area and then loaded into one of the composting bays. A mixer/agitator machine mixes, aerates, and moves the

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[6]The moisture of the compost piles must be maintained within a range of 50 to 60 percent moisture (wet basis). If the piles are too wet or too dry, the composting process will be retarded and additional time will be required to produce the same quality product.

material down the bay at the rate of 12 feet per day. This continuous movement and agitation eliminates the requirement for a separate turning schedule. It takes 21 days for the material to move through the bay and complete the composting process. As the final product reaches the receiving pit, it is removed and stored outside on the bare ground where it is allowed to mature before being sold or processed for the wholesale market.

The last model evaluated in this study employs an open unturned windrow procedure that takes advantage of a fixed aeration system and eliminates the turning operation. A box-manure spreader is used to construct the compost piles over a series of 4-inch aeration pipes. Radial blade blowers then force air through the pipe to provide the oxygen necessary for the aeration process. Two months are needed to complete the composting process and the windrows are formed on an asphalt surface to ensure year-round operation. In addition, the windrows can be placed closer together than in Systems 3 and 4 because the piles do not have to be turned.

There was a wider range in the capital requirements and cost estimates for the off-farm compost systems than for the on-farm models because more variation in technology was incorporated into the commercial enterprises. For example, System 4 required the lowest initial investment, $913,408, while System 3 required the largest investment, over $1.5 million, a range of more than $674 thousand (Table 2). The major contributing factor to the dispersion in capital requirements was the type of compost structure or surface constructed for each model. Excluding the screening and bagging facility, which was required for all of the off-farm operations, the IPS facility for System 5 cost $1.2 million, the eight open-sided compost structures for System

3 cost over $1.1 million, and the asphalt surfaces for Systems 4 and 6 cost $483,632 and $687,880, respectively.

Although land and machinery and equipment requirements had a smaller impact on the total initial investment, the IPS facility in System 5 eliminated the need to purchase many of the resources required in the other three operations to form and/or turn windrows. Only 2.5 acres of land were needed for the fifth model compared to an average of 10.2 acres for the other systems, while the in-vessel composting procedure also eliminated the need to purchase a manure spreader, a windrower, and a 100 HP Tractor.

System 4 also had the lowest total annual fixed costs of the four models, $179,201 at 50 percent output capacity and $187,493 at 100 percent capacity (Tables 3 and 4). System 6 had the second lowest fixed expenses, $218,044 at 50 percent operational capacity and $228,277 at 100 percent capacity, while the fixed costs for System 5 totalled $243,463 at 50 percent capacity and $269,141 at 100 percent capacity. System 3 had the highest annual fixed cost estimates of these models, $273,148 at 50 percent output and $292,409 at 100 percent output. Like capital requirements, these estimates were primarily influenced by the costs associated with owning the compost facilities. The annual ownership cost of the IPS facility for the fifth prototype was $148,800, and the eight open-sided compost structures for the third model cost $146,144. In addition, the yearly repair and maintenance cost, included in general overhead, was $36,000 for the IPS facility and $23,568 for the open-sided structures. The fixed cost estimates for the asphalt pavement in the fourth and sixth operations were $59,970 and $81,540, respectively, and the repair and maintenance cost estimates were $4,836 and $6,576, respectively. The annual fixed cost for the machinery and equipment

for System 5 was less than half the cost estimates of the other models. This expense was slightly over $25,000 for System 5 compared to $56,871 for System 6, $57,692 for System 3, and $61,771 for System 4.

The annual labor requirements to support each enterprise are listed in Table 2. Detailed labor summaries for each operation are presented in the appropriate appendix tables for each system. Because they are similar operations, the time required to load the windrow bays in System 5 is exhibited and compared to the time needed to create the windrows in the other models. Similarly, the man-hours required to maintain the in-vessel composting procedure are presented and compared to the hours required by the rest of the systems to turn the windrows. In addition, the labor requirements discussed below are the estimates for each model operating at full capacity. To calculate the number of man-hours needed to produce 50 percent the total volume, simply divide these estimates by two.

There was a difference of 1,638 man-hours between the least labor-intensive operation -- 3,588 man-hours for System 5 -- and the most labor intensive operation -- 5,227 man-hours for System 4. The fifth model offered a significant reduction in labor relative to that for the other prototypes because less time was needed to load the IPS bays than to create windrows. An estimated 609 man-hours were used to load the IPS bays compared to the 2,736 man-hours needed to create windrows in the other operations, a difference of 2,126 man-hours. The sixth compost system required the second fewest man-hours because the forced-air procedure eliminated the need to turn the windrows or to maintain the composting process. Eliminating this procedure decreased the labor requirements for System 6 by 489 man-hours compared to those for

System 3, 1,060 man-hours compared to those for System 4, and 1,548 man-hours compared to those for System 5. All prototypes required the same amount of time to complete the screening and bagging operation, 945 man-hours, and to stockpile the output, 484 man-hours.

System 5 had the lowest total annual variable costs of all the off-farm systems, $35,745 at 50 percent of the operating capacity and $471,490 at 100 percent capacity (Tables 3 and 4). The variable expenses for materials were the same for all the systems, $204,820 for 50 percent output and $409,640 for 100 percent output, and there was relatively little variation among the four models in the total interest charges on the operating capital. System 5 had the lowest interest on operating capital, $14,388 at 50 percent capacity and $28,776 at 100 percent capacity, while System 4 had the highest interest charges, $15,344 at 50 percent capacity and $30,688 at 100 percent capacity, for ranges of $956 and $1,912, respectively. Therefore, the major differences in variable costs between the prototypes were a result of labor expenses and the cost of operating the machinery and equipment. As was previously discussed, System 5 was the least labor-intensive enterprise; consequently its variable labor costs were also the lowest, $10,765 for 50 percent output and $21,530 for 100 percent production. The labor expenses for the most labor-intensive operation, System 4, were $15,680 at 50 percent capacity and $31,359 at full capacity. Labor costs for Systems 3 and 6 were $13,968 and $12,498, respectively, for 50 percent output, and $27,937 and $24,996, respectively, for 100 percent output.

System 5 also had the lowest variable cost for operating machinery and equipment, $5,772 for 50 percent capacity and $11,544 for 100 percent capacity. The estimated cost of operating machinery and equipment for the 50

and 100 percent output levels were $11,874 and $23,749 for System 6, $13,968 and $30,762 for System 3, and $15,680 and $31,117 for System 4[7]. The machinery and equipment cost estimates for System 5 were less than those of the other models because compost windrows did not have to be constructed or rotated. Similarly, the cost estimates for the sixth operation were lower than those for Systems 3 and 4 because the windrows did not have to be turned.

The total cost per ton of output ranged from $23.11 for System 4 to $26.13 for System 3 at 50 percent operating capacity. Comparable costs for Systems 5 and 6 were $23.96 per ton and $21.53 per ton, respectively. Cost estimates at 100 percent output were $19.78 for System 3, $17.26 for System 4, $18.52 for System 5, and $17.91 for System 6. Another way to examine these cost estimates is according to the expected utilization of the output; that is, by the unit cost of the final product intended for either bulk or bagged sales. Therefore, as a final step, the fixed and variable costs incurred as a result of preparing 20 percent of the output for the wholesale bagged market were allocated directly to the estimated cost per bag. These expenses included the cost of bags, the costs associated with owning and operating the screening and bagging facility, and the cost of stockpiling and storing the bagged product. Eighty percent of the remaining expenses, such as the cost of forming and turning windrows, were allocated to the cost of the final product sold in bulk form, and 20 percent of these costs were allocated to the cost of the bagged product.

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[7]The machinery and equipment variable cost estimate for System 5 includes the cost of operating the IPS facility, $7,250, plus the cost of operating the machinery and equipment, $4,294, at 100 percent operating capacity (Appendix Table 5.3).

System 3 had the highest total costs per unit for both forms of output, $26.32 per ton for the bulk product and $1.49 per bag for the bagged output when operating at 50 percent of its total capacity compared to $19.90 per ton and $1.13 per bag at full operating capacity (Tables 3 and 4). The lowest unit costs were estimated for System 4, $21.20 per ton and $1.30 per bag at 50 percent operating capacity and $17.09 per ton of bulk product and $1.03 per bag at 100 percent capacity. The unit costs of running the fifth model at half its total capacity were $23.92 per ton and $1.39 per bag compared to $18.51 per ton and $1.08 per bag at full operating capacity. Finally, the cost estimates for System 6 were $22.96 per ton and $1.36 per bag at 50 percent capacity and $17.82 per ton and $1.05 per bag at 100 percent capacity.

Summary and Conclusions

The objective of this study was to estimate the land, equipment, labor, and cost requirements associated with operating six model compost facilities. Two systems were designed for existing poultry operations, while four other prototypes were developed for off-farm commercial businesses. The on-farm models had an input capacity of 10,000 tons per year and the off-farm systems could treat 40,000 tons per year. Production schedules, input requirements, and annual production budgets were developed assuming each model was operated at 50 percent of its total capacity and at 100 percent capacity. Cost estimates were based on 1989 prices.[8]

The most significant difference between the two on-farm compost systems was the initial capital investment needed, $157,381 for the first model

[8]Annual fluctuations in interest rates and other input prices might affect the cost estimates. It is recommended that potential operators revise these cost estimates to more accurately reflect their individual business situations before making any investment decisions.

compared to $181,140 for the second model. System 1 was slightly more labor intensive, had lower fixed costs, and required more time to complete the composting process, while System 2 was more capital intensive, had lower variable costs, and needed less time for the compost procedure. The total cost per unit of output was lower for System 1 than for System 2 at the 50 percent operating capacity, $17.68 per ton versus $18.24 per ton, but slightly higher at 100 percent capacity, $14.98 versus $14.90 per ton (Figure 1). This reversal was primarily a result of adjusting the general overhead expenses to reflect the changes in fixed labor cost estimates at the two output levels (Table 3 and 4). Since System 1 is more labor intensive, the difference between the fixed costs per unit of output was greater at the 50 percent operating capacity, $1.15 per ton, than at 100 percent capacity, $0.51 per ton (Figure 1). Consequently, this variation was sufficient to cause the relationship between total unit costs for each system to be reversed as the output level increased from 50 percent to 100 percent.

