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(Update of the May 2004 draft)

Cost and Returns Analysis of Manure Management Systems Evaluated in 2004 under the North Carolina Attorney General Agreements with Smithfield Foods, Premium Standard Farms, and Front Line Farmers

TECHNOLOGY REPORT: BEST (FAN + TFS AND FILTRAMAT + TFS)

Prepared as Part of the Full Economic Assessment of Alternative Swine Waste Management Systems Under the Agreement Between the North Carolina Attorney General and Smithfield Foods

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Retrofit Cost per 1,000 pounds Steady State Live Weight per year: $114.56
Standardized Feeder-to-Finish Farm with 4,320 head (Tables BEST.34- BEST.42)
10-Year Amortization, Pit-Recharge, N limited Irrigation onto Forages

Includes:	Lift Station and Manure Evacuation:	$ 9.45 / 1,000 lbs. SSLW / Yr.
	FAN Feed Tank:	$ 6.89 / 1,000 lbs. SSLW / Yr.
	FAN Separator:	$ 21.14 / 1,000 lbs. SSLW / Yr.
	TFS Feed Tank:	$ 12.35 / 1,000 lbs. SSLW / Yr.
	TFS System:	$ 51.47 / 1,000 lbs. SSLW / Yr.
	Increased Land Application Cost:	$ 13.26 / 1,000 lbs. SSLW / Yr.

Range:	Across Farm Sizes and Types (Pit-Recharge): / 1,000 lbs. SSLW / Yr.	$66.70 To $593.44
	Across Farm Sizes and Types (Flush): / 1,000 lbs. SSLW / Yr.	$80.05 To $822.75

Confidence in Estimates:

Medium to Medium-Low
Based on 14 months evaluation, real commercial setting data for electricity use and price, construction and operating performance and expense. Standardized model assumes performance beyond demonstrated loading rates and includes an untested component (holding pond).

Costs by Category:

Direct Construction:	$ 62.13 / 1,000 lbs. SSLW / Yr.
Contractor Overhead:	$ 22.16 / 1,000 lbs. SSLW / Yr.
Total Operating:	$ 17.01 / 1,000 lbs. SSLW / Yr.
Increased Land Application Cost:	$ 13.26 / 1,000 lbs. SSLW / Yr.

Sensitivity Analysis: FAN + TFS System

Effect of Expected Economic Life, Interest Rate, and Overhead Rate on Predicted Annualized Construction and Overhead Cost ($ / 1,000 lbs. SSLW)

Capital Recovery Factor (CRF)		Overhead Rate	
		20 %	43.1 %
Low-Cost Projection (15-year economic life, 6 % interest rate)	0.1030	$53.51	$61.72
Baseline Cost Projection (10-year economic life, 8 % interest rate)	0.1490	$72.41	**$84.29***
High-Cost Projection (7-year economic life, 10 % interest rate)	0.2054	$95.55	$111.92

* This predicted cost was estimated using the assumptions that are applied throughout the report—10-year economic life, 8 % interest rate, and 43.1 % overhead rate.

Effect of Electricity Price on Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)

Electricity Price ($ / kWh)	Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)
Low-Cost Electricity ($0.06 / kWh)	$15.45
Baseline Cost of Electricity ($0.08 / kWh)	**$17.01***
High-Cost Electricity ($0.10 / kWh)	$18.57

* This predicted cost was estimated using the assumption that is applied throughout the report--$0.08 / kWh.

The sensitivity of predicted costs and returns to a few critical assumptions is illustrated above by recalculating **annualized construction and overhead cost** with lower and higher values for amortization rate (cost recovery factor) and for overhead rate. The number in bold face $84.29 is the actual predicted 2004 construction and overhead cost for the FAN + TFS system on a 4,320 head feeder to finish farm with pit recharge and nitrogen limited land application to forage. Numbers are recalculated using two overhead rates: 20% and 43.1%, and three combinations of interest rate and maximum expected economic life: 15 year life and 6% interest rate, 10 year life and 8% interest rate, and 7 year life and 10% interest rate. The range of selected parameter values has a significant effect on the predicted value of annual construction and overhead costs.

Similarly, predicted **annual operating costs** of the FAN + TFS system are recalculated using higher and lower prices for electricity. The 25% increase or decrease in electricity price has a slight effect on the predicted annual operating cost per unit reflecting limited use of electricity by the FAN + TFS system.

Note that the sensitivity analysis is not intended to propose alternative costs and returns estimates. It is solely intended to illustrate the sensitivity of the results to changes in parameter values.

Break-even Analysis on By-product Prices: FAN + TFS System

Breakeven analysis is conducted for systems that produce potentially marketable by-products in order to determine the by-product price required to cover the cost of the system. The FAN + TFS system produces separated solids and liquid effluent. Breakeven analysis is conducted for the separated solids.

Break-even Analysis on Separated Solids: 4,320-Head Feeder to Finish Farm

Cost to be Recovered	($ / 1,000 lbs. SSLW / Year)	Breakeven Price @ 996 lbs. / 1.000 lbs. SSLW per Year*
		($ / ton)
Cost of system excluding TFS	$37.48	$75
Cost of FAN + TFS	$114.56	$230

* Calculated as 581,285 wet pounds per year.

The table above presents partial and total breakeven prices. The first row of numbers in the table presents the breakeven price of the additional technology necessary to produce the by-product excluding the TFS system (it remains to be seen how separated solids mass and composition would change in the absence of the TFS system.). The bottom line in the table is the price necessary to offset the cost of the entire retrofitted manure management system.

Summary of Results: Filtramat + TFS System

Retrofit Cost per 1,000 pounds Steady State Live Weight per year: $146.50
Standardized Feeder-to-Finish Farm with 4,320 head (Tables BEST.81- BEST.89)
10-Year Amortization, Pit-Recharge, N limited Irrigation onto Forages

Includes:	Lift Station and Manure Evacuation:	$ 9.45 / 1,000 lbs. SSLW / Yr.
	Filtramat Feed Tank:	$ 17.93 / 1,000 lbs. SSLW / Yr.
	Filtramat Separator:	$ 40.25 / 1,000 lbs. SSLW / Yr.
	TFS Feed Tank:	$ 11.15 / 1,000 lbs. SSLW / Yr.
	TFS System:	$ 53.12 / 1,000 lbs. SSLW / Yr.
	Increased Land Application Cost:	$ 14.60 / 1,000 lbs. SSLW / Yr.

Range:	Across Farm Sizes and Types (Pit-Recharge): / 1,000 lbs. SSLW / Yr.	$81.97 To $770.17
	Across Farm Sizes and Types (Flush): / 1,000 lbs. SSLW / Yr.	$96.42 To $1,017.39

Confidence in Estimates:

Medium to Medium-Low
Based on 6 to 8 months evaluation, real commercial setting data for electricity use and price, construction and operating performance and expense. Uncertainty about actual fraction of flow treated and hypothetical land application of solids.

Costs by Category:

Direct Construction:	$ 78.98 / 1,000 lbs. SSLW / Yr.
Contractor Overhead:	$ 29.14 / 1,000 lbs. SSLW / Yr.
Total Operating:	$ 23.78 / 1,000 lbs. SSLW / Yr.
Increased Land Application Cost:	$ 14.60 / 1,000 lbs. SSLW / Yr.

Sensitivity Analysis: Filtramat + TFS System

Effect of Expected Economic Life, Interest Rate, and Overhead Rate on Predicted Annualized Construction and Overhead Cost ($ / 1,000 lbs. SSLW)

Capital Recovery Factor (CRF)		Overhead Rate	
		20 %	43.1 %
Low-Cost Projection (15-year economic life, 6 % interest rate)	0.1030	$69.90	$80.69
Baseline Cost Projection (10-year economic life, 8 % interest rate)	0.1490	$92.50	**$108.12***
High-Cost Projection (7-year economic life, 10 % interest rate)	0.2054	$120.16	$141.69

* This predicted cost was estimated using the assumptions that are applied throughout the report—10-year economic life, 8 % interest rate, and 43.1 % overhead rate.

Effect of Electricity Price on Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)

Electricity Price ($ / kWh)	Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)
Low-Cost Electricity ($0.06 / kWh)	$20.95
Baseline Cost of Electricity ($0.08 / kWh)	**$23.78***
High-Cost Electricity ($0.10 / kWh)	$26.60

* This predicted cost was estimated using the assumption that is applied throughout the report--$0.08 / kWh.

The sensitivity of predicted costs and returns to a few critical assumptions is illustrated above by recalculating **annualized construction and overhead cost** with lower and higher values for amortization rate (cost recovery factor) and for overhead rate. The number in bold face $108.12 is the actual predicted 2004 construction and overhead cost for the Filtramat + FAN system on a 4,320 head feeder to finish farm with pit recharge and nitrogen limited land application to forage. Numbers are recalculated using two overhead rates: 20% and 43.1%, and three combinations of interest rate and maximum expected economic life: 15 year life and 6% interest rate, 10 year life and 8% interest rate, and 7 year life and 10% interest rate. The range of selected parameter values has a significant effect on the predicted value of annual construction and overhead costs.

Similarly, predicted **annual operating costs** of the Filtramat + TFS system are recalculated using higher and lower prices for electricity. The 25% increase or decrease in electricity price has a small effect on the predicted annual operating cost per unit reflecting limited use of electricity by the Filtramat + TFS system.

Note that the sensitivity analysis is not intended to propose alternative costs and returns estimates. It is solely intended to illustrate the sensitivity of the results to changes in parameter values.

Break-even Analysis on By-product Prices: Filtramat + TFS System

Breakeven analysis is conducted for systems that produce potentially marketable by-products in order to determine the by-product price required to cover the cost of the system. The Filtramat + TFS system produces separated solids and liquid effluent. Breakeven analysis is conducted for the separated solids.

Break-even Analysis on Separated Solids: 4,320-Head Feeder to Finish Farm

Cost to be Recovered	($ / 1,000 lbs. SSLW / Year)	Breakeven Price @ 1,196 lbs. / 1,000 lbs. SSLW per Year*
		($ / ton)
Cost excluding the TFS system	$67.63	$113
Cost Filtramat + TFS system retrofit	$146.50	$244

* Calculated as 697,542 wet pounds per year.

The table above presents partial and total breakeven prices. The first row of numbers in the table presents the breakeven price of the additional technology necessary to produce the by-product excluding the TFS system (it remains to be seen how separated solids mass and composition would change in the absence of the TFS system.). The bottom line in the table is the price necessary to offset the cost of the entire retrofitted manure management system.

1. Overview of the Biomass Energy Sustainable Technology (BEST)

1.1 Farm Overview

This candidate technology is located on Murphy Brown's Corbett Farm Units #1, #3, and #4 near Rose Hill, NC. Corbett Farm #1 has five finishing houses with natural ventilation and a steady-state head capacity of 3,320 (Westerman). Each house is equipped with fully-slatted floors and flush tanks to remove manure twice per day (per aisle). The number of tanks per house and the number of tanks required to flush an entire house vary at Farm #1 (Worley-Davis). As such, the total flush volume / house / day also varies across the five houses. On average, Farm #1 total daily flush volume is equal to 31,923 gallons (Westerman). Corbett Farm #3 has two finishing houses with natural ventilation and a steady-state head capacity of 1,600 (Worley-Davis, Westerman). Houses in Farm #3 are equipped with fully-slatted floors and flush tanks to remove manure twice per day. Four flush tanks are required to flush an entire house at Farm #3 Worley-Davis). Corbett Farm #4 has two finishing houses with natural ventilation and a steady-state head capacity of 2,448 (Worley-Davis, Westerman). Houses in Farm #4 are equipped with partially-slatted floors and flush tanks to remove manure twice a day (per aisle). Four flush tanks are necessary for flushing an entire house at Farm #4. The total average daily flush volume for Corbett 3 and 4 combined is reported to equal 37,801 gallons / day (Westerman).[1]

Prior to the installation of the BEST system, all of the flushed manure from Farm #1 was pumped to one single-stage anaerobic lagoon (single-cell system) with dimensions of approximately (irregularly shaped) 373' x 247' at the bank top. Total lagoon treatment volume of this cell was reported as 355,128 ft^3 (Worley-Davis). At Farm #3, a three-cell system was used to treat flushed manure prior to the construction of the BEST system. Two cells (Cells #1 and #2) received flushed manure from the barns and subsequently overflowed into a lift station that pumped excess water into the third cell. The third cell (Cell #3) was a shared cell which also received excess water from Farm #4. Cells #1 and #2 were irregularly shaped with no specified dimensions. These cells had 131,247 ft^3 and 187,191 ft^3 of treatment volume respectively. They were bypassed upon the installation of the BEST system. Cell #3's dimensions were 300' x 220' and its treatment volume was reported as 435,095 ft^3 (Worley-Davis). Farm #4 used a two-cell system to treat flushed manure prior to the installation of the BEST system. The first cell received flushed manure from Farm #4 barns. Excess wastewater flowed via gravity to a lift station and was pumped to the shared cell (referred to as Cell #3 above) that also had liquid effluent from Farm #3 pumped to it. The dimensions of the first cell were unspecified due to its irregular shape. It was bypassed upon construction of the BEST

[1] Average daily volumes discharged are calculated using flow data in Westerman and Arogo report. The actual barn discharge might be higher for both farms than the reported volume due to frequently occurring by-pass of flow meters.

system and its total treatment volume was reported as 335,128 ft^3. The shared cell's (Cell #3) dimensions and treatment volume are reported above (Worley-Davis).

1.2 Technology Overview

The biomass energy sustainable technology (BEST) incorporates solids/liquid separation systems to collect swine manure solids. The stated goal of the BEST system is to separate and collect swine manure solids containing a dry matter content of 30 % or higher. BEST's separated swine manure solids were sent to a testing facility (Energy Products of Idaho) for fluidized bed combustion tests to measure energy value and emissions. BEST's ash content is being sent to a second testing facility (Applied Chemical Technology) for incorporation into fertilizer blends. BEST's system performance is measured by comparing the mass of solids and nutrients recovered in separated solids to the calculated inputs that enter the system. This report only evaluates the on-farm part of the technology installed on Corbett #1, 3 and 4.

Two different solids/liquid separation systems were installed on Murphy-Brown farms during the first half of 2003. Performance data has been collected from May 2003 to December 2003. The construction of the first solids/liquid separation system was completed on March 28, 2003. The first bag of separated solids was weighed on April 29 for this system. The first system is comprised of a screw-press separator (FAN® Separator, Inc.) followed by tangential flow gravity-settling tanks (TFS system) (QED Occtech). This system (FAN + TFS) is located at Murphy-Brown's Corbett Farm Unit #1. Construction of the second separation system was finished on April 25, 2003. Its first bag of separated solids was weighed on May 2. The second system involves a screen and hydraulic press separator (Filtramat ™ separator) followed again by the TFS system. This system (Filtramat + TFS) is located on Murphy-Brown's Corbett Farm Unit #4 and also receives flushed manure from nearby Farm Unit #3. The sampling of inputs and outputs began on June 17 for both separation systems (Westerman, et al.). At each site, sampling was generally conducted twice per month. In the paragraphs that follow, BEST's two different separation systems will be described in more detail.

