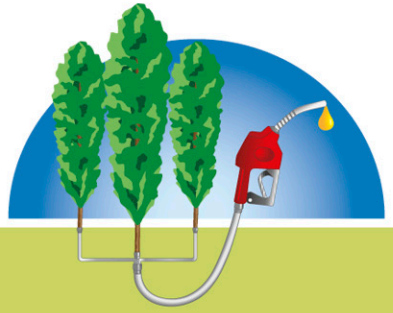

hardwoodbiofuels.org

Advanced **Hardwood Biofuels** Northwest

# Evaluation of the economics of drop-in biofuel production from coppiced poplar grown on suitable rangeland and cropland in the Pacific Northwest


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UCDAVIS
UNIVERSITY OF CALIFORNIA


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

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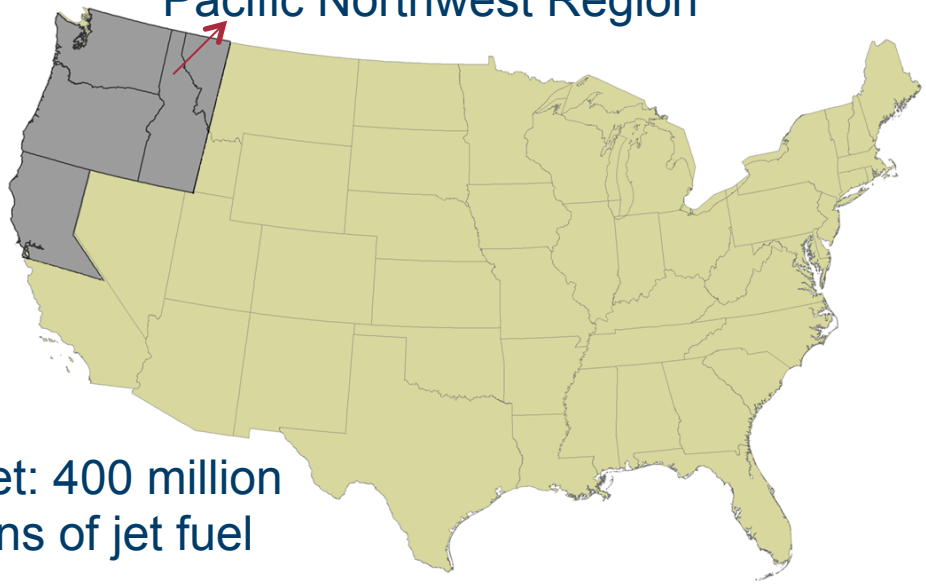
# Advanced Hardwood Biofuels Northwest

Purpose grown hybrid poplars

Drop-in replacement transportation fuels

Pacific Northwest Region

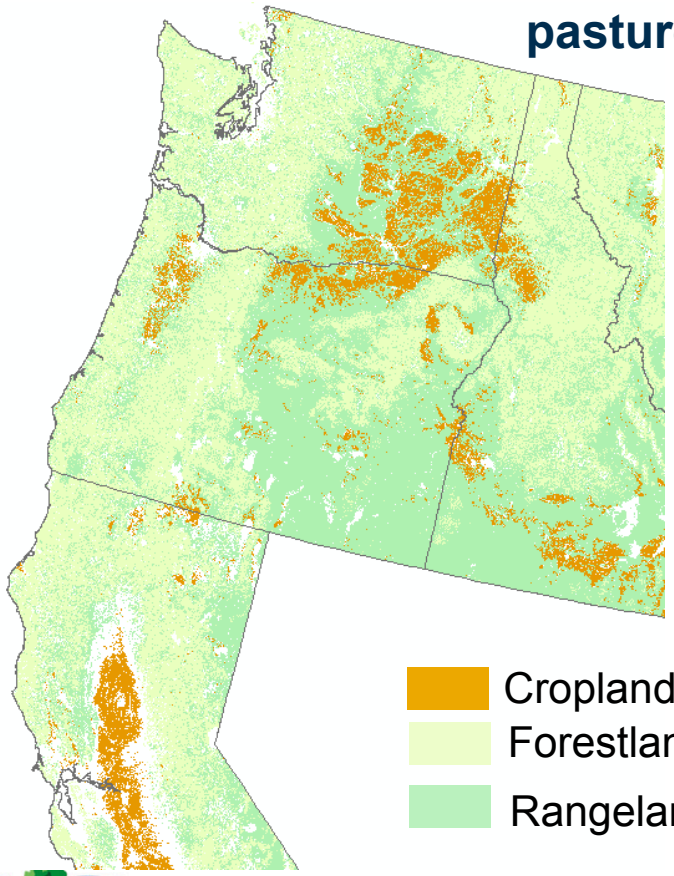


Target: 400 million gallons of jet fuel

Washington State University · Oregon State University OSU · Agriculture Center of Excellence · UC Davis University of California · University of Idaho · University of Washington · ZeaChem · New Holland Agriculture · GreenWood Resources · Rocky Mountain Wildlife Institute