System 2 has slightly lower production costs if it is operated at or near full capacity. As the utilization of each compost facility decreases, System 1's total cost per unit of output increases at a slower rate than that of the second model. If the potential owner is confident that the compost facility will be operated at or near full capacity, then System 2 offers greater potential cost savings. However, given the uncertainties associated with starting a new business venture -- factors such as the actual market size, the actual utilization rate of the compost system, etc. -- entrepreneurs should consider the first model if they do not believe the facility will be able to achieve or maintain an output level at or near full capacity. Of

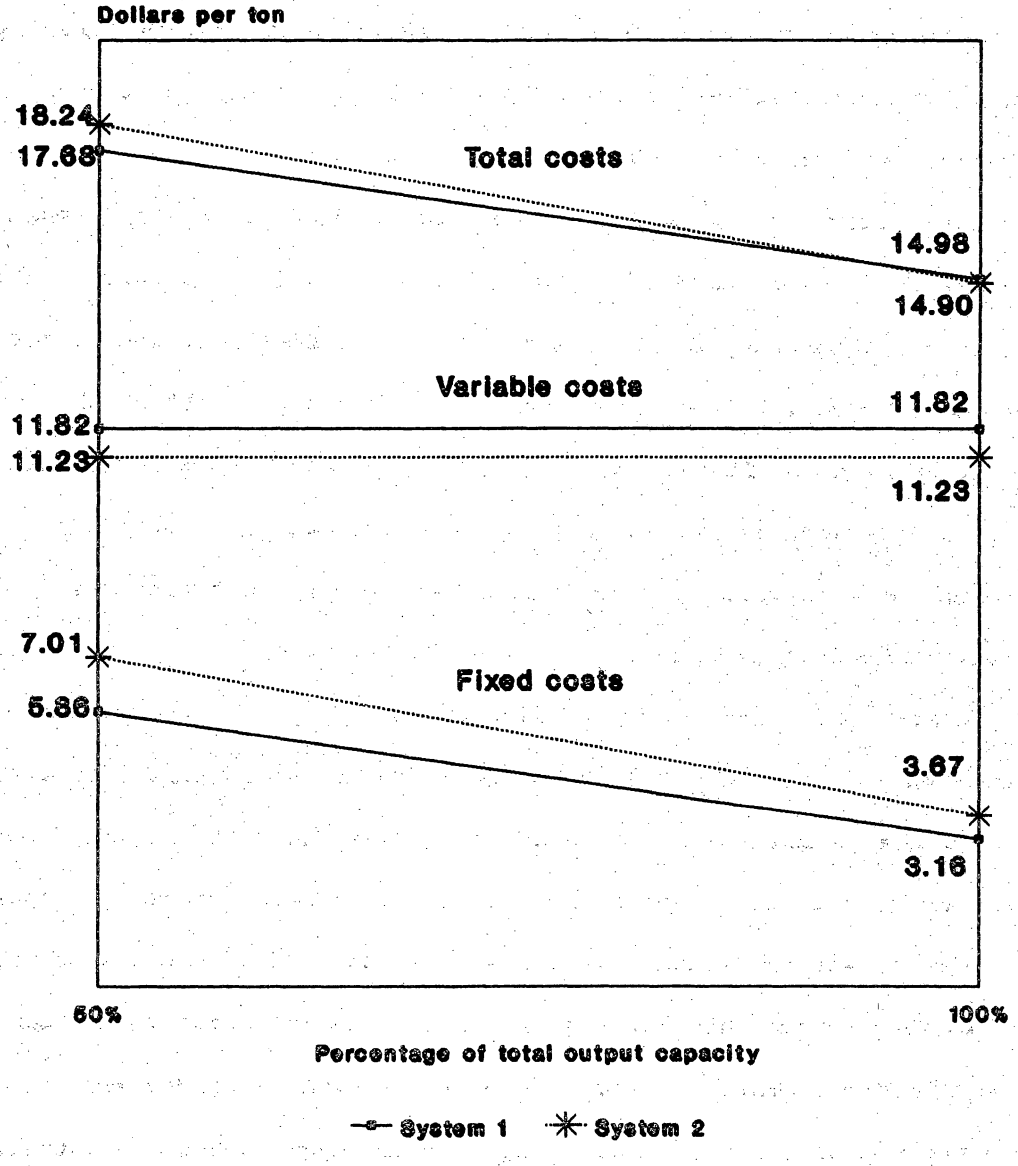

Figure 1. Estimated costs of production of bulk output for on-farm compost systems

course, if labor costs increase relative to the cost of other inputs, System 2 will become even more attractive than System 1.

System 3 had the highest capital investment requirements, over $1.5 million, the second largest labor requirements, 4,656 man-hours, and the highest costs per unit of output at both levels of production relative to those for the other three off-farm commercial models. The costs for the bulk product were $26.32 per ton at 50 percent capacity and $19.90 per ton at 100 percent capacity, while the costs for the bagged output were $1.49 per bag at 50 percent production and $1.13 per bag at full production (Figures 2 and 3). In addition, System 3 had the largest variation in costs per unit of output between its 50 and 100 percent operating capacities. There was a difference of $6.42 per ton for the bulk product between the 50 and 100 percent capacities, $26.32 per ton versus $19.90 per ton, and $0.36 per bag for the bagged output -- $1.49 per bag versus $1.13 per bag.

The fourth prototype was the least capital-intensive but the most labor-intensive model. The initial capital investment for this design was $913,408, and 5,226 man-hours of labor were needed to perform the necessary operations. System 4 also had the lowest unit costs of any of the four commercial models examined in this study. These costs were $21.20 per ton and $1.30 per bag at 50 percent capacity and $17.09 per ton and $1.03 per bag at 100 percent capacity (Figures 2 and 3). Furthermore, the differences in the costs between the 50 percent output level and the 100 percent production level were smaller for this system than for the other three designs. This cost differential was $4.11 per ton for the bulk product and $0.27 per bag for the bagged output.

The IPS compost design, System 5, required the least amount of land, 2.5 acres, the least amount of labor, 3,588 man-hours, the second largest capital

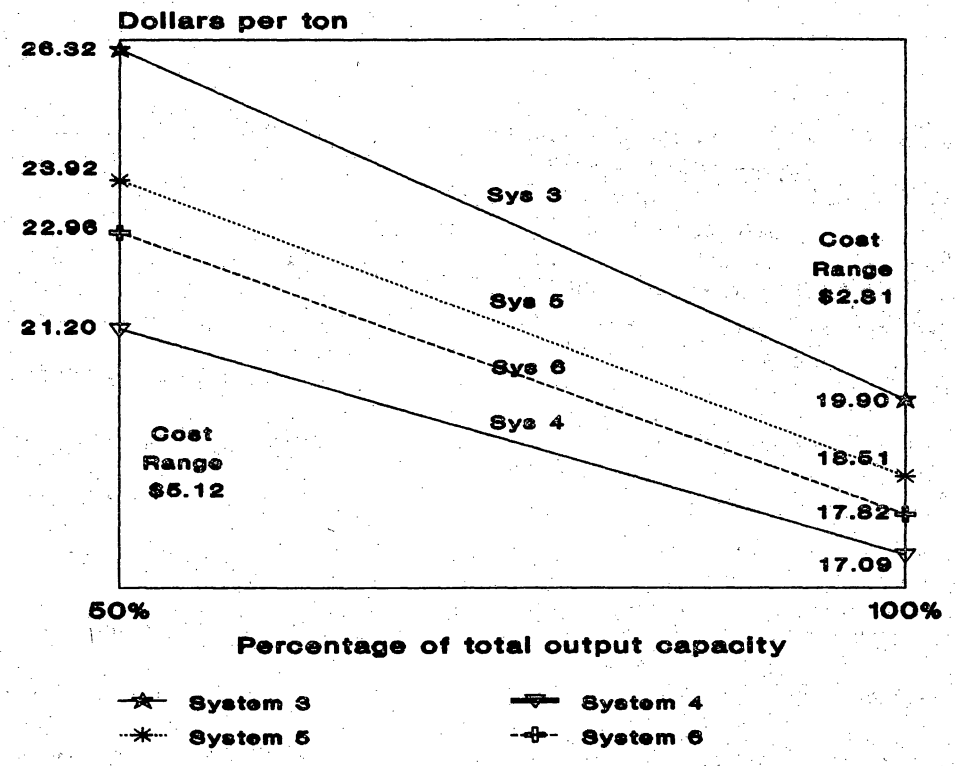

Figure 2. Estimated costs of production of bulk output for off-farm compost systems

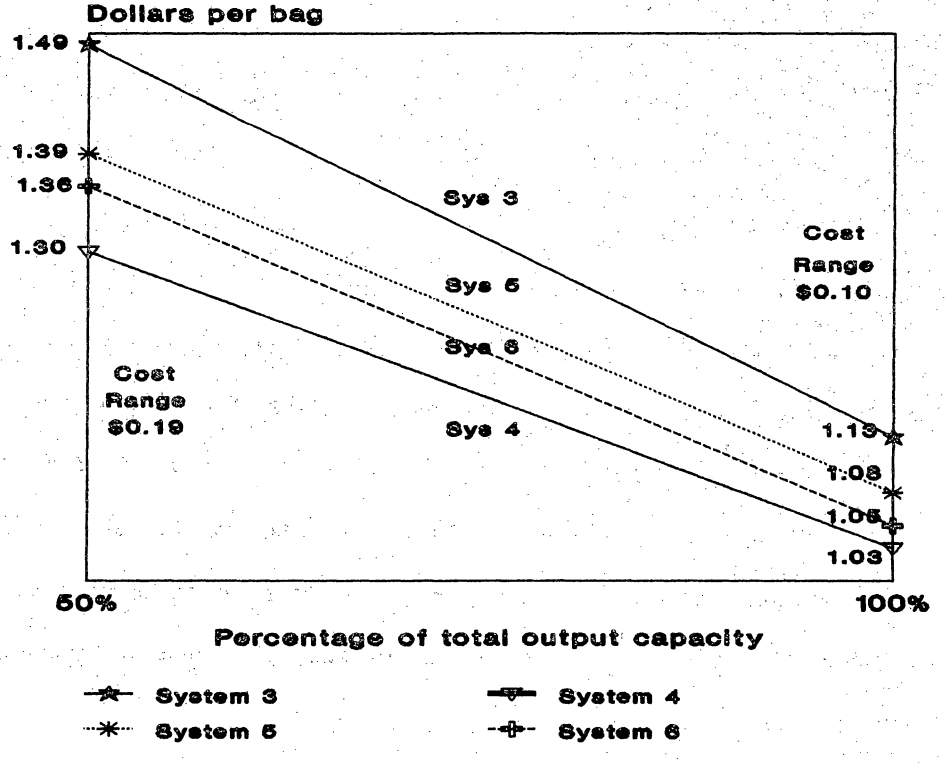

Figure 3. Estimated costs of production of bagged output for off-farm compost systems

investment, over $1.3 million, and accounted for the third highest costs per unit of output. At 50 percent operating capacity, the total costs were $23.92 per ton for the bulk output and $1.39 per bag for the bagged product compared to $18.51 per ton and $1.06 per bag at 100 percent capacity (Figures 2 and 3). The cost differentials of $5.41 per ton for the bulk product and $0.33 per bag for the bagged product between the two output levels were also the third largest spreads among the four off-farm models.

System 6 ranked first in the amount of land required, 10.9 acres, second in the initial capital investment, about $1.0 million, second in total labor requirements, 4,166 man-hours, and accounted for the second lowest cost per unit of output. The estimated costs for this model were $22.96 per ton for the bulk product and $1.36 per bag for the bagged output at 50 percent capacity compared to $17.82 per ton and $1.05 per bag at 100 percent capacity (Figures 2 and 3). The cost differences of $5.14 per ton and $0.31 per bag for the bulk and bagged product, respectively, between the 50 and 100 percent production levels were also the second lowest cost spreads among the four commercial systems examined in this study.

Like in the on-farm models, the unit output cost estimates for each off-farm system were reduced significantly as the operating capacity increased from 50 to 100 percent (Figures 2 and 3). However, unlike the on-farm designs, the relative ranking of the off-farm systems in terms of production costs did not change as output increased. That is, System 4 offers the lowest per-unit output costs for both the bagged and bulk product at the 50 and 100 percent operating capacities, while System 3 had the highest costs. Therefore, the fourth model should be considered before the other prototypes if the investment decision is based solely on production costs. However, non-economic

factors could also influence the final decision. If the manager wants to minimize the composting time or to maintain a small labor force, System 5 should be considered before the other models.

As previously mentioned, it is assumed that each system described in this chapter can produce compost that will be readily acceptable to the horticultural industry. One critical element not discussed is management. Although it was not in the scope of this study to detail management requirements for producing compost, it must be recognized that a high level of management will be needed. Because composting is a biological process, attention to certain details along with timely observations and decisions will be essential. Several of the more critical factors to consider are identified below.

