



Project 001(D) Alternative Jet Fuel Supply Chain Analysis

The Pennsylvania State University

Project Lead Investigator

Saurabh Bansal
Associate Professor of Supply Chain Management
Department of Supply Chain and Information Systems
The Pennsylvania State University (PSU)
405 Business
University Park, PA 16802
814.863.3727
Sub32@psu.edu

University Participants

The Pennsylvania State University PI(s)

- Saurabh Bansal, Associate Professor of Supply Chain Management
- Lara Fowler, Senior Lecturer, Law School; Assistant Director, Penn State Institutes of Energy and the Environment
- Ekrem Korkut, Law School,
- Gaby Gilbeau (through August 2019), Staff Attorney

The Washington State University

- Kristin Brandt, Staff Engineer

University of Tennessee

- Tim Rials, Associate Dean AgResearch
- Burt English, Professor of Agricultural and Resource Economics

Project Funding Level

FAA Funding: \$200,000
Matching, PSU: \$200,000
Total Funding: \$400,000

Investigation Team

- 1.3.1 **(Lead: Bansal; supported by Brandt and English):** risk-reward profit sharing modeling for first facilities
- 1.3.2 **(Lead: Bansal; supported by Brandt and English):** additional quantification of risk and uncertainties in supply chains (foundational part of task above)
- 1.3.3 **(Lead: Bansal; supported by Brandt and English):** supply chain risk analysis tools for farmer adoption
- 1.4.1 **(Lead: Fowler; supported by Korkut):** national survey of current and proposed state and federal programs that monetize ecosystem services
- 1.4.3 **(Lead: Fowler; supported by Korkut):** support in stakeholder engagement efforts



Project Overview

The project focuses on developing a qualitative and quantitative understanding of factors that can help the establishments of biofuel supply chains aimed at supplying alternative jet fuels. Efforts have been made in the past to establish these supply chains. However, many of these efforts have been unsuccessful because of a lack of clarity regarding what incentives stakeholders would require to engage in these supply chains and devote their resources to invest in the facilities required for these supply chains. To this end, the project has two goals:

1. Develop pro forma cash flows that represent the financial status of various participants in biofuel supply chains for alternative jet fuels, and
2. Understand the policy landscape that exists in various parts of the United States to encourage these supply chains and identify further policy initiatives that may be needed.

Task 1.3.1 - Risk-Reward Profit Sharing Modeling for First Facilities

Pennsylvania State University

Objective

Develop a transparent risk-sharing tool to provide all partners with an understanding of the cash flows and risks faced by all supply chain partners.

Research Approach

We first collected a large number of risk sharing tools that have been proposed in the supply chain literature. Subsequently, we narrowed the list down to 9–12 mechanisms. We created an Excel-based framework in which the cash flows of all supply chain partners are modeled by using the numbers from the techno-economic analyses developed by WSU. This framework incorporates the risk sharing mechanisms.

Milestone

We developed the Excel models for four realistic configurations by using data from techno-economic analysis models from WSU.

Major Accomplishments

We developed an Excel-based framework showing the cash flows of four key stakeholders of alternative jet fuel supply chains: farmers, preprocessors, refineries, and airlines. The framework shows various risk sharing contracts that each of the stakeholders can extend to others, as well as the financial burden or opportunity associated with these mechanisms. The framework also shows the government's financial burden of supporting these mechanisms. The framework is developed for four levels of refinery capacities. Overall, this framework can be used as a decision support tool by various stakeholders to determine whether to engage in alternative jet biofuel supply chains and negotiate with each other.

Publications

We anticipate publishing a paper based on combined work from the last year and the coming year.

Outreach Efforts

The tool has been discussed at three avenues at the ASCENT enterprise.

Awards

None.

Student Involvement

None.

Plans for Next Period

We intend to run some focus group and laboratory studies to quantify the expected benefit from the tool. We recently ran a pilot study with undergraduate students, but it did not work well. Undergraduate students may not be an optimal study

population, because they may not have the training to understand complex Excel cash flows. We will re-run the study with MBA students in spring 2020.

Task 1.3.2 - Additional Quantification of Risk and Uncertainties in Supply Chains (Foundational Part of Task Above)

Pennsylvania State University

Objective

Develop methods to rely on expert judgments to quantify uncertainties associated with biofuel supply chains.

Research Approach

We developed a new econometric approach to quantify probability distributions of uncertain quantities such as yield or demand when a panel of experts provides judgments regarding the most likely values. This approach exploits the well-known theory of generalized least squares in statistics, for the context in which historical data are available to calibrate expert judgments or when these data are not available.

Milestone(s)

We have described the method in two manuscripts provided as attachments with the annual report. In the first manuscript, we develop a two-stage procedure to calibrate expert judgements for the distribution of biofuel uncertainties, such as the uncertain yield of new varieties of oil seeds, demand, or selling price. In the first step of the procedure, we calibrate the expert judgements by using historical data. Specifically, we use prior judgments provided by experts and compare them with actual realizations (such as predicted yield versus actual yield) to determine the frequency with which each expert over- or underestimated the uncertainty, e.g., expert 1 underestimated the yield 60% of the time, but expert 2 underestimated the yield 90% of the time. In the second step, we use this information to determine the optimal way to aggregate the experts' judgments to determine the mean and standard deviation of the probability distributions. In the second manuscript, we develop a new optimization protocol to determine the optimal acreage for growing specific crops, by taking into account the estimated mean and standard deviation as well as incorporating the variability in these estimates.

Major Accomplishments

Theoretical development and a numerical study have demonstrated the promise of this approach.

Publications

One paper has been accepted pending editorial changes. The second paper is finished.

