Integrated Waste Management Approaches (Integrated Waste Management Solutions)

Gordon A. Wells

Tradex AgriSystems Inc. #300, 4500 - 16th Avenue N.W. Calgary, AB T3B 0M6
Email: gordon@tradexagrisystems.com

■ Introduction

The impact of US$50 per barrel oil on our businesses is not something that can be ignored. Led by China's insatiable appetite for raw materials and political unrest in key oil producing countries, higher energy prices are likely to continue in the short to medium term. Higher world oil prices directly impact North American natural gas prices; therefore, we will be paying more to heat our homes and businesses this winter. A mild winter will help, but a longer-term strategy to deal with higher energy costs is essential.

Higher energy prices have motivated some hog producers to switch to coal to heat their barns over winter. This one-dimensional reactive strategy ignores longer-term proactive opportunities that deserve further scrutiny. One solution to higher energy costs may be right under our noses - in this instance, hog manure.

Increasingly, intensive livestock enterprises are coming under public pressure over concerns related to manure and potential adverse effects such as odour, water contamination, as well as animal and people welfare. Hog production in particular is a magnet for this type of pressure. The poor prices received by pork producers in recent years have not encouraged much innovation or risk taking in the industry. There have been some exceptions, one of which is new approaches to waste management involving multiple or integrated approaches. Three integrated waste management initiatives involving hog production will be discussed in this presentation.

■ Bio-Terre Systems Inc.

Bio-Terre Systems is a Canadian owned company, with DGH Engineering Ltd., Le Groupe SM Inc. and Les Entreprises Kanitek Inc. as partners. Agriculture and Agri-Food Canada (AAFC) have patented the Bio-Terre technology. Bio-Terre has taken low temperature anaerobic digestion from the laboratory to the field. AAFC continues to be a technical partner in Bio-Terre Systems.

The Bio-Terre process uses anaerobic bacteria conditioned to operate at temperatures of 15°C to 25°C, and survive in a dormant state at temperatures as low as 5°C. The organisms tolerate a wide range of conditions that typically develop on farms: variable loading rates and frequencies, variable acidity/alkalinity, and variable ammonia concentration. The test site selected for development of this system is Cook Feeders Ltd. in Teulon, Manitoba. The focus of work is the design of earth basin reactors, and remote monitoring and management of a commercial unit.

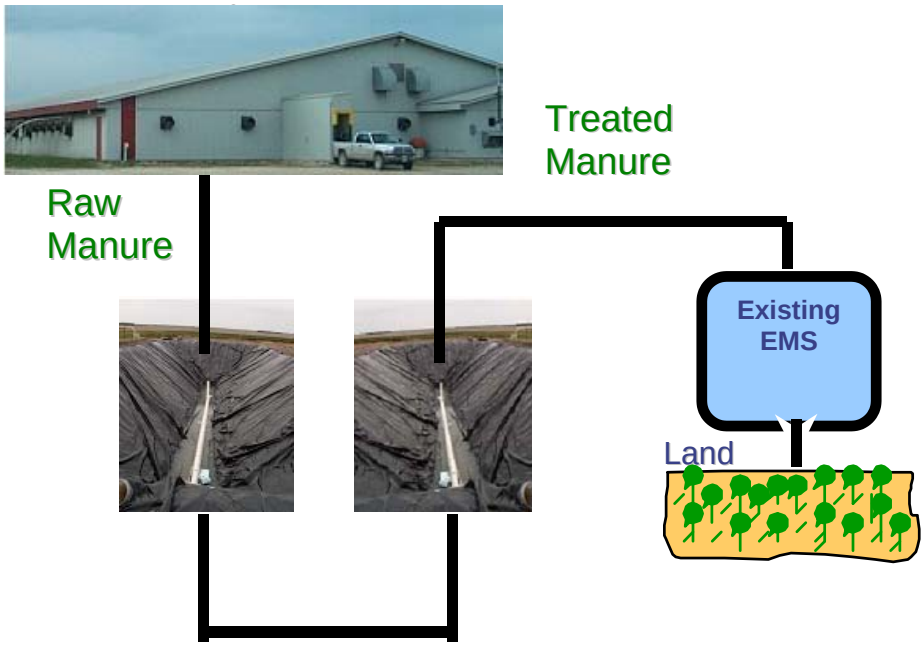
Cook Feeders facilities and treatment process include a barn holding capacity of 6,000 finisher pigs (eight rooms of 750 head each). The operation is all-in/all-out. The average weight of the pigs at entry is 22.5 kg and average weight leaving the barn is 111 kg. Each cycle is approximately 120 days, and interval between cycles is seven days.

