Technical Memorandum

To: Lynn Thornton, Kelly Norton, Grande Cheese Company
Tim Trotter, Executive Director, WI Dairy Business Association

From: Doug Thomas, Senior Project Manager, Houston Engineering Inc.
Tim Erickson, Engineer III, Houston Engineering Inc.

Subject: FSF/LASA FARM ES/FieldPrint Platform Dairy Farm Sustainability Assessment

Date: August 10, 2021

PURPOSE AND RESULT OVERVIEW

The purpose of this technical memorandum is to provide a holistic view of a farm's energy use and greenhouse gas emissions for dairy operations, including milk production and cultivated acres that support milk production. This effort fits within a broader framework of sustainability projects that are being led and established by Farmers for Sustainable Food (FSF).

To complete this analysis, we compiled and now present sustainability metrics from farms that supply milk to Grand Cheese as well as farms that are participating in the Lafayette Ag Stewardship Alliance (LASA) Pilot Sustainability Project. The metrics are focused on energy use and greenhouse gas emissions for milk and crop production. The analysis used results generated from U.S. Dairy's Farmers Assuring Responsible Management (FARM) Environmental Stewardship (ES) program and Field to Market's FieldPrint Platform (FPP). This analysis further informs FARM ES in that while FARM ES collects data on crops produced, it does not generate energy use and greenhouse gas emission values for them.

This analysis is unique in that it provides a holistic view of energy use and greenhouse gas emission for the whole farming operation, including milk and crop production. This is done by presenting and comparing data collected and assessed in FPP for the 2019 crop year as well as FARM ES 2019 reports. The project compares the farms that supply milk to Grande Cheese against FPP project and FARM ES regional and national averages. FPP also calculates sustainability metrics for land use, water quality, soil carbon, soil conservation, biodiversity, and irrigation water use. The memo presents information on the water quality and soil carbon metrics as they have been determined to be of importance to both the LASA pilot sustainability project and Grande Cheese.

Results presented are based on three farms that are part of Grande Cheese's supply chain, which have completed FARM ES evaluations, and are members of the LASA pilot sustainability project. Overall, the sustainability assessment demonstrates these farms' commitment to sustainability both on the milk side as well as the feed crops being grown through quantifiable scores/metrics for both energy use and greenhouse gas emissions. Through its use of FPP, the LASA pilot sustainability project provides insight into additional environmental metrics for land use efficiency, soil conservation, soil carbon, water quality, and biodiversity.

Figures 1 and **2** show the total combined energy use and greenhouse gas emissions for the three farms. They provide a first-time look into the total energy use and emissions for both milk production and the crops grown and used in the dairy operation.