The FAN + TFS system utilizes flushed manure from Farm #1 houses that flows by gravity to a collection pit (lift station). From the collection pit, the swine manure first travels to a 15.1 m^3 (4,000 gal.) above-ground feed tank before being pumped to a screw-press separator located on an elevated platform. The feed tank is equipped with an overflow pipe that allows excess liquids to gravity flow to the lagoon. The FAN screw-press separator has a screen with 0.25-mm. openings and is also constructed with a return line to the feed tank. This return line allows the feed pump to maintain a continuous "full feed rate" to the FAN separator. From the FAN separator, solids exit into a bag that can hold 454 kg (1,000 lbs.) of separated solids at about 32 % dry matter. Liquid that passes through the FAN separator screen flows by gravity to a 71.2-m^3 (18,800 gal.) above-ground feed tank that is equipped with an overflow pipe that enables excess liquid to gravity flow to the lagoon. Liquid is next pumped to the TFS system. The total TFS

system is comprised of two duplicate TFS systems that operate in parallel—each having a 2.2-m diameter tank with a cone bottom, followed by a 1.2-m diameter tank with a cone bottom that is used for sludge thickening. Nozzles within the larger tank's cone bottom that operate for 90 seconds / hour provide fresh water to aid in washing down the solids. A positive displacement pump works continuously to send the settled slurry to the smaller TFS tank for sludge thickening. Finally, settled sludge from the smaller tank is pumped back to the FAN feed tank to be combined with flushed manure from Farm #1 barns. Nearly all of the liquid effluent associated with the TFS system is produced in the first TSF tank and gravity flows to a treatment pond. Upon treatment, it is recycled for flushing the barns (Westerman et al.).

The Filtramat + TFS system utilizes flushed manure from Farm #3 and Farm #4 houses. Farm #4's flushed manure flows by gravity to a 56.8-m^3 (15,000 gal.) in-ground concrete collection tank, while flushed manure from Farm #3 is pumped into the same tank. From the collection tank, the flushed manure is pumped to the solids separation system. The Filtramat system consists of sloping concave screens and a hydraulic press. It has two identical screens with 0.5-mm. horizontal slot openings which, along with the Filtramat's sloping construction, allow separated solids to migrate into a hopper. Solids are next fed into a chamber to be pressed by a hydraulic cylinder. Once pressed, solids drop onto a conveyor and are carried into a bag that holds 454 kg (1,000 lbs.) of separated solids at about 32 % dry matter. Liquid that passes through the Filtramat screens flows by gravity to an 18.9-m^3 (5,000 gal.) in-ground concrete tank that serves as the feed tank for the TFS system. The TFS system used in the Filtramat + TFS technology operates in exactly the same manner as described in the FAN + TFS technology above (Westerman, et al.).

2. Mass Balances and Performance Data for Biomass Energy Sustainable Technology (BEST) (Tables BEST.1-BEST.3)

Performing a total system mass balance on the BEST technology proved difficult because of the system's construction. Each BEST site (Farm #1 and Farms #3/#4) was equipped with two equalization tanks, and each tank had exit pipes designed to control maximum liquid levels. Excess liquid could "overflow" to the lagoon based on the design of these pipes. Thus, not all of the flushed manure from the barns was treated by either the FAN or Filtramat separation systems. Also, not all of the effluent from the FAN and Filtramat separators was treated by the TFS system. Sludge from the sludge thickening tank was also pumped back to the equalization tanks for the FAN and Filtramat separators. This further complicated performing a mass balance for the entire BEST system. Because the total system did not receive all of the flushed manure from the barns, the amount of solids recovered with the BEST technology (as constructed at Corbett Farms #1, #3, and #4) can only be correlated to a steady-state pig live weight by assuming that a similar unknown rate of by-pass occurs on all farms with these systems.

Flushed barn effluent entering the FAN + TFS system had an average total solids (TS) content of 0.81 % (measured before equalization tank where TFS sludge is returned). Flushed barn effluent entering the Filtramat + TFS system had a TS content of 0.67 % (measured before equalization tank where TFS sludge is returned). Upon being treated by the FAN + TFS technology, returned flushing liquid had a TS content of 0.36 %. Flushing liquid treated by the Filtramat + TFS system contained a 0.33 % TS content. The majority of remaining solids in the flush liquid were dissolved solids (Westerman, et al.).

Table BEST.1 shows a summary of the flow and mass of solids removed using both the FAN and Filtramat systems. The numbers in Table 1 reflect data collected from 4/28/03 to 12/11/03, although, for various reasons, the systems were not operating continuously during this time interval. TFS sludge was returned directly to the Filtramat screw press, but not included in the Filtramat inflow. For this reason, mass of solids / unit flow readings are significantly higher for the Filtramat system than for the FAN system.

Table BEST.2 summarizes the nutrient characteristics of the separated solids for each of the two BEST systems. Readings are shown for nitrogen content (TKN), phosphorus content (TP), and potassium content (K). Moisture content of separated solids was around 70 % for each of the two BEST systems (Westerman, et al.).

3. Electrical Use (Table BEST.3)

Electrical use was generally greater for the FAN + TFS system than for the Filtramat + TFS system over the duration of the operational evaluation period. The FAN + TFS system had a daily range of electrical consumption of between 150-250 kWh throughout the evaluation period. The Filtramat + TFS system had a daily range of electrical consumption of 100-200 kWh until 10/07/03 when two pumps were in operation. After this date, when only one pump was used, daily electrical use fell to 50-100 kWh for the Filtramat + TFS system. Table BEST.3 shows monthly electrical usage for the two systems for the months of July through December of 2003. In Table BEST.3, the FAN + TFS system uses an average of 178.17 kWh of electricity per day for an operating cost of $14.25 per day (assuming a rate of $0.08 / kWh). The Filtramat + TFS system uses an average of 111.27 kWh of electricity per day for an operating cost of $8.90 per day (assuming a rate of $0.08 / kWh). Annually, the FAN + TFS system will cost $5,206.03 to operate as it was constructed and operated at Corbett Farm #1. The Filtramat + TFS system will cost $3,251.27 to operate annually based on the way in which it was constructed and operated on Corbett Farms #3 and #4.

4. Invoiced Construction Costs of the BEST System (Tables BEST.4-BEST.15)

Invoiced construction costs for the BEST system have been divided into two sections. Tables BEST.4-BEST.9 summarize the costs associated with construction of the FAN + TFS technology that was used on Corbett Farm #1. Tables BEST.10-BEST.15

summarize the costs of constructing the Filtramat + TFS technology that was operated on Corbett Farms #3 and #4. Tables BEST.10-BEST.15 are analogous to Tables BEST.4-BEST.9, but for a different system.

Table BEST.4 lists the costs associated with the FAN separator. Table BEST.5 shows the invoiced costs of the TFS system as it was constructed for use with the FAN separator. Tables BEST.6 and BEST.7 summarize the invoiced construction costs for the equalization tanks and lift station, respectively. Miscellaneous costs associated with the FAN + TFS system are listed in Table BEST.8. These costs include consulting fees, maintenance costs, and materials and labor costs that could not be allocated to any of the above unit processes. Dirt work and labor to restore the site after construction is also allocated to miscellaneous costs. Plumbing labor and materials, and electrical installation were not allocated by unit process. There were only invoiced totals for each category. Because each of the four unit processes (FAN separator, TFS system, equalization tanks, lift station) used all of these services, the costs for each category were divided evenly across the unit processes. Table BEST.9 summarizes the total construction costs of the FAN + TFS system by unit process. The total invoiced construction cost of this technology retrofit was $230,159.62. The FAN separator (20 %) and TFS system (48 %) accounted for most of this system's construction costs.

Tables BEST.10-BEST.13 list the construction costs associated with the unit processes for the Filtramat + TFS system. Specifically, Table BEST.10 shows the Filtramat separator costs, Table BEST.11 summarizes the TFS system costs (as constructed for use with the Filtramat separator), Table BEST.12 lists the equalization tank costs, and Table BEST.13 details the costs of the lift station. Table BEST.14, analogous to Table BEST.8, lists the miscellaneous costs associated with the Filtramat + TFS system. As in the earlier tables, the cost categories of plumbing labor and materials and electrical installation were allocated equally across the four primary unit processes. This is because each unit process used all of these services, but submitted invoices provided only the total cost (not invoices allocated across unit process). Table BEST.15 summarizes the total construction cost of the Filtramat + TFS system by unit process. The total cost sums to $295,750.73, or about 28 % more from the FAN + TFS system. Like the FAN + TFS system, the separator (29 %) and TFS system (39 %) account for the majority of the cost in the Filtramat + TFS system While the TFS systems are nearly equal in construction cost between the two technologies, the separators, equalization tanks, and lift station are all significantly more costly for the Filtramat + TFS technology.

5. Overview of Cost Modeling for FAN + TFS Technology (Tables BEST.16-BEST.62)

Invoiced construction costs are reported for the FAN + TFS system technology as it was built on Corbett Farm Unit #1 in Tables BEST.4-BEST.8 and summarized in total in Table BEST.9. In the next step, the economic modeling team took the data reported in Tables BEST.4-BEST.8 and modified them for missing components, unnecessary charges, and outdated prices.

Tables BEST.16-BEST.24 represent modified complete construction and operating cost incurred at the experimental site. The numbers in these tables reflect the BEST FAN + TFS technology as it was operated under Farm #1 conditions (3,320 feeder-to-finish pigs with a flush system of manure removal). The primary changes between the numbers in Tables BEST.4 – 9 and Tables BEST.16 – 24 are that consulting charges and charges for unused material were removed; our standard contractor's overhead rate and operating costs were added.

In the next step, estimates of costs that would occur on standard (representative) North Carolina farms were calculated. These costs are presented in Tables BEST.25-BEST.33 for a 4,320-head feeder-to-finish facility using a flush system of manure removal. Tables BEST.34-BEST.42 present the estimated costs for a standard North Carolina 4,320-head capacity feeder-to-finish operation with a pit-recharge system of manure removal. A representative NC 8,800-head feeder-to-finish facility with a flush manure removal system is reported in Tables BEST.43-BEST.51. Finally, a standard NC 4,000-sow farrow-to-wean operation using a flush system of manure removal is reported in Tables BEST.52-BEST.60 for the FAN + TFS technology. Tables BEST.61 and BEST.62 extrapolate costs of the FAN +TFS technology to other representative farm sizes and types for all DWQ permitted farms and for Smithfield Foods/Premium Standard Farms owned operations only, respectively.

For both the actual FAN + TFS technology at Corbett Farm #1 and for the FAN + TFS technology as modeled on representative farms, nitrogen-based land applications were more costly than phosphorus-based land applications. Generally, land application to forages was more costly than land application to row crops. Also, phosphorus-based application to row crops was generally the least expensive scenario, while nitrogen-based application to forages was the most expensive scenario. This was not always the case, however (e.g., 4,000-sow farrow-wean).

The FAN+TFS technology located on the experimental farm at Corbett Farm #1 is using a retrofitted lift station that already existed on the farm prior to the BEST technology installation. In order to approximate the cost of building a new lift station on Corbett Farm #1 we have modified the cost of lift station located on Corbett Farm #3 and used it in the model. The actual plumbing (labor and material) charges were replaces with our standard $910 /barn charge and the cost of 5-hp pump was reduced from $2,695 to $1,734.20.

Nutrient removed in solids reported throughout the document are based on data presented in BEST.2. It is interesting to note low N, P and K content of separated solids throughout the document.[2]

[2] For an example, see table BEST.24 for nutrient content of separated solids.

5.1 Actual Cost for FAN + TFS Technology at Corbett Farm #1 (Tables BEST.16-BEST.24)

Table BEST.16 shows the actual specifications of Corbett Farm #1 that were used for the cost estimate calculations and summarizes annualized costs by land application scenario (nitrogen-based application to forages, nitrogen-based application to row crops, phosphorus-based application to forages, and phosphorus-based application to row crops).[3] Annualized costs for the whole farm and per 1,000 lbs. of SSLW (incremental cost or per unit) are reported. In Table BEST.16, per unit costs of the retrofit for each of the four land application scenarios range from $142.74 (phosphorus-based application to row crops) to $156.28 (nitrogen-based application to forages) per 1,000 pounds SSLW per year, with an average of $149.07. Tables BEST.17-BEST.21 summarize costs of individual unit processes of the FAN + TFS technology including the lift station and manure evacuation (BEST.17), FAN feed tank (BEST.18), FAN separator (BEST.19), TFS feed tank (BEST.20), and TFS system (BEST.21). Table BEST.16 reports the total costs associated with the unit processes listed above. Total construction costs are reported as $316,701.99, while operating costs are estimated as $10,208.57. The total annualized cost of the FAN + TFS technology before land application is estimated to be $61,455.50 for the 3,320-head feeder-to-finish facility at Corbett Farm #1. Tables BEST.22 (lagoon effluent) and BEST.23 (solids) report land application costs associated with the FAN + TFS technology. Used in conjunction with the numbers reported at the end of Table BEST.16, total annualized and incremental cost estimates can be calculated. These numbers are reported in at the top of Table BEST.16 for each of the four scenarios of land application. Table BEST.24 reports the mass balance of nutrients associated with the BEST FAN +TFS technology. This table is necessary to derive the numbers found in Tables BEST.22 and BEST.23. Electric power cost for the system was estimated at $3,782.02 by the model. It underestimates the electric power cost based on data reported in BEST.3 by approximately $1,500 per year.

5.2 Standardized Costs for FAN + TFS Technology at a 4,320-Head Feeder-to-Finish Farm with a Flush System (Tables BEST.25-BEST.33)

Tables BEST.25- BEST.33 provide estimates of the cost of constructing and operating the FAN + TFS technology on a standard (representative) North Carolina 4,320-head feeder-to-finish facility using a flush system for manure removal. Table BEST.25 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized retrofit with FAN + TFS technology. The standardized incremental (per unit) costs range from $105.56 (phosphorus-based application to row crops) to $116.58 (nitrogen-based application to forages) for each of the four land application scenarios, with an average of $110.66. Tables BEST.26-BEST.30 are analogous to Tables BEST.17-BEST.21. They report standardized costs for the same unit processes as listed in the above section (in the same order). Table BEST.25 also summarizes the total costs associated with the standardized FAN + TFS technology for a 4,320-head finishing facility with a flush

[3] For more on land application, see Appendix B.

system (summing the unit processes reported in Tables BEST.26-BEST.30). Total construction costs are estimated at $307,651.80, while total operating costs are reported as $10,559.49. Total annualized costs before land application are estimated at $60,254.63 for this representative farm size and type. Tables BEST.31 (lagoon effluent) and BEST.32 (solids) summarize the land application costs associated with the standardized model for each of four scenarios. Table BEST.33 provides an estimated mass balance of nutrients for this representative NC farm.