The barn has partially slotted floors (1/3 slab, 2/3 solids) with shallow gravity drain gutters/pull plug. The gutters are drained at two-week intervals. Manure is transferred to the lift station daily. The lift station discharges to a three-cell EMS with a capacity of 400 days manure production. The reported production rate for methane and biogas follows:

- 0.22~0.25 m^3 methane/kg COD fed.
- 0.75 m^3 biogas/kg volatile matters degraded.
- 118 L biogas/finisher/day.

The estimate of potential methane and biogas production on the Cook Feeders site is 500 m^3 methane (CH^4)/day and 700 m^3 biogas/day. The estimated potential energy recovery is equivalent to a gross heat value 17.9 GJ/day (207 kW), and estimated gross energy production is 5,000 kW-h/day from CH^4 and 1,100 kW-h/day from biogas. The potential economic benefit to Cook Feeders is electricity generation of 400 MW-h per year, worth $24,000 annually. This would cover the farm's annual hydro demand of 122 MW-h, as well as provide surplus heat.

Figure 1. Bio-Terre Treatment Schematic



The main objectives of the Bio-Terre demonstration unit are;

- To construct and operate a full field prototype, low temperature, anaerobic digester for the treatment of swine waste.
- To verify and demonstrate the applicability of the process under Western Canadian climatic conditions.
- To demonstrate that the barriers to the widespread use of this profitable and environmentally friendly system can be overcome.

The demonstration is set up as a two-year project.

- Phase one focuses on organic matter stabilization of the Bio-Terre reactors and methane production.
- Phase two will concentrate on operational optimization and electricity generation.

■ Home Farms Technologies Inc.

Home Farms Technologies Inc's. operational headquarters are in Brandon, Manitoba. Their vision is "to be the leading force in finding the total solution to the world's environmental challenges". The Co-Chairman and Chief Executive Officer is Bobby Curtola, a well-known Canadian entertainer.

The company has an asset base of $2.5 million, with intellectual properties patent pending in Canada, United States and under Patent Convention Treaty filings in 68 counties. Home Farm Technologies has an impressive management team, experienced advisory council and important strategic alliances in many parts of the world.

