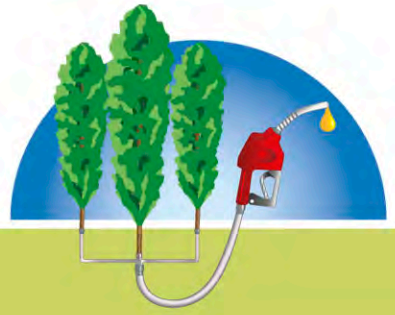

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Advanced **Hardwood Biofuels** Northwest

Hybrid Poplar as a Green Energy Resource in the Pacific Northwest

Varaprasad Bandaru

UC Davis Energy Institute

UC DAVIS
UNIVERSITY OF CALIFORNIA

Contributors: Andrew Cooke, Yueyue Fan, Judy Hannah, Quinn Hart, Mark Jenner, Stephen Kaffka, Yuanzhe Li, Justin Merz, Nathan Parker, Yu Pei, Olga Prilepova, Luke Rogers, Peter Tittmann, Boon-Ling Yeo, Bryan Jenkins

USDA United States Department of Agriculture National Institute of Food and Agriculture

Overview

- Background on hybrid poplar features and research requirements for poplar biofuel industry
- Description of integrated modeling framework
- Application of integrated modeling framework in the Pacific Northwest region
- Conclusions and future work

Poplar – A biofuel feedstock option in the PNW

- Long history of success in several markets.
- Accessibility to production and harvesting technology.

Poplar plantations at Jefferson, OR

Harvesting of poplar

- Adaptable to various climate and soil conditions.
- Multiple crop rotations with coppicing practice.

Biofuel Supply Chain – Key Challenges

Economic, Environmental, Social Sustainability

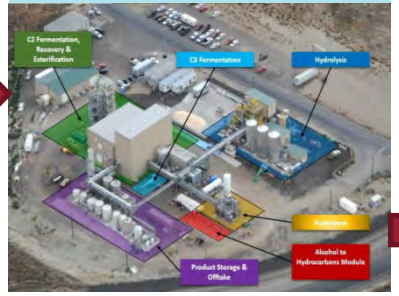
Feedstock Production

- Suitable lands and their feedstock potentials
- Competition with other crops
- Ecological responses

Feedstock Logistics

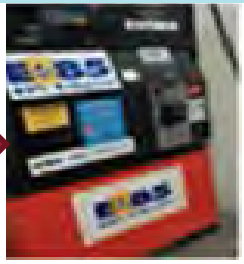
- Biomass and transportation costs
- Biomass harvesting trends
- Preprocessing and storage
- Quality management
- Environmental impacts