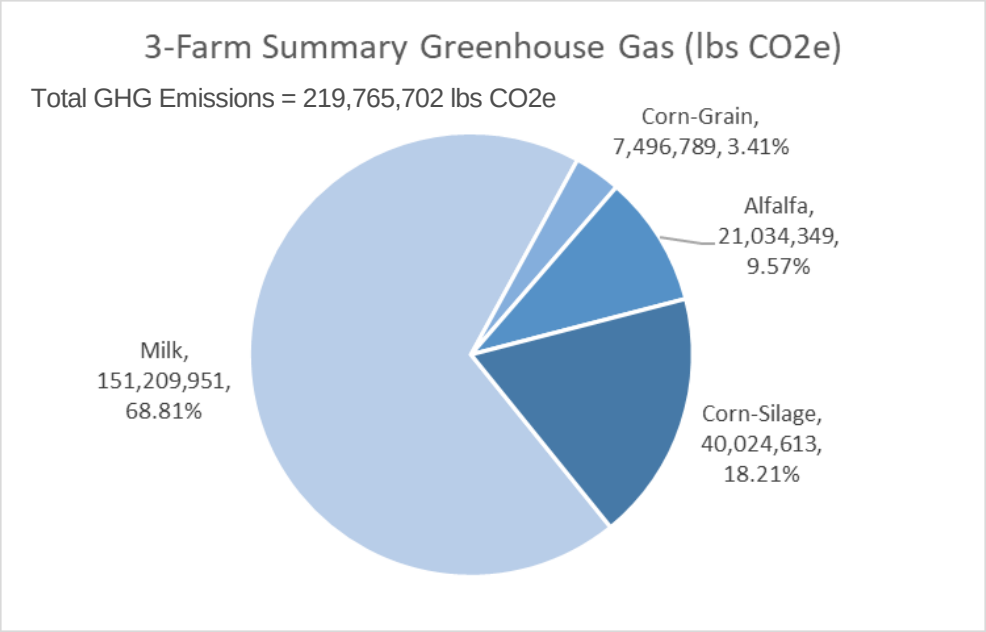


Figure 1. Total Greenhouse Gas summary for three-farm Group

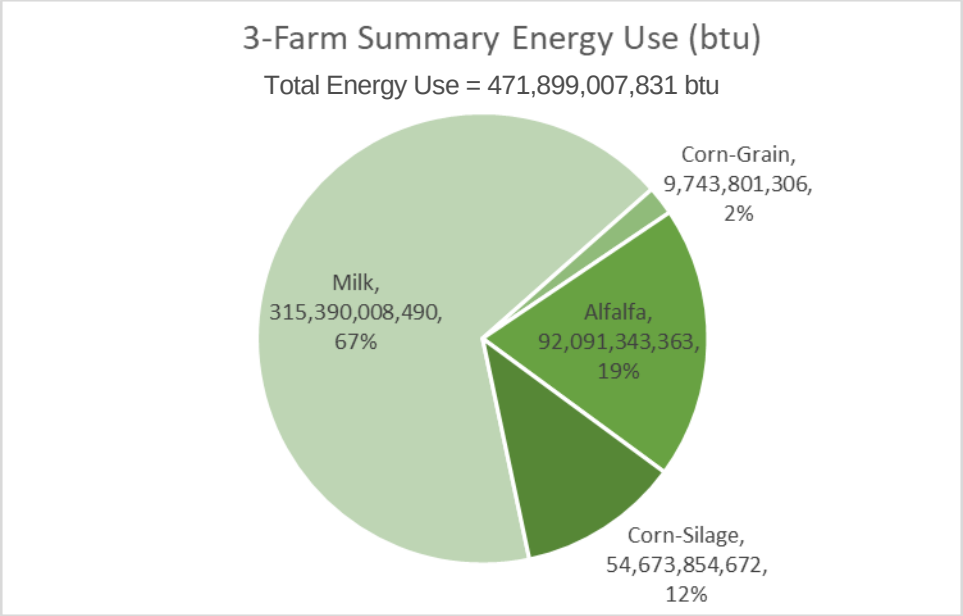


Figure 2. Total Energy Use summary for three-farm Group

For crop production, in the LASA pilot sustainability project, the crops evaluated included alfalfa, corn silage, and corn grain. **Figures 3** and **4** show FPP results for the corn silage production and comparisons with project benchmarks for energy use and greenhouse gas emissions for the three farms. This comparison shows that the combination of conservation practices, nutrient management plans, and conservation cropping systems employed on these farms demonstrate have a positive impact on sustainability scores.