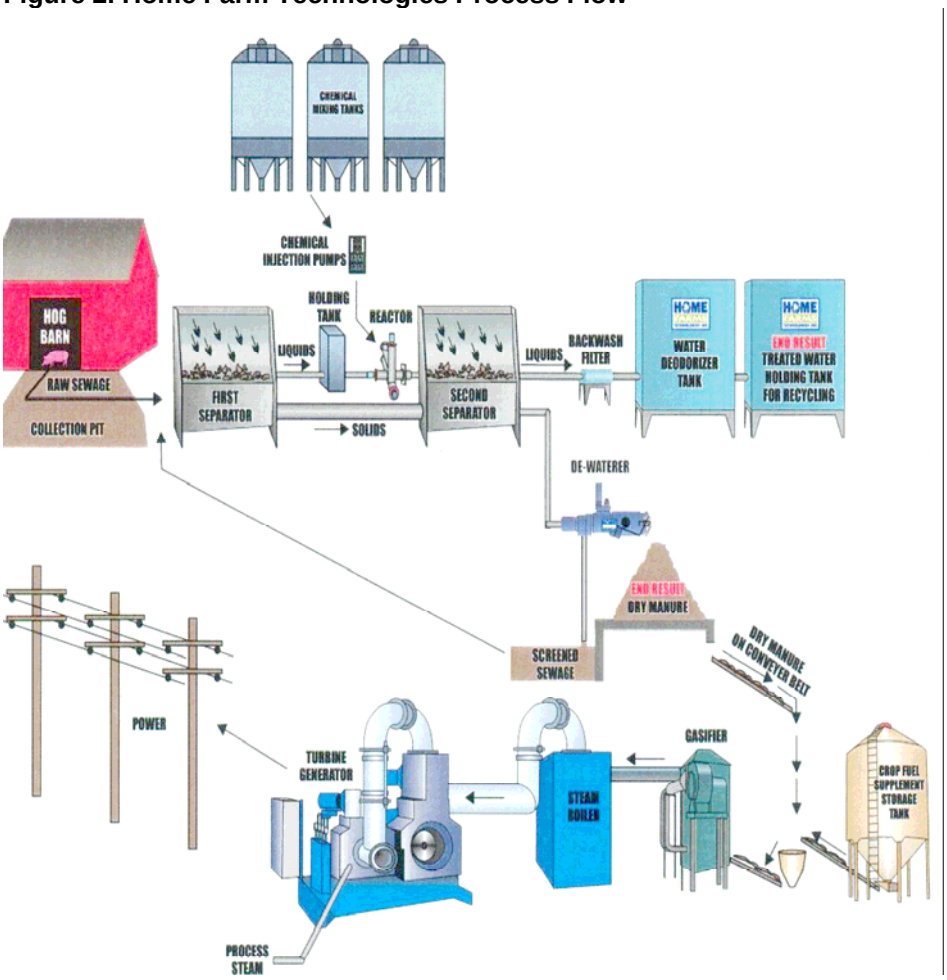
Home Farms Technologies' integrated waste management system differs from the traditional anaerobic digestion of organic matter to produce biogas, in which the resulting biogas is used as fuel to operate a co-generation unit producing electrical and thermal energy. In its place, Home Farms Technologies processes effluent such as hog manure through their Enviro Reactor™,which mechanically and chemically separates the majority of the solids from the liquids. The company has an Enviro Reactor™ operating successfully on a 600-head farrow-to-finish hog enterprise at Green Acres Hutterite Colony, Wawanesa, Manitoba.

Home Farms Catalyst™ is a pre-treatment process composed of natural microorganisms that flourish in a moist environment. The Catalyst™ is injected in the barn flushing system where the organisms attack the bacteria, diminish the gaseous emissions and soften the heavier solids. This pre-treatment prepares the liquid manure for optimum separation when processed by the Enviro Reactor™.

The solids can be either composted, or used as fuel in their Energy Reactor or Gasifier to produce steam that runs a turbine generator producing thermal and/or electrical energy. Agriculture and Agri-Food Canada carried out an analysis of a sample from the flocculation process and identified the fertilizer value of the liquids and solids as 2.8 kg of P_20 and 1.71 kg of K_2O per 1,000 litres. This translates into a fertilizer value (N-P-K) of 0.28-0.06-0.17. Moisture content of the sample was 98.7%. The solids after the screw press contained 5.2 kg of N, 3.7 kg of P_20_5 and 1.5 Kg of K_2) per Wet tonne. The fertilizer value of this fraction was 0.52-0.37-0.15 based on 70% moisture.

The following diagram illustrates the initial flow of manure or other effluent through the Enviro Reactor™ and Energy Reactor, resulting in energy and two recyclable bi-products.

Figure 2. Home Farm Technologies Process Flow



▪ Clear-Green Environmental Inc.

Clear-Green Environmental Inc. is “a project development and advanced environmental technology company that focuses on value-added processing of organic waste streams”. The company is focused on developing projects that apply advanced biotechnology and separation processes to provide environmentally friendly, cost-effective, waste management alternatives designed to meet the specific needs of their clients.

Clear-Green’s first venture is a partnership with SaskPower and Cudworth Pork Investors Group in Saskatchewan. The consortium has constructed a full-scale

commercial demonstration project that processes liquid hog manure continuously produced by a nearby 1,200 farrow-to-finish hog facility. The hog facility is charged a fee to process the manure through the plant. The tipping fee charged to the hog facility approximates what it costs the facility to dispose of the manure.

