

# **SPARC: Southeast Partnership for Advanced Renewables from Carinata**

## **Making the Southeast Carinata Supply Chain a Reality**

**David Wright, Ian Small and S. George**

**Sustainable Aviation in the Southeast: Moving from Strategic to Tactical**

**April 24-25, 2019**

**UT, Knoxville, TN**



**SPARC**





# SPARC

Southeast Partnership for Advanced Renewables from Carinata



**NC STATE UNIVERSITY**



RDL Ag  
Services LLC



# What is carinata?- nonedible oilseed

## Carinata Characteristics

Closely related to rapeseed

Drought and heat tolerance

High oil content

Oil is high in erucic acid

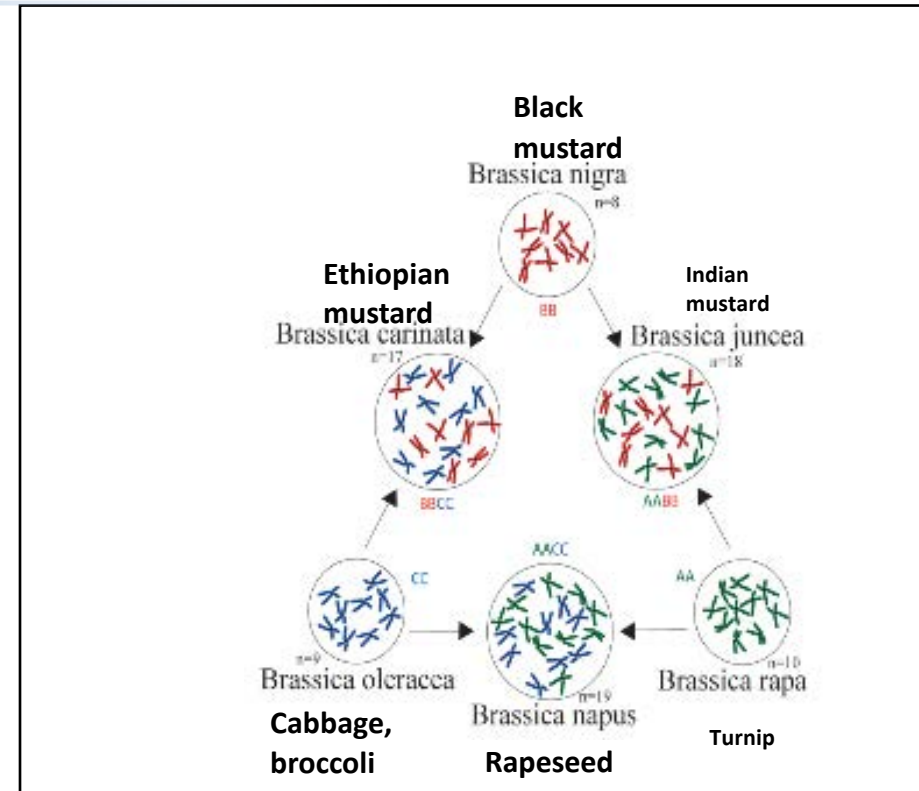
**\*Non-food oilseed crop\***

High protein seed meal

More shatter resistant than  
canola

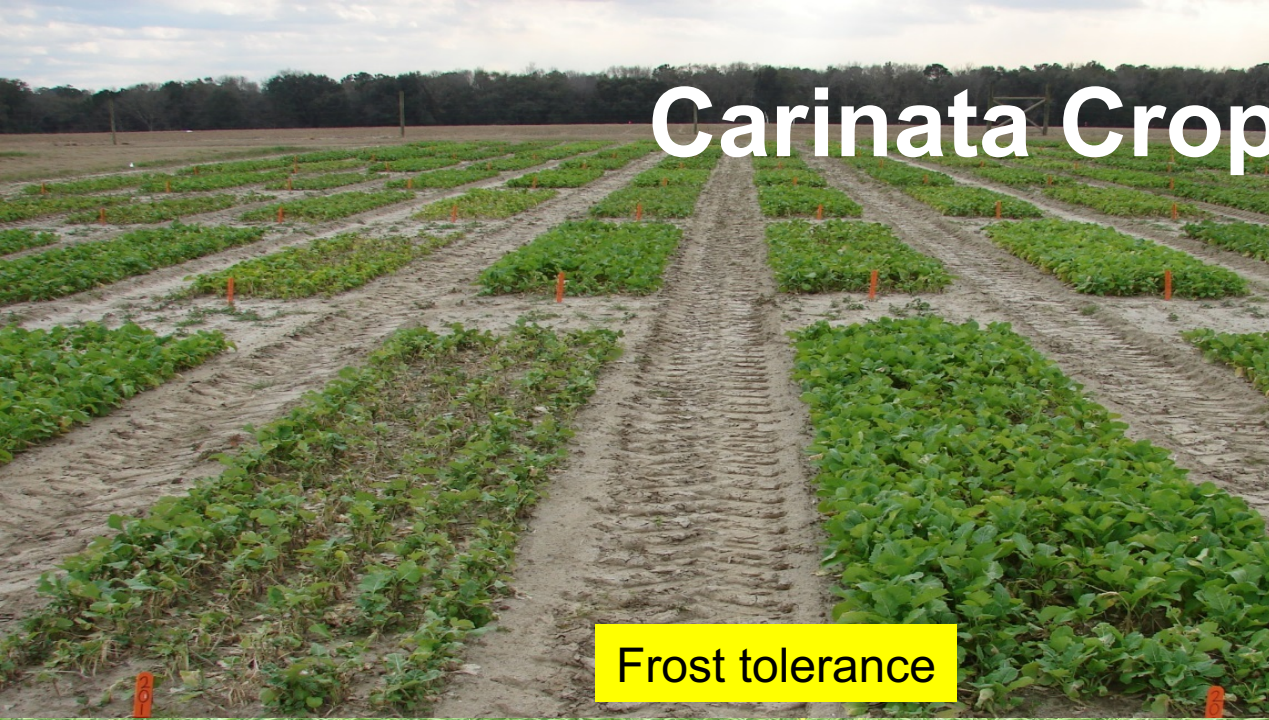
Planted, harvested and processed  
in normal grain channels