Biofuel Production



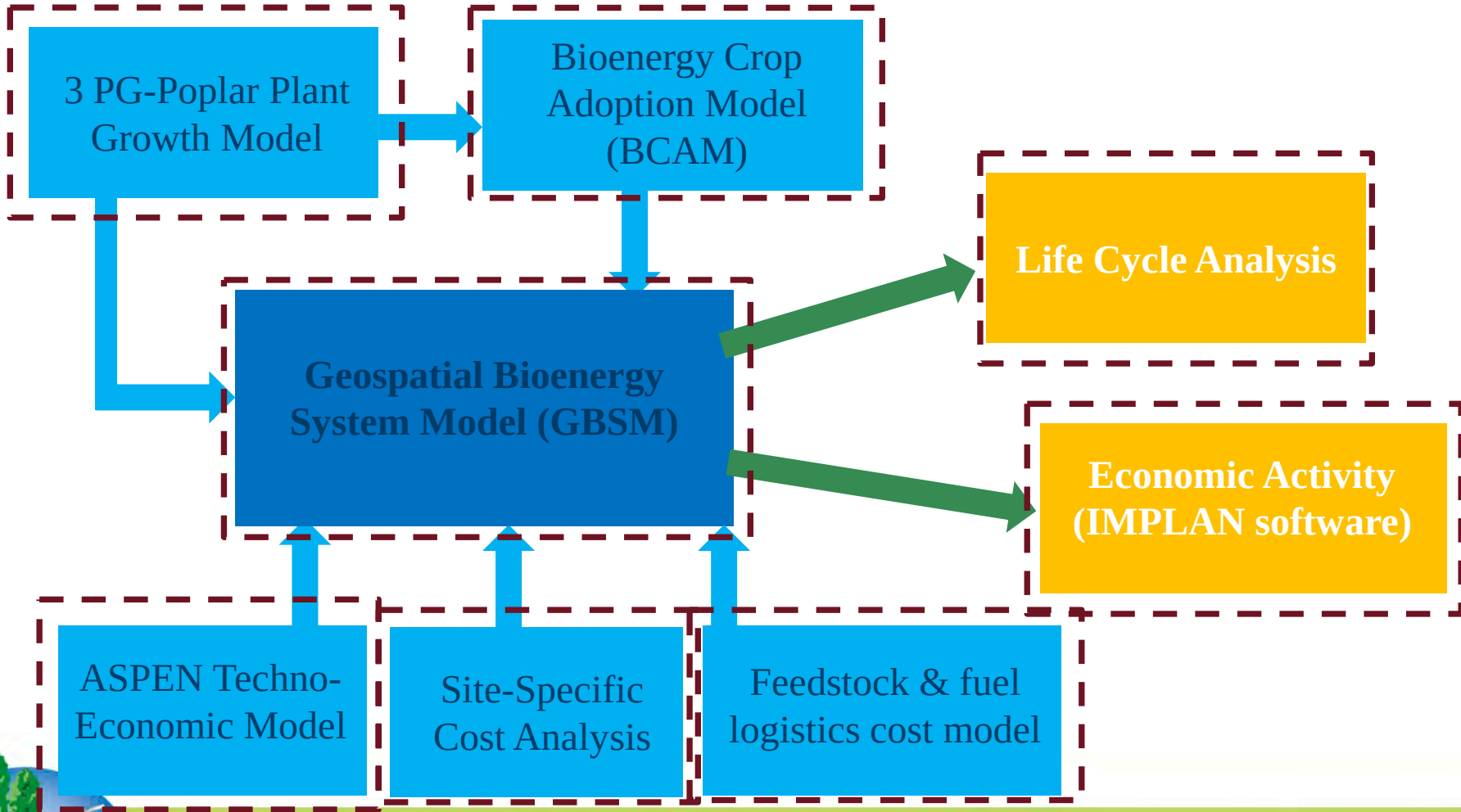
- Land & infrastructure needs
- Operating costs
- Technology options

Biofuels Distribution



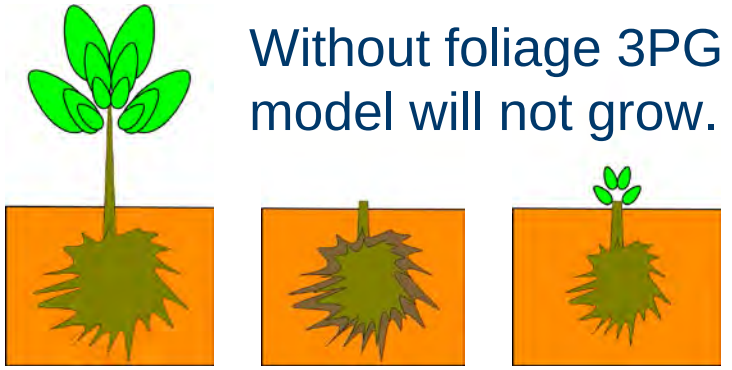
- Transportation
- Storage
- Dispensing

Integrated Modeling Framework



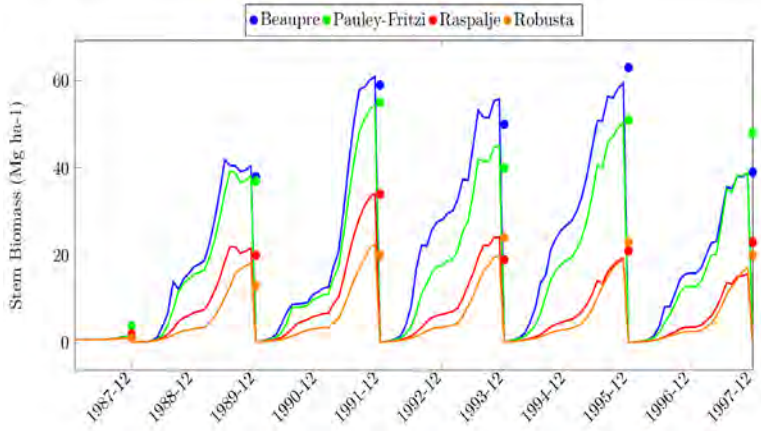
Poplar Growth Modeling

- Developed coppicing module in Physiological Principles in Predicting Growth (3PG) forest growth model.



Without foliage 3PG model will not grow.