5.3 Standardized Costs for FAN + TFS Technology at a 4,320-Head Feeder-to-Finish Farm with a Pit-Recharge System (Tables BEST.34-BEST.42)

Tables BEST.34- BEST.42 provide estimates of the cost of constructing and operating the FAN + TFS technology on a standard (representative) 4,320-head feeder-to-finish farm in North Carolina with a pit-recharge system for manure removal. The type of manure removal system used is the only difference between the farm modeled in Tables BEST.34-BEST.42 versus the one modeled in Tables BEST.25-BEST.33. The sizes of FAN feed tank and TFS feed tank were adjusted to accommodate higher amounts of manure loaded at one time (when a pit empties versus when a gutter is flushed). Table BEST.34 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized FAN + TFS technology. The standardized incremental (per unit) costs range from $103.54 (phosphorus-based application to row crops) to $114.56 (nitrogen-based application to forages) for each of the four land application scenarios, with an average incremental cost of $108.64. Using a pit-recharge system of manure removal is about 2 % less costly than using a flush system for the FAN + TFS technology on a standardized 4,320-head finishing farm. As with other technologies, pit-recharge systems are less costly than flush systems for the FAN + TFS technology. However, the differences in per unit cost are smaller between the two manure removal systems for the FAN + TFS technology as compared to other technologies (assuming a 4,320-head feeder-finish facility). Tables BEST.35-BEST.39 list the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables BEST.26-BEST.30 (and BEST.17-BEST.21). Changes in recycled liquid volume in the pit-recharge system versus the flush system cause some cost estimates to change between the two sets of tables. Table BEST.34 summarizes the total costs associated with the standardized FAN + TFS technology for a 4,320-head finishing facility with a pit-recharge system (summing the unit processes presented in Tables BEST.35-BEST.39). Total construction costs are estimated at $304,033.05, while total operating costs are reported as $9,921.57. Total annualized costs before land application are estimated at $59,077.41 for this representative farm size and type. Tables BEST.40 (lagoon effluent) and BEST.41 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.42 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

5.4 Standardized Costs for FAN + TFS Technology at an 8,800-Head Feeder-to-Finish Farm with Flush System (Tables BEST.43-BEST.51)

Tables BEST.43- BEST.51 provide estimated costs of constructing and operating the FAN + TFS technology on a standard (representative) 8,800-head feeder-to-finish farm in North Carolina with a flush system for manure removal. Table BEST.43 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized FAN + TFS technology. The standardized incremental (per unit) costs for the 8,800-head finishing facility range from $84.43 (phosphorus-based application to row crops) to $91.25 (nitrogen-based application to forages) across the four scenarios, with an average incremental cost of $87.49. Compared to the 4,320-head finishing facility using a flush system, the average incremental costs of this 8,800-head farm are about 21 % less costly. Based on this finding, the model suggests that economies of scale are present for the FAN + TFS technology. Specifically, significant economies of scale are present in the FAN feed tank and FAN separator. In fact, nearly all of the FAN + TFS technology's economies of scale are found in these two unit processes. Tables BEST.44-BEST.48 list the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those seen in Tables BEST.35-BEST.39 (as well as Tables BEST.26-BEST.30 and BEST.17-BEST.21). Table BEST.43 summarizes the total costs associated with the standardized FAN + TFS technology for an 8,800-head finishing facility using a flush system of manure removal. Total construction costs are estimated at $530,640.44, while total operating costs are reported as $18,483.58. Total annualized costs before land application are estimated at $104,687.06 for this representative farm size and type. While these total construction costs are higher than in the standardized 4,320-head model, the per unit capacity costs are lower. That is because the 8,800-head facility contains 1,188,000 pounds of steady-state live weight (SSLW) as compared to the 583,200 pounds of SSLW housed in the 4,320-head facility. Tables BEST.49 (lagoon effluent) and BEST.50 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.51 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

5.5 Standardized Costs for FAN + TFS Technology at a 4,000-Sow Farrow-to-Wean Farm with Flush System (Tables BEST.52-BEST.60)

Tables BEST.52- BEST.60 provide estimates of the construction and operating costs of retrofitting the FAN + TFS technology onto a standard (representative) North Carolina 4,000-sow farrow-to-wean operation using a flush system for manure removal. This representative farm contains 1,732,000 pounds of SSLW—the largest of any standard farm modeled for the FAN + TFS technology. Table BEST.52 also provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized FAN + TFS technology. The standardized incremental (per unit) costs range from $108.86 (phosphorus-based application to forages) to $116.26 (nitrogen-based application to forages) / 1,000 lbs. SSLW / year across the four land application scenarios. The average

incremental cost for this model is $112.46. Tables BEST.53-BEST.57 report the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables BEST.44-BEST.48 (as well as Tables BEST.35-BEST.39, BEST.26-BEST.30, and BEST.17-BEST.21) while some of the costs will change between the two sets of tables. Table BEST.52 summarizes the total costs associated with the standardized FAN + TFS technology for a 4,000-sow farrow-to-wean operation (summing the unit processes described in Tables BEST.53-BEST.57). Total construction costs are estimated at $991,109.49, while total operating costs are reported as $41,507.83. Total annualized costs before land application are estimated at $202,724.23 for this representative farm size and type. Tables BEST.58 (lagoon effluent) and BEST.59 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.60 provides an estimated mass balance of nutrients for the 4,000-sow farrow-to-wean operation modeled for the FAN + TFS technology.

5.6 Extrapolation of FAN + TFS per Unit Costs to Other Farm Types and Sizes (Tables BEST.61-BEST.62)

Table BEST.61 summarizes per unit costs ($ / 1,000 lbs. SSLW) of the FAN + TFS technology for each of the 25 size of farm / type of operation combinations. This table uses the representative farm size for permitted North Carolina farms within a size / type combination (as seen in Appendix FS, Tables FS.1 and FS.4). Incremental (per unit) costs are shown for both pit-recharge and flush systems and costs in Table BEST.61 assume a nitrogen-based land application to forages is utilized. Table BEST.62 is analogous to Table BEST.61, but uses Smithfield Foods/Premium Standard Farms (SF/PSF) owned operations only. Incremental costs are again shown for both pit-recharge and flush systems. To calculate the incremental costs in Table BEST.62, the representative SF/PSF owned farm size is used for each size / type combination. As in Table BEST.61, the costs in Table BEST.62 assume that a nitrogen-based land application to forages is chosen. In Tables BEST.61 and BEST.62, per unit costs decrease as the size of the farm increases as the FAN + TFS technology demonstrates economies of scale for all types of operations. The FAN feed tank and FAN separator are the specific unit processes that contribute most significantly to the economies of scale demonstrated by this technology.

6. Overview of Cost Modeling for Filtramat + TFS Technology (Tables BEST.63-BEST.109)

Invoiced construction costs of the Filtramat + TFS system technology as it was built on Corbett Farm Units #3 and #4 are reported by unit process in Tables BEST.10-BEST.14 and summarized in total in Table BEST.15. In the next step, the economic modeling team took the data reported in Tables BEST.10-BEST.14 and modified them for missing components, unnecessary costs, and outdated prices.

Tables BEST.63-BEST.71 represent modified complete construction and operating cost incurred at the experimental site. The numbers in these tables reflect the BEST Filtramat + TFS technology as it was operated under Farm #3 and #4 conditions (4,048 feeder-to-finish pigs with a flush system of manure removal). Differences between Tables BEST.10 – 15 and Tables BEST.63 – 71 are that consulting charges and charges for unused material were removed; our standard contractor's overhead rate and operating costs were added.

In the next step, estimates of costs that would occur on standard (representative) North Carolina farms were calculated. These costs are presented in Tables BEST.72-BEST.80 for a 4,320-head feeder-to-finish facility using a flush system of manure removal. Tables BEST.81-BEST.89 present the costs associated with a standard North Carolina 4,320 head capacity feeder-to-finish operation with a pit-recharge system of manure removal. A representative NC 8,800-head feeder-to-finish facility with a flush manure removal system is reported in Tables BEST.90-BEST.98. The final standard NC farm described in this report is a 4,000-sow farrow-to-wean operation using a flush system of manure removal. Tables BEST.99-BEST.107 detail the costs associated with using the Filtramat + TFS technology at the 4,000-sow facility. Tables BEST.108 and BEST.109 extrapolate costs of the Filtramat +TFS technology to other representative farm sizes and types for all DWQ permitted farms and for Smithfield Foods/Premium Standard Farms owned operations only, respectively.

The Filtramat and TFS feed tanks were sized according to the data and design obtained from the BEST Corbett Farm #3 and #4 DWQ permit application and personal communications with Elmer Environmental. In the original design, it was assumed that the two inclined screens in Filtramat separator were able to process about 50 gallons per minute. This design criterion was revised to 100 gallons per minute during the actual trial.[4] The implications of originally underestimating flow capacity of the Filtramat separator are an oversized Filtramat feed tank and an undersized TFS tank. In order to be consistent with actual measurements and environmental findings obtained at the site, the design criteria was not changed in the model.

Land applications to forages were more generally more costly than land applications to row crops. Also, phosphorus-based land application to row crops was generally the least costly scenario, while phosphorus-based application to forages was generally the most costly scenario. This was not always the case, however (e.g., 4,000-sow farrow-wean).

6.1 Actual Cost for Filtramat + TFS Technology at Corbett Farm #3 and #4 (Tables BEST.63-BEST.71)

Table BEST.63 shows the actual specifications of Corbett Farm #1 that were used for the cost estimate calculations and summarizes annualized costs by land application scenario

[4] The Filtramat system installed on Corbett Farm #3 and #4 is capable of treating 50 gallons of waste per minute per screen (100 gallons / minute / system). This is approximately double the original estimate from the Filtramat distributor.

(nitrogen-based application to forages, nitrogen-based application to row crops, phosphorus-based application to forages, and phosphorus-based application to row crops).[5] Annualized costs for the whole farm and per 1,000 lbs. of SSLW (incremental cost or per unit) are reported. In Table BEST.63, per unit costs of the retrofit for each of the four land application scenarios range from $149.90 (phosphorus-based application to row crops) to $164.65 (phosphorus-based application to forages) per 1,000 pounds SSLW per year, with an average of $157.82. Tables BEST.64-BEST.68 summarize costs associated with individual unit processes of the Filtramat + TFS technology. Specifically, the costs of the following unit processes are detailed: lift station and manure evacuation (BEST.64), Filtramat feed tank (BEST.65), Filtramat separator (BEST.66), TFS feed tank (BEST.67), and TFS system (BEST.68). Table BEST.63 reports the total costs associated with the unit processes listed above. Total construction costs are reported as $388,576.22, while operating costs are estimated as $15,062.80. The total annualized cost of the Filtramat + TFS technology before land application is estimated to be $79,861.46 for the 4,048-head feeder-to-finish facilities at Corbett Farm #3 and #4. Tables BEST.69 (lagoon effluent) and BEST.70 (solids) report land application costs associated with the Filtramat + TFS technology. Used in conjunction with the numbers reported at the end of Table BEST.63, the total annualized and incremental cost estimates can be calculated. These numbers are reported in at the top of Table BEST.63 for each of the four scenarios of land application. Table BEST.71 details the mass balance of nutrients associated with the BEST Filtramat +TFS technology. This table is necessary to derive the numbers found in Tables BEST.69 and BEST.70. Electric power cost for the system was estimated at $7,597.51 by the model. It overestimated the electric power use and cost based on data reported in BEST.3 by approximately $4,346.24 per year. This is mainly due to the fact that the average cost presented in BEST.3 includes estimates when only one pump was operating. At that time, when only one pump was used, daily electrical usage fell to 50-100 kWh for the Filtramat + TFS system from 150-200 kWh per day.

6.2 Standardized Costs for Filtramat + TFS Technology at a 4,320-Head Feeder-to-Finish Farm with a Flush System (Tables BEST.72-BEST.80)

Tables BEST.72- BEST.80 provide estimates of the cost of constructing and operating the Filtramat + TFS technology on a standard (representative) North Carolina farm.

The representative farm modeled is a 4,320-head feeder-to-finish facility using a flush system for manure removal. Table BEST.72 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized retrofit with Filtramat + TFS technology. The standardized incremental (per unit) costs range from $137.13 (phosphorus-based application to row crops) to $151.97 (phosphorus-based application to forages) for each of the four land application scenarios, with an average of $144.88. Tables BEST.73-BEST.77 are analogous to Tables BEST.64-BEST.68. They report standardized costs for the same unit processes as listed in the above section. Table BEST.72 also summarizes the total costs associated with the standardized Filtramat + TFS technology for a 4,320-

[5] For more on land application, see Appendix B.

head finishing facility with a flush system (summing the unit processes reported in Tables BEST.73-BEST.77). Total construction costs are estimated at $383,184.08, while total operating costs are reported as $14,490.09. Total annualized costs before land application are estimated at $78,222.52 for this representative farm size and type. Tables BEST.78 (lagoon effluent) and BEST.79 (solids) summarize the land application costs associated with the standardized model for each of four scenarios. Table BEST.80 provides an estimated mass balance of nutrients for this representative NC farm.

6.3 Standardized Costs for Filtramat + TFS Technology at a 4,320-Head Feeder-to-Finish Farm with a Pit-Recharge System (Tables BEST.81-BEST.89)

Tables BEST.81- BEST.89 provide estimates of the cost of constructing and operating the Filtramat + TFS technology on a standard (representative) 4,320-head feeder-to-finish farm in North Carolina with a pit-recharge system for manure removal. The type of manure removal system used is the only difference between the farm modeled in Tables BEST.81-BEST.89 and the farm modeled in Tables BEST.72-BEST.80. The size of Filtramat feed tank and TFS feed tank was adjusted to accommodate higher amounts of manure discharged at one time for barns equipped with pit recharge system. Table BEST.81 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Filtramat + TFS technology. The standardized incremental (per unit) costs range from $134.89 (phosphorus-based application to row crops) to $149.74 (phosphorus-based application to forages) for each of the four land application scenarios, with an average incremental cost of $142.65. The 4,320-head farm with pit-recharge system is slightly less expensive (~ 1.5 %) than the 4,320-head farm with flush system. Tables BEST.82-BEST.86 detail the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables BEST.73-BEST.77 (and BEST.64-BEST.68). Changes in recycled liquid volume in the pit-recharge system versus the flush system cause some cost estimates to change between the two sets of tables. Table BEST.81 summarizes the total costs associated with the standardized Filtramat + TFS technology for a 4,320-head finishing facility with a pit-recharge system (summing the unit processes detailed in Tables BEST.82-BEST.86). Total construction costs are estimated at $378,628.23, while total operating costs are reported as $13,866.99. Total annualized costs before land application are estimated at $76,920.46 for this representative farm size and type. Tables BEST.87 (lagoon effluent) and BEST.88 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.89 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

6.4 Standardized Costs for Filtramat + TFS Technology at an 8,800-Head Feeder-to-Finish Farm with Flush System (Tables BEST.90-BEST.98)

Tables BEST.90- BEST.98 provide estimates of the cost of constructing and operating the Filtramat + TFS technology on a standard (representative) 8,800-head feeder-to-finish farm in North Carolina with a flush system for manure removal. Table BEST.90

provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Filtramat + TFS technology. The standardized incremental (per unit) costs for the 8,800-head finishing facility range from $102.07 (phosphorus-based application to row crops) to $112.84 (phosphorus-based application to forages) across the four scenarios, with an average incremental cost of $107.44. Compared to the 4,320-head finishing facility using a flush system, the average incremental costs of this 8,800-head farm are about 26 % less costly. Based on this finding, the model suggests that economies of scale are present for the Filtramat + TFS technology. Specifically, significant economies of scale are present in the Filtramat feed tank and the Filtramat separator. Other unit processes for this technology demonstrate little or no economies of scale. Tables BEST.91-BEST.95 list the projected costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those seen in Tables BEST.82-BEST.86 (as well as Tables BEST.73-BEST.77 and BEST.64-BEST.68). Table BEST.90 summarizes the total costs associated with the standardized Filtramat + TFS technology for an 8,800-head finishing facility using a flush system of manure removal. Total construction costs are estimated at $619,949.31, while total operating costs are reported as $22,598.84. Total annualized costs before land application are estimated at $124,893.41, for this representative farm size and type. While these total construction costs are higher than in the standardized 4,320-head model, the per unit capacity costs are lower. That is because the 8,800-head facility contains 1,188,000 pounds of steady-state live weight (SSLW) as compared to the 583,200 pounds of SSLW housed in the 4,320-head facility. Tables BEST.96 (lagoon effluent) and BEST.97 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.98 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

6.5 Standardized Costs for Filtramat + TFS Technology at a 4,000-Sow Farrow-to-Wean Farm with Flush System (Tables BEST.99-BEST.107)

Tables BEST.99- BEST.107 provide estimates intended to reflect the construction and operating costs of retrofitting the Filtramat + TFS technology onto a standard (representative) North Carolina farm. As seen in Table BEST.99's assumptions, the representative farm chosen is a 4,000-sow farrow-to-wean operation using a flush system for manure removal. This representative farm contains 1,732,000 pounds of SSLW—the largest of any standard farm modeled for the Filtramat + TFS technology. Table BEST.99 also provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Filtramat + TFS technology. The standardized incremental (per unit) costs range from $131.15 (phosphorus-based application to row crops) to $136.57 (nitrogen-based application to forages) / 1,000 lbs. SSLW / year across the four land application scenarios. The average incremental cost for this model is $133.58. Tables BEST.100-BEST.104 detail the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those seen in Tables BEST.91-BEST.95 (as well as Tables BEST.82-BEST.86, BEST.73-BEST.77, and BEST.64-BEST.68)—only some of the costs will change between the two sets of tables. Table BEST.99 summarizes the total costs associated with the standardized Filtramat + TFS

technology for a 4,000-sow farrow-to-wean operation (summing the unit processes described in Tables BEST.100-BEST.104). Total construction costs are estimated at $1,166,414.99, while total operating costs are reported as $45,402.31. Total annualized costs before land application are estimated at $237,005.80 for this representative farm size and type. Tables BEST.105 (lagoon effluent) and BEST.106 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table BEST.107 provides an estimated mass balance of nutrients for the 4,000-sow farrow-to-wean operation modeled for the Filtramat + TFS technology.

