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**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: AGRICLEAN

**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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1. Overview of the AgriClean Technology

1.1. Farm Overview

The AgriClean system was evaluated on the Bobby Ray Harris Farm near Greenville, NC (Pitt County). This is a feeder-to-finish operation with 12 houses each containing 960 finishing hogs, for a total capacity of 11,520 animals. The AgriClean system has been designed to treat the waste from all 12 of the houses on the Bobby Ray Harris Farm—a steady-state live weight of 1,555,200 pounds.

Houses at the Bobby Ray Harris Farm use a tunnel ventilation system and have fully-slatted floors. Prior to the construction of the AgriClean technology, the houses incorporated a pit-recharge system for manure removal. Each house had one main pit that was comprised of four rows. The volume of each pit was 40,000 gallons and the pits were emptied once per week. The waste removal system and pit-emptying schedule have been altered with the construction of the AgriClean system. This technology proposes to use the AgriJet™ system to remove manure from the barns.

Prior to the construction of the AgriClean system, all of Bobby Ray Harris Farm's manure was treated by an anaerobic lagoon. The existing lagoon at this site measures 933' x 355' at its top bank with a side slope of 1/3. The total temporary storage volume of this lagoon is reported as 887,587.8 ft³.

1.2. Technology Overview

The following unit processes have been identified for the AgriClean technology:

- 1) AgriJet™ system
- 2) Modifications to waste evacuation system
- 3) Equalization tank
- 4) Heat exchanger
- 5) Anaerobic digester
- 6) Flare
- 7) Settling tank
- 8) FAN separator
- 9) Solids storage
- 10) Return to lagoon
- 11) Return to houses
- 12) Land application of liquids
- 13) Land application of separated solids

The AgriJet™ system is designed to limit the flow of waste from the houses to a rate of between 25,000 and 30,000 gallons per day (at 5-6 % total solids). It is a pressurized flush technology that is intended to provide controlled water usage as required for waste removal from the houses. The existing drain lines at Bobby Ray Harris Farm will be intercepted with tees to direct the waste to a 30,000-gallon receiving tank. This tank is designed to serve as an equalization basin to ensure that the anaerobic digester receives a constant flow of influent. Dependent on the level of substrate in the digester, waste will be pumped from the equalization tank to the digester every 4 to 6 hours. The flow rate is designed such that the entire daily amount of flushed waste will be directed to the digester over a 24 hour period. Also, while in the equalization tank, a chemical (FeCl) is added to the waste to control the formation of H₂S in the digester.

Before entering the anaerobic digester, the waste will first pass through a heat exchanger. The heat exchanger is intended to raise the temperature of digester influent to a level between 38 and 45° C. The anaerobic digester has a capacity of 312,000 gallons and a stated hydraulic retention time of 10-12 days. A slow-running mixer is operated continuously to homogenize the substrate and to avoid sedimentation of solids. The stated goal of the anaerobic digester is to remove 55-65 % of soluble COD and volatile solids. As the AgriClean system is currently designed, all biogas created in the treatment process will be used to heat influent or flared.

Upon exiting the anaerobic digester, effluent enters a settling tank before passing through a FAN separator that is intended to remove the majority of the solids (up to 90 %). The liquid portion of the separated effluent will be piped back to the existing lagoon. From there, a portion of the treated liquids will be recirculated for use with the AgriJet™ flushing system. The remaining portion of treated liquids will be land applied. The separated solids associated with the AgriClean technology will also be land applied.

2. Invoiced Construction Costs of the AgriClean Technology (Tables AC.1-AC.7)

Tables AC.1-AC.7 report the invoiced construction costs of the AgriClean technology as built on Bobby Ray Harris Farm. The cost data in these tables was provided by Cavanaugh and Associates and is based on actual cost invoices submitted to Cavanaugh by the technology providers. Cavanaugh attributed the invoices to the AgriClean technology's various unit processes, as summarized in Tables AC.1-AC.6. The invoiced cost unit processes are as follows: equalization tank (Table AC.1), digester, including heat exchanger and boiler (Table AC.2), settling tank (Table AC.3), gas storage (Table AC.4), and solids separator (Table AC.5). Table AC.6 lists miscellaneous costs associated with the construction of the AgriClean technology at Bobby Ray Harris Farm, including a flare and steel building to house equipment. Table AC.7 summarizes the invoiced costs that are listed in Tables AC.1-AC.6. Total invoiced construction costs for the AgriClean technology sum to \$364,562.01. Note that these costs exclude the 43.1% contractor overhead charges that are part of the standard cost and returns analysis in these reports. The majority of the invoiced costs (~ 63%) are associated with AgriClean's steel tank digester. Cost invoices were not provided for the AgriJet™ waste evacuation

system, so this unit process is not included in the total construction cost summary presented in Table AC.7.

