FARM to FLY FLORIDA
FEASIBILITY STUDY REPORT

FARM to FLY
FROM THE GROUND UP

TCERDA
Treasure Coast Education, Research & Development Authority

USDA Rural Development
Committed to the future of rural communities.

ACKNOWLEDGEMENTS

The Treasure Coast Research Park would like to acknowledge the participation of project stakeholders from growers to end users, from St. Lucie County, the State of Florida and throughout the United States and in allied countries involved in the search for and optimization of pathways to sustainable fuel and co-product production. Special Thanks to:

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1.0 EXECUTIVE SUMMARY

The Treasure Coast Education and Research Development Authority (TCERDA) undertook a study, with grant support from the USDA Florida State Rural Development Office, to examine the economic viability of developing a partnership to create a sustainable alternative jet fuel (SAJF) supply chain in South Florida. More than a feasibility study, this research included a preliminary investigation into the economic, social and environmental sustainability of cultivation and processing of industrial sugar and starch row crops including beets, tubers, sweet sorghum and cane to produce SAJF and certain intermediate and coproducts, including ethanol, renewable diesel, dairy cattle feed and others.

The study actively brought together stakeholders in the proposed supply chain(s) to define success for this feasibility study and the creation of a commercial- scale South Florida SAJF and bioproducts industry. The key stakeholder groups were actively engaged throughout the study through regular phone calls and quarterly meetings. It is the project stakeholders' views, priorities and actions that guided the feasibility study to successful conclusion and set the stage for ultimate project success.

This study concludes that the creation of an SAJF supply chain in South Florida is indeed attainable and could create numerous economic, social and environmental benefits.

This study concludes that the creation of an SAJF supply chain in South Florida is indeed attainable and could create numerous economic, social and environmental benefits. The model developed during the study contemplates a five-stage (year) timeline to scale-up to 200 million gallons of annual SAFJ production with economic impacts in the range of 35,000 jobs and $3 Billion annually. Further, the model accounts for the potential to partner with one or more fuel producers applying different technologies and pathways, but ultimately producing precursor fuels and/or SAJF at scale. Significant components of the economic benefits are modeled to come from revenue generated from the sale of an intermediate-product, beet mash, as a local, nutritious dairy cattle feed.

One of the ultimate, key measures of sustainability and success - as defined by many of the key stakeholders - is the maintenance of land currently in agriculture production for that purpose. The scale-up of an SAJF industry provides a real opportunity to avoid large-scale land conversion in the face of the citrus greening blight currently devastating growers in Florida. Further, South Florida SAJF industry scale-up provides real potential to mitigate two of the highest priority environmental issues of concern to stakeholders – climate change and local water quality.

This study report describes the backdrop for, the pathway to, and the sustainability implications of capitalizing on the SAJF and bioeconomy opportunity in South Florida.

2.0 INTRODUCTION

a. LOCAL CONDITIONS

- Economic and social impacts of the citrus greening blight
- Risk of land conversion and overdevelopment
- Opportunity to preserve citrus farming and diversify agriculture
- Water quality and ecosystem health concerns

During the last several years, South Florida has emerged as a headline location where both agricultural challenges (loss of the citrus crop to insect infestation) and environmental challenges (algae bloom pollution over a broad coastal area) have emerged as twin crises in Florida's efforts to fuel its sustainable development.

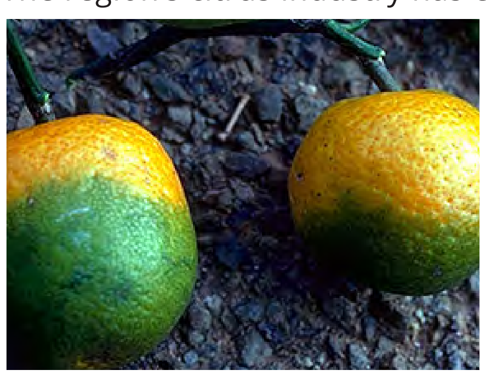
Mike Adams
TCERDA Board Chair & Owner, Adams Ranch

"2016 has been an exciting year of exploration and learning. This is a dynamic group of professionals moving this project forward towards a solid, sensible and sustainable future."

- Mike Adams, Adams Ranch, Owner

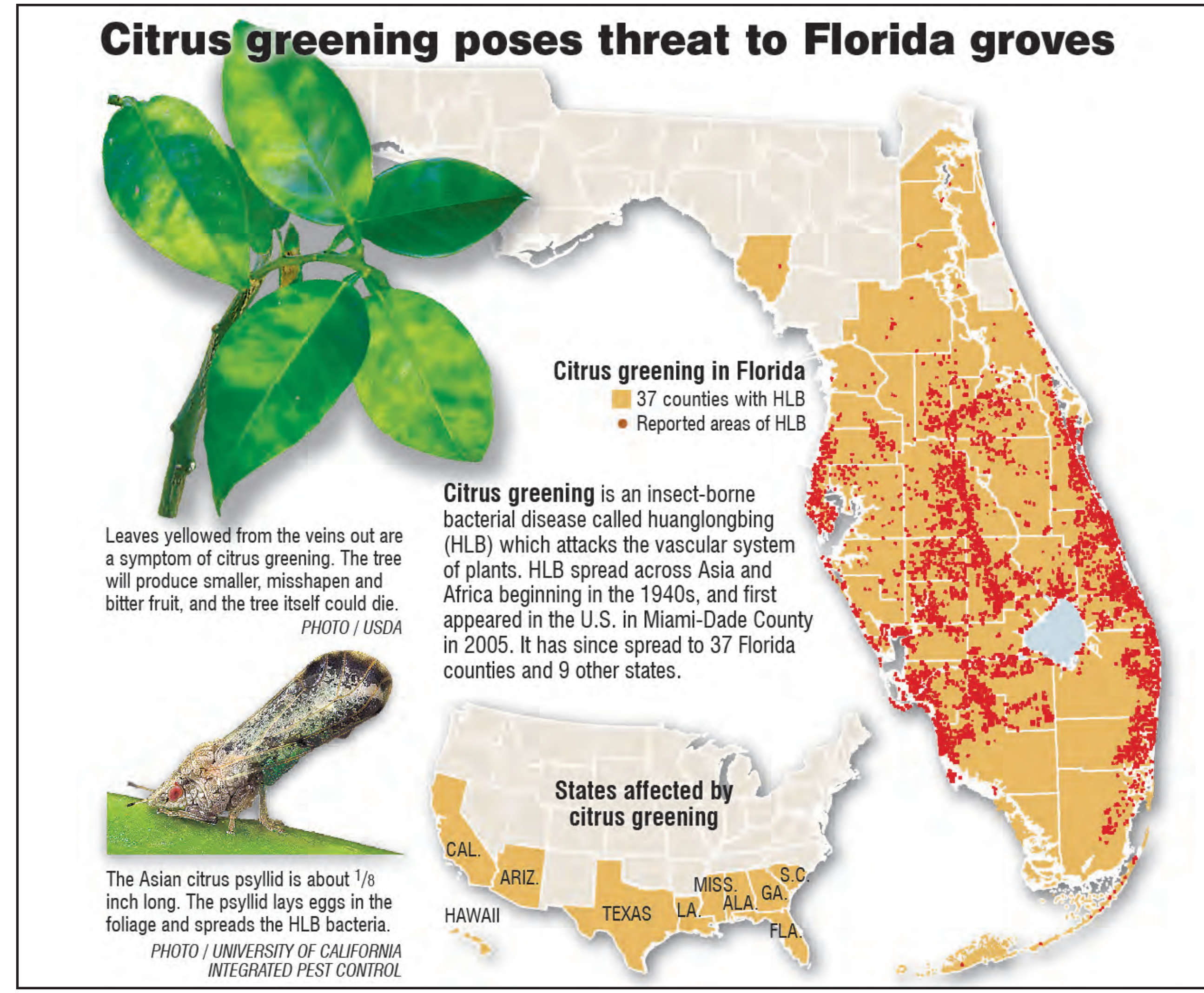
CITRUS GREENING

The region's citrus industry has experienced a 75% loss in crops, due to the devastating effect of insect infestation and associated greening. Given there appears to be no cure or opportunity to reverse the damage done by greening, creation of a vibrant industrial sugar and starch crop industry could diversify farmers' revenue-generating opportunities while complimenting efforts to protect the unblighted citrus groves, thereby boosting the region's agricultural economy and keeping land in agricultural production.



Source http://postonpolitics.blog.mypalmbeachpost.com/

Without this kind of large-scale relief, the sale of citrus-producing land for conversion to residential, commercial and industrial uses and the loss of young farmers in the state to other occupations and regions of the country is a foregone conclusion. The SAJF and bioeconomy markets for these crops can render the use of blighted lands for agriculture production attractive again, reinvigorating the local economy through the profitability of growers and creation of significant job growth in South Florida rural communities.



source http://extra.heraldtribune.com/

Rick Minton,
Former TCERDA Board Chair

"There will be some dynamics to this program which are unknown at this point. I see the farmers and ag from our community becoming invested in the process. It's a higher value-added crop to augment the cattle business which can be up or down. Citrus used to do that and this can supplant that. In the meantime, there may be some varieties of citrus that are a solution to greening and canker."

- Rick Minton, Former TCERDA Board Chair

THE INDIAN RIVER LAGOON

Nestled within the Treasure Coast's east coast and a string of barrier islands is the beautiful Indian River Lagoon (IRL). This diverse, shallow estuary is where salt water from the Atlantic Ocean blends with freshwater from the land and tributaries. The 156-mile-long waterway stretches from Ponce de Leon Inlet in northern Florida's Volusia County down to the southern boundary of Martin County. This lagoon is home to a rich array of plants and animals.

The lagoon is a critical water body in the state and has experienced excess nutrient pollution in addition to excess freshwater flows for many decades. Approximately 47,000 acres – which equates to about 60% of the lagoon's seagrass coverage - has been lost since 2011 due to a problem with "superblooms" and brown algae. This led to the loss of 135 manatees, 300 pelicans, and 76 dolphins, not to mention roughly a half a billion dollars' worth of seagrass.[1]

Source http://www.sjrwmd.com

In addition to the devastating loss of animals, an economic trickle-down effect has hit area businesses hard. The lagoon supports a multitude of industries and activities, from fishing and recreation to tourism and agriculture. A study concluded that the economic benefits of the Indian River Lagoon totaled more than $3.7 billion in 2007 alone and accounts for 15,000 jobs. The charter fishing, tour companies, and hospitality businesses have turned to the government for answers. Among these answers is the reduction of run-off from fertilizers into the estuaries—nutrients that many claim come from citrus- growing operations. Preliminary indications are that sugar beet production can mitigate excess nutrient runoff water pollution, due to greater nutrient retention during the intercropping period.

Source http://postonpolitics.blog.mypalmbeachpost.com/

Algae bloom in Indian River Lagoon

Source http://www.floridatoday.com/

Ben DeVries
Former CEO & Executive Director
Treasure Coast Research Park

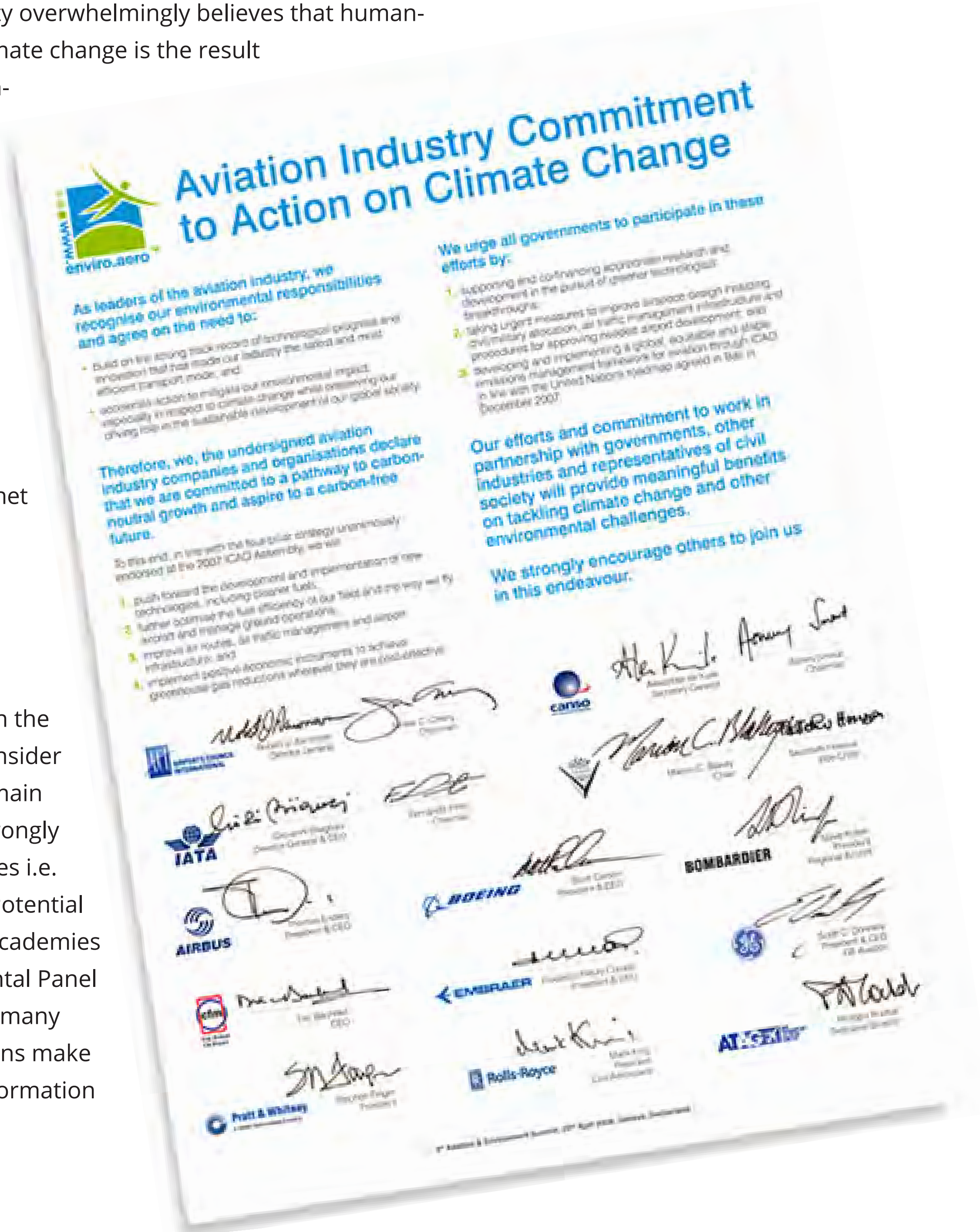
> *"Building a SAJF supply chain in Florida will meet the needs of Florida's expanding commercial aviation, Florida's farmers, and help clean up Florida's rivers and estuaries."*
>
> *- Ben DeVries*
> *Former CEO & Executive Director*
> *Treasure Coast Research Park*

[1] Waymer, Jim and Walters, Tim. "Indian River Lagoon: What went wrong?" Florida Today Online. May 2, 2014.

NATIONAL AND GLOBAL REALITIES

- Climate change science and policy
- Aviation's climate change commitments and the role of sustainable alternative jet fuels

The global, scientific community overwhelmingly believes that human-induced, or anthropogenic, climate change is the result of human activities and human-induced climatic dynamics that have resulted, and will continue to result, in an accumulation of greenhouse gases (GHGs) in the atmosphere. GHGs, while necessary to sustain life on earth, are accumulating at an accelerated rate in the atmosphere that is resulting in the gradual warming of the planet and causing climate change. GHGs include: CO_2, CH_4, N_2O, and fluorinated gases. While CO_2 makes up the majority of anthropogenic GHG emissions (80%+) and is most abundant in the atmosphere, one must also consider how long the various gases remain in the atmosphere and how strongly they impact global temperatures i.e. consider the Global Warming Potential (GWP). The EPA, the National Academies of Science, the Intergovernmental Panel on Climate Change (IPCC), and many other agencies and organizations make publicly available reference information on climate change.


Aviation Industry Commitment to Action on Climate Change

enviro.aero

As leaders of the aviation industry, we recognise our environmental responsibilities and agree on the need to:

Therefore, we, the undersigned aviation industry companies and organisations declare that we are committed to a pathway to carbon-neutral growth and aspire to a carbon-free future.

We urge all governments to participate in these efforts by:

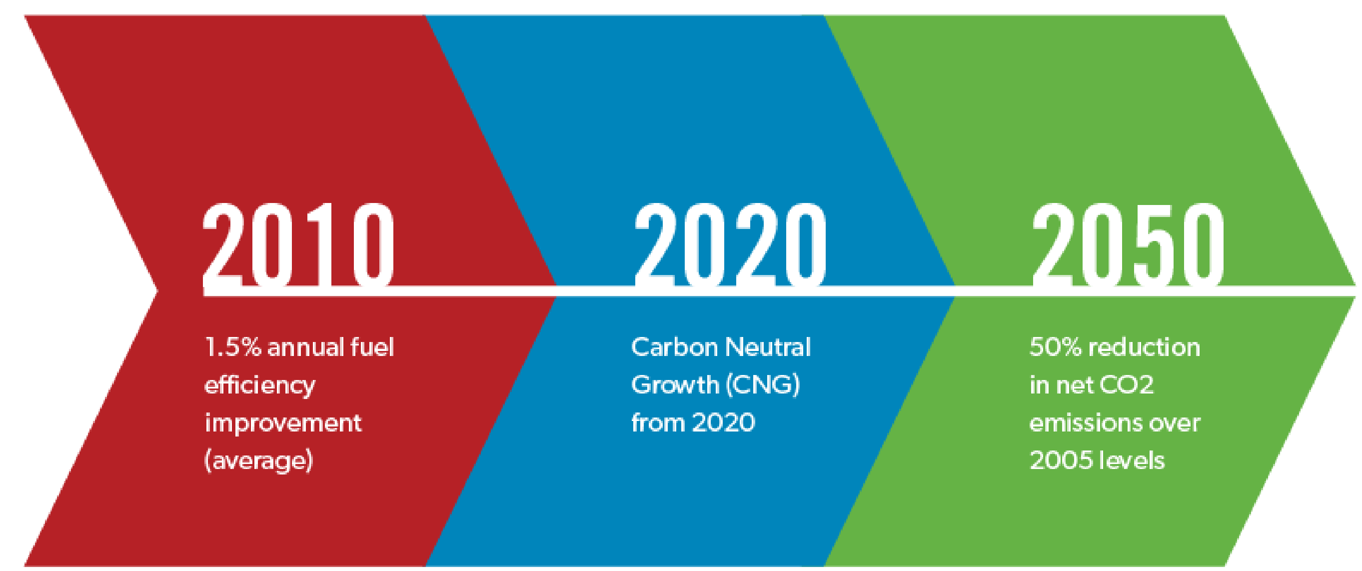
Our efforts and commitment to work in partnership with governments, other industries and representatives of civil society will provide meaningful benefits on tackling climate change and other environmental challenges.

We strongly encourage others to join us in this endeavour.

It is understood that jet fuel consumption accounts for approximately 4% to 5% of global GHG emissions today.[2] As aviation grows and is projected to continue to grow, at an annual average rate of around 5%[3], the emissions growth trajectory raises substantial concerns and has driven a robust, long dialogue and significant work by the airline industry and global policy makers on how best to mitigate the industry's carbon footprint. This work has driven an intense, decade-long focus on the development and commercialization of sustainable alternative jet fuels (SAJF), which typically deliver lifecycle GHG emission reductions in the range of 50% to 90% relative to conventional, petroleum based jet-fuel.