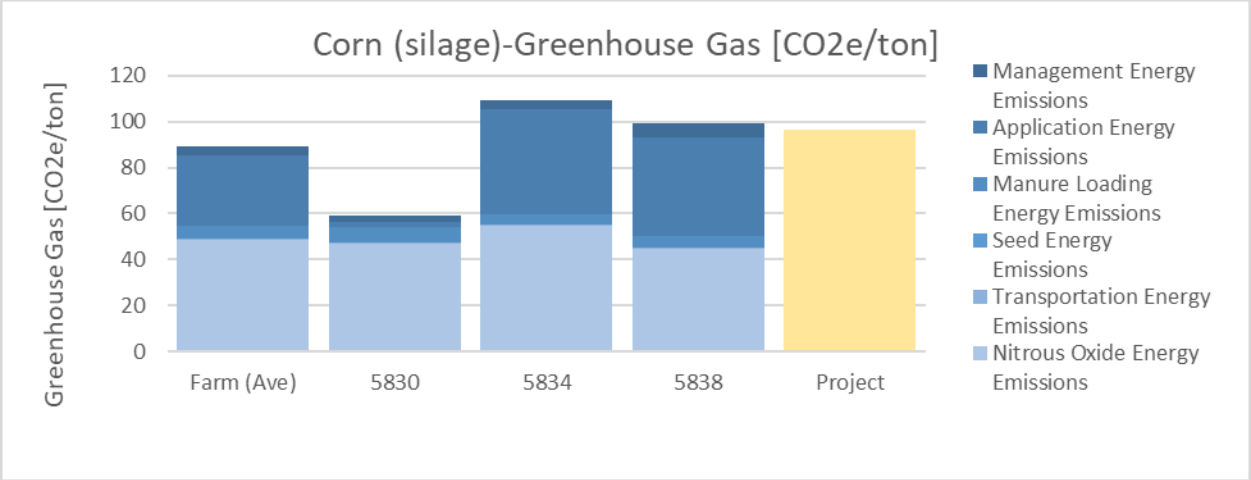


Figure 3. FPP calculated Greenhouse Gas Emission summary for three-farm Group

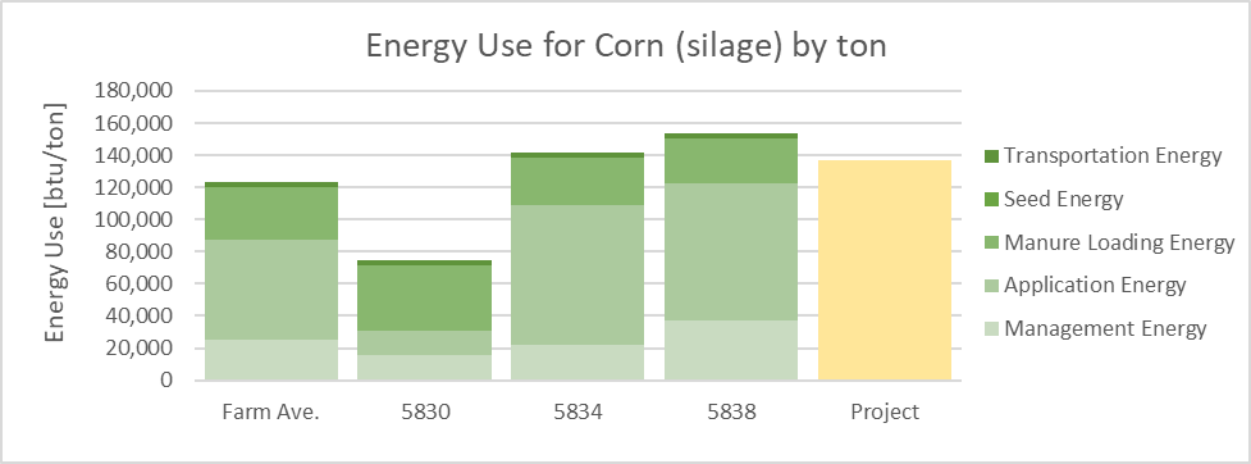


Figure 4. FPP calculated Energy Use summary for three-farm Group

FPP as noted previously calculates on-farm sustainability metrics for land use, water quality, soil carbon, soil conservation, biodiversity, and irrigation water use. These metrics are valuable in that they further inform the food supply chain on other environmental issue/concerns that are raised and/or heard in discussion about environmental sustainability of the food supply chain. **Figure 5** shows four of the eight FPP metrics that were determined to be important to the LASA Pilot Sustainability Project and Grandee Cheese. It provides a comparison the of the three farms evaluated in this report with the aggregated metric scores of the 12 farms that participated in the 2019 crop year FPP evaluation.

