Cropping System, Agroecological Zone, and Nitrogen Use Efficiency Effect on Greenhouse Gas Mitigation for Biodiesel Feedstock Production

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Expansion of biofuel cropping systems requires better spatial resolution of life cycle greenhouse gas (GHG) emissions and mitigation potentials. Simulation modeling was carried out to understand the impact of agro-ecological zone (AEZ), and nitrogen (N) use efficiency (NUE) for inland Pacific Northwest canola and Midwestern soybean biodiesel GHG mitigation potential.

Vensim® PLE systems dynamics modeling software was used to determine the impact of the three variables in question (cropping system, agro-ecological zone, and nitrogen use efficiency) (Figure 1). The two cropping systems were Midwestern soybeans and inland Pacific Northwest canola. Soybean production area was presumed to be static, whereas canola production area was projected to increase over time. Three AEZs in the inland Pacific Northwest were investigated in the scope of this work. They included rain-fed dryland areas with less than 43 cm of annual rainfall, rain-fed dryland areas with greater than or equal to 43 cm of annual rainfall, and irrigated areas. Improvements in NUE were simulated by holding N fertilizer rates constant while simultaneously increasing canola or soybean grain yields at rates that are consistent with past improvement rates for yield.

In Pacific Northwest canola production, results indicated that the nitrous oxide (N_2O) emission rate assumed has a drastic effect on feasibility of biofuel crops. At moderate N_2O emission rates and on a per hectare basis, the three AEZs in question (annual crop, crop-fallow, and irrigated) were similar. The annual cropping rain-fed AEZ and crop-fallow rain-fed AEZ have a much greater GHG mitigation potential over time for the entire Pacific Northwest area in question compared to the irrigated AEZ due to differences in land area available for canola production. Increased yield per area over time and coincident improved NUE has a modest effect on GHG mitigation potential. Rate of canola adoption has a major effect on GHG mitigation potential, but was inconsequential if N_2O emission rates were not curtailed. Thus, increasing efficiency in nitrogen fertilizer use, minimizing soil conditions leading to N_2O emissions, and enhancing canola production adoption rate will have the greatest impact on GHG mitigation potential.

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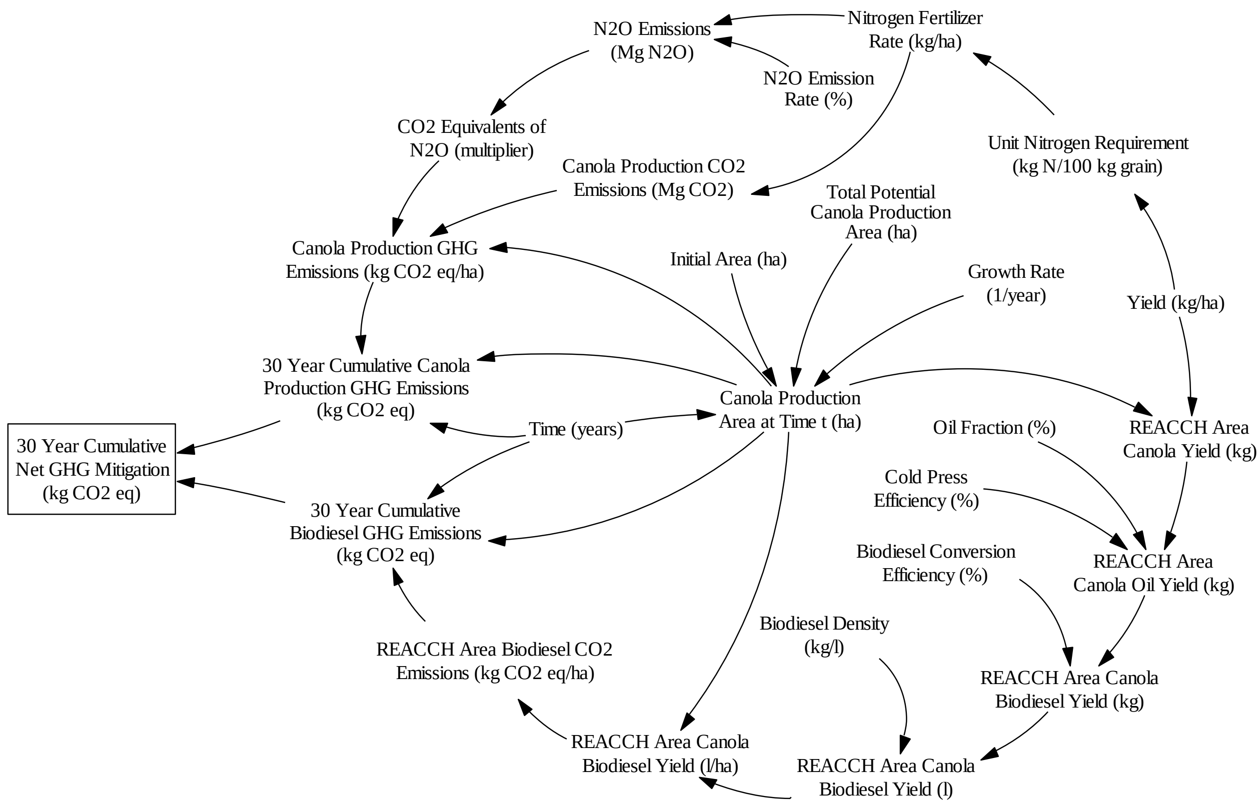

Figure 1. General causal loop diagram of the inland Pacific Northwest canola systems dynamics model.