- Validated the model against published field sites of hybrid poplar with coppice management.

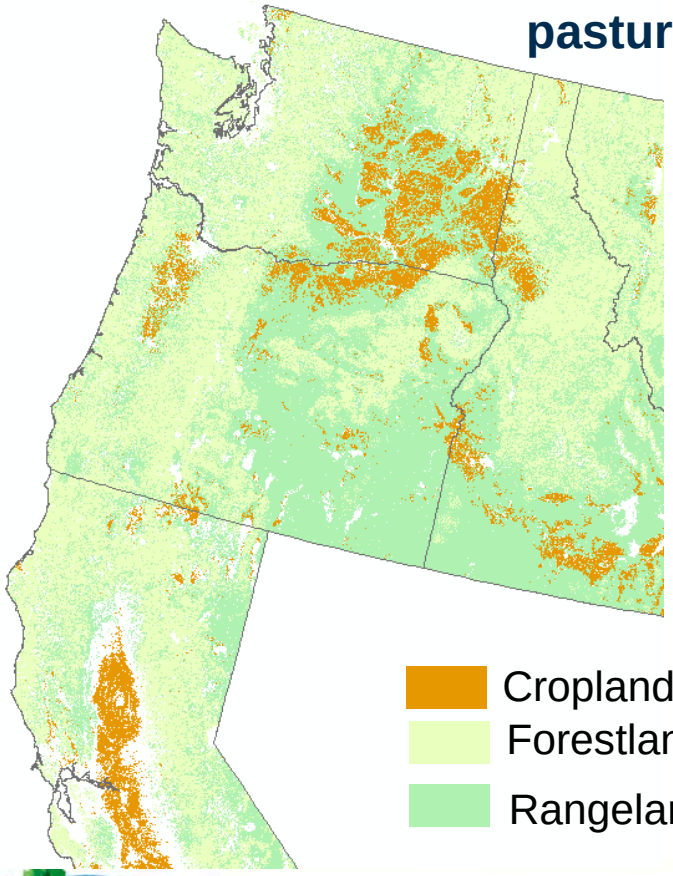


Simulations (lines) vs. measured (circles) biomass

Oral: Quinn et al, *The Modeling poplar growth as a short rotation woody crop for biofuels in the Pacific Northwest.*

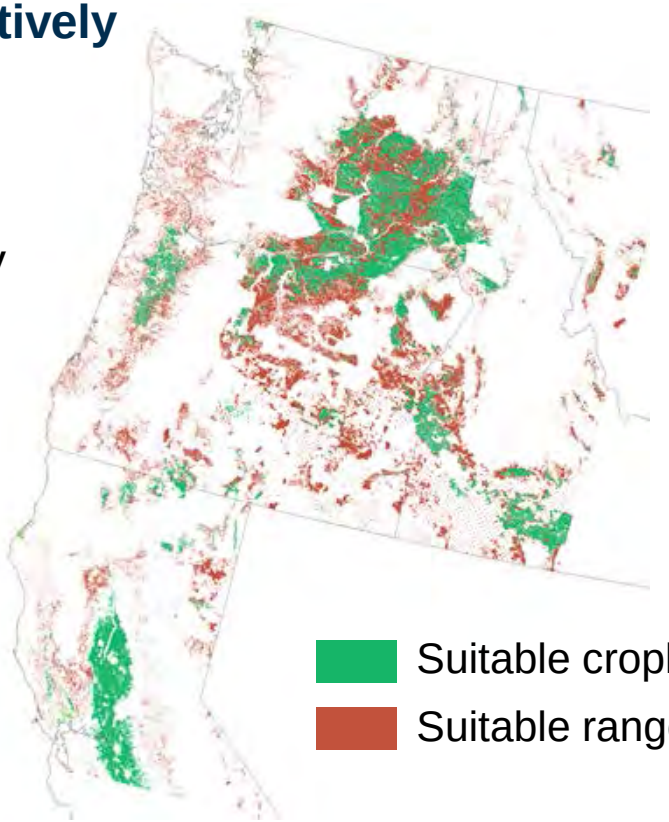
Suitable Agricultural Lands for Poplar Cultivation in PNW region