## Mustard family (Brassicaceae)

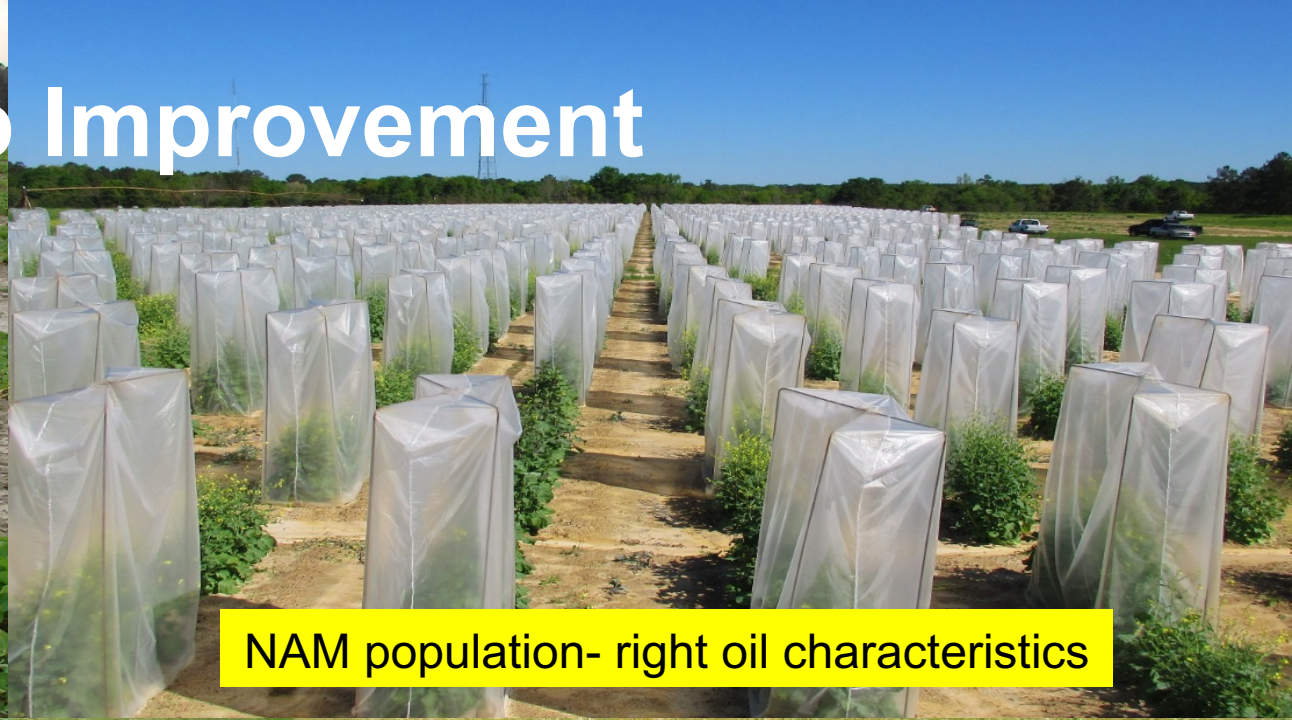


[http://en.wikipedia.org/wiki/Triangle\\_of\\_U](http://en.wikipedia.org/wiki/Triangle_of_U)

# Carinata Crop Improvement



Frost tolerance



NAM population- right oil characteristics



High yielding



Early maturing

Agrisoma investment >\$5 million in SE US to date

# Field in full bloom at the end of March

Emergence/seedling establishment



25 DAP

Vegetative



70 DAP

Bolting



95 DAP

Flowering



120 DAP

Seed development/maturation



145/175 DAP

Seed desiccation



190 DAP



March 11



March 26



April 27



April 15

# Why Carinata?



- Cover Crop – non iLUC (winter grown in SE)
- Seamless fit into existing agriculture production and supply chain systems
- Standard oil seed solvent crush – no waste
- Non-food oil highly suitable for “drop in” biofuels
- High Protein Non GMO meal
- Purposely grown crop that competes with wastes on GHG reduction w/soil health benefits.

# Why Carinata?

## **Crop timing conducive for production and consistent feedstock supply**

- Planted on fallowed underutilized lands
- Planted in fall and harvested in spring in the southeast (No-iLUC)
- Low water footprint
- Double cropped for increased farmer revenue-leaving May-October for summer crop



# What's in a bag of carinata seed?



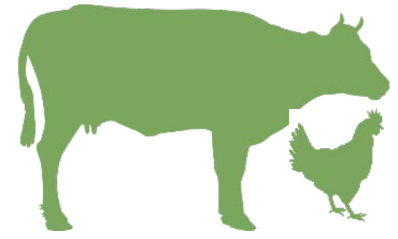
Seed sold to farmers in 50 lb bags to plant 10 acres.



One bag of seed can produce 18 tons of seed.



18 tons of seed produces 2000 gallons of jet fuel which can fly most fully loaded regional jets for 9 hours of flight, from North Florida to California and back.



The residual high-protein meal can be used to produce animal feed or other valuable co-products



# Carinata Fit into SE Cropping Systems



- Carinata fits well in cropping systems in the south as a winter crop (cotton, peanut, soybean, grain sorghum, late corn, etc.)
- No yield penalties are expected with the summer crop following carinata
- Further refinements are being made to make the crop a better fit with other crops for different latitudes
- High yields of both carinata and following crops make this an attractive crop while enhancing soil health and other benefits
- New higher yielding varieties of carinata are being developed which are shorter season that will aid the transition from winter to summer crops along with shorter season summer crops