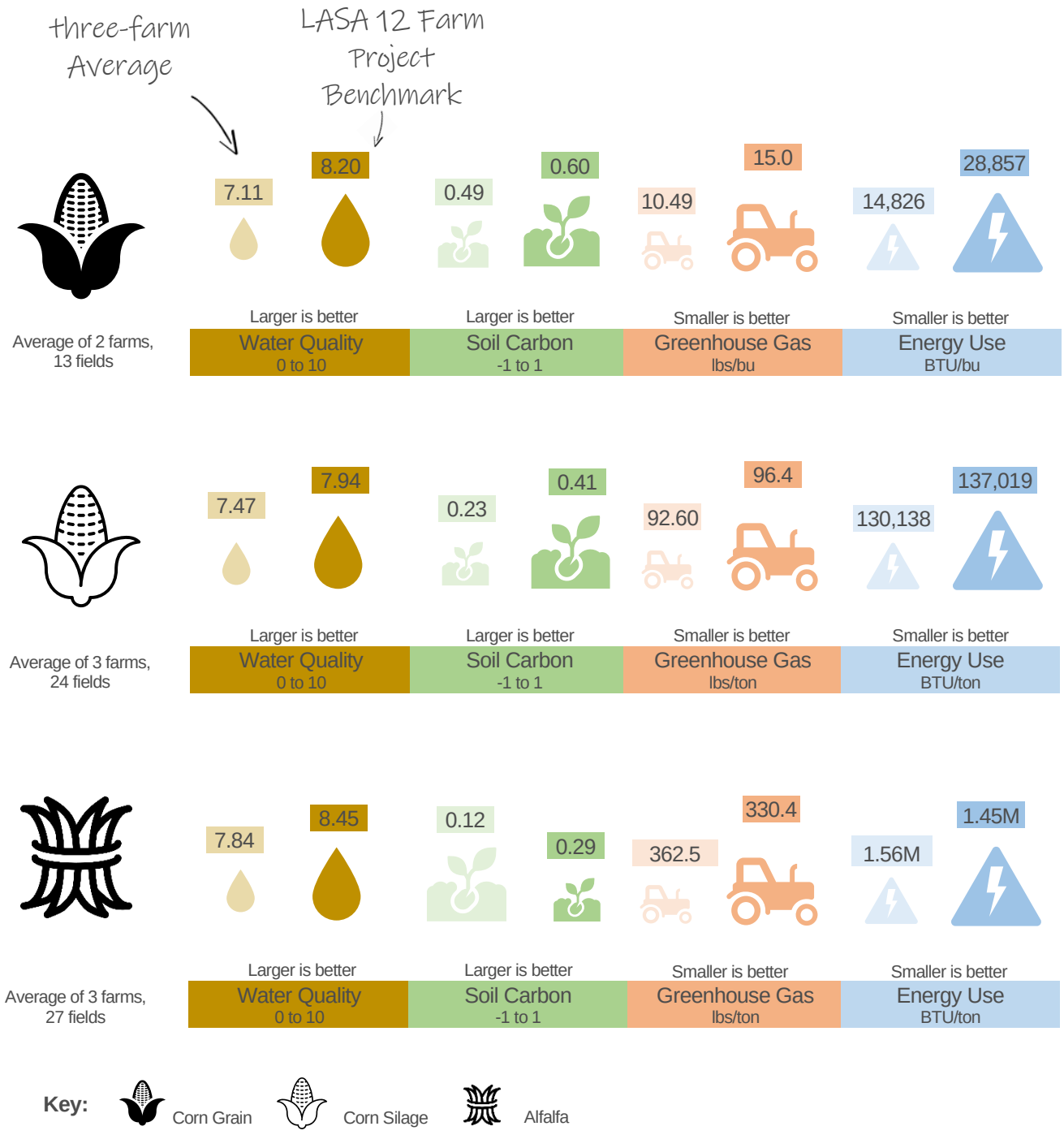


Figure 5. FPP LASA pilot sustainability project select metrics summary for three-farm group

This evaluation and assessment concluded that using combined energy use and greenhouse gas emissions metric from FARM ES and FPP can provide valuable information on a farm's overall environmental sustainability. This approach can also benefit parties in the food supply chain by linking the additional environmental sustainability metrics of land use, water quality, soil carbon, soil conservation, biodiversity, and irrigation water use.

Data presented in this technical memorandum has been aggregated and anonymized according to data privacy and confidentiality requirements of the two assessment/evaluation tools used.

BACKGROUND ON ASSESSMENT TOOLS

Field to Market's Fieldprint Platform

Field to Market's FPP was used for the on-farm sustainability metrics portion of the LASA Pilot Sustainability Project. FPP was chosen as it was developed at the national level, has pathways for sustainability claims, is currently being used in over 72 Fieldprint projects throughout the US, and is supported by over 135 partners coming from five sectors within the agricultural/food supply chain.

FPP is a confidential tool used to explore the relationships between a farmer/grower's management systems and natural resource impacts. The tool provides estimates of the operational efficiency of the farming operation and helps to highlight areas of potential improvement. Data made public is aggregated and anonymized unless the grower has agreed to its use.

FPP measures a field's sustainability footprint based on eight sustainability metrics:

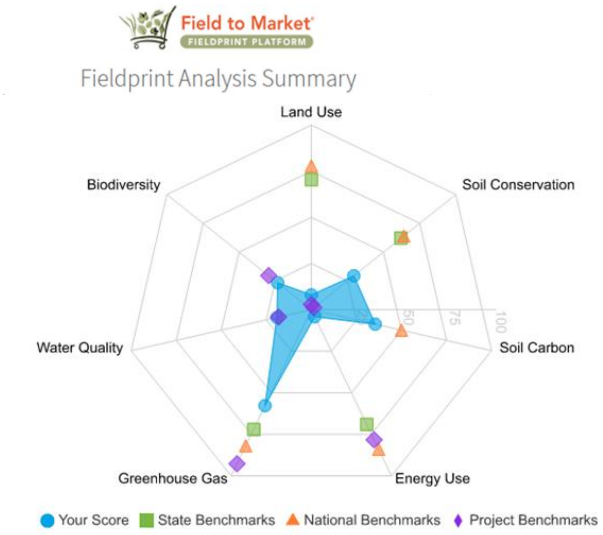
- greenhouse gas emissions,
- energy use,
- land use,
- water quality,
- soil carbon,
- soil conservation,
- biodiversity, and
- irrigation water use.

