

ATIP Foundation Biojet Fuel Regional Forum Series:
“Accelerated Commercial Development of Hydrotreated Renewable Jet Fuel (HRJ)
from Redesigned Oilseed Feedstocks Supply Chains”

Summary Report on Three Regional Forums Convened in 2017

Wes Jurey, Foundation CEO, and Richard J. Brenner, Director, ATIP Foundation

Executive Summary

In 2017, the ATIP Foundation orchestrated three regional forums to seek stakeholder input on the challenges and opportunities for adoption and commercialization of research results on converting oilseeds to hydrotreated renewable jet fuel. The underlying purpose was to determine a path forward that would support broad scale development of a sustainable alternative fuel industry; the ultimate goal being to promote rural economic development resulting in job opportunities along the supply chain from crop to jet fuel.

The forums’ fundamental premise: that economic development is the creation of wealth in which community benefits are realized. It is fundamentally driven by the conversion of materials into consumable products, such as oilseeds to jet fuel, creating jobs and economic opportunity through each step in the conversion process where that conversion takes place.

Forum attendees included invited regional thought leaders, representing sectors of: (1) municipal, county, and state elected officials; (2) business and industry; (3) academia; (4) finance; (5) economic and workforce development; and (6) the supply chain, from grower to consumer. Our premise is that successfully launching the supply chain necessary to bring new products to market, based on research outcomes, requires the support of all six identified sectors.

From an agricultural-based perspective, there are four questions that must be answered. *Will the farmer plant the crop? Is there a sustainable market for the crop? Will the financial community put capital at risk to finance it? Will the market support a sustainable price point for the produced product?*

The research presented at the forums addressed alternative jet fuel demand, oilseed production, the requisite supply chain for oilseed-based alternative fuel, the economics of production, and the most effective yield on the variety of oilseed crops grown. The forum shared the outcomes of the research, followed by participant discussion that focused on six key issues: (1) education and awareness; (2) finance/access to capital; (3) access to Federal research and technology; (4) public policy; (5) the need for a trained and skilled workforce in support of the industry; and (6) the need to develop the necessary supply chain. From those perspectives, several issues were consistently and clearly identified by participants at all three forums.

1. DEMAND

Clearly, there is a growing demand for alternative fuels. But at today's oil prices, production return on investment (ROI) does not approach 20% (a level viewed as incentivizing investment and sector build-out) while delivering cost competitive fuel. It was also recognized that viability is dependent upon the production of co-products and other value-added products in order to move to a viable ROI. This further complicates the development of the supply chain that must, to a degree, be integrated in terms of the co-products that must be produced (e.g., creating both jet fuel and animal feed from oilseed production).

2. POLICY/REGULATORY

There is a clear need and role for policy, regulation, and incentives to deal with the ROI issue. However there is significant uncertainty in national policy, and such is a major concern relative to the risk for those who choose to explore the use of alternative jet fuel. Beyond the Federal policies of RFS-2 (Renewable Fuel Standard) and tax treatment, only a few states (e.g. California, Oregon, Minnesota) have legislatively approved policy that may additionally incentivize the alternative fuels market. Clearly there is a need for thought, relative to overall national policy that might foster industry progression.

As one example of feedstock-incentivizing efforts, it was noted that the biomass crop assistance program (BCAP), intended to incentivize conversion of biomass, is limited in terms of geography, definitions, total available funding, and uncertainty of appropriation. As an example, North and South Dakota, one of the key growing regions, does not have access to a biomass conversion facility that accepts agricultural residues.

3. FINANCE/ACCESS TO CAPITAL

There is clearly a paucity of investment and financial activities in the biofuel sector. As an example, both the ATIP Foundation and our co-hosts made concerted efforts of inclusion to engage the finance and investment community, yet only 1 of 55 invitees attended. It is perhaps noteworthy that the one individual who did attend was personally recruited by the President of the ATIP Foundation, who agreed to attend only after being fully informed about the demand for alternative fuel, the USDA loan guarantee program, and the Department of Defense and airline industry offtake agreements. Participants recognize that this situation could be changed if there were a large number of commercialization entities currently seeking funding for new facilities, but such is not currently the case due to issues with facility ROI discussed herein.

4. EDUCATION & AWARENESS

It became clear that education and awareness are paramount to the previous topics, and the need is on multiple fronts: the community of consumers (perhaps less of an issue for jet fuel production and use),

the business community, local/regional investment community; elementary, high school, local college and university communities, and local/regional elected officials. The general issue is a lack of awareness and knowledge of the local economic and environmental benefits. It appears that the successful growth of this industry will require broad education and awareness campaigns in each region of the country, based on the regional agricultural systems and the challenges each faces.

5. FOOD vs FUEL

This issue was identified at all three forums. Participants recognize that the public may perceive that this is an issue (that must be addressed as a component of the overall education and awareness program), but stressed that the *Brassica* oilseed crop consists of 40% oils and 60% fiber and protein – essentially producing food AND fuel. These crops also enhance yield of another food (wheat) in a subsequent rotation. Further, some of the growth of non-food oilseeds will be accomplished by using land that is fallowed (in current mono-/duo-culture cropping systems) for the purpose of weed, pest, soil improvement or moisture management.

6. RESEARCH/TECHNOLOGY

Two key technology advances are deemed of vital importance. These are: (1) advances in the biorefinery operations of cracking the seed-oil lipid chains and hydrolyzing for production of biofuels, and; (2) continuing genetic selections for developing high-yielding, regionally-adaptive plant varieties for biofuel and co-products (high oil quality and quantity, high in protein content for animal feed) that also are drought and cold-tolerant. While both are critical to the future growth of the industry, attendees also encourage further research directed toward developing other high value co-products from oilseed crops.

SUMMATION

In terms of growing the industry and optimizing supply chains for generating wealth and job opportunities, a lack of public education and awareness of the oilseed industry and the complexity of the supply chain are two key issues that must be addressed in the regions through activities of academicians and the extension service.

Based on the input provided by forum participants, those knowledgeable about the growth of this industry are both supportive and optimistic about the eventual success of developing a sustainable alternative fuel industry from oilseed crops. There was general agreement that success, however, will be dependent upon four critical issues: (1) the development of a diversified supply chain that is financially sustainable; (2) the support of the financial investment community; (3) consistent public policy; and (4) an extensive public education and awareness campaign.

