

Poultry Waste Treatment For Energy and Fertilizer Production Using Thermophilic Anaerobic Digestion

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INTRODUCTION

The problem of disposing of poultry waste in large intensive rearing houses provides for a potential opportunity derived from waste pollution. The organic fractions contained in poultry waste provide nutrients and energy for microbes to convert energy into biogas; residual solids and liquids into organic fertilizers. The anaerobic digestion process is now being employed for pollution reduction, fertilizer production and generation of renewable energies.

Digester technology has progressed from the generation of biogas to light Victorian street lamps (Exeter, UK in the 1880's), to modern Megawatt power stations with associated fertilizer factories (1990's). Poultry waste organics convert to high levels of biogas. Excellent fertilizers are obtained from digestion of livestock wastes. Poultry waste lends itself to digestion because it is high in organics and inorganic nutrients. A thermophilic environment results in pathogen removal and associated remediation, (reduces BOD and COD), with raw livestock waste.

OBJECTIVES

- 1) Develop digester operational parameters that maximize fertilizer and biogas (energy) production from poultry waste while maintaining pathogen reduction levels that exceed EPA guidelines.
- 2) Demonstrate the efficacy of digested poultry litter as replacement for commercial fertilizers for vegetable crops, corn and pasture grasses.

Table 1. Fertilizer Composition and Source for Each Crop.

Fertilizer	N-P-K	Source
Root Crops Alive	3-4-3	Gardens Alive!, Lawrenceburg, IN
Complete Bridge	7-2-5	Harmony Products, Inc., Chesapeake, VA
Poultry Litter	2-1.2-0.6	Moorefield Digester, Moorefield, WV, Operated by Taylor and Thomas Environmental
Sweet Corn Alive	6-3-3	Gardens Alive! Lawrenceburg, IN
Hoffman Azalea	10-4-6	A H Hoffman Inc., Lancaster, PA

Table 2. Fertilizer Application Rates (Dry Weight Equivalent) by Crop

Crop	Bridge Fertilizer	Commercial Fertilizer	Poultry Litter application	Poultry Litter "heavy" application
Purple Top White Globe Turnip	195g per 33 feet	454g per 33 feet	680g per 33 feet	1360g per 33 feet
Kandi Corn	409 g per 33 feet	477 g per 33 feet	1428g per 33 feet	2858g per 33 feet
Patriot and Bluejay Blueberry	71g per plant	50g per plant	250g per plant	500g per plant

DIGESTER OPERATIONAL PARAMETERS

THERMOPHILIC ANAEROBIC DIGESTER—134^oF

BIOGAS YIELDS

9-12 Ft³/lb Volatile Solids added
2.2 Mwh Electricity—1 Million Broilers
1.5 Mwh Electricity—1 Million Layers

POLLUTION REDUCTION

Chemical Oxygen Demand
50-60% Reduction

Biological Oxygen Demand
60-80% Reduction

PATHOGEN REDUCTION

Salmonella sp.
Virtually Complete Destruction

E. coli
99.9999% Reduction

Fecal streptococci
99.99% Reduction.

Figure 1. Fertilizer Effects on Turnip Mean Fresh Weight

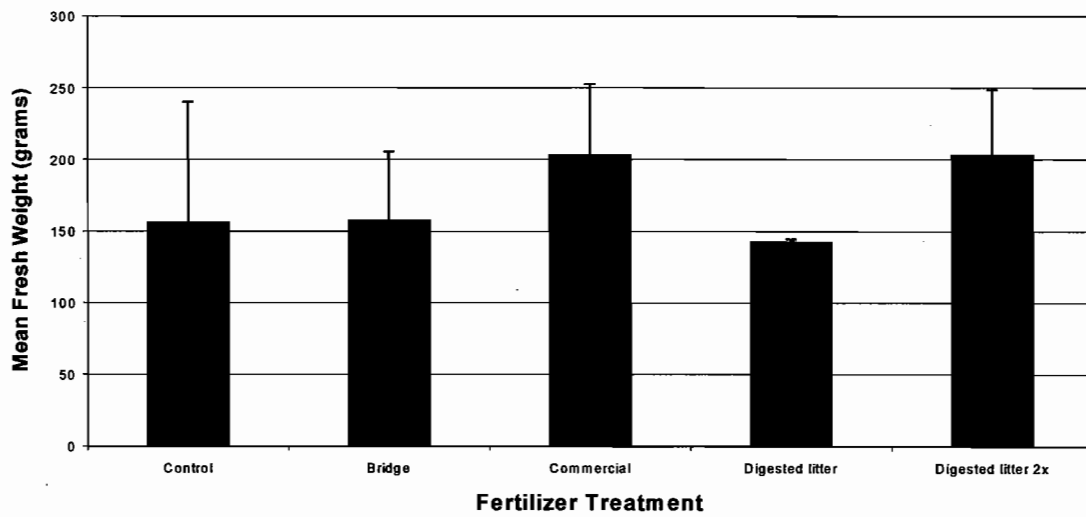


Table 3. Turnip Mean Fresh Weight by Fertilizer Treatment

Fertilizer Treatment	Mean Fresh Weight (grams)
Control	156.0 a*
Bridge	157.7 a
Commercial	202.7 b
Digested Litter 2x	202.8 b

*Values followed by the same letter are not significantly different at P = 0.05 by the DMC test.