6.6 Extrapolation of Filtramat + TFS Technology Per Unit Costs to Other Farm Types and Sizes (Tables BEST.108-BEST.109)

Table BEST.108 summarizes per unit costs ($ / 1,000 lbs. SSLW) of the Filtramat + TFS technology for each of the 25 size of farm / type of operation combinations. This table uses the representative farm size for permitted North Carolina farms within a size / type combination. Incremental (per unit) costs are shown for both pit-recharge and flush systems and costs in Table BEST.108 assume a nitrogen-based land application to forages is utilized. Table BEST.109 is analogous to Table BEST.108, but uses Smithfield Foods/Premium Standard Farms (SF/PSF) owned operations only. Incremental costs are again shown for both pit-recharge and flush systems. To calculate the incremental costs seen in Table BEST.109, the representative SF/PSF farm size is used for each size / type combination. As in Table BEST.108, the costs in Table BEST.109 assume that a nitrogen-based land application to forages is chosen. As seen in Tables BEST.108 and BEST.109, projected per unit costs generally decrease as the size of the farm increases. This finding suggests that the Filtramat + TFS technology demonstrates economies of scale for all types of operations. The Filtramat feed tank and Filtramat separator are the specific unit processes that contribute most significantly to the economies of scale demonstrated by this technology.

7. Summary and Conclusions

The BEST system evaluation actually includes two distinct albeit similar systems. The system on Corbett Farm #1 employs a FAN separator and a TFS separator in sequence to remove solids from the barn effluent. The system serving Corbett Farms #3 and #4 employs a Filtramat separator and a TFS separator in sequence. The liquid effluent from the separators on both farms flows to the existing lagoons. The solids were collected in 1,000 pound bags and some bags were sent to off-site locations for evaluation as a fuel for combustion and for evaluation of the ash as an input to fertilizer. In the absence of a confirmed off-farm outlet for separated solids, our model assumes that all separated solids and liquids are land applied at either nitrogen- or phosphorus-limiting rates. The primary modifications to the invoiced costs for the retrofitted systems are removal of engineering consulting costs and application of our standard rates for contractor overhead as well as the application of standard prices for various components and inputs to the systems. For both systems, the TFS component was the largest component of

construction cost and the separator (FAN or Filtramat) was the next most expensive component. Feed (flow equalization) tanks, lift station, and pumps are among the other components of the system. Electricity to operate pumps and separators is the primary operating input in addition to labor and repairs.

Standardized cost estimates for retrofitting farms with the FAN and TFS system range from $66.70 per 1,000 pounds SSLW per year for a large feeder-to-finish farm with a pit-recharge system to $822.75 per 1,000 pounds SSLW per year for a small wean-to-feeder farm with a flush system. Standardized cost estimates for retrofitting farms with the Filtramat and TFS system range from $81.97 per 1,000 pounds SSLW per year for a large feeder-to-finish farm with a pit-recharge system to $1,017.39 per 1,000 pounds SSLW per year for a small wean-to-feeder farm with a flush system.

References

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Worley-Davis, Lynn. Research Assistant. Animal and Poultry Waste Management Center. North Carolina State University. BEST System, Project Information. 2002.

Tables BEST.1 through BEST.3: Actual Performance Data and Mass Balances from the Two BEST Systems

Table BEST.1. Summary of Flow and Mass of Solids Removed—BEST System

	FAN + TFS	Filtramat + TFS
Operating period (days)	227	230
Days operated	160	167
Total flow (m^3)	19,733	23,894
Mass of solids (kg) (wet basis)	43,756	67,676
Mass of solids per unit flow (kg / m^3)	2.8	4.4

Source: Westerman, et al.

Table BEST.2. Summary of Nutrient Content of Separated Solids —BEST System

	FAN + TFS	Filtramat + TFS
Moisture content	68 %	70 %
Nitrogen (TKN)	0.449 %	0.636 %
Phosphorus (TP)	0.112 %	0.225 %
Potassium (K)	0.279 %	0.338 %

Source: Westerman, et al.

Table BEST.3. Summary of Electrical Usage by Month for the BEST System (Based on Daily Meter Readings)

	FAN + TFS		Filtramat + TFS	
Month	Days in operation	kWh	Days in operation	kWh
July, '03	9	1,824	16	2,394
August, '03	19	3,527	23	3,194
September, '03	19	3,672	15	2,159
October, '03	6	875	5	308
November, '03	17	2,581	23	1,553
December, '03	8	1,418	11	740
Totals	78	13,897	93	10,348
Monthly Averages	13.0	2,316.17	15.5	1,724.67

	Avg. kWh	Cost*	Avg. kWh	Cost*
Daily Operating Cost	178.17	$14.25	111.27	$8.90
Annual Operating Cost	65,075.38	$5,206.03	40,640.94	$3,251.27

* Operating costs are based on a rate of $0.08 / kWh.

Tables BEST.4 through BEST.9: Invoiced Costs for the BEST FAN + TFS System

Table BEST.4. Invoiced Construction Costs of FAN Separator (FAN + TFS)

Component	Cost
FAN Separator	$23,838.50
Labor and materials to fabricate and install separator	$13,313.50
Install separator platform	$4,849.29
Electrical installation	$2,304.04
Plumbing labor	$960.95
Plumbing materials	$960.95
Miscellaneous labor and materials	$143.00
Total Cost of FAN Separator	**$46,370.23**

Table BEST.5. Invoiced Construction Costs of TFS System (FAN + TFS)

Component	Cost
TFS system	$96,700.00
Pumps (1-hp)	$5,880.67*
Pumps (1/3-hp)	$269.21
Control panels	$1,550.00
Labor and materials for concrete pad	$1,549.29
Labor and materials to install and upsize drain lines	$845.00
Electrical installation	$2,304.04
Plumbing labor	$960.95
Plumbing materials	$960.95
Total Cost of TFS System	**111,020.11**

* Adjusted for overnight shipping

Table BEST.6. Invoiced Construction Costs of Equalization Tanks (FAN + TFS)

Component	Cost
FAN Feed Tank (4,000-Gallon)	
Tank	$2,884.00
Labor, materials, and equipment for installation of tanks	$3,922.00
5-hp sewage pump	$2,695.00
Control panels	$1,490.00
Float switches	$99.00
Concrete for tank pad	$272.85
Stone for tank pad	$22.47
Concrete work and labor	$40.94
Electrical installation	$1,152.02
Plumbing labor and materials	$960.95
Tank freight	$150.00
Taxes	$175.00
Cost of FAN Feed Tank	**$13,864.23**
TFS Feed Tank (18,000-Gallon)	
Tank	$4,475.00
Labor, materials, and equipment for installation of tanks	$6,597.00
Pumps	$7,620.67
Control panel	$295.00
Float switches	$99.00
Concrete for tank pad	$818.55
Stone for tank pad	$67.41
Concrete work and labor	$40.94
Electrical installation	$1,152.02
Plumbing labor and materials	$960.95
Tank freight	$300.00
Taxes	$406.90
Cost of TFS Feed Tank	**$22,833.44**
Total Cost of Equalization (Feed) Tanks	**$36,697.67**

Table BEST.7. Invoiced Construction Costs of Lift Station (FAN + TFS)

Component	Cost
Control panel	$295.00
Float switches	$66.00
Concrete work and labor	$81.87
Electrical installation	$2,304.03
Plumbing labor	$960.95
Plumbing materials	$960.95
Total Cost of Lift Station	**$4,668.80**

Table BEST.8. Invoiced Miscellaneous Construction Costs of BEST System (FAN + TFS)

Component	Cost
Elmer Environmental consulting fees	$16,211.87
Maintenance, monitoring, and collection costs	$2,675.74
Installation materials and labor	$556.70
Unaccounted for control panels/float switches	$508.50
Materials and labor to move 2 loading chutes	$6,400.00
Dirt work and labor	$5,050.00
Total Miscellaneous Cost	**$31,402.81**

Table BEST.9. Summary of BEST Construction Costs by Unit Process (FAN + TFS)

Unit Process	Cost	% of Total Cost
FAN separator	$46,370.23	20.15 %
TFS system	$111,020.11	48.24 %
FAN feed tank (4,000-gallon)	$13,864.23	6.02 %
TFS feed tank (18,000-gallon)	$22,833.44	9.92 %
Lift station	$4,668.80	2.03 %
Elmer Environmental consulting fees	$16,211.87	7.04 %
Maintenance and miscellaneous costs	$15,190.94	6.60 %
Total Cost of BEST FAN + TFS System	**$230,159.62**	**100.00 %**

Tables BEST.10 through BEST.15: Invoiced Costs for the BEST Filtramat + TFS System

Table BEST.10. Invoiced Construction Costs of Filtramat Separator (Filtramat +TFS)

Component	Cost
Envirogain equipment	$33,000.00
Solids conveyor	$7,254.12
Labors and materials to fabricate and install separator	$9,407.00
Air compressor system	$3,463.86
Air compressor installation	$1,365.00
Control panel	$285.00
Pump (1/2-hp)	$325.24
Variable speed flow control	
Flow meter	$3,724.00
1-hp variable speed drive	$2,196.00
PLC	$650.00
NEMA 4 x SS enclosure	$928.00
Floats, relays, and miscellaneous hardware	$325.00
Engineering, drawings, travel, and administration	$2,618.00
Tax	$663.67
Shipping	$200.00
Consultant installation fees	$750.00
Variable speed flow control subtotal	**$12,054.67**
500-gallon tank	$350.83
Float switches	$132.00
Electrical installation	$3,250.00
Plumbing labor	$4,075.34
Plumbing materials	$4,075.33
Concrete labor and materials	$2,045.00
Miscellaneous Filtramat labor and materials	$4,816.00
Skytrack	$1,200.00
Total Cost of Filtramat Separator	**$87,099.39**

Table BEST.11. Invoiced Construction Costs of TFS System (Filtramat + TFS)

Component	Cost
TFS system	$96,700.00
Pumps (1-hp)	$5,880.67
Pumps (1/3-hp)	$272.49
Control panels	$1,550.00
Labor and materials for concrete pad	$1,400.00
Labor and materials to install and upsize drain lines	$845.00
Electrical installation	$3,250.00
Plumbing labor	$2,582.04
Plumbing materials	$2,582.04
Total Cost of TFS System	**$115,062.24**

Table BEST.12. Invoiced Construction Costs of Equalization Tanks (Filtramat + TFS)

Component	Cost
Filtramat Feed Tank	
Tank labor and materials (cast-in-place)	$18,845.00
Labor and materials to set tank	$552.50
5-hp sewage pump	$2,695.00
1-hp pumps and equalization tank pump	$2,112.50
Control panel	$1,195.00
Float switches	$132.00
Electrical installation	$1,625.00
Plumbing labor and materials	$2,712.54
Crane rental	$390.00
Cost of Filtramat Feed Tank	**$30,259.54**
TFS Feed Tank	
Tank (4,000-gallon)	$2,480.00
Labor and materials to set tank	$552.50
Pumps	$7,620.67
Control panel	$285.00
Float switches	$132.00
Electrical installation	$1,625.00
Plumbing labor and materials	$2,712.54
Crane rental	$390.00
Cost of TFS Feed Tank	**$15,797.71**
Total Cost of Equalization (Feed) Tanks	**$46,057.25**

Table BEST.13. Invoiced Construction Costs of Lift Station (Filtramat + TFS)

Component	Cost
5,000-gallon tank	$5,616.00
Screen	$226.00
5-hp sewage pump	$2,695.00
Control panel	$1,195.00
Float switches	$132.00
Electrical installation	$3,250.00
Plumbing labor	$2,582.04
Plumbing materials	$2,582.04
Miscellaneous lift station labor and materials	$4,355.97
Total Cost of Lift Station	**$22,634.05**

Table BEST.14. Invoiced Miscellaneous Construction Costs of BEST System (Filtramat + TFS)

Component	Cost
Elmer Environmental consulting fees	$16,211.87
Maintenance, monitoring, and collection costs	$2,675.73
Installation materials and labor	$301.70
Unaccounted for control panels/float switches	$508.50
Backhoe rental	$200.00
Dirt work and labor	$5,000.00
Total Miscellaneous Cost	**$24,897.80**

Table BEST.15. Summary of BEST Construction Costs by Unit Process (Filtramat + TFS)

Unit Process	Cost	% of Total Cost
Filtramat separator	$87,099.39	29.45 %
TFS system	$115,062.24	38.91 %
Filtramat feed tank	$30,259.54	10.23 %
TFS feed tank	$15,797.71	5.34 %
Lift station	$22,634.05	7.65 %
Elmer Environmental consulting fees	$16,211.87	5.48 %
Maintenance and miscellaneous costs	$8,685.93	2.94 %
Total Cost of BEST Filtramat + TFS System	**$295,750.73**	**100.00 %**

Tables BEST.16 through BEST.24: Actual Costs and Mass Balances for the BEST FAN + TFS System for a 3,320-Head Feeder to Finish Farm with Flush System

Table BEST.16. FAN + TFS System (BEST) Assumptions and Total Annualized Costs—Actual Costs and Performance Data

Number of Animals	**3,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 70,045.65**	**$ 64,665.06**
	If Phosphorus-Based Application	**$ 68,561.30**	**$ 63,974.59**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 156.28**	**$ 144.28**
	If Phosphorus-Based Application	**$ 152.97**	**$ 142.74**

Note: Daily volume discharged from barns is 31,923 gallons / day including recharge liquid.
SSLW equals 448,200 pounds.