It is important to establish a good blend of the materials to be composted in the initial product mix. In general, the C/N ratio (available carbon to available nitrogen) of all materials combined should be between 20/1 and 30/1 to ensure complete decomposition of organic material and a satisfactory end product. In addition, the moisture content of the initial blend should be between 50 and 60 percent. If the moisture content is much higher, the blend will not be able to retain sufficient oxygen to maintain the process. All materials to be added to the initial compost should be thoroughly mixed to ensure thorough decomposition.

Finally, the compost piles must be turned or otherwise aerated frequently. This allows replenishing of oxygen, blending of materials, and prevention of excess pile temperatures. In general, pile temperatures should be maintained between 50°C and 70°C or for two to three weeks. After this, the

piles will begin to cool and should be allowed to "cure" until the composting process is completed.

Because different organic materials will have varying rates of composting, it is wise to gain experience with a given material on a small scale prior to developing a large-scale project.

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Appendices

Appendix 1. Compost System 1

System 1 needs 7.2 acres of land, 4.9 acres for the windrows, 0.7 acres for storing the finished product, 0.6 acres for a retention pond and 1 acre for the border (Appendix 1, Figure 1).

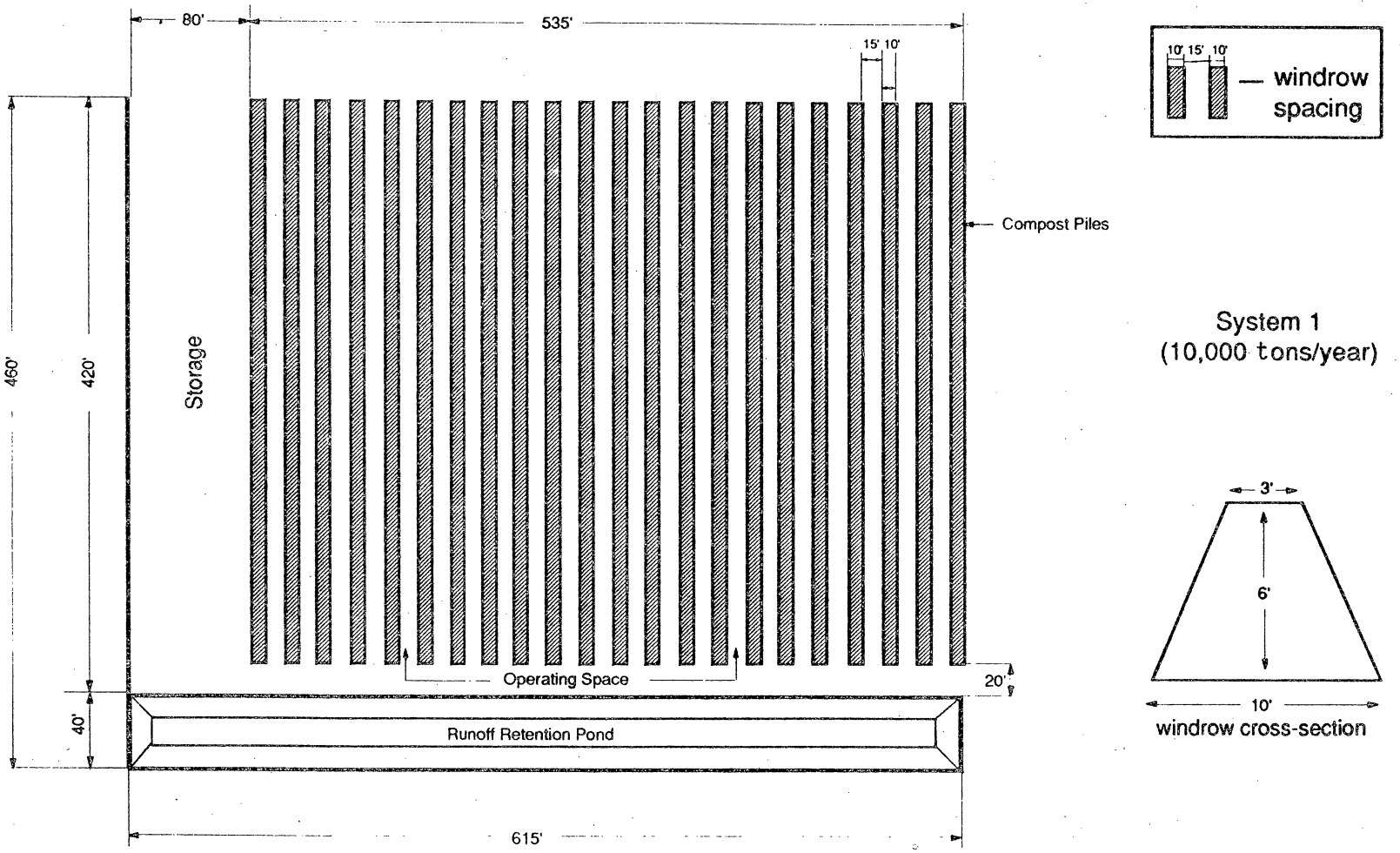
This compost system required an estimated capital investment of $157,381 (Appendix 1, Table 1). Land and improvements totaled $44,640, while machinery and equipment accounted for $112,741. The largest expenditures were $60,000 for a front-end loader, $36,000 for land improvements, and $30,000 for a 100 HP tractor. The total capital investment per ton of salable product was $17.53.

Total annual fixed costs were $28,361 or $3.16 per ton of salable product (Appendix 1, Table 2). Expenses for the major cost categories were: $5,673 for land and improvements, $18,123 for machinery and equipment, $4,200 for general overhead, and $365 for interest on general overhead, insurance and taxes.

This system requires a total of 1,383.6 man-hours of labor per year (Appendix 1, Table 3). The most labor-intensive operations were forming the compost piles, which requires 684 man-hours, and turning the piles, which requires 636 man-hours. The front-end loader is used 583 hours and the tractor and manure spreader are each used 517 hours.

Total variable costs for System 1 were $106,121 per year, or $11.82 per ton of output (see Appendix 1, Table 4). Materials costs, including poultry litter, sawdust, and delivery fees, accounted for $79,225, while machinery and equipment expenses totaled $12,177. The most expensive piece of equipment to

operate was the 160 HP front-end loader, which had a projected operating cost of $12.59 per hour.



Appendix 1, Figure 1. Possible site plan for System 1 (10,000 tons/year)

Appendix 1, Table 1. Capital requirements for compost system 1, 10,000-ton annual capacity

Item	Description	Unit	Useful Life	Quantity	Cost Per Unit	Total Cost	Percent of Total Cost[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre		7.2	1,200	$ 8,640	5.5
+ Improvements	Grading (5%) with Retention Pond	Acre	20		5,000	36,000	22.9
Subtotal						$ 44,640	28.4
Machinery & Equipment:							
Tractor, 100 HP	100 HP, Diesel	Each	10	1	30,000	$ 30,000	19.0
Front-End Loader	3 Cu Yd, Skid Steer, 160 HP, Used	Each	10	1	60,000	60,000	38.1
Truck	2 Ton, Dump Bed, Used	Each	10	1	10,000	10,000	6.4
Box Manure Spreader	332 Cu Ft Capacity	Each	10	1	10,841	10,841	6.9
Water Pump	2 HP	Each	10	1	1,300	1,300	0.8
Thermometer	Industrial, 6 Ft Long Stem	Each	10	10	60	600	0.4
Subtotal						$112,741	71.6
Grand Total						$157,381	100.0
Capital Investment per Ton of Final Product[b]						$17.526	

[a] Subtotals may not add due to rounding.
[b] Final product = 8,980 tons

Appendix 1, Table 2. Annual fixed cost estimates for compost system 1, 10,000-ton annual capacity

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land	$ ---	$1,123	$ ---	$ 86	$1,209
+ Improvements	Grading, Retention Pond	1,800	2,340	180	144	4,464
Subtotal		$1,800	$3,463	$180	$230	$5,673
Machinery & Equipment:						
Tractor	100 HP, Diesel	$2,538	$2,250	$173	$138	$ 5,099
Front-End Loader	160 HP, Diesel, 3 Cu Yd, Used	5,070	4,504	346	277	10,197
Truck	2 Ton, Dump Bed, Used	933	694	54	43	1,724
Box Manure Spreader	332 Cu Ft Capacity	424	309	24	19	776
Water Pump	2 HP	117	93	7	6	223
Thermometers	Industrial, 6 Ft Long Stem	60	39	3	2	104
Subtotal		$7,873	$7,889	$607	$485	$18,123
General Overhead:						
License	Privilege License					$ 25
General Repairs & Maintenance[a]	grounds					360
Insurance, Personnel	Workman's Comp., FICA, Health, Unemployment					3,815
Subtotal						$ 4,200
Interest on General Overhead, Insurance & Taxes	Computed at 13 Percent per Annum for Six Months					$ 365
Total Annual Fixed Costs						$28,361
Annual Fixed Cost per Ton of Final Product[b]						$ 3.158

[a]Repair and maintenance costs for land improvements and buildings. Repair costs for machinery and equipment are included in the hourly variable cost estimates.
[b]Final Product = 8,980 tons

Appendix 1, Table 3. Total annual labor and power inputs for compost system 1, 10,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Creating Windrows	Front-End Loader, 160 HP	63.6	53.0
	Tractor, 100 HP with Box Manure Spreader, 332 Cu Ft	620.4	517.0
Turning Windrows	Front-End Loader, 160 HP	636.0	530.0
Stockpiling Product	Front-End Loader, 160 HP	63.6	53.0
Total		1,383.6	

Appendix 1, Table 4. Annual variable cost estimates for compost system 1, 10,000-ton annual capacity

Item	Description	Cost Per Unit	Unit	Quantity	Total Cost
Materials:					
Poultry Litter		Tons	5.00	6,500.00	$ 32,500.00
Sawdust	Bulking Agent	Tons	8.35	3,500.00	29,225.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	3,500.00	17,500.00
Subtotal					$ 79,225.00
Machinery & Equipment:					
Tractor	100 HP, Diesel	Hours	6.65	517.00	$ 3,438.05
Front-End Loader	160 HP, Diesel, 3 Cu Yd Used	Hours	12.59	636.00	8,007.24
Box Manure Spreader	332 Cu Ft Capacity	Hours	1.00	517.00	517.00
Water Pump	2 HP	KWH	0.07	2,222.20	155.55
Subtotal					$ 12,117.84
Labor	Total Estimated Hours	Hours	6.00	1,383.60	$ 8,301.60
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	99,644.44	$ 6,476.89
Total Annual Variable Cost					$106,121.33
Annual Variable Cost per Ton of Final Product[a]					$11.818