In furthering this initiative, the Foundation emphasizes the importance of engaging a broader group of stakeholders in each region. In these forums, under-representation of the finance and economic/workforce development sectors was apparent in the discussions. We strongly recommend that any subsequent forums on the theme of advancing the bioeconomy with goals of economic development and job creation, whether convened by USDA or others, include more even representation by the six sectors.

This report further recommends two specific ways in which USDA can take an active role in promoting next steps. First, USDA should include the use of Rural Development resources (RD Enterprise) to convene business development activities (advisory groups) while also furthering commercialization of these research outcomes. A specific avenue of implementation is suggested. Second, USDA NIFA could increase funding in the Agriculture and Food Research Initiative, Coordinated Agricultural Projects programs (AFRI CAP) in the specific area of research / development and commercialization of targeted plant-derived alternative jet fuel in additional regions of the U.S. This could follow in the footsteps of the recently announced grant to the Southeast Partnership for Advanced Renewables from Carinata (SPARC) at the University of Florida that targets development of a winter carinata for the SE growing region. Additionally, NIFA announced funding for the University of Arizona on an R&D project for biofuels derived from guayule.

Notably, both NIFA-funded projects include an Advisory Board/Committee and incorporation of training (workforce development) to assure sustainability. The ATIP Foundation would encourage NIFA awardees also to seek engagement with representatives from sectors of economic development, education, and state / local elected policy makers to optimize community benefits in the process of adoption and commercialization. Also, inclusion of some who were involved in the HRJ grant would result in representation from the first completed plant-based biofuel project under the NIFA programs. Thus, within the span of 5 years, the foundation may very well be laid for a geographically broad sustainable alternative jet fuel industry from oilseed and other plant-based crops.

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Introduction

In 2012, the United States Department of Agriculture (USDA), National Institute for Food and Agriculture (NIFA) issued a grant for *Accelerated Commercial Development of Hydrotreated Renewable Jet Fuel (HRJ) from Redesigned Oilseed Feedstocks Supply Chains*.¹ The stated need for the project was clearly articulated by the submitters:

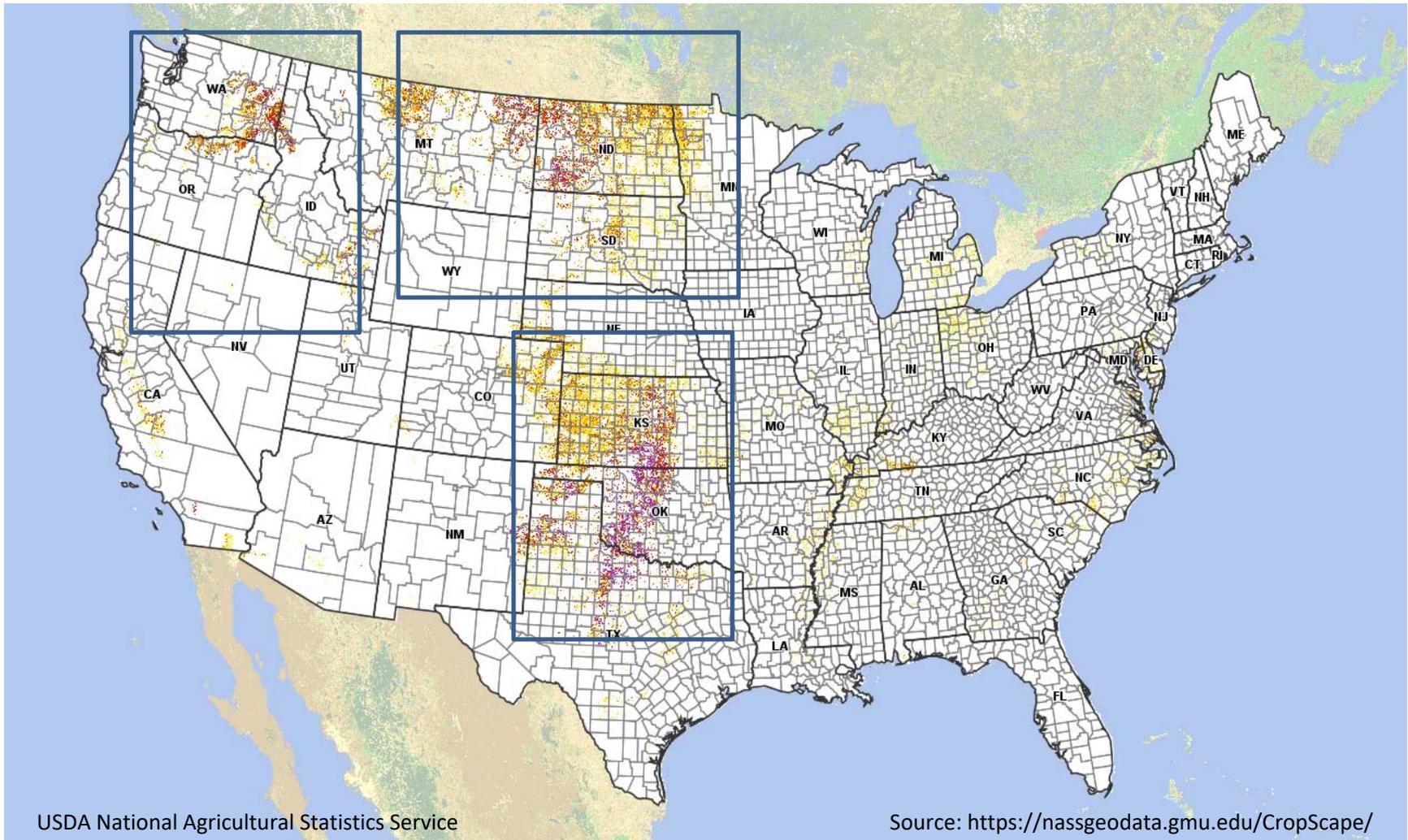
“Certified hydrotreated renewable jet (HRJ)² fuels from plant oils have been commercially demonstrated and certified for aviation use, but full-scale production has not occurred because pricing is not competitive with petroleum fuels. In the near term, HRJ fuel provides a significant short-term technology pathway for helping meet air transportation and military needs for alternative fuels. Secure and stable fuel sources are essential for economic sustainability and national security. The commercial aviation industry has established a goal of carbon neutral growth by 2020 and cutting net greenhouse gas (GHG) production by 50% by 2050 from 2005 levels (International Air Traffic Association (IATA), 2009). Similarly, the Navy has set an ambitious goal of deploying a strike group of ships and planes powered with renewable fuels by 2016.”