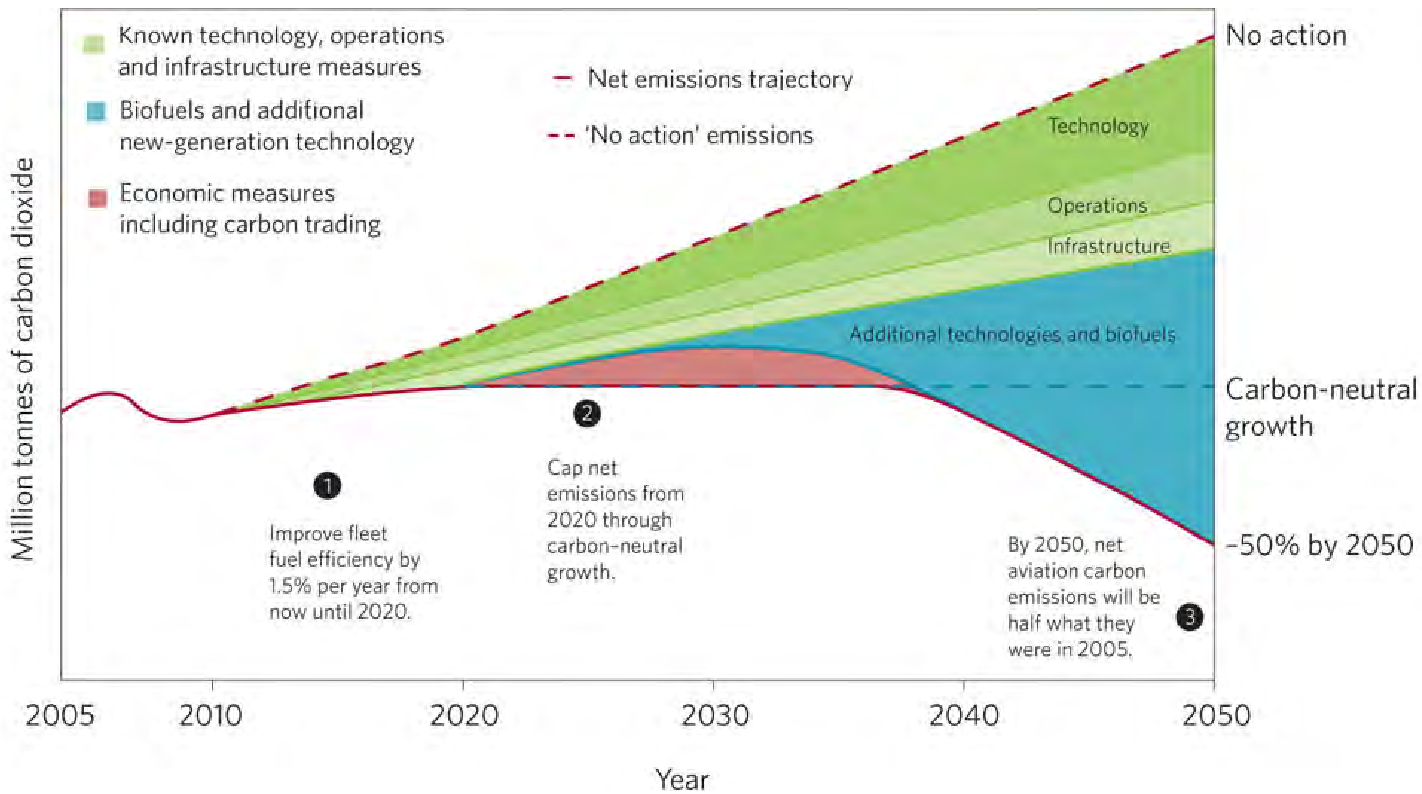
The focus continues to intensify as the industry anticipates how it will meet its climate change commitments, including global carbon neutral growth from 2020 and 50% reduction in emissions by 2050, relative to a 2005 baseline.

All indications are that the industry will only accomplish its carbon goals if alternative sustainable aviation fuels become readily available and cost competitive by 2030. Further, the International Civil Aviation Organization (ICAO) - the United Nations specialized agency tasked with establishing and enforcing global aviation standards - is moving steadily in the direction of approving a global carbon neutral growth scheme that will start in 2020 (CNG2020). The scheme was approved in October of 2016; it is a foregone conclusion that it will include a mechanism for airlines to take credit for emissions reductions from SAJF in meeting GHG emissions reduction requirements–in effect providing an additional, global economic incentive for the production of SAJF.



[2] Ross, Dr. Davide. GHG Emissions Resulting from Aircraft Travel v 9.2 6 May 2009. http://www.carbonplanet.com/downloads/Flight_Calculator_Information_v9.2.pdf, accessed 16 September 2016.

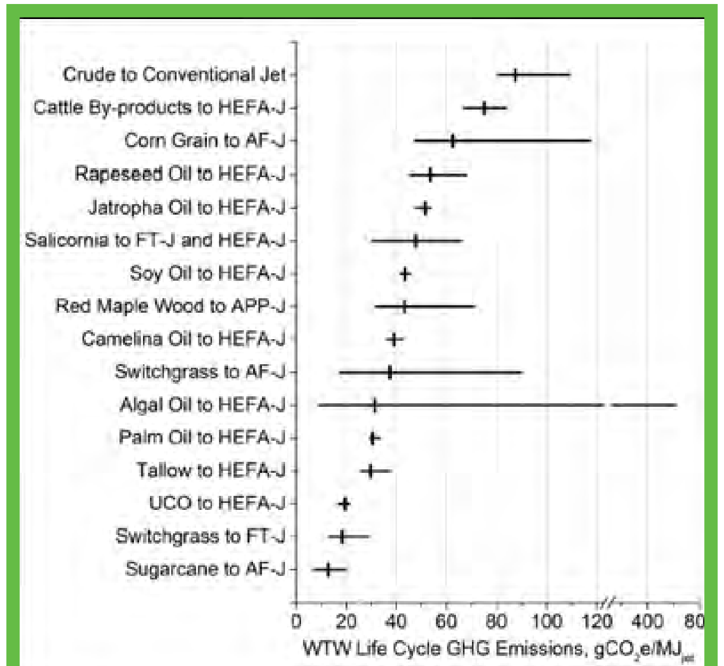
[3] IATA. Airlines Expect 31% Rise in Passenger Demand by 2017. 10 December 2013. http://www.iata.org/pressroom/pr/Pages/ 2013-12-10-01.aspx Accessed 16 September 2016.



Source http://www.nature.com/nclimate/journal/v2/n5/fig_tab/nclimate1493_F1.html

Recently published by the Executive Office of the President of the United States, the Federal Alternative Jet Fuels Research and Development Strategy cites that "[o]ver the past decade, significant progress has been made by commercial and military aviation to develop, evaluate, and deploy AJFs that can cost-effectively meet the challenges described above. Since 2009 ASTM International has approved five different types of AJFs. The past year has witnessed more than a half dozen announcements in the United States of fuel purchase agreements between renewable fuel producers, airlines, and military. But at present, AJFs that compete with petroleum fuel on price are not yet produced in volumes sufficient to meet the needs of the aviation industry." [4]

In addition to the GHG reduction benefits, airlines are also motivated to commercialize economically viable SAJFs to diversify their supply of jet fuel and mitigate volatility in the traditional jet fuel market. Increasing the supply and geographic diversification of production of jet fuel, which is approximately 35% of an airline's cost to operate, is a powerful value proposition for airlines.



[4] Federal Alternative Jet Fuels Research and Development Strategy. Product of the Aeronautics Science and Technology Subcommittee Committee on Technology of the National Science and Technology Council. June 2016. Executive Office of the President of the United States.

3.0 Stakeholders

- **Stakeholders at the center**
- **Stakeholder groups**
- **Engagement and commitment**

From the inception of this study, the project team placed stakeholders and stakeholder engagement at the front and center of all project efforts. At the January, 2016 study Kick-Off Meeting at the Treasure Coast Research Park, over 100 interested parties gathered to learn, express interest, share views and shape the work of the study and larger project.[5] Stakeholders were organized into five groups representing the project value chain, including: growers, processors, government, environment and sustainability interest groups, and end users.

These stakeholder group categories were created to be highly inclusive, and stakeholders that did not fit neatly into one of the five categories were integrated into a group of their choosing. For example, the seed company representatives mostly self-identified with the growers, community representatives self-identified with the environmental and sustainability or government groups, etc.

Stakeholders at the Farm to Fly Kick-off meeting at the Treasure Coast Research Park

Since study inception, the number of stakeholders involved, i.e., the Working Group, has grown to just shy of 200 individuals, including rich representation from all of stakeholder groups. Across all stakeholder groups, the Working Group members came to the table to share insights, values, vision and resources to ensure near-, mid-, and long-term project success. As barriers and challenges surfaced during the Feasibility Study, Working Group members delivered solutions.

[5] See Appendix C for a complete list of Kick-Off Meeting Attendees.

a. Stakeholders Delivering Solutions

It became clear during the feasibility study that equipment for a critical processing step between beet harvest and refining was not readily or cost-effectively available. Dr. Gillian Eggleston and Dr. Randy Cameron from the Agricultural Research Service of the US Department of Agriculture (ARS USDA) stepped in to bring a steam explosion unit and research support to

Richard Machek of USDA presents a check to former St. Lucie County Commissioner Kim Johnson

Ben DeVries leading a stakeholder group meeting at the Farm to Fly Kick-off

the table. In addition, they offered to ship and share equipment to stabilize the sugar from the beets from the Southern Regional Research Center in New Orleans, Louisiana (LA) to Florida for on-site use during the Phase I beet harvest. This equipment, while not a permanent solution, will enable Phase I theoretical projections to be tested.

Many of the project stakeholders are providing at cost equipment and services in the early phases of the study in order to contribute to project advancement and success. Beta Seed is providing planting and harvesting equipment from North Dakota; the growers are asking only to recoup their input costs of planting, and the processors are carving out valuable slots in their demonstration unit schedules to produce the first barrels of SAJF and SAJF precursors.

4.0 Stakeholder Vision: from Feasibility to Success

- **Feasibility Study Success factors**
- **Ultimate Project Success**
- **Five-Phase Timeline**

A significant part of the project kick-off meeting was spent defining feasibility study and ultimate project success. The participants were broken into four break-out groups large enough to ensure each stakeholder group was represented (where possible) and small enough to ensure each

SUCCESS FACTORS	
Feasibility Study	**Full Scale**
Quantify the sustainability value proposition – the economic, social and environmental value - to the county and state	**Sustainable endeavor (environmental, social and economic)**
Map the timeline/pathway to profitability and ASTM certification (identify opportunities to reduce cost); map the supply chain and quantify economics and production potential of multiple crops and coproducts	**Profitability across the entire supply chain (growers, processors, distributors, fuel companies, airlines, etc.)**
Identify potential value-adding co-products	Legislative, regulatory and policy supports/parody are consistent with other crops and fuels e.g. crop insurance FSA, B-cap eligibility, Title I Exemption, etc.
Identify potential barriers to success and possible strategies to overcome them ▲ Grower access to capital (loan availability up to $300K, 7-year loans, loan flexibility/ability to weather highs and low, catastrophic weather/climatic events ▲ USDA loan guarantee program (possible solution) ▲ Sustainability concerns ▲ Adequate purchase commitments/off-take agreements to secure financing ▲ Consistent, reliable flow of money through the supply chain ▲ Failure to create a sustainable economic model	Minimum of 15,000,000 gallons of annual SAJF production
Identify viable intermediate income-generation potential for growers	Fuel meets ASTM specifications
Identify what can Fed/state/county agencies do to help (permitting requirements)	Growers are growing and land is retained for agricultural production
Identify logistics and infrastructure needs (ideal locations for intermediate and final processing facilities; rail access is currently limited)	SAJF supply certainty for end users

group participant would have the opportunity to provide input. Many insights were shared during this session, and ultimately each break-out group was asked to distill their highest priority messages and views on both feasibility study and ultimate project success during the concluding plenary session. The feasibility study and ultimate project success criteria emphasized by most or all stakeholder groups are reflected in the following table, with all four stakeholder groups emphasizing the bolded factors.[6]

Post Kick-Off meeting, the project team immediately homed in on the stakeholder-identified feasibility study success criteria and worked throughout the study to meet all stakeholder expectations.

Where the project team was not able to fully meet these criteria for success, steps were taken to do so in subsequent phases of this project. As an example, by the time this study was complete, the project team was unable to quantify the potential value of a scaled SAJF supply chain to local water quality. The team has, however, scoped and is seeking funding for an ancillary project that would enable that valuation. Details on how each of the identified study success criteria have been met are provided in subsequent sections of this report.

Kim Johnson,
Former County Commissioner
St. Lucie County Board

"Florida will always be a great ag state. We have great beaches, and we are a great vacation destination, but one of our greatest assets has always been agriculture. We have a lot of land, and I am excited for our farmers because they can create opportunities for jobs. Those jobs will come in the form of people putting in the crops, pulling the crops, and production and manufacturing of those crops. It's A-Z straight here from Florida, and by the way, Fort Pierce, and it can benefit people all over the state, all over the country, and quite possibly all over the world. How cool is that?"

- Kim Johnson
Former County Commissioner, St. Lucie County

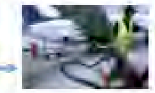
[6] A complete report of the study Kick-Off Meeting can be found in Appendix B.

5.0 The SAJF Value Chain

Figure 1: Core Components of the SAJF Value Chain
Source http://www.qantas.com.au/img/350x232/environ1-a.jpg

Core components of the SAJF value chain are generally consistent across feedstocks, processors, conversion technologies, and end users, as reflected in Figure 1. The meaningful differences among SAJF production opportunities, including creation of value-adding co-products, are found at the next level of detail. In this case, the value chain differentiators include the feedstock, and multiple fuel conversion and coproduct production pathways that can be applied.

Florida Farm 2 Fly Value Chain



	UPSTREAM PROCESS		DOWNSTREAM PROCESS	
	Sugar Growers	**Sugar Transformers**	**Biofuel Producers**	**Jet Fuel User/Distributor**
Program Participants:	• Adams Ranch • International Farming • Southern Planter • Kings Ranch • Colvin Co	• (TBD)	• Amyris/TOTAL • GEVO • Lanzatech • REG	• JetBlue • FedEx • American Airlines
Primary Input(s):	Farming Components	Sugar Crops	• Sucrose (Sugar) • Nutrients • Hydrogen	• Neat Biojet • Fossil Jet A
Output:	Sugar Crops	Sugar Molasses	Neat Biojet	Certified Biojet Blend
Process Steps:	• Farming • Harvesting • Transport: Field to Sugar Transformer	• Crushing • Milling • Separation/Filtration • Transport: Plant to Biofuel Producer	• Sugar Pasteurization • Fermentation • Hydrogenation • Distillation • ASTM Biojet Certification • Transport: To Jet Fuel User • Global Bioenergies	• Biojet Storage • Blending Biojet/Fossil • Fuel Blend Storage • ASTM Fuel Certification • Transport: To Airport • DLA Energy

José Alvarez
Adjunct & Emeritus Professor
University of Florida
Farm Management &
Production Economics

"If sweet sorghum can be produced as a rotation crop and some of the practices in the sugarcane industry can be utilized, sweet sorghum can become profitable as ethanol prices rise."

*- José Alvarez,
Adjunct & Emeritus Professor
University of Florida*

a. Feedstock

- **Feedstock crops**
- **Production potential**
- **Feedstock processing**
- **Upstream co-products**

This study evaluated economic and environmental implications of a multi-sugar crop rotation to maximize yields, grower revenues and realize nutrient retention benefits associated with the energy beets. SAJF feedstock from a three crop rotation of energy cane, energy beets and sweet sorghum appears optimal in that it delivers the following benefits:

- **Energy crops ready for cultivation as a feedstock**
- **A continuous source of revenue for the growers when the energy beet is used in crop rotation during the winter and summer seasons**
- **Cost-efficient sugar yields**
- **Robust nutrient uptake, in particular by the energy beets, thereby avoiding nutrient runoff and excessive loading in nearby waterways**

Year 1 Targeted

	inputs	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
acres	200	200	200	200	200	200	200	200	200	200	200	200	200
beets (3 mo harvest @ ton/acre)	38	-	-	2,533	2,533	2,533	-	-	-	-	-	-	-
sorghum (4 mo harvest @ ton/acre)	42	-	-	-	-	-	-	2,100	2,100	2,100	2,100		
Total (tons)	16,000	-	-	2,533	2,533	2,533	-	2,100	2,100	2,100	2,100	-	-
WHOLE BEET - CATTLEFEED													
daily crop (tons/workdays)	20	-	-	126.7	126.7	126.7	-	105.0	105.0	105.0	105.0	-	-
4 axle - truckloads/day	34	-	-	3.7	3.7	3.7	-	3.1	3.1	3.1	3.1	-	-
DRY - CATTLEFEED													
dry cattle feed (tons) w/ 16% sugar @%DM/ton	8%	-	-	202.67	202.67	202.67	-	168.00	168.00	168.00	168.00	-	-
daily dry cattle feed (tons/workday)		-	-	10.13	10.13	10.13	-	8.40	8.40	8.40	8.40	-	-
single axle - (tons/truckload/workday)	10	-	-	1.01	1.01	1.01	-	0.84	0.84	0.84	0.84	-	-
0													
daily steamed mash (tons)		-	-	133	133	133	-	110	110	110	110		
gal/day (@10 lbs/gal)		-	-	26,600	26,600	26,600	-	22,050	22,050	22,050	22,050	-	-
dehydration (gal/day)	70%	-	-	18,620	18,620	18,620	-	15,435	15,435	15,435	15,435	-	-
wet mash mash (gal/day)		-	-	7,980	7,980	7,980	-	6,615	6,615	6,615	6,615	-	-
% full with two week buffer @ # 20,000 gal holding tanks)	5.0	0%	0%	80%	80%	80%	0%	66%	66%	66%	66%	0%	0%
ALTERNATIVE CO-PRODUCTS													
sugar as % total crop (ton)	16.0%	-	-	405.3	405.3	405.3	-	336.0	336.0	336.0	336.0	-	-
biochar	7%	-	-	177.3	177.3	177.3	-	147.0	147.0	147.0	147.0	-	-
cattlefeed (ton) w/ 10% sugar	10%	-	-	204.3	204.3	204.3	-	169.3	169.3	169.3	169.3	-	-

Figure 2: Year 1 Targeted

Industrial sugar crops (ISC) are already being tested by the University of Florida's Institute of Food and Agricultural Sciences and the USDA Agriculture Research Service at the TCERDA site. Preliminary results on the best near-term sources for domestic U.S. supply have been favorable and well-received by sugar-based alternative biofuels companies.

Source http://agriculturewire.com/wp-content/uploads/2014/04/Rossiya_sokrashaet_posevnie_ploshadi_pod_saharnoy_svekloy.jpeg

Amy Lyons
Independent Consultant
for Betaseed, Inc.

"Why feed beets? It's highly digestible fiber with efficient rumination via slow released sugars that are tied into the fiber, and cows love 'em," so they're easy to feed."

- Amy Lyons, Betaseed, Inc.

Brian Boman
Professor Emeritus
University of Florida

The companies represented here today want to do it because biofuel is the right thing to do. There is a lot that goes with this, not only farmers getting a stable income, but the income base it provides to the community and the stability which goes with this."

- Brian Boman, Professor Emeritus
Department of Agricultural & Biologic Engineering
University of Florida, IRECC

Distributed Conversion of Sucrose Root Crop Feedstock

A critical processing step to sugar stabilization and coproduct production

Recent research has demonstrated the ability to recover valuable coproducts and functionality from agricultural processing of feedstock biomass from energy beets with, or without, a simple water wash unit operation. A continuous, pilot scale process for the enhanced release and recovery of fermentable sugars and pectic material from sugar beets was developed and used to demonstrate general fit for purpose.

After the beets are harvested, they are chopped and fed through a FitzMill and reduced to pieces under 1/8 inch in diameter which are then fed into the steam explosion "jet" cooker. Using continuous pumping, steam injection and controlled back pressure, all three components are liberated from their cellular entrapment and recovered with a simple water wash.