[a]Final Product = 8,980 tons

Appendix 2. Compost System 2

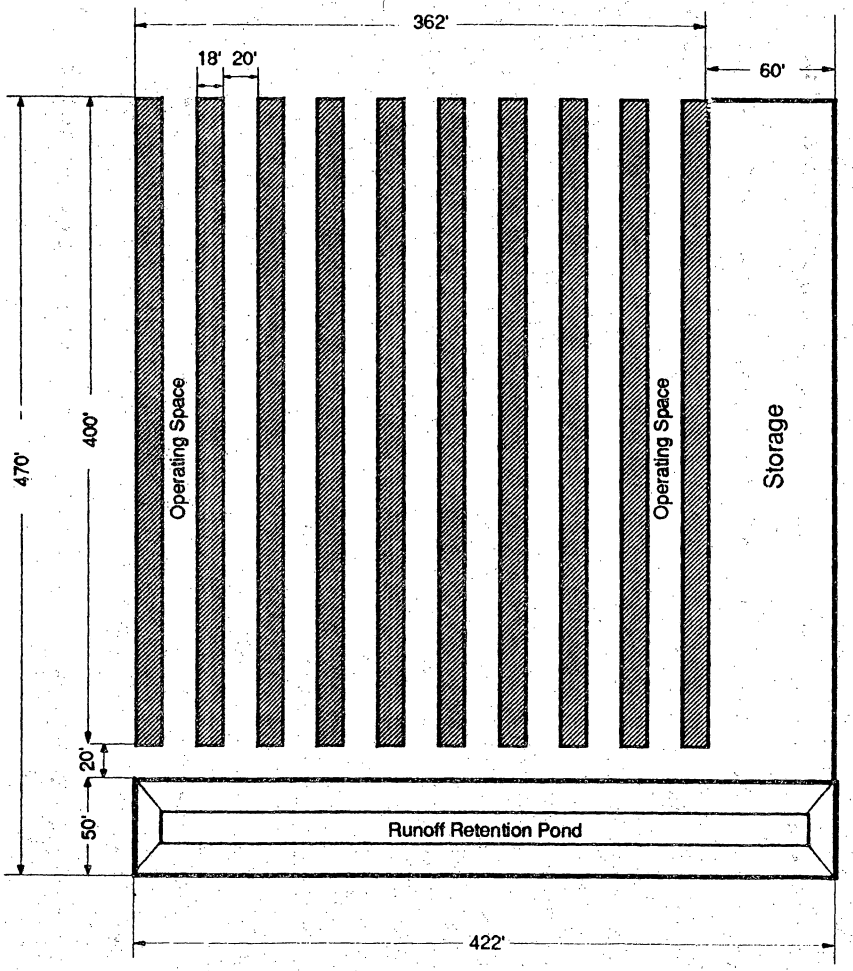
This system requires a total of 5.2 acres of land. The majority of the land, 3.3 acres, is needed to form the windrows, while 0.6 acres are used to stockpile or store the finished product, 0.5 acres are needed for the retention pond, and 0.8 acres are used as a border for the operation (Appendix 2, Figure 1).

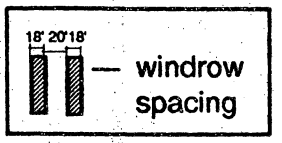
The initial capital investment for System 2 was estimated to total $181,140 or $20.17 per ton of salable product (Appendix 2, Table 1). Machinery and equipment purchases accounted for $148,900, while land and improvements totaled $32,240. The most expensive capital purchase was $60,000 for a used 160 HP front-end loader. The next largest expenditure was $35,000 for the compost pile turner, and the 100 HP tractor was the third largest investment at a cost of $30,000.

Total annual fixed costs were $32,968, or $3.67 per ton of output (Appendix 2, Table 2). Land and improvements accounted for $4,097 of the total, machinery and equipment for $25,431, general overhead for $3,120, and interest on general overhead for $320.

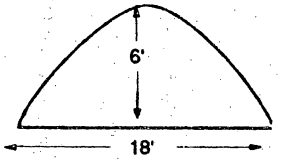
System 2 required an estimated 1,195 man-hours per year to complete the production schedule (Appendix 2, Table 3). Slightly more than 829 man-hours were needed to create the windrows, while 320 man-hours were required to turn the windrows, and almost 64 man-hours were needed to stockpile the final product.

The annual variable costs for this system totaled $100,876, or $11.23 per ton of salable product (Appendix 2, Table 4). The major expense was for materials, accounting for $79,225. Machinery and equipment cost $8,323, labor was $7,171, and interest on operating capital accounted for $6,157.





System 2
(10,000 tons/year)



windrow cross-section

Appendix 2, Figure 1. Possible site plan for System 2 (10,000 tons/year)

Appendix 2, Table 1. Capital requirements for compost system 2, 10,000-ton annual capacity

Item	Description	Unit	Useful Life	Quantity	Cost Per Unit	Total Cost	Percent of Total Cost[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre		5.2	1,200	$ 6,240	3.4
+ Improvements	Grading (5%) and Retention Pond	Acre	20		5,000	26,000	14.4
Subtotal						$ 32,240	17.8
Machinery & Equipment:							
Tractor, 60 HP	60 HP, Gas, Used	Each	10	1	7,500	$ 7,500	4.1
Tractor, 100 HP	100 HP, Diesel	Each	10	1	30,000	30,000	16.6
Front-End Loader	3 Cu Yd, Skid Steer, 160 HP, Used	Each	10	1	60,000	60,000	33.1
Truck	2 Ton, Dump Bed, Used	Each	10	1	10,000	10,000	5.5
Windrower	6' x 18'; 2,799 Cu Yd/Hr	Each	10	1	35,000	35,000	19.3
Box Manure Spreader	269 Cu Ft Capacity	Each	10	1	4,500	4,500	2.5
Water Pump	2 HP	Each	10	1	1,300	1,300	0.7
Thermometer	Industrial, 6 Ft Long Stem	Each	10	10	60	600	0.3
Subtotal						$148,900	82.2
Grand Total						$181,140	100.0
Capital Investment per Ton of Final Product[b]						$20.171	

[a] Subtotals may not total due to rounding.
[b] Final Product = 8,980 tons

Appendix 2, Table 2. Annual fixed cost estimates for compost system 2, 10,000-ton annual capacity

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land &	$ —	$ 811	$ —	$ 62	$ 873
+ Improvements	Grading, Retention Pond	$1,300	1,690	130	104	3,224
Subtotal		$1,300	$2,501	$130	$166	$ 4,097
Machinery & Equipment:						
Tractor, 60 HP	60 HP, Diesel, Used	$ 634	$ 563	$ 43	$ 35	$ 1,275
Tractor, 100 HP	100 HP, Diesel	2,538	2,250	173	138	5,099
Front-End Loader	62 HP, Diesel, 1.25 Cu Yd. Used	5,070	4,504	346	277	10,197
Truck	2 Ton, Dump Bed, Used	933	694	54	43	1,724
Windrower	6' x 18'; 2,799 Cu Yd/Hr	3,280	2,418	186	149	6,033
Box Manure Spreader	269 Cu Ft Capacity	424	309	24	19	776
Water Pump	2 HP	117	93	7	6	223
Thermometers	Industrial, 6 Ft Long Stem	60	39	3	2	104
Subtotal		$11,787	$10,870	$836	$669	$25,431
General Overhead:						
License	Privilege License					$ 25
General Repairs & Maintenance[a]	Grounds					260
Insurance, Personnel	Workmen's Comp., FICA, Health, Unemployment					2,835
Subtotal						$ 3,120
Interest on General Overhead, Insurance & Taxes	Computed at 13 Percent per Annum for Six Months					$ 320
Total Annual Fixed Costs						$32,968
Annual Fixed Costs per Ton of Final Product[b]						$3.671

[1]Repair and maintenance costs for land improvements and buildings. Repair costs for machinery and equipment are included in the hourly variable cost estimates.
[b]Final Product = 8,980 tons

Appendix 2, Table 3. Total annual labor and power inputs for compost system system 2, 10,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Creating Windrows	Front-End Loader, 160 HP	63.6	53.0
	Tractor, 100 HP with Box Manure Spreader, 269 Cu Ft	765.6	638.0
Turning Windrows	Tractor, 60 HP with Windrower	302.4	252.0
Stockpiling Product	Front-End Loader, 160 HP	63.6	53.0
Total		1,195.2	

Appendix 2, Table 4. Annual variable cost estimates for compost system 2, 10,000-ton annual capacity

Item	Description	Unit	Cost Per Unit	Quantity	Total Cost
Materials:					
Poultry Litter		Tons	5.00	6,500.00	$ 32,500.00
Sawdust	Bulking Agent	Tons	8.35	3,500.00	29,225.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	3,500.00	17,500.00
Subtotal					$ 79,225.00
Machinery & Equipment:					
Tractor, 60 HP	60 HP, Diesel, Used	Hours	5.24	252.00	$ 1,320.48
Tractor, 100 HP	100 HP, Diesel	Hours	6.65	638.00	4,242.70
Front-End Loader	160 HP, Diesel, 1.25 Cu Yd, Used	Hours	12.59	106.00	1,334.54
Windrower, Pull Type	6' x 18'; 2,799 Cu Yd/Hr	Hours	4.00	252.00	1,008.00
Box Manure Spreader	269 Cu Ft Capacity	Hours	0.41	638.00	261.58
Water Pump	2 HP	KWH	0.07	2,222.20	155.55
Subtotal					$ 8,322.85
Labor	Total Estimated Hours	Hours	6.00	1,195.20	$ 7,171.20
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	94,719.05	$ 6,156.74
Total Annual Variable Cost					$ 100,875.79
Annual Variable Cost per Ton of Final Product[a]					$11.233

[a]Final Product = 8,980 tons

Appendix 3. Compost System 3

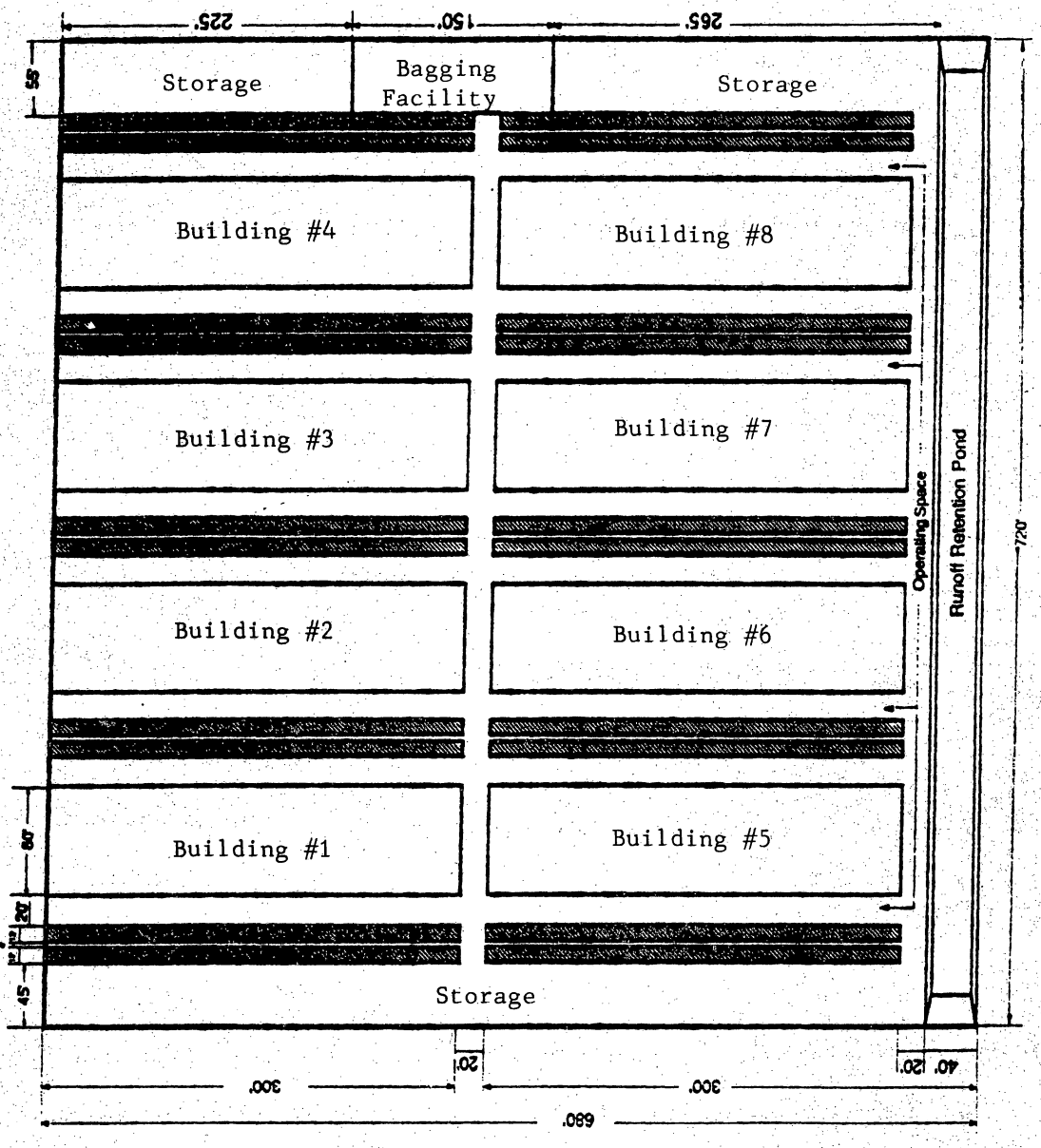
System 3 needs 10.1 acres of land (Appendix 3, Figure 1). This model requires 6.0 acres for the eight open-sided composting buildings and 2.2 acres of open ground to complete the last month of the composting process. The remaining 1.9 acres are used to store the final product, construct a screening and bagging facility, build a retention pond, and clear a border around the operation.