Twenty-two scientists representing USDA’s Agricultural Research Service (ARS) and their Land Grant university partners conducted research in the three agronomic regions (See Figure 1; based on wheat production) encompassing the Pacific Northwest, the Northern Plains, and the Southern Plains. Research addressed five objectives ranging from improving oilseed feedstocks (principally oilseeds in *Brassica* spp.), crop production for various varieties, efficiency in converting these plant oils to jet fuel, and adoption requirements for producers; the research was successfully completed in early 2017. The sixth objective was focused on initiating the process of adoption and commercialization of research outcomes with the ultimate goal of promoting rural economic development and job opportunities along the supply chain from crop to jet fuel.

¹ Grant from USDA’s National Institute of Food and Agriculture (NIFA) # 2012-10008-19727 (and subsequent USDA Agricultural Research Service (USDA ARS) Cooperative Agreement 59-3620-3-004 to the ATIP Foundation).

² Note that new terminology was developed by the industry in the five year performance period. This fuel conversion process is now referred to as Hydroprocessed Esters and Fatty Acids producing synthetic paraffinic kerosene (HEFA-SPK).

Figure 1. Principle wheat growing areas of U.S. where canola (and other *Brassica* spp.) can be a rotational crop (for alternative jet fuel) may also enhance wheat production.



Methodology and Format for Regional Forums

The ATIP Foundation orchestrated three regional forums in 2017, with the assistance of regional co-hosts and sponsors³. Forums were convened in Richland, WA, (June 6; co-host Washington State University), Fargo, ND, (June 13; ND Department of Commerce and North Dakota State University), and Wichita, KS, (July 11; Wichita State University and Kansas State University). The goal of each regional forum was to assemble a mix of stakeholders (about 40-60 participants) from various community sectors to seek their input on the challenges and opportunities for adoption and commercialization of research results on sustainable alternative jet fuel (SAJF), from HEFA-SPK processing, or other processes currently finalizing development. Forum attendees were by invitation-only, issued by co-hosts, to key regional thought leaders from sectors of: (1) local, state and federal elected and appointed officials; (2) economic and workforce development; (3) academia; (4) investment and finance; (5) agricultural and environmental organizations, and (6) industry, representing the entire supply chain from growers to end users. Representation from all these sectors is critical in shaping the growth of this industry.

In advance of each forum, confirmed participants were presented with a “read ahead” document prepared by lead scientists that provided a synopsis of the research findings of the various grant components for each objective of the study (Attachment A).

The agenda for each forum included welcoming comments by the regional co-host institutions and the ATIP Foundation (for example, see Attachment B). Formal presentations by grant participants and others were structured to cover three critical topics. These were: (a) demand for alternative jet fuel by the airline industry and other end users, and current and projected production of oilseed crops in the region; (b) highlights of research and results from the 5-year research project by objective, and; (c) a look at federal programs to “move forward” in the adoption and commercialization of sustainable alternative jet fuel.

Notes, attributed to each commenter, were taken on the fly by representatives of the co-host. Following the forum, participants received a link to the raw notes as a Google Document and a 2-week window of opportunity to edit their specific comments, or add additional comments. Thereafter, the document was closed by Richard Brenner of the ATIP Foundation, who reviewed comments, clarified with authors as needed, redacted all names of comment contributors, and provided the documents to participants as a record of the forums. The term canola is used within the document as a representation of all the oilseed species that were studied in the grant and is not meant to be assigned just to the species canola.

³ The ATIP Foundation acknowledges funding and in-kind sponsorship from USDA ARS coordinator of the NIFA grant Dr. Terry Isbell, Peoria, IL; and in-kind support from the Executive Director Steve Csonka of the Commercial Airline Alternative Fuel Initiative (CAAFI), and co-hosts making the regional forums possible (Washington State University; North Dakota Department of Commerce, and North Dakota State University; and Wichita State University and Kansas State University).

Results and Conclusions

Economic development is the creation of wealth in which community benefits are realized. It is more than a jobs program --- it is an investment in growing local and regional economies and enhancing the quality of life for all residents. The fundamental purpose and expected outcome of each forum were to create awareness and understanding --- among the various sectors represented -- of the USDA research program and outcomes, and to explore how these outcomes can be commercially produced to generate wealth and create jobs within the region, particularly rural America.

Invitations and Participation by Region and Sector

Tables 1 and 2 provide the descriptive statistics for invitations and participation by sector. Collectively, co-hosts issued 841 invitations, and 157 invitees attended the forums. The majority of invitations were issued to academia (mean=32.9%), followed by industry (18.1%), local/state/federal government officials (16.7%), producers of oilseed crops (12.3%), economic and workforce officials (7.6%), investments and finance officials (6.8%), and agriculture / environmental / other non-profit organizations (5.6%). Academia exhibited the highest positive RSVP rate to attend (34.7%), followed by local/state/federal government (22.1%⁴), industry (16.4%), producers of oilseed crops (10.6%), agriculture and other NGO organizations (10.5%), and economic and workforce development (5.1%). The lowest response rate occurred with invitees from the investment and finance sectors (0.7%), with only one of 55 invitees attending any of the forums (Wichita).

Themes and issues raised by presenters and participants

There were several key themes raised by presenters and participants during the forum series. In this section of the report, we will accumulate these, but may also highlight any issues raised at individual forums.

Growing demand for alternative fuels. A presentation and overview by representatives of the Commercial Airline Alternative Fuel Initiative (CAAFI®) clearly indicated that the airline industry, and federal consumers (Department of Defense and National Guard) are highly engaged and supportive of drop-in alternative fuels. Their stated goal of achieving 50% alternative energy use (U.S. Navy) by 2020 is on track and portends a promising future of demand for biofuels⁵. The commercial airline industry projects that current SAJF projects in development by several producers represent a demand for new oilseed introduction of nearly two million acres per year. In 2016 nearly 1.7M

⁴ This relatively high percentage is due in part to the multiple presentations made by 5 federal employees at each of the forums.

