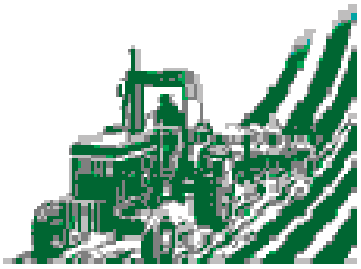
THE CONTRIBUTION OF AGRIBUSINESS TO POLK COUNTY, FLORIDA

SUPPLEMENT 5

BIO-ENERGY, BIO-FUELS & BIO-WASTE-REMOVAL

Can These Green Technologies
Be Used as New "Crops" to Expand Agriculture's
Economic & Social Contribution to Polk County?



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Can These Green Technologies
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Polk County Farm Bureau

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OVERVIEW

SEVERAL NEW TECHNOLOGIES MAY OFFER OPPORTUNTIES to increase the profitability of Polk County's agricultural operations – and greatly expand its social and economic contributions to local communities.

These technologies would create:

> *Bio-energy* – production of power through a conversion process – such as by burning wood or by using bacteria in a "digester" – to release energy from plant-derived material.
>
> *Bio-fuel* – a renewable alternative for liquid transportation fuel produced from plant-derived materials.

These technologies also can provide:

> *Bio-waste-removal* – Some technologies can convert urban and industrial wastes into power and liquid fuel, thus providing an environmentally beneficial, cost-effective alternative to existing disposal methods.
>
> Green, living plants also can be used as filters to remove pollutants and contaminants from soil and water through a process known as *phytoremediation*. The plants disperse some pollutants and contaminants through photosynthesis. Some are used by the plant as growth enhancers, and thus are rendered harmless and turned into cellulose. Some accumulate and are sequestered by the plants. The plants then can be harvested and used to produce power or liquid fuel, thus permanently removing sequestered contaminants from the environment.

These technologies offer the opportunity for Polk County, the state of Florida and the entire U.S. to achieve energy independence, where renewable crops and the wastes of our society can be converted to liquid fuel, steam, hydrogen and electricity.

Many of these "green" technologies still are in their nascent, experimental stages. Some are in limited commercial production, but have yet to be widely accepted because improvements still are needed to make them fully viable and competitive with existing technologies.

Two technologies, however, are ready for Polk County to use right now. Moreover, these technologies offer the opportunity to grow profitable crops on exiting ag lands, limit the impacts of human activities on the environment, accommodate new development in more cost-effective ways, and create new jobs.

At the same time, successful implementation of these technologies could catapult Polk County into the forefront of national efforts to utilize emerging technologies to create new, ongoing sources of revenue for agricultural operations, incorporate agricultural operations into the developed landscape, promote energy independence, and improve the environmental quality of our communities.

THE NEED

With the onset of Citrus Canker, with new insect pests and diseases appearing almost annually, with the recent spate of major storms and with the advent of urban sprawl, it is apparent that Polk County's – and indeed all of Florida's – traditional agricultural cropping systems and land management techniques are in transition.

New strategies for generating income from these "transition acres" and from the adjacent agricultural land must be developed if the lands are to be retained as green spaces or until other beneficial and profitable uses become apparent.

As citrus grove after grove is being ripped out, bewildered and dismayed landowners are faced with limited options for what to re-plant. Few crops have sufficient economic value to replace citrus. Moreover, virtually no existing commercial crop can generate sufficient revenues to compete with the rapidly appreciating values of land for development.

New ideas and new cropping systems are needed to fill the void being created by disease, pests, the regulatory environment and urban encroachment.

The county's rapid development is creating a set of complex challenges and choices as well. As new residents move into the county, they need new houses, new roads, new schools and new services. The influx of people, ideas, and revenues has a positive impact on the county. But there are negatives as well: more energy and fuel is needed and more wastes are produced. As a result, impact fees and taxes have been rising in an attempt to pay for the services needed by new residents and to expand the infrastructure to dispose of wastes.

THE OPPORTUNITY

A demonstration project is being developed to produce bioenergy and biofuels and implement bio-waste-removal on a pilot basis in St. Lucie County. The project is being built around an innovative land use plan for Adams Ranch and Cloud Grove, using the Rural Lands Stewardship Program. A similar project could be launched in Polk County.

This project would create a profitable "bio-cropping" and "waste-to-energy" system that addresses, long-term, the disposal of urban and industrial wastes and the creation of clean renewable energy from new cropping systems, thereby creating a method for the profitable retention of agriculture and green space in Polk County.