The steam-exploded sugar beets are readily used as a fermentation feedstock, without the addition of hydrolyzing enzymes, using large plastic tanks with mixing paddles and conventional brewer's yeast. After fermentation, traditional distillation equipment concentrates the fully fermented mash to 185 proof bioethanol and leaves a distiller's beet mash coproduct usable as cattle feed in either its wet form or dried into pellets.

The pectin within the steam-exploded biomass can be treated with a calcium chelating alkaline salt to modify the pectic component, rendering functionality to the entirety of the biomass. The functionalized biomass can then be dried and milled for use as a liquid viscosity modifier, a heavy metal chelator or drying control agent.

Our next step is to move the process to a local group of farms using truck-mounted, post-harvest steam explosion beet processing and bio-distillation equipment. Initially, we propose to configure the equipment to fit into a shipping container transportable on a flat-bed truck. One container will be equipped with a feed belt, beet chopper, FitzMill and steam explosion cooker. Plastic fermentation tanks will be delivered to the participating

farms sufficient to ferment their anticipated beet harvest. A second container will be equipped with a pump, distillation unit, and holding tank to concentrate and collect the fermented mash.

This mobile approach will reduce total transport costs and minimize carbon emissions. A working group consisting of local growers, dairies, cattlemen, feed companies, fuel distributors, seed companies, and interested research scientists will be recruited to coordinate this collaborative effort.

KEY CHALLENGE:

Post-harvest sugar beet processing is required to stabilize sugar from the beets. Equipment availability and processing ownership are currently undetermined for next phases of the project.

PATHWAY TO RESOLUTION:

The project team should work with growers to move the process to a local group of farms using truck-mounted, post-harvest steam explosion beet processing and bio-distillation equipment.

b. Coproducts

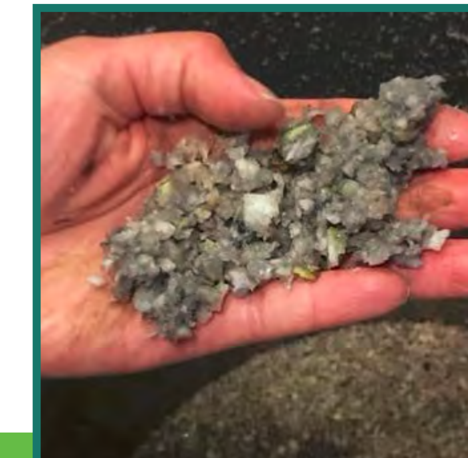
Sugar beet pulp shreds are a coproduct of the sugar beet industry valued as an excellent feed resource for all types of livestock. Sugar beet pulp shreds are the fibrous portion of the sugar beet left after the sugars are removed, and are mechanically pressed and dried to reduce the water content to approximately 9%. Sugar beet pulp fiber is highly digestible, extremely palatable feed that provides multiple benefits in terms of animal health, appearance and growth rate. Sugar beet pulp shreds can easily be stacked and stored, and changes in temperature are not harmful if reasonably dry conditions are maintained, and they are not susceptible to rodent or insect damage. In the context of this project, beet pulp provides an additional revenue source for growers and substantially improves project economics.

c. Fuel Conversion

- **ASTM AJF approved production pathways**
- **Conversion technologies and providers**

Before aircraft can use any alternative jet fuels, those fuels must meet rigorous criteria spelled out in aviation fuel specifications, which include physical and fit-for-purpose properties. The specifications for alternative jet fuels are defined in ASTM Standard D7566, and specific annexes to the Standard apply to individual processes for producing alternative jet fuel.[7]

Since 2009, five alternative jet fuel pathways have been approved. The five approved alternative jet fuel types represent four different processes associated with various feedstock types. Two of these pathways could be applied to this scenario, which include: Hydroprocessed Fermented Sugars to Synthetic Isoparaffins (HFS-SIP), made by microbial conversion of sugars to hydrocarbons, and; Alcohol-to-Jet Synthetic Paraffinic Kerosene (ATJ-SPK) derived from isobutanol from multiple feedstocks.[8]



HFS-SIP

Approved in 2014 up to a 10% blend, entails the fermentation of sugars into a hydrocarbon molecule using modified yeasts. The existing approved process produces a C15 hydrocarbon molecule called farnesene, which after hydroprocessing to farnesane, can be used as a blendstock in jet fuel.

ATJ-SPK

Approved in 2016 up to 30% blend, a yeast biocatalyst converts sugars (carbohydrates) to isobutanol, followed by oligomerization and hydrogenation to yield a hydrocarbon jet fuel blendstock.

[7] CAAFI. Frequently Asked Questions. http://www.caafi.org/about/faq.html accessed 19 September 2016.
[8] Ibid.

Three biofuel companies have supported this feasibility study by providing insights into their facilities and technologies, supply chains, economics and certification and qualification boundaries. The three companies are: Amyris-Total, GEVO, and LanzaTech.

Spiro G. Lekoudis
Co-chair ASTS Director
Weapons Systems, Defense Research and Engineering
Office of the Secretary of Defense

“Among transportation fuel users, aviation is uniquely positioned for industry-wide use of AJFs. Unlike cars, planes have no near-term alternatives to liquid fuels, and they benefit from a concentrated fueling infrastructure with a limited number of fueling stations (airports) and a limited number of large fuel buyers (airlines and military). Aviation benefits from an aligned industry and government approach to fuel development and approval.”

- Spiro G. Lekoudis, Co-chair ASTS Director
Office of the Secretary of Defense

Erin Heitkamp
Former Global Sustainability Practice Leader
Wenck

“The TCERDA-led Florida Farm-to-Fly project is an excellent example of stakeholder engagement – a critical element to many endeavors, and in particular when standing up and sustaining a new industry. By effectively engaging key stakeholder groups, TCERDA has secured dedicated, invested partners that will help to ensure and share in the long-term success of the Farm-to-Fly initiative.”

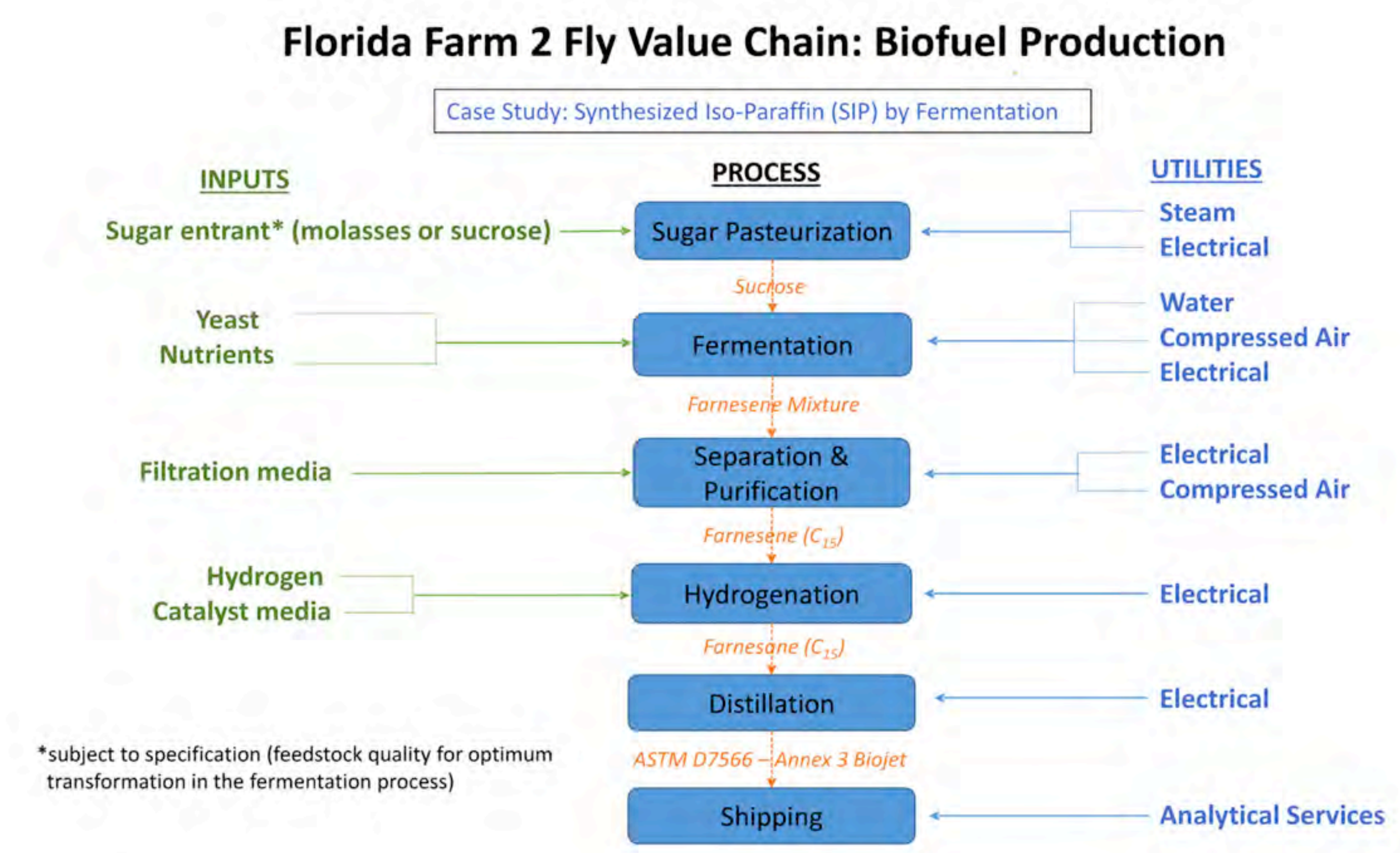
- Erin Heitkamp
Former Global Sustainability Practice Leader
Wenck

In October 2016, government, industry and civil society representatives agreed on a new global market-based measure (GMBM) to control CO_2 emissions from international aviation. The historic move came as the Plenary Session of the UN aviation agency’s 39th Assembly agreed to recommend adoption of a final Resolution text for the GMBM. 66 States, representing more than 86.5% of international aviation activity, agreed to participate in the global MBM scheme from its outset.”

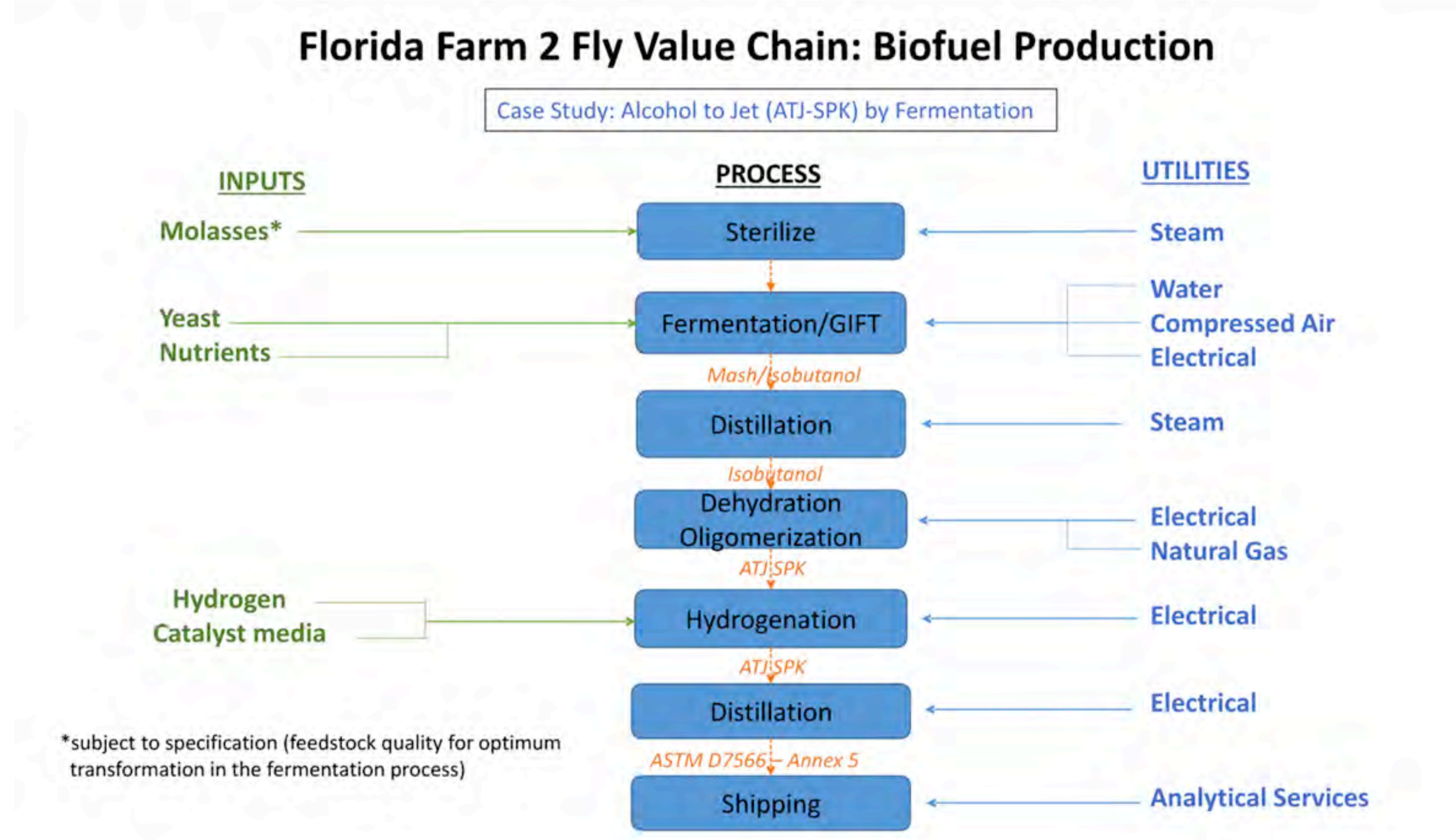
- ICAO

Beet processing stages
(Left to right)
1.Chopped Beets 2. Liquified Beets 3. Filtered Beets 4. Distilled Beets (Ethanol)

Amyris-Totals' conversion pathway is approved under ASTM D7566 Annex 3, which is the HFS-SIP pathway.



Gevo's conversion pathway is approved under the ASTM D7566 Annex 5, which is the ATJ-SPK pathway.



The ASTM organization is currently contemplating an expansion of the ATJ-SPK pathway to include the conversion of all alcohols – not just butanol. Lanzatech's conversion technology will fall under the ATJ-SPK pathway if this change is approved, as it involves conversion of ethanol to jet fuel.

The three companies focused on the feedstock as an input for fuel production have all committed to collaborating with the project team beyond completion of this feasibility study to schedule time at their facilities to produce, at cost, one barrel of SAJF (or its approved pre-cursor product) using sugar or ethanol processed from the first harvest of the energy beets planned for April 2017.

Amyris-Total has also provided a letter of support for the project that looks ahead to full-scale up and contemplates the following components of an off-take agreement. The complete letter is included as Appendix C to this report.

Future Goals

- 10-year supply contracts for raw sugar at a cost of ≤ $0.10/lb
- 900,000 to 1,500,000 MT of raw sugar/year supplied under those contracts (i.e.,TRS - sugar availability (@67 brix/700 kg/m3 sugar concentration))
- Guarantees by the State of Florida regarding the supply and pricing under these contracts
- State and local financial support for the DSHC plant's utilities and infrastructure
- Low-cost, long term lease of land that has current or potential rail access
- Access to cost-effective hydrogenation CMOs to transform the farnesene into biojet
- Biojet offtake agreements for 75% of the DSHC plant's design volume;
- State and local property and income tax abatement
- The extension of the federal RFS2 legislation and approval of a pathway to enable RIN capture
- Stakeholders' assistance with obtaining regulatory and environmental approvals

d. SAJF Blending, Testing and Certification

All SAJF approved pathways require blending of the alternative jet fuel with conventional, petroleum-based jet fuel in order satisfy ASTM requirements and be considered a "drop-in" jet fuel. Blend limitations for each of the approved pathways are detailed in the following table.

APPROVED ALTERNATIVE FUEL PRODUCTION PATHWAYS[9]

The ASTM blend limitations are not currently, and will not likely be for some time, a barrier to the expansion and growth of the SAJF industry. The demand for these fuels will far outstrip supply for the foreseeable future (to be discussed in more detail in the next section of this report).

At full scale, the project will need to optimize utilization of existing blending infrastructure and operations. On-airport blending is an option if the fuel system infrastructure is configured to ensure proper management of fuel inventories and QC process.

Once blended, tested and certified as meeting ASTM requirements, the SAJF blend is fully fungible in the jet fuel storage and distribution infrastructure in the U.S. and most of the world. This means it can be shipped by rail, ship, pipeline or truck to any airport and be comingled in storage tanks, fueling trucks and hydrant systems without issue.

e. SAJF Users

- **Demand**
- **Engaged Airlines and Freight Haulers**

As mentioned in the previous sections of this report, the demand for SAJF will far outstrip supply for the foreseeable future. Figure 3 below indicates current jet fuel consumption in Florida alone exceeds one billion gallons annually. A South Florida industrial-sugar based SAJF industry, at full scale, could deliver approximately 200 million gallons, or about 20% of the current demand for jet fuel in FL. Given industry growth rates, 200 million gallons will constitute substantially less than 20% of the jet fuel demand over time. Further, the market for SAJF is by no means confined to the state of Florida.

[9] The National Academies Press. 5 Sustainable Alternative Jet Fuels. https://www.nap.edu/read/23490/chapter/8#74 accessed 19 September 2016.

As the airline industry is targeting SAJFs to deliver far greater than 20% of their emissions reductions required to accomplish established climate change goals, there is no question there is a market for Florida-produced SAJF – as long as it is sustainably produced and supplied cost competitively. Airlines also recognize that SAJF is a brand new industry and that projects of this nature will not typically be able to deliver cost-competitive product in early phases. There is some appetite to commit to procurement of limited quantities of SAJF at premium pricing in order to support project scale-up and secure access to future, larger volumes of cost-competitive product.

JET A & TRANSPORT FUEL TO CO_2 WORKSHEET

TCERDA · FARM to FLY · USDA Rural Development

	Deep Water Horizon Spill	Florida Jet A	Florida Transportation	US Domestic Jet A	US Domestic Transportation	World Jet A	World Transportation
% of US domestic transportation consumption [barrels]	0.1%	1.0%	7.1%	16.3%	100.0%	59.1%	1093.9%
barrels/ year	3,800,000	32,800,000	227,325,000	522,550,000	3,212,000,000	1,898,500,000	35,134,900,000
gallons / year [52 gallon/barrel]	197,600,000	1,705,600,000	11,820,900,000	27,172,600,000	167,024,000,000	98,722,000,000	1,827,014,800,000
barrels/day	10,411	89,863	622,808	1,431,644	8,800,000	5,201,370	96,260,000
gallons /day	541,370	4,672,877	32,386,027	74,445,479	457,600,000	270,471,233	5,005,520,000
Tons of CO^2	2,084,680	17,994,080	124,710,495	286,670,930	1,762,103,200	1,041,517,100	19,275,006,140
Pounds of CO^2/year [21.1 lbs/gal Jet A]	4,169,360,000	35,988,160,000	249,420,990,000	573,341,860,000	3,524,206,400,000	2,083,034,200,000	38,550,012,280,000
Cubic Feet of CO^2/year [8.7 cu.ft/lb; @1 atmosphere, 70 degrees]	479,236,782	313,096,992,000	2,169,962,613,000	4,988,074,182,000	30,660,595,680,000	18,122,397,540,000	335,385,106,836,000
Land Area [square miles]		65,755		3,806,000		57,000,000	
Land Area covered 2015-2025 [feet]		1.7	11.8	0.5	2.9	0.1	2.1
Land Area covered 2015-2065 [feet]		8.5	59.2	2.4	14.4	0.6	10.6

Figure 3: Jet A & Transport Fuel to CO_2 Worksheet

Of note, aviation markets for sugar-based fuels have already been established in both South America and Europe, with operations initiated by Brazilian (GOL) and European (Air France and Lufthansa) operators. These significant foreign market gateways for the U.S. are existent within Florida.