⁵ Estimated at 8M barrels per year of renewable fuel in a recent presentation by the Navy at the 2017 Advanced Bioeconomy Leadership Conference in Washington, DC.

Table 1. Descriptive statistics on number of invitations issued by three regional co-hosts within broad sector designations, and the actual number that attended each regional forum.

Region	No. Invited by sector								No. Participated by sector							
	Industry	Local / State / Federal gvmt.	Economic & workforce	Investment / finance	Academia	Ag. & environ.	Producers	Total	Industry	Local / State / Federal gvmt.	Economic & workforce	Investment/ finance	Academia	Ag. & environ.	Producers	Total
Pacific Northwest (Richland, WA)	84	111	30	12	135	34	40	446	13	13	4	0	19	8	15	72
Northern Plains (Fargo, ND)	23	21	19	4	37	9	17	130	6	12	2	0	9	5	1	35
Southern Plains (Wichita, KS)	47	24	4	39	106	6	39	265	7	7	2	1	26	3	4	50
Totals	154	156	53	55	278	49	96	841	26	32	8	1	54	16	20	157

Table 2. Invitations and participation in three regional forums, expressed as percentages represented by broad sector designations.

Region	% Invited (no. invited per sector/total no. invited per region)								% Participated (no. participants by sector/total no. participants per region)							
	Industry	Local / State / Federal gvmt.	Economic & workforce	Investment / finance	Academia	Ag. & environ.	Producers	Total	Industry	Local / State / Federal gvmt.	Economic & workforce	Investment/ finance	Academia	Ag. & environ.	Producers	Total
Pacific Northwest (Richland, WA)	18.8	24.9	6.7	2.7	30.3	7.6	9.0	100.0	18.1	18.1	5.6	0.0	26.4	11.1	20.8	100.0
Northern Plains (Fargo, ND)	17.7	16.2	14.6	3.1	28.5	6.9	13.1	100.0	17.1	34.3	5.7	0.0	25.7	14.3	2.9	100.0
Southern Plains (Wichita, KS)	17.7	9.1	1.5	14.7	40.0	2.3	14.7	100.0	14.0	14.0	4.0	2.0	52.0	6.0	8.0	100.0
Mean (n=3)	18.1	16.7	7.6	6.8	32.9	5.6	12.3	Mean (n=3)	16.4	22.1	5.1	0.7	34.7	10.5	10.6	
SD (n=3)	0.6	7.9	6.6	6.8	6.2	2.9	3.0	SD (n=3)	2.1	10.7	0.9	1.2	15.0	4.2	9.3	

acres of canola was grown in the U.S., but nearly all for edible products and industrial lubricants. However, at today's oil prices, SAJF production return on investment does not approach 20% while delivering cost competitive fuel; this argues that canola grown exclusively for biofuel is not feasible. In all forums, participants recognized the need for **co-products and other value-added products**; at the Wichita forum, a USDA researcher provided an historical perspective that developing co-products to bolster production economics from corn was a research process that has been decades-long. Co-product development from oilseeds was not a part of the SAJF research grant.

It is noteworthy that a large, stable and growing market opportunity currently exists for 24 billion gallons per year (Bgpy) U.S. markets, and 84Bgpy worldwide for SAJF derived from all sources. Comments during all three forums supported the idea that early adopters --- perhaps at slightly higher pricing than fossil fuels --- would stimulate and provide "purchase order" support for financing and building production capacity, hopefully from field to refinery.

Incentives and support for alternative jet fuel (policy). There was some discussion on mandates for biofuels and whether that is good policy or even sustainable. Uncertainty in national policy and the markets is a major concern and risk for those predisposed to explore use of alternative jet fuel. Carefully crafted national policy could address that, but there does not appear to be any movement on the horizon (e.g. with the Renewable Fuel Standards (RFS-2), the incentives of which are not currently sufficient to enable broad commercialization with purpose-grown oilseeds). However, in absence of a national policy, some states and nations are developing their own. California enacted a Low Carbon Fuel Standards (LCFS) mandate in 2007 that was implemented via final rule in 2015, and Oregon passed an LCFS in March 2015. Similarly, British Columbia passed a mandate in 2008, and several efforts in the United Kingdom and European nations promote biofuels. At present, the only commercial-scale SAJF production in the U.S. is coming from the AltAir Fuels refinery in Paramount, CA, and the HEFA-SPK from that facility is being delivered to multiple customers.

Off-take agreements for future anticipated production capacity have been negotiated by a number of airlines with multiple producers (using various feedstocks and conversion processes) for approximately 200 million gallons per year (Mgpy) of neat SAJF. This means that capacity for all of the next several envisioned facilities is sold out, provided developers can close on financing (which currently is viewed as tenuous). Comments by participants at the forums recommended that such positive early efforts in CA perhaps should be broadened to include other airport operations in these regions, and could serve as examples for other major air terminals such as Chicago (ORD), Atlanta (ATL), Dallas-Fort Worth (DFW), Jacksonville (JAX), Baltimore-Washington (BWI).

Although there was some discussion suggesting that airports (instead of an airline) perhaps could play a lead role in promoting SAJF (suggesting that airlines do not have stable demand, airports typically do), airports do not / cannot buy fuel - airlines do, either individually or through their

consortia. A recent study, explored at Seattle-Tacoma International Airport, noted that, although an airport cannot purchase planes or fuel,

“... it could pay directly for SAF co-benefits. Public dollars cannot cover a commodity used by a for-profit private firm. However, SAF produces direct air quality benefits, reduces greenhouse gas emissions, and supports regional economic development—all of which are valued by airports.” (see Klauber, Adam, Annie Benn, Charlotte Hardenbol, Craig Schiller, Isaac Toussie, Misha Valk, Jeff Waller. Innovative Funding for Sustainable Aviation Fuel at U.S. Airports: Explored at Seattle-Tacoma International. Rocky Mountain Institute, SkyNRG, July 2017.