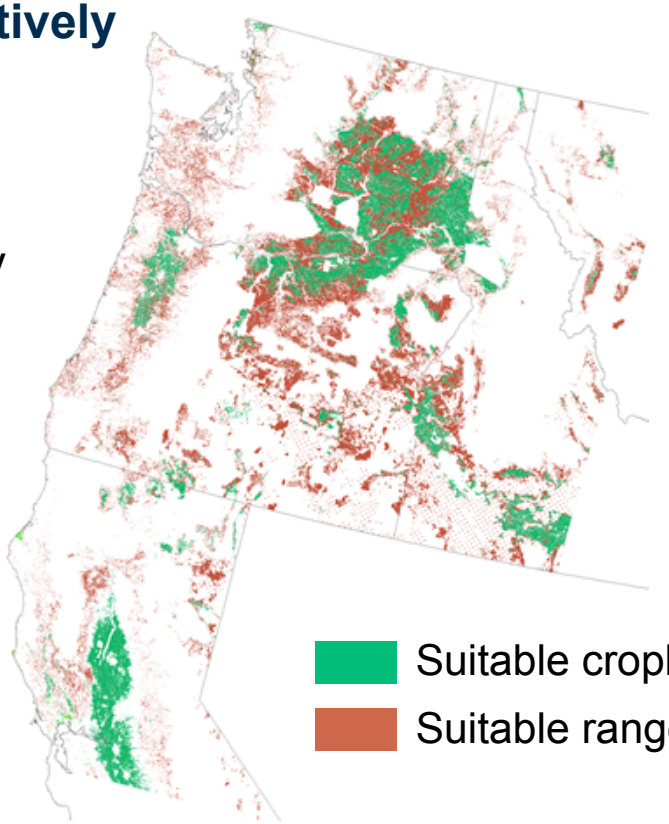
# Suitable Agricultural Lands for Poplar Cultivation in PNW region