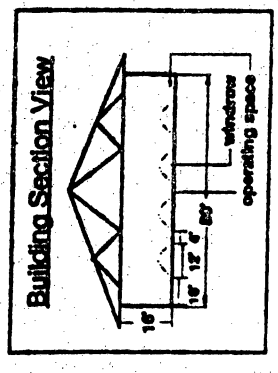
An initial investment of $1,588,104 was needed for this model (Appendix 3, Table 1). Land and improvements accounted for $62,620, the buildings cost $1,208,908, and machinery and equipment totaled $316,576. The capital investment per ton of salable product was $44.21.

Total annual fixed costs were $292,409, or $8.14 per ton of output (Appendix 3, Table 2). Land and improvements accounted for $7,958, buildings comprised $149,902, machinery and equipment cost $57,692, general overhead accounted for $71,273, and interest on overhead cost $5,584.

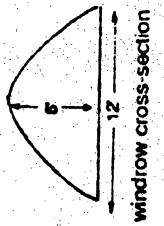
This system requires 4,656 man-hours of labor per year (Appendix 3, Table 3). The most labor-intensive operation is creating windrows, accounting for slightly over 2,481 man-hours. Screening 20 percent of the final product prior to bagging is the second most labor-intensive step and uses 696 man-hours, while the bagging operation needs almost 250 man-hours.

The variable costs totaled $498,780, or $13.89 per ton of salable product (Appendix 3, Table 4). Materials cost $409,640, while machinery and equipment totaled $30,761, labor accounted for $27,937, and the interest on operating capital was $30,442. The annual variable cost was $13.89 per ton of salable product.





System 3
(40,000 tons/year)



Appendix 3, Figure 1. Possible site plan for System 3 (40,000 tons/year)

Appendix 3, Table 1. Capital requirements for compost system 3, 40,000 - ton annual capacity

ITEM	DESCRIPTION	UNIT	USEFUL LIFE	QUANTITY	COST PER UNIT	TOTAL COST	PERCENT OF TOTAL COST[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre		10.1	1,200	$ 12,120	0.8
+ Improvements	Grading (5%) and Retention Pond	Acre	20		5,000	50,500	3.2
Subtotal						$ 62,620	4.0
Buildings:							
Composting	81' x 300; Open-Sided	Each	20	8	147,326	$1,178,608	74.2
Screening & Bagging	50' x 100'	Each	20	1	30,300	30,300	1.9
Subtotal						$1,208,908	76.1
Machinery & Equipment:							
Tractor, 100 HP	100 HP, Diesel	Each	10	1	30,000	$ 30,000	1.9
Front-End Loader	3 Cu. Yd., Skid Steer 160 HP, Used	Each	10	1	60,000	60,000	3.8
Truck	2 Ton, Dump Bed, Used	Each	10	2	10,000	20,000	1.2
Windrower	Self-Propelled, 300 HP Diesel, 6' x 12'	Each	10	1	96,000	96,000	6.0
Box Manure Spreader	332 Cu. Ft. Capacity	Each	10	1	10,841	10,841	0.7
Bagging Machine	20 Bags/Minute; 2 Cu. Ft. Bags	Each	10	1	48,000	48,000	3.0
Separator Screens	26.7 Cu. Yd./Hr Capacity	Each	10	1	9,000	9,000	0.6
Fork Lift	3,000 Lb Lift	Each	10	1	5,695	5,695	0.4
Water Pump	2 HP	Each	10	4	1,300	5,200	0.3
Thermometer	Industrial, 6 Ft Long Stem	Each	10	40	60	2,400	0.2
Pallets	45" x 48"	Each	5	6,400	4.60	29,440	1.8
Subtotal						$ 316,576	19.9
GRAND TOTAL						$1,588,104	100.0
Capital Investment per Ton of Final Product[b]						$44.212	

[a] Subtotals may not add due to rounding.
[b] Final Product = 35,920 tons

APPENDIX TABLE 3.1. ANNUAL FIXED COST ESTIMATES FOR COMPOST SYSTEM 3, 40,000 TON ANNUAL CAPACITY

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land	$ ---	$ 1,576	$ ---	$ 121	$ 1,697
+ Improvements	Grading, Retention Pond	2,525	3,282	252	202	6,261
Subtotal		$ 2,525	$ 4,858	$ 252	$ 323	$ 7,958
Buildings:						
Composting	81' x 300', Open-Sided	$58,928	$76,608	$5,896	$4,712	$146,144
Screening & Bagging	50' x 100'	1,515	1,970	152	121	3,758
Subtotal		$60,443	$78,578	$6,048	$4,833	$149,902
Machinery & Equipment:						
Tractor	100 HP, Diesel	$ 2,538	$ 2,250	$ 173	$ 138	$ 5,099
Front-End Loader	160 HP, Diesel, 3 Cu. Yd., Used	5,070	4,504	346	277	10,197
Truck	2 Ton, Dump Bed, Used	1,866	1,388	108	86	3,448
Windrower, Self-Propelled	300 HP, Diesel, 6' x 12'	8,112	7,207	554	444	16,317
Box Manure Spreader	332 Cu Ft Capacity	1,021	746	57	46	1,870
Bagging Machine	20 Bags/Minute	4,320	3,432	264	211	8,227
Separator Screens	26.7 Cu Yr/Hr	810	644	50	40	1,544
Fork Lift	3000-lb Lift	514	406	31	25	976
Water Pumps	2 HP	468	372	28	24	892
Thermometers	Industrial, 6' Long Stem	240	156	12	10	418
Pallets	45" x 48"	6,400	2,048	128	128	8,704
Subtotal		$30,090	$23,153	$1,751	$1,429	$ 57,692
General Overhead:						
License	Privilege License					$ 25
General Repairs & Maint[1]	Buildings & Grounds					24,831
Insurance, Personnel	Workmen's Comp, FICA, Health, Unemployment					16,417
Administrative & Management Costs	Manager					30,000
Subtotal						$ 71,273
Interest on General Overhead, Insurance & Taxes	Computed at 13 Percent per Annum for Six Months					$ 5,584
Total Annual Fixed Costs						$292,409
Annual Fixed Cost Per Ton of Final Product[2]						$8.141

[1]Repair and Maintenance Costs for Land Improvements and Buildings. Repair Costs for Machinery and Equipment are Included in the Hourly Variable Cost Estimates.
[2]Final Product = 35,920 Tons

Appendix 3, Table 3. Total annual labor and power inputs for compost system 3, 40,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Creating Windrows	Front-End Loader, 160 HP	254.5	212.0
	Tractor, 100 HP with Box Manure Spreader, 332 Cu Ft	2,481.6	2,068.0
Turning Windrows	Windrower, Self-Propelled, 300 HP	489.6	408.0
Screening Product	Separator Screens	696.0	580.0
Bagging Product	Bagging Machine[a]	249.6	208.0
Stockpiling Bulk Product	Front-End Loader, 160 HP	230.4	192.0
Stockpiling/Loading Bagged Product	Tractor, 100 HP, with Fork Lift	254.4	212.0
Total		4,656.1	

[a] 20 2-cu ft bags per minute

Appendix 3, Table 4. Annual variable cost estimates for compost system 3, 40,000-ton annual capacity

Item	Description	Unit	Cost Per Unit	Quantity	Total Cost
Materials:					
Poultry Litter	Delivered	Tons	7.00	26,000.00	$182,000.00
Sawdust	Bulking Agent	Tons	8.35	14,000.00	116,900.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	14,000.00	70,000.00
Bags	2 Cu Ft Capacity	Each	0.21	194,000.00	40,740.00
Subtotal					$409,640.00
Machinery & Equipment:					
Tractor, 100 HP	100 HP, Diesel	Hours	6.65	2,280.00	$ 15,162.00
Front-End Loader	160 HP, Diesel, 3 Cu Yd, Used	Hours	10.85	404.00	4,383.40
Windrower, Self-Propelled	300 HP, Diesel, 6' x 12'	Hours	18.52	408.00	7,556.16
Box Manure Spreader	332 Cu Ft Capacity	Hours	1.00	2,068.00	2,068.00
Bagging Machine	20 Bags/Minute	Hours	1.52	208.00	316.16
Separator Screens	26.7 Cu Yd/Hr	Hours	0.33	580.00	191.40
Fork Lift	3,000-Lb Lift	Hours	2.18	212.00	462.16
Water Pumps	2 HP	KWH	0.07	8,888.80	622.22
Subtotal					$ 30,761.50
Labor	Total Estimated Hours	Hours	6.00	4,656.10	$ 27,936.60
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	468,338.10	$ 30,441.98
Total Annual Variable Costs					$498,780.08
Annual Variable Cost per Ton of Final Product[a]					$13.886