<https://www.rmi.org/insights/reports/innovativefunding-sea-tac-2017/>)

The referenced report identified four potential funding mechanisms that SEA-TAC airport could use to capitalize on these co-benefits, thus identifying a possible model role that SEA-TAC could play in promoting sustainable alternative fuel (SAF). The report concludes:

“We recommend that the Port establishes a dedicated team to build the business case for a local supply chain as a critical next step. This likely involves identifying affordable and abundant feedstock sources, mapping production synergies, working with FAA and state authorities, and exploring partnership opportunities with other SAF demand centers. Creating an investable business case will require creative solutions and engagement with multiple stakeholders. The Port of Seattle is well positioned to facilitate this exercise given its active position at the intersection of airlines, fuel suppliers, governments, and the broader community.”

We would add that the suggested “dedicated team” should include the agriculture-based feedstock suppliers as well.

Engagement with the finance and investment community. Note that previous paragraphs have made mention of the paucity of investment and finance activities in the biofuel sector. Although the ATIP Foundation and co-hosts made concerted efforts of inclusion, attendance clearly reaffirmed that there is a need for greater engagement to facilitate a sustainable support mechanism and supply chain for creating regional wealth and opportunity. In fact, collectively, 55 individuals from the finance and investment sectors were invited to attend these three forums, but one and only one attended (Wichita).

Perhaps this is a regional / local issue, and given the recent SEA-TAC report discussed above, a proposed development of a specific regional effort to advance SAF may be a prerequisite to engage the investment community. Thus, the “dedicated team” referenced above might also enlist bankers and investors as well as representatives from the entire supply chain from seed production, crop production, transport, crushing facilities, and biorefinery / fuel producers.

Education and awareness. This issue is paramount to the previous topics, and the need is on multiple fronts: the community of consumers, the business community, local / regional investment community, elementary and high school communities in addition to colleges and universities, and local/ regional elected officials. Generally, the population is unaware of the importance of developing these renewable fuel sources to avoid dependence on foreign fossil fuels, or domestic fossil fuels with their concomitant long-term environmental burdens. With the backdrop of current increased production of fossil fuels in the U.S. (largely from fracking), the environmental advantages of using a renewable crop that also reduces the carbon footprint is noteworthy and that message should be strongly broadcast to the public, including those who can grow the crops, crush the seeds, refine the oil, blend the fuels, and distribute to local / regional markets. One participant offered the argument that the land and water being degraded by fracking could instead be used for oilseeds which would create more permanent, environmentally sound, and locally retained benefits.

Needed is an education and awareness campaign (at each venue) as to the benefits of plant-based biofuels to the sustainability of the land, community, and the local economy, while emphasizing the value of biofuels to the military and commercial airliners. For example, CAAFI can provide information on a number of benefits (commercial and military) from plant-based alternative fuels, such as lower carbon emissions; academia and cooperative extensions can address co-product potentials and “value to soil health and quality;” and Department of Commerce and city / county elected officials can address local economic opportunities both from feedstock production and post-harvest processing. The campaign must have a clearly-articulated and consistent message that promotes economic development, wealth creation, and job opportunities in the biofuel industry.

An education and awareness campaign may lead to workforce development. City and county officials and educators are key, in that attendees of these forums recommended that this “education” needs to be initiated at the 8th grade level in schools, and continue in the curriculum through secondary schools, local colleges, and universities. As one participant stated “why not a special curriculum path for those who want to work in the biofuel logistics arena?” Therefore, engaging key thought leaders in the local school board, and at state levels may facilitate these goals. One notable comment from Wichita suggested that a video – released through YouTube – should be developed to promote the value and benefits of crop-based biofuel production. The target is the millennium generation (and beyond). As stated by a participant who read a comment provided at the forum...

“It seems to me that the average age of the participants [in the forum] skewed towards the older end of the range. There was also the comment [by a younger member of the forum] that this may be a generation-long change for wide adoption, and I believe the younger generation will be more open to change and risk-tolerance. So it might be worth some time

thinking about how to reach out to the younger farmers/producers to get this information out, and get their perspective on how to proceed.”

(underscore and bracketed statements added by authors of this report).

Issues for producers of oilseed crops for alternative fuels. Generally, farmers resist changing from crops for which they have years of experience and “comfort.” They are resistant to try new crops unless: (a) there is a significant crop insurance program available to reduce the risks; (b) there is minimal investment in equipment needed to plant and harvest; (c) there is a reasonable certainty of a local market for their crop, and; (d) no risk to current cropping strategies and production of commodity crops on the same acreage (e.g., wheat).

Regarding *Incentives and support (supply)*, forum participants noted that the 2014 Farm Bill created the Biomass Crop Assistance Program (BCAP) for renewable energy. However, availability of the program is geographically limited (clearly expressed by the forum attendees, indicating that South Dakota, North Dakota, and parts of Montana do not have access), and constrained by availability of an authorized regional / local facility to accept a particular biomass. Establishment of an approved BCAP region requires a group of producers or a biomass processor to submit a proposal for inclusion in the program. As the BCAP program notes, it is also subject to the uncertainties of annual appropriations from Congress. See <https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdfiles/Energy/BCAP%20Facility%20Listing%20FY2017.pdf> for the complete list of the 52 facilities located in AL (1), AZ (2), CA (25), CO (3), and FL (3), GA (1), ID (3), IA (3), KS (1), MI (1), MN (3), MT (1), NE (1) NM (2) and OR (2) and the biomass they are authorized to accept. Most accept woody biomass residues, but generally do not accept crop residues or oils.

Crop insurance for canola and camelina as oilseed crops is improved in some regions. Issues of “insurance availability,” timing of “cover crops” and their relationship to “cover crops and the summer-fallow” may be geographically complex issues, well beyond the scope of this report. Interested readers are referred to “Frequently Asked Questions -- 2016 Cover Crops Crop Insurance, Cover Crops and NRCS Cover Crop Termination Guidelines” at the USDA Risk Management Agency website (<https://www.rma.usda.gov/help/faq/covercrops2016.html>).

At all three forums, the agronomics of canola and relationship to wheat production were discussed. No new equipment is needed. Producers in the Southern Plains reported that working canola into a wheat rotation showed subsequent wheat yields improved by 10%-20%; a recently completed Kansas State University study documented 18%-52% increases in wheat yields. Thus, incentives to grow canola include much more than value for jet fuel, edible oil, and animal feed.