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



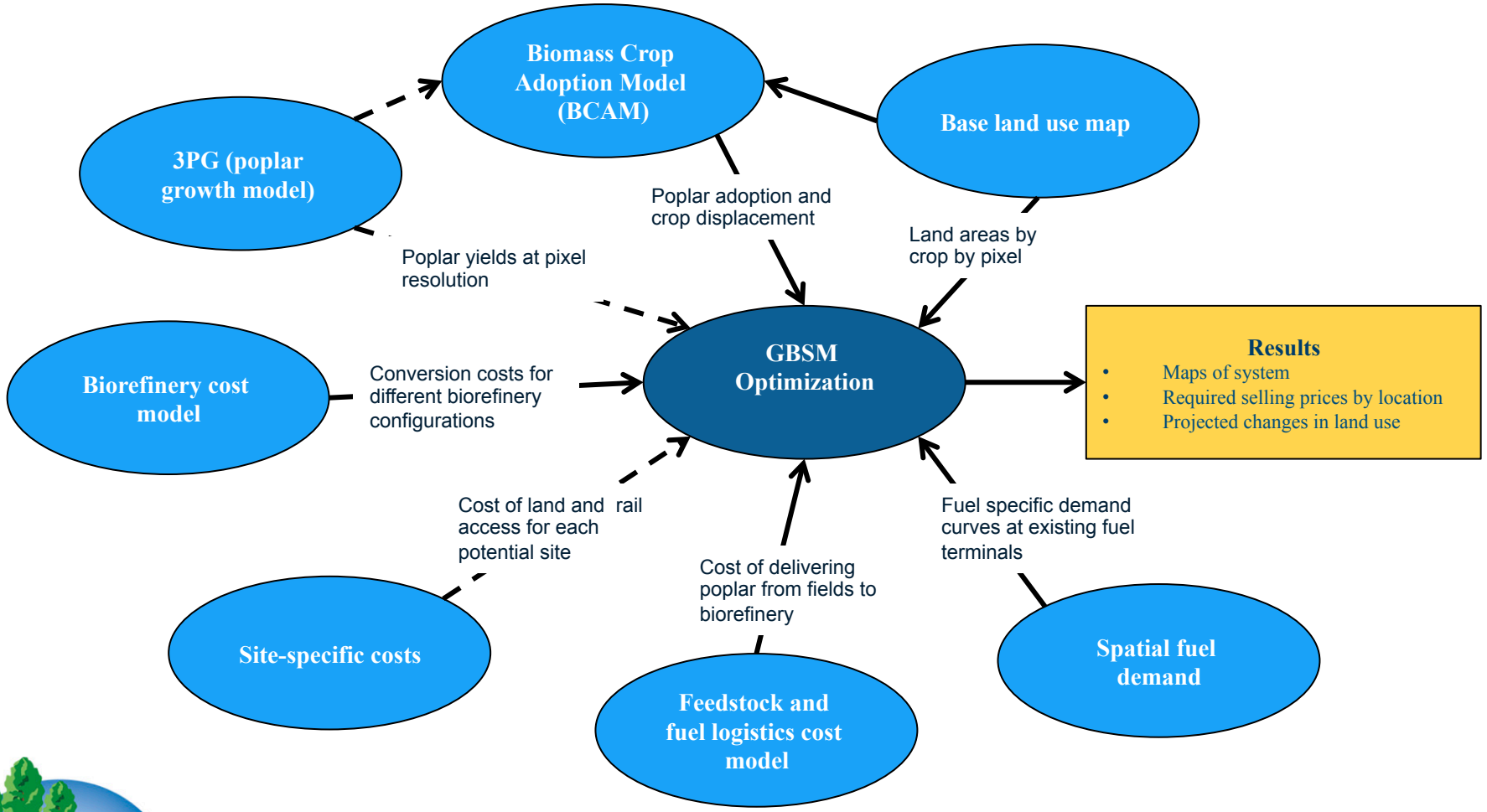
Croplands
Forestlands
Rangelands

Land suitability factors



Suitable croplands
Suitable rangelands

# Modeling Flow

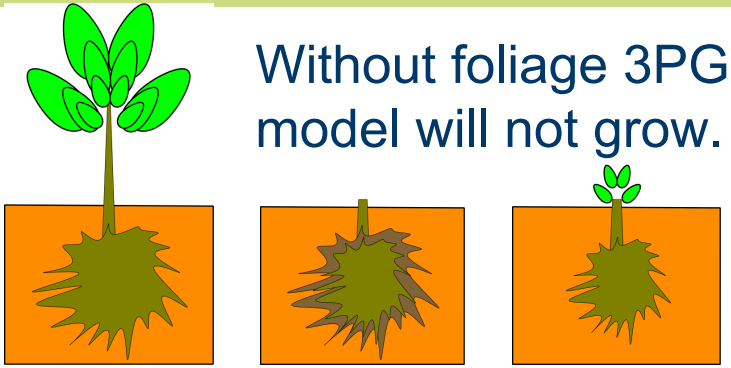


# Methods: Estimation of biomass yields

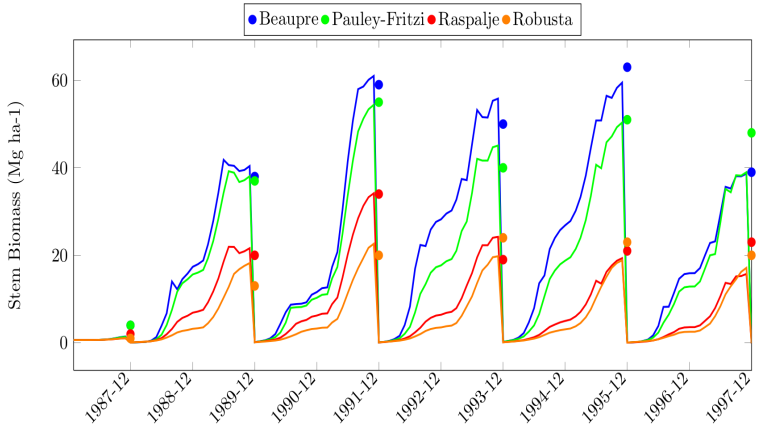
- Developed coppicing module in Physiological Principles in Predicting Growth (3PG) forest growth model.

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

**Web tool:**
http://alder.bioenergy.casil.ucdavis.edu/3pgModel/



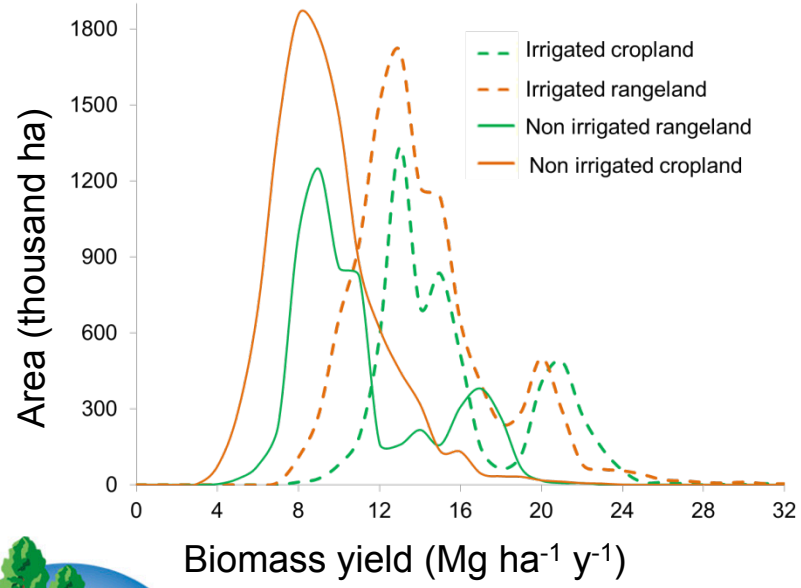
Without foliage 3PG model will not grow.