Rich Altman
CAAFI
Executive Director, Emeritus

"The TCERDA-led Rural Business Development program has put St. Lucie County and Florida on the national sustainable biofuels and co-products map. With at least five producers engaged with an equal or greater number of airlines, a clear path to making St. Lucie county a national capital for non-food sugar based fuel and animal feed coproducts has been defined for scale up and execution in a manner which few others have accomplished"

- Rich Altman
CAAFI Executive Director, Emeritus

Tom Opderbeck
American Airlines
Manager of Sustainability

"We have been monitoring developments in international environmental regulations and exploring opportunities to reduce our carbon footprint through alternative jet fuels. Our role as consumers is pretty simple – if there is fuel that can meet our specifications, we'd be happy to buy it at a good price."

- Tom Opderbeck
American Airlines, Manager of Sustainability

Fernando Garcia
Amyris, Inc.
Senior Director
Scientific & Regulatory Affairs

"Amyris has acheived commercial scale. We're commercial - we're ready when the plant sugars are ready and economical."

- Fernando Garcia
Amyris, Inc., Senior Director, Scientific and Regulatory Affairs

6.0 Supply Chain Economics

The project team gathered information from stakeholders at all steps along the supply chain to create a complete picture of supply chain economics from very early to mature stages of the project. The following pro formas summarize the FL sugar-to-SAJF supply chain economics as analyzed by the project team, with input and refinement from project stakeholders. All costs are based on actual, current market pricing data, where available, and on informed estimates where market pricing data is not readily available.

Annual Estimated SJF Feedstock Yields and Inputs - South Florida

Full Season				
Item	Quantity Per Acre	Unit	Price or Cost	Value or Cost/Acre
Gross Return				
$0.090	Benola Root			
	12.34	ton		$ 2,221.20
$0.060	Cattle Feed			
	7.24	ton		$ 868.80
	80	ton	$ 38.63	$ 3,090.00
annual season				
Operating Inputs				
Seed:	47%			
Seed	29%	unit		$ 195.00
				$ 195.00
Fertilizer:				
Nitrogen - Preplant	40	lb	$ 0.34	$ 13.76
P205	200	lb	$ 0.48	$ 96.00
K20	80	lb	$ 0.46	$ 37.12
Micronutrients	2	ac	$ 10.00	$ 20.00
Nitrogen-Liquid	240	lb	$ 0.37	$ 88.32
				$ 255.20
Pesticides:				
Counter 15G L-N-L	28	lb	$ 2.15	$ 60.20
Glyphosate applications	192	oz	$ 0.18	$ 34.56
AMS	15	lb	$ 0.51	$ 7.65
Herbicide Application	6	ac	$ 7.00	$ 42.00
Fungicide Application	6	ac	$ 25.00	$ 150.00
				$ 294.41
Custom & Consultants:				
Custom Fertilizer Application	2	ac	$ 7.00	$ 14.00
Consultant	2	ac	$ 16.00	$ 32.00
				$ 46.00
Crop Insurance:				
NAD		ac		$ 100.00
				$ 100.00
Irrigation Costs:				
Irrigation	1	ac	$ 40.00	$ 40.00
				$ 40.00
Machinery/Land Pre & Spraying:				
Fuel - Diesel	35	gal	$ 3.70	$ 129.50
Lube	2	ac	$ 17.52	$ 35.04
Machinery Repairs	2	ac	$ 20.00	$ 40.00
				$ 204.54
Labor:				
Labor (Machine)	8	hr	$ 15.00	$ 120.00
Labor (Irrigation - cp)	1.8	hr	$ 10.20	$ 18.36
Labor (Other)	1	hr	$ 10.00	$ 10.00
				$ 148.36
Harvest Cost:				
Harvester Cost (Custom)		ton		$ 198.00
Hauling Charge	80	ton	$ 2.00	$ 160.00
Washing/Chipping	76	ton	$ 2.00	$ 152.00
Pelletizing/Bagging/Ensiling	7.24	ton	$ 6.00	$ 43.44
				$ 553.44
Total Cost per Season				$ (1,836.95)
Gross Return - from Above				$ 3,090.00
Net Gain (Loss)			68%	$ 1,253.05

Sweet Sorghum with Ratoon	May to October (6.5 months)			
Item	Quantity Per Acre	Unit	Price or Cost	Value or Cost/Acre
Gross Return				
$0.090	Benola Root			
14.0%	5.88	ton	$ 180.00	$ 1,058.40
$0.075	Cattle Feed			
10.0%	4.2	ton	$ 120.00	$ 504.00
	42	ton	$ 37.20	$ 1,562.40
one full crop + ratoon crop				
no seed, fertilizer, or irrigation for ratoon crop with 1/2 yield				
Operating Inputs				
Seed:				
Swseet Sorghum Seed	0.75	unit	$ 10.00	$ 7.50
				$ 7.50
Fertilizer:				
Nitrogen - Preplant	20	lb	$ 0.34	$ 6.88
P205	100	lb	$ 0.48	$ 48.00
K20	40	lb	$ 0.46	$ 18.56
Micronutrients	1	ac	$ 10.00	$ 10.00
Nitrogen-Liquid	120	lb	$ 0.37	$ 44.16
				$ 127.60
Pesticides:				
Counter 15G L-N-L	14	lb	$ 2.15	$ 30.10
Glyphosate applications	96	oz	$ 0.18	$ 17.28
AMS	7.5	lb	$ 0.51	$ 3.83
Herbicide Application	3	ac	$ 7.00	$ 21.00
Fungicide Application	3	ac	$ 25.00	$ 75.00
				$ 147.21
Custom & Consultants:				
Custom Fertilizer Application	1	ac	$ 7.00	$ 7.00
Consultant	1	ac	$ 16.00	$ 16.00
				$ 23.00
Crop Insurance:				
NAD	0	ac	$ 40.00	$ -
				$ -
Irrigation Costs:				
Irrigation	0	ac	$ 40.00	$ -
				$ -
Machinery/Land Pre & Spraying:				
Fuel - Diesel	15	gal	$ 3.70	$ 55.50
Lube	1	ac	$ 17.52	$ 17.52
Machinery Repairs	1	ac	$ 20.00	$ 20.00
				$ 93.02
Labor:				
Labor (Machine)	6	hr	$ 15.00	$ 90.00
Labor (Irrigation - cp)	0	hr	$ 10.20	$ -
Labor (Other)	0.5	hr	$ 10.00	$ 5.00
				$ 95.00
Harvest Cost:				
Harvester Cost (Custom)	42	ton	$ 2.00	$ 84.00
Hauling Charge	42	ton	$ 2.00	$ 84.00
Washing/Chipping	38	ton	$ 2.00	$ 76.00
Pelletizing/Bagging/Ensiling	4.2	ton	$ 6.00	$ 25.20
				$ 269.20
Total Cost per Crop				$ (762.53)
Gross Return - from Above				$ 1,562.40
Net Gain (Loss)			105%	$ 799.88

Roundup Ready Benola Root	Mid-October to April (5.5 months)			
Item	Quantity Per Acre	Unit	Price or Cost	Value or Cost/Acre
Gross Return				
$0.090	Benola Root			
17.0%	6.46	ton	$ 180.00	$ 1,162.80
$0.075	Cattle Feed			
8.0%	3.04	ton	$ 120.00	$ 364.80
	38	ton	$ 40.20	$ 1,527.60
one full crop				
Operating Inputs				
Seed:				
Roundup Ready Beet Seed	0.5	unit	$ 375.00	$ 187.50
* Includes fungicide & insecticide seed treatment				
				$ 187.50
Fertilizer:				
Nitrogen - Preplant	20	lb	$ 0.34	$ 6.88
P205	100	lb	$ 0.48	$ 48.00
K20	40	lb	$ 0.46	$ 18.56
Micronutrients	1	ac	$ 10.00	$ 10.00
Nitrogen-Liquid	120	lb	$ 0.37	$ 44.16
				$ 127.60
Pesticides:				
Counter 15G L-N-L	14	lb	$ 2.15	$ 30.10
Glyphosate applications	96	oz	$ 0.18	$ 17.28
AMS	7.5	lb	$ 0.51	$ 3.83
Herbicide Application	3	ac	$ 7.00	$ 21.00
Fungicide Application	3	ac	$ 25.00	$ 75.00
				$ 147.21
Custom & Consultants:				
Custom Fertilizer Application	1	ac	$ 7.00	$ 7.00
Consultant	1	ac	$ 16.00	$ 16.00
				$ 23.00
Crop Insurance:				
NAD	1	ac	$ 100.00	$ 100.00
				$ 100.00
Irrigation Costs:				
Irrigation	1	ac	$ 40.00	$ 40.00
				$ 40.00
Machinery/Land Pre & Spraying:				
Fuel - Diesel	20	gal	$ 3.70	$ 74.00
Lube	1	ac	$ 17.52	$ 17.52
Machinery Repairs	1	ac	$ 20.00	$ 20.00
				$ 111.52
Labor:				
Labor (Machine)	2	hr	$ 15.00	$ 30.00
Labor (Irrigation - cp)	1.8	hr	$ 10.20	$ 18.36
Labor (Other)	0.5	hr	$ 10.00	$ 5.00
				$ 53.36
Harvest Cost:				
Harvester Cost (Custom)	38	ton	$ 3.00	$ 114.00
Hauling Charge	38	ton	$ 2.00	$ 76.00
Washing/Chipping	38	ton	$ 2.00	$ 76.00
Pelletizing/Bagging/Ensiling	3.04	ton	$ 6.00	$ 18.24
				$ 284.24
Total Cost per Crop				$ (1,074.43)
Gross Return - from Above				$ 1,527.60
Net Gain (Loss)			42%	$ 453.18

Figure 4: Annual Estimated SJF Feedstock Yields and Inputs - South Florida

Target Supply Chain Yield Improvement

F2F Supply Chain Yield Improvement VALUE RISK MAP (crop, sugar content, Advanced BioFuel conversion)										
V.6			A	B	C	D	E	F	G	H
	Annual Improvement	3%	103%	106%	109%	113%	116%	119%	123%	127%
Initial Yields	Feedstock crop (tons/acre)	80.0	82.4	84.9	87.4	90.0	92.7	95.5	98.4	101.3
15.4%	Sugar processing (tons)	12.3	12.7	13.1	13.5	13.9	14.3	14.7	15.2	15.6
58.7%	Feed Co-product (tons)	7.2	7.5	7.7	7.9	8.1	8.4	8.6	8.9	9.2
47.0%	Bio-ethanol processing (tons)	5.8	6.0	6.2	6.3	6.5	6.7	6.9	7.1	7.3
29.0%	Sustainable Jet Aviation processing (tons)	3.6	3.7	3.8	3.9	4.0	4.1	4.3	4.4	4.5
TOTAL SUPPLY CHAIN YIELD IMPROVEMENT			103%	106%	109%	113%	116%	119%	123%	127%
Sustainable Jet Aviation Fuel (gallons/acre)		1,145	1,180	1,215	1,251	1,289	1,328	1,367	1,408	1,451
equivalent Bio-ethanol (gallons/acre)		1,450	298,690	922,951	2,851,919	8,812,430	27,230,409	84,141,964	259,998,668	803,395,884
3X	Acres	1	200	600	1,800	5,400	16,200	48,600	145,800	437,400
	Feedstock crop (tons)	80.0	16,480	50,923	157,353	486,220	1,502,419	4,642,475	14,345,249	44,326,819
	Sugar (tons)	12.3	2,542	7,855	24,272	74,999	231,748	716,102	2,212,755	6,837,412
	Feed Co-Product	7.2	1,491	4,609	14,240	44,003	135,969	420,144	1,298,245	4,011,577
	Bio-ethanol (tons)	5.8	1,195	3,692	11,408	35,250	108,922	336,568	1,039,995	3,213,584
	Sustainable Jet Aviation (tons)	3.6	737	2,278	7,039	21,750	67,207	207,670	641,699	1,982,849
TOTAL Sustainable Jet Aviation (gallons)		1,145	236,000	729,000	2,252,000	6,960,000	21,506,000	66,454,000	205,344,000	634,512,000
Breakeven Analysis assuming 2 1/2 crops with annual cost % reduction:					-3.0%					
	Seed	$ 195	$ 189	$ 183	$ 178	$ 173	$ 167	$ 162	$ 158	$ 153
	Fertilizer	$ 255	$ 248	$ 240	$ 233	$ 226	$ 219	$ 213	$ 206	$ 200
	Pesticides	$ 294	$ 286	$ 277	$ 269	$ 261	$ 253	$ 245	$ 238	$ 231
	Consultants	$ 46	$ 45	$ 43	$ 42	$ 41	$ 40	$ 38	$ 37	$ 36
	Insurance & Irrigation	$ 140	$ 136	$ 132	$ 128	$ 124	$ 120	$ 117	$ 113	$ 110
	Machinery, Fuel	$ 205	$ 198	$ 192	$ 187	$ 181	$ 176	$ 170	$ 165	$ 160
annual profit % increase	Labor	$ 148	$ 144	$ 140	$ 135	$ 131	$ 127	$ 124	$ 120	$ 116
	Harvest	$ 553	$ 537	$ 521	$ 505	$ 490	$ 475	$ 461	$ 447	$ 434
2.0%	Profit	$ 1,253	$ 1,278	$ 1,304	$ 1,330	$ 1,356	$ 1,383	$ 1,411	$ 1,439	$ 1,468
Gross Feedstock - cost/acre		$ 3,090	$ 3,060	$ 3,032	$ 3,006	$ 2,983	$ 2,961	$ 2,941	$ 2,924	$ 2,908
	gross - cost/# sugar	$ 0.125	$ 0.120	$ 0.116	$ 0.111	$ 0.107	$ 0.103	$ 0.100	$ 0.096	$ 0.093
$125	Cattle feed	$ 905	$ 905	$ 905	$ 905	$ 905	$ 905	$ 905	$ 905	$ 905
Net of Feedstock - cost/acre		$ 2,185	$ 2,155	$ 2,127	$ 2,101	$ 2,078	$ 2,056	$ 2,036	$ 2,019	$ 2,003
NET - cost/# sugar		$ 0.089	$ 0.085	$ 0.081	$ 0.078	$ 0.075	$ 0.072	$ 0.069	$ 0.067	$ 0.064
Feedstock Cost/Sustainable Jet Fuel Gallon		$ 1.91	$ 1.83	$ 1.75	$ 1.68	$ 1.61	$ 1.55	$ 1.49	$ 1.43	$ 1.38
DRAFT		Processing Cost/Sustainable Jet Fuel Gallon							DRAFT	
		Demonstration			Scale up			FULL SCALE		
	Feedstock transformation	$ 0.60	$ 0.60	$ 0.60	$ 0.50	$ 0.50	$ 0.50	$ 0.40	$ 0.42	$ 0.40
	Utilities	$ 0.45	$ 0.45	$ 0.45	$ 0.35	$ 0.35	$ 0.35	$ 0.30	$ 0.28	$ 0.26
	Labor	$ 0.38	$ 0.38	$ 0.38	$ 0.34	$ 0.34	$ 0.34	$ 0.29	$ 0.28	$ 0.25
	Capital recovery	$ 0.35	$ 0.35	$ 0.35	$ 0.30	$ 0.30	$ 0.30	$ 0.25	$ 0.23	$ 0.21
	Chemicals	$ 0.25	$ 0.25	$ 0.25	$ 0.20	$ 0.20	$ 0.20	$ 0.18	$ 0.16	$ 0.14
	Logistics	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.16	$ 0.14	$ 0.12
	Administration	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.20	$ 0.16	$ 0.14	$ 0.12
	Markup (20%)	$ 0.49	$ 0.49	$ 0.49	$ 0.42	$ 0.42	$ 0.42	$ 0.35	$ 0.33	$ 0.30
	SUBTOTAL	$ 2.91	$ 2.91	$ 2.91	$ 2.51	$ 2.51	$ 2.51	$ 2.09	$ 1.98	$ 1.80
Cost per Sustainable Jet Fuel per Gallon										
SUBTOTAL		$ 4.82	$ 4.74	$ 4.66	$ 4.19	$ 4.12	$ 4.06	$ 3.58	$ 3.41	$ 3.18
RFS - D5 RIN Credit		$0.75	$0.75	$0.75	$0.75	$0.75	$0.75	$0.75	$0.75	$0.75
NET Wholesale Cost of SJA Fuel per Gallon										
SJAF		$ 4.07	$ 3.99	$ 3.91	$ 3.44	$ 3.37	$ 3.31	$ 2.83	$ 2.66	$ 2.43
Jet Fuel	3%	$1.45	$1.49	$1.54	$1.58	$1.63	$1.68	$1.73	$1.78	$1.84
NET Wholesale Cost of SJA Blended Fuel Gallon										
Blended	50%	$ 2.76	$ 2.74	$ 2.72	$ 2.51	$ 2.50	$ 2.49	$ 2.28	$ 2.22	$ 2.13

Figure 5: Target Supply Chain Yield Improvement

Field of Sorghum plants
Source http://agriculturewire.com/us-new-experimental-grain-sorghum-shows-high-yield-potential/

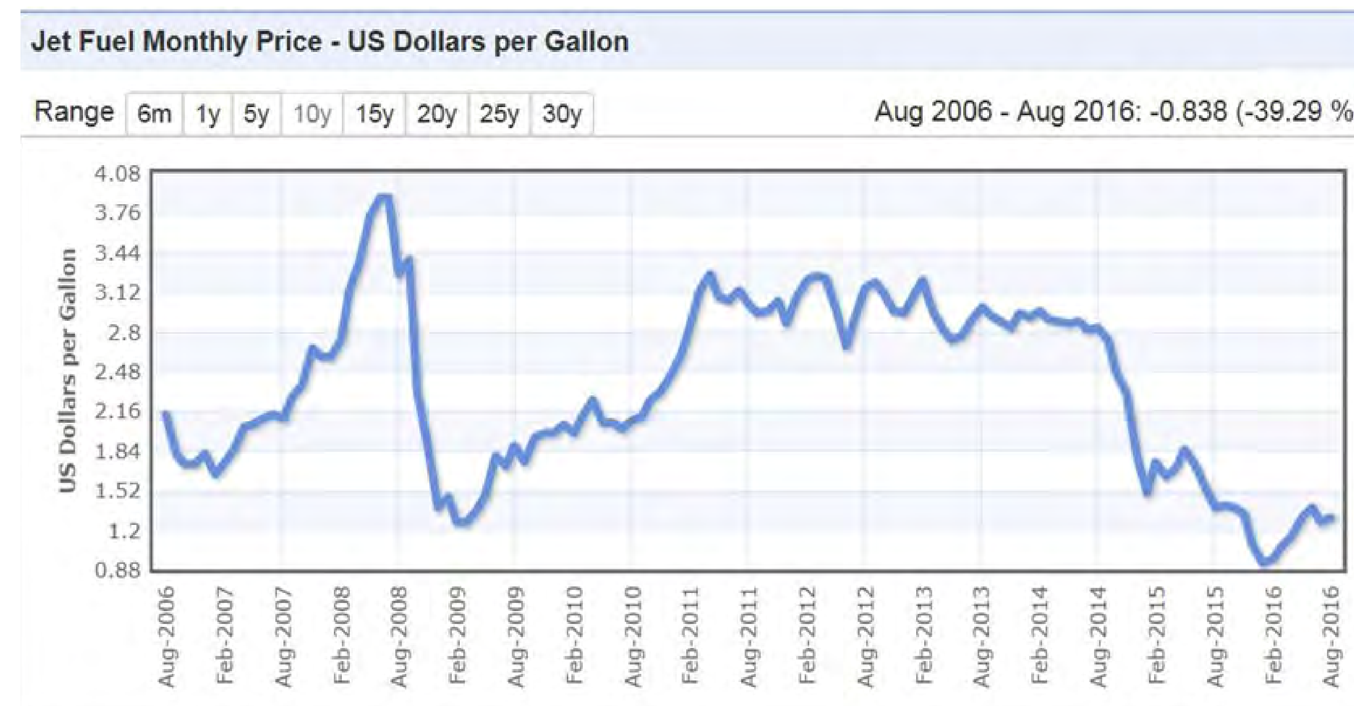
Cattle eating Sorghum feed
Source http://www.stepbystep.com/how-to-feed-cattle-sorghum-34470/

Zane R. Helsel, PhD
Emeritus Extension Specialist in Agriculture Energy with Rutgers Cooperative Extension and Rutgers University
Courtesy Professor of Agronomy University of Florida

"Sweet sorghum has been designated by the United States Department of Energy as a potentially viable biofuel crop for the Southeast. There are numerous reasons for considering sweet sorghum as a bioenergy crop in Florida. It can be established as part of a rotation, with the potential of more than 400 gallons of ethanol per acre in four months, compared to sugarcane, with the potential of 700 gallons of ethanol per acre in twelve months."