TOTAL CONSTRUCTION COST	**$**	**316,701.99**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$**	**10,208.57**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$**	**61,455.50**

Table BEST.17. FAN + TFS System (BEST) Lift Station and Manure Evacuation Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor	$ 2,582.04	$ 384.80
Plumbing Materials	$ 2,582.04	$ 384.80
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,755.28	$ 1,453.82
Total Construction Cost	$ 32,389.33	$ 5,396.47
Electric Power Cost		$ 265.85
Maintenance Cost		$ 358.09
Property Taxes		$ 114.98
Total Operating Cost		$ 738.92
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 6,135.39**

Table BEST.18. FAN + TFS System (BEST) FAN Feed Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 7,131.00	$ 1,062.73
Control Panel	$ 1,490.00	$ 222.05
Pumps	$ 2,695.00	$ 971.14
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 336.26	$ 50.11
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 5,975.48	$ 890.52
Total Construction Cost	$ 19,839.71	$ 3,526.21
Electric Power Cost		$ 738.46
Maintenance Cost		$ 335.09
Property Taxes		$ 70.43
Total Operating Cost		$ 1,143.98
TOTAL ANNUALIZED COST OF FAN FEED TANK		**$ 4,670.19**

Table BEST.19. FAN + TFS System (BEST) FAN Separator Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Separator and Platform	$ 23,838.50	$ 3,552.64
Labor and Materials to Fabricate and Install Separator	$ 13,313.50	$ 1,984.10
Separator Platform Installation	$ 4,849.29	$ 722.69
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 2,064.90	$ 307.73
Contractor & Engineering Services & Overhead	$ 19,985.57	$ 2,978.44
Total Construction Cost	$ 66,355.80	$ 9,888.97
Electric Power Cost		$ 738.46
Maintenance Cost		$ 1,545.57
Property Taxes		$ 235.56
Total Operating Cost		$ 2,519.60
TOTAL ANNUALIZED COST OF FAN SEPARATOR		**$ 12,408.57**

Table BEST.20. FAN + TFS System (BEST) TFS Feed Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 11,372.00	$ 1,694.76
Pumps	$ 7,620.67	$ 2,746.10
Control Panel	$ 295.00	$ 43.96
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 926.90	$ 138.14
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 9,665.84	$ 1,440.50
Total Construction Cost	$ 32,092.38	$ 6,393.10
Electric Power Cost		$ 1,174.86
Maintenance Cost		$ 658.61
Property Taxes		$ 113.93
Total Operating Cost		$ 1,947.40
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 8,340.51**

Table BEST.21. FAN + TFS System (BEST) TFS System Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 269.21	$ 97.01
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,549.29	$ 230.89
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 1,921.90	$ 286.42
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 50,004.67	$ 7,452.17
Total Construction Cost	$ 166,024.78	$ 26,042.17
Electric Power Cost		$ 864.39
Maintenance Cost		$ 2,404.90
Property Taxes		$ 589.39
Total Operating Cost		$ 3,858.68
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 29,900.85**

Table BEST.22. FAN + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,350.31	$ 7,968.75
If Phosphorus-Based Application	$ 14,698.02	$ 8,158.58
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	6.22	19.71
If Phosphorus-Based Application	6.70	18.30
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 373.05	-
If Phosphorus-Based Application	$ 401.72	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 14,977.26	$ 8,370.69
If Phosphorus-Based Application	$ 14,244.55	$ 8,560.68
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (401.93)
If Phosphorus-Based Application	-	$ (402.10)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 51.75	-

Note: 3,382,342 gallons / year of effluent land applied at Corbett Farm #1

Table BEST.23. FAN + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,214.54	$	4,818.66
If Phosphorus-Based Application	$	6,869.66	$	4,765.25
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		4.11		13.32
If Phosphorus-Based Application		11.30		30.19
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	246.52		-
If Phosphorus-Based Application	$	677.94		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	4,943.42	$	5,111.22
If Phosphorus-Based Application	$	5,074.55	$	5,415.66
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(292.56)
If Phosphorus-Based Application		-	$	(650.42)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	24.60		-
If Phosphorus-Based Application	$	1,117.18		-

Note: 446,728 lbs. / year of solids land applied at Corbett Farm #1

Table BEST.24. FAN + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Actual Costs and Performance Data

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	67,196.80	19,256.00	33,034.00
Removed in Separated Solids (FAN + TFS)	1,987.94	478.45	1,269.15
Applied to Land in Lagoon Effluent	3,530.48	331.53	4,362.21
Nutrients Unaccounted For	61,678.38	18,446.03	27,402.64

Tables BEST.25 through BEST.33: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,320-Head Feeder to Finish Farm with Flush System (FAN + TFS)

Table BEST.25. FAN + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Number of Animals	**4,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 67,990.33**	**$ 62,618.70**
	If Phosphorus-Based Application	**$ 65,974.58**	**$ 61,561.60**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 116.58**	**$ 107.37**
	If Phosphorus-Based Application	**$ 113.13**	**$ 105.56**

Note: Daily volume discharged from barns is 33,505 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

TOTAL CONSTRUCTION COST	**$ 307,651.80**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 10,559.49**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 60,254.63**

Table BEST.26. FAN + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 4,550.00	$ 678.08
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,076.50	$ 1,352.67
Total Construction Cost	$ 30,135.67	$ 4,857.57
Electric Power Cost		$ 279.02
Maintenance Cost		$ 310.05
Property Taxes		$ 106.98
Total Operating Cost		$ 696.05
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 5,553.62**

Table BEST.27. FAN + TFS System (BEST) FAN Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 6,562.50	$ 978.01
Control Panel	$ 1,490.00	$ 222.05
Pumps	$ 2,695.00	$ 971.14
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 336.26	$ 50.11
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 2,902.02	$ 432.49
Total Construction Cost	$ 16,197.75	$ 2,983.45
Electric Power Cost		$ 775.05
Maintenance Cost		$ 323.72
Property Taxes		$ 57.50
Total Operating Cost		$ 1,156.28
TOTAL ANNUALIZED COST OF FAN FEED TANK		**$ 4,139.72**

Table BEST.28. FAN + TFS System (BEST) FAN Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Separator and Platform	$ 23,838.50	$ 3,552.64
Labor and Materials to Fabricate and Install Separator	$ 13,313.50	$ 1,984.10
Separator Platform Installation	$ 4,849.29	$ 722.69
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 2,064.90	$ 307.73
Contractor & Engineering Services & Overhead	$ 19,985.57	$ 2,978.44
Total Construction Cost	$ 66,355.80	$ 9,888.97
Electric Power Cost		$ 775.05
Maintenance Cost		$ 1,545.57
Property Taxes		$ 235.56
Total Operating Cost		$ 2,556.19
TOTAL ANNUALIZED COST OF FAN SEPARATOR		**$ 12,445.16**

Table BEST.29. FAN + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 13,118.75	$ 1,955.08
Pumps	$ 7,620.67	$ 2,746.10
Control Panel	$ 295.00	$ 43.96
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 926.90	$ 138.14
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 4,764.51	$ 710.05
Total Construction Cost	$ 28,937.80	$ 5,922.98
Electric Power Cost		$ 1,202.70
Maintenance Cost		$ 693.55
Property Taxes		$ 102.73
Total Operating Cost		$ 1,998.97
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 7,921.95**

Table BEST.30. FAN + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 269.21	$ 97.01
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,549.29	$ 230.89
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 1,921.90	$ 286.42
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 50,004.67	$ 7,452.17
Total Construction Cost	$ 166,024.78	$ 26,042.17
Electric Power Cost		$ 1,157.71
Maintenance Cost		$ 2,404.90
Property Taxes		$ 589.39
Total Operating Cost		$ 4,152.00
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 30,194.17**

Table BEST.31. FAN + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,546.41	$ 8,124.29
If Phosphorus-Based Application	$ 14,924.41	$ 8,294.54
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	8.05	25.50
If Phosphorus-Based Application	8.66	23.69
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 482.78	-
If Phosphorus-Based Application	$ 519.89	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,063.63	$ 8,644.45
If Phosphorus-Based Application	$ 14,337.56	$ 8,814.92
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (520.16)
If Phosphorus-Based Application	-	$ (520.37)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 66.97	-

Note: 4,377,222 gallons / year of effluent modeled to be land applied

Table BEST.32. FAN + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,732.47	$	5,210.30
If Phosphorus-Based Application	$	7,880.63	$	5,127.41
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		5.35		17.33
If Phosphorus-Based Application		14.70		39.28
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	320.78		-
If Phosphorus-Based Application	$	882.13		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,379.68	$	5,590.98
If Phosphorus-Based Application	$	5,544.82	$	5,973.73
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(380.68)
If Phosphorus-Based Application		-	$	(846.33)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	32.01		-
If Phosphorus-Based Application	$	1,453.67		-

Note: 581,285 lbs. / year of solids modeled to be land applied

Table BEST.33. FAN + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	87,436.80	25,056.00	42,984.00
Removed in Separated Solids (FAN + TFS)	2,586.72	622.56	1,651.43
Applied to Land in Lagoon Effluent	4,568.93	429.04	5,645.31
Nutrients Unaccounted For	80,281.15	24,004.40	35,687.26

Tables BEST.34 through BEST.42: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,320-Head Feeder to Finish Farm with Pit-Recharge System (FAN + TFS)

Table BEST.34. FAN + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Number of Animals	**4,320**
Type of Operation	**Feeder-Finish**
Barn Cleaning System	**Pit-Recharge System**

Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 66,813.12**	**$ 61,441.48**
	If Phosphorus-Based Application	**$ 64,797.37**	**$ 60,384.39**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 114.56**	**$ 105.35**
	If Phosphorus-Based Application	**$ 111.11**	**$ 103.54**

Note: Daily volume discharged from barns is 28,361 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

TOTAL CONSTRUCTION COST	**$ 304,033.05**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 9,921.57**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 59,077.41**

Table BEST.35. FAN + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 4,550.00	$ 678.08
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,076.50	$ 1,352.67
Total Construction Cost	$ 30,135.67	$ 4,857.57
Electric Power Cost		$ 236.18
Maintenance Cost		$ 310.05
Property Taxes		$ 106.98
Total Operating Cost		$ 653.21
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 5,510.79**

Table BEST.36. FAN + TFS System (BEST) FAN Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 6,875.00	$ 1,024.58
Control Panel	$ 1,490.00	$ 222.05
Pumps	$ 2,695.00	$ 971.14
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 336.26	$ 50.11
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 2,902.02	$ 432.49
Total Construction Cost	$ 16,197.75	$ 2,983.45
Electric Power Cost		$ 656.06
Maintenance Cost		$ 323.72
Property Taxes		$ 57.50
Total Operating Cost		$ 1,037.29
TOTAL ANNUALIZED COST OF FAN FEED TANK		**$ 4,020.73**

Table BEST.37. FAN + TFS System (BEST) FAN Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Separator and Platform	$ 23,838.50	$ 3,552.64
Labor and Materials to Fabricate and Install Separator	$ 13,313.50	$ 1,984.10
Separator Platform Installation	$ 4,849.29	$ 722.69
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 2,064.90	$ 307.73
Contractor & Engineering Services & Overhead	$ 19,985.57	$ 2,978.44
Total Construction Cost	$ 66,355.80	$ 9,888.97
Electric Power Cost		$ 656.06
Maintenance Cost		$ 1,545.57
Property Taxes		$ 235.56
Total Operating Cost		$ 2,437.20
TOTAL ANNUALIZED COST OF FAN SEPARATOR		**$ 12,326.17**

Table BEST.38. FAN + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 9,500.00	$ 1,415.78
Pumps	$ 7,620.67	$ 2,746.10
Control Panel	$ 295.00	$ 43.96
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 926.90	$ 138.14
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 4,764.51	$ 710.05
Total Construction Cost	$ 25,319.05	$ 5,383.68
Electric Power Cost		$ 1,109.58
Maintenance Cost		$ 621.17
Property Taxes		$ 89.88
Total Operating Cost		$ 1,820.63
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 7,204.31**

Table BEST.39. FAN + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 269.21	$ 97.01
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,549.29	$ 230.89
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 1,921.90	$ 286.42
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 50,004.67	$ 7,452.17
Total Construction Cost	$ 166,024.78	$ 26,042.17
Electric Power Cost		$ 978.95
Maintenance Cost		$ 2,404.90
Property Taxes		$ 589.39
Total Operating Cost		$ 3,973.24
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 30,015.42**

Table BEST.40. FAN + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,546.41	$ 8,124.29
If Phosphorus-Based Application	$ 14,924.41	$ 8,294.54
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	8.05	25.50
If Phosphorus-Based Application	8.66	23.69
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 482.78	-
If Phosphorus-Based Application	$ 519.89	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,063.63	$ 8,644.45
If Phosphorus-Based Application	$ 14,337.56	$ 8,814.92
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (520.16)
If Phosphorus-Based Application	-	$ (520.37)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 66.97	-

Note: 4,377,222 gallons / year of effluent modeled to be land applied

Table BEST.41. FAN + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,732.47	$	5,210.30
If Phosphorus-Based Application	$	7,880.63	$	5,127.41
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		5.35		17.33
If Phosphorus-Based Application		14.70		39.28
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	320.78		-
If Phosphorus-Based Application	$	882.13		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,379.68	$	5,590.98
If Phosphorus-Based Application	$	5,544.82	$	5,973.73
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(380.68)
If Phosphorus-Based Application		-	$	(846.33)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	32.01		-
If Phosphorus-Based Application	$	1,453.67		-

Note: 581,285 lbs. / year of solids modeled to be land applied

Table BEST.42. FAN + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	87,436.80	25,056.00	42,984.00
Removed in Separated Solids (FAN + TFS)	2,586.72	622.56	1,651.43
Applied to Land in Lagoon Effluent	4,568.93	429.04	5,645.31
Nutrients Unaccounted For	80,281.15	24,004.40	35,687.26

Tables BEST.43 through BEST.51: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for an 8,800-Head Feeder to Finish Farm with Flush System (FAN + TFS)

Table BEST.43. FAN + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Number of Animals	**8,800**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 108,400.85**	**$ 103,047.10**
	If Phosphorus-Based Application	**$ 103,986.44**	**$ 100,307.81**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 91.25**	**$ 86.74**
	If Phosphorus-Based Application	**$ 87.53**	**$ 84.43**

Note: Daily volume discharged from barns is 68,251 gallons / day including recharge liquid.
SSLW equals 1,188,000 pounds.

TOTAL CONSTRUCTION COST	**$ 530,640.44**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 18,483.58**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 104,687.06**

Table BEST.44. FAN + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 9,100.00	$ 1,356.17
Precast Tank (4,000-gallon)	$ 11,232.00	$ 1,673.90
Fabricate and Deliver Screen	$ 452.00	$ 67.36
Sewage Pump	$ 3,468.40	$ 1,249.83
Control Panel	$ 2,390.00	$ 356.18
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 6,500.00	$ 968.69
Miscellaneous Lift Station Labor and Materials	$ 8,711.94	$ 1,298.34
Contractor & Engineering Services & Overhead	$ 18,153.00	$ 2,705.33
Total Construction Cost	$ 60,271.34	$ 9,715.15
Electric Power Cost		$ 568.37
Maintenance Cost		$ 620.10
Property Taxes		$ 213.96
Total Operating Cost		$ 1,402.43
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 11,117.58**

Table BEST.45. FAN + TFS System (BEST) FAN Feed Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 9,500.00	$ 1,415.78
Control Panel	$ 1,490.00	$ 222.05
Pumps	$ 2,695.00	$ 971.14
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 336.26	$ 50.11
Electrical Installation	$ 1,152.02	$ 171.68
Plumbing Labor and Materials	$ 960.95	$ 143.21
Contractor & Engineering Services & Overhead	$ 2,902.02	$ 432.49
Total Construction Cost	$ 16,197.75	$ 2,983.45
Electric Power Cost		$ 1,578.81
Maintenance Cost		$ 323.72
Property Taxes		$ 57.50
Total Operating Cost		$ 1,960.03
TOTAL ANNUALIZED COST OF FAN FEED TANK		**$ 4,943.48**

Table BEST.46. FAN + TFS System (BEST) FAN Separator Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Separator and Platform	$ 23,838.50	$ 3,552.64
Labor and Materials to Fabricate and Install Separator	$ 13,313.50	$ 1,984.10
Separator Platform Installation	$ 4,849.29	$ 722.69
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 2,064.90	$ 307.73
Contractor & Engineering Services & Overhead	$ 19,985.57	$ 2,978.44
Total Construction Cost	$ 66,355.80	$ 9,888.97
Electric Power Cost		$ 1,578.81
Maintenance Cost		$ 1,545.57
Property Taxes		$ 235.56
Total Operating Cost		$ 3,359.94
TOTAL ANNUALIZED COST OF FAN SEPARATOR		**$ 13,248.91**

Table BEST.47. FAN + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 28,236.16	$ 4,208.02
Pumps	$ 15,241.34	$ 5,492.19
Control Panel	$ 295.00	$ 43.96
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 926.90	$ 138.14
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 1,921.90	$ 286.42
Contractor & Engineering Services & Overhead	$ 8,959.71	$ 1,335.26
Total Construction Cost	$ 57,984.04	$ 11,862.12
Electric Power Cost		$ 1,828.14
Maintenance Cost		$ 1,419.19
Property Taxes		$ 205.84
Total Operating Cost		$ 3,453.17
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 15,315.29**