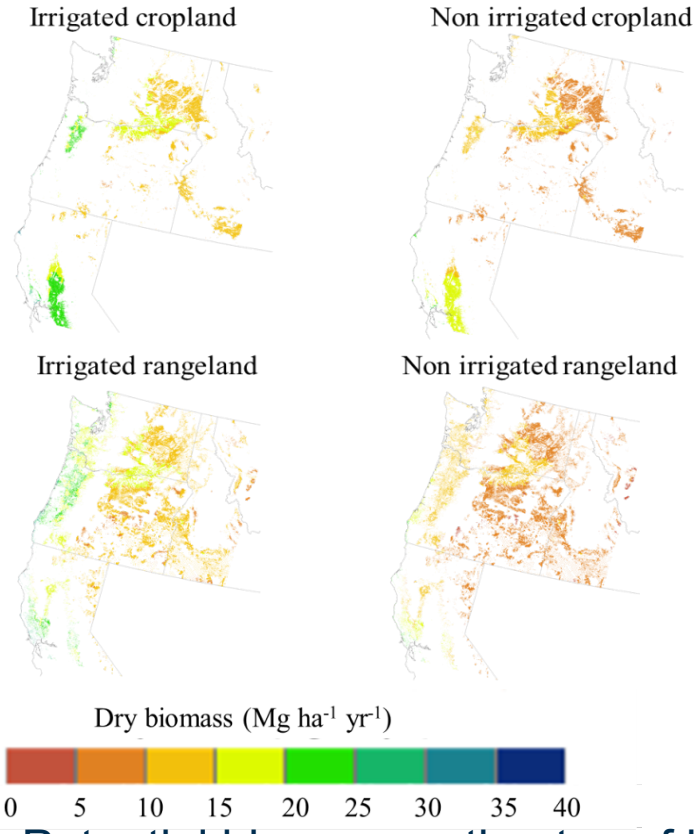



Simulations (lines) vs. measured (circles) biomass

# Application of Poplar Growth Model

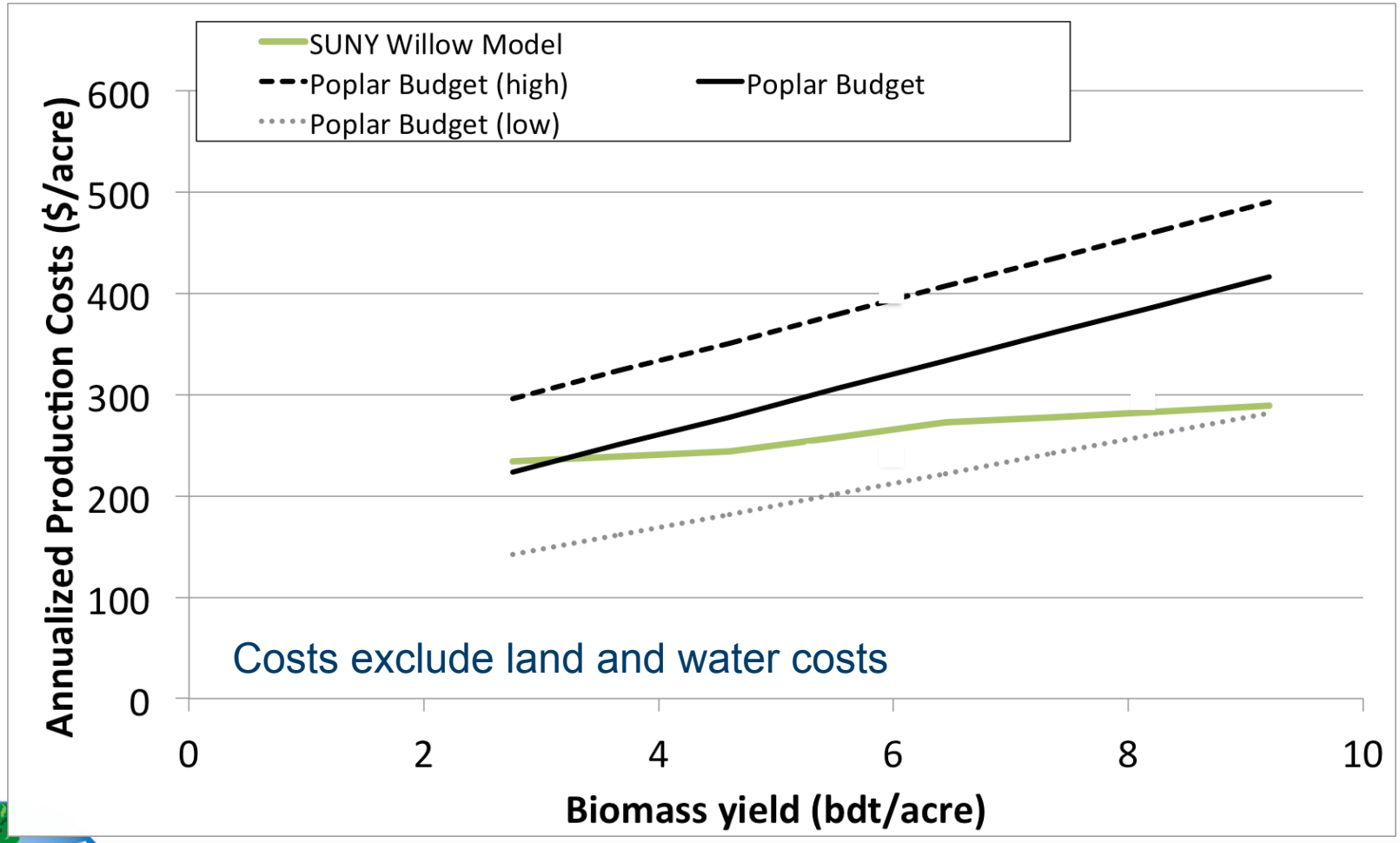
- Applied model to produce regional biomass estimates on different agricultural lands in the Pacific Northwest




