New Integrated Ethanol-Feedlot-Methane System
Under Development in South Dakota

From Philip Lusk, Resource Development Associates, Washington, DC

If the results of an ongoing feasibility study turn out as envisioned, corn and beef cows will be converted into value-added products at an innovative agricultural processing complex in South Dakota. The new system, under development by PRIME (Pierre Renewable Integrated Meat & Energy) Technologies, LLC, will integrate an enclosed custom cattle feedlot, an anaerobic digester, and a modified ethanol unit.

The PRIME complex will be a “closed-loop” system that produces beef, fuel ethanol, methane, and biochemical fertilizers. Each of the component technologies proposed for use is well proven on a “stand-alone” basis. However, none have previously been combined to fully capture their economies of scope through process integration.

PRIME’s first generation complex will consist of an ethanol plant with a capacity of 15 million gallons of ethanol per year, an adjoining feed yard holding 25,000 head of cattle with a closed manure collection system, and an anaerobic digester. The anaerobic digester will produce methane for use by the ethanol plant and biochemical fertilizers for use by farmers. The PRIME complex has the opportunity to substantially reduce energy and material inputs.

The proposed concept is ideal for small rural communities. Using a co-op style management corporation, the complex relies on local crops as the feedstocks for the fuel ethanol plant and local ranchers will provide the feeder cattle. Corn by-products from ethanol production are used as enriched cattle feed in the form of wet distillers grains and solubles (WDGS) that can replace more than 40% of the corn feed presently used. The WDGS will be fed in the adjoining and enclosed cattle feedlot. The WDGS feed mixture will increase cattle growth rates and reduce the use of hormones and antibiotics in the feed ration, while producing a higher quality beef.

Other system benefits include a reduction in environmental pollutants such as biochemical oxygen demand (BOD), pathogens, methane, ammonia, and nitrous oxide (N2O) emissions. Nutrient pollution will be decreased because nutrients will be captured for recycling as organic biochemical fertilizers. Preliminary estimates indicate that 16% less corn will be required by the integrated complex, which equivalently increases ethanol conversion efficiency from 2.6 gallons per bushel of corn to 3.1 gallons per bushel.

Despite the efforts of the research community to develop energy crops, corn remains the least-cost source of sugars for ethanol production today. However, the complex allows the use of emerging ethanol production technologies that convert the hemicellulosic fraction of agricultural residues (such as corn stover) into five-carbon sugars that can be fermented and distilled when it makes economic sense. The complex will benefit farmers and ranchers monetarily, as well as mitigate possible pollution problems. Moreover, rural economic development will benefit from the implicit multiplier effect resulting from the jobs directly created by implementing the proposed system.

PRIME officials recently announced that its project consortium is progressing on schedule to complete Phase II—a feasibility study—for the $40 million project. The agricultural processing complex will be located in Sully County, 15 miles north of Pierre, South Dakota, and will be one of the largest new operations of its kind in the state.

PRIME officials also recently confirmed the receipt of $800,000 in federal funding for the next phase of the project’s development. The funding provisions were contained in the final
appropriations bill of the 106th US Congress. The Federal funding will match $402,500 provided by the Governor’s Office of Economic Development (GOED) through the South Dakota Value-Added Ag Subfund.

In the October 10, 2000 announcement of the GOED decision, Larry Gabriel, South Dakota Secretary of Agriculture, said: “This project is a good opportunity for our beef and corn producers in that it allows them to capture almost 100% per cent of the value to their products.”

PRIME is a South Dakota limited liability company. PRIME founders are Dakota Ag Energy, Inc., the technology’s owner, headquartered in Sioux Falls, SD, and J.E.S. Farms, owner of a 17,000 acre irrigated corn and cattle operation in Sully County, SD.

At project completion, PRIME ownership will include a farmer-owned cooperative, ranchers, agri-business interests, and initial investors, in a structure that will fully conform to South Dakota’s Amendment E requirements. (Amendment E is intended to maximize farmer and rancher ownership in new agri-business enterprises in South Dakota.)

An important aspect of the technology is the discovery that the high-protein "spent grains" from the ethanol unit, when fed in high concentrations to ruminant animals (both beef and dairy cattle), substantially improve feeding efficiency and beef or milk output. A 10% or more increase in feeding efficiency saves about 16% of the corn used to meet the needs of the system. This is corn that can be used to produce more ethanol in this or another PRIME complex. Incorporating cellulosic biomass represents another savings of corn, corn that can be used to meet the needs of this or another PRIME facility. The marketing of carbon credits potentially provides further protection in times of economic stress.