Certainty of a local market for canola and other oil seeds (e.g., camelina, rapeseed) may be less clear, in part due to supply chain logistics. If identity preservation is needed in crushing facilities to segregate edible from non-edible oils (biofuels, industrial lubricants), locally convenient storage

facilities may not be sufficiently partitioned. The value for edible canola oil is currently significantly greater than for biofuel oil. More certain is the value of the principal co-product ---- a high fiber and protein animal feed resulting from the crushing process of canola, versus less valuable meal from rapeseed. Distance to crushing facilities also affects transportation costs (and how much that discounts the farmers' revenues) and economic feasibility for local producers. The same is true for the next step in the supply chain --- distance to biorefinery operations. The FAA-funded ASCENT Center of Excellence Project 1 team is focused on research to determine supply chain impacts and identify opportunities to enhance supply chain development (see <https://ascent.aero/project/alternative-jet-fuel-supply-chain-analysis/>).

Food versus fuel debate. This issue was raised at all three forums. Participants recognized that the public may feel this is an issue, and must be addressed in an education and awareness program, stressing that the same canola crop produces 40% oils (edible oil for human consumption, oils for fuels), and 60% high protein feed for livestock / poultry, while also enhancing wheat production in the subsequent rotation, and that there are feedstock options that can be grown during traditionally fallow periods without interfering with primary food crop rotations.

Technology advances. Discussion on this topic can be summarized from two perspectives. Industry continues to make technological advances in extracting oils and proteins, and in biorefining operations of cracking the oil-seed lipid chains to produce an efficient continuum of customized transportation fuels in response to end-user needs and value. The slide set from CAAFI summarizes the processes and partnerships developed to support the aviation fuels. Attendees of the forums also encouraged further research directed toward developing other high-value products arising from oilseed crops, and continuing the genetic selection for varieties specifically beneficial to alternative fuel (C18-C22 carbon chains), and in developing regionally-adaptive plant varieties that are high in protein content for animal feed, have high oil quality, high yield and that also are drought tolerant and cold tolerant.

Regulatory issues. Participants in the Wichita forum described the use of plant growth regulators in canola growing regions of the world to optimize plant height, flowering, harvesting parameters, and making plants less susceptible to freeze. It was noted by U.S. producers that these products are not yet approved for use in the U.S. (subject to FDA and USDA APHIS regulatory processes), but approval for research purposes in the Pacific Northwest has recently been issued.

Summary of forums and conclusions

The three forums convened were appropriately targeted for the wheat-growing regions that differed by climate, and the research presented by the scientists conveyed some of the key differences and how further research is needed on regionally-adaptive varieties of *Brassica* spp. Growers that participated in the forums had either some positive experience with canola crops, or showed a willingness to try the crop in their rotations. Attendance by industry (seed companies, storage and processing companies) was supportive of expanding the industry; discussions were useful in helping them shape their strategies. In terms of growing the industry and optimizing supply chains for generating wealth and job opportunities, a lack of public education and awareness of the oilseed industry and the complexity of the supply chain is a key issue that must be addressed in the regions through activities of academicians and the extension service.

Based on the input provided by forum participants, those knowledgeable about the growth of this industry are both supportive and optimistic about the eventual success of developing a sustainable alternative fuel industry from oilseed crops. There was general agreement that success, however, will be dependent upon four critical issues: (1) the development of a diversified supply chain that is financially sustainable; (2) the support of the financial investment community; (3) consistent public policy; and (4) an extensive public education and awareness campaign.

In furthering this initiative, the Foundation emphasizes the importance of engaging a broader group of stakeholders in each region. In these forums, under-representation of the finance and economic/workforce development sectors was apparent in the discussions. We strongly recommend that any subsequent forums on the theme of advancing the bioeconomy with goals of economic development and job creation, whether convened by USDA or others, include more even representation by the six sectors.

USDA should also take an active role in promoting next steps from this research project in two specific ways. First, USDA could evaluate their use of Rural Development resources (RD Enterprise Grants, Value Added Producer Grants, or possibly even more targeted mechanisms) to convene business development activities (e.g. feasibility studies) while also furthering commercialization of these research outcomes. Other funding sources from USDA could be explored and considered, such as the Commodity Credit Corporation to determine whether a role could be developed to further production of plant-based biofuels. One approach for this increased effort could be to enhance engagement of the Pacific Northwest where they have an extensive history in aviation innovation and its pioneering work in the development of an aviation alternative fuel ecosystem. The outcomes of this research project and these forums can potentially be incorporated into work being planned for FY'18 by Project 001 of the FAA's ASCENT Center of Excellence in the PNW. We suggest that USDA representatives to ASCENT supplement advisory representation to broaden stakeholder input (sector representation); these should include producers of crops and feedstocks (farmers), the investment community, and elected state / local policy

makers ---- a more complete working group to expand development of plant-based alternative jet fuel. This could serve as a model to other geographic regions interested in exploring how individual sectors in the supply chain can participate, perhaps through a facilitator, to stand-up a new industrial segment.

Second, USDA NIFA could increase funding in the AFRI CAP program in the specific area of research, development and commercialization of plant-derived alternative jet fuel in additional regions of the U.S. This could follow the example of the recently announced NIFA funding (about \$7M each) of projects led by University of Florida and by University of Arizona. In the SE U.S., Florida will lead an effort “...to establish a *Brassica carinata* (carinata) based resilient and sustainable advanced jet fuel and bioproducts supply chain in the Southeast U.S. ...” across 6 states using 15 advanced *carinata* genotypes to optimize agronomics and management regionally. This project also involves the Southeast Partnership for Advanced Renewables from Carinata (SPARC) that includes Agrisoma and ARA Laboratories. In the SW U.S., University of Arizona will lead an effort to “... cultivate two desert-dwelling crops, guayule and guar, for a sustainable bioeconomy...” Both crops are drought and heat tolerant and produce biomass year-round on marginal lands. This project involves five universities in CO, NM, AZ, IA; Bridgestone Americas, Inc. and Mercurius Biofuels Inc., and federal labs including the Pacific Northwest Laboratories (DOE) and USDA-ARS.

Notably, both projects include an Advisory Board/Committee and incorporation of training (workforce development) to assure sustainability. The ATIP Foundation would encourage NIFA awardees also to seek engagement with representatives from sectors of economic development, education, and state / local elected policy makers to optimize community benefits in the process of adoption and commercialization. Also, inclusion of some who were involved in the HRJ grant would result in representation from the first completed plant-based biofuel project under the NIFA programs. Thus, within the span of 5 years, the foundation may very well be laid for a sustainable alternative jet fuel industry from oilseed and other plant-based crops.