Potential biomass estimates of hybrid poplar on suitable agricultural lands

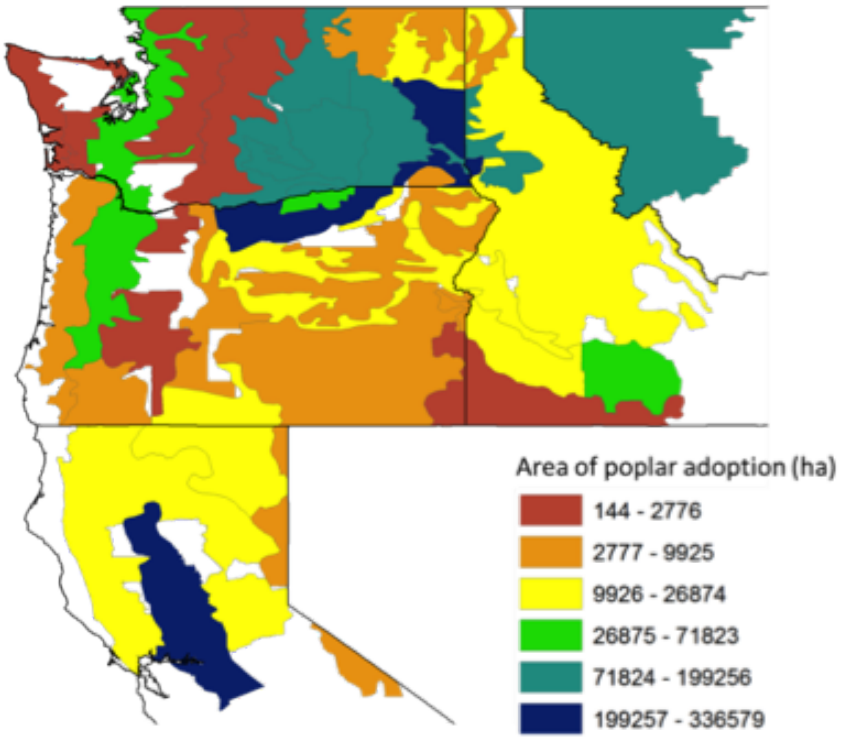
# Simple production budget



# 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.

- Many 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

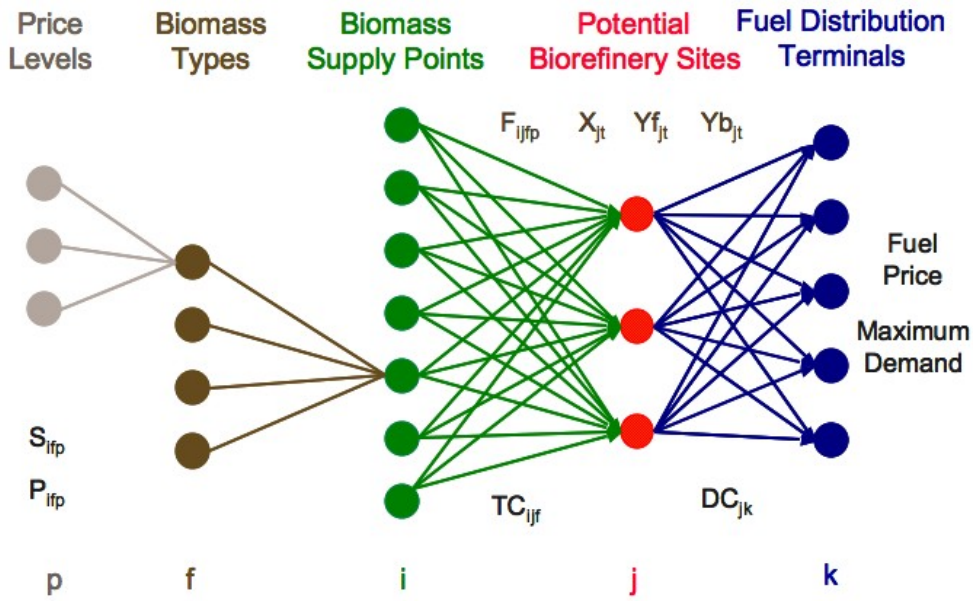
# Geospatial Modeling - Biorefinery Siting