For the greenhouse gas emission and energy use scores they are derived from the following activities associated with the production of crops:

- Management Energy– energy used in field operations including tillage, planting, harvesting and passes across the field to apply nutrients and chemicals
- Application Energy – energy required to produce commercial fertilizer and crop protectant products
- Manure Loading Energy – energy required for the loading and spreading of manure
- Seed Energy – energy requires to produce the seed used for the crop
- Irrigation Energy – energy required to run the pumps
- Post-Harvest Treatment Energy – energy required for any activity (except transportation) after harvest and prior to the first point of sale such as crop drying

- Transportation Energy – energy used for the hauling of the crop harvest from the farm to the first point of sale or storage.
- Nitrous Oxide – emission of N2O from soil biological processes. This is impacted by the amount and type of organic matter on the field, the amount and type of organic and inorganic nitrogen fertilizer amendments, the timing of application, and the source of fertilizer.

Each Field to Market metric measures a specific environmental outcome that is important for environmental sustainability, calculated and measured at the scale of a farm, responsive to changes in farm management, and uses robust science to support accurate modeling of environmental impact. With each FPP assessment, farmers can assess change over time and identify areas of operational improvement. **Figure 6** shows an example output from FPP for a corn grain field.



Metric	Your Result	Project Benchmark	State Benchmark	National Benchmark
Land Use (acre / bushel)	0.0045	0.0041	0.0069	0.0074
Soil Conservation (ton / acre / year)	3.0	1.0	3.5	3.6
Soil Carbon	0.17	N/A	N/A	0.00
Energy Use (btu / bushel)	9303	28857	25291	35312
Greenhouse Gas (lbs_co2e / bushel)	8.8	15.0	9.3	11.4
Water Quality	8.35	8.20	N/A	N/A
Biodiversity	71%	70%	N/A	N/A

Figure 6. Example field level FPP results (corn grain)

U.S. Dairy, FARM ES

FARM ES estimates farm-level greenhouse gas emissions and energy intensity using a scientific, peer reviewed model. The evaluation results are life cycle based—in other words, they represent all the greenhouse gas emissions and energy use associated with the farm's milk production, from the point of resource extraction ("cradle") to the farm gate. For example, the greenhouse gas emissions associated with energy use represent emissions from drilling or mining the energy source, processing the fuel, and burning it on the farm. Greenhouse gas results are reported in pounds of carbon dioxide (CO_2) equivalent per pound of fat and protein corrected milk (FPCM). FPCM normalizes milk to the same scale so farms can track their results consistently even if milk

output changes year to year. With each FARM ES evaluation, farmers, cooperatives, and processors can assess change over time, identify areas of operational improvement, and report progress to their customers.

FARM ES collects data and evaluates the following operations associated with milk production:

- Milk production
- Herd Profile
- Energy Use
- Feed
- Nutrient Management Plans
- Manure Management Systems

FARM ES Outputs

FARM ES estimates the farm's greenhouse gas and energy use footprints. See **Figure 1** for example results. The total greenhouse gas footprint is divided based on where the emissions come from, including feed production, on-site enteric (emissions from the cow's digestive processes), on-site manure, and on-site energy use. The energy results are divided into feed production and on-site energy. "On-site" refers to dairy activities on the farm. If the operation purchases feed but does not engage in feed production activities, the output will still generate an estimate for the environmental impacts of the purchased feed. Results are compared to regional and national averages. These averages come from the industry's LCA research. Benchmarks for feed production emissions are not available in FARM ES Version 2.