Table BEST.48. FAN + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 193,400.00	$ 28,822.30
Pumps (1-hp)	$ 11,761.34	$ 4,238.18
Pumps (1/3-hp)	$ 538.42	$ 194.02
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 3,098.58	$ 461.78
Drain Lines (labor and materials)	$ 1,690.00	$ 251.86
Electrical Installation	$ 4,608.08	$ 686.74
Plumbing Labor and Materials	$ 3,843.80	$ 572.84
Site Restoration	$ 10,000.00	$ 1,490.29
Contractor & Engineering Services & Overhead	$ 99,341.28	$ 14,804.78
Total Construction Cost	$ 329,831.50	$ 51,753.79
Electric Power Cost		$ 2,358.30
Maintenance Cost		$ 4,778.80
Property Taxes		$ 1,170.90
Total Operating Cost		$ 8,308.00
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 60,061.79**

Table BEST.49. FAN + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 16,425.02	$ 8,821.17
If Phosphorus-Based Application	$ 15,938.75	$ 8,903.73
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	16.24	51.48
If Phosphorus-Based Application	17.49	47.81
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 974.43	-
If Phosphorus-Based Application	$ 1,049.32	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,450.60	$ 9,871.04
If Phosphorus-Based Application	$ 14,754.27	$ 9,954.03
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (1,049.86)
If Phosphorus-Based Application	-	$ (1,050.30)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 135.16	-

Note: 8,834,813 gallons / year of effluent modeled to be land applied

Table BEST.50. FAN + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	7,859.13	$	6,748.90
If Phosphorus-Based Application	$	12,198.67	$	6,494.37
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		10.89		35.30
If Phosphorus-Based Application		29.95		80.01
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	653.44		-
If Phosphorus-Based Application	$	1,796.94		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	7,140.48	$	7,524.36
If Phosphorus-Based Application	$	7,440.54	$	8,218.37
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(775.46)
If Phosphorus-Based Application		-	$	(1,724.00)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	65.21		-
If Phosphorus-Based Application	$	2,961.19		-

Note: 1,184,099 lbs. / year of solids modeled to be land applied

Table BEST.51. FAN + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	178,112.00	51,040.00	87,560.00
Removed in Separated Solids (FAN + TFS)	5,269.24	1,268.17	3,364.02
Applied to Land in Lagoon Effluent	9,221.76	865.96	11,394.26
Nutrients Unaccounted For	163,621.00	48,905.87	72,801.71

Tables BEST.52 through BEST.60: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,000-Sow Farrow to Wean Farm with Flush System (FAN + TFS)

Table BEST.52. FAN + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Number of Animals	**4,000**
Type of Operation	**Farrow-Wean**
Barn Cleaning System	**Flush System**

Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 201,356.88**	**$ 196,969.82**
	If Phosphorus-Based Application	**$ 188,541.11**	**$ 192,275.39**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 116.26**	**$ 113.72**
	If Phosphorus-Based Application	**$ 108.86**	**$ 111.01**

Note: Daily volume discharged from barns is 158,582 gallons / day including recharge liquid.
SSLW equals 1,732,000 pounds.

TOTAL CONSTRUCTION COST	**$ 991,109.49**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 41,507.83**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 202,724.23**

Table BEST.53. FAN + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 6,370.00	$ 949.29
Precast Tank (4,000-gallon)	$ 11,232.00	$ 1,673.90
Fabricate and Deliver Screen	$ 452.00	$ 67.36
Sewage Pump	$ 3,468.40	$ 1,249.83
Control Panel	$ 2,390.00	$ 356.18
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 6,500.00	$ 968.69
Miscellaneous Lift Station Labor and Materials	$ 8,711.94	$ 1,298.34
Contractor & Engineering Services & Overhead	$ 16,976.37	$ 2,529.98
Total Construction Cost	$ 56,364.71	$ 9,132.94
Electric Power Cost		$ 1,320.62
Maintenance Cost		$ 620.10
Property Taxes		$ 200.09
Total Operating Cost		$ 2,140.82
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 11,273.76**

Table BEST.54. FAN + TFS System (BEST) FAN Feed Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 6,562.50	$ 978.01
Control Panel	$ 1,490.00	$ 222.05
Pumps	$ 5,390.00	$ 1,942.28
Float Switches	$ 198.00	$ 29.51
Concrete (work and labor)	$ 336.26	$ 50.11
Electrical Installation	$ 2,304.04	$ 343.37
Plumbing Labor and Materials	$ 1,921.90	$ 286.42
Contractor & Engineering Services & Overhead	$ 5,016.93	$ 747.67
Total Construction Cost	$ 23,219.63	$ 4,599.42
Electric Power Cost		$ 3,668.40
Maintenance Cost		$ 479.67
Property Taxes		$ 82.43
Total Operating Cost		$ 4,230.50
TOTAL ANNUALIZED COST OF FAN FEED TANK		**$ 8,829.92**

Table BEST.55. FAN + TFS System (BEST) FAN Separator Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Separator and Platform	$ 47,677.00	$ 7,105.28
Labor and Materials to Fabricate and Install Separator	$ 26,627.00	$ 3,968.21
Separator Platform Installation	$ 9,698.58	$ 1,445.37
Electrical Installation	$ 4,608.08	$ 686.74
Plumbing Labor and Materials	$ 4,129.80	$ 615.46
Contractor & Engineering Services & Overhead	$ 39,971.14	$ 5,956.88
Total Construction Cost	$ 132,711.60	$ 19,777.94
Electric Power Cost		$ 7,336.79
Maintenance Cost		$ 3,091.15
Property Taxes		$ 471.13
Total Operating Cost		$ 10,899.07
TOTAL ANNUALIZED COST OF FAN SEPARATOR		**$ 30,677.01**

Table BEST.56. FAN + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 63,763.03	$ 9,502.57
Pumps	$ 30,482.68	$ 10,984.39
Control Panel	$ 295.00	$ 43.96
Float Switches	$ 99.00	$ 14.75
Concrete (work and labor)	$ 926.90	$ 138.14
Electrical Installation	$ 4,608.08	$ 686.74
Plumbing Labor and Materials	$ 3,843.80	$ 572.84
Contractor & Engineering Services & Overhead	$ 17,350.10	$ 2,585.68
Total Construction Cost	$ 121,368.59	$ 24,529.07
Electric Power Cost		$ 3,466.49
Maintenance Cost		$ 2,976.31
Property Taxes		$ 430.86
Total Operating Cost		$ 6,873.66
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 31,402.73**

Table BEST.57. FAN + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 386,800.00	$ 57,644.61
Pumps (1-hp)	$ 23,522.68	$ 8,476.36
Pumps (1/3-hp)	$ 1,076.84	$ 388.04
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 6,197.16	$ 923.56
Drain Lines (labor and materials)	$ 3,380.00	$ 503.72
Electrical Installation	$ 9,216.16	$ 1,373.48
Plumbing Labor and Materials	$ 7,687.60	$ 1,145.68
Site Restoration	$ 20,000.00	$ 2,980.59
Contractor & Engineering Services & Overhead	$ 198,014.52	$ 29,510.00
Total Construction Cost	$ 657,444.96	$ 103,177.03
Electric Power Cost		$ 5,503.26
Maintenance Cost		$ 9,526.59
Property Taxes		$ 2,333.93
Total Operating Cost		$ 17,363.79
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 120,540.82**

Table BEST.58. FAN + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 17,071.56	$ 9,333.98
If Phosphorus-Based Application	$ 16,685.17	$ 9,352.01
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	22.27	70.59
If Phosphorus-Based Application	23.98	65.56
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 1,336.21	-
If Phosphorus-Based Application	$ 1,438.91	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,735.35	$ 10,773.63
If Phosphorus-Based Application	$ 15,060.91	$ 10,792.26
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (1,439.65)
If Phosphorus-Based Application	-	$ (1,440.25)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 185.35	-

Note: 12,114,996 gallons / year of effluent modeled to be land applied

Table BEST.59. FAN + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,088.20	$	5,475.24
If Phosphorus-Based Application	$	8,584.34	$	5,368.97
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		6.22		20.17
If Phosphorus-Based Application		17.11		45.72
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	373.35		-
If Phosphorus-Based Application	$	1,026.70		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,677.59	$	5,918.31
If Phosphorus-Based Application	$	5,865.73	$	6,353.99
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(443.07)
If Phosphorus-Based Application		-	$	(985.02)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	37.26		-
If Phosphorus-Based Application	$	1,691.90		-

Note: 676,547 lbs. / year of solids modeled to be land applied

Table BEST.60. FAN + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	117,000.00	37,040.00	77,000.00
Removed in Separated Solids (FAN + TFS)	3,010.63	724.58	1,922.07
Applied to Land in Lagoon Effluent	12,645.57	1,187.48	15,624.68
Nutrients Unaccounted For	101,343.79	35,127.94	59,453.25

Tables BEST.61 and BEST.62: Predicted Costs and Returns Extrapolated to Various Representative Farm Sizes and Farm Types Based on Standardized Costs and Performance Data for Flush and Pit-Recharge Systems (FAN + TFS)

Table BEST.61. $ / 1,000 Pounds of Steady-State Live Weight (SSLW) for DWQ Permitted Representative Type of Operation / Size of Farm Combinations—FAN + TFS Technology

	Size of Farm (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Type of Operation					
Farrow-wean					
Rep. # of sows	752	1,540	2,400	4,000	6,000
Pit-recharge system	$208.50	$132.05	$120.29	$107.57	$102.16
Flush system	$211.65	$133.28	$120.30	$119.33	$112.99
Farrow-feeder					
Rep. # of sows	500	1,200	2,000	3,600	5,500
Pit-recharge system	$258.92	$141.80	$125.74	$113.31	$107.85
Flush system	$266.27	$174.86	$164.81	$148.82	$157.04
Farrow-finish					
Rep. # of sows	150	500	1,000	1,200	2,000
Pit-recharge system	$237.23	$129.23	$94.77	$79.87	$84.16
Flush system	$240.06	$132.53	$110.11	$113.92	$100.33
Wean-feeder					
Rep. head capacity	3,840	20,000	N/A	N/A	N/A
Pit-recharge system	$434.97	$124.55	N/A	N/A	N/A
Flush system	$615.73	$363.62	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	2,448	5,280	8,800	12,240	17,136
Pit-recharge system	$152.50	$96.17	$77.03	$68.97	$66.70
Flush system	$153.68	$97.08	$92.91	$80.09	$83.16

Table BEST.62. $ / 1,000 Pounds of Steady-State Live Weight (SSLW) for Smithfield Foods/Premium Standard Farms Representative Type of Operation / Size of Farm Combinations—FAN + TFS Technology

	Size of Farm (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Type of Operation					
Farrow-wean					
Rep. # of sows	650	1,700	2,400	4,000	7,000
Pit-recharge system	$240.58	$119.99	$120.29	$107.57	$102.73
Flush system	$241.82	$144.94	$120.30	$119.33	$118.13
Farrow-feeder					
Rep. # of sows	675	1,200	2,000	3,419	5,500
Pit-recharge system	$193.82	$141.80	$125.74	$119.22	$107.85
Flush system	$250.14	$174.86	$164.81	$155.98	$157.04
Farrow-finish					
Rep. # of sows	N/A	500	1,000	1,200	2,000
Pit-recharge system	N/A	$141.80	$125.74	$113.31	$107.85
Flush system	N/A	$174.86	$164.81	$148.82	$157.04
Wean-feeder					
Rep. head capacity	2,808	N/A	N/A	N/A	N/A
Pit-recharge system	$593.44	N/A	N/A	N/A	N/A
Flush system	$822.75	N/A	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	1,240	5,100	8,800	12,246	17,136
Pit-recharge system	$299.09	$99.57	$77.03	$68.94	$66.70
Flush system	$300.27	$100.46	$92.91	$80.05	$83.16

Tables BEST.63 through BEST.71: Actual Costs and Mass Balances for the BEST Filtramat + TFS System for a 4,048-Head Feeder to Finish Farm with Flush System

Table BEST.63. Filtramat + TFS System (BEST) Assumptions and Total Annualized Costs—Actual Costs and Performance Data

Number of Animals	**4,048**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 88,568.08**	**$ 84,511.11**
	If Phosphorus-Based Application	**$ 89,978.03**	**$ 81,916.30**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 162.07**	**$ 154.65**
	If Phosphorus-Based Application	**$ 164.65**	**$ 149.90**

Note: Daily volume discharged from barns is 37,801 gallons / day including recharge liquid.
SSLW equals 546,480 pounds.

TOTAL CONSTRUCTION COST	**$**	**388,976.22**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$**	**15,062.80**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$**	**79,861.46**

Table BEST.64. Filtramat + TFS System (BEST) Lift Station and Manure Evacuation Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor	$ 2,582.04	$ 384.80
Plumbing Materials	$ 2,582.04	$ 384.80
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,755.28	$ 1,453.82
Total Construction Cost	$ 32,389.33	$ 5,396.47
Electric Power Cost		$ 314.80
Maintenance Cost		$ 358.09
Property Taxes		$ 114.98
Total Operating Cost		$ 787.87
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 6,184.34**

Table BEST.65. Filtramat + TFS System (BEST) Filtramat Feed Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank Labor and Materials (cast-in-place)	$ 19,235.00	$ 2,866.58
Labor and Materials to Set Tank	$ 552.50	$ 82.34
Pump (5-hp)	$ 2,695.00	$ 971.14
Filtramat Pumps (1-hp)	$ 2,112.50	$ 761.24
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 13,041.86	$ 1,943.62
Total Construction Cost	$ 43,301.40	$ 7,469.10
Electric Power Cost		$ 3,312.77
Maintenance Cost		$ 749.42
Property Taxes		$ 153.72
Total Operating Cost		$ 4,215.90
TOTAL ANNUALIZED COST OF FILTRAMAT FEED TANK		**$ 11,685.01**

Table BEST.66. Filtramat + TFS System (BEST) Filtramat Separator Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Envirogain Equipment	$ 33,000.00	$ 4,917.97
Solids Conveyor	$ 7,254.12	$ 2,614.01
Installation (labor and materials)	$ 15,423.00	$ 2,298.48
Air Compressor System	$ 3,463.86	$ 1,248.20
Air Compressor Installation	$ 1,365.00	$ 203.43
Control Panel	$ 285.00	$ 42.47
Pump (1/2-hp)	$ 325.24	$ 117.20
Variable Speed Flow Control (flow meters, variable flow drive)	$ 6,120.00	$ 912.06
Variable Speed Flow Control (PLC, enclosure, relays, floats)	$ 1,903.00	$ 283.60
500-Gallon Tank	$ 350.83	$ 52.28
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 8,150.67	$ 1,214.69
Concrete Labor and Materials	$ 2,045.00	$ 304.77
Contractor & Engineering Services & Overhead	$ 35,802.19	$ 5,335.58
Total Construction Cost	$ 118,869.91	$ 20,048.76
Electric Power Cost		$ 1,383.72
Maintenance Cost		$ 1,965.35
Property Taxes		$ 421.99
Total Operating Cost		$ 3,771.06
TOTAL ANNUALIZED COST OF FILTRAMAT SEPARATOR		**$ 23,819.83**

Table BEST.67. Filtramat + TFS System (BEST) TFS Feed Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 2,480.00	$ 369.59
Labor and Materials to Set Tank	$ 942.50	$ 140.46
Pumps (1-hp)	$ 7,620.67	$ 2,746.10
Control Panel	$ 285.00	$ 42.47
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 6,808.81	$ 1,014.71
Total Construction Cost	$ 22,606.52	$ 4,979.43
Electric Power Cost		$ 1,280.04
Maintenance Cost		$ 525.72
Property Taxes		$ 80.25
Total Operating Cost		$ 1,886.02
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 6,865.45**