Outreach Efforts

N/A

Awards

None.

Student Involvement

None.

Plans for Next Period

The second paper will be finalized during the period. Any revisions required for the first paper will also be made in the next 1-2 years.

Task 1.3.3 – Supply Chain Risk Analysis Tools for Farmer Adoption

Pennsylvania State University

Objective(s)

Understand farmers' risk preferences over a long duration and how these preferences affect their decisions to grow crops that can support alternative jet fuel supply chains.

Research Approach

We surveyed farmers to understand their risk preferences over extended durations. Specifically, we showed them sample yield ranges over extended periods and asked them to estimate the lowest equivalent guaranteed yield that they would be willing to accept given the uncertain yields. We used these responses for statistical analyses.

Milestone(s)

We have completed the survey and finished a manuscript based on the survey.

Major Accomplishments

We compiled data from 43 farmers in central Pennsylvania regarding their preferences given the uncertain yields from their land. The results quantify the loss of value that farmers attribute to an uncertain yield. The reported results are for both 1-year and 10-year horizons. For the 10-year horizon, we also report results with an initial yield buildup, as is the case with most biofuel crops. The key takeaways from this study are that: (a) farmers' valuation of a new crop decreases acutely as the uncertainty in yield increases, and (b) the initial build-up period of low yields can be a large deterrent to farmers' adopting new crops for the purpose of supporting biofuels.

Publications

The second paper is finished and has been submitted to sponsors.

Outreach Efforts

N/A

Awards

None.

Student Involvement

None.

Plans for Next Period

We plan on submitting a journal article based on the paper during the coming year.

Task 1.4.1 - National Survey of Current and Proposed State and Federal Programs that Monetize Ecosystem Services

Pennsylvania State University

Objective(s)

Conduct a survey and summarize current and proposed state and federal programs to monetize economic systems.

Research Approach

This task builds on and continues the work done under ASCENT Project 01, Task 8.1, which focused on the biomass and water quality benefits to the Chesapeake Bay watershed. Under this task, we examined the biofuel law and policy landscape of the Pacific Northwest and Southeast regions, as well as the state of Hawaii. We also researched federal biofuel law and policy. We have had a change in personnel working on this project. Lara Fowler remains the lead; however, Gaby Gilbeau left the project in August 2018, and Ekrem Korkut joined the project during the fall of 2018.



Milestone(s)

We have captured this research in three region-specific white papers describing the biofuel law and policy incentives, and the ecosystem service drivers for the subregions:

- Project 01A, Tasks 3.1, the Pacific Northwest
- Project 01B, Task 3.2, Hawaii
- Project 01E, the Southeast

Copies of these documents are available online:

- Western U.S. policy paper (with a focus on Washington State): <https://psu.box.com/s/l9ektkcr8lk10gjq9314jmm9djmmhf>
- Southeast policy paper (with a focus on Tennessee): <https://psu.box.com/s/iyeowdfo0447t4ya8dl5md2zu5un48u6>
- Hawaii policy paper: <https://psu.box.com/s/92a7tl19tpphg69t4ff12t9d4rdshgq1>

Major Accomplishments

We have captured this research in three regional white papers describing the biofuel law and policy incentives. In addition, we have researched and are nearly finished with drafting a document summarizing aviation and biofuel at the national level in the United States. We are starting to examine legal and policy drivers from other parts of the world.

Publications

The white papers have been sent to ASCENT leads for review and comment.

After these papers are reviewed for circulation, we anticipate circulating them to ASCENT team members and seeking publication.

Outreach Efforts

An economic model to motivate land use conversion has been demonstrated at Civil Aviation Alternative Fuels Initiative meetings in previous years (that aspect of this task is no longer ongoing). For the law and policy dynamics, Lara Fowler and Gaby Gilbeau (formerly on the project team) provided a presentation to the ASCENT team on March 25, 2019, giving an update on national and regional legal changes.

Awards

None.

Student Involvement

During summer 2019, PSU hosted a Drawdown Scholars Research Experience for Undergraduates focused on reducing greenhouse gas emissions. As part of this project, Lara Fowler and Ekrem Korkut worked with undergraduate scholars who had questions associated with biofuel law and policy, including providing them with the white papers and engaging in discussions.

Starting in the fall of 2019, Ekrem Korkut transitioned from a research assistant to a full-time student at the Penn State School of International Affairs. He has continued to work on the ASCENT project as a part-time research assistant.

Plans for Next Period

Future research will expand on these regional and national overviews to explore law and policy drivers at the national level. This work will continue to expand to a variety of environmental service and credit trading markets and will help support work identified by other ASCENT team members.



Task 1.4.3 - Help Support Stakeholder Engagement Efforts

Pennsylvania State University

Objective

Facilitate dialogue among producers, industry, government, and other affected stakeholders.

Research Approach

Our work under this objective focused on stakeholder engagement and facilitation of effective dialogue to help bridge the gaps among producers, industry, government, and other affected stakeholders. This role supports other team members' needs.

Milestone

These efforts supported the stakeholder engagement efforts led by other teams, including but not limited to the regional partners identified in ASCENT Project 01, Tasks 3.1, 3.2, and 3.3.

Major Accomplishments

While we held initial conversations with partners in Tennessee, the process was delayed because of constraints for the Tennessee partners. We have continued to participate in discussions and calls related to potential stakeholder engagement needs.

Publications

N/A

Outreach Efforts

N/A

Awards

None.

Student Involvement

None.

Plans for Next Period

Future work under this objective will include presenting to the project partners on facilitation skills and tactics. Additional support for regional projects will be offered as needed for facilitation and stakeholder engagement sessions as the regional projects move to the deployment stage.