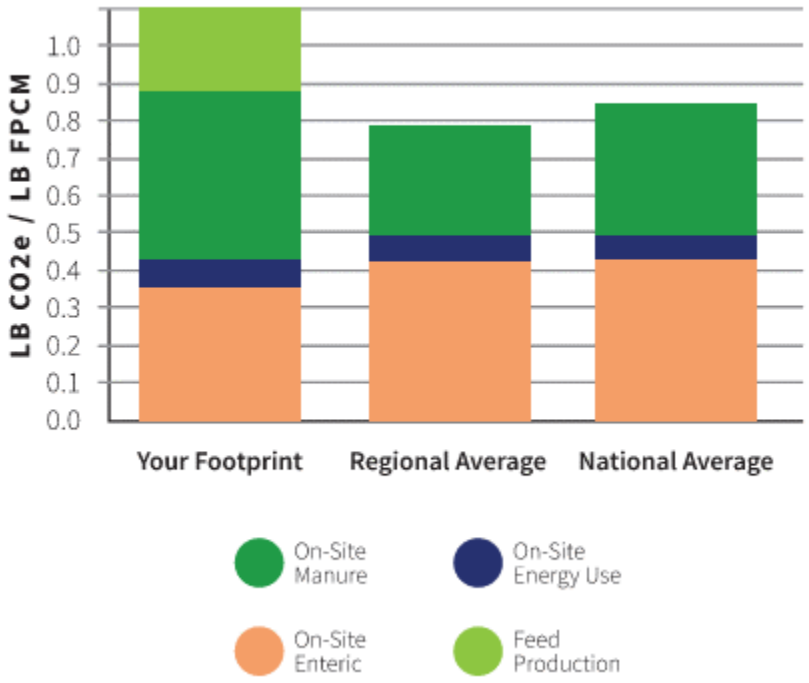


Figure 7. Example farm greenhouse gas emissions

Data Privacy

The farmers' personal information is private. The FARM ES program and the Innovation Center for U.S. Dairy only use aggregated, anonymous results in public-facing reports. Talk to your evaluator to find out more about how your co-op or processor uses FARM ES data. Some co-ops and processors use aggregated, anonymous results to answer customer questionnaires about on-farm sustainability.

ASSESSMENT METHODS

FieldPrint® Platform - On-farm Crop Production Sustainability

The Fieldprint® Platform was employed to complete an assessment that included a three-farm level summary based on the farms that participated in the LASA pilot sustainability project and supply milk to Grande Cheese. The assessment involved generating field level results, but these are not presented in this report based on Field to Market's data privacy policy.

The assessment and results presented are based on 2019 crop year data. The following four metrics identified as important to the LASA pilot project are highlighted in the body of this memo:

- energy use,
- greenhouse gas emissions,
- water quality, and
- soil carbon

Metric values are greenhouse gas emissions (lb CO_2e/lb or ton of product), energy use (BTU/lb or ton of product), soil carbon (unitless value from -1 to 1 where a negative value means the land is losing carbon and a positive value means the land is gaining carbon) and water quality (unitless from 0-10 where a larger value is more desirable).

FARM ES - feed and milk product production for whole farm operation

Our FARM ES assessment covered a period from 2019-2020. The FARM ES outputs were provided to Houston Engineering, Inc. (HEI) for use this assessment. The following is a brief overview of the portions of FARM ES used in this study.

A portion of FARM ES is specific to feed production. It supplies a measure of time spent on pasture for lactating, dry, and youngstock (if applicable); average daily DMI for the production period (lbs/day) for lactating herd; and percentage makeup on a dry matter basis. ***It is important to note that this is not a measure of energy used or greenhouse gas emissions generated in the production of the crops themselves. FARM ES collects data on crop production for informational purposes so that scientists can refine FARM ES over time. It does not impact the greenhouse gas or energy footprint results within FARM ES.***

Greenhouse gases are reported as pounds of CO_2 equivalent per pound of FPCM produced. The results are divided into areas of production: feed production, on-site enteric, on-site manure, and on-site energy use. "On-

site" refers to dairy activities on the farm. If the operation purchases feed but does not engage in crop production activities, the output will still generate an estimate for the impacts of the purchased feed.

Energy use is reported in megajoules per pound of FPCM produced. On-site energy is divided into renewable and non-renewable. Renewable energy, like solar and wind, have less greenhouse gas emissions than non-renewable energy, like diesel or gas. Grid electricity is included within "non-renewable" energy, even though some electric grids in the US do in fact use renewable energy.

FARM ES uses regional and national averages to show/compare an individual farm to these values as means to identify areas of potential improvement. This evaluation did not present that information for the three common farms as it would have required more time and resources than were available to the HEI for this project.

RESULTS

FieldPrint® Platform - On-farm Crop Production Sustainability

Eight-Farm Summary

The project evaluated eight farms that produce milk and are participants in the LASA Pilot Sustainability Project. The FPP results of this evaluation are in Appendix A. They present a summary and graphs showing the average FPP metric values for water quality, soil carbon, greenhouse gas, and energy use values presented for the eight dairy farms participating in the LASA Farmer Pilot Sustainability Project.

Three-Farm Summary

From the eight-farm pool, the three farms that ship milk to Grande Cheese were separated out with the results for the four FPP metrics (water quality, soil carbon, greenhouse gas, and energy use) shown in **Figure 5**. The four metrics were identified as important environmental indicators for the LASA Pilot Sustainability Project and Grande Cheese.