Table BEST.68. Filtramat + TFS System (BEST) TFS System Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 272.49	$ 98.19
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,400.00	$ 208.64
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 5,164.08	$ 769.60
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 51,746.83	$ 7,711.80
Total Construction Cost	$ 171,809.07	$ 26,904.90
Electric Power Cost		$ 1,306.18
Maintenance Cost		$ 2,485.84
Property Taxes		$ 609.92
Total Operating Cost		$ 4,401.95
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 31,306.84**

Table BEST.69. Filtramat + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,490.87	$ 9,872.07
If Phosphorus-Based Application	$ 14,686.51	$ 8,129.79
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	7.53	14.78
If Phosphorus-Based Application	8.53	23.33
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 451.70	-
If Phosphorus-Based Application	$ 512.02	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,039.17	$ 10,189.10
If Phosphorus-Based Application	$ 13,840.02	$ 8,618.25
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (317.03)
If Phosphorus-Based Application	-	$ (488.46)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 334.47	-

Note: 4,095,448 gallons / year of effluent land applied at Corbett Farm #3 and #4

Table BEST.70. Filtramat + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,333.83	$	5,370.49
If Phosphorus-Based Application	$	11,805.15	$	5,576.63
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		8.74		28.32
If Phosphorus-Based Application		28.32		91.18
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	524.19		-
If Phosphorus-Based Application	$	1,698.90		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,654.10	$	5,992.57
If Phosphorus-Based Application	$	6,092.26	$	7,051.48
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(622.07)
If Phosphorus-Based Application		-	$	(1,474.85)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	155.55		-
If Phosphorus-Based Application	$	4,013.99		-

Note: 653,622 lbs. / year of solids land applied at Corbett Farm #3 and #4

Table BEST.71. Filtramat + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Actual Costs and Performance Data

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	81,931.52	23,478.40	40,277.60
Removed in Separated Solids (Filtramat + TFS)	4,226.98	1,445.16	2,182.45
Applied to Land in Lagoon Effluent	2,647.99	422.55	4,964.99
Nutrients Unaccounted For	75,056.55	21,610.69	33,130.17

Tables BEST.72 through BEST.80: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,320-Head Feeder to Finish Farm with Flush System (Filtramat + TFS)

Table BEST.72. Filtramat + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Number of Animals	**4,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 86,740.65**	**$ 82,635.10**
	If Phosphorus-Based Application	**$ 88,630.01**	**$ 79,972.00**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 148.73**	**$ 141.69**
	If Phosphorus-Based Application	**$ 151.97**	**$ 137.13**

Note: Daily volume discharged from barns is 33,505 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

TOTAL CONSTRUCTION COST	**$ 383,184.08**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 14,490.09**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 78,222.52**

Table BEST.73. Filtramat + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 4,550.00	$ 678.08
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,076.50	$ 1,352.67
Total Construction Cost	$ 30,135.67	$ 4,857.57
Electric Power Cost		$ 279.02
Maintenance Cost		$ 310.05
Property Taxes		$ 106.98
Total Operating Cost		$ 696.05
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 5,553.62**

Table BEST.74. Filtramat + TFS System (BEST) Filtramat Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank Labor and Materials (cast-in-place)	$ 17,185.75	$ 2,561.18
Labor and Materials to Set Tank	$ 493.64	$ 73.57
Pump (5-hp)	$ 2,695.00	$ 971.14
Filtramat Pumps (1-hp)	$ 2,112.50	$ 761.24
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 12,133.27	$ 2,125.83
Total Construction Cost	**$ 40,284.69**	$ 8,074.08
Electric Power Cost		$ 3,276.99
Maintenance Cost		$ 707.25
Property Taxes		$ 143.01
Total Operating Cost		$ 4,127.25
TOTAL ANNUALIZED COST OF FILTRAMAT FEED TANK		**$ 11,146.78**

Table BEST.75. Filtramat + TFS System (BEST) Filtramat Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Envirogain Equipment	$ 33,000.00	$ 4,917.97
Solids Conveyor	$ 7,254.12	$ 2,614.01
Installation (labor and materials)	$ 15,423.00	$ 2,298.48
Air Compressor System	$ 3,463.86	$ 1,248.20
Air Compressor Installation	$ 1,365.00	$ 203.43
Control Panel	$ 285.00	$ 42.47
Pump (1/2-hp)	$ 325.24	$ 117.20
Variable Speed Flow Control (flow meters, variable flow drive)	$ 6,120.00	$ 912.06
Variable Speed Flow Control (PLC, enclosure, relays, floats)	$ 1,903.00	$ 283.60
500-Gallon Tank	$ 350.83	$ 52.28
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 8,150.67	$ 1,214.69
Concrete Labor and Materials	$ 2,045.00	$ 304.77
Contractor & Engineering Services & Overhead	$ 35,802.19	$ 5,335.58
Total Construction Cost	$ 118,869.91	$ 20,048.76
Electric Power Cost		$ 1,226.46
Maintenance Cost		$ 1,965.35
Property Taxes		$ 421.99
Total Operating Cost		$ 3,613.80
TOTAL ANNUALIZED COST OF FILTRAMAT SEPARATOR		**$ 23,662.56**

Table BEST.76. Filtramat + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 2,215.79	$ 330.22
Labor and Materials to Set Tank	$ 842.09	$ 125.50
Pumps (1-hp)	$ 7,620.67	$ 2,746.10
Control Panel	$ 285.00	$ 42.47
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 6,651.66	$ 991.29
Total Construction Cost	$ 22,084.74	$ 4,901.67
Electric Power Cost		$ 1,202.01
Maintenance Cost		$ 520.44
Property Taxes		$ 78.40
Total Operating Cost		$ 1,800.85
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 6,702.52**

Table BEST.77. Filtramat + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 272.49	$ 98.19
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,400.00	$ 208.64
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 5,164.08	$ 769.60
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 51,746.83	$ 7,711.80
Total Construction Cost	$ 171,809.07	$ 26,904.90
Electric Power Cost		$ 1,156.38
Maintenance Cost		$ 2,485.84
Property Taxes		$ 609.92
Total Operating Cost		$ 4,252.15
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 31,157.04**

Table BEST.78. Filtramat + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,543.66	$ 9,896.99
If Phosphorus-Based Application	$ 14,768.22	$ 8,169.89
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	8.02	15.75
If Phosphorus-Based Application	9.09	24.85
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 481.24	-
If Phosphorus-Based Application	$ 545.51	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,062.41	$ 10,234.75
If Phosphorus-Based Application	$ 13,866.38	$ 8,690.29
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (337.76)
If Phosphorus-Based Application	-	$ (520.40)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 356.34	-

Note: 4,363,268 gallons / year of effluent modeled to be land applied

Table BEST.79. Filtramat + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,517.65	$	5,486.11
If Phosphorus-Based Application	$	12,724.35	$	5,694.57
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		9.32		30.22
If Phosphorus-Based Application		36.42		97.31
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	559.41		-
If Phosphorus-Based Application	$	2,185.32		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,792.25	$	6,149.98
If Phosphorus-Based Application	$	6,255.33	$	7,268.51
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(663.87)
If Phosphorus-Based Application		-	$	(1,573.95)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	166.00		-
If Phosphorus-Based Application	$	4,283.70		-

Note: 697,542 lbs. / year of solids modeled to be land applied

Table BEST.80. Filtramat + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	87,436.80	25,056.00	42,984.00
Removed in Separated Solids (Filtramat + TFS)	4,511.00	1,542.26	2,329.09
Applied to Land in Lagoon Effluent	2,821.16	450.18	5,289.67
Nutrients Unaccounted For	80,104.64	23,063.55	35,365.24

Tables BEST.81 through BEST.89: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,320-Head Feeder to Finish Farm with Pit-Recharge (Filtramat + TFS)

Table BEST.81. Filtramat + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Number of Animals	**4,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Pit-Recharge System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 85,438.59**	**$ 81,333.04**
	If Phosphorus-Based Application	**$ 87,327.95**	**$ 78,669.94**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	Row Crops
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 146.50**	**$ 139.46**
	If Phosphorus-Based Application	**$ 149.74**	**$ 134.89**

Note: Daily volume discharged from barns is 28,361 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

TOTAL CONSTRUCTION COST	**$ 378,628.23**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 13,866.99**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 76,920.46**

Table BEST.82. Filtramat + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 4,550.00	$ 678.08
Precast Tank (4,000-gallon)	$ 5,616.00	$ 836.95
Fabricate and Deliver Screen	$ 226.00	$ 33.68
Sewage Pump	$ 2,695.00	$ 971.14
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Miscellaneous Lift Station Labor and Materials	$ 4,355.97	$ 649.17
Contractor & Engineering Services & Overhead	$ 9,076.50	$ 1,352.67
Total Construction Cost	$ 30,135.67	$ 4,857.57
Electric Power Cost		$ 236.18
Maintenance Cost		$ 310.05
Property Taxes		$ 106.98
Total Operating Cost		$ 653.21
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 5,510.79**

Table BEST.83. Filtramat + TFS System (BEST) Filtramat Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank Labor and Materials (cast-in-place)	$ 14,547.31	$ 2,167.98
Labor and Materials to Set Tank	$ 417.85	$ 62.27
Pump (5-hp)	$ 2,695.00	$ 971.14
Filtramat Pumps (1-hp)	$ 2,112.50	$ 761.24
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 10,963.43	$ 1,633.88
Total Construction Cost	$ 36,400.64	$ 6,440.68
Electric Power Cost		$ 3,234.15
Maintenance Cost		$ 652.97
Property Taxes		$ 129.22
Total Operating Cost		$ 4,016.35
TOTAL ANNUALIZED COST OF FILTRAMAT FEED TANK		**$ 10,457.03**

Table BEST.84. Filtramat + TFS System (BEST) Filtramat Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Envirogain Equipment	$ 33,000.00	$ 4,917.97
Solids Conveyor	$ 7,254.12	$ 2,614.01
Installation (labor and materials)	$ 15,423.00	$ 2,298.48
Air Compressor System	$ 3,463.86	$ 1,248.20
Air Compressor Installation	$ 1,365.00	$ 203.43
Control Panel	$ 285.00	$ 42.47
Pump (1/2-hp)	$ 325.24	$ 117.20
Variable Speed Flow Control (flow meters, variable flow drive)	$ 6,120.00	$ 912.06
Variable Speed Flow Control (PLC, enclosure, relays, floats)	$ 1,903.00	$ 283.60
500-Gallon Tank	$ 350.83	$ 52.28
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 8,150.67	$ 1,214.69
Concrete Labor and Materials	$ 2,045.00	$ 304.77
Contractor & Engineering Services & Overhead	$ 35,802.19	$ 5,335.58
Total Construction Cost	$ 118,869.91	$ 20,048.76
Electric Power Cost		$ 1,038.17
Maintenance Cost		$ 1,965.35
Property Taxes		$ 421.99
Total Operating Cost		$ 3,425.51
TOTAL ANNUALIZED COST OF FILTRAMAT SEPARATOR		**$ 23,474.27**

Table BEST.85. Filtramat + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 1,875.61	$ 279.52
Labor and Materials to Set Tank	$ 712.81	$ 106.23
Pumps (1-hp)	$ 7,620.67	$ 2,746.10
Control Panel	$ 285.00	$ 42.47
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 6,449.32	$ 961.14
Total Construction Cost	$ 21,412.95	
Electric Power Cost		$ 1,108.88
Maintenance Cost		$ 513.64
Property Taxes		$ 76.02
Total Operating Cost		$ 1,698.54
TOTAL ANNUALIZED COST OF TFS FEED TANK		**$ 6,500.09**

Table BEST.86. Filtramat + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
TFS System	$ 96,700.00	$ 14,411.15
Pumps (1-hp)	$ 5,880.67	$ 2,119.09
Pumps (1/3-hp)	$ 272.49	$ 98.19
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 1,400.00	$ 208.64
Drain Lines (labor and materials)	$ 845.00	$ 125.93
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 5,164.08	$ 769.60
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 51,746.83	$ 7,711.80
Total Construction Cost	$ 171,809.07	$ 26,904.90
Electric Power Cost		$ 977.63
Maintenance Cost		$ 2,485.84
Property Taxes		$ 609.92
Total Operating Cost		$ 4,073.39
		$ 30,978.29

Table BEST.87. Filtramat + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,543.66	$ 9,896.99
If Phosphorus-Based Application	$ 14,768.22	$ 8,169.89
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	8.02	15.75
If Phosphorus-Based Application	9.09	24.85
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 481.24	-
If Phosphorus-Based Application	$ 545.51	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,062.41	$ 10,234.75
If Phosphorus-Based Application	$ 13,866.38	$ 8,690.29
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (337.76)
If Phosphorus-Based Application	-	$ (520.40)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 356.34	-

Note: 4,363,268 gallons / year of effluent modeled to be land applied

Table BEST.88. Filtramat + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,517.65	$	5,486.11
If Phosphorus-Based Application	$	12,724.35	$	5,694.57
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		9.32		30.22
If Phosphorus-Based Application		36.42		97.31
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	559.41		-
If Phosphorus-Based Application	$	2,185.32		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,792.25	$	6,149.98
If Phosphorus-Based Application	$	6,255.33	$	7,268.51
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(663.87)
If Phosphorus-Based Application		-	$	(1,573.95)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	166.00		-
If Phosphorus-Based Application	$	4,283.70		-

Note: 697,542 lbs. / year of solids modeled to be land applied

Table BEST.89. Filtramat + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	87,436.80	25,056.00	42,984.00
Removed in Separated Solids (Filtramat + TFS)	4,511.00	1,542.26	2,329.09
Applied to Land in Lagoon Effluent	2,821.16	450.18	5,289.67
Nutrients Unaccounted For	80,104.64	23,063.55	35,365.24

Tables BEST.90 through BEST.98: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for an 8,800-Head Feeder to Finish Farm with Flush System (Filtramat + TFS)

Table BEST.90. Filtramat + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Number of Animals	**8,800**
Type of Operation	**Feeder-Finish**
Barn Cleaning System	**Flush System**

Annualized Cost ($ / Year)

		Forages	Row Crops
	If Nitrogen-Based Application	**$ 130,076.58**	**$ 125,142.77**
	If Phosphorus-Based Application	**$ 134,048.01**	**$ 121,263.90**

Per Unit Cost ($ / 1,000 lbs. of SSLW)

		Forages	Row Crops
Total Annualized Cost			
(Discounted over 10 years)	If Nitrogen-Based Application	**$ 109.49**	**$ 105.34**
	If Phosphorus-Based Application	**$ 112.84**	**$ 102.07**

Note: Daily volume discharged from barns is 68,251 gallons / day including recharge liquid.
SSLW equals 1,188,000 pounds.