The elimination of the protein drying section substantially reduces ethanol plant capital, operating, and energy costs. These savings can then be re-invested in the customized, enclosed cattle feedlot and anaerobic digestion plant. These additional components make cattle feeding cost competitive in South Dakota’s climate, and virtually eliminate feedlot odors and water and soil contamination.

The anaerobic digester replaces traditional animal waste storage tanks and lagoons, a major cause of pollution and feedlot odor. The digester takes a disposal problem and potential pollution source (manure) and converts it into biogas and slurry called digestate. The biogas contains approximately 60%-70% methane and is water saturated. The balance of the biogas mixture is CO2, and some parts per million of hydrogen sulfide (H2S). The biogas will be used to meet the majority of the ethanol plant’s internal energy requirements.

Digestate contains a recoverable solid fiber with physical attributes similar to those of a moist peat moss, and will have a total solids concentration of 35%-40%. After separation in a processing facility, the fiber will be combined with appropriate admixtures and composted in windrows for 5-10 days until final maturation. After final maturation, the composted fiber product will be hauled off-site for use on the lands of participating farms as a soil improver.

After the fiber is removed, a liquid fraction called "filtrate" is created. A portion will be recycled as make-up water for the AD plant. Filtrate can be spread directly onto farmland for its nutrient value, and has combined nitrogen, potassium, and phosphate (N-P-K) percentages ranging from 3%-4.5% on a dry matter basis. The filtrate will be pumped into a special storage system sized to hold 12 months worth of liquid. The liquid can be shipped to participating farms for use as an organic nutrient. If markets could be developed, some of the filtrate could be used to create bottled or bulk nutrient products with additional processing.

If warranted, these biofertilizers can also be enriched with minerals and microorganisms and customized to enhance a region’s depleted soil. Surface application of the biochemical fertilizer from the PRIME complex also allows the use of low input farming practices, as opposed to the
more energy intensive plowing practices. This significantly reduces fossil fuel use, and further augments carbon sequestration, helping to prevent soil erosion.

“In order to take advantage of the powerful synergies of this integrated process, we must combine several different disciplines and types of expertise”, noted the PRIME project director, Victor W. Schlesinger, Omaha, Nebraska. “We believe that we have assembled the most experienced, and qualified, firms from these various disciplines, and that this project will substantially benefit from their knowledge.”

The PRIME consortium includes the following firms: Katzen International Inc., Cincinnati, OH (ethanol design and engineering); Agricultural Engineering Associates, Inc., Uniontown, KS (feedlot design and civil engineering); Dr. Terry Klopfenstein, University of Nebraska-Lincoln Animal Sciences Department (ruminant animal nutrition); Saunders County Feeders, Mead, NE (enclosed cattle feeding); Resource Development Associates, Washington, DC (anaerobic digestion & bio-fertilizers); Biorefiner, Washington, DC (biorefineries & greenhouse gas reduction); and Dakota Ag Energy, Inc., Sioux Falls, SD (technology development & project financing).

“This marriage of cattle feeding with ethanol production is long overdue”, said Pat Tracy, manager of J.E.S. Farms. “It value-adds South Dakota’s two largest industries, and will bring new investment and quality jobs to our rural communities. With projects like this one, South Dakota’s farmers and ranchers can break the vicious spiral of lower and lower commodity prices, and participate in a profitable processing venture.”

The first PRIME complex is projected to be on-line in early-2002. It will create up to 50 quality direct jobs, process approximately 8 million bushels of corn annually, and will have a feedlot capacity of approximately 25,000 head (over 60,000 head of finished cattle on an annual basis).

As the process is successfully demonstrated, project sponsors expect to build more of the integrated complexes throughout South Dakota and other Northern Plains states. PRIME officials say that almost 40 PRIME facilities, each with 15 million gallons of ethanol capacity, would be needed in South Dakota alone to utilize all the corn grain currently shipped from the state.

Perhaps the best feature is the projected economics for PRIME facilities. Because of proximities and integration of its components, PRIME complexes are economically attractive with an estimated Internal Rate of Return (IRR) that exceeds 25%. This is achievable because of economies of scope and scale. A PRIME complex can reduce commodity transportation costs, reduce ethanol plant capital and operating costs because it is no longer necessary to dry the distillers grains, permit the co-utilization of facilities, equipment and personnel, and allow for the reuse of energy, water and nutrients throughout the system.

On top of this, by capturing and reusing effluents, PRIME officials say it is possible to have their facilities achieve “zero discharge” status. This significantly decreases the harmful environmental impact of some of today’s current practices.

For additional information on PRIME, contact Vic Schlesinger, PRIME Project Director, 10906 North 61st Street, Omaha, NE 68152-4234; phone +1 402 572 5649.