Figures 8 and **9** display the FPP sustainability metrics for greenhouse gas and energy use for individual farms. They include the source of emission and/or energy use for the operation categories that are calculated and make up the whole farm score.

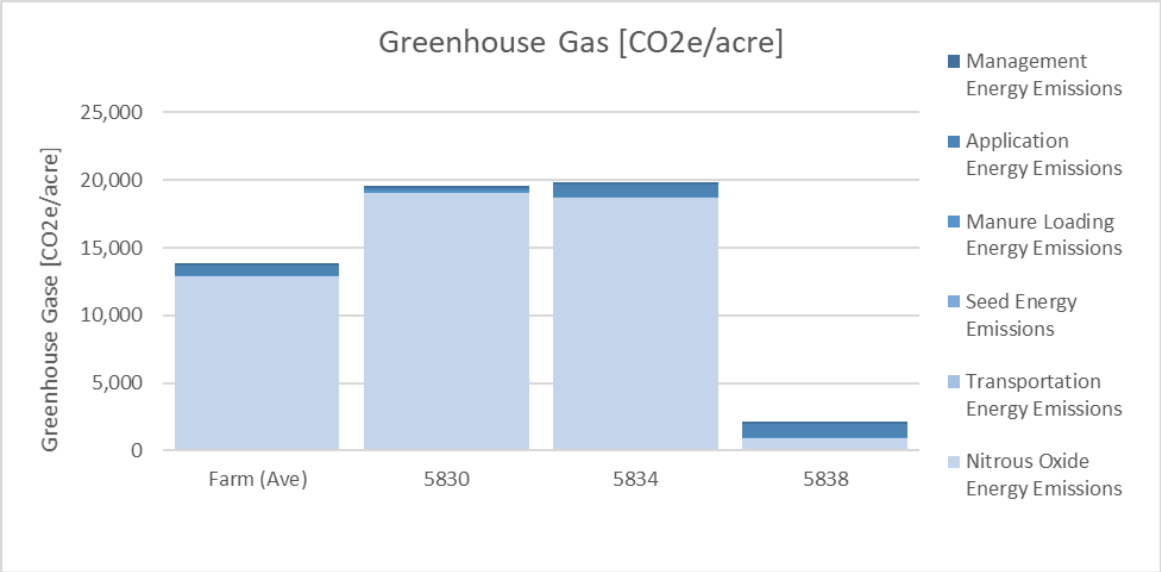


Figure 8. Greenhouse Gas summary for Three-Farm Group

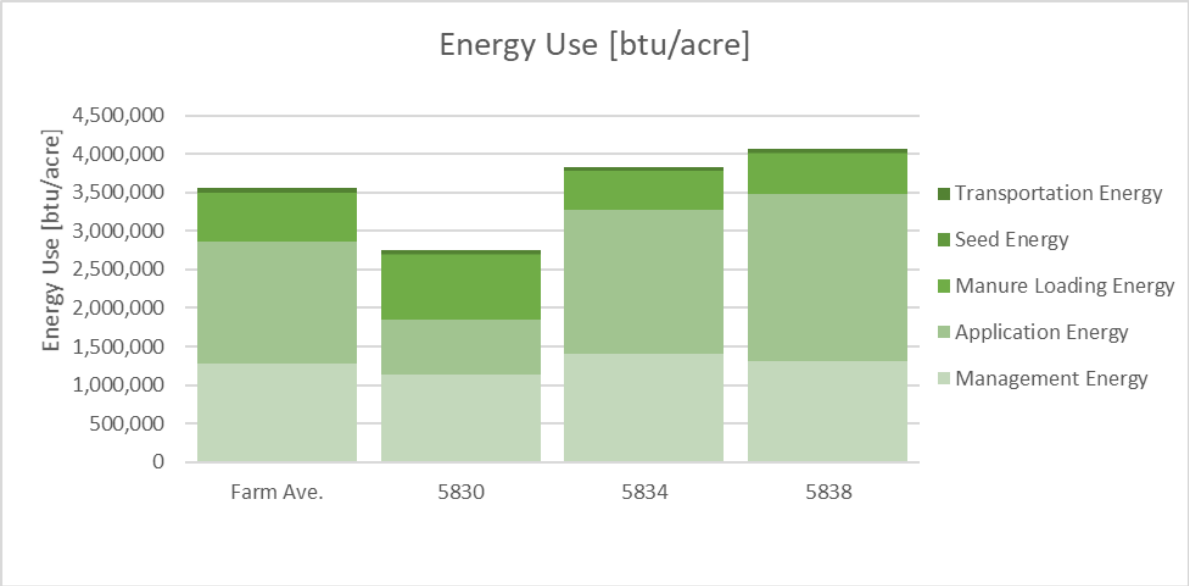


Figure 9. Energy Use summary for Three-Farm Group

Figures 10 and **11** present greenhouse gas and energy use by crop type. The LASA Pilot Sustainability Project focused on alfalfa, corn silage, and corn grain. The graphs show the greenhouse gas emission and energy use by crop and by farm, which are compared to project as well as historical state and national benchmarks. Use of historical state and national benchmarks allows farms to identify metrics where they can consult with a trusted advisor to identify practices that could improve scores.

