Energy Beet Farming Data Used in TRE Energy Beet Ethanol LCFS Pathway

1. Energy Beet Yield

The energy beet yield (37.8 ton/acre) is based on an average of average yields by energy beet variety conducted in 2013 by Steven Kaffka of UC Davis at Five Points Ranch in Five Points California. The soil type at Five Points Ranch is very similar to the soil that TRE's beets are grown on.

See data in separate [undisclosed] spreadsheet "Kaffka_Five Points_2013_Total yield_June-2013_beet harvest_10-31-13.xlsx". The data includes 10 beet varieties with 4 data points each. Averages for each of the 10 were calculated (see table below) and then an overall average was calculated. Dr. Kaffka is an expert in energy beet farming in California and consulted with TRE on this project. He provided this data to TRE.

Table 1. UC Davis Beet Yield Results from Five Points Ranch (2013)

Beet Variety	*Count*	*Average ton/acre*
012-HX-001	4	43.9
012-HX-002	4	35.9
012-HX-003	4	38.4
012-HX-011	4	38.4
012-HX-012	4	39.2
012-HX-013	4	35.2
BTS-DAR-271	4	39.1
BTS-DFR-241	4	38.5
BTS-DNR-261	4	32.3
BTS-DRR-251	4	37.3
	Average	**37.8**

2. Diesel Fuel

The diesel fuel input (4.5 gallon/acre) is based on data from Delta Distillers Beets (DDB) trial plots in Tracy; DDB is TRE's feedstock supplier. See attached [undisclosed] documentation of the trial plots.

3. Nitrogen (N) Fertilizer

The nitrogen input (160 lb-N/acre) is a conservative input based on data from Mayberry (2000). According to Dr. Steve Kaffka, the sugar beets are not sensitive to the type of nitrogen fertilizer used and TRE's life cycle assessment is based on urea fertilizer as DDB plans to use urea on the beet fields.

4. Phosphorus (P) and Potassium (K) Fertilizer

The Phosphorus (15 lb-P_2O_5/acre) and potassium (25 lb K_2O/acre) inputs are based on a table of Purdue recommended (http://www.hort.purdue.edu/newcrop/afcm/sugarbeet.html) for sugar beets (see Table 2 below). The Purdue study recommends a fertilizer input of 10 – 80 lb-P_2O_5/acre and 25 – 115 lb K_2O/acre for sugar beets. Higher P soil results (lb/acre) require lower P fertilizer inputs and the same is true for K. The Sacramento-San Joaquin Delta region features a rich mix of peat soil, which is high in P, and mineral soil, which is high in K. Based on the demonstrated high beet yields in the region and high soil P and K, the TRE's beet P and K inputs are estimated to be near the low end of the recommended range.

Table 2. Purdue Phosphate and Potash Recommendations for Sugarbeets

Phosphorus P Soil test Levels lb/acre)				Potassium K Soil test Levels (lb/acre)			
L 0-9	M 10-19	H 20-29	VH >30	L 0-99	M 100-199	H 200-299	VH >300
P_2O_5 lb/acre				K_2O lb/acre			
60	35	10	0	85	50	15	0
60	35	10	0	90	55	20	0
65	40	15	0	95	55	20	0
70	40	15	0	100	60	20	0
75	45	15	0	105	65	20	0
80	50	15	0	115	70	25	0

5. Herbicide

The herbicide input (1.625 lb herbicide/acre) is based on data from the DDB trial plots in Tracy. See attached [undisclosed] documentation. The herbicide is assumed to be 25% of each of the 4 herbicides in CA-GREET (due to lack of specific data).

6. Insecticide

The insecticide input (1.55 lb herbicide/acre) is based on data from trial plots in Tracy. See attached [undisclosed] documentation.

7. Irrigation

Irrigation water use (102.05 m^3 water/tonne beets) for sugar beets in the San Joaquin Valley is based on data from Long et al. (1994) and the associated pumping electricity consumption rate (0.86 MJ_e/m^3 water) is based on data from Kendall et al. (2015). The life cycle assessment assumes 50% surface water availability (50% of the irrigation water used requires pumping). These factors were combined to calculate the irrigation electricity rate of 12.19 kWh/tonne beets.

8. Residue N Content

Nitrogen contained in the energy beet residue (tops and leaves) left on the field contribute to nitrous oxide emissions and the residue nitrogen content is based on Frissel (2012). The book indicates a residue yield of 0.026 dry lb residue/lb of beets harvested and a residue nitrogen content of 0.03 lb N/dry lb residue; these values imply a residue nitrogen content of 800 g N/tonne beets harvested.

References

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