- 6.02 and 10.3 million ha of suitable croplands and pasture lands respectively



Croplands
Forestlands
Rangelands

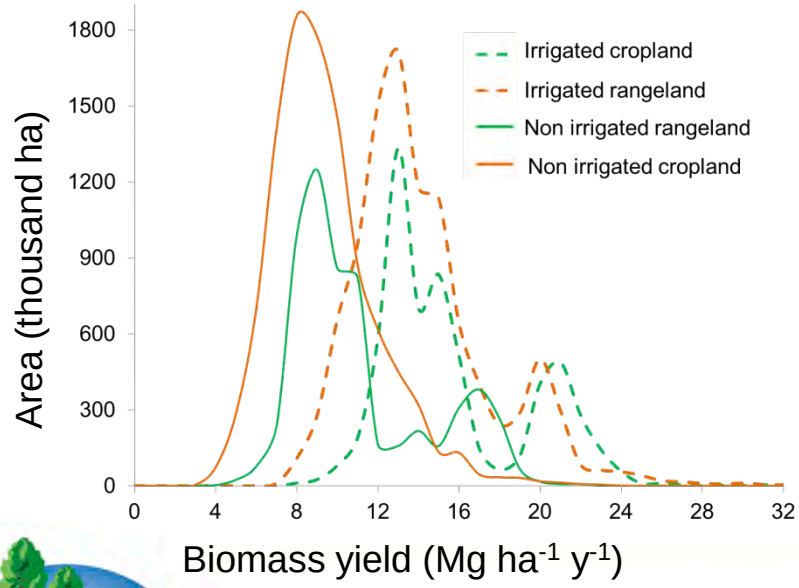
Land suitability factors

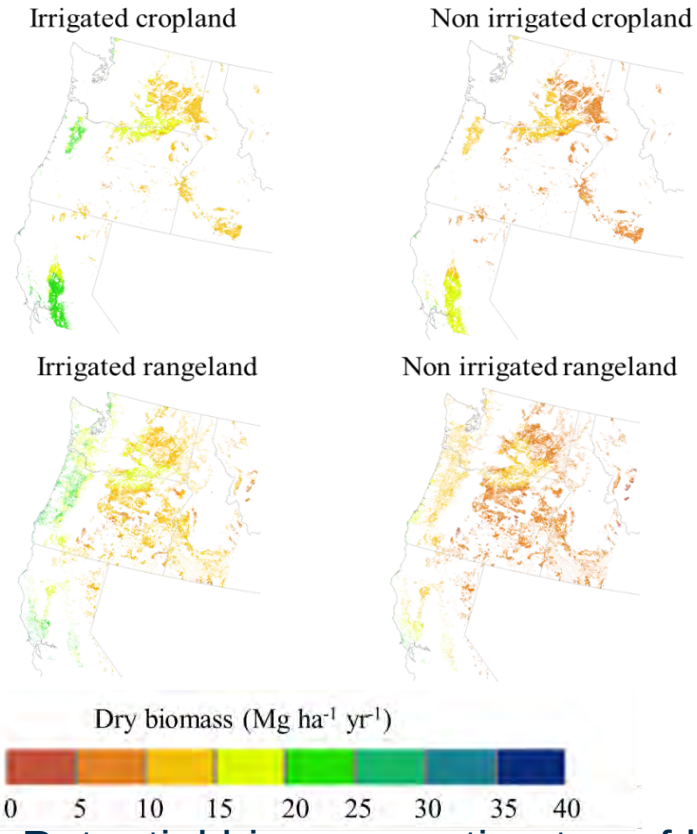


Suitable croplands
Suitable rangelands

Application of Poplar Growth Model

- Applied model to produce regional biomass estimates on different agricultural lands in the Pacific Northwest