**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)

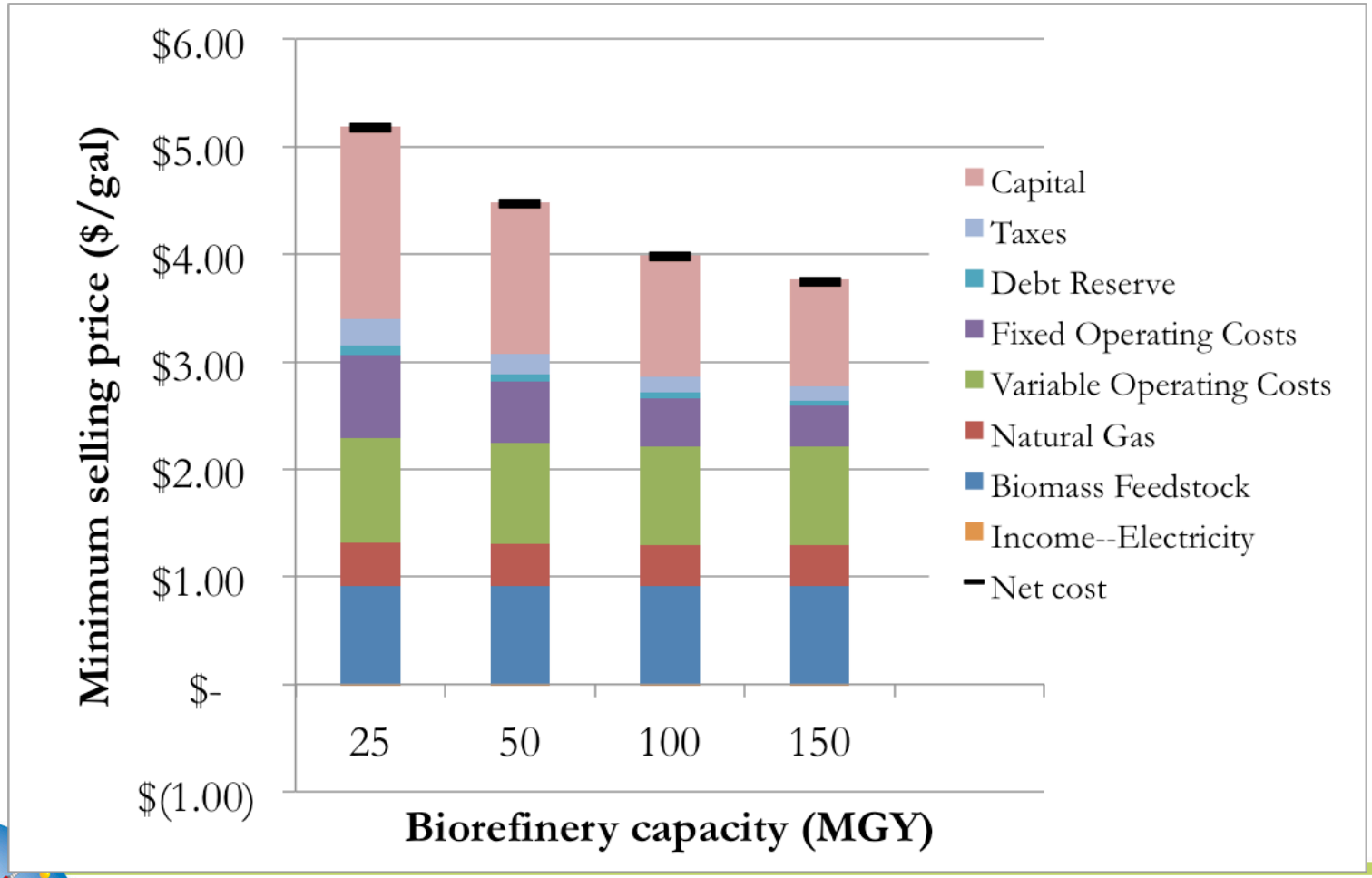



$$Profit = \sum_{jkt} fuelprice \cdot gge_t \cdot T_{jkt} + \sum_{jt} cop_t \cdot Yb_{jt} - Cost$$

*where*

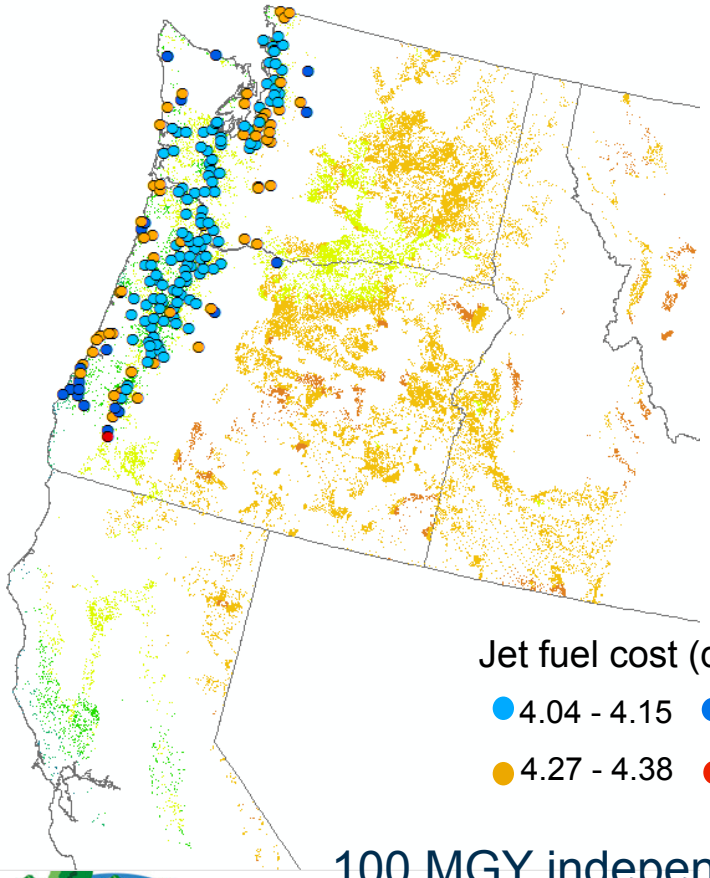
$$Cost = \sum_{ijfp} [PC_{ijfp} + DC_{ijf}] \cdot F_{ijfp} + \sum_{jt} a_t \cdot X_{jt} + \sum_{jt} b_t \cdot Yf_{jt} + \sum_{jkt} TC_{jk} \cdot T_{jkt}$$

