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Oilseeds for Renewable Jet Fuel

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Introduction

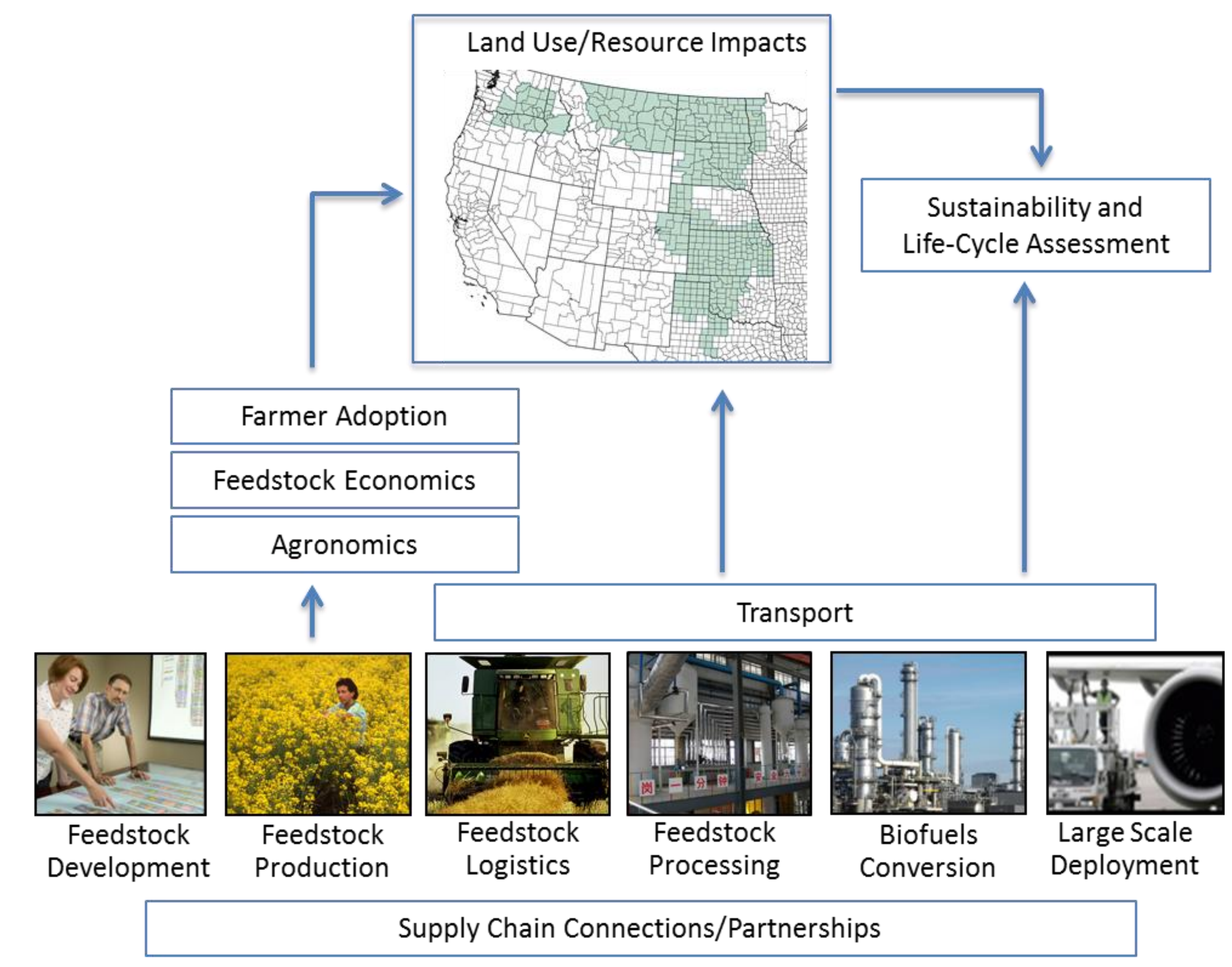
The commercial aviation industry and military agencies have set goals for use of renewable aviation fuels. Oilseeds in the brassicaceae family (canola, rapeseed, camelina sativa, brassica carinata) have been identified as potential feedstocks for renewable jet fuel, and renewable jet fuels made from some of these oilseeds have been certified for commercial use. Also, these oilseeds appear to be well-suited to production in the wheat-producing areas of the western U.S. However, it is important to understand how these oilseeds might fit into existing agricultural systems, including the social acceptability of these crops, agronomic suitability, economic viability for producers and processors, and impacts on natural resources and the environment.