- Zane R. Helsel, Emeritus Extension Specialist in Agriculture Energy with Rutgers and Courtesy Professor of Agronomy with University of Florida

As stated in Section 6.0a of this report, airlines' demand for SAJF is contingent on the product being sustainably produced and cost competitive. The economic pro formas suggest that the cost of production of FL sugar-based SAJF renders the product uncompetitive with conventional petroleum jet fuel today. The point in the decade-long scale-up process at which FL sugar-based SAJF could become cost competitive is largely contingent on the price of conventional jet fuel. If one assumes jet fuel prices grow at a slow, but steady rate from current prices which have ranged from $.98 to $1.38 over the past six months (February through August, 2016), cost-competiveness will never be realized.[10] However, conventional jet fuel prices have been highly volatile over the last decade and are currently at historically low prices. When comparing the projected full-scale production cost of FL sugar-based SAJF to conventional jet fuel prices over the past ten years, one can conclude price competiveness would have been achievable about 50% of the time.



Description: U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price FOB

Unit: US Dollars per Gallon

Figure 6: Jet Fuel Monthly Price - US Dollars per Gallon [11]

[10] Jet Fuel Monthly Price – US Dollars per Gallon http://www.indexmundi.com/commodities/?commodity=jet-fuel accessed 28 September 2016.
[11] Ibid.

It is worth noting that a significant part of SAJF product economic projections is the estimated revenue from the sale of RINs under the RFS. While RIN prices have also been highly volatile in recent years, current advanced biofuel RIN prices are trading at between $.95 and $1.00, reflecting potential for a $.20 to $.25 production cost improvement over the costs reflected in the pro forma.

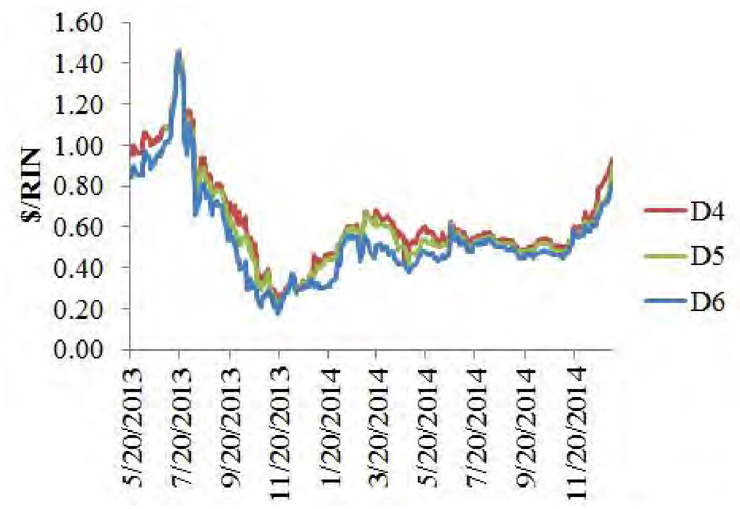


Figure 7: Historic RIN Prices

One element of project economics that is clear and not highly dependent on volatile market fluctuations, is the substantial improvement in production economics when feedstocks can be converted to SAJF or precursor products at a nearby commercial-scale plant, rather than in batches at plants in far-flung places. In order to improve the likelihood of and accelerate the timeline to FL sugar-based SAJF industry profitability, an SAJF conversion plant should be constructed in Florida or nearby as soon as possible.

KEY CHALLENGE:

Production economics will not likely be price-competitive until a new sugar-to-SAJF (or an immediate precursor product) plant is built in or near South Florida. Even then, cost-competitiveness is contingent on fluctuations in prices of conventional, petroleum-based jet fuel. Further, biofuel companies engaged in this study require supply contracts of substantial volume and pre-determined price, in order to proceed with plant siting, design and construction.

PATHWAY TO RESOLUTION:

The project team should intensify current efforts to facilitate creation of a project development plan and timeline agreeable to growers and biofuel company(ies) that minimizes time to plant construction and operation, and thereby moves the project to profitability as soon as possible.

7.0 Sustainability

The airline industry is demanding SAJF, not AJF. Top of mind for the vast majority of airlines is the sustainability of the fuels. As with every SAJF project in the world, some of the sustainability issues to be considered, like climate change, are universal, while many others are specific to the project and are driven by local and regional dynamics. There are a number of economic, social and environmental sustainability considerations that must be accounted for in this project – chief among them are:

- **Florida farming history and culture**
- **Job creation/maintenance**
- **Food vs. fuel**
- **Climate Change**
- **Water Quality**

The Roundtable on Sustainable Biomaterials (RSB) out of Europe has become the platinum standard for assuring SAJF project development adheres to rigorous criteria. Specifically, RSB provides a global standard and certification scheme for sustainable production of biomaterials and biofuels. The project team has engaged RSB in this feasibility study and the larger project and will work with growers and processors to achieve RSB certification.

Following is more detail on each of the priority sustainability issues that have been flagged for this project.

KEY CHALLENGE:

Ensuring SAJF produced is truly sustainable.

PATHWAY TO RESOLUTION:

Engage RSB in this feasibility study and the larger project, and work with growers and processors to achieve RSB certification.

a. Climate Change

The global carbon footprint from jet fuel constitutes somewhere in the range of 4% of global GHG emissions, and without aggressive mitigative efforts, including SAJF scale-up, the industry carbon footprint is projected to steadily and substantially grow over time.

The global airline industry has aligned around sustainability criteria for SAJF that includes a requirement for reduction in the lifecycle GHG emissions from the fuel relative to conventional, petroleum-based jet fuel. Practically, the SAJF that is being produced in the world today typically boasts lifecycle GHG emission reductions in the range of 50% to 90%, relative to conventional jet fuel. While a rigorous life cycle GHG analysis has not yet been conducted for the production pathways under development by this project, preliminary assessments indicate these fuels will deliver emissions reductions in this same range. As noted in the Federal Policy and Regulatory Considerations section below, a rigorous lifecycle GHG assessment is a top priority next step for the project.

b. Water Quality

- **Septic tank sludge management**
- **Nutrient runoff and drainage management**
- **Valuation of environmental benefits**

The Florida Oceanographic Society has reported that high nitrogen levels in the estuary and coastal waters is causing algae blooms, negatively impacting fish, oyster reefs, sea grass habitat and near-shore reefs.[12]

Source www.icao.int/environmental-protection/CarbonOffset/PublishingImages/CarbonCalculator.png

[12] ORCA Kilroy Water Quality Station Data. (July 2016). Retrieved from https://www.floridaocean.org

Stakeholders engaged in this project repeatedly point to local water quality concerns as among the most material environmental issues facing the region. Further, the impacts that any new agricultural endeavors might have on water quality – to its detriment or benefits, are top priority. Of indirect relevance to this project, there is a growing awareness of complicating nutrient loading factors, unrelated to agricultural activity, that must be accounted for, as well. A recent study completed by Martin County, Florida, found septic systems to be a significant part of increasing nitrogen loading in waterways.[13]

http://floridahikes.com/wp-content/uploads/2011/12/Orlando-Wetlands-Park-scene.jpg

As this feasibility study progressed and it became clear that the issue of climate change would be equaled or trumped by water quality as a top priority environmental concern associated with standing up an SAJF industry in South Florida, the project team decided to take steps to acquire funding to study the potential to mitigate these concerns through a follow-on project. The proposed project study, "Combining Environmental & Natural Resource Economic Gain with Sustainable Renewable Energy Crop Scale-up in South Florida," seeks to:

- **identify and pursue a multiyear scale-up of sustainable energy crops**
- **define environmental and economic opportunity created by the strategies identified under the Rural Development program**
- **bring to bear paradigms and innovative techniques being developed to analyze and control nutrient runoff, including, but not limited to, the use of buffer crops to absorb excess nutrients (phosphorus and nitrogen)**

Those paradigms will be applied on a watershed level, such as to the Indian River watershed in Florida's Treasure Coast region in South Florida. The proposed project seeks to enhance both environmental and economic gains by addressing, simultaneously, the creation of end products of value, added quantifiable environmental gains from avoided water remediation costs through the advancement of understanding of potential for success of various sustainable agriculture incentive programs, and through the composition of the project team to include environmental NGO and government interests in the area of GHG and water resources, enable a united effort to put St. Lucie County and the state of Florida in a leadership position to successfully align stakeholders to jointly advocate for and achieve lasting sustainable growth prospects.

[13] LaPointe, B., Herren, L. 2015 Martin County Watershed to Reef Septic Study. Final Report. Presented to the Martin County Board of County Commissioners. March 4 2016

c. Law and Policy

- **Local restrictions**
- **Permitting requirements**
- **Policy and regulatory considerations**

KEY CHALLENGE:

Stakeholders have voiced concerns over project implications on already severely compromised local water quality, in particular in the Indian River Lagoon.

PATHWAY TO RESOLUTION:

The project team has already taken significant steps to procure funding for an ancillary study to quantify the potential value of a scaled SAJF supply chain to local water quality and to explore policy and best management practices that could be applied.

Ed Fielding
County Commissioner
Martin County, FL

"Over a period of time, we have been developing the steps to develop this and achieve the economies and make this system work. It is close to being able to be implemented. I see the ag business being interested because we have the interim step that is quite necessary – the processors – the companies who will take the initial product, the juices, and make them into the end product."

- Ed Fielding
Martin County Commissioner

Federal Policy and Regulatory Considerations

RIN CREDIT GENERATION

Revenues from RIN credits under the Renewable Fuel Standard (RFS2) that could be generated from the production of SAJF from this initiative significantly improve production economics and could accelerate scale-up. In order to generate RINs for sale, a number of EPA requirements must first be met. Top priority among these requirements is EPA approval of a renewable fuel production pathway that documents the ability to generate a specific kind of RIN (D-code(s)) with a specific combination of feedstock(s), production process(es), and finished products (fuel types). The production pathways contemplated in this study are not currently approved RIN-generating pathways.

As the petition process, including ultimate approval of a new pathway, is understood to take up to two years, it is paramount that the project find resources to commence this process in short order. The lifecycle GHG assessment component of this process takes time, resources and requires rigorous adherence to modeling protocols. Details on other components of this process can be found in the EPA regulations (Title 40, Chapter 1, Part 80, Subpart M, §80.1416). The project team should accelerate current efforts to initiate the lifecycle GHG assessment as a critical precursor step to applying for approval of the RIN generation pathway(s). Note, as well, the issue of concern over duplicate credit generation and proposed pathway to resolution detailed in the section on USDA below.

KEY CHALLENGE:
The production pathways contemplated in this study are not currently approved RIN-generating pathways.

PATHWAY TO RESOLUTION:
The project team should accelerate current efforts to initiate the lifecycle GHG assessment as a critical precursor step to applying for approval of the RIN generation pathway(s).

Department of Energy BioEnergy Technology Office (DOE BETO) Project Support

To date, the DOE BETO office policy has limited its engagement in the execution of pilot production of jet fuel from alcohols created from Florida-grown industrial sugars. DOE BETO has funded ATJ pathway development work through a flight program with Virgin Atlantic Airlines. BETO has not supported to date testing of Florida alcohols that likely will not reach the status of "ethanol fuel quality" under the Virgin Atlantic program.

Project staff consider it reasonable and have approached DOE BETO staff to consider the testing of Florida alcohols, using DOE funds, if funding support is limited to specific alcohols which Lanzatech would like to study in order to help ensure the commercial viability of the ATJ pathway at their Soperton, GA facility. Use of this pathway will likely depend on ethanol production being pursued in Florida under a separate funding source.

KEY CHALLENGE:
To date, the DOE BETO office policy has limited its engagement in the execution of pilot production of jet fuel from alcohols created from Florida-grown industrial sugars.

PATHWAY TO RESOLUTION:
Additional efforts should be made by the project team to advance discussions with DOE BETO on this topic.

Title 1

Title 1 to the USDA Food Commodity program (called the commodity program in general terms) lays out the terms for which subsidies may be paid for food commodities, of which sugar is one. Pursuant to project visits with the EPA and USDA, it is clear both agencies are averse to allowing the feedstock to qualify for credits under the commodity program and the finished fuels to qualify for RIN credit generation under the RFS2.

One approach to resolving this issue under discussion among the project team is to propose the use of chemical markers that will translate into the sugars produced. Project agriculture research experts have indicated that such an approach is practical. The project team should request that USDA via ARS/NIFA recommend an approach that will be acceptable to EPA and USDA commodity management focals that will enable RIN generation.

KEY CHALLENGE:
EPA and USDA are averse to allowing project feedstock to qualify for credits under both Title 1 to the USDA Food Commodity program and the RFS2.

PATHWAY TO RESOLUTION:
The project team should request that USDA via ARS/NIFA recommend an approach that will be acceptable to EPA and USDA commodity management focals that will enable RIN generation.

Source
www.hoosieragtoday.com

Crop Insurance

It is critical to the adoption of the proposed energy crop rotation by growers that the energy crops be insured to levels equivalent to food crops under programs administered by Farm Services Administration. To date, the project has ascertained that suitable programs do exist at the Federal level. However, there has not yet been a specific finding that the energy crops under consideration can apply to these programs.

Project leadership needs to establish if the subject crops will be eligible for non-food crop insurance programs and communicate to growers the specifics of those terms. If the crops do not presently qualify, the project should seek to secure assurances of applicability as part of the project scale up.

KEY CHALLENGE:
It is critical to growers that the energy crops be insured to levels equivalent to food crops under programs administered by Farm Services Administration.

PATHWAY TO RESOLUTION:
Project leadership needs to establish if the subject crops will be eligible for non-food crop insurance programs and communicate to growers the specifics of those terms.

Canan Balaban
Associate Director
Florida Energy
Systems Consortium

"The TCERDA led program to produce sustainable alternative jet fuel (SAJF) was initiated with $700,000 funding from the Florida Office Energy to grow industrial sugar beets in St. Lucie area as an alternate energy crop. The follow up feasibility study funding from USDA Florida State Rural Development Office and Ben DeVries' great leadership brought all the stakeholders together including producers, processors, and airlines. The program demonstrated the feasibility of sustainable cultivation and processing of industrial sugar and starch crops including beets, tubers, sweet sorghum and cane to produce SAJF, ethanol, renewable diesel, and dairy cattle feed. The foundation now is in place for a scale up. Great leadership, strong team to make Florida one of the Hubs of SAFJ production."

\- Canan Balaban
Florida Energy Systems Consortium
Associate Director

Tod Mowery
County Commissioner
Vice Chairman
St. Lucie County

"....it is about change, and there is a change in this industry that we're talking about, and we're going to be a part of it, and we're excited about that, and we hope you'll be involved with this as well."

\- Tod Mowery
St. Lucie County Commissioner and
Vice Chair, St. Lucie County

Larry Lee
Florida State Representative
District 84

"Whatever we can do from the state level, we're here to serve and help."

\- Larry Lee
Florida State Representative
District 84

Richard Machek
USDA Rural Development
State Director of Florida
and Virgin Islands

"There is a lot of potential out there. Not only in the fuel part of it but it's the by products – the byproducts. Guess what? Any of you cattleman, if you ship your cattle out to Oklahoma or somewhere to fatten them up it costs you six or seven cents a pound to send them out there. What if you had the byproduct? You could have the fattening pens right here in Florida – full cycle right here. So there is potential out there."

\- Richard Machek
USDA Rural Development, State Director of
Florida and Virgin Islands

Stan Mayfield steam explosion equipment

8.0 Transforming Raw Beet to Sugar, Feed Pellet, and Ethanol

Plant Inspection and Feasibility Demonstration Reports

by David Dodds, PhD

PLANT INSPECTIONS

Between November 8th -10th, four facilities in Florida were toured as part of the effort to see what existing capital assets might be used for the F2F program. The four facilities were; Stan Mayfield biorefinery in Perry, Renewable Spirits in Winter Haven, Tropicana in Fort Pierce, and Peace River Citrus in Bartow.

STAN MAYFIELD

This was built by the University of Florida, which still owns the equipment, but is on land owned by Georgia Pacific. The plant was built as a demo plant for cellulosic ethanol production using Professor Lonnie Ingram's E.coli platform. That project was funded by a grant from the State of Florida and successfully completed. As the project is complete the plant is now idle, a buyer or other arrangement is being actively sought by the university.

The plant was designed to run on sugarcane bagasse, and used a "steam explosion + acid" biomass pretreatment process followed by enzymatic hydrolysis to give both 5-carbon and 6-carbon sugars, which were then fermented to ethanol. The ethanol was recovered in a single stage rectifying column coupled with a pervaporation membrane to produce 98% ethanol as the final product.

Prof. Ingram has handled beets at bench scale and expressed the belief that chopped beets could be sent through the horizontal hydrolyser (without acid) at 120C to 190C. This would need to be tested with several hundred pounds of chopped beets. There is also a horizontal centrifuge which might be useful to separate excess liquid, if this is necessary. The fermenters available have volumes from 2 gal to 10,000 gal.