# Economies of scale in biojet process

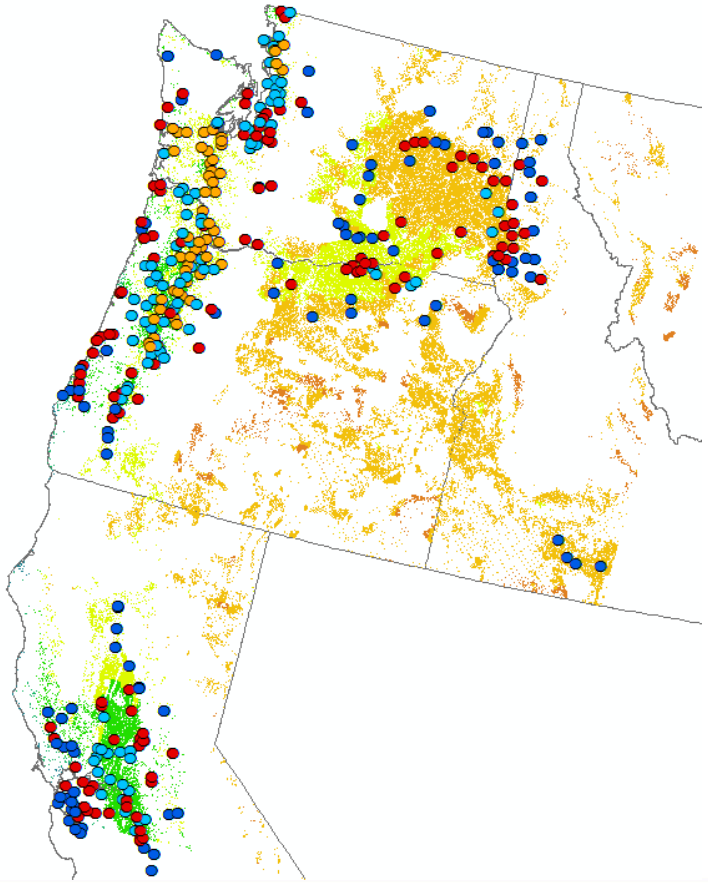


# Geospatial Modeling - Biorefinery Siting

Suitable rangelands



Combination of Croplands and rangelands



Jet fuel cost (dollars/gal)

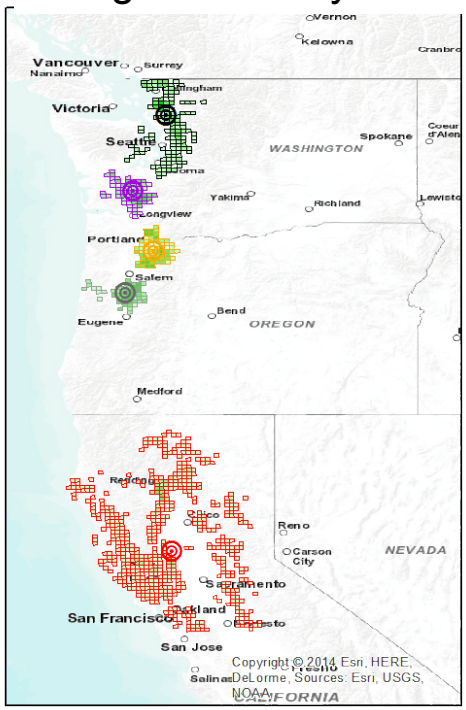
- 4.04 - 4.15
- 4.15 - 4.27
- 4.27 - 4.38
- 4.38 - 4.5

100 MGY independent facilities

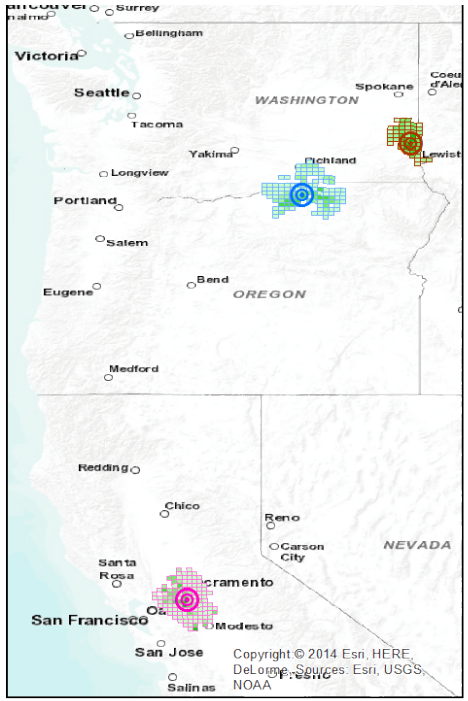
# Geospatial Modeling - Biorefinery Siting

- The best locations for biorefineries using poplar grown on rangeland are in western Washington and Oregon.
- The California rangeland biorefinery is ~$1/gal more expensive.
- The best location for biorefineries using poplar grown on cropland is in central California.