Approach

A multi-disciplinary research project was initiated to investigate the agronomic performance of different oilseed species under varying conditions across the western U.S. wheat belt, provide regionalized strategies to integrate sustainable oilseed production into existing land uses, and provide strategic guidance on economic, social, and environmental sustainability. An analytical framework was developed that includes modeling oilseed agronomic productivity, oilseed production economics, farmer willingness to produce oilseeds, larger supply chain effects including transportation and biorefinery siting, and sustainability and life-cycle assessment.

As part of this effort, a break-even profitability modeling approach was used to spatially analyze where these oilseeds are economically profitable to produce, quantify potential oilseed supply, and evaluate impacts on natural resources and the environment. This approach is demonstrated for the state of North Dakota, where the break-even profitability modeling approach was used to compare the profitability of growing oilseeds relative to other annual crops for a range of oilseed prices. The approach utilized the EPIC (Environmental Policy Integrated Climate) model to simulate crop yields under varying weather conditions for each SSURGO soil map unit within North Dakota. Net returns were calculated for each cropping system (2yr crop sequence x tillage combination) on each soil map unit and each oilseed price, and the system with the highest net return was selected as the economic optimum on that soil for that oilseed price. The EPIC model simulations also provided estimates of natural resource impacts including soil erosion, soil organic carbon, nutrient runoff and leaching, and fertilizer use. Results for each map unit were aggregated up to 9 km x 9 km grid cells. For this analysis industrial rapeseed was modeled as the only renewable jet fuel feedstock, and it was assumed that edible canola production would not be displaced by rapeseed production.

Analytical Framework

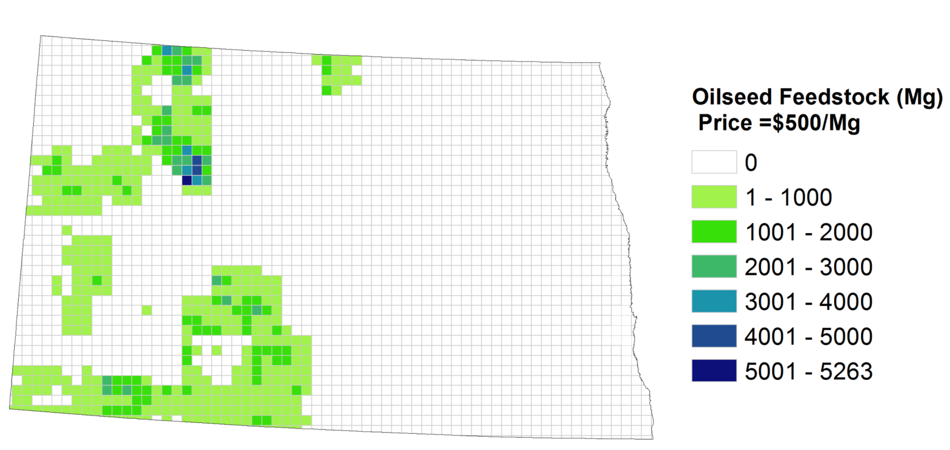


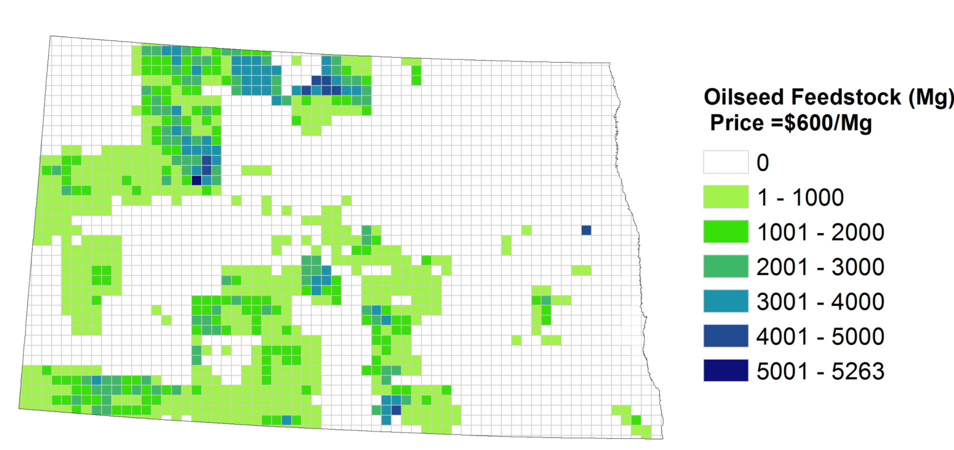
Scenario: Oilseed Price = $500/Mg
298,000 Mg Oilseed
131,000 Mg Oil
64,400 Mg Jet Fuel (22.5 million gallons)