The goal is to develop expertise in feedstock production and biomass utilization that will:

- Reduce environmental impacts of human activities,
- Keep agricultural lands economically viable and in production,
- Utilize publicly-owned lands as a source of biomass materials,
- Produce bioenergy and biofuels in an economical, efficient and sustainable manner using gaseous substrate fermentation, and
- Create a model that can be adapted to localized conditions by others.

THIS PROJECT WILL HAVE SEVEN OBJECTIVES:

OBJECTIVE 1: Use existing technologies as the basis for creating a profitable "bio-cropping" and "waste-to-energy" system. For nearly 40 years, Dr. Gordon Prine of the University of Florida developed plant species for the production of high volume biomass. Dr. Prine called one of these plants "energy cane." Energy cane is a high biomass per acre producer. At the time, this cropping system did not flourish, due to cheap coal, cheap fuel, and a vibrant citrus industry. That was then. Now "energy cane" offers a practical "transition" crop that can replace citrus groves lost to canker and be used to produce bioenergy and biofuel.

Pasture grass expert Dr. Paul Meslevy of the University of Florida's Ona, Florida experiment station also can contribute plant species that can be employed in a wide array of growing conditions to produce biomass.

In addition, an existing "synthesis gas fermentation" technology can profitably convert municipal solid wastes (MSW) into liquid and electric energy, thereby alleviating urban solid waste and biosolids disposal problems. This process also can be used in conjunction "urban water re-use" strategies, thereby allowing for the low cost expansion of the infrastructure to accommodate waste water treatment systems.

OBJECTIVE 2: Investigate an array of bio-crops and cropping systems using alternate crop materials, production methods and harvesting techniques to find the crops and cropping systems that will:

- have the highest degree of compatibility with localized environmental features,
- require the lowest number of inputs,
- return the highest possible yields per acre per year, and
- produce the highest BTUs per pound or kg.

The investigating team includes six plant pathologists, including one of the leading small grains experts in the Southeastern United States and a national leader in the implementation of prevention-based Integrated Pest Management systems who has served for more than a decade as a member of the National Sustainable Agriculture Advisory Council, including two years as chair, and who heads up the largest crop consulting firm in Florida. The investigators have access to 100 University of Florida scientists who are available on an immediate phone recognition basis and 45 other

scientists at 30 other universities and the U.S. Department of Agriculture. The investigators also have access to an established network of research farms and stocks of plant cultures with well-documented properties for use in the project.

OBJECTIVE 3: Develop cropping systems that will serve as waste disposal and waste removal technologies to augment or replace traditional solid waste, wastewater and stormwater treatment facilities. These systems will include the use of created wetlands and phytoremediation cells, where plants are used as natural living filters to remove pollutants, and where the plants are harvested on a regular basis to eliminate sequestered contaminants, thus providing a source of biomass for the production of biofuels.

One of the project cooperators is the leading U.S. company in the design and operation of phytoremediation projects. Its plant- and soil-based systems have been used for a host of successful projects that have garnered national awards and widespread approval from regulators and the communities in which they serve. Moreover, its top national expert in the application of these technologies is based in Tampa.

OBJECTIVE 4: Investigate ways in which other waste streams and environmental pollutants can be collected, using existing collection and disposal systems, and fed into the biostream.

OBJECTIVE 5: Incorporate Florida's innovative, new rural land use program – the Rural Land Stewardship Program, chapter 163.3177(11)(d), Florida Statutes. The St. Lucie County project site is centered on Adams Ranch, selected by the cattle industry as one of the eight "ranches of the century" to celebrate the millennium by showcasing the very best national examples of cattle production practices that combine animal husbandry and production skills with environmental stewardship.

The 23,000-acre Adams Ranch and nearby Cloud Grove, site of an innovative new town that will be built from the ground up, with homes, businesses, offices and municipal services for 20,000 people, are part of an innovative experiment by St. Lucie County to use the Rural Lands Stewardship Program (RLSP) to accommodate development pressures and promote more concentrated, compact settlement patterns while preserving important environmental resources and open space.

The RLSP sets up a mechanism whereby natural resource values on a property are assigned a market value that allows them to compete effectively with other types of land uses. Moreover, the RLSP provides landowners with a means of obtaining this enhanced value from market place transactions in return for protecting natural resources and transferring certain rights of use and entitlements to another parcel of property where development can take place. This allows the RLSP to:

- accommodate development in more environmentally compatible patterns;
- protect large areas of environmentally sensitive lands at very little or no cost to the public; and

- be established and funded through private investment and market economy transactions.