3. Overview of Standardized Cost Modeling

The economics team was not able to use the invoiced construction cost data to construct standardized cost models for the AgriClean technology. The cost and returns team did not receive a principal investigators' report or sufficient operating and performance data to model the costs and performance of the AgriClean technology. Because of a lack of performance data, a standardized cost model could not be constructed for this technology.

In addition to the construction cost invoices, data necessary to have completed the model includes the following.

- Purchase and installation cost and expected life of the AgriJet system,
- The electricity use, labor, and repairs and maintenance costs and the volume and composition of liquid used by the AgriJet system per house per day,
- The average and maximum daily volume and composition of effluent from each house including TKN, P, COD, total solids, volatile solids,
- The average daily cost of pumping and volume and composition of material pumped from the equalization tank to the digester,
- The average price, form, and quantity of FeCl added to the equalization tank per day and per gallon of effluent or other design denominator,
- The average temperature of influent to the heat exchanger and/or the digester and the average temperature of the digester daily throughout the year,
- The quantity of fuel or electricity consumed to provide supplemental heat to the digester during start-up and during operation throughout the year,
- The quantity of electricity used to operate controls, pumps, and mixers in the digester, settling tank, separator, heat exchanger, and return to lagoon,
- The average annual labor, repairs and maintenance cost for each of the digester, settling tank, separator, and heat exchanger,
- The volume and composition of gas produced by the digester on a daily basis throughout the year including percentages of methane, CO₂ and H₂S,
- The volume and temperature of effluent entering the heat exchanger from the digester and of effluent leaving the heat exchanger per hour and per day,
- The volume and composition of material entering the settling tank and the volume and composition of material leaving the settling tank to the separator each day,
- The volume and composition of liquid and of solids leaving the FAN separator,
- The volume and composition of liquid recycled to remove manure from the barns,
- The volume and composition of liquids that are land applied,
- The volume and composition of solids that are land applied.

In the absence of sufficient data, no demonstration based cost and returns model could be prepared.

References

Cavanaugh and Associates. Invoiced Construction Cost Data. Personal communication with and/or data submitted by Jason Wilson. January 2005.

Tables AC.1 through AC.7: Invoiced Construction Costs of the AgriClean Technology

Table AC.1. Invoiced Construction Costs of AgriClean Equalization Tank (Cavanaugh)

Component	Cost
6,000-gallon precast pump tank	\$8,895.00
Submersible sewage pump	\$1,640.51
Control panel	\$572.61
Total Cost of Equalization Tank	\$11,108.12

Table AC.2. Invoiced Construction Costs of AgriClean Digester (Cavanaugh)

Component	Cost
Glass-lined steel tank	\$47,406.00
Glass-lined steel roof	\$25,991.00
Tank labor	\$30,836.00
Mixer / heat exchanger	\$24,068.62
Structural steel, etc. for media support	\$22,558.85
3" solid corrugated media	\$48,125.74
Progressive cavity pumps	\$6,441.00
Footing and floor	\$12,657.89
Boiler	\$9,998.40
Total Cost of Digester	\$228,083.50

Table AC.3. Invoiced Construction Costs of AgriClean Settling Tank (Cavanaugh)

Component	Cost
Glass-lined steel tank	\$10,737.00
Tank labor	\$3,265.00
Footing and floor	\$5,037.06
Total Cost of Settling Tank	\$19,039.06

Table AC.4. Invoiced Construction Costs of AgriClean Gas Storage (Cavanaugh)

Component	Cost
1,000-gallon cylindrical cone bottom tank	\$2,570.00
Tank cover	\$1,400.00
Support stand	\$952.00
Bulkhead fittings	\$345.00
Total Cost of Gas Storage	\$5,267.00

Table AC.5. Invoiced Construction Costs of AgriClean Solids Separator (Cavanaugh)

Component	Cost
FAN press screw separator	\$23,230.49
½-HP effluent pump	\$173.75
Package sewage system	\$305.41
Control panel	\$3,571.70
Total Cost of Solids Separator	\$27,281.35

Table AC.6. Invoiced Miscellaneous Construction Costs of AgriClean Technology (Cavanaugh)

Component	Cost
Biogas flare	\$10,755.00
Steel building	\$8,570.92
Electrical costs	\$49,371.24
Bobby Harris invoices	\$5,085.82
Total Miscellaneous Costs	\$73,782.98

Table AC.7. Summary of Invoiced Construction Costs for AgriClean Technology

System Component	Cost	% of Total Cost
Equalization tank	\$11,108.12	3.05 %
Digester	\$228,083.50	62.56 %
Settling tank	\$19,039.06	5.22 %
Gas storage	\$5,267.00	1.45 %
Solids separator	\$27,281.35	7.48 %
Flare	\$10,755.00	2.95 %
Steel building	\$8,570.92	2.35 %
Miscellaneous costs	\$54,457.06	14.94 %
Total Cost of AgriClean Technology	\$364,562.01	100.00 %