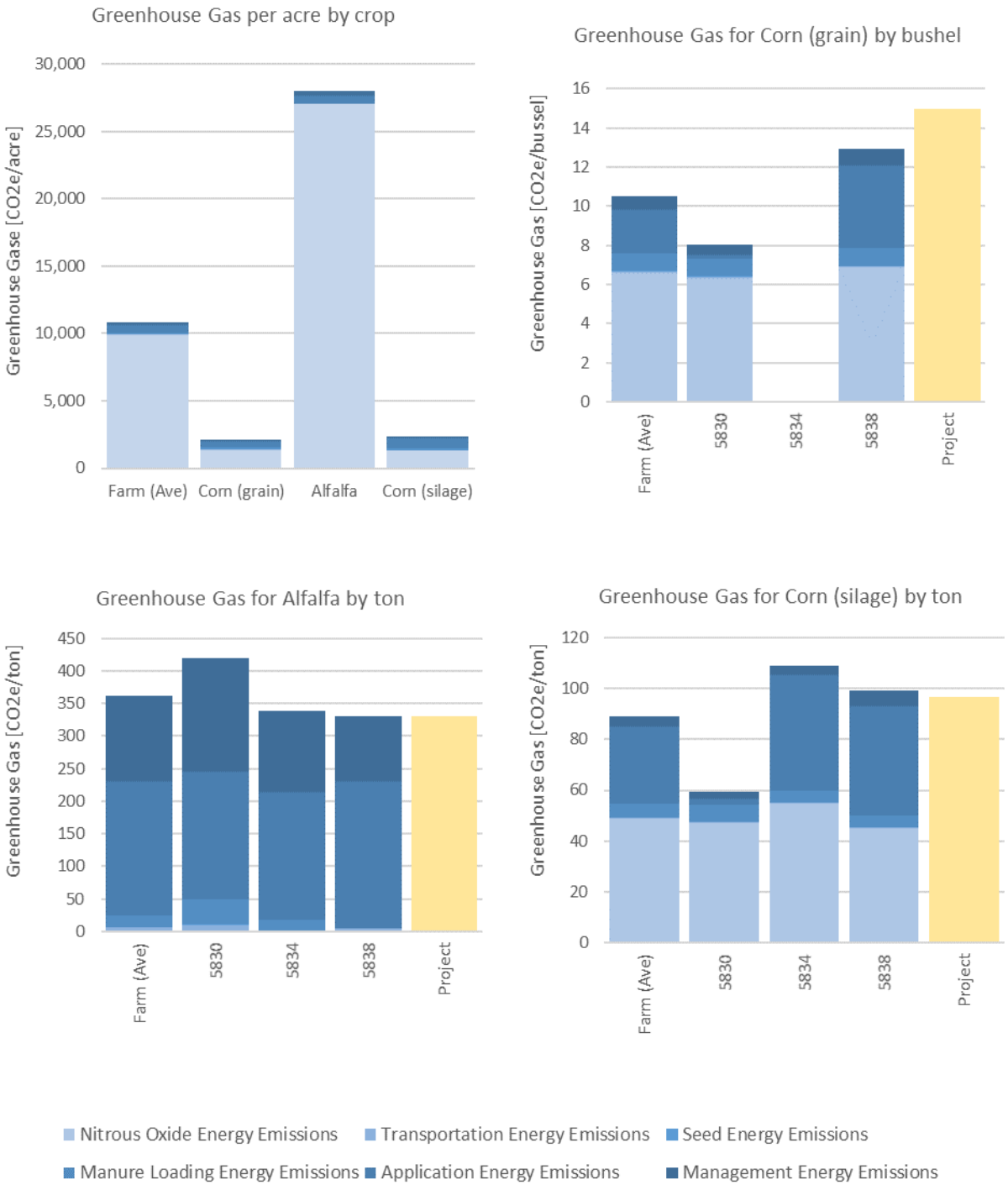


Figure 10. Average Greenhouse Gas Emissions for Three-Farm Group.