# Production Goals

**3500 lb seed/acre**



**200 gal oil/acre**



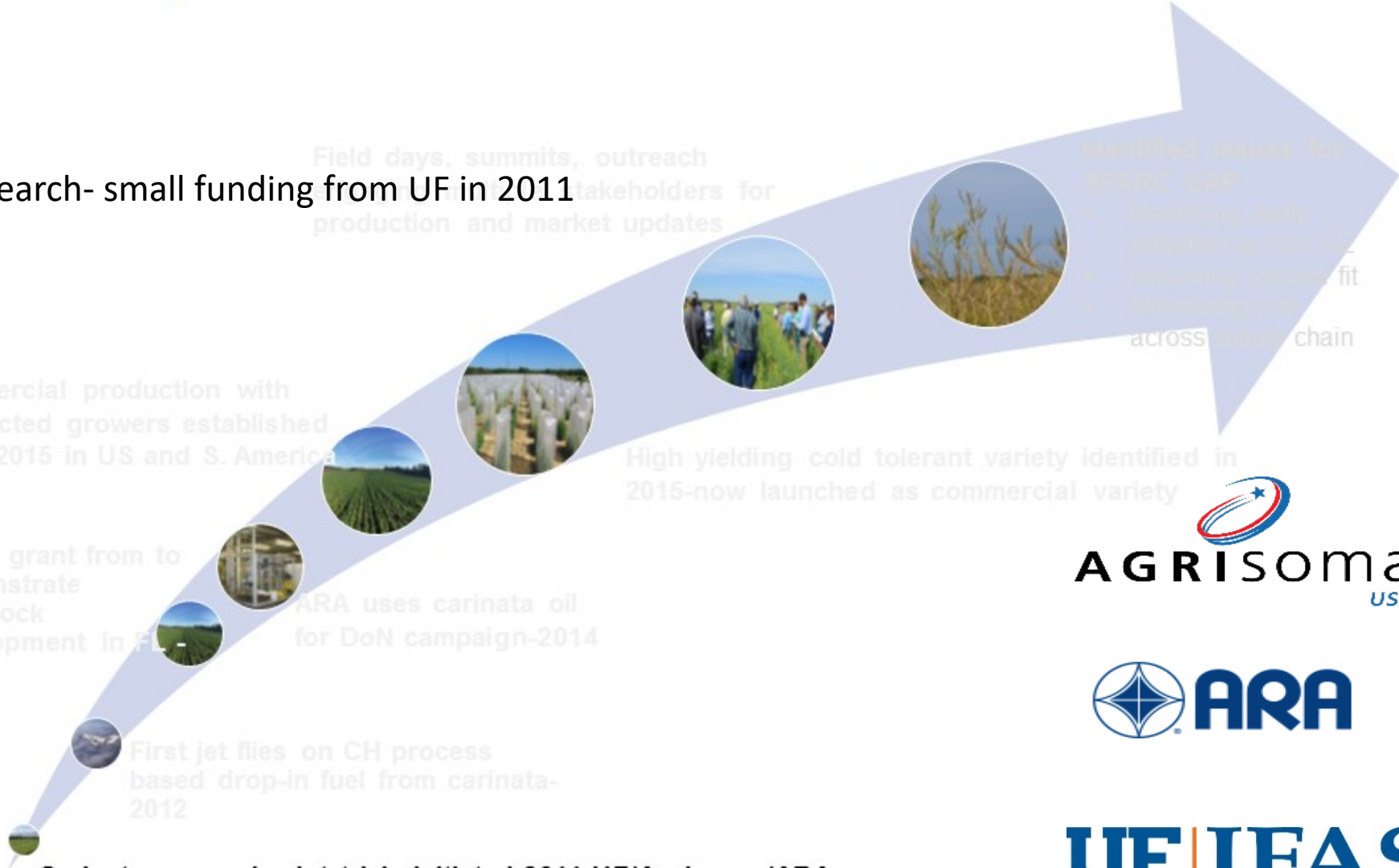
**\$200-300 profit/acre**



**3 mil. acres in the SE can produce 600 mil gal of biofuels**

# History of carinata in the Southeast US

Initial research- small funding from UF in 2011



Field days, summits, outreach  
stakeholders for  
production and market updates

Identified issues for  
SPARC CAP  
• seedling cost  
• water stress  
• growing season fit  
• marketing  
across supply chain

Commercial production with  
contracted growers established  
since 2015 in US and S. America

High yielding cold tolerant variety identified in  
2015-now launched as commercial variety

\$1.1m grant from to  
demonstrate  
feedstock  
development in FL  
2013

ARA uses carinata oil  
for DoN campaign-2014

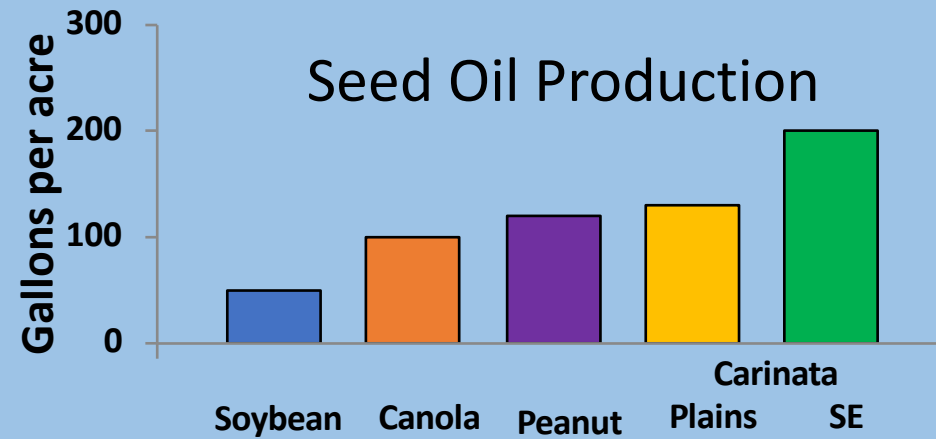
First jet files on CH process  
based drop-in fuel from carinata-  
2012

Carinata research plot trials initiated-2011-UF/Agrisoma/ARA



# Oilseed Crops for Bioenergy

**B. carinata (Ethiopian mustard) is an excellent non-food oilseed crop for biofuels**



| Crop     | ~ % Seed Oil | Crude Protein Meal |
|----------|--------------|--------------------|
| Peanut   | 50           | 51                 |
| Canola   | 43           | 41                 |
| Carinata | 42+          | 45                 |
| Soybean  | 18           | 49                 |
| Cotton   | 16           | 30-45              |
| Corn     | 3            | >40 DDG            |