TOTAL CONSTRUCTION COST	**$ 619,949.31**
TOTAL OPERATING COST INCLUDING ROYALTIES	**$ 22,598.84**
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 124,893.41**

Table BEST.91. Filtramat + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 9,100.00	$ 1,356.17
Precast Tank (4,000-gallon)	$ 11,232.00	$ 1,673.90
Fabricate and Deliver Screen	$ 452.00	$ 67.36
Sewage Pump	$ 3,468.40	$ 1,249.83
Control Panel	$ 2,390.00	$ 356.18
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 6,500.00	$ 968.69
Miscellaneous Lift Station Labor and Materials	$ 8,711.94	$ 1,298.34
Contractor & Engineering Services & Overhead	$ 18,153.00	$ 2,705.33
Total Construction Cost	$ 60,271.34	$ 9,715.15
Electric Power Cost		$ 568.37
Maintenance Cost		$ 620.10
Property Taxes		$ 213.96
Total Operating Cost		
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		

Table BEST.92. Filtramat + TFS System (BEST) Filtramat Feed Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank Labor and Materials (cast-in-place)	$ 35,008.01	$ 5,217.23
Labor and Materials to Set Tank	$ 1,005.56	$ 149.86
Pump (5-hp)	$ 2,695.00	$ 971.14
Filtramat Pumps (1-hp)	$ 2,112.50	$ 761.24
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 1,625.00	$ 242.17
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 20,035.30	$ 2,985.85
Total Construction Cost	$ 66,520.90	$ 10,929.49
Electric Power Cost		$ 3,566.34
Maintenance Cost		$ 1,073.94
Property Taxes		$ 236.15
Total Operating Cost		
TOTAL ANNUALIZED COST OF FILTRAMAT FEED TANK		

Table BEST.93. Filtramat + TFS System (BEST) Filtramat Separator Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Envirogain Equipment	$ 33,000.00	$ 4,917.97
Solids Conveyor	$ 7,254.12	$ 2,614.01
Installation (labor and materials)	$ 15,423.00	$ 2,298.48
Air Compressor System	$ 3,463.86	$ 1,248.20
Air Compressor Installation	$ 1,365.00	$ 203.43
Control Panel	$ 285.00	$ 42.47
Pump (1/2-hp)	$ 325.24	$ 117.20
Variable Speed Flow Control (flow meters, variable flow drive)	$ 6,120.00	$ 912.06
Variable Speed Flow Control (PLC, enclosure, relays, floats)	$ 1,903.00	$ 283.60
500-Gallon Tank	$ 350.83	$ 52.28
Float Switches	$ 132.00	$ 19.67
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 8,150.67	$ 1,214.69
Concrete Labor and Materials	$ 2,045.00	$ 304.77
Contractor & Engineering Services & Overhead	$ 35,802.19	$ 5,335.58
Total Construction Cost	$ 118,869.91	
Electric Power Cost		$ 2,498.34
Maintenance Cost		$ 1,965.35
Property Taxes		$ 421.99
Total Operating Cost		$ 4,885.68
		$ 24,934.45

Table BEST.94. Filtramat + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 4,513.64	$ 672.67
Labor and Materials to Set Tank	$ 1,715.37	$ 255.64
Pumps (1-hp)	$ 15,241.34	$ 5,492.19
Control Panel	$ 285.00	$ 42.47
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 12,060.19	$ 1,797.32
Total Construction Cost	$ 40,042.08	$ 9,188.24
Electric Power Cost		$ 1,826.73
Maintenance Cost		$ 982.57
Property Taxes		$ 142.15
Total Operating Cost		
TOTAL ANNUALIZED COST OF TFS FEED TANK		

Table BEST.95. Filtramat + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 193,400.00	$ 28,822.30
Pumps (1-hp)	$ 11,761.34	$ 4,238.18
Pumps (1/3-hp)	$ 544.98	$ 196.38
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 2,800.00	$ 417.28
Drain Lines (labor and materials)	$ 1,690.00	$ 251.86
Electrical Installation	$ 6,500.00	$ 968.69
Plumbing Labor and Materials	$ 10,328.16	$ 1,539.20
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 100,670.60	$ 15,002.89
Total Construction Cost	$ 334,245.08	$ 52,412.93
Electric Power Cost		$ 2,355.60
Maintenance Cost		$ 4,940.68
Property Taxes		$ 1,186.57
Total Operating Cost		$ 8,482.85
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 60,895.78**

Table BEST.96. Filtramat + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 16,419.42	$ 10,310.38
If Phosphorus-Based Application	$ 16,123.79	$ 8,835.14
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	16.19	31.78
If Phosphorus-Based Application	18.35	50.16
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 971.29	-
If Phosphorus-Based Application	$ 1,100.99	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,448.13	$ 10,992.08
If Phosphorus-Based Application	$ 14,303.60	$ 9,885.47
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (681.70)
If Phosphorus-Based Application	-	$ (1,050.33)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 719.20	-

Note: 8,806,387 gallons / year of effluent modeled to be land applied

Table BEST.97. Filtramat + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	9,334.11	$	7,149.00
If Phosphorus-Based Application	$	21,868.84	$	7,312.70
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		18.99		61.55
If Phosphorus-Based Application		74.19		198.22
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,139.53		-
If Phosphorus-Based Application	$	4,451.57		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	7,856.43	$	8,501.33
If Phosphorus-Based Application	$	8,691.21	$	10,518.89
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(1,352.33)
If Phosphorus-Based Application		-	$	(3,206.19)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	338.14		-
If Phosphorus-Based Application	$	8,726.06		-

Note: 1,420,918 lbs. / year of solids modeled to be land applied

Table BEST.98. Filtramat + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (8,800-Head Feeder-Finish with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	178,112.00	51,040.00	87,560.00
Removed in Separated Solids (Filtramat + TFS)	9,189.08	3,141.65	4,744.45
Applied to Land in Lagoon Effluent	5,693.94	908.61	10,676.15
Nutrients Unaccounted For	163,228.98	46,989.74	72,139.41

Tables BEST.99 through BEST.107: Predicted Costs and Returns and Mass Balance Based on Standardized Costs and Performance Data for a 4,000-Sow Farrow to Wean Farm with Flush System (Filtramat + TFS)

Table BEST.99. Filtramat + TFS System (BEST) Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Number of Animals	**4,000**		
Type of Operation	**Farrow-Wean**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	
(Discounted over 10 years)	If Nitrogen-Based Application		**$ 232,836.52**
	If Phosphorus-Based Application	**$ 228,880.62**	**$ 227,152.39**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost		Forages	
(Discounted over 10 years)	If Nitrogen-Based Application		**$ 134.43**
	If Phosphorus-Based Application	**$ 132.15**	**$ 131.15**

Note: Daily volume discharged from barns is 158,582 gallons / day including recharge liquid.
SSLW equals 1,732,000 pounds.

TOTAL CONSTRUCTION COST	**$ 1,166,414.99**
	$ 45,402.31
TOTAL ANNUALIZED COSTS WITHOUT LAND APPLICATION	**$ 237,005.80**

Table BEST.100. Filtramat + TFS System (BEST) Lift Station and Manure Evacuation Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Waste Evacuation	$ 6,370.00	$ 949.29
Precast Tank (4,000-gallon)	$ 11,232.00	$ 1,673.90
Fabricate and Deliver Screen	$ 452.00	$ 67.36
Sewage Pump	$ 3,468.40	$ 1,249.83
Control Panel	$ 2,390.00	$ 356.18
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 6,500.00	$ 968.69
Miscellaneous Lift Station Labor and Materials	$ 8,711.94	$ 1,298.34
Contractor & Engineering Services & Overhead	$ 16,976.37	$ 2,529.98
Total Construction Cost	$ 56,364.71	$ 9,132.94
Electric Power Cost		$ 1,320.62
Maintenance Cost		$ 620.10
Property Taxes		$ 200.09
Total Operating Cost		$ 2,140.82
TOTAL ANNUALIZED COST OF LIFT STATION AND MANURE EVACUATION		**$ 11,273.76**

Table BEST.101. Filtramat + TFS System (BEST) Filtramat Feed Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Tank Labor and Materials (cast-in-place)	$ 81,341.95	$ 12,122.35
Labor and Materials to Set Tank	$ 2,336.44	$ 348.20
Pump (5-hp)	$ 2,695.00	$ 971.14
Filtramat Pumps (1-hp)	$ 4,225.00	$ 1,522.47
Control Panel	$ 1,195.00	$ 178.09
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 3,250.00	$ 484.35
Plumbing Labor and Materials	$ 5,425.08	$ 808.50
Contractor & Engineering Services & Overhead	$ 43,415.70	$ 6,470.22
Total Construction Cost	$ 144,148.17	$ 22,944.66
Electric Power Cost		$ 4,318.59
Maintenance Cost		$ 2,222.25
Property Taxes		$ 511.73
Total Operating Cost		$ 7,052.57
TOTAL ANNUALIZED COST OF FILTRAMAT FEED TANK		**$ 29,997.23**

Table BEST.102. Filtramat + TFS System (BEST) Filtramat Separator Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Envirogain Equipment	$ 66,000.00	$ 9,835.95
Solids Conveyor	$ 14,508.24	$ 5,228.02
Installation (labor and materials)	$ 30,846.00	$ 4,596.96
Air Compressor System	$ 3,463.86	$ 1,248.20
Air Compressor Installation	$ 1,365.00	$ 203.43
Control Panel	$ 570.00	$ 84.95
Pump (1/2-hp)	$ 650.48	$ 234.40
Variable Speed Flow Control (flow meters, variable flow drive)	$ 12,240.00	$ 1,824.12
Variable Speed Flow Control (PLC, enclosure, relays, floats)	$ 1,903.00	$ 283.60
500-Gallon Tank	$ 701.66	$ 104.57
Float Switches	$ 264.00	$ 39.34
Electrical Installation	$ 6,500.00	$ 968.69
Plumbing Labor and Materials	$ 16,301.34	$ 2,429.38
Concrete Labor and Materials	$ 4,090.00	$ 609.53
Contractor & Engineering Services & Overhead	$ 68,702.94	$ 10,238.76
Total Construction Cost	$ 228,106.52	$ 37,929.90
Electric Power Cost		$ 8,308.37
Maintenance Cost		$ 3,719.45
Property Taxes		$ 809.78
Total Operating Cost		$ 12,837.59
		$ 50,767.50

Table BEST.103. Filtramat + TFS System (BEST) TFS Feed Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 10,487.55	$ 1,562.95
Labor and Materials to Set Tank	$ 3,985.69	$ 593.99
Pumps (1-hp)	$ 30,482.68	$ 10,984.39
Control Panel	$ 285.00	$ 42.47
Float Switches	$ 528.00	$ 78.69
Electrical Installation	$ 6,500.00	$ 968.69
Plumbing Labor and Materials	$ 2,712.54	$ 404.25
Contractor & Engineering Services & Overhead	$ 23,697.01	$ 3,531.55
Total Construction Cost	$ 78,678.47	$ 18,166.98
Electric Power Cost		$ 3,465.68
Maintenance Cost		$ 1,934.40
Property Taxes		$ 279.31
Total Operating Cost		$ 5,679.39
		$ 23,846.37

Table BEST.104. Filtramat + TFS System (BEST) TFS System Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Component	Total Cost	Annualized Cost
TFS System	$ 386,800.00	$ 57,644.61
Pumps (1-hp)	$ 23,522.68	$ 8,476.36
Pumps (1/3-hp)	$ 1,089.96	$ 392.77
Control Panel	$ 1,550.00	$ 231.00
Concrete Pad (labor and materials)	$ 5,600.00	$ 834.57
Drain Lines (labor and materials)	$ 3,380.00	$ 503.72
Electrical Installation	$ 13,000.00	$ 1,937.38
Plumbing Labor and Materials	$ 20,656.32	$ 3,078.40
Site Restoration	$ 5,000.00	$ 745.15
Contractor & Engineering Services & Overhead	$ 198,518.15	$ 29,585.06
Total Construction Cost	$ 659,117.11	$ 103,429.01
Electric Power Cost		$ 5,501.72
Maintenance Cost		$ 9,850.36
Property Taxes		$ 2,339.87
Total Operating Cost		$ 17,691.94
TOTAL ANNUALIZED COST OF TFS SYSTEM		**$ 121,120.95**

Table BEST.105. Filtramat + TFS System (BEST) Sprayfield Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 17,068.36	$ 10,616.70
If Phosphorus-Based Application	$ 17,128.26	$ 9,328.09
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	22.24	43.67
If Phosphorus-Based Application	25.21	68.91
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 1,334.42	-
If Phosphorus-Based Application	$ 1,512.61	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 15,733.94	$ 11,553.26
If Phosphorus-Based Application	$ 14,627.58	$ 10,771.09
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (936.56)
If Phosphorus-Based Application	-	$ (1,443.00)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 988.08	-

Note: 12,098,724 gallons / year of effluent modeled to be land applied

Table BEST.106. Filtramat + TFS System (BEST) Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,988.00	$	5,777.65
If Phosphorus-Based Application	$	14,199.18	$	5,988.32
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		10.85		35.17
If Phosphorus-Based Application		42.39		113.25
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	651.08		-
If Phosphorus-Based Application	$	2,543.45		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,143.72	$	6,550.32
If Phosphorus-Based Application	$	6,670.01	$	7,820.21
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(772.67)
If Phosphorus-Based Application		-	$	(1,831.89)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	193.20		-
If Phosphorus-Based Application	$	4,985.72		-

Note: 811,856 lbs. / year of solids modeled to be land applied

Table BEST.107. Filtramat + TFS System (BEST) Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,000-Sow Farrow-Wean with Flush System)

Nutrient Balance	**Nitrogen (lbs. / year)**	**Phosphorus (lbs. / year)**	**Potassium (lbs. / year)**
Generated At Barn	117,000.00	37,040.00	77,000.00
Removed in Separated Solids (Filtramat + TFS)	5,250.27	1,795.01	2,710.79
Applied to Land in Lagoon Effluent	7,822.67	1,248.30	14,667.51
Nutrients Unaccounted For	103,927.06	33,996.69	59,621.71

Tables BEST.108 and BEST.109: Predicted Costs and Returns Extrapolated to Various Representative Farm Sizes and Farm Types Based on Standardized Costs and Performance Data for Flush and Pit-Recharge Systems (Filtramat + TFS)

Table BEST.108. $ / 1,000 Pounds of Steady-State Live Weight (SSLW) for DWQ Permitted Representative Type of Operation / Size of Farm Combinations— Filtramat + TFS Technology

	Size of Farm (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Type of Operation					
Farrow-wean					
Rep. # of sows	752	1,540	2,400	4,000	6,000
Pit-recharge system	$260.52	$159.30	$138.89	$124.68	$124.29
Flush system	$262.84	$161.62	$163.93	$136.57	$133.18
Farrow-feeder					
Rep. # of sows	500	1,200	2,000	3,600	5,500
Pit-recharge system	$321.56	$170.43	$144.59	$129.27	$125.00
Flush system	$330.91	$205.81	$208.24	$180.17	$173.51
Farrow-finish					
Rep. # of sows	150	500	1,000	1,200	2,000
Pit-recharge system	$312.17	$154.01	$108.92	$106.66	$94.91
Flush system	$317.03	$158.87	$142.14	$131.00	$121.49
Wean-feeder					
Rep. head capacity	3,840	20,000	N/A	N/A	N/A
Pit-recharge system	$566.45	$154.34	N/A	N/A	N/A
Flush system	$761.65	$412.10	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	2,448	5,280	8,800	12,240	17,136
Pit-recharge system	$202.42	$121.42	$93.53	$81.97	$87.00
Flush system	$204.65	$123.65	$109.49	$108.36	$96.42

Table BEST.109. $ / 1,000 Pounds of Steady-State Live Weight (SSLW) for Smithfield Foods/Premium Standard Farms Representative Type of Operation / Size of Farm Combinations—Filtramat + TFS Technology

	Size of Farm (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Type of Operation					
Farrow-wean					
Rep. # of sows	650	1,700	2,400	4,000	7,000
Pit-recharge system	$299.14	$145.65	$138.89	$124.68	$119.78
Flush system	$301.47	$170.12	$163.93	$136.57	$136.51
Farrow-feeder					
Rep. # of sows	675	1,200	2,000	3,419	5,500
Pit-recharge system	$242.98	$170.43	$144.59	$135.21	$125.00
Flush system	$298.61	$205.81	$208.24	$188.18	$173.51
Farrow-finish					
Rep. # of sows	N/A	500	1,000	1,200	2,000
Pit-recharge system	N/A	$154.01	$108.92	$106.66	$94.91
Flush system	N/A	$158.87	$142.14	$131.00	$121.49
Wean-feeder					
Rep. head capacity	2,808	N/A	N/A	N/A	N/A
Pit-recharge system	$770.17	N/A	N/A	N/A	N/A
Flush system	$1,017.39	N/A	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	1,240	5,100	8,800	12,246	17,136
Pit-recharge system	$391.01	$125.46	$93.53	$81.94	$87.00
Flush system	$393.24	$127.69	$109.49	$108.31	$96.42