The ATIP Foundation is available to assist and facilitate these processes as Agency and regional interests warrant.

Presentations and notes from the June 6, 2017 forum in Richland, WA can be found at:

https://www.dropbox.com/sh/7ozh3chjqfsz83m/AADcT_QYYo9ToFC6dApuEYBa?dl=0

Presentations and notes from the June 13, 2017 forum in Fargo, ND can be found at:

https://www.dropbox.com/sh/g4lszugmc4r00fo/AADh_ZYMIUH5b72IGK1PH3a?dl=0

Presentations and notes from the July 11, 2017 forum in Wichita, KS can be found at:

<https://www.dropbox.com/sh/vxai0l2vzhnx6e/AABPW6X9e5Q2PhgJfIG6QRnHa?dl=0>

Forum: Accelerated Commercial Development of Hydrotreated Renewable Jet Fuel (HRJ) from Redesigned Oilseed Feedstocks Supply Chains

Read-Ahead Document for Participants of the Richland, WA (June 6, 2017), Fargo, ND (June 13, 2017) and Wichita, KS (July 11, 2017) Forums

Economic development is the creation of wealth in which community benefits are realized. It is more than a jobs program; it's an investment in growing your economy and enhancing the quality of life for all residents. The fundamental purpose and expected outcome of the forum is to create awareness and understanding of the USDA research and to explore how outcomes can be commercially produced to generate wealth and create jobs within the region, particularly rural America.

The ATIP Foundation, Washington State University, the North Dakota Department of Commerce, North Dakota State University, Wichita State University, and Kansas State University, in partnership with the U.S. Department of Agriculture, are convening this forum series as a critical next step to the successful completion of a multi-year, multi-disciplinary research project titled “Accelerated commercial development of hydrotreated renewable jet fuel (HRJ) from redesigned oilseed feedstocks supply chains.” This forum begins that process of stimulating thinking toward shaping the commercialization and growth of this biofuel industry by bringing together key thought leaders from sectors of (1) local, county, & state elected and appointed officials; (2) economic and workforce development; (3) academia; (4) finance; (5) business & industry and (6) the entire supply chain from growers to end users. Representation by these sectors is critical in shaping the growth of this industry.

Below is a “read ahead” synopsis of research findings provided to prepare participants for the forum. A noteworthy inclusion in this document is a recent article on this topic published by the U.S. Canola Association.

Synopsis of Grant Research Components

Objective 1: Improve Feedstocks. The team conducted phenotypic screening for *Brassica napus* germplasm under four environments; Ames, Iowa, Moscow and Genesee, ID and Akron CO where both winter and spring lines were evaluated. Winter entries did not survive. Spring trials were conducted and phenotypic observations and yields were collected from each entry. *B. napus* winter oilseed germplasm genotypes (640 lines) and 240 spring germplasm in addition to 220 RILs from 2 winter and 2 spring populations were planted in Moscow and Genesee, ID in the fall of 2014 and spring of 2015, respectively. Post-harvest phenotypic data collection (pod length, seeds/pod, and seed size) was collected on all trials. The phenotype data (including crop establishment, flowering date, plant height, leaf morphology, pod length and seeds per pods),

was compiled and is currently being analyzed over sites and years. Genome-wide association study (GWAS) was conducted. Phenotypic data from 2012, 2013, 2014 and 2015 was collected in up to four locations (Ames, IA, Akron, CO, Genesee and Moscow, ID) and data combined for association with the genetic marker data already collected in this study. Of the of the 241 Spring *B. napus* accessions planted in the field, 178 had genotypic data and were analyzed in years 1-2 of the project. The GWAS identified known and potentially novel markers associated with oil composition and phenology. Approximately 500 lines of spring *Brassica napus* have been prepared for Sequenced-based Genotyping by the team in Maricopa, AZ, and sent to Stoneville, MS for sequencing on an Illumina HiSeq 2500 machine. These lines include most of the spring lines that were phenotyped in the field trials but have not yet been genotyped.

Objective 2: Develop regionalized strategies for production. Six winter and 12 spring-type Brassicaceae genotypes were evaluated for seed and oil yield under drought and heat stress. Stress trials were conducted in Pendleton, OR, Moscow, ID, Sydney, MT, Temple TX, Akron, CO, Mandan, ND, Morris, MN, and Ames, IA as needed to evaluate genotypes under a range of water and temperature regimes. Measurements collected were phenological stage, biomass, leaf area, pod set, and seed per pod, and seed yield. Cold tolerance was mainly exhibited in ‘Joelle’ Camelina. Other winter-types were susceptible to freezing and did not survive except in ID, which had a mild winter. Under optimal conditions in IA and MN, the highest yielding spring-types were *Brassica napus* canola and *B. carinata* mustard. In contrast, spring-types showing tolerance to combined drought and heat stress in OR and MT were *B. juncea* mustard and *B. napus* canola. Nearly all data for the three years of the study have been organized into spread sheets for entry into a global database for the project. The combination of water and temperature regimes across locations will allow the relationships between seed and oil yield, and individual and combined stresses to be established. In TX, measurements of growth and canopy temperature helped to establish heat unit parameters for calibrating the Agricultural Land Management Alternative with Numerical Assessment Criteria (ALMANAC) modeling of growth of two winter-types and four spring-types. Using a growth chamber, the minimum soil moisture and soil temperature requirements were determined for germination of the six spring-type genotypes of seed lots from OR and MN. In-line, optical near infrared sensors were installed on a combine harvester and on a conveyor belt at an elevator to assess variance of seed oil concentration in these points in the supply chain. If variability is known, then grain could be blended to achieve a single seed oil concentration and optimize a cold pressing operation. EPIC model simulations were updated for all of North Dakota using canola oilseed crop parameters. Break-even analysis was conducted showing oilseed supply and natural resource impacts for all 9km x 9km grid cells in the state. Results were used as inputs for transportation analysis using the Alternative Fuel Transportation Optimization Tool AFTOT (external collaboration with the Department of Transportation’s Volpe Center) and also for life-cycle assessment of greenhouse gas and net energy impacts. Output summaries were also added for water-related outputs (evapotranspiration, runoff, leaching) to be used as inputs for life-cycle assessment (LCA).