Rangelands only




Croplands only




Location and feedstock sheds for biorefineries

Miles
0 40 80 160 240 320
0 85 170 340 510 680
Kilometers

7,475 19,315 36,445 56,493 91,945
Annual Poplar Production (tons)

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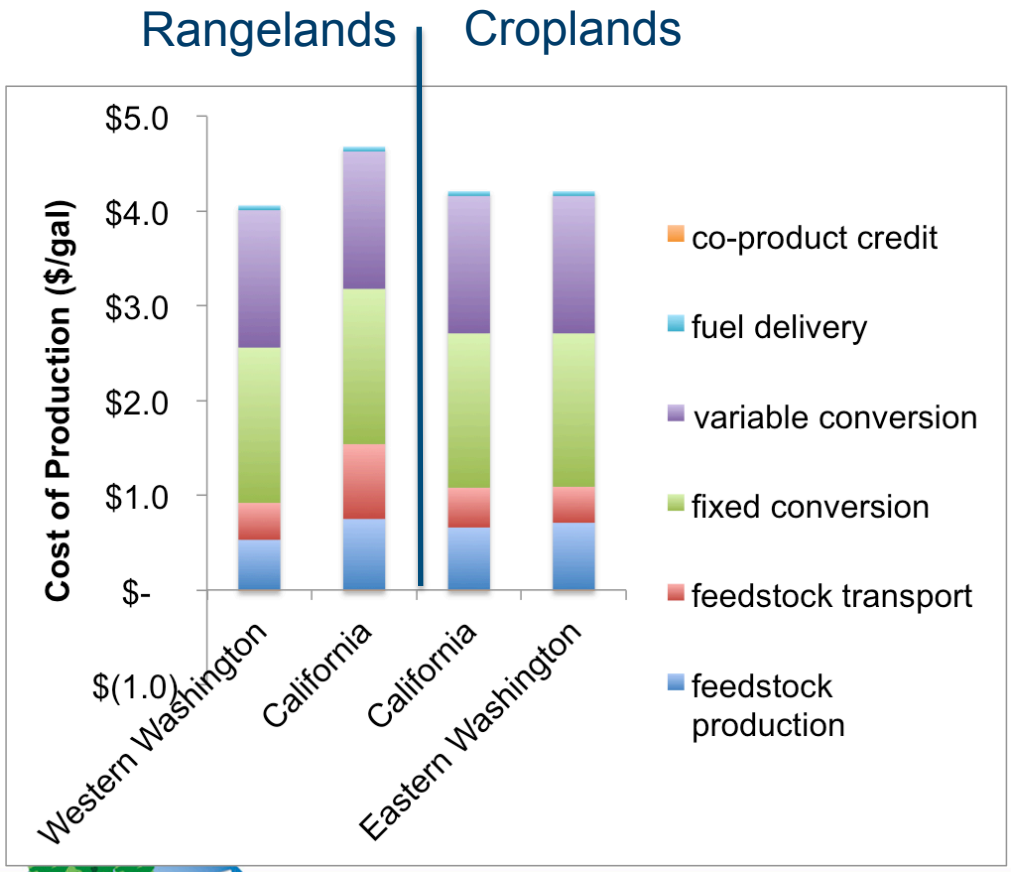
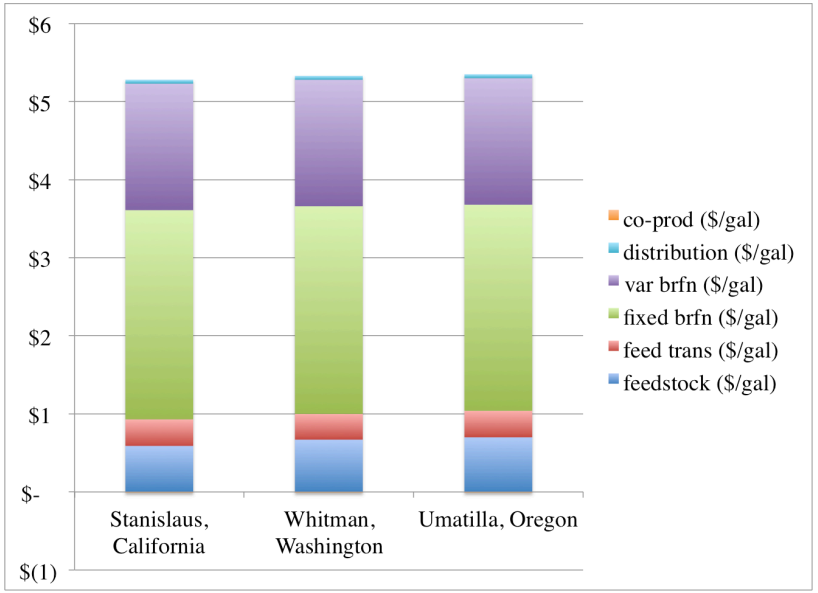
USDA United States Department of Agriculture
National Institute of Food and Agriculture

# Cost breakdown for biorefineries

## 100 MGY biorefineries




## 25 MGY biorefineries



# 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.

# Conclusions

- The cost of producing drop-in jet fuel from hybrid poplar is currently prohibitive.
  - preliminary estimate of minimum selling price for jet fuel are on the order of $4.25/gal.
- The economies of scale for the biorefineries push toward large facilities with scales above one million dry tons per year input.
  - If the size of biorefineries is restricted to 300,000 dry tons per year input, the cost of producing fuel increases by 25%.
- Siting of poplar plantations and biorefineries favors regions with high poplar yields and suitable rangeland.

# Thank You!