**Meal feeding trials with cattle**





**Seed**

**Unfiltered  
crude**

**Filtered  
crude**

**Diesel**

**Naphtha**

**Jet**

**Pelleted  
Meal**

# Established Carinata Value Chain

*Develop, test and introduce Carinata to farmers*



Seed

Farming

Logistics

Crush



Biofuels

Customers



Oil

Meal



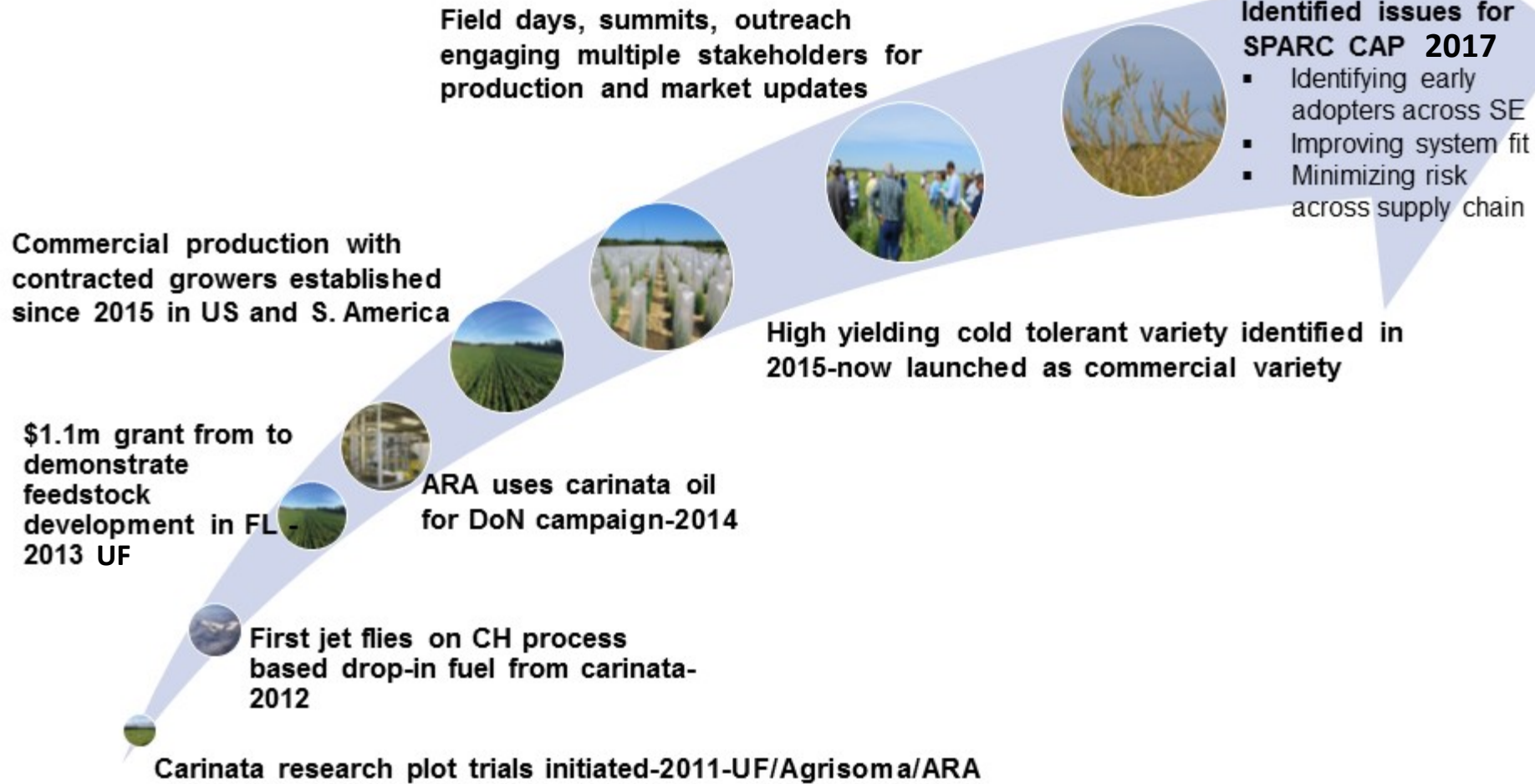
Meal Customers

# Laying the foundation for SPARC



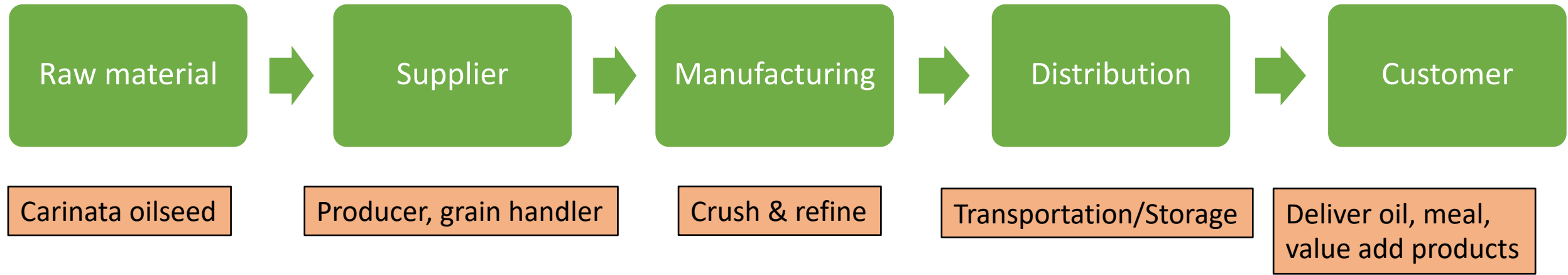
United States Department of Agriculture  
National Institute of Food and Agriculture

**9 universities, 4 USDA  
facilities, over 80  
scientists**

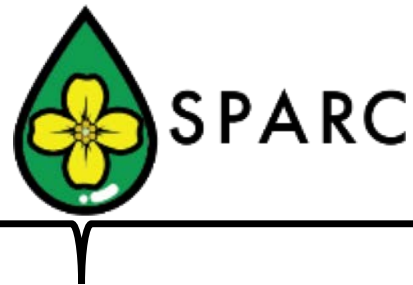




## SPARC in a nutshell (seed pod)



- Germplasm improvement earliness, cold tolerance
- Adaptability to various SE geographies
- Shift in mindset
- Focus on profitability
- Availability of infrastructure
- Help producer succeed
- Incentives
- Infrastructure
- Infrastructure
- Optimization
- Product testing & compatibility
- Regulatory boundaries
- Market access/demand for green products



**Research, Extension, Education, partnering with industry to overcome challenges**

# SPARC Vision for Commercial Deployment

## Demonstrate capacity

- Refine feedstock production and expansion for maximum productivity
- Develop risk mitigation and optimization tools to support scaling
- Establish communities of practice and stakeholder consortia spurring sustained interest and investment

## Increase Demand

- Provide renewable fuel and co-product samples to multiple endusers
- Demonstrate value of meal based co-products
- Demonstrate value along entire supply chain

## Ramp up capacity

- Policy informed by scientific process and stakeholder engagement
- Scale SE US carinata production
- Drive infrastructure establishment to support the carinata enterprise

## Build resilient supply chain

- Develop comprehensive support system-from producer to end user
- Ensure economic value and low risk across supply chain through robust supply chain modeling
- Build workforce to sustain carinata supply chain



# An example of the work of SPARC: Working within the framework of Sustainability

## **Selection of germplasm for SE**

- Earliness
- Cold tolerance
- Oil and seed yield

## **Improved soil quality**

- Build residue; increase organic matter
- Reduce soil erosion

## **Enhanced nutrient use efficiency**

- Reduce nutrient leaching
- N, P, K scavenger
- Increase nutrient cycling in a rotation system (year round cropping)