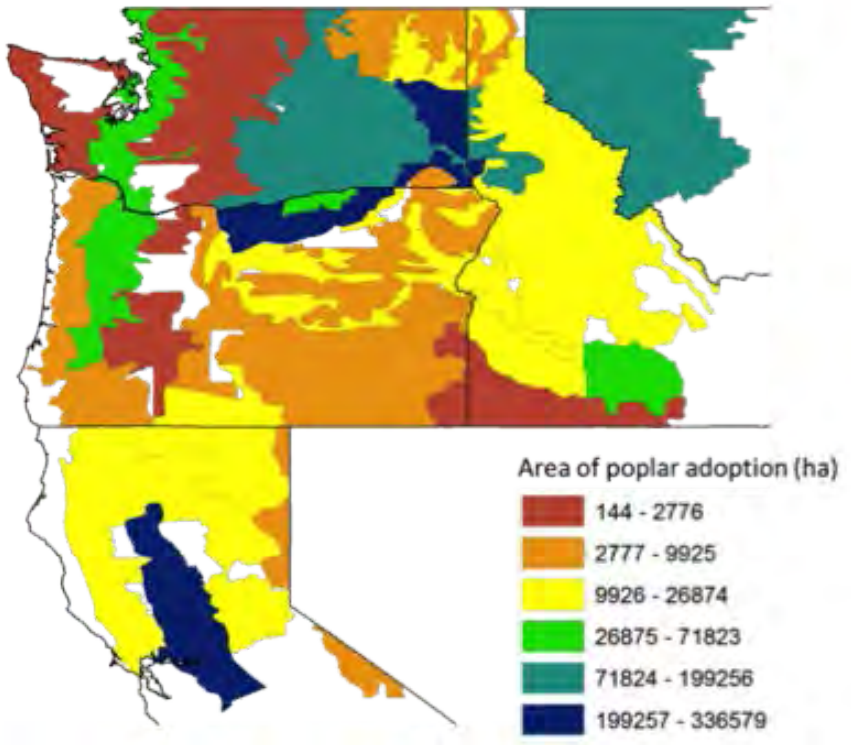


Potential biomass estimates of hybrid poplar on suitable agricultural lands

Economics Feasibility of Poplar Adoption

- Built poplar budgets based on variable poplar yields and ran the Bioenergy Crop Adoption Model (BCAM) to project poplar adoption.

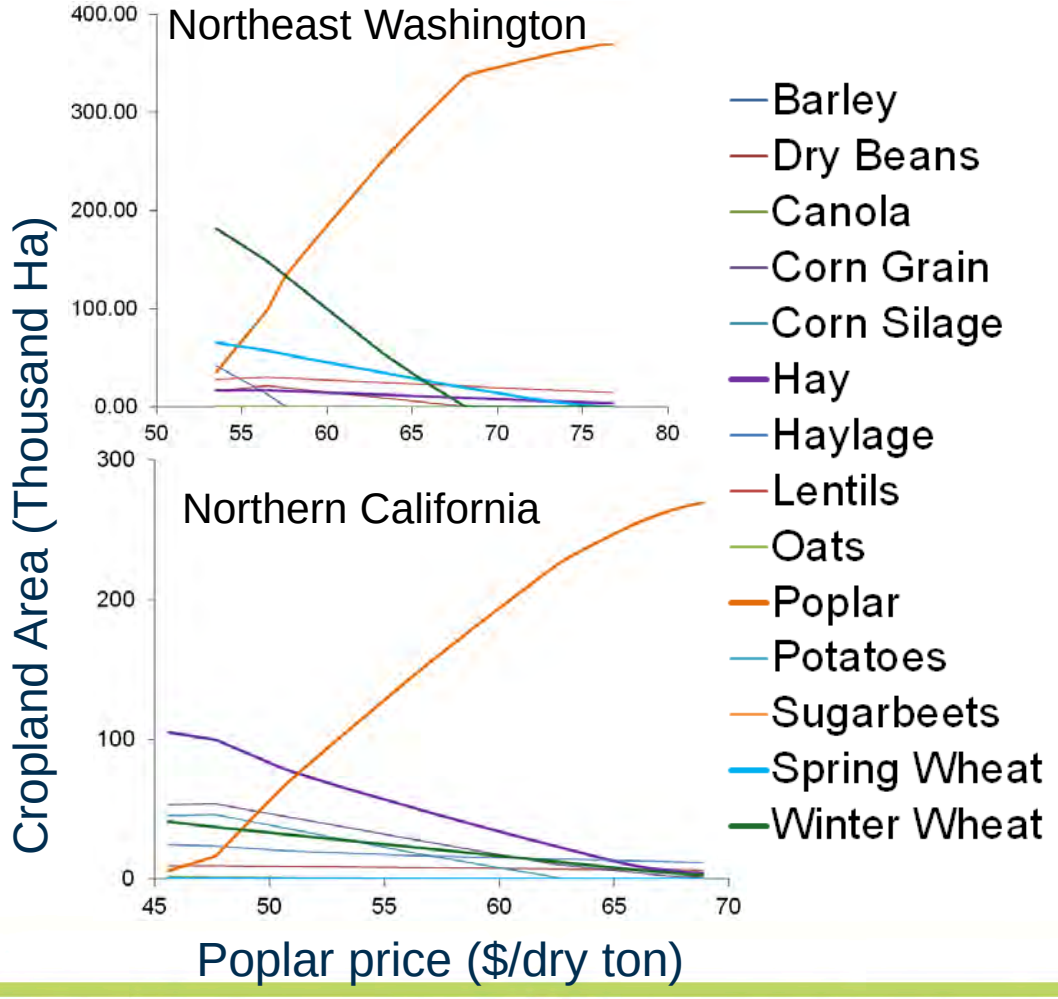
- Most of the marginal crops (e.g. hay, oats) could be displaced with hybrid poplar at a poplar price of $80/ dry ton).