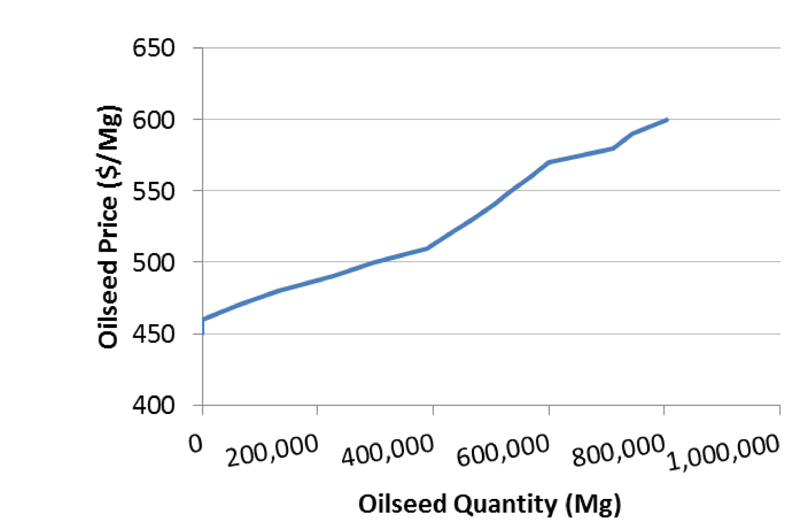
Scenario: Oilseed Price = $600/Mg
805,000 Mg Oilseed
354,000 Mg Oil
174,000 Mg Jet Fuel (60.8 million gallons)