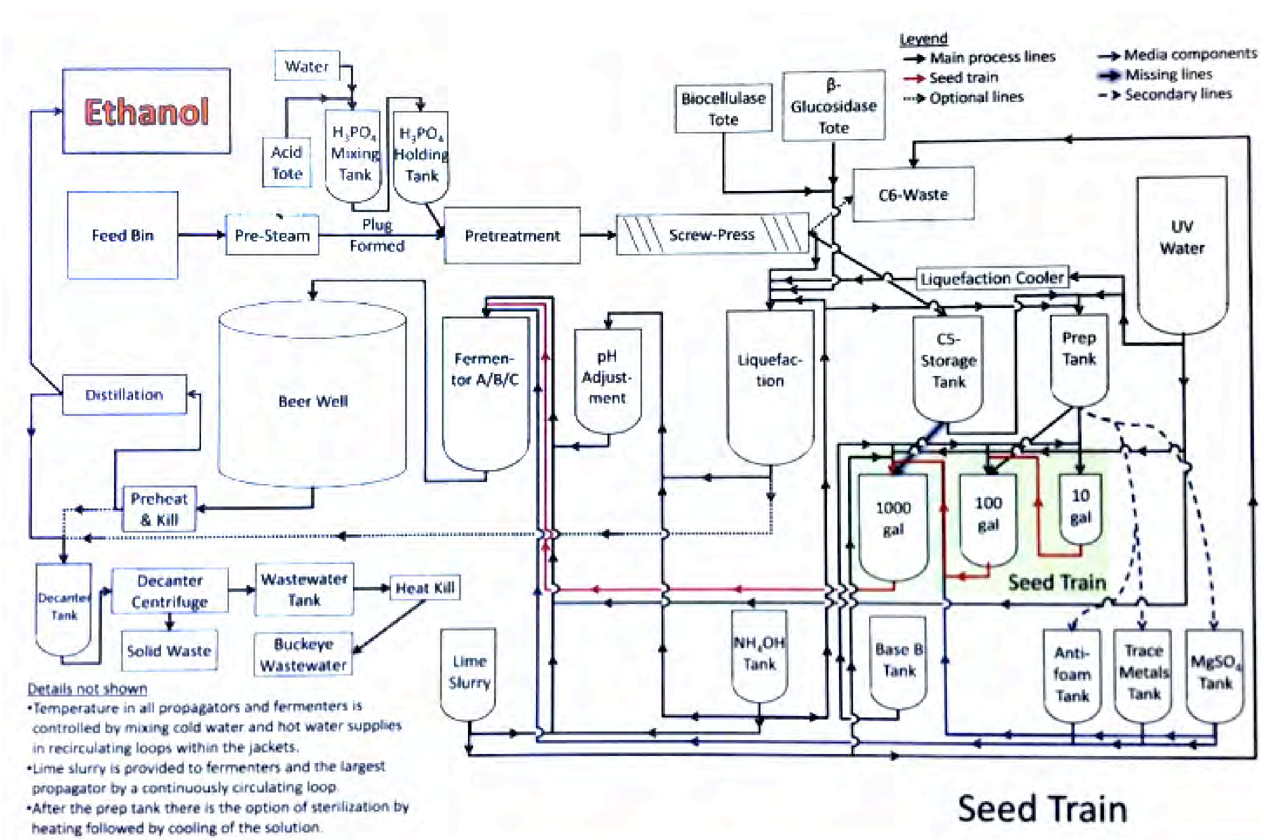
A process flow diagram of the process is attached. The beets would be run from the feed bin, through all steps into liquefaction, fermentation, into the beer well and then distillation. The beets contain sufficient water (70%) that the moisture content of the process streams running from the pre-treatment and pre-steam steps would contain very nearly the same solid/moisture ratio of the bagasse process that has been run in the plant. The bagasse was air-lifted from the unloading pad, and this would not be possible with beets; a conveyor would be necessary,

Stan Mayfield plant

probably transporting the beets as pieces after chopping. A chopper (or suitable mill) would need to be placed outside the main building on the unloading pad to accomplish this.

This system would be best used for producing as much ethanol as possible from the entire beet, including the pulp. It would produce very little residual pulp for the cattle feed market, but would produce some amount of DDGs that could be mixed with beet pulp from another process for pelletizing.

With the exception of the ethanol rectifier, the entire plant is enclosed and in good condition. There is also space on the enclosed pad that has full head space and could accommodate equipment need to test the conversion of ethanol to jet fuel, to install intermediate scale fermentors or other temporary equipment for process testing. A control room with the necessary computers and software is present, along with labs for analytical work and the necessary microbiology.



Stan Mayfield process flow diagram

RENEWABLE SPIRITS

The equipment here is used to process citrus peel and even whole fruit culls, and is a larger scale version of the steam jet cooker that has been discussed for processing beets. The plant processes citrus peel by steam explosion to extract citrus oil before fermentation of sugars contained in the remaining slurry. No enzymes are used, so the entire cooked pulp is fermented "as is". The equipment has been privately assembled and has been arranged empirically to operate on citrus peel. The products are ethanol and limonene. The fruit peel is chopped and run into a jet cooker, with the resulting slurry pumped through a tube reactor to give an adequate residence time for breakdown of the pulp. The pressure is let down in a flash tank, and limonene is recovered via steam distillation of the slurry during the pressure let down. The slurry is sent to the fermentor, where it undergoes further liquefaction with enzymes and followed by fermentation to ethanol. A distillation package produces 95% ethanol with the remaining stillage transported by tanker for cattle feed. Chopped beets could likely be fed into the point where citrus peel is now charged to the process.

TROPICANA

A complete description of the operation of a full commercial scale citrus plant was provided. After the juice is removed from the citrus fruit, the peel is chopped, mixed with lime to break down the pectin, and then run into screw presses to recover the juice from the peel. This is steam-distilled to recover the limonene, and the resulting material sent through multi-effect evaporators to produce a high Brix syrup. To fit with the existing citrus harvest, beets would have to wait until about mid-May or the beginning of June for processing.

PEACE RIVER CITRUS

A tour of the peel process part of this plant was provided, and the company was very excited to arrange it. The tour was of the portion of the plant that handles the citrus peel after the juice has been removed (the juicing section would not be useful for the beet project). The peel (grapefruit at the time of the tour) is first run through a hammer mill; a photo of the resulting material is attached. Lime (calcium hydroxide) is added at about 1-2% by weight, and the resulting process stream is mixed in a large screw-mixer / conveyor that take about 12-15 minutes to bring the mixture to a screw press. During this time, the lime breaks down the pectin, which is necessary for the press to work effectively. The material entering the screw press is about 80% moisture, which would be close to the moisture level of chopped and milled beets. The juice from the pressing is steam-stripped to remove limonene, and then run through an evaporator train to give a high Brix syrup. The remaining solids are sent through a rotary dryer to reduce the moisture content to approximately 10-12%. The resulting material is sent to a pellet mill. Photos of the pulp before and after drying, as well as of the pellets, are attached.


Peace River citrus plus lime after hammer mill


Peace River citrus plus lime after pressing


Peace River citrus after drying


Peace River citrus pellets

SUMMARY

There are four facilities that could be used with minimal alteration. The Stan Mayfield facility is designed and equipped to ferment the entire sugar beet material, both the sucrose and the pulp, to produce exclusively ethanol with a small amount of DDGs. The peel operations of the citrus mills could produce both a high-Brix sugar stream plus pellets for cattle feed; no limonene would be produced as no limonene is present in sugar beets. The DDGs from the Stan Mayfield facility could be brought to one of the citrus mills and added to the process stream going to pellets immediately before the dryer step.

FEASIBILITY DEMONSTRATION

The simplest feasibility test considered was the processing raw sugar beets through the peel section of an existing citrus processing plant. The goal was to determine if the existing peel processing operation of a citrus mill is able to process a new feedstock, sugar beets, while making no changes in either operating conditions or equipment but while also maintaining two of the three product streams of the mill; solid material for cattle feed, and a sugar stream. (The third product stream from citrus peel operations, limonene, cannot be produced as limonene is not present in sugar beet.)

As the moisture, solids and pectin content of the sugar beet is very similar to citrus peel, the risk of a non-productive result was considered minimal. Of chief concern was whether the lime treatment of the sugar beet would give sufficient digestion of the pectin to allow proper functioning of the screw presses for separation of the juice (containing the sucrose) and the residual solid pulp.

The Tropicana peel processing facility at Ft. Pierce was made available for this study during the second week of June, 2017, following completion of commercial citrus processing. 20 tons of beets were purchased and shipped to the Tropicana facility, and were processed on June 14, 2017 with a high degree of success.

The beets were unloaded from the transport truck and loaded into the process at the point where culls and other citrus material would be charged to the peel processing equipment, and the whole, raw beets were moved without difficulty by several auger transporters. No bridging or other issues were encountered. Some hold-up of material in an intermediate storage bin did occur, but this was due to the very low volume of material that was being processed, and would not be an issue of the plant were operating with a higher volume of beets.

The beets were treated with lime and passed through the hammer mill without any changes to the lime charging or other operating conditions of the Tropicana facility. After reaction with lime (conducted exactly as with citrus peel) the beet material was sent to screw presses. These appeared to perform normally, although the operators reported needed to apply a slightly higher operating pressure than with citrus peel. The solid material exiting the screw presses appeared very similar to citrus material, although the operators reported it seemed to have a slighter higher water content. A picture of this material is attached, and can be compared to the picture of the citrus material exiting the screw press at the Peace River facility. The appearance of the two materials is only different in color, with the beet material being a drab brown color rather than the yellow/orange color of the citrus peel.

Both the higher operating pressure of the screw presses and the slightly greater water content of the material exiting the presses did not pose any operational issue, and could probably be mitigated by decreasing the size of the screens on the hammer mill, or a slightly longer reaction time with the lime.

The solid material exiting the screw press went to the rotary drier. The material dried very quickly, reaching a water content of less than 5%. This was probably due to low volume of material being dried, rather than to the beet material itself. A picture of this material is attached, and should be compared to the dried citrus material from the Peace River plant. Again, the color difference is visible, but the beet material has a more fibrous appearance and texture. In appearance, texture, and odor, the dried beet material reminded everyone in the plant of shredded wheat breakfast cereal, with some of the team describing the odor as being similar to baked pie crust. Samples of this material were recovered for analysis of nutritional content for cattle feed.

The dried beet material was judged to dry to run into the pellet mill, and an effort was made to raise the moisture content of this material. This was achieved, but the material was then probably too moist for pelleting and it produced only a small number of pellets before the pellet dies plugged. However, it was clear to the team that if a charge of beets comparable to the standard amount of citrus peel were being run, rather than the very low volume that was available for the demonstration, that the pelleting would very likely proceed successfully with only small adjustments to the drying.


A sugar beet at the Tropicana site


Wet beet pulp exiting the screw press at the Tropicana site


Beet pulp after drying, before going to the pellet mill at the Tropicana site

The raw juice exiting the screw press clearly contained a large amount of very fine particulate matter, possibly from soil residue present on the surface of the beets or embedded in the surface of the beet itself. The juice stream was sent to the evaporation equipment to produce molasses, and the equipment appeared to function

normally with no operational issues. Due to limitations of steam supply, evaporation proceeded to give molasses of just over 30 Brix, rather than 60 Brix as intended. However, this was strictly due to steam supply, and unrelated to the beets.

Samples of both the dried beet material and the molasses were sent for analysis, including testing of the beet pulp for cattle feed, and the molasses for fermentation by Gevo, Amyris, and Global Bioenergy, and fermentation to ethanol to be provided to Lanzatech for further conversion to jet fuel.

In summary, the demonstration run was a nearly complete success. The low volume of beets, only 20 tons in a plant designed to handle 3,000 tons on a daily basis, prevented the completion of the pelleting process, but this did not interfere with the production of material for testing as cattle feed. The evaporation step was limited by steam supply unrelated to the beets, but sufficient molasses was produced to allow testing for the production of renewable aviation fuel.

Samples of both the molasses and dried beet pulp were sent to Cumberland Valley Analytical Services in Waynesboro, PA. Cumberland Labs provides analyses for cattle feed, and the standard analyses were performed on two samples each of the molasses and the dried beet pulp. The results are attached in Appendix D. A document provided by Cumberland Labs explaining each of the tests is also included in this appendix.
The results indicate that both the dried pulp and the molasses are very similar to the dried pulp and molasses from citrus peel and can provide the same feedstock to the cattle industry as is currently provided by citrus peel. A nutritional assessment of the dried beet pulp was made by Holly Ballantine and Larry Davis.

> *"This beet byproduct is comparable to citrus pulp and will supply usable fiber and sugar for energy requirements. This byproduct analysis indicates this is an appropriate feed for dairy and beef rations."*
>
> *- Larry Davis, United Feed Co-Op, Inc.*
> *and*
> *Holly T. Ballantine, PhD, Dairy Nutrition*

The molasses product will probably require further treatment before being used for fermentation as it likely contains residual oils and organic acids from the citrus peel material that was sent through the machinery prior to the sugar beets, and these materials are known to inhibit fermentations. This situation would be avoided if the citrus peel plant were run at full capacity using only sugar beets so that there would be no residue from citrus peel.

This demonstration run shows that it is clearly possible for citrus peel operations to be immediately used to process raw sugar beet with no changes in equipment and minimal changes in operating conditions, while maintaining the output of existing cattle feed material and molasses.

9.0 Roadmap

We agreed that Florida F2F Project teams' goals going forward should be:

1. Produce SAJF in Florida from Florida grown feedstock
2. Secure long term Florida grower commitment to feedstock cultivation
3. Ramp up grower planting in sync with in-place ABF/SAJF production capacity and added capacity as needed
4. Engage airline stakeholders along with existing Florida commercial aviation Fuel Consortium at all major Florida hubs starting with ABF/SAJF offtake agreements at Ft. Lauderdale, Orlando, or Miami pursuant to willingness of the major operators.
5. Expand our current airline stakeholders (jetBlue, American, Delta, United, FedEx, DOD) to included other parties that have expressed interest (e.g. Delta, UPS)
6. Ensure that cattle feed and other co-product production leveraging Citrus processing facility partnership outcomes and multiple fuel and chemical processor opportunities.
7. Create an action plan that has the potential to produce 200 MGY of Florida SAJF as well as cattle feed and coproduct as early as 2020 as well as approaches to maximize the resiliency of the supply chain as factors of production and markets beyond fuel production optimize at varying rates.

Following is a first cut at our F2F Year 1 to Year 4 action plan from here:

1. Write up a one page program description of our plan to replace the equivalent of one Deep Water Horizon of fossil fuel (200 MGY) with Florida grown and processed ABF & SAJF by 2020 for review with airline stakeholders and DOD (DLA Energy) as well as processor stakeholders.

2. Secure letters of support from F2F airline stakeholders, growers, processors to create a Florida SAJF supply chain by 2020 for presentation to FL FDACS and Department of Citrus, the Florida Citrus industry, USDA,DOE, EPA, DOT, Florida's congressional delegation, benefiting localities and airline end users and cattle feed customers. The process at this time can best begin with pursuit of a USDA Rural Development, Value Added Producer Grant and in Federal FY 17. Where appropriate and applicable this pathway and other similar approaches may require private contributions.

3. Approach stakeholder Airlines and as appropriate Airline Fuel Consortium managers at Orlando, Ft. Lauderdale and Miami (at a minimum) to approveseek the purchase of Florida produced ASTM qualified /RSB certified renewable diesel for ground services and sustainable Jet (SAJF) fuels consistent with the following schedule to foster ABF SAJF feed stock cultivation.

4. Based on favorable outcomes of the Tropicana test (sec. 8.0) seek to work to the following schedule:

Work to the following schedule subject to supply chain commitments.

A. Year 1

   i. Plan for industrial sugar processing from beets grown in Florida capable of producing 100,000 gal renewable diesel by proven processors and/or 50,000 gallons of SAJF from existing facilities outside Florida provided by those processors.
   ii. Produce levels of cattle feed for in state consumption from, the initial processing facility and acreages of beet feedstocks.
   iii. Build the commercial plan for a single citrus processing facility predicated on scale up outcomes (see section 8) utilizing funding from public sources shared with private sector using the USDA Value added producer grant mechanism of other equivalent programs.

B. Year 1.5 - Initiate planning process for added scale up for the initial and/or added facilities capable of producing.

   i. Industrial sugars capable 250,000 gal renewable diesel produced in Florida (250 acres ABF) and/or 125,000 gallons of SAJF in Florida Feedstock).
   ii. Production of commensurate cattle feed production suitable for production and consumption in Florida.
   iii. Initiate discussion to develop processing plant development with proven processors to process renewable Diesel and/or jet or ethanol in FL as well as sustainable co-products. Include the multiple project stakeholders identified in the report and/or other established sustainable bioproduct producers.

C. Year 2

   i. Secure industrial sugar production and capable of supporting the processing of 1,000,000 gal renewable diesel produced inside and/or outside Florida (1,000 acres) and or 500,000 gallons of renewable jet from citrus processors or other entities ABF.
   ii. Establish initial agreements with a candidate processor or processor identified in Year 1 +.
   iii. Plan to optimize supply chain resilience to maximize economic benefits and possible environmental gains.

D. Year 2+

   i. Secure industrial sugar production capable of production 5,000,000 gal renewable diesel and or 2.5 million SAJF for production outside Florida (from 5,000 acres ABF Feedstock) and multiple citrus

processors excess capacity and/or idle facilities.
   ii. Ensure that animal feed co-product market including distribution plans are matured with multiple identified FL citrus producers.
   iii. Update resiliency and environmental planning as results warrant.

E. Year 3 - Plan for commercial operations in Florida
   i. 10,000,000 gal renewable diesel produced in Florida (10,000 acres ABF Feedstock).
   ii. 10,000,000 gal SAJF produced in Florida and expand diesel integration into ground operations and logistics.
   iii mature animal feed commercial production and distribution including consideration of export (outside FL) as markets and product quality justify.

F. Year 3+ – Commercial operations
   i. 50,000,000 gal renewable diesel produced in Florida (50,000 acres ABF Feedstock).
   ii. 50,000,000 gal SAJF produced in Florida and expand diesel integration of SAJF into ground operations and logistics.
   iii Expand animal feed commercial production and distribution predicated on Year 2 experience and market supply/demand.

G. Year 4 – Commercial operations
   i. 100,000,000 gal renewable diesel produced in Florida (100,000 acres ABF Feedstock).
   ii. 100,000,000 gal SAJF produced in Florida and expanded diesel integration into ground operations and logistics.
   iii Animal feed production and distribution implementation as warranted and required along with added coproduct production as identified by processors.

H. Year 4+ – Commercial operations
   i. 200,000,000 gal renewable diesel produced in Florida (200,000 acres ABF Feedstock).
   ii. 200,000,000 gal SAJF produced in Florida and expanded integration of SAJF into ground operations and logistics.
   iii Cattle feed and added co-product production commensurate with citrus processor and fuel and chemical processors participants and the optimal approach to and economic/environmental resiliency.

10.0 Next Steps

Near to mid-term next steps in the interest in moving the section 9 roadmap are recommended as follows.

1. Secure the complete analysis of outputs from the section 8 tests in Appendix D to establish
   a. Specific scale up requirements for sugar and feedstock output optimization from Brownfield citrus facilities
   b. Obtain results from the processing of industrial sugars and or ethanol to inform scale up development
   c. Fully engage cattle feed coops in both the assessment and the development of plans for the utilization and scale up of cattle feed production.

2. Inform and integrate, and merge the efforts of SAJF/ABF processors and interested citrus processors (as well as other possible approaches to rapid feedstock to sugar outputs in collaboration with F2F grower participant's to enable and present a cohesive supply chain in the pursuit of the above roadmap.

3. Inform and forge alliances with State (FDACS, Department of Citrus, and others) as well as local county interests prepared to invest resources in scale up activities what can be supported by Public / private partnerships. Start with but do not limit to pursuit of the FY17 Rural Development Value added producer grant to support commercial planning for road map implementation.

4. Inform end user stakeholders, environmental interests and others who can add their requirements and constraints to project development needs to ensure full supply chain engagement going forward. Include the consideration of added co-products production end users to maximize commercial appeal to processors to enhance the competitiveness of Florida based development.

5. Secure agreements of supply chain participants to continue to participate in and contribute to scale up including but not limited to airline, ground transport, marine diesel and cattle feed buyers. Do so by seeking engagement of those interests in support of the above roadmap and via subsequent follow-up programs.

APPENDIX A

Amyris-Total Letter of Support

AMYRIS | TOTAL

June 5, 2015

Mr. Ben DeVries
Chief Executive Officer
Treasure Coast Education, Research and Development Authority (TCERDA)
2199 South Rock Road
Fort Pierce, FL 34945

Re: Non-Binding Letter of Support for TCERDA's Energy Sugar-to-Biojet Facility Project

Dear Mr. DeVries:

As you know, due to the success of Amyris and TOTAL's Direct Sugar to Hydrocarbon ("DSHC") biorefinery process, which converts sugar feedstocks into an ASTM International synthesized hydrocarbon turbine fuel, TCERDA held exploratory discussions with Amyris and TOTAL regarding possible interest in TCERDA's proposed Energy Sugar-to-Biojet Facility Project (the "Proposed Project"). While many details of the Proposed Project remain incomplete at this time, TCERDA asked if Amyris and TOTAL would submit a non-binding, letter of support regarding the Proposed Project so that TCERDA can further pursue and attract necessary governmental and stakeholder support.

