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ADVANCED TECHNOLOGY AND MODELING SUPPORT BIOFUEL PRODUCTION FROM BEETS IN CALIFORNIA

**Soutien de la production de biocarburant provenant de betteraves sucrières
par technologie avancée et modélisation en Californie / Unterstützung der
Produktion von Biokraftstoff aus Zuckerrüben in Kalifornien durch
fortschrittliche Technologie und Modellierung**

ABSTRACT

A farmer owned cooperative has formed to create ethanol from sugar (energy) beets in California's San Joaquin Valley. If successful, beets will be planted and harvested year-round, ethanol will be made directly from ground roots, and several energy by-products from crop biomass will be created in an integrated biorefinery. California's Low Carbon Fuel Standard (LCFS) encourages production of ethanol from beets with the lowest associated fuel carbon intensity (CI) and green house gas (GHG) emissions. Integrated economic optimization and life cycle modeling (LCA) based on actual production data and biorefinery design is being used to optimize crop rotations and agronomic practices, and to quantify and minimize fuel CI and correlated GHG emissions. Initial CI estimates for beet production are $9.7 \text{ g Co}_{\text{eq}} \text{ MJ}^{-1}$, and for the fuel including transportation and biorefinery GHG emissions are $20.7 \text{ g Co}_{\text{eq}} \text{ MJ}^{-1}$ based on estimated average daily root and sugar yields of 90 t ha^{-1} and 14.8 t ha^{-1} , without accounting for indirect land use (ILUC). Depending on the success of enzymatic digestion of root marc, ethanol yields are estimated to be 9000 to 11200 L ha^{-1} . Crop substitution, needed for ILUC estimates, is quantified. New technology that reduces GHG emissions per ton of roots such as herbicide tolerance, reduced tillage, precision application of fertilizer, drip and digitally managed overhead irrigation systems all are encouraged by the need to reduce biofuel CI and can be quantified at the cropping system level using the modeling approach described. Savings of irrigation water, herbicides and fertilizer can be achieved and are discussed. Farm level data required for economic analysis and LCA also are a basis for sustainability assessment and certification.