[a]Final Product = 35,920 tons

Appendix 4. Compost System 4

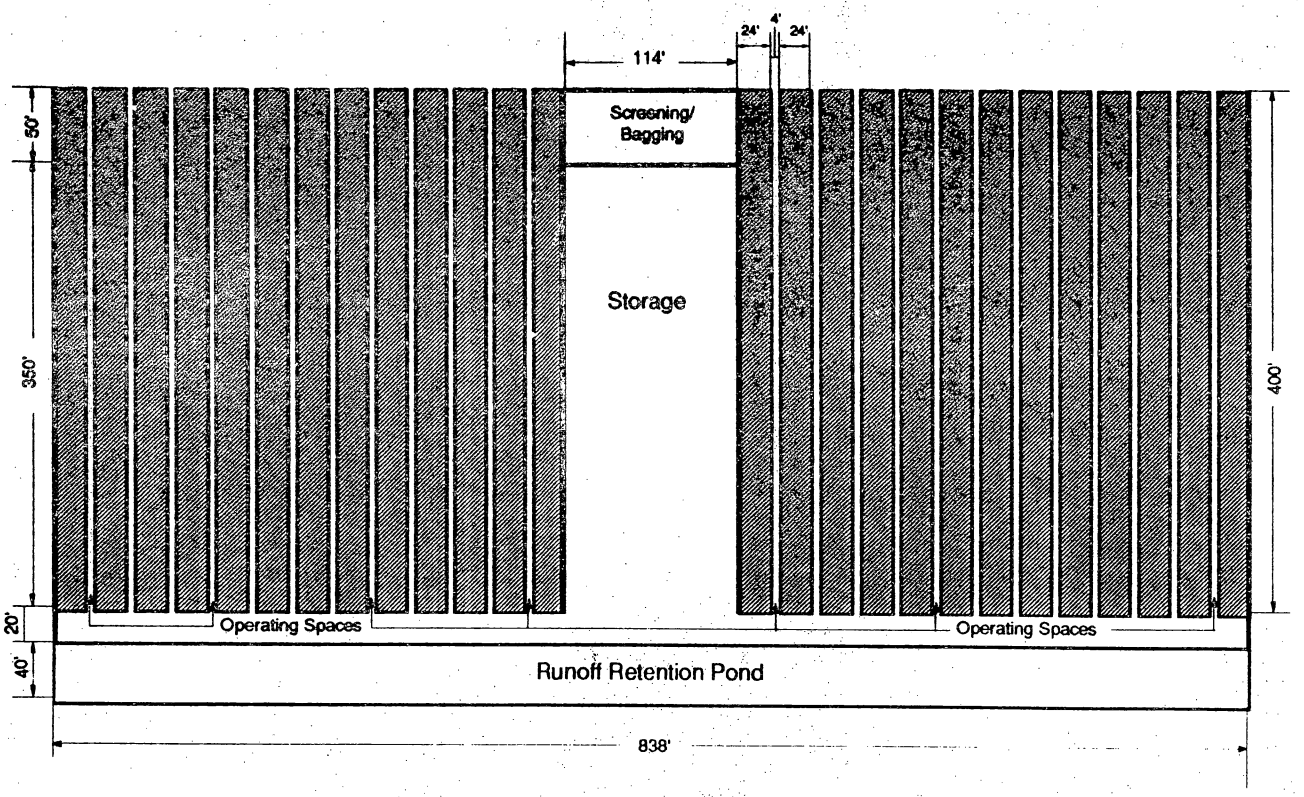
System 4 needs a total of 9.5 acres (Appendix 4, Figure 1). The asphalt surface requires 7.5 acres; 6.6 acres for the windrows and 0.9 acres for storing the final product. Another 0.7 acre is used to build the retention pond, while the screening and bagging facility needs 0.1 acre and the border around the entire system uses 1.2 acres.

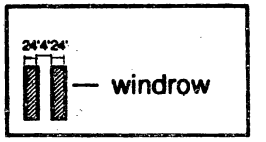
The estimated capital investment for this prototype totaled $913,408, or $25.43 per ton of output (Appendix 4, Table 1). The asphalt pavement cost $483,632, while machinery and equipment accounted for $340,576, land plus improvements comprised $58,900, and the screening and bagging facility was $30,300.

Total annual fixed expenses were $187,493, or $ 5.22 per ton of output (Appendix 4, Table 2). Land and improvements cost $7,487, buildings totaled $63,728, machinery and equipment amounted to $61,771, general overhead cost $50,656, and interest on overhead totaled $3,851.

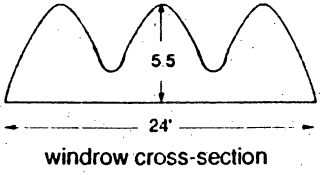
System 4 required over 5,226 man-hours to service its annual production schedule (Appendix 4, Table 3). Creating the compost piles accounted for most of the labor requirements, 2,736 man-hours, while 1,060 man-hours were needed to turn the windrows. Operations associated with preparing 20 percent of the final product for the bag market, screening and bagging required over 945 man-hours.

The total annual variable costs were $502,804, or $14.00 per ton of salable product (Appendix 4, Table 4). Materials was the largest expense, accounting for $409,640. The cost of operating and maintaining the machinery and equipment was $31,117, while labor cost $31,359, and the interest charge on operating capital was $30,688.





System 4
(40,000 tons/year)



windrow cross-section

Appendix 4, Figure 1. Possible site plan for System 4 (40,000 tons/year)

Appendix 4, Table 1. Capital requirements for compost system 4, 40,000-ton annual capacity

Item	Description	Unit	Useful Life	Quantity	Cost Per Unit	Total Cost	Percent of Total Cost[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre		9.5	1,200	$ 11,400	1.2
+ Improvements	Grading (5%) and Retention Pond	Acre	20		5,000	47,500	5.2
Subtotal						$ 58,900	6.4
Buildings:							
Screening & Bagging	50' x 100'	Each	20	1	30,300	$ 30,300	3.3
Asphalt Pavement		Sq Ft	20	289,600	1.67	483,632	52.9
Subtotal						$513,932	56.3
Machinery & Equipment:							
Tractor, 100 HP	100 HP, Diesel	Each	10	1	30,000	$ 30,000	3.3
Front-End Loader	3 Cu Yd, Skid Steer 160 HP, Used	Each	10	1	60,000	60,000	6.6
Truck	2 Ton, Dump Bed, Used	Each	10	2	10,000	20,000	2.2
Windrower	Self-Propelled, 100 HP Diesel, 3000 Cu Yd/Hr Capacity	Each	10	1	120,000	120,000	13.1
Box Manure Spreader	332 Cu Ft Capacity	Each	10	1	10,841	10,841	1.2
Bagging Machine	20 Bags/Minute; 2 Cu Ft Bags	Each	10	1	48,000	48,000	5.2
Separator Screens	26.7 Cu Yd/Hr Capacity	Each	10	1	9,000	9,000	1.0
Fork Lift	3000-Lb Lift	Each	10	1	5,695	5,695	0.6
Water Pump	2 HP	Each	10	4	1,300	5,200	0.6
Thermometers	Industrial, 6 Ft Long Stem	Each	10	40	60	2,400	0.3
Pallets	45" x 48"	Each	5	6,400	4.60	29,440	3.2
Subtotal						$340,576	37.3
Grand Total						$913,408	100.0
Capital Investment per Ton of Final Product[b]						$25.429	

[a] Subtotals may not add due to rounding.
[b] Final Product = 35,920 tons

Appendix 4, Table 2. Annual fixed cost estimates for compost system 4, 40,000-ton annual capacity

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land	$ —	$ 1,482	$ —	$ 114	$ 1,596
+ Improvements	Grading, Retention Pond	2,375	3,088	238	190	5,891
Subtotal		$ 2,375	$ 4,570	$ 238	$ 304	$ 7,487
Buildings:						
Screening & Bagging	50' x 100'	$ 1,515	$ 1,970	$ 152	$ 121	$ 3,758
Asphalt Pavement	289,600 Sq. Ft.	24,182	31,436	2,418	1,934	59,970
Subtotal		$25,697	$33,406	$2,570	$2,055	$ 63,728
Machinery & Equipment:						
Tractor	100 HP, Diesel	$ 2,538	$ 2,250	$ 173	$ 138	$ 5,099
Front-End Loader	160 HP, Diesel, 3 Cu Yd, Used	5,070	4,504	346	277	10,197
Truck	2 Ton, Dump Bed, Used	1,866	1,388	108	86	3,448
Windrower, Self-Propelled	100 HP, Diesel, 3000 Cu Yd/Hr	10,140	9,009	693	554	20,396
Box Manure Spreader	332 Cu Ft Capacity	1,021	746	57	46	1,870
Bagging Machine	20 Bags/Minute	4,320	3,432	264	211	8,227
Separator Screens	26.7 Cu Yr/Hr	810	644	50	40	1,544
Fork Lift	3000-lb Lift	514	406	31	25	976
Water Pumps	2 HP	468	372	28	24	892
Thermometers	Industrial, 6 Ft Long Stem	240	156	12	10	418
Pallets	45" x 46"	6,400	2,048	128	128	8,704
Subtotal		$32,118	$24,955	$1,890	$1,539	$ 61,771
General Overhead:						
License	Privilege License					$ 25
General Repairs & Maint.[a]	Buildings & Grounds					6,069
Insurance, Personnel	Workmen's Comp., FICA, Health, Unemployment					14,562
Administrative & Management Costs	Manager					30,000
Subtotal						$ 50,656
Interest on General Overhead, Insurance & Taxes	Computed on 13 Percent per Annum for Six Months					$ 3,851
Total Annual Fixed Costs						$187,493
Annual Fixed Cost per Ton of Final Product[b]						$5.220

[a] Repair and maintenance costs for land improvements and buildings.
[b] Final Product = 35,920 tons

Appendix 4, Table 3. Total annual labor and power inputs for compost system 4, 40,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Creating Windrows	Front-End Loader, 160 HP	254.5	212.0
	Tractor, 100 HP with Box Manure Spreader, 332 Cu Ft	2,481.6	2,068.0
Turning Windrows	Windrower, Self-Propelled, 300 HP	1,060.0	884.0
Screening Product	Separator Screens	696.0	580.0
Bagging Product	Bagging Machine[a]	249.6	208.0
Stockpiling Bulk Product	Front-End Loader, 160 HP	230.4	192.0
Stockpiling/Loading Bagged Product	Tractor, 100 HP, with Fork Lift	254.4	212.0
Total		5,226.5	

[a] 20 2-cu ft bags per minute

Appendix 4, Table 4. Annual variable cost estimates for compost system 4, 40,000-ton annual capacity

Item	Description	Unit	Cost Per Unit	Quantity	Total Cost
Materials:					
Poultry Litter	Delivered	Tons	7.00	26,000.00	$182,000.00
Sawdust	Bulking Agent	Tons	8.35	14,000.00	116,900.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	14,000.00	70,000.00
Bags	2 Cu Ft Capacity	Each	0.21	194,000.00	40,740.00
Subtotal					$409,640.00
Machinery & Equipment:					
Tractor, 100 HP	100 HP, Diesel	Hours	6.65	2,280.00	$ 15,162.00
Front-End Loader	160 HP, Diesel, 3 Cu Yd, Used	Hours	10.85	404.00	4,383.40
Windrower, Self-Propelled	100 HP, Diesel, 3,000 Cu Yd/Hr	Hours	8.95	884.00	7,911.80
Box Manure Spreader	332 Cu Ft Capacity	Hours	1.00	2,068.00	2,068.00
Bagging Machine	20 Bags/Minute	Hours	1.52	208.00	316.16
Separator Screens	26.7 Cu Yd/Hr	Hours	0.33	580.00	191.40
Fork Lift	3,000-Lb Lift	Hours	2.18	212.00	462.16
Water Pumps	2 HP	KWH	0.07	8,888.80	622.22
Subtotal					$ 31,117.14
Labor	Total Estimated Hours	Hours	6.00	5,226.50	$ 31,359.00
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	472,116.14	$ 30,687.55
Total Annual Variable Costs					$502,803.69
Annual Variable Cost per Ton of Final Product[a]					$13.998

[a]Final Product = 35,920 tons

Appendix 5. Compost System 5

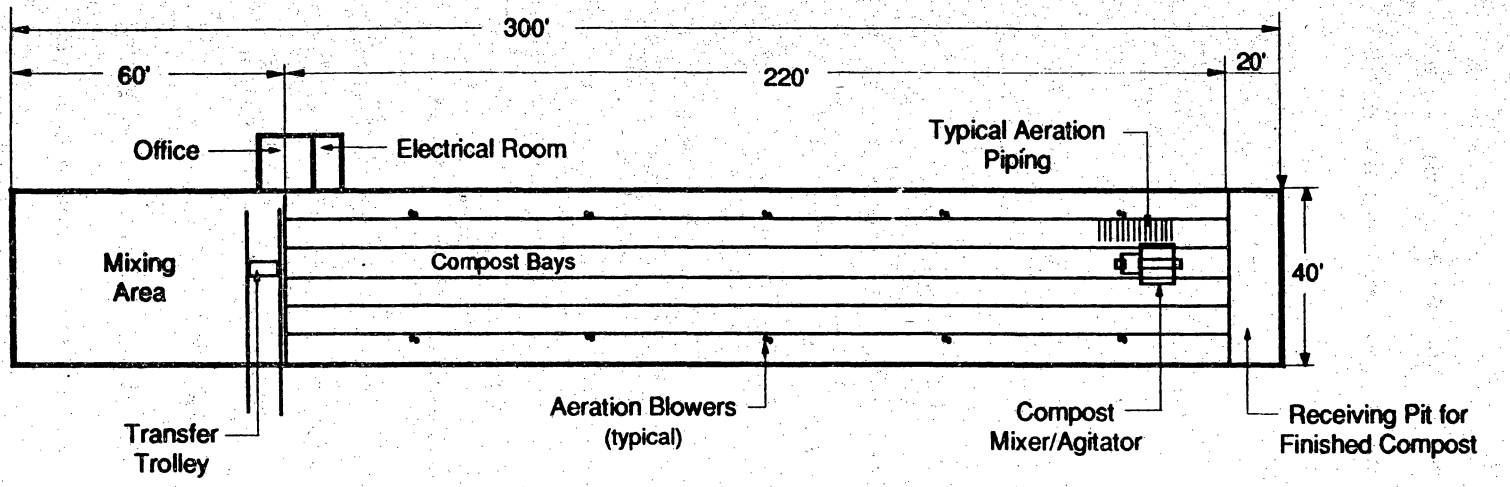
The land requirement for this model is 2.5 acres. The IPS building needs 0.4 acres, while the storage area uses 2 acres and the screening and bagging facility requires 0.2 acres (Appendix 5, Figure 1).