The Cudworth project produces biogas through anaerobic digestion of hog manure produced by the Cudworth Pork Investors Group hog facility. The biogas is used to fuel a co-generation unit built and operated by SaskPower, producing electrical energy that is delivered into SaskPower's electrical grid.

Thermal energy from the electrical generator is captured and returned to Clear-Green. The biodigester uses a portion of the thermal energy and a portion is sold to the hog facility. The digested sludge is returned to the nearby EMS system. Further processing of the sludge into higher value fertilizer components is being evaluated. The biogas plant has been operating at steady state for about six months. Clear-Green estimates the plant has a seven year payback but would like to reduce this the payback period to four years.

Clear-Green uses an advanced Continuous Stirred Tank Reactor based on European biogas designs currently in place across Germany and Western Europe. They use a two-stage digestion process that operates in the thermophilic range (37ºC to 38ºC). The plant was constructed starting in September 2003 and began operating in January 2004. Full-scale gas production was achieved in May 2004 and the SaskPower turbines were launched into full-scale operation in June. It has been operating at a steady state since that time with only a few minor operational issues. The second phase of the project will proceed in the near future and they are now in the planning stages. Detailed testing has been undertaken to produce a refined ammonia-based fertilizer that can range from a 7-0-0 to a 15-0-0-type product that compares to synthetically produced fertilizers.

Their focus is not to sell turnkey plants to farmers. Their strategy includes:

- Form partnerships with waste producers to build operating plants where the company brings the technology, capital and operations (business model) and the waste producers supply the site, commit to a contract and can invest in the plant as a partner if they choose.
- They are interested in hog operations and all forms of livestock, but as a component, or one of the many waste suppliers, to the projects they expect to engage in the future. They do not discount the opportunity with plants that would only use manure as an input, but are aware that in most cases, there are additional substrates that can constitute an even better plant.
- Slaughter plants and food processors are a big part of their focus right now, simply because of the rapidly changing nature of the industry and the demand they are experiencing. They believe that this simply emphasizes

that the opportunity to produce energy and fertilizer from waste is a growing area.

■ New Integrated Waste Management Approaches (IWMS) – How are they Working?

Anaerobic digestion systems are well known and widely used throughout the world. The factor most strongly influencing the economic merit of an anaerobic digestion facility is maximizing the sales of all usable co-products. Advanced technology end-use applications can increase the economic value of biogas, but only after sufficient production scale has been achieved to significantly reduce the unit cost of ownership.

The use of more sophisticated anaerobic digestion processes for industrial waste treatment will increase. Anaerobic digestion can decompose some organic toxic and hazardous materials in co-digestion schemes and this potential will be realised. For the future, the driving forces for the use of anaerobic digestion will probably drift away from energy production. Organic stabilisation, pathogen reduction, and the production of a high-quality soil improver will be important reasons to use anaerobic digestion in developing countries. Energy savings in operation and minimal sludge production from anaerobic digestion versus aerobic treatment will become more important in energy and landfill deficient areas.

Companies such as Clear-Green Environmental, Home Farm Technologies and Bio-Terre Systems are the companies most likely to commercialize integrated waste management solutions. Individual hog enterprises are less likely to lead these types of projects; however, they may be willing participants as suppliers of hog manure and users of electrical and thermal energy. Also, they may be investors in biogas plants once the economics of these plants has been proven.

The location of integrated waste management plants will be a major factor in determining their economic success. Economic success is not guaranteed. Capital costs, availability and types of raw material, process control and management, competing energy prices, proximity to high energy consumers, environmental regulations, and innovation to develop new products with higher value are just some of the factors that will determine success or failure.

Disposal of manure from intensive livestock production is changing from what has been a problem to an opportunity. It will be innovation that drives these opportunities. Innovation generates options on future products and services. Successful innovation requires a well-developed capital market that allows people to invest in these possibilities to determine if they are home runs or just base hits. Innovative integrated waste management businesses are beginning

to attract the capital required to build and operate these facilities. The outlook is encouraging but it will not happen over night. At least we are heading in the right direction.

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