Area under poplar adoption at $68/dry ton

Poplar Adoption Behavior

- Poplar adoption patterns vary not only with poplar yields and prices but also with characteristics of the cropping region.



Poster: Boon-Ling Yeo et al, *The Bioenergy Crop Adoption Model (BCAM): Economics of sustainably producing hybrid poplars as a short-rotation woody biomass feedstock in the Pacific Northwest*

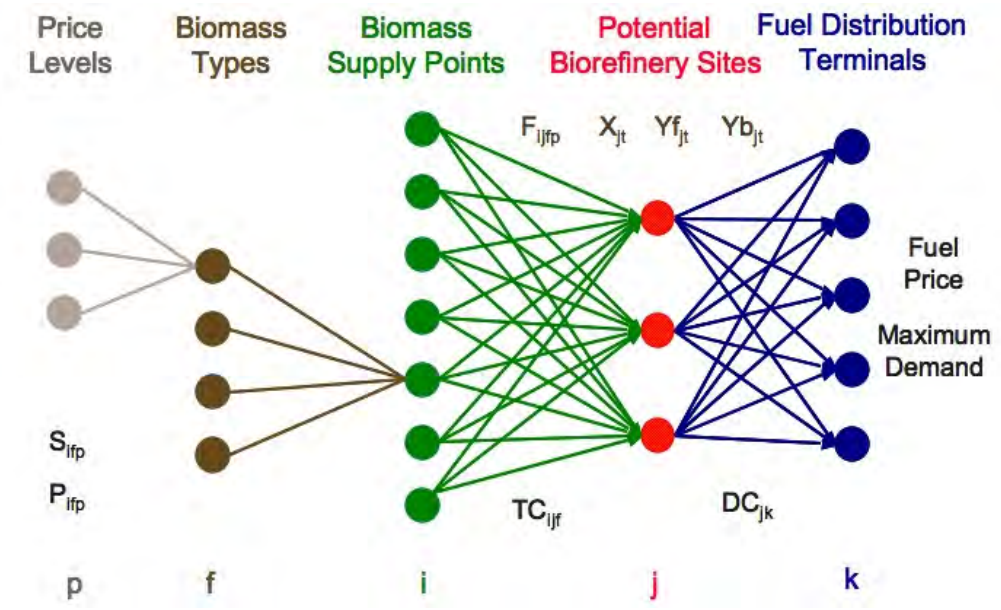
Geospatial Modeling - Biorefinery Siting

Input:

- Feedstock farm gate price
- Transportation costs
- Facility costs
- Distribution costs

Output:

- Optimum biorefinery sites and sizes
- Feedstock and fuel demands and logistics
- Profit at a range of fuel prices (fuel supply curve)



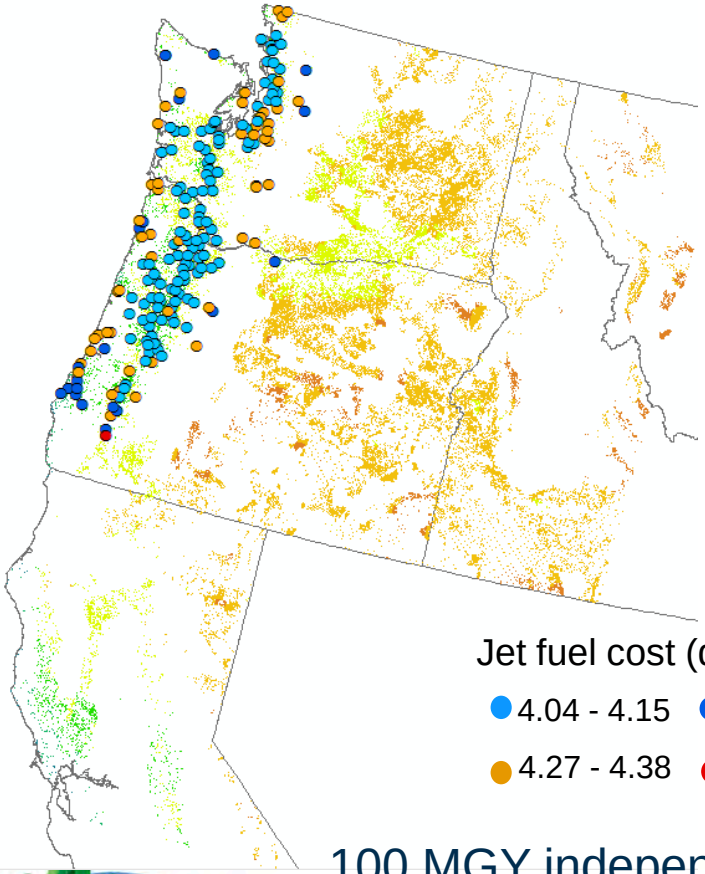
$$Profit = \sum_{jkt} fuelprice \cdot gge_t \cdot T_{jkt} + \sum_{jt} cop_t \cdot Yb_{jt} - Cost$$