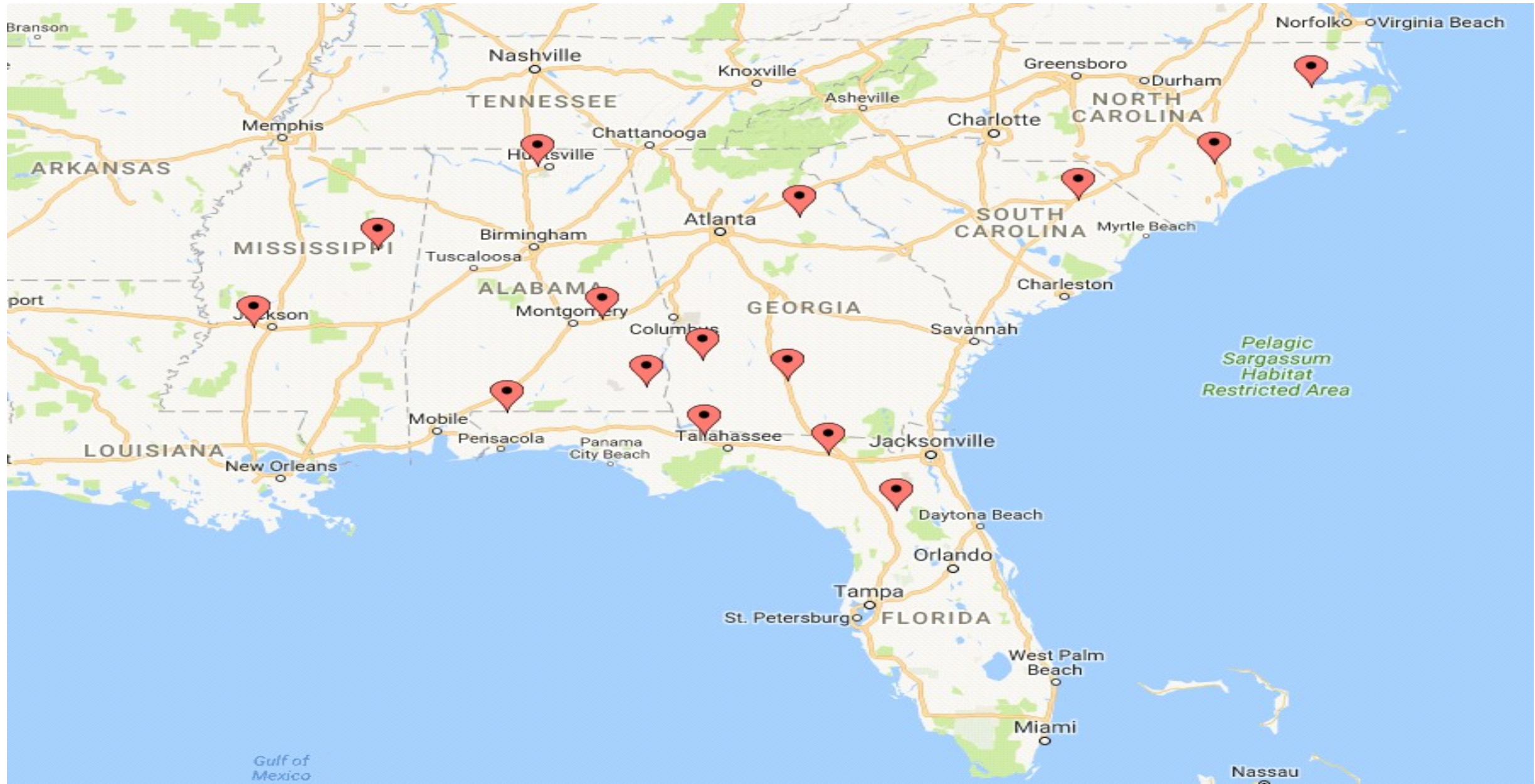
## **Pest reduction**

- Suppress weeds
- Reduce nematodes



SE regional partners bring in experience working on winter oilseed BMPs and sustainable cropping systems

# SPARC Performance Locations

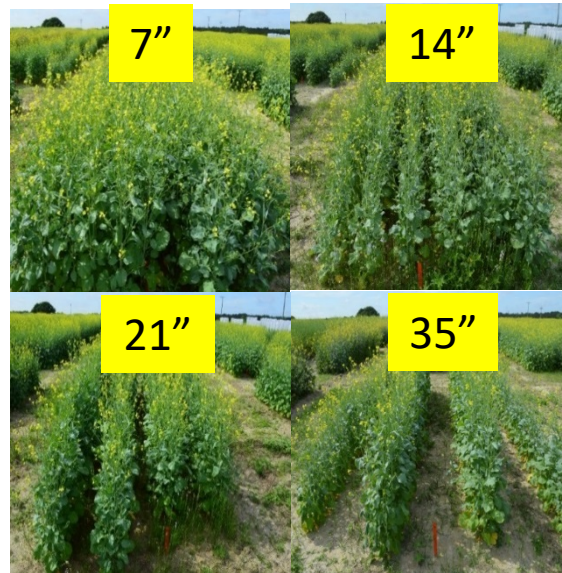


# Carinata Best Management Practices

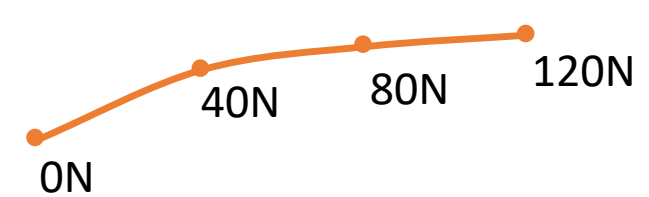
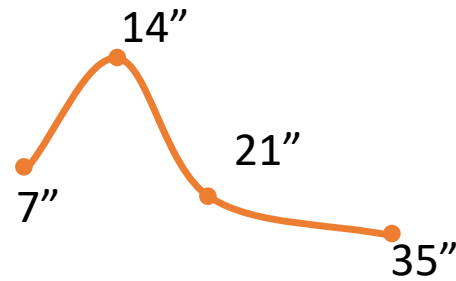
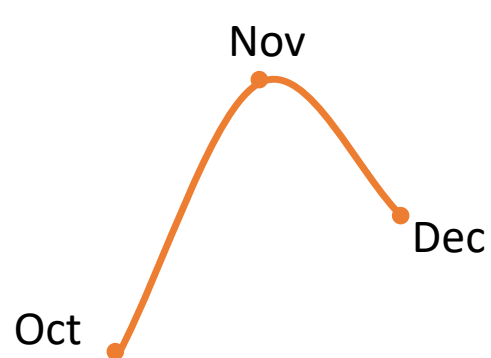
Planting date



Row spacing



Nitrogen nutrition



# SPARC: Intensifying Production within the framework of Sustainability (Modeling)



## Site Suitability

- Locations for growing carinata relative to environmental constraints
- Estimate probability of growing carinata in the SE

## Life Cycle Assessment

- Cradle to grave life cycle analysis
- Energy efficiency and emissions analysis using GREET
- Biogeochemistry of carinata rotation systems using Daycent modeling
- Watershed impact of carinata rotation systems