The initial capital investment for this model was $1,388,135, or $38.64 per ton of marketable product (Appendix 5, Table 1). The IPS facility cost $1,200,000 and machinery and equipment amounted to $142,335. Land and improvements and the screening and bagging facility accounted for $15,500 and $30,300, respectively.

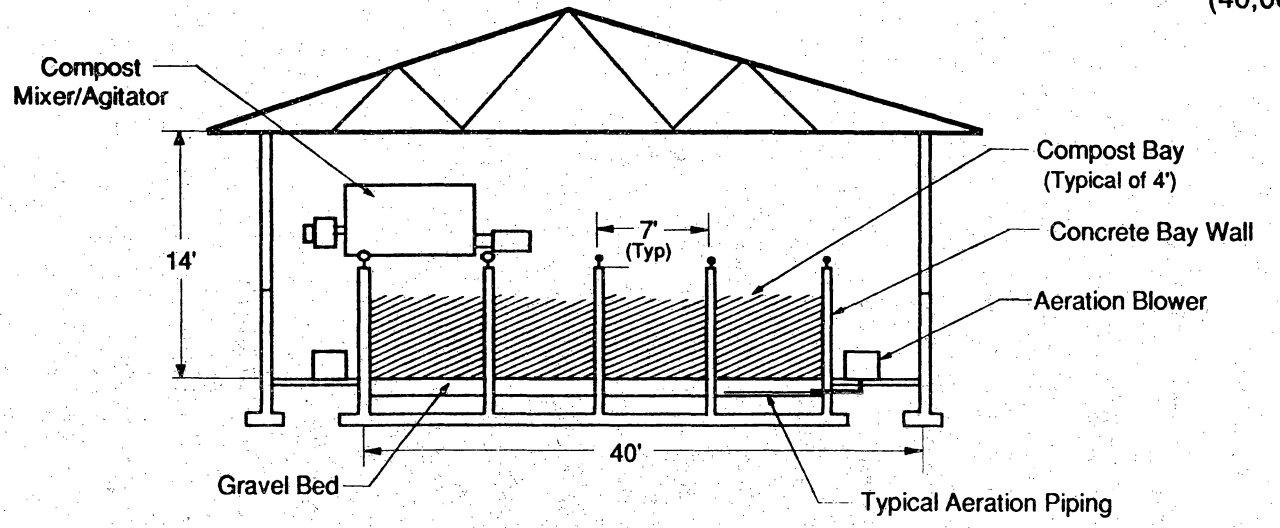
Annual fixed expenses totaled $269,141, or $7.49 per ton of output (Appendix 5, Table 2). There were $1,969 allocated to land and improvements, $152,558 for buildings, $25,066 for machinery and equipment, $83,325 for general overhead, and $6,223 for interest on overhead.

System 5 needs 3,588 man-hours of labor per year to perform all the required operations (Appendix 5, Table 3). Over 1,548 man-hours per year are needed to maintain and service the IPS composting procedure and almost 610 man-hours per year are used to load raw product into the compost bays. Screening the output uses 696 man-hours, while stockpiling and loading the marketable product, both bulk and bagged material, uses over 484 man-hours.

The total variable costs were estimated to be $471,491 per year, or $13.13 per ton of output (Appendix 5, Table 4). The cost of materials was the largest expenditure, accounting for $409,640, and interest charges on operating capital were the second most expensive outlay, $28,776. Labor was the third largest category, $21,530, and machinery and equipment costs totaled $4,294. The cost associated with operating the IPS facility accounted for $7,250.



System 5
(40,000 tons/year)



Appendix 5, Figure 1. Possible site plan for System 5 (40,000 tons/year)

Appendix 5, Table 1. Capital Requirements for compost system 5, 40,000-ton annual capacity

Item	Description	Unit	Useful Life	Quantity	Cost Per Unit	Total Cost	Percent of Total Cost[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre		2.5	1,200	$ 3,000	0.2
+ Improvements	Grading (5%) and Retention Pond	Acre	20		5,000	12,500	0.9
Subtotal						$ 15,500	1.1
Buildings:							
Composting Facility	Building, Control System and Skid Steer Loader	Each	20	1	1,200,000	$1,200,000	86.4
Screening & Bagging	50' x 100'	Each	20	1	30,300	30,300	2.2
Subtotal						$1,230,300	88.6
Machinery & Equipment:							
Front-End Loader/	1.25 Cu Yd, 62 HP	Each	10	1	25,000	$ 25,000	1.8
Fork Lift	3,000-Lb Lift	Each	10	1	5,695	5,695	0.4
Truck	2 Ton, Dump Bed, Used	Each	10	2	10,000	20,000	1.4
Bagging Machine	20 Bags/Minute; 2 Cu Ft Bags	Each	10	1	48,000	48,000	3.5
Separator Screens	26.7 Cu Yd/Hr Capacity	Each	10	1	9,000	9,000	0.6
Water Pump	2 HP	Each	10	4	1,300	5,200	0.4
Pallets	45" x 48"	Each	5	6,400	4.60	29,440	2.1
Subtotal						$ 142,335	10.2
Gramd Total						$1,388,135	100.0
Capital Investment per Ton of Final Product[b]						$38.645	

[a] Subtotals may not add due to rounding.
[b] Final Product = 35,920 tons

Appendix 5, Table 2. Annual fixed cost estimates for compost system 5, 40,000-ton annual capacity

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land	$ ---	$ 390	$ ---	$ 30	$ 420
+ Improvements	Grading, Retention Pond	625	812	62	50	1,549
Subtotal		$ 625	$ 1,202	$ 62	$ 80	$ 1,969
Buildings:						
Composting Faciltiy	Building, Control System and Skid Steer Loader	$ 60,000	$ 78,000	$ 6,000	$4,800	$148,800
Screening & Bagging	50' x 100'	1,515	1,970	152	121	3,758
Subtotal		$ 61,515	$ 79,970	$ 6,152	$4,921	$152,558
Machinery & Equipment:						
Front-End Loader	62 HP, Diesel, 1.25 Cu Yd , Used	$ 634	$ 563	$ 43	$ 35	$ 1,275
Truck	2 Ton, Dump Bed, Used	1,866	1,388	108	86	3,448
Bagging Machine	20 Bags/Minute	4,320	3,432	264	211	8,227
Separator Screens	26.7 Cu Yr/Hr	810	644	50	40	1,544
Fork Lift	3000-Lb Lift	514	406	31	25	976
Water Pumps	2 HP	468	372	28	24	892
Pallets	45" x 48"	6,400	2,048	128	128	8,704
Subtotal		$15,012	$ 8,853	$ 652	$ 549	$ 25,066
General Overhead:						
License	Privilege License					$ 25
General Repairs & Maint.[a]	Buildings & Grounds					36,883
Insurance, Personnel	Workmen's Comp., FICA, Health, Unemployment					16,417
Administrative & Management Costs	Manager					30,000
Subtotal						$ 83,325
Interest on General Overhead, Insurance & Taxes	Computed at 13 Percent per Annum for Six Months					$ 6,223
Total Annual Fixed Costs						$269,141
Annual Fixed Cost per Ton of Final Product[a]						$7.493

[a]Repair and maintenance costs for land improvements and buildings.
[b]Final Product = 35,920 tons

Appendix 5, Table 3. Total annual labor and power inputs for compost system 5, 40,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Loading Windrow Bays	Tractor, 100 HP, with Front-End Loader, 62 HP Diesel	609.6	508.0
Maintaining Composting Process	Hand	1,548.4	---
Screening Product	Separator Screens	696.0	580.0
Bagging Product	Bagging Machine[a]	249.6	208.0
Stockpiling Bulk Product	Tractor, 100 HP, with Front-End Loader, 62 HP Diesel	230.4	192.0
Stockpiling/Loading Bagged Product	Front-End Loader, 62 HP Diesel	254.4	212.0
Total		3,588.4	

[a] 20 2-cu ft bags per minute

Appendix 5, Table 4. Annual variable cost estimates for compost system 5, 40,000-ton annual capacity

Item	Description	Unit	Cost Per Unit	Quantity	Total Cost
Materials:					
Poultry Litter	Delivered	Tons	7.00	26,000.00	$182,000.00
Sawdust	Bulking Agent	Tons	8.35	14,000.00	116,900.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	14,000.00	70,000.00
Bags	2 Cu Ft Capacity	Each	0.21	194,000.00	40,740.00
Subtotal					$409,640.00
Composting Facility:	Front End Loader, Skid Steer				$ 293.82
	Mixer	KWH	0.07	43,683.00	3,057.81
	Blowers	KWH	0.07	55,691.70	3,898.42
Subtotal					$ 7,250.05
Machinery & Equipment:					
Front-End Loader	62 HP, Diesel	Hours	3.86	700.00	$ 2,702.00
Bagging Machine	20 Bags/Minute	Hours	1.52	208.00	316.16
Separator Screens	26.7 Cu Yd/Hr	Hours	0.33	580.00	191.40
Fork Lift	3,000-Lb Lift	Hours	2.18	212.00	462.16
Water Pump	2 HP	KWH	0.07	8,888.80	622.22
Subtotal					$ 4,293.94
Labor	Total Estimated Hours	Hours	6.00	3,588.40	$ 21,530.40
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	442,714.39	$ 28,776.44
Total Annual Variable Costs					$471,490.83
Annual Variable Cost per Ton of Final Product[a]					$13.126