where

$$Cost = \sum_{ijfp} [PC_{ijp} + DC_{ijf}] \cdot F_{ijfp} + \sum_{jt} a_t \cdot X_{jt} + \sum_{jt} b_t \cdot Yf_{jt} + \sum_{jkt} TC_{jk} \cdot T_{jkt}$$

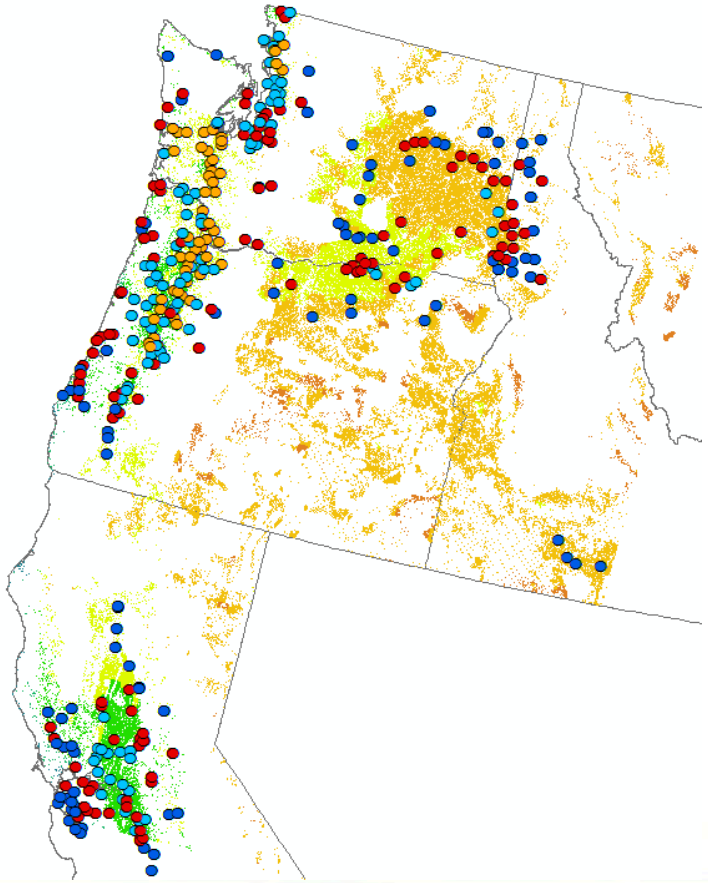
Geospatial Modeling - Biorefinery Siting