## Techno-Economic Analysis

- Whole farm financial optimization
- \$ per gallon of carinata-based jet fuel
- Carbon abatement cost
- The role of current and needed policy initiatives
- Supply chain resiliency evaluation

## Distribution optimization-FTOT

- bottoms-up modeling to make recommendations on where infrastructure needs to be set up
- currently looking at multiple scenarios of processing facilities and end-user locations

Establishing path to acceptable business case for all stakeholders in the supply chain, all co-products



- **Establish Carinata Community of Practice with early adopters**
- **Stakeholder needs assessment**
- **Develop Extension Tools-Learning modules, fact sheets, pubs and apps**
- **Field days, webinars and workshops**

# Coordinating events with partners



Regional Production Meetings



Research and Production Summits



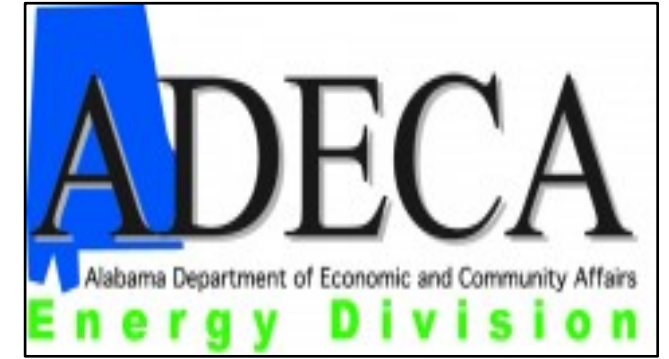
Plot Tours



Field Days/Tours



# SPARC Engagement- Facilitating Commercial & Economic Development



# Partnerships

# UF-Agrisoma partnership

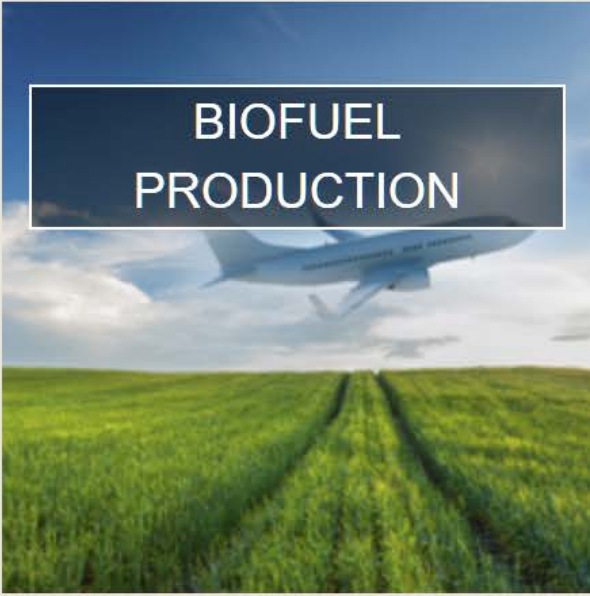
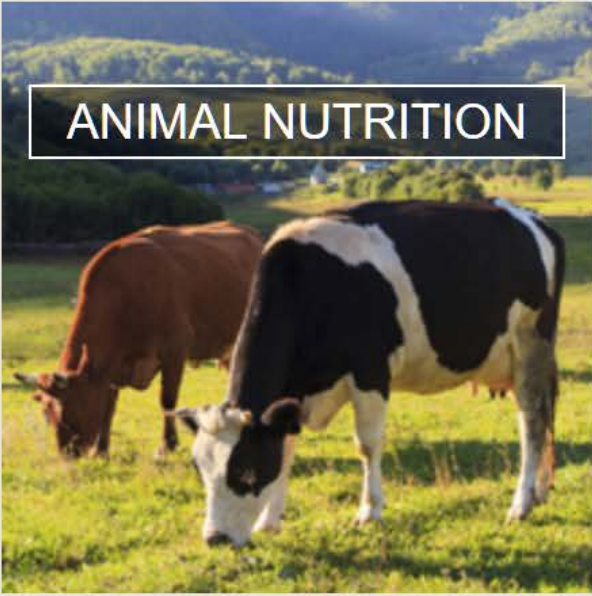
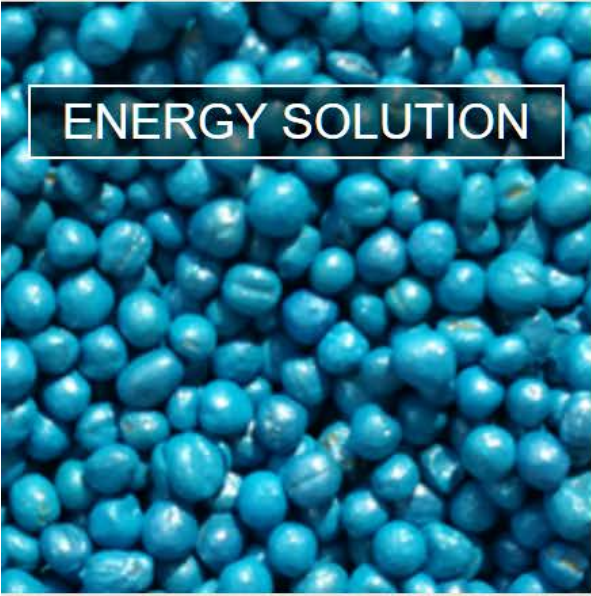


Image credit: Agrisoma

# Research translated to initiation of commercialization



Dedicated to increasing efficiency in every aspect of the supply chain from growers to end users



Combine harvesting of commercial carinata



First shipment of carinata loaded at Cargill's port facility in Tampa from SE production

# Success stories- 100% 'drop-in' carinata jet fuel



On October 29, 2012, ReadiJet was flown in the world's first ever 100% biofuel flight using fuel that meets petroleum specifications without blending. (Agrisoma and partners)



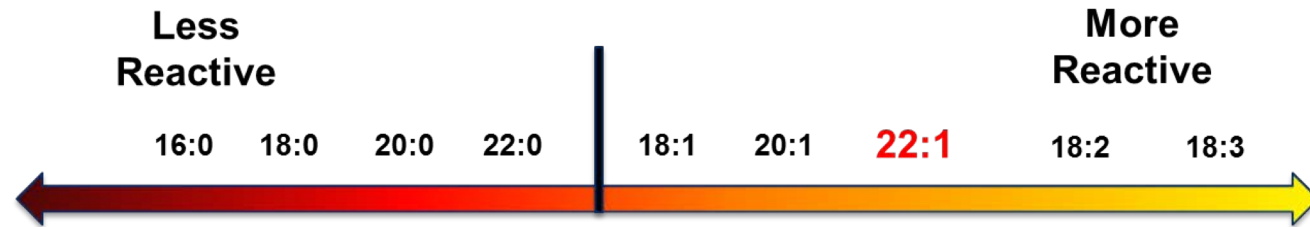
# UF-ARA partnership



# Conversion of Carinata Oil

High concentration of Erucic acid (22:1)