Consequently, Amyris and TOTAL provide this non-binding letter as a statement of their interest to continue to explore the Proposed Project with TCERDA, including the feasibility of constructing a DSHC biojet manufacturing facility in Florida. Amyris and TOTAL desire to note that their interest in the Proposed Project beyond additional discussions is conditioned upon the Proposed Project's realization of:

- 10-year supply contracts for raw sugar at a cost of ≤ $0.10/lb;
- 900,000 to 1,500,000 MT of raw sugar/year supplied under those contracts (i.e., TRS - sugar availability (@ 67 brix/700 kg/m³ sugar concentration));
- Guarantees by the State of Florida regarding the supply and pricing under these contracts;
- State and local financial support for the DSHC plant's utilities and infrastructure;
- Low-cost, long term lease of land that has current or potential rail access;
- Access to cost-effective hydrogenation CMOs to transform the farnesene into biojet;
- Biojet offtake agreements for 75% of the DSHC plant's design volume;
- State and local property and income tax abatement;
- The extension of the federal RFS2 legislation and approval of a pathway to enable RIN capture; and
- Stakeholders' assistance with obtaining regulatory and environmental approvals.

Additionally, given the time required for feedstock development, facility design/construction, and regulatory approvals, Amyris and TOTAL reiterate to TCERDA that they cannot commit, under any circumstances, to a DSHC facility commissioning prior to 2020.

Amyris and TOTAL greatly appreciate the opportunity to participate in the Proposed Project, and we look forward to understanding more aspects of the Proposed Project as TCERDA progresses it.

Sincerely,

James A. Iacoponi
Vice President, Renewable Fuels
Amyris, Inc.

Jean-Marc Otero-del-Val
Deputy Senior Vice President, Biotechnologies
TOTAL, S.A.

APPENDIX B

Stakeholder Meeting Summaries & Agendas

January 7, 2016 Agenda

9:00 am – 10:00 am	Tour (optional)	Trolley
10:30 am – 11:10 am	Registration	Reception
11:00 am – 12:15 am	Panel Discussion Introductions: TCERDA Chair - Mike Adams ***Defining Advance Biofuel Leadership*** Moderator: Patrick Sheehan, ex-FDACS Office of Energy - End User: Rich Altman, CAAFI - Grower: Tom Lindsey, IFCO - Processor: Fernando Garcia, Amyris/Total - Agronomy: Brian Boman, PhD, UF IFAS - Seed: Frank Turano, PhD, CEO, Plant Sensory - Government: Ed Fielding, Commissioner Martin County	Room 219
12:15 am – 12:30 pm	Break & Networking	Reception
12:30 pm – 1:30 pm	Luncheon & Remarks Tod Mowery, Commissioner, St. Lucie County USDA Check Hand off - Florida USDA RD Director - Richard Maychek - St. Lucie County Commissioner Chair – Kim Johnson	Room 219
1:30 pm – 1:45 pm	Break & Networking	Reception
1:45 pm – 2:45 pm	Roundtables: What's the Right Question? Four Working Groups (Facilitator, Scribe, Timekeeper) Feedstock Regulation Logistics Finance	Room 219
2:45 pm – 3:00 pm	Afternoon Break & Networking	Reception
3:15 pm – 3:45 pm	General Session: Next Steps	Room 219

January 7, 2016 Summary

The Treasure Coast Economic Research and Development Authority (TCERDA), along with partners USDA Rural Development, St. Lucie County, University of Florida, University of Florida Extension, Commercial Aviation Alternative Fuels Initiative (CAAFI), Indian River St. College, and St. Lucie Public Schools, hosted a kick-off meeting of the Florida Farm to Fly 2 (F2F2) initiative at the Treasure Coast Research Park in Fort Pierce, FL on January 7, 2016. Participants included more than 80 individuals from key stakeholder groups including: feedstock/crop growers; processors and technical service companies; fuel companies; end users/buyers; community leaders and local, state and national governments, and; environment and sustainability organizations (NGOs).

The following tables summarize the prevailing messages shared by participants during a series of presentations, organized roundtable discussions and "in the margin" conversations. The roundtable discussions took place in four groups (Green, Red, Blue and Yellow), all of which were structured to include at least one representative from each stakeholder group, where possible.

F2F2 STUDY GROUP – STAKEHOLDER MATRIX

Supply Chain Success Factor	Grower	Processor	End user	Govt	EnvirNGO
Maximum yields; Co-products; minimum inputs, price and quantity risk, volatility	X	X			
ASTM specification, reliable supply, competitive market pricing			X		
Sustainable job creation, food, energy water security				X	
Sustainable land use, improved air and water quality, resolve food vs fuel debate				X	X

STAKEHOLDER FEEDBACK

Supply Chain Success Factor	Grower	Processor	End user	Govt/NGO
Growers need near-term, interim income generating solutions ($/acre/year)	X			X
Growers need long-term purchase commitments i.e. off-take agreements	X			
Growers want to keep growing – need new, profitable, market flexible crop options and creative, revenue generating complimentary uses for land i.e. seed processing facility, cattle grazing	X			X
Demonstrate field performance of crops; prove intermediate product yields, etc.	X			
Sugar beets need to be round-up ready (significant productivity implications) per growers	X			
Demonstrate field performance of crops; prove intermediate product yields, etc.	X			
Partnership is essential (local government, seed companies, co-op)	X	X	X	X
Logistics and infrastructure needs are important and should be explored		X	X	X
Renewable fuel must ultimately be cost-competitive (end-users/buyers); concern (based on back-of-the-envelope math) that economics won't work if RJF must be cost competitive with conventional jet fuel, given current global energy prices	X		X	
Multiple sugar crops/year-round growth and co-products are essential to making economics work	X	X		
Legislation, regulation and policy must level the playing field (i.e. need Farm Bill supports for crop (B-cap, crop insurance, etc.)	X			X

SUCCESSFUL FARM2FLY2.0 FEASIBILITY STUDY

F2F2 Study Deliverables	Grower	Processor	End user	Govt/NGO
Identify viable intermediate income-generation potential for growers	X			X
Identify what can Fed/state/county agencies do to help (permitting requirements)	X			X
Identify potential barriers to success and possible strategies to overcome them • Grower access to capital (loan availability up to $300K, 7-year loans, loan flexibility/ability to weather highs and low, catastrophic weather/climatic events; USDA loan guarantee program as possible means solution) • Sustainability concerns • Adequate purchase commitments/off-take agreements to secure financing • Consistent, reliable flow of money through the supply chain • Failure to create a sustainable economic model	X			X
Identify steps required to overcome food vs. fuel debate for this project				X
Identify potential value-adding co-products	X	X		
Identify logistics and infrastructure needs (ideal locations for intermediate and final processing facilities; rail access is currently limited)		X		
Quantify the sustainability value proposition – the economic, social and environmental value - to the county and state	X	X	X	X
Map the timeline/pathway to profitability and ASTM certification (identify opportunities to reduce cost); map the supply chain and quantify economics and production potential of multiple crops and coproducts	X	X	X	X

FORWARD VIEW OF SUPPLY CHAIN SUCCESS

Long-Term Indicators of Success	Grower	Processor	End user	Govt/NGO
Growers are growing and land is retained for agricultural production	X			X
Sustainable endeavor (environmental, social and economic)	X	X	X	X
Supply chain profitability (growers, processors, distributors, fuel companies, etc.) a. shared risks/shared rewards (length of purchase contracts/off-take agreements) b. guaranteed cost recovery for growers (price floor, crop insurance, etc.) c. long-term (3-yr, 7 yr, or more) purchase/off-take agreements (for intermediate products from growers) d. partnership (seed, growers, processors, fuel companies, government) e. economics must work (government role, recognize this is a new industry) f. value-added products (i.e. pulp, coke) g. right-priced feedstocks (crops) h. competitive fuel price	X	X	X	X
Legislative, regulatory and policy supports/parody are consistent with other crops and fuels e.g. crop insurance FSA, B-cap eligibility, Title I Exemption, etc.	X		X	X
Supply certainty to end users			X	
Minimum of 15,000,000 gallons of annual renewable jet fuel production		X	X	
Fuel meets ASTM specifications			X	

January 7, 2016 Summary continued

Study Timeline and Milestones

1. Stakeholder Focus Groups	February – March	April - June
a. Growers	individual & group calls TBD	Working group meeting TBD
b. Processors	individual & group calls TBD	Working group meeting TBD
c. End users	individual & group calls TBD	Working group meeting TBD
d. Environmental Groups	individual & group calls	Working group meeting
e. Financiers	individual & group calls	Working group meeting
f. Government	individual & group calls	Working group meeting

2. Policy & Infrastructure Milestones	
a. Growers	See Supply Chain Development Below
b. Processors	See Supply Chain Development Below
c. End users	TBD
d. Environmental groups	TBD
e. Financiers	TBD
f. Government	TBD

3. Supply Chain Development Targets to achieve Sustainable BioChem Feedstock Market

2017 Stage I (100 acres)	April – May	June – July		August September
a. Grower	sugar 1,000 tons			
b. Processors		ethanol 100,000 gallons		
c. End users - Aviation			SAJ	33,500 gallons
d. End users - Transportation			Renewable Diesel	33,500 gallons

2018 Stage II (1,000 acres)	April – May	June – July		August September
a. Grower	sugar 10,000 tons			
b. Processors		ethanol 1,000,000 gallons		
c. End users - Aviation			SAJ	335,000 gallons
d. End users - Transportation			Renewable Diesel	335,000 gallons

2019 Stage III (10,000 acres)	April – May	June – July		August September
a. Grower	sugar 100,000 tons			
b. Processors		ethanol 10,000,000 gallons		
c. End users - Aviation			SAJ	3,500,000 gallons
d. End users - Transportation			Renewable Diesel	3,500,000 gallons

FULL SCALE COMMERCIAL CULTIVATION AND PROCESSING

2020 Stage IV (50,000 acres)	April – May	June – July		August September
a. Grower	sugar 500,000 tons			
b. Processors		ethanol 50,000,000 gallons		
c. End users - Aviation			SAJ	17,500,000 gallons
d. End users - Transportation			Renewable Diesel	17,500,000 gallons

April 26, 2016 Agenda

Time	Farm2Fly Feasibility Study Sponsored by Treasure Coast Education, Research and Development Authority (TCERDA)	Bioenergy Feedstock Production in Florida's Heartland Sponsored by South Florida State College (SFSC)
8:00 – 10:00 am	**Room 100A** - Registration and Networking; **Moderator Patrick Sheehan** Welcome & Introductions **Mr. Ben DeVries**, CEO TCERDA – Feasibility Study Update and Roadmap to Scale Report **Keynote Speaker: Dr. Lisa Conti**, Deputy Commissioner and Chief Science Officer at Florida Department of Agriculture and Consumer Services • Room 100A	
10:00 – 12:00 pm	10:00 – **Session 1A – Stakeholder Break-Out Session Topics & Discussion Leader Team • GROWERS: Room 100A** 10:05 - Individual Processor presentations to Grower Working Group 11:05– Grower Working Group Forum, joint discussion on target F2F project output, Crop data types & metrics; **Dr. Maninder Singh**, UF Agronomy Department. Facilitator **Ben DeVries** **END USERS: Room 102** 10:05 - Individual Processor presentations to End User Working Group 11:05 - End user Working Group Forum, targeted F2F2 project output. Facilitator **Mr. Rich Altman**. **PROCESSORS: Room 106** 10:05 – Individual presentations to growers and end user Working Groups. 11:05 – Processor Working Group Forum joint discussion on targeted F2F2 project output, Randall Bowman. Facilitator **David Dodds**.	10:00 - **Session 1B – Production and Bioprocessing of Industrial Sugar Crops for Advanced Biofuels • Room 219** Moderated by **Dr. Grace Danao**, SFSC 10:05 – **Dr. Pratap Pullammanappallil**, UF Agricultural and Biological Engineering Department (biogas production) 10:25 – **Mr. Terry Felderhoff**, UF Microbiology and Cell Science Department (genetic improvements of sweet sorghum) 10:45 – **Dr. Maninder Singh**, UF Agronomy Department (energy beets production) 11:05 – BREAK 11:10 – **Dr. John Erickson**, UF Agronomy Department (sweet sorghum and cultivation and management 11:30 – **Dr. Gillian Eggleston**, USDA Agricultural Research Service (processing of sweet sorghum) 11:50 – BREAK
12:00 – 1:00 pm	**LUNCH • Room 219A** (Box lunches will be served) Speakers: ❖ **Mr. Mark Satterlee**, Deputy Administrator, St. Lucie County and **Mr. Richard Machek**, State Director of USDA Rural Development for Florida/U.S. Virgin Islands	
1:00 – 2:30 pm	1:00 – BREAK 1:15 – **Session 2A, Room 100A** ❖ Update on "Fit for Purpose" Beet Processing **Dr. Christina Dorado, Dr. Randall Cameron, Scott Stevenson** **Working Group Forum Summary Reports - Room 100A** • Breakout session reports • Critical success factors • Working group assignments • Timeline for next steps	1:00 – **Session 2B – Production and Bioprocessing of Oilseeds, Algae and Woody Biomass • Room 219** Moderated by **Dr. Grace Danao**, SFSC 1:05 – **Dr. Andy Seepaul**, UF Agronomy Department (*Brassica caranata* production) 1:25 – **Mr. Peter McClure**, Terviva (pongamia production and management) 1:45 – **Dr. George Philippidis**, USF Patel College of Global Sustainability (biomass algae production and processing) 2:05 – **Mr. Randall Bowman** (woody biomass production and gasification) 2:25 – BREAK
2:30 – 3:00 pm	**Room 100A** - Joint Concluding Remarks **Moderator Patrick Sheehan**	
3:00 – 4:00 pm	**Tour** of Treasure Coast Research Park and USDA Labs (Please RSVP at REGISTRATION)	
6:00 pm?	**"NO HOST" Dinner** – Attendees are invited to reconvene and share local cuisine and conversation.	

October 20, 2016 Agenda

Time	The Future of Sustainable Aviation Jet Fuel (SAJF) Feedstock in Florida Sponsored by the Treasure Coast Research Park
9:00 – 10:00 am	**Registration and Networking**
10:00 – 10:20 am	**Welcome & Introductions** ❖ **Host, Mr. Ben DeVries, CEO TCERDA** ❖ **Rich Altman, Director Emeritus, Commercial Aviation Alternative Fuels Initiative (CAAFI)**
10:20 – 12:30 pm	**Roundtable - The Future of SAJF Feedstock in Florida** **10:20 – Ben DeVries** [Update - Florida Farm2Fly 2.0 Feasibility Study; polysaccharide based Sustainable Aviation Jet Fuel (SAJF) Feedstock Supply Chain by the Numbers] **10:40 – Rich Altman** [CAAFI state initiatives, water quality impact framework, End user purchase agreements, & purchase targets] **11:10 – Amy Lyons** [Update – Beet cultivation & United Feed Coop purchase agreement] **11:40 – David Dodds & Randall Cameron** [Update - Steam explosion technology for field processing of beet to sugar syrup and shredded beet pulp] **12:00 – Q&A, Invited Discussion, & Wrap up**
12:45 – 1:45 pm	**Lunch** (Please RSVP at REGISTRATION for free of charge lunch) ❖ **Keynote Speaker: Joseph Mueller, Assistant Director of USDA Rural Development for Florida/U.S. Virgin Islands**
2:00 – 3:30 pm	**Breakout – CHALLENGES & NEXT STEPS** **1) Production Economics** **2) Policy & Regulatory Barriers** **3) Sustainability & NGO Validation**
3:30- 3:45 pm	**WRAP UP**
5:30 – 8:30 pm	**"NO HOST" Dinner –** Attendees are invited to reconvene and share local cuisine and conversation. (Please RSVP at REGISTRATION)

APPENDIX C

TCERDA F2F2 Project Working Group Roster

Florida Farm to Fly 2.0 - ABF Supply Chain Working Group

Name_Last	Name_First	Organization	Role
Abbey	Jennifer	USDA NCRS	Federal Government
Adams	Mike	Adams Ranch	Grower
Adams	Aaron	Lazy Arrow Farms	Grower
Albrick	Chris	Blume Energy	Fuel Processor
Altman	Richard	CAAFI	Facilitator
Anker	Shari	SLC Conservation Alliance	NGO
Ashby	Erik	REG Life Sciences, LLC	Fuel Processor
Babson	David	Union of Concerned Scientists	NGO
Bachelor	Jane	TCERDA	TCERDA
Baer	Michael	US Airways	Airlines
Bainter	Brett	Ducks Unlimited Florida	NGO
Balaban	Canan	University of Florida - FESC	Scientist
Bartz	Linda	St Lucie County Commissioner	Local Government
Batalini	Jim	SLC Free Trade Zone	Government
Bernhardson	Duane	BetaSeed	Grower
Boman	Brian	University of Florida IFAS - FESC	Grower / Scientist
Botelho	Michael	USDA Rural Development	Federal Government
Bournique	Doug	Indian River Citrus League	Grower
Bowes	Ed	SLC Audubon	NGO

Name_Last	Name_First	Organization	Role
Bowman	Randall	University of Florida	Scientist
Bramble	Barbara	National Wildlife Foundation	NGO
Britt	Gerald	University of Florida	Research
Bronson	Stan	Florida Earth Foundation	NGO
Brown	Kevin	South Florida State College	Scientist
Cameron	Randall	USDA ARS	Federal Government
Campbell	Todd	USDA Rural Development	Federal Government
Caron	Susie	St Lucie County Commissioner's Aide	Local Government
Case	Laurie	St Lucie County	Government
Cassidy	Chris	USDA Rural Development	Federal Government
Cave	Ronald	University of Florida	Scientist
Center	Tim	Sustainable Florida - Collins Center	NGO
Challacombe	Jonrob	Farm Credit	Lender
Chanin	Peter	Corner Stone Resources	Processor
Charles	Lee	Florida Audubon Society	NGO
Cheney	Patrick	Colvin & Co, LLP	Grower
Colvin	Greyson	Colvin & Co, LLP	Grower
Comer	Bruce	Ocean Park	Distributor
Conti	Lisa	FDACS - Office of Energy	Government
Cooper	Stuart	Zenviba Tech Company	Processor

Name_Last	Name_First	Organization	Role
Cooper	Kevin	Indian River State College	Scientist
Corrick	Dennis	Dean Mead	Civic
Cruse	Chuck	MetLife	Lender
Danao	Mary-Grace	South Florida State College	Scientist
Dantzler	Rick	USDA FSA	Federal Government
Davis	Larry	United Feed Co-Op inc	Grower
Davis	Ken (& Donna)	Davis Citrus, Inc.	Grower
Davis	Spencer	Farm Credit	Lender
Davis	Megan	Florida Atlantic University	Scientist
Dedea	John	UPS	Airlines
DeVries	Ben	TCERDA	Facilitator
Dillman	John	BetaSeed	Seed Producer
Dodds	David	Dodds & Associates	Facilitator
Domen	Michael	DLA Energy	Fuel Processor
Dooley	Tim	Blue Goose Properties	Grower
Dorado	Christina	USDA ARS	Scientist
Drager	Eric	Audubon Florida	NGO
Duke	Garrett	Duke Citrus Caretaking	Grower
DuVall	Dean	Alaska Airlines	Airlines
Dzadovsky	Chris	St Lucie County Commissioner	Local Government

Name_Last	Name_First	Organization	Role
Eggleston	Gillian	USDA ARS	Scientist
Elena	Schmidt	Standards Development Director, RSB - Roundtable on Sustainable Biomaterials	NGO
Erickson	John	University of Florida IFAS - FESC	Scientist
Fairbairn	John	Colvin & Co, LLP	Grower
Farinos	Jose	TCERDA	Civic
Federhoff	Terry	University of Florida	Scientist
Fielding	Ed	Martin County	Local Government
Fogarty	Nicole	St. Lucie County	Local Government
Freese	Duane	Green City Develpoment Group	Government
Garcia	Fernando	Amyris/ Total	Fuel Processor
Garner	Todd	Proctectfuel	Fuel Distributor
Gerk	Cindy	NREL	Scientist
Gillam	Adam	Citi Bank	Lender
Givens	Stacy	TCERDA	TCERDA
Goodiel	Yvette	Martin County - Hort Ext Agent	Scientist
Griffin	Amy	Environomental Resource Department	NGO
Gruber	Pat	GEVO	Processor
Harmon	Laurel	Lanza Tech	Fuel Processor
Heinicka	Kevin	TCERDA	Civic
Heitkamp	Erin	Wenck Associates	Facilitator