This is only the second time that Florida's new RLSP statute has been used. The RLSP project is being closely watched by other counties, both in Florida and in other states. Successful implementation of the Adams Ranch/Cloud Grove RLSP will promote widespread adoption of the RLSP in other parts of Florida, and its adoption or adaptation as a "smart growth" tool in other states. This project will expand on the RLSP by developing practical ways to use feedstock production and biomass utilization to:

- limit environmental impacts of settlements, and
- generate an ongoing cash flow from open space.

OBJECTIVE 6: Utilize public lands as a source of biomaterials. The project team will explore opportunities to allow private parties to enter into long-term leases to remove exotics, invasive species and windfall from public lands, and to grow and harvest plants well-suited as feedstocks for the production of biofuels and power. Methods will be developed as part these leases to ensure that the uses of these lands are consistent with the guidelines and management purposes of public lands, and environmentally compatible with all natural functions.

OBJECTIVE 7: Establish a pilot facility and end-to-end demonstration project to incorporate Objectives 1-6 above and produce economical sources of biofuel, bioenergy and bio-waste-removal.

THE TECHNOLOGY

Dr. James Gaddy of Bioengineering Resources, Inc. (BRI) of Fayetteville, Arkansas has been working for the past 15 years on a renewable liquid fuels technology. This technology converts any organic waste material or hydrocarbon into ethanol. It also creates low-cost electricity as a by-product of the process.

The BRI process (gaseous substrate fermentation) can take crop residues, wood wastes, indeed any carbonaceous materials or wastes, convert them to gas, and feed the gas to a bacterial culture that will create a renewable liquid fuel, ethanol. This process is more than a possibility. It has been operating for four years in a pilot facility at the University of Arkansas, and will go into commercial production in 2006.

BRI's patented biocatalytic process offers the opportunity for renewable crops and the wastes of our society to be converted into liquid fuel, steam, hydrogen and electricity. This process is unique:

- The BRI Process involves the fermentation of syngas. Unlike other fermentation technologies, the bio-catalytic process is highly selective and produces only ethanol, resulting in very high yields while avoiding costly additional processing to separate ethanol from other lower grade products.

- Feedstocks need not be chipped, shredded or sorted to remove metal and glass; different feedstocks also can be blended.
- Ambient temperature and pressures are used, and capital and energy costs are minimized.
- The cooling of the syngas exiting the gasifier creates the opportunity to produce steam and generate electricity. In general, this can supply 50 M BTU per gallon of ethanol produced.
- The waste streams require minimal treatment. A small non-hazardous ash stream (5-10% of the raw material) comes from the gasifier and can be land filled, or if resulting from agricultural feedstocks, can be land applied. There is also a small purge of spent cells from fermentation that either goes to wastewater treatment or is recycled back to the gasifier.
- The BRI reaction time in the fermentation vessel is a matter of a few minutes. This compares well with the long reaction time of 36-48 hours for the other processes currently in use. Also sterilization is not necessary, since the CO in the syngas eliminates most contaminants.

Chemistry: The overall chemical reaction during the gasification of biomass can be approximated as the partial oxidation of carbohydrate (cellulose) as follows:

(1) $8CH_2O + O_2 + 4N_2 \rightarrow 6CO + 2CO_2 + 8H_2 + 4N_2$

The above equation is typical of an air blown gasifier, with nitrogen present in the effluent. If pure oxygen is used, nitrogen is eliminated. Steam also may be used as the oxidizer, producing a gas richer in hydrogen. The CO, CO_2 and H_2 are then converted by proprietary microorganisms to produce ethanol by the following equations:

(2) $6CO + 3H_2O \rightarrow CH_3CH_2OH + 4CO_2$

(3) $6H_2 + 2CO_2 \rightarrow CH_3CH_2OH + 3H_2O$

All of the carbon and hydrogen in the initial raw material could be converted into ethanol; hence yields are quite high. Combining equations (1) - (3) gives:

(4) $8CH_2O + O_2 + (4N_2) \rightarrow 2.33\ CH_3CH_2OH + 3.33CO_2 + H_2O + (4N_2)$

From Equation (4), the maximum theoretical yield of ethanol is computed to be 135 gallons per dry ton of carbohydrate. By comparison, hydrolysis/fermentation processes which convert only the cellulose and, possibly the hemicellulose, have maximum theoretical yields of about 85 gallons per dry ton. Equation (4) shows a 60% carbon to ethanol yield with an oxygen blown gasifier. From Equations (2) and (3), it can be shown that with a 2:1 hydrogen-to-CO ratio in the syngas, the process becomes CO_2 neutral, and only ethanol (no CO_2) is produced by the fermentation.