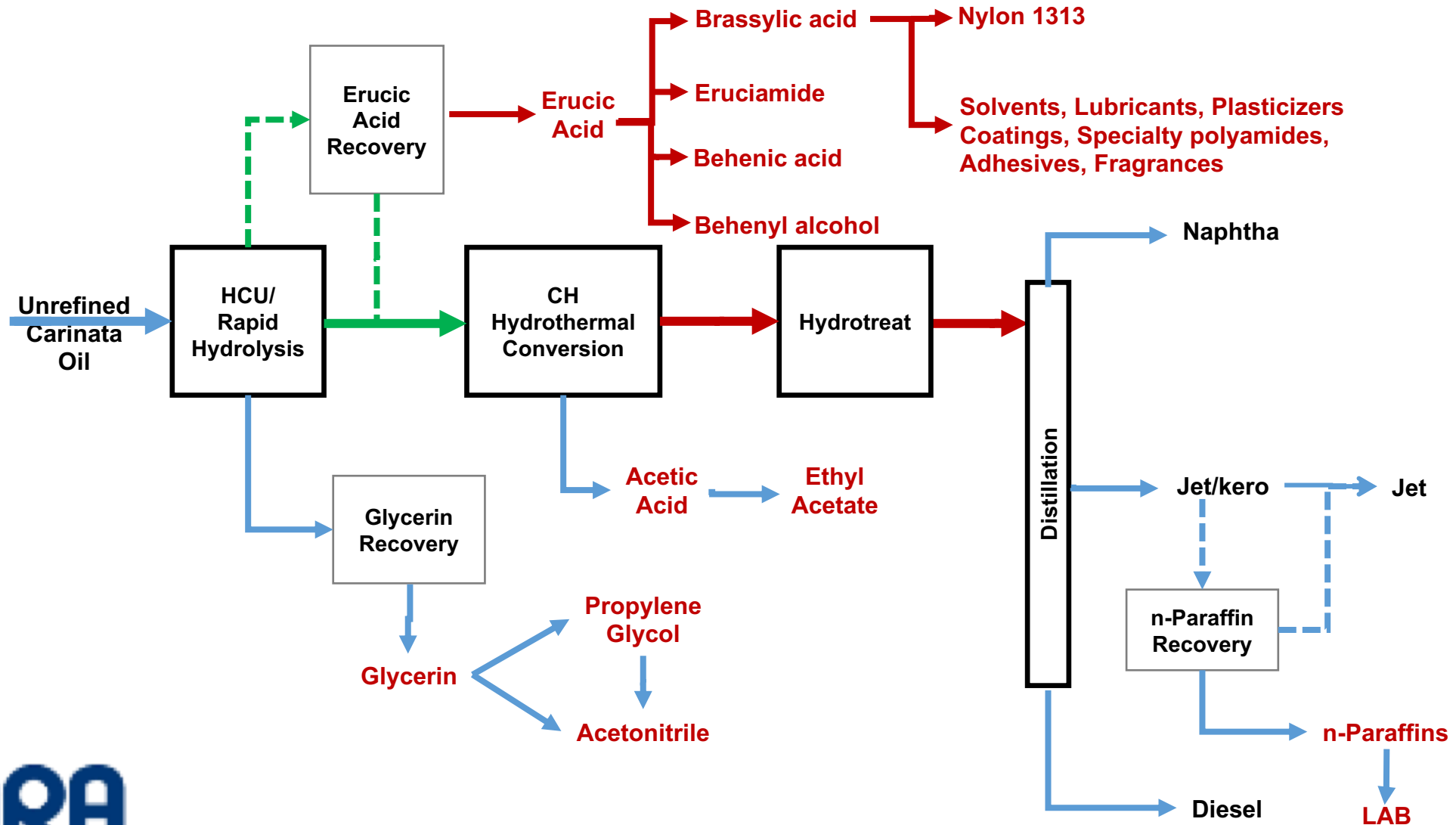
- Unsaturated FFAs are more reactive



- High yield of cycloparaffins & aromatics
- High density and energy content
- Excellent low-temperature properties