[a]Final Product = 35,920 tons

Appendix 6. Compost System 6

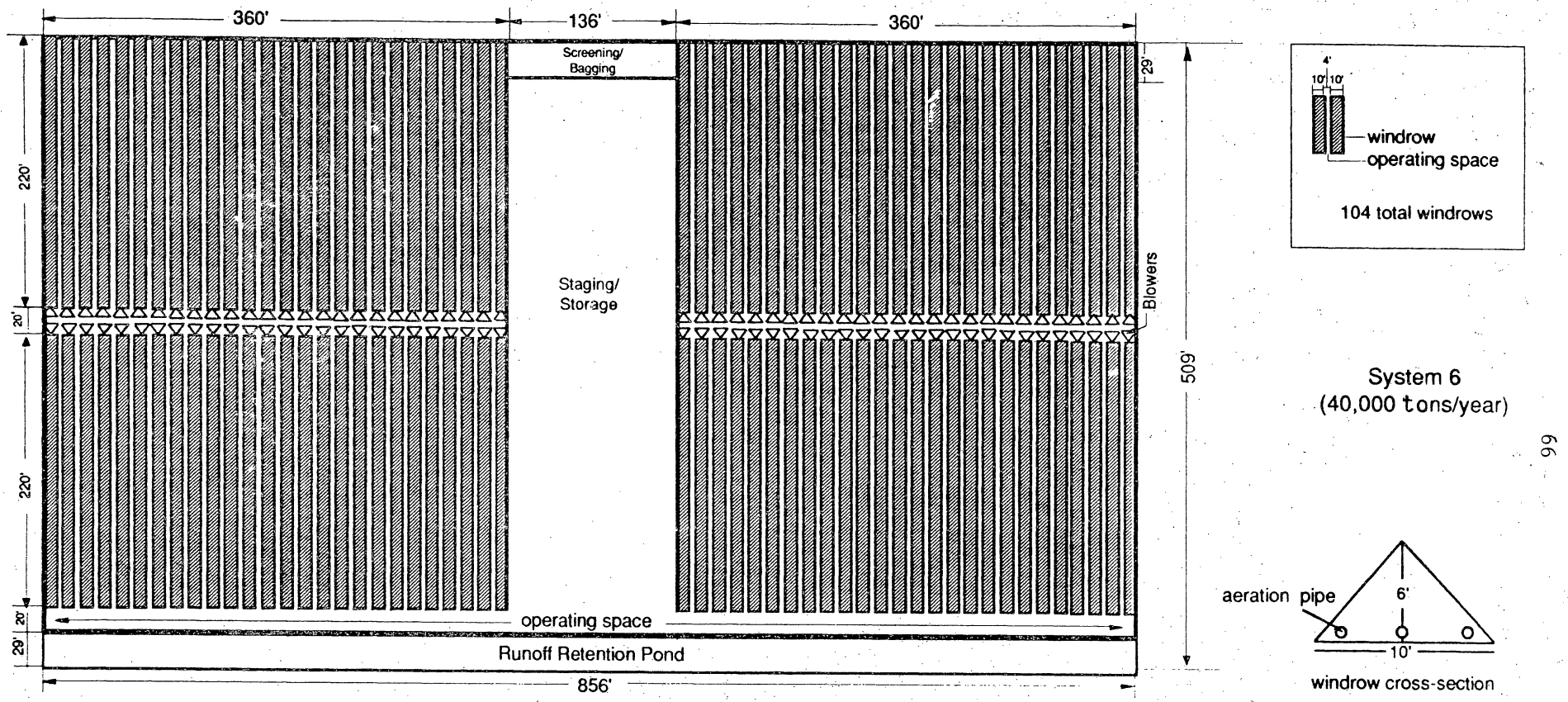
Approximately 10.9 acres of land are required for System 6 (Appendix 6, Figure 1). The area used to construct the compost piles needs 7.6 acres and the storage area uses 1.3 acres. The retention pond and border require 0.6 and 1.3 acres, respectively.

This system's initial capital investment was $1,066,620, or $29.69 per ton of marketable product (Appendix 6, Table 1). The largest expenditure was $687,580 for the asphalt pavement and the screening and bagging building. The machinery and equipment cost $311,160, and the land plus improvements totaled $67,580.

Annual fixed expenses for System 6 were $228,227, or $6.36 per ton of output (Appendix 6, Table 2). This total included $85,298 for buildings and facilities, $72,183 for general overhead, $56,871 for machinery and equipment, $8,588 for land and improvements, and $5,337 for interest on general overhead.

A total of 4,166 man-hours are needed to support this compost system (Appendix 6, Table 3). More than 2,735 man-hours are used to create and maintain the compost piles, while 945 man-hours are required to screen and bag 20 percent of the salable product. The remaining 484 man-hours are employed to stockpile the output.

Annual operating expenses for this model totaled $488,180, or $13.59 per ton of marketable product (Appendix 6, Table 4). The variable costs for each category were: materials, $409,640, machinery and equipment, $23,749, labor, $24,996, and interest on operating capital, $29,795.



Appendix 6, Figure 1. Possible site plan for System 6 (40,000 tons/year)

Appendix 6, Table 1. Capital Requirements for compost system 6, 40,000-ton annual capacity

Item	Description	Unit	Useful Life	Quantity	Cost Per Unit	Total Cost	Percent of Total Cost[a]
			Years		Dollars	Dollars	Percent
Land	Unimproved Land	Acre	---	10.9	1,200	$ 13,080	1.2
+ Improvements	Grading (5%) and Retention Pond	Acre	20		5,000	54,500	5.1
Subtotal						$ 67,580	6.3
Buildings:							
Screening & Bagging	50' x 100'	Each	20	1	30,300	$ 30,300	2.8
Asphalt Pavement	460' x 856'	Sq. Ft.	20	393,760	1.67	657,580	61.7
Subtotal						$687,880	64.5
Machinery & Equipment:							
Tractor, 100 HP	100 HP, Diesel	Each	10	1	30,000	$ 30,000	2.8
Front-End Loader	3 Cu Yd, Skid Steer 160 HP, Used	Each	10	1	60,000	60,000	5.6
Truck	2 Ton, Dump Bed, Used	Each	10	2	10,000	20,000	1.9
Box Manure Spreader	332 Cu Ft Capacity	Each	10	1	10,841	10,841	1.0
Bagging Machine	20 Bags/Minute; 2 Cu Ft Bags	Each	10	1	48,000	48,000	4.5
Separator Screens	26.7 Cu Yd/Hr Capacity	Each	10	1	9,000	9,000	0.8
Fork Lift	3,000-Lb Lift	Each	10	1	5,695	5,695	0.5
Water Pump	2 HP	Each	10	4	1,300	5,200	0.5
Thermometers	Industrial, 6 Ft Long Stem	Each	10	40	60	2,400	0.2
Blowers	3 HP, 15 5/8" Radial Arm Blowers	Each	10	104	871	90,584	8.5
Pallets	45" x 48"	Each	5	6,400	4.60	29,440	2.8
Subtotal						$311,160	29.2
Grand Total						$1,066,620	100.0
Capital Investment per Ton of Final Product[b]						$29.694	

[a] Subtotals may not add due to rounding.
[b] Final Product = 35,920 tons

Appendix 6, Table 2. Annyal fixed cost estimates for compost system 6, 40,000-ton annual capacity

Item	Description	Depreciation	Interest	Insurance	Taxes	Total
Land	Unimproved Land	$ ---	$ 1,700	$ ---	$ 131	$ 1,831
+ Improvements	Grading, Retention Pond	2,725	3,542	272	218	6,757
Subtotal		$ 2,725	$ 5,242	$ 272	$ 349	$ 8,588
Buildings:						
Screening & Bagging	50' x 100'	$ 1,515	$ 1,970	$ 152	$ 121	$ 3,758
Asphalt Pavement	393,760 Sq. Ft.	32,879	42,743	3,288	2,630	81,540
Subtotal		$34,394	$44,713	$ 3,440	$2,751	$85,298
Machinery & Equipment:						
Tractor	100 HP, Diesel	$ 2,538	$ 2,250	$ 173	$ 138	$ 5,099
Front-End Loader	160 HP, Diesel, 3 Cu Yd , Used	5,070	4,504	346	277	10,197
Truck	2 Ton, Dump Bed, Used	1,866	1,388	108	86	3,448
Box Manure Spreader	332 Cu Ft Capacity	1,021	746	57	46	1,870
Bagging Machine	20 Bags/Minute	4,320	3,432	264	211	8,227
Separator Screens	26.7 Cu Yd/Hr	810	644	50	40	1,544
Fork Lift	3000-Lb Lift	514	406	31	25	976
Water Pumps	2 HP	468	372	28	24	892
Thermometers	Industrial, 6 Ft Long Stem	240	156	12	10	418
Blowers	3 HP, 15 5/8" Radial Arms	8,112	6,448	520	416	15,496
Pallets	45" x 48"	6,400	2,048	128	128	8,704
Subtotal		$30,090	$22,394	$1,717	$1,401	$ 56,871
General Overhead:						
License	Privilege License					$ 25
Drainage Pipe	4" Perforated, 687 Rolls					17,862
General Repairs & Maint.[a]	Buildings & Grounds					7,879
Insurance, Personnel	Workmen's Comp., FICA, Health, Unemployment					16,417
Administrative & Management Costs	Manager					30,000
Subtotal						$ 72,183
Interest on General Overhead, Insurance & Taxes	Computed at 13 Percent per Annum for Six Months					$ 5,337
Total Annual Fixed Costs						$228,277
Annual Fixed Cost per Ton of Final Product[b]						$6.355

[a]Repair and maintenance costs for land improvements and buildings.
[b]Final Product = 35,920 Tons

Appendix 6, Table 3. Total annual labor and power inputs for compost system 6, 40,000-ton capacity

Type of Operation	Equipment Used	Hours/Year	
		Labor	Power
Creating and Maintaining Static Windrows	Front-End Loader, 160 HP	254.0	212.0
	Tractor, 100 HP, with Box Manure Spreader, 332 Cu Ft	2,481.6	2,068.0
Screening Product	Separator Screen	696.0	580.0
Bagging Product	Bagging Machine[a]	249.6	208.0
Stockpiling Bulk Product	Front-End Loader, 160 HP	230.4	192.0
Stockpiling/Loading Bagged Product	Tractor, 100 HP, with Fork Lift	254.4	212.0
Total		4,166.0	

[a] 20 2-cu ft bags per minute

Appendix 6, Table 4. Annual variable cost estimates for compost system 6, 40,000-ton annual capacity

Item	Description	Unit	Cost Per Unit	Quantity	Total Cost
Materials:					
Poultry Litter	Delivered	Tons	7.00	26,000.00	$182,000.00
Sawdust	Bulking Agent	Tons	8.35	14,000.00	116,900.00
Delivery Fee	Sawdust Delivery Fee	Tons	5.00	14,000.00	70,000.00
Bags	2 Cu Ft Capacity	Each	0.21	194,000.00	40,740.00
Subtotal					$409,640.00
Machinery & Equipment:					
Tractor	100 HP, Diesel	Hours	6.65	2,280.00	$ 15,162.00
Front-End Loader	160 HP, Diesel, 3 Cu Yd Used	Hours	10.85	404.00	4,383.40
Box Manure Spreader	332 Cu Ft Capacity	Hours	1.00	2,068.00	2,068.00
Bagging Machine	20 Bags/Minute	Hours	1.52	208.00	316.16
Separator Screens	26.7 Cu Yd/Hr	Hours	0.33	580.00	191.40
Fork Lift	3,000-Lb Lift	Hours	2.18	212.00	462.16
Water Pumps	2 HP	KWH	0.07	8,888.80	622.22
Blowers	3 HP, 15 5/8" Radial Arms	KWH	0.07	7,764.70	543.53
Subtotal					$ 23,748.87
Labor	Total Estimated Hours	Hours	6.00	4,166.00	$ 24,996.00
Interest Charge on Operating Capital	Computed at 13 Percent on an Annual Basis for Six Months	Percent	6.5	458,384.87	$ 29,795.02
Total Annual Variable Costs					$488,179.89
Annual Variable Cost per Ton of Final Product[a]					$13.591

[a]Final Product = 35,920 tons