Suitable rangelands



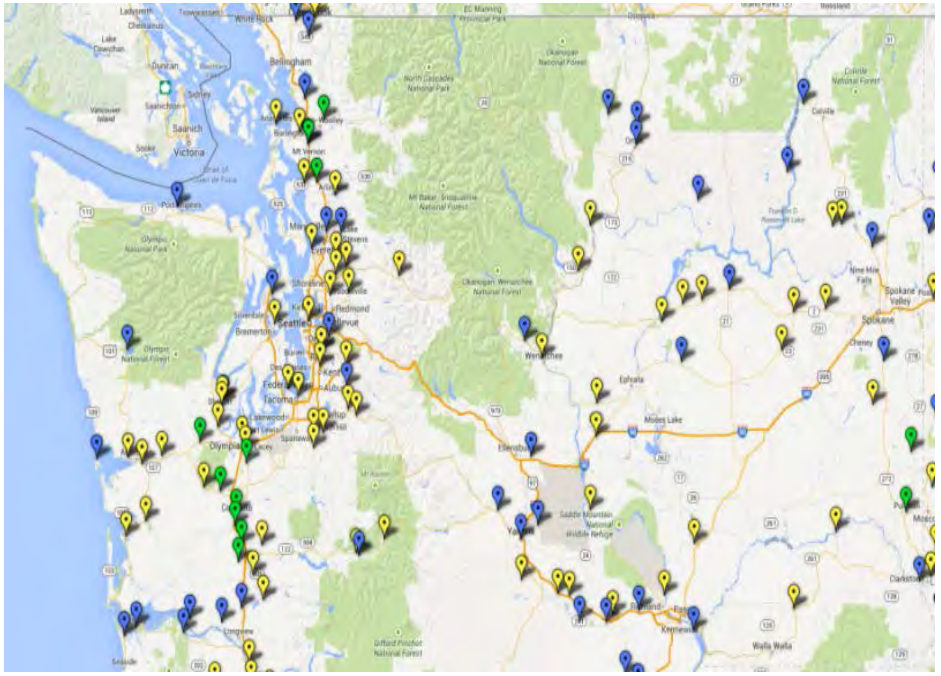
100 MGY independent facilities

Combination of Croplands and rangelands



Geospatial Modeling - Biorefinery Siting

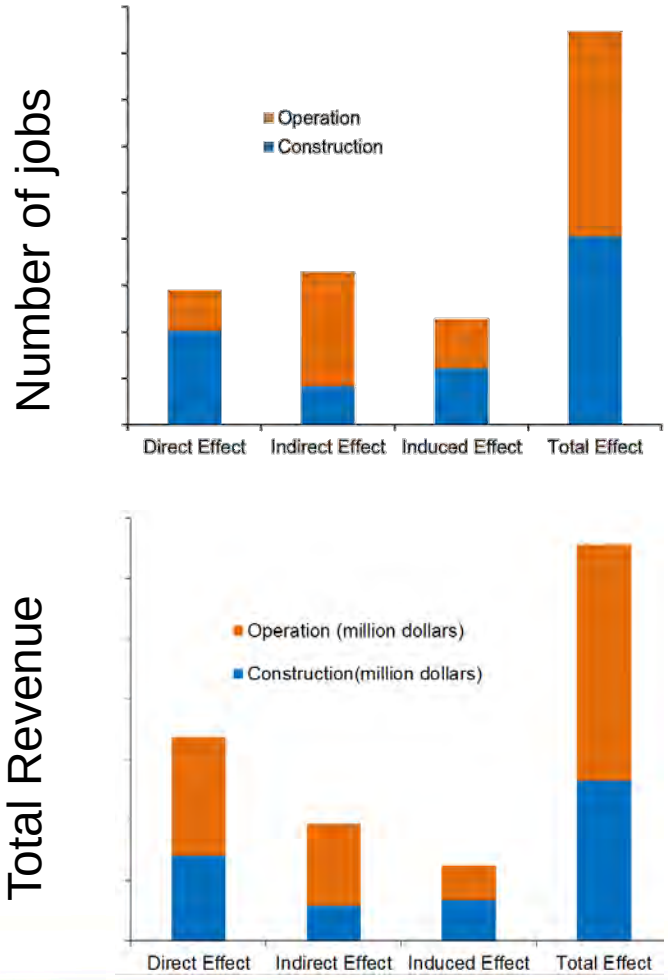
- The costs of production of 100 MGY facilities are reduced by more than $1/gallon compared to smaller 25 MGY biorefineries at the best sites.



Potential sites for independent 25 MGY facilities in Washington based on croplands and rangelands

Economic impacts of a biofuel industry in the Pacific Northwest

- IMPLAN used to estimate job and other economic effects in the region
- Provides estimates of direct facility effects, indirect effects for supporting industries linked to the facility, and other induced (lifestyle) effects.



Conclusions & future work

- There are approximately 6.02 and 10.3 million ha of suitable croplands and pasture lands respectively in the PNW region, of which 2.1 million ha of poplar could be adopted on croplands in substitution of other crops at a price of $68 per dry metric ton.
- Independent biorefinery siting analysis indicates that the lowest selling price of jet fuel could be $4.03/gallon ($1.06/L) in the PNW.

Future work

- Assessing supplementary feedstock supply through the integrated model.
- Integrating time dependence and depot modeling in biorefinery siting model.
- More extensive modeling of environmental impacts associated with regional poplar production.
- Multi-criteria optimization for feedstock production and biorefinery siting.

Thank You!