# SPARC: Maximizing value through multiple product development



# Other Carinata Alternative Jet Fuel Events



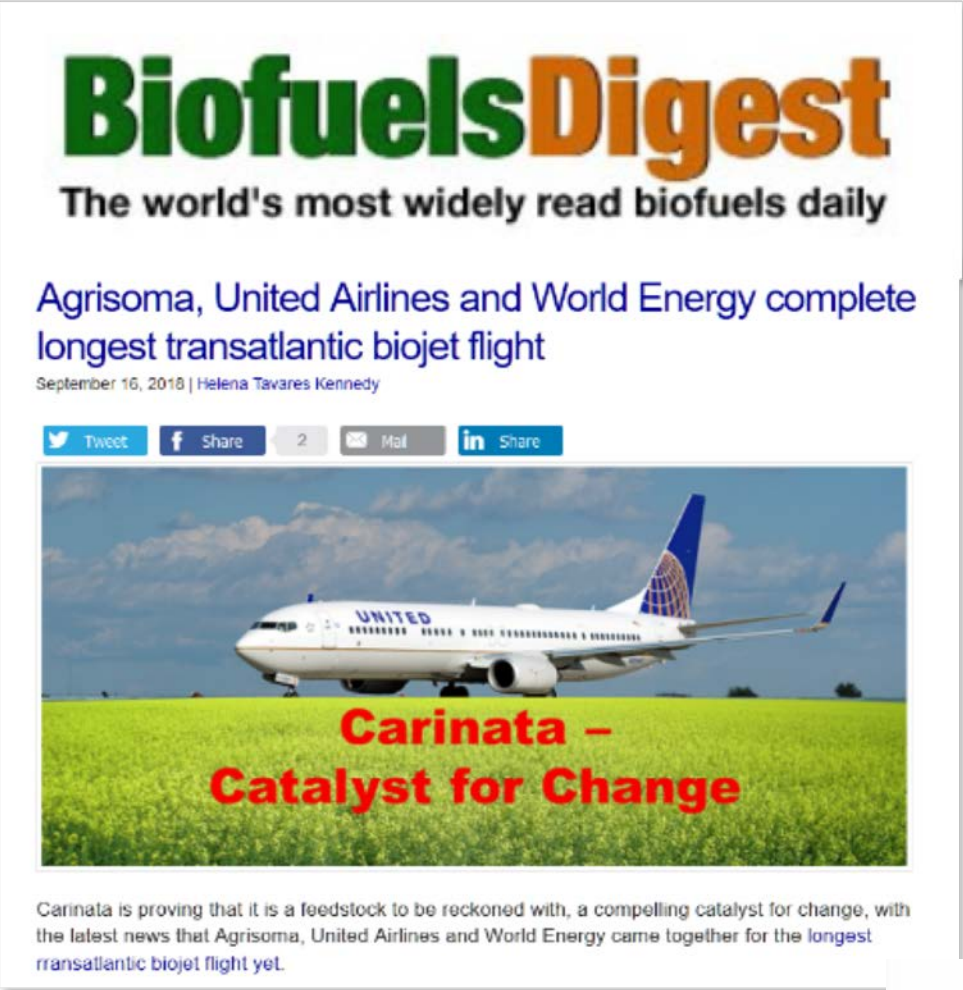
**QANTAS** 

Destinations ▾ Flight deals ▾ Plan ▾ Book ▾

## World first USA to Australia biofuel flight

In January 2018 we operated the world's first dedicated biofuel flight between the United States and Australia: QF96 from Los Angeles to Melbourne. The historic trans-Pacific 15-hour flight operated with approximately 24,000kg of blended biofuel, saving 18,000kg in carbon emissions.

Qantas used biofuel processed from Brassica Carinata, a non-food, industrial type of mustard seed, developed by Canadian-based agricultural-technology company, [Agrisoma Biosciences](#). Carinata is planted in the off-season so it provides landholders supplementary income and doesn't interfere with a farm's primary production. The plant is water efficient, reduces erosion and nutrients.







## BiofuelsDigest

The world's most widely read biofuels daily

### Agrisoma, United Airlines and World Energy complete longest transatlantic biojet flight

September 16, 2018 | Helena Tavares Kennedy

 Tweet  Share 2  Mail  Share



**Carinata – Catalyst for Change**

Carinata is proving that it is a feedstock to be reckoned with, a compelling catalyst for change, with the latest news that Agrisoma, United Airlines and World Energy came together for the longest transatlantic biojet flight yet.

Industry partners are demonstrating successful flights and aviation commitment resulting in pull for the carinata product



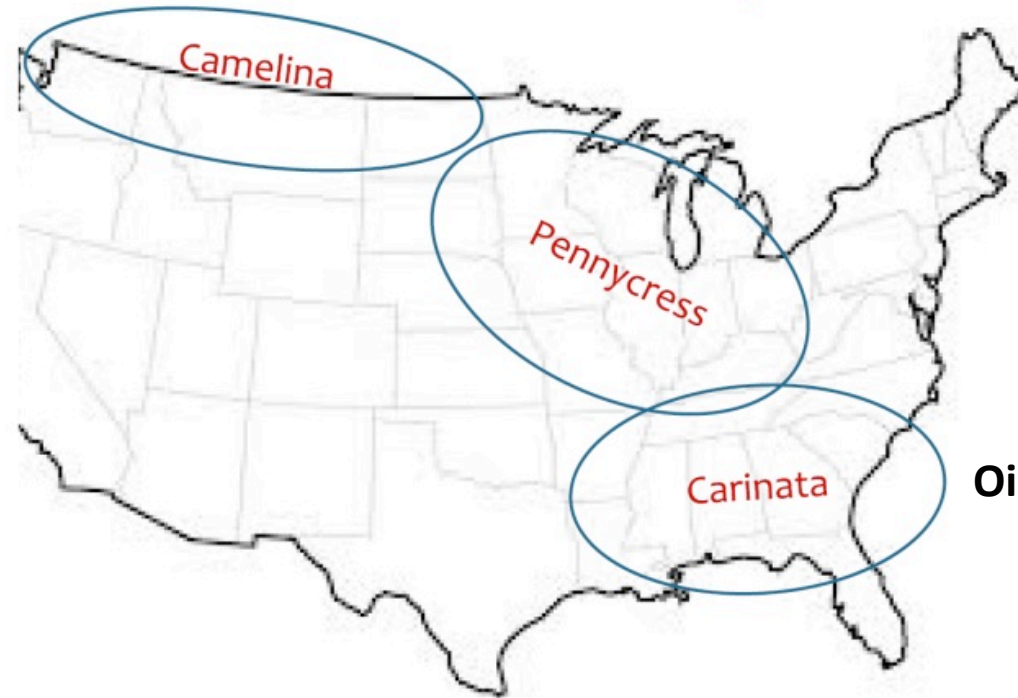


# Winter “cover” oilseeds

## Huge production potential without ILUC...

- \* Carinata below freeze line
  - \* 12-20 M acres

Targeting most sustainable solutions:  
Low, or Zero, impact LUC/ILUC & F-v-F solutions;  
Environmental Services a plus.



# SPARC Teams and Objectives

 **Feedstock Development**












**Activities**

- Optimum geno-pheno-type identification for various SE US regions
- Fertility management
- System fit of carinata in the SE cropping system context
- Weed management and product development
- Disease and pest management
- Systems modeling


 **Fuel and Co-product Development**










**Activities**

- Hydrothermal cleanup
- Production of unblended drop-in fuels
- Co-product production and testing

 **Outreach, Education, Workforce Development**

**Activities**

- Link research and extension for feedback and project improvement
- Document drivers of adoption, assess stakeholder needs
- Develop extension learning tools
- Stakeholder engagement
- K-12, undergraduate and graduate education in bioenergy
- Internships and career development in the field of bioenergy and bioeconomy




 **Meal Efficiency**











**Activities**

- Nutritional evaluation in poultry
- Glucosinolates in carinata meal and performance in cattle
- Recovery of co-product streams from carinata meal

 **System Metrics**

Dawson, GA

**Activities**

- Economic analysis
- Watershed modeling
- Life Cycle Analysis

 **Supply Chain**





**Activities**

- Feasibility analysis for post-harvest logistics, infrastructure development
- Secure resilient 24/7 feedstock supply

# Challenges/opportunities for any “new” bioenergy feedstock

- Maximizing yields within the SE US (commercialization and sustainability closely linked to yields)
- Scaling up adoption (education around rotational fit, production know-how etc.)- apprehension about interference with summer crops
- Access to local infrastructure- storage, crush, buy back model (excellent commercial involvement driving access).
- Supply chain development (Agrisoma is driving development)
- Demand for oil has been higher than production and biofuel companies want large quantities
- Policy incentives still evolving- LCFS, tax credits, etc

# SPARC-Partnership for Progress



United States Department of Agriculture  
National Institute of Food and Agriculture



# SPARC a regional effort

Thank you!



United States Department of Agriculture  
National Institute of Food and Agriculture