Name_Last	Name_First	Organization	Role
Hicks	Lindsey	DLA Energy	Airlines
Hill	Tom	Farm Bureau	Lender
Hoo	Maurice	Reit Americas	Grower
Hopkins	John	Indian River State College	Government
Hurley	Tom	Becker Farms	Grower
Hutchcraft	Mitch	Kings Ranch	Grower
Iademarco	James	Global Bioenergies	Processor
Jacobs	Michelle	USDA Rural Development	Federal Government
Jerkins	Walter "Tom"	Blue Goose Properties	Grower
Johnson	Jeremiah	TCERDA Liasions	Civic
Johnson	Jeff	St. Lucie County	Local Government
Johnson	Kim	St Lucie County Commissioner	Local Government
Johnston	Glen	US Enviro Fuels - GEVO affiliate	Fuel Processor
Joyner	Mike	Florida Dept of Agriculture and Consumer Services	State Government
Keller	Deb	Nature Conservancy	NGO
Koestoyo	Robin	University of Florida - IFAS	Federal Government
Kozak	Greg	United Airlines	Airlines
Kozak	Robert	Atlantic Biomass Conversions	Scientist
Krohn	Bradley	US Enviro Fuels - GEVO affiliate	Fuel Processor
Lamb	Marshall	USDA ARS	Federal Government

Name_Last	Name_First	Organization	Role
Lamb	Stuart	Viesel Fuels	Processor
Langdale	Jason	Southern Plant	Grower
Lapointe	Brian	Harbor Branch Florida Atlantic University	Research
Leeds	John	FDACS - Office of Energy	State Government
Libsack	Steve	Plant Sensory	Grower/Seed Producer
Lindenfeld	Sara	Jet Blue	Airlines
Lindsey	Tom	IFCO - International Farming Co	Grower
Loeb	Michael	Teri Pinney Associates	Civic
Loveridge	Annmarie	Lakela's Mint chapter of the Florida Native Plant Society	NGO
Lubimir	John	Biome Recovery of Florida	Processor
Lyons	Amelia	BetaSeed	Grower/Seed Producer
Machek	Richard	USDA Rural Development	Federal Government
Matlack	Sandra	USDA ARS	Federal Government
Matthes	Stefan	Culpepper & Terpening INC	Civic
McCants	Gina	TCERDA	Local Government
McClernan	Joe	BetaSeed	Grower/Seed Producer
McClure	Peter	TerViva - Evans Properties	Grower
McCorkle	Sherry	Congressman Thomas J. Rooney	Government
McGinn	Kathy	St Lucie School Board	TCERDA
McGovern	Michelle	Senator Bill Nelson Office	Federal Government

Name_Last	Name_First	Organization	Role
Melville	Erik	Raymond James & Ass.	TCERDA
Mendelsohn	Sophia	Jet Blue	Airlines
Mendez	Yashira	USDA Rural Development (CONTINGENCY)	Federal Government
Meyer	Dave	Lanza Tech	Fuel Processor
Miller	Joey	St Lucie Tire and Battery	Civic
Milliron	John	Mansfield Oil	Distributor
Mitchell	Martin	Clariant	Fuel Processor
Morgan	Russell	USDA NCRS	Federal Government
Mowry	Tod	St Lucie County Commissioner	Local Government
Murdock	Joel	FEDEX	Airlines
Murphy	Travis	River Country Land and Cattle/Grower	Grower
Na	Chaein	University of Florida	Scientist
Nazzaro	Paul	Advanced Fuel Solutions	Processor
Neal	Anita	UF/IFAS Extension - SLCO	Federal Government
Norris	Mrs.	Norris Groves	Grower
Norris	Daniel	Norris Groves	Grower
Olson	Leslie	St Lucie County	Local Government
Opderbeck	Tom	American Airlines	Airlines
Pattison	Charles	1000 Friends of Florida	NGO
Paul	Sheryl	Environomental Resource Department	NGO

Name_Last	Name_First	Organization	Role
Pedraza	Amy	USDA NCRS	Federal Government
Pepper	Aaron	SouthEast Renewable Fuels	Processor
Peter	Gary	University of Florida SFRC - FESC	Scientist
Philippe	Marchand	Amyris/ Total	Fuel Processor
Philippidis	George	University of Florida	Scientist
Pinney	Terri	Teri Pinney Associates	Civic
Posey	Stan	FDACS - Office of Energy	Government
Poyner	Bob	Bernard & Egan	Grower
Pratt	Rip	Indian River Biodiesel	Processor
Pruitt	Ken	St. Lucie County	Local Government
Pullammanappallil	Pratap	University of Florida	Scientist
Reyes	Ismael (Maelo)	USDA NCRS	Federal Government
Richman	Buddy	Synergy Werks	Processor
Ries	Irene-Eva	One More Gereration & SLC Audubon Naturalist	NGO
Rogers	Gaylon	Green City Develpoment Group	Grower
Satterlee	Mark	County Admin	Local Government
Schultheis	Spike	Challenger Ventures Group, LLLC and IRSC	Government
Scully	Brian	USDA ARS	Federal Government
Seepaul	Ramdeo	University of Florida	Scientist
Sheehan	Patrick	The Gregson Group	Facilitator

Name_Last	Name_First	Organization	Role
Sheehan	Matt	Chevron	Fuel Processor
Shepp	Shannon	Florida Department of Citrus	State Government
Singh	Maninder pal	Everglades Research & Education Center	Grower
Skvarch	Edward	UF/IFAS Extension Agent III	Scientist
Sommerfeld	Milton	ASU College of Technology & Innovation	Research
Soucy	Brice	Poseidon Water	Research
Stevenson	Scott	Renewable Spirits	Processor
Stoffella	Peter	TCERDA	Civic
Stone	Charles	Charles Stone Grove	Grower
Sturtz	Robert	World Fuel Services Corp.	Fuel Distributor
Suau	Stephen	Pro Water Source	Civic
Tesch	Peter	Economic Development Council of St. Lucie County	Civic
Tindal	Chris	Navy	Federal Government
Tipton	Howard	County Admin	Local Government
Tomsic	Mark	USDA FSA	Federal Government
Townsend	Cathy	St Lucie County Commissioner	Local Government
Turano	Kathy	Plant Sensory	Seed Producer
Turano	Frank	Plant Sensory	Seed Producer
Walk	Steve	Proctectfuel	Fuel Distributor
Warner	Greg	Synergy Werks	Processor

Name_Last	Name_First	Organization	Role
Wiatrak	John	St. Lucie County International Airport	Local Government
Wilkes	Jerry	Synergy Werks	Processor
Woerner	George	Woerner Ind.	Grower
Wright	Alan	University of Florida	Research
Wyman	Charles	Vertimass	Fuel Processor

APPENDIX D

Please visit the following link to understand the CVAS Lab Report
http://www.foragelab.com/Media/Understanding_Your_CVAS_Forage.pdf

Cumberland Valley Analytical Services
Laboratory services for agriculture ... from the field to the feed bunk.

Type: BEET PULP
Farm: NO FARM NAME
Desc: BEET SILAGE
DEVRIES BEN
TREASURE COAST EDU, RESEARCH & DEV.

Copies to: LYONS, AMELIA
MCCANTS, REGINA
Regression: OH

Lab ID: **22252 072**
Sampled: **06/13/2017**
Arrived: **06/20/2017**
Completed: **07/05/2017**
Reported: **07/05/2017**

BEET SILAGE

SAMPLE INFORMATION			
Lab ID:	22252 072	Series:	
Crop Year:	2017	Version:	1.0
Cutting#:			
Feed Type:	BEET PULP		

CHEMISTRY ANALYSIS RESULTS	
Moisture	7.5
Dry Matter	92.5

PROTEINS	% SP	% CP	% DM
Crude Protein			7.8
Adjusted Protein			7.8
Soluble Protein		53.9	4.2
Ammonia (CPE)			
ADF Protein (ADICP)		9.8	0.77
NDF Protein (NDICP)		11.2	0.88
NDR Protein (NDRCP)			
Rumen Degr. Protein			
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	84.4	18.2
aNDF		21.6
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	11.45	2.47
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)		
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
uNDF (30 hr)		
uNDF (240 hr)		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		50.2	31.1
Water soluble CHO (Sugar)			
Starch		0.9	0.6
Soluble Fiber			
Starch Digestibility (7 hr)			
Fatty Acids, Total (%DM)			
Crude Fat			1.16
Acid Hydrolysis Fat			

MINERALS	
Ash (%DM)	8.32
Calcium (%DM)	1.95
Phosphorus (%DM)	0.14
Magnesium (%DM)	0.20
Potassium (%DM)	1.36
Sulfur (%DM)	0.11
Sodium (%DM)	0.32
Chloride (%DM)	0.31
Iron (PPM)	1019
Manganese (PPM)	61
Zinc (PPM)	37
Copper (PPM)	16
Molybdenum (PPM)	
Selenium (PPM)	
Nitrate Ion (%DM)	

FERMENTATION	
Total VFA	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Propionic Acid (%DM)	
Butyric Acid (%DM)	
Isobutyric Acid (%DM)	
1, 2 Propanediol (%DM)	

ENERGY & INDEX CALCULATIONS	
pH	
TDN (%DM)	72.3
Net Energy Lactation (Mcal/lb)	0.78
Schwab/Shaver NEL (Processed)	
Schwab/Shaver NEL (Unprocessed)	
Net Energy Maintenance (Mcal/lb)	0.81
Net Energy Gain (Mcal/lb)	0.52
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	
NDF Dig. Rate (Kd, %HR, Van Amburgh, iNDF)	
Relative Feed Value (RFV)	
Relative Feed Quality (RFQ)	
Milk per Ton (lbs/ton)	
Dig. Organic Matter Index (lbs/ton)	
Non Fiber Carbohydrates (%DM)	62.0
Non Structural Carbohydrates (%DM)	31.7
DCAD (meq/100gdm)	33.0

Definitions and explanation of report terms

Additional sample information, source and lab pictures

Cumberland Valley Analytical Services
Laboratory services for agriculture ... from the field to the feed bunk.

Type: DISTILLERS SOLUBLES
Farm: NO FARM NAME
Desc: BEET SILAGE
DEVRIES BEN
TREASURE COAST EDU, RESEARCH & DEV.

Copies to: LYONS, AMELIA
MCCANTS, REGINA
Regression: OH

Lab ID: **22252 091**
Sampled: **06/13/2017**
Arrived: **06/21/2017**
Completed: **07/03/2017**
Reported: **07/03/2017**

BEET SILAGE

SAMPLE INFORMATION			
Lab ID:	22252 091	Series:	
Crop Year:	2017	Version:	1.0
Cutting#:			
Feed Type:	DISTILLERS SOLUBLES		

CHEMISTRY ANALYSIS RESULTS	
Moisture	7.9
Dry Matter	92.1

PROTEINS	% SP	% CP	% DM
Crude Protein			7.9
Adjusted Protein			7.9
Soluble Protein		50.6	4.0
Ammonia (CPE)			
ADF Protein (ADICP)		8.7	0.69
NDF Protein (NDICP)		19.2	1.52
NDR Protein (NDRCP)			
Rumen Degr. Protein			
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	84.9	18.3
aNDF		21.5
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	14.45	3.11
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)		
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
uNDF (30 hr)		
uNDF (240 hr)		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		53.0	32.5
Water soluble CHO (Sugar)			
Starch		0.7	0.4
Soluble Fiber			
Starch Digestibility (7 hr)			
Fatty Acids, Total (%DM)			
Crude Fat			0.84
Acid Hydrolysis Fat			

MINERALS	
Ash (%DM)	9.96
Calcium (%DM)	1.95
Phosphorus (%DM)	0.14
Magnesium (%DM)	0.20
Potassium (%DM)	1.34
Sulfur (%DM)	0.10
Sodium (%DM)	0.31
Chloride (%DM)	0.36
Iron (PPM)	1141
Manganese (PPM)	62
Zinc (PPM)	37
Copper (PPM)	15
Molybdenum (PPM)	
Selenium (PPM)	
Nitrate Ion (%DM)	

FERMENTATION	
Total VFA	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Propionic Acid (%DM)	
Butyric Acid (%DM)	
Isobutyric Acid (%DM)	
1, 2 Propanediol (%DM)	

ENERGY & INDEX CALCULATIONS	
pH	
TDN (%DM)	69.7
Net Energy Lactation (Mcal/lb)	0.75
Schwab/Shaver NEL (Processed)	
Schwab/Shaver NEL (Unprocessed)	
Net Energy Maintenance (Mcal/lb)	0.77
Net Energy Gain (Mcal/lb)	0.49
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	
NDF Dig. Rate (Kd, %HR, Van Amburgh, iNDF)	
Relative Feed Value (RFV)	
Relative Feed Quality (RFQ)	
Milk per Ton (lbs/ton)	
Dig. Organic Matter Index (lbs/ton)	
Non Fiber Carbohydrates (%DM)	61.3
Non Structural Carbohydrates (%DM)	32.9
DCAD (meq/100gdm)	31.9

Definitions and explanation of report terms

Additional sample information, source and lab pictures

Cumberland Valley Analytical Services
Laboratory services for agriculture ... from the field to the feed bunk.

Type:	**LIQUID, MISC.**	**Copies to:**	**LYONS, AMELIA**	Lab ID:	**22252 088**
Farm:	**NO FARM NAME**		**MCCANTS, REGINA**	Sampled:	**06/13/2017**
Desc:	**BEET MOLASSES**			Arrived:	**06/20/2017**
	DEVRIES BEN			Completed:	**07/03/2017**
	TREASURE COAST EDU, RESEARCH & DEV.	**Regression:**	**OH**	Reported:	**07/03/2017**

BEET MOLASSES

SAMPLE INFORMATION			
Lab ID:	22252 088	Series:	
Crop Year:	2017	Version:	1.0
Cutting#:			
Feed Type:	LIQUID, MISC.		

CHEMISTRY ANALYSIS RESULTS	
Moisture	75.2
Dry Matter	24.8

PROTEINS	% SP	% CP	% DM
Crude Protein			9.4
Adjusted Protein			9.4
Soluble Protein		72.6	6.8
Ammonia (CPE)			
ADF Protein (ADICP)		3.1	0.29
NDF Protein (NDICP)		3.5	0.33
NDR Protein (NDRCP)			
Rumen Degr. Protein			
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	71.2	0.9
aNDF		1.3
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	196.41	2.57
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)		
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
uNDF (30 hr)		
uNDF (240 hr)		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		71.2	42.3
Water soluble CHO (Sugar)			
Starch		2.3	1.3
Soluble Fiber			
Starch Digestibility (7 hr)			
Fatty Acids, Total (%DM)			
Crude Fat			20.90
Acid Hydrolysis Fat			

MINERALS	
Ash (%DM)	9.35
Calcium (%DM)	1.81
Phosphorus (%DM)	0.20
Magnesium (%DM)	0.24
Potassium (%DM)	1.72
Sulfur (%DM)	0.06
Sodium (%DM)	0.50
Chloride (%DM)	0.62
Iron (PPM)	922
Manganese (PPM)	63
Zinc (PPM)	61
Copper (PPM)	23
Molybdenum (PPM)	
Selenium (PPM)	
Nitrate Ion (%DM)	

FERMENTATION	
Total VFA	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Propionic Acid (%DM)	
Butyric Acid (%DM)	
Isobutyric Acid (%DM)	
1, 2 Propanediol (%DM)	

ENERGY & INDEX CALCULATIONS	
pH	
TDN (%DM)	106.0
Net Energy Lactation (Mcal/lb)	1.20
Schwab/Shaver NEL (Processed)	
Schwab/Shaver NEL (Unprocessed)	
Net Energy Maintenance (Mcal/lb)	1.26
Net Energy Gain (Mcal/lb)	0.90
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	
NDF Dig. Rate (Kd, %HR, Van Amburgh, iNDF)	
Relative Feed Value (RFV)	
Relative Feed Quality (RFQ)	
Milk per Ton (lbs/ton)	
Dig. Organic Matter Index (lbs/ton)	
Non Fiber Carbohydrates (%DM)	59.4
Non Structural Carbohydrates (%DM)	43.6
DCAD (meq/100gdm)	44.5

Definitions and explanation of report terms

Additional sample information, source and lab pictures

Cumberland Valley Analytical Services
Laboratory services for agriculture ... from the field to the feed bunk.

Type:	**LIQUID, MISC.**	**Copies to:**	**LYONS, AMELIA**	Lab ID:	**22252 088**
Farm:	**NO FARM NAME**		**MCCANTS, REGINA**	Sampled:	**06/13/2017**
Desc:	**BEET MOLASSES**			Arrived:	**06/20/2017**
	DEVRIES BEN			Completed:	**07/03/2017**
	TREASURE COAST EDU, RESEARCH & DEV.	**Regression:**	**OH**	Reported:	**07/06/2017**

BEET MOLASSES

SAMPLE INFORMATION			
Lab ID:	22252 088	Series:	
Crop Year:	2017	Version:	2.0
Cutting#:			
Feed Type:	LIQUID, MISC.		

CHEMISTRY ANALYSIS RESULTS	
Moisture	75.2
Dry Matter	24.8

PROTEINS	% SP	% CP	% DM
Crude Protein			9.4
Adjusted Protein			9.4
Soluble Protein		72.6	6.8
Ammonia (CPE)			
ADF Protein (ADICP)		3.1	0.29
NDF Protein (NDICP)		3.5	0.33
NDR Protein (NDRCP)			
Rumen Degr. Protein			
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	71.2	0.9
aNDF		1.3
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	196.41	2.57
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)		
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
uNDF (30 hr)		
uNDF (240 hr)		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		53.4	42.3
Water soluble CHO (Sugar)			
Starch		1.7	1.3
Soluble Fiber			
Starch Digestibility (7 hr)			
Fatty Acids, Total (%DM)			
Crude Fat			1.13
Acid Hydrolysis Fat			

MINERALS	
Ash (%DM)	9.35
Calcium (%DM)	1.81
Phosphorus (%DM)	0.20
Magnesium (%DM)	0.24
Potassium (%DM)	1.72
Sulfur (%DM)	0.06
Sodium (%DM)	0.50
Chloride (%DM)	0.62
Iron (PPM)	922
Manganese (PPM)	63
Zinc (PPM)	61
Copper (PPM)	23
Molybdenum (PPM)	
Selenium (PPM)	
Nitrate Ion (%DM)	

FERMENTATION	
Total VFA	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Propionic Acid (%DM)	
Butyric Acid (%DM)	
Isobutyric Acid (%DM)	
1, 2 Propanediol (%DM)	

ENERGY & INDEX CALCULATIONS	
pH	
TDN (%DM)	80.9
Net Energy Lactation (Mcal/lb)	0.86
Schwab/Shaver NEL (Processed)	
Schwab/Shaver NEL (Unprocessed)	
Net Energy Maintenance (Mcal/lb)	0.91
Net Energy Gain (Mcal/lb)	0.61
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	
NDF Dig. Rate (Kd, %HR, Van Amburgh, iNDF)	
Relative Feed Value (RFV)	
Relative Feed Quality (RFQ)	
Milk per Ton (lbs/ton)	
Dig. Organic Matter Index (lbs/ton)	
Non Fiber Carbohydrates (%DM)	79.2
Non Structural Carbohydrates (%DM)	43.6
DCAD (meq/100gdm)	44.5

Definitions and explanation of report terms

Additional sample information, source and lab pictures


This
"BEETS"
This
200 million gallons of SAJF produced
from 200,000 acres of Florida Farmland
"BEETS"
the 200 million gallons Deep
Water Horizon fossil fuel spill.