Objectives 3 Oilseed processing. Seven cultivars with different fatty acid profiles (high in oleic acid and low to high erucic acid) were selected for extraction and refining to evaluate their conversion into HRJ fuel. The oils were extracted either by cold pressing, cooking the seeds before pressing, or prepressing followed by solvent extraction. Oils obtained by cold pressing had the lowest amount of phospholipids as indicated by its phosphorus content (16 ppm P). Pressed oils from cooked seeds had significantly more phospholipids (60 to 110 ppm P) but lower than the solvent extracted oil (132 ppm P). Most oils had sulfur content less than 20 ppm. Each oil was acid degummed, chemically refined using 9.5% NaOH, and then bleached with silica and activated diatomaceous earth. The phospholipids were completely removed after bleaching. Both degumming and bleaching reduced the sulfur in the oil to 4 to 11 ppm S, depending on the amount present in the starting crude oil. One gallon of bleached oil from each cultivar was provided to UOP for conversion into HRJ.

Objective 4: HRJ Conversion. Completed hydrocracking of soybean, Invigor L130, Pacific Gold and Gem into jet fuel. Estimated yield of jet fuel based on feed analytical properties (carbon chain length) gave 60.3, 61.2, 65.6 and 66.7% conversion with a total distillate of 78, 79, 80 and 80% respectively. The conversion results indicate longer chain-length fatty acids, like erucic acid, are advantageous for higher levels of jet fuel production. There is also a small economic advantage to the fatty acids having higher saturation levels.

Objective 5: Systems Analysis (Biofuels Development). A prototype Oilseed Break-even Price Impact Explorer was developed in collaboration with the National Agricultural Library. This data discovery and visualization tool allows users to interactively display geospatial results for the break-even analysis, including oilseed quantities, oilseed production area, and associated environmental impacts. The portable version of the Policy Analysis System (POLYSYS) model was used to analyze price impacts for the North Dakota break-even price scenarios. The Impact analysis for Planning (IMPLAN) model was used to analyze regional and local economic impacts. Initial IMPLAN analysis was completed using the results from the North Dakota break-even price scenarios. Results indicate job creation associated with new oilseed production ranging from 84 to 700 jobs depending on the level of oilseed production. The IMPLAN analysis did not include analysis of any new processing or biorefining facilities. Life cycle assessments for greenhouse gas emissions, energy demand, and water footprint of oilseeds are being conducted based on simulations from the Environmental Policy Integrated Climate EPIC model and the AFTOT model. Analysis for HRJ in North Dakota showed HRJ reduced fossil energy demand for jet fuel production by more than 60%, and reduced greenhouse gas emissions by 42 to 114% depending on the allocation method used and how oilseeds are incorporated into existing crop rotations. The goal in the water footprint analysis is to answer the central question whether incorporating oilseed biofuel production into the wheat belt will increase or decrease water use compared to the current cropping systems. Initial results for North Dakota, show that introducing fuel oilseeds to existing crop rotations slightly decreases the amount of water used for crop production. While total water foot ranged from 131 to 143 m³ per GJ of HRJ produced,

only 4% of this footprint was categorized as “blue” water sourced from surface or groundwater resources.

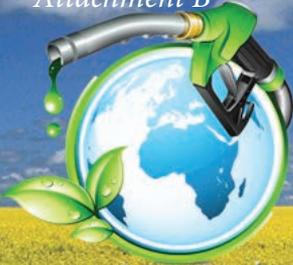
Objective 6: Education and Outreach. An extension survey was conducted to identify information and training needs for extension and outreach providers, so that they can provide accurate and complete information to agricultural producers. Results indicate that extension and outreach agents require additional training on biofuel feedstock production, especially economic and logistical aspects. Assessment of farmers' willingness to produce specialized oilseeds for biojet fuel production under contract indicated that they would be willing to produce oilseeds in rotation with wheat under the right contract. Farmers' want contracts that provide them with positive net returns, shorter term periods, access to crop insurance to mitigate risk, cost-share, and an "Act of God" clause. In addition, farmers' desire to have oilseeds that have improved shatter resistance, resistance to pests, winter hardiness and an extended direct combine window. Analyses show that farmers' are willing to pay or give up net returns under the contract to have these contract and oilseed attributes.

HRJ Grant Participants:

AeCAP
ATIP Foundation
Cornell University
Kansas State University
Keygene
Michigan Tech
South Dakota School of Mines and Technology
University of Idaho
University of Maryland
University of Tennessee
UOP/Honeywell
USDA Agriculture Research Service
USDA National Institute of Food and Agriculture
USDA Natural Resource Conservation Service

HRJ Forum Series Co-hosts / Sponsors:

ATIP Foundation
Commercial Aviation Alternative Fuels Initiative (CAAFI ®)
Kansas State University
North Dakota Department of Commerce
North Dakota State University
USDA Rural Development
Washington State University
Wichita State University



Oilseed-to-Biojet Fuel Forum Agenda

June 13, 2017 | Fargo, ND

Photo Credit: Rick Craig

Accelerated Commercial Development of Hydrotreated Renewable Jet Fuel (HRJ) from Redesigned Oilseed Feedstocks Supply Chains

- 8:00 AM** **Registration**
- 8:30 AM** **Welcome and Overview**
North Dakota Hosts and Wes Jurey, ATIP
- 9:30 AM** **Panel Discussions**
Rick Brenner, ATIP Panel Moderator
- Sustainable Alternative Jet Fuel (SAJF)
 Demand and Supply Status
 Steve Csonka, CAAFI
- Grant Overview
 Terry Isbell, USDA-ARS
- Oilseed Evaluations for Stress Environments
 Russ Gesch, USDA-ARS
- 10:30 AM** **Break**
- 10:45 AM** **Panel Discussions (continued)**
- Economics of Production
 David Archer, USDA-ARS
- HRJ Conversion Analysis
 Michael Brodeur-Campbell, Honeywell UOP
- Moving Forward: Federal Programs
 Chris Cassidy, USDA-Renewable Energy Advisor
- 11:30 AM** **Lunch**
- 12:30 PM** **Dialogue and Discussion for the Northern Plains**
Wes Jurey, ATIP
- 3:00 PM** **Adjourn**