Table 4. ANOVA of fertilizer treatment effects on blueberry yield.

Source	DF	SS	MS	F
Fertilizer treatment	3	41627.41	13875.8	0.70*
Error	18	357597.5	19866.53	
Total (Adjusted)	21	399224.9		
Total	22			

* Term not significant at alpha = 0.05

Figure 2. The effects of fertilizer treatment on blueberry yield

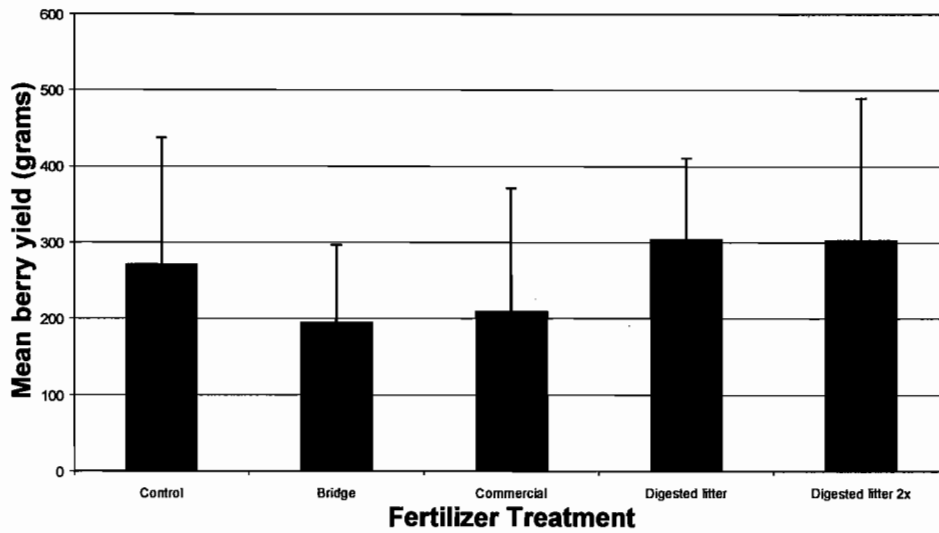


Figure 3. Fertilizer Effects on Corn Ear Fresh Weight

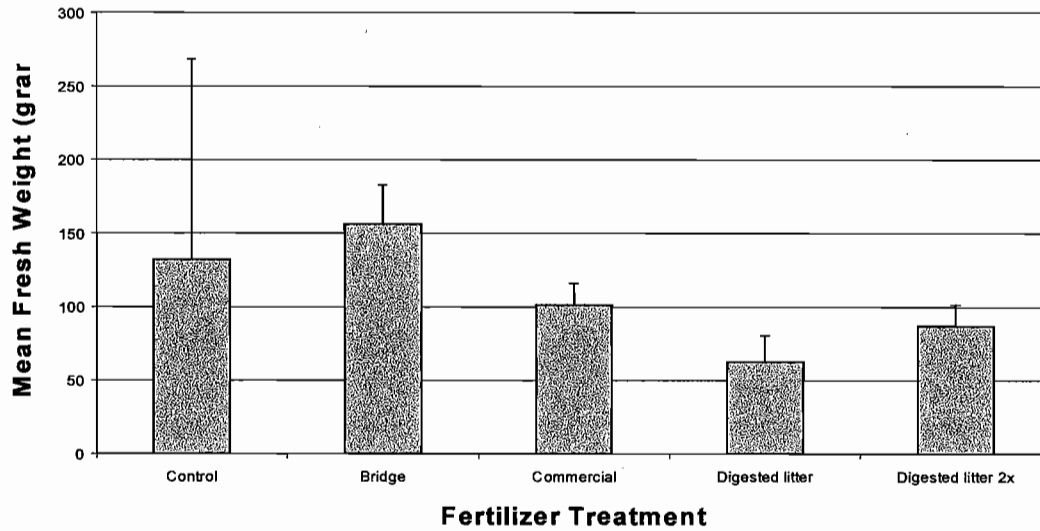
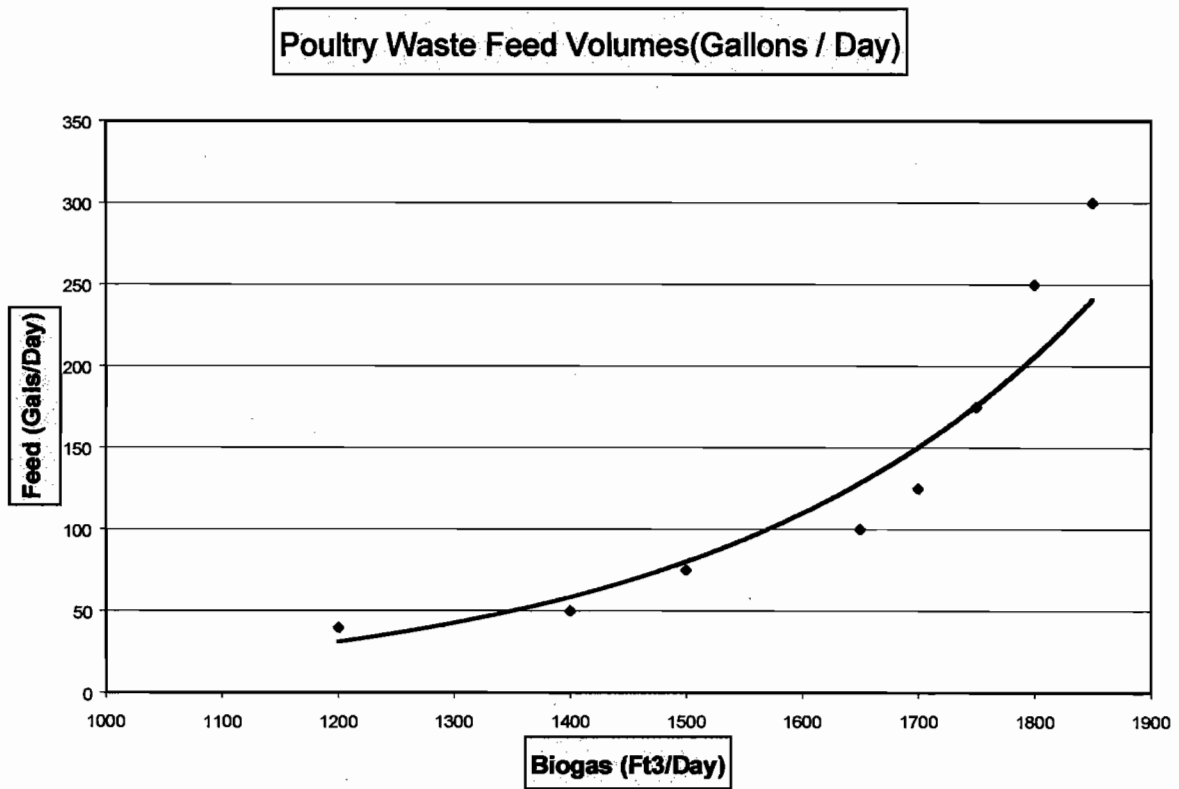


Table 5. Corn Mean Fresh Weight by Fertilizer Treatment

Fertilizer Treatment	Mean Fresh Weight (g)
Control	124.2 b*
Bridge	156.8 b
Commercial	101.7 b
Digested Litter 1x	62.5 a

*Values Followed by the same letter are not significantly different at P = 0.05 by the DMC test.

**FIGURE 6.
DIGESTER PERFORMANCE**



CONCLUSIONS

1. Digester performed well in specific biogas yields, pollution reduction and pathogen removal. The energy produced can be sold to the grid on full-scale units.
2. Organic fertilizer produced good crop growth yields. There was no statistical difference (at the 0.05 level) for the different fertilizer treatments, except for turnips where heavy organic treatment and commercial fertilizer were significantly higher than the control.
3. Organically grown crops command a higher price than traditional fertilizer crops. Digested litter can provide an excellent organic fertilizer with good crop yields.
4. Anaerobic digestion enables poultry waste to produce organic fertilizer, high in nitrogen, for sale as well as biogas energy for sale. The return on capital is attractive for investment in the technology.

REFERENCES

1. Stafford D A. (1992). Anaerobic Fermentation. *J. Soc. Dairy Technology*. **45**, 84-89.
2. Etheridge, SP, Stafford DA, Hughes DA and Leroff UEA. (1985). The Production of Fertilizer from Anaerobic Digesters used to treat Agricultural Residues. *Alternative Sources of Energy for Agriculture*. FFTC Book series No **28**. 18-36.
3. Kispert RG, Stafford DA, Wentworth RL and Crabtree DD. (1996). Development and Installation of a Remote Process Control System for Anaerobic Digestion. *Marseilles Conference Energy from Biomass*. 1-5.
4. Etheridge SP and Stafford DA,. (1988). The Anaerobic Digestion of Pig Waste in Four Different Reactor Designs. In: *Global Bioconversions, III*, CRC Press, Boca Raton. Fl. 139-161.

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