IS GARBAGE A CROP?

Inasmuch as we know it is wrong, the piling up of garbage is hugely profitable in the short term. Indeed, the disposal of wastes in landfills creates so much short-term wealth

that, in order to displace this system, we must be able to demonstrate how to replace this revenue source. After all "if it don't make money it don't make sense."

Polk County is no different than anywhere else in this regard. The bottom line is, a landfill that generates about $12,000 a day in revenue to the County must be jealously protected. The project team understands this.

What is proposed through this project is a public-private partnership that will reduce public waste disposal costs and generate new revenue sources to offset the county's income from landfill operations.

This project will show how, through avoided costs, revenue sharing and negotiating an advantageous liquid fuels contract for the various municipalities all parties can benefit from partnering in a "waste-to-energy" project.

The project team also can negotiate a highly favorable, hedged "steam contract" with the county's processing plants to shield them from price spikes in gas supplies. This is a principal cost component in the operations of these facilities. There also is the possibility of providing electric power in return for the guaranteed long-term delivery of a portion of the citrus wastes that are generated, turning an expense item into a profit center, thereby helping to assure the continued presence of these companies in the community.

CAN POLK COUNTY GROW ITS OWN ENERGY & FUEL?

The technologies being used in this project offer a way to convert the organic wastes of today's society into a feedstock that can fuel future energy needs.

ETHANOL - A LOGICAL FUEL ALTERNATIVE

Fossil fuel-based gasoline is the world's largest source of man-made carcinogens and the number one source of toxic emissions. Ethanol is a logical alternative to petroleum based fuels. It is a sustainable resource that contributes to energy independence by allowing countries to produce green energy from their own renewable resources.

Ethanol is already being used around the world in gasoline blends of 10-85%. Vehicles running on blends of ethanol and gasoline, using ethanol as an oxygenate, produce 20% fewer harmful emissions than vehicles burning gasoline alone. Ethanol also improves octane performance.

Ethanol is the best alternative to replace MTBE, the current oxygenate mandated for us with gasoline in heavily populated areas that experience air quality problems. Within five years MTBE will be totally banned from use by the federal government. Many states have already banned MTBE and have turned to ethanol to meet the oxygenate requirements imposed by the government. California alone used close to one billion gallons of ethanol in 2004.

During the past 25 years, government and private industry in the United States have spent $9 billion attempting to develop economic and environmentally sound methods for the

creation of fuel from biomass. To date, ethanol has been produced chemically from ethylene or biologically from the fermentation of sugars from carbohydrates found in agricultural crops like corn. Sugar fermentation has, thus far, been the only technology to commercially produce ethanol from biomass, but it is only marginally profitable.

The BRI Process is an economically viable technological leap that creates ethanol (as well as hydrogen and electricity) from carbon-based matter. BRI's Renewable Energy Process could expand the world's supply of electrical energy, supplement gasoline and significantly reduce dependence on oil.

BRI PROCESS BENEFITS

The BRI Process makes possible the co-production of electricity and ethanol from any carbon based materials including feedstock found in the following categories:

- Municipal solid waste
- Biosolids found in sewage treatment sludges
- Agricultural residues
- Timber and wood waste
- Used tires or plastics
- Coal, natural gas and other hydrocarbons
- Crops grown specifically to produce biomass

Carbon-based feedstock from existing wastes represents one of America's most promising domestic renewable energy sources. Over 1.5 billion tons of forestry, agricultural and municipal solid wastes are created in the U.S. each year. With a reasonable conversion efficiency, these residues (many of which create serious disposal problems) could supply 10 percent of America's fuel and energy needs.

Currently, the U.S. produces about 3.4 billion gallons of ethanol annually, which is blended at a rate of 10% with gasoline to reduce pollution. The amount of ethanol that can be produced from corn will meet only 4% of America's needs based upon a blending ratio of 10%. The BRI Process can make this difference. In addition, for every 1,000,000 gallons of ethanol produced by the BRI Process, a carbon credit of 6,000 tons is earned towards reduction in greenhouse gasses.

CONCLUSION

This project will demonstrate ways in which Polk County's green spaces, its ability to utilize urban waste water, its ability to dispose of wastes in a non-polluting facility and its ability to generate renewable power and fuel can be used both to accommodate rapid urbanization and to limit the impacts of human activities.

This project also will develop guidelines, tools, and management systems that provide a basis for decisions on land use, and for evaluating the technical and economic viability of biomass production, markets, and revenue streams for local areas.