Supply Impacts

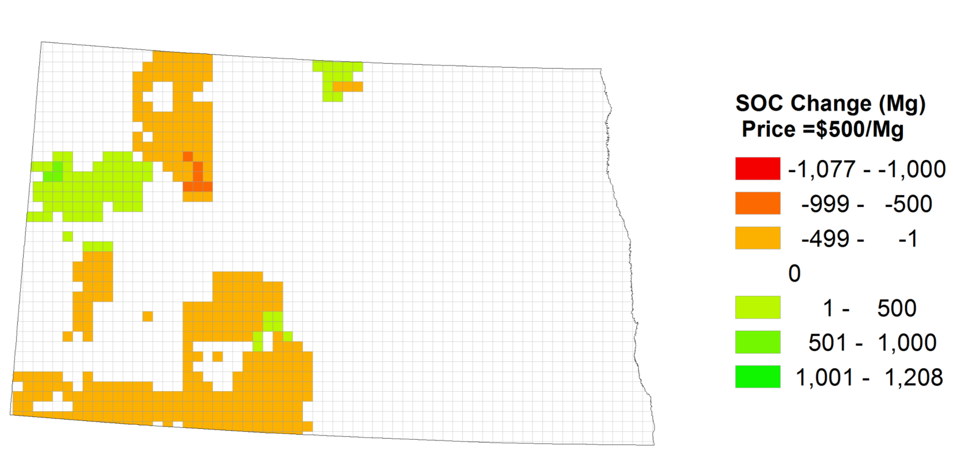
Oilseed Quantity

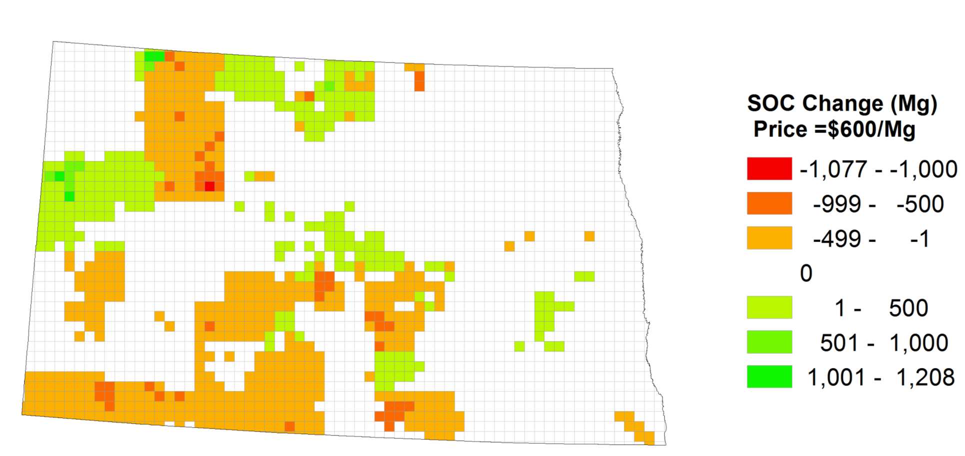


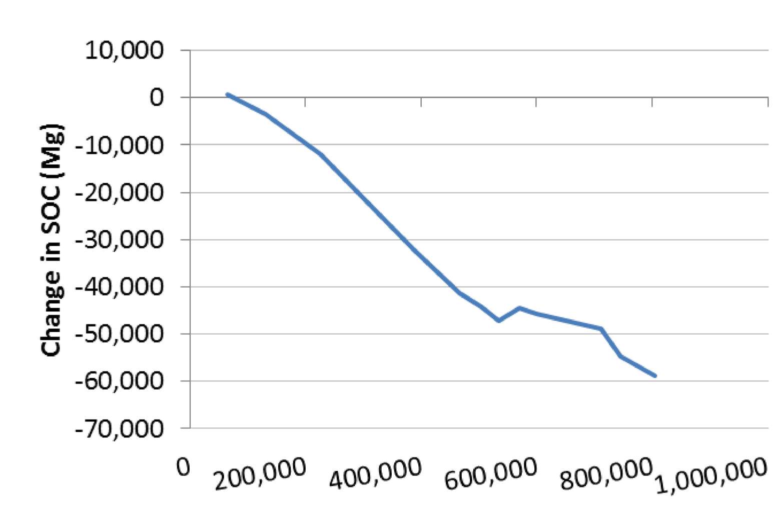




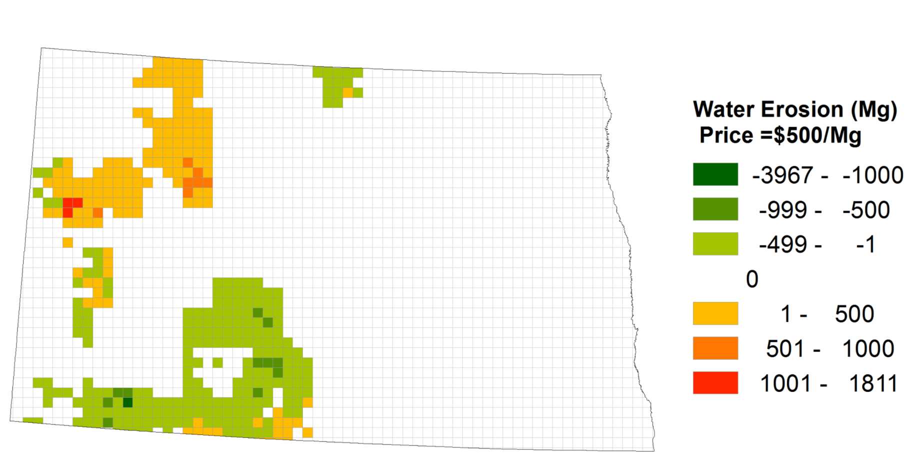
Soil Organic Carbon

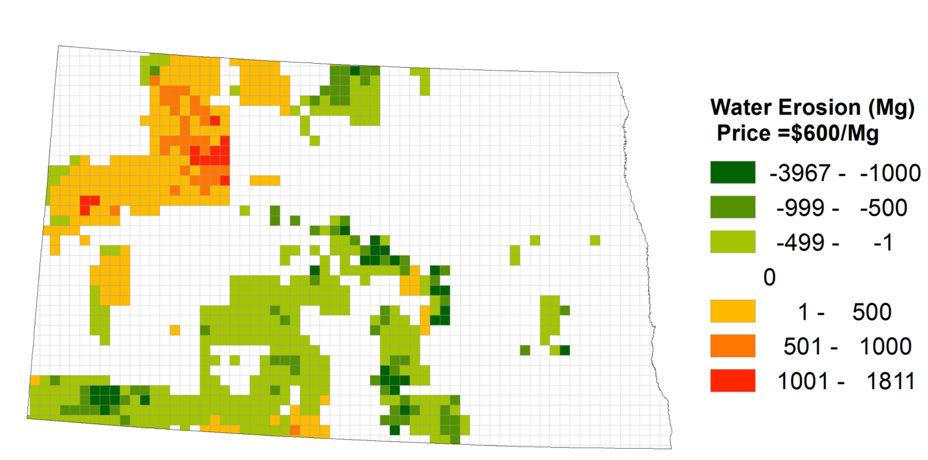


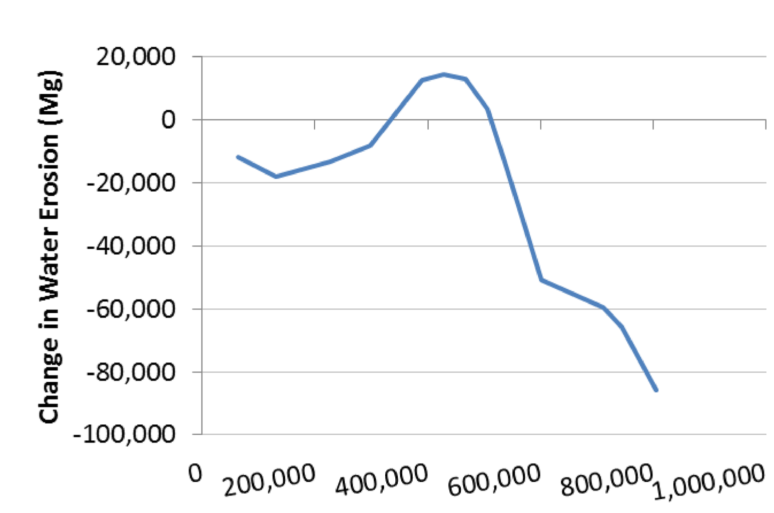




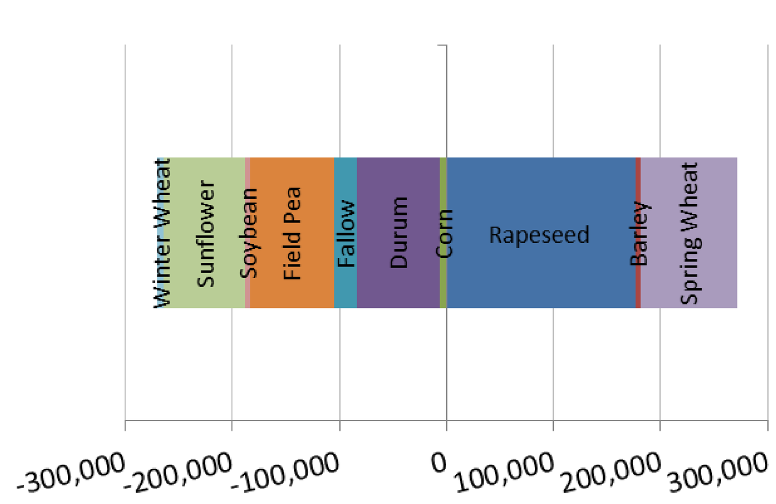
Soil Erosion (Water)

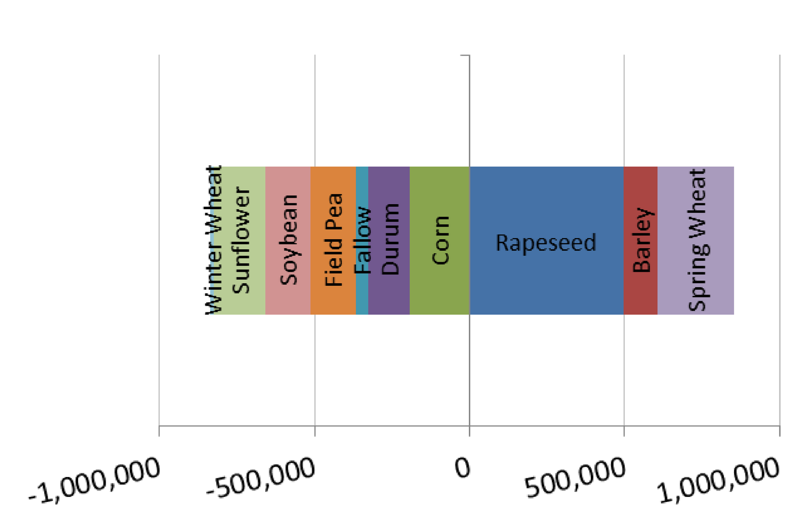






Crop Area





Conclusions

Based on break-even profitability modeling, industrial rapeseed production for jet fuel would be expected to occur primarily in areas of SW and NW North Dakota, with the production area expanding at higher oil price levels. Effects on soil organic carbon (SOC) and soil erosion due to water (water erosion) would vary geographically. Overall SOC levels would tend to decrease with increasing oilseed production. At low levels of oilseed production, water erosion would decrease, but would increase at intermediate levels of oilseed production before decreasing as oilseed production continued to increase. Interestingly, areas where SOC would be expected to decrease often appear to be areas where water erosion would also decrease. These effects are related to the specific production shifts expected to occur at each geographic location. While some rapeseed production would occur in place of fallow, production of several other crops could be displace by increased rapeseed production. This analysis will be expanded to include other oilseeds and to cover the rest of the western wheat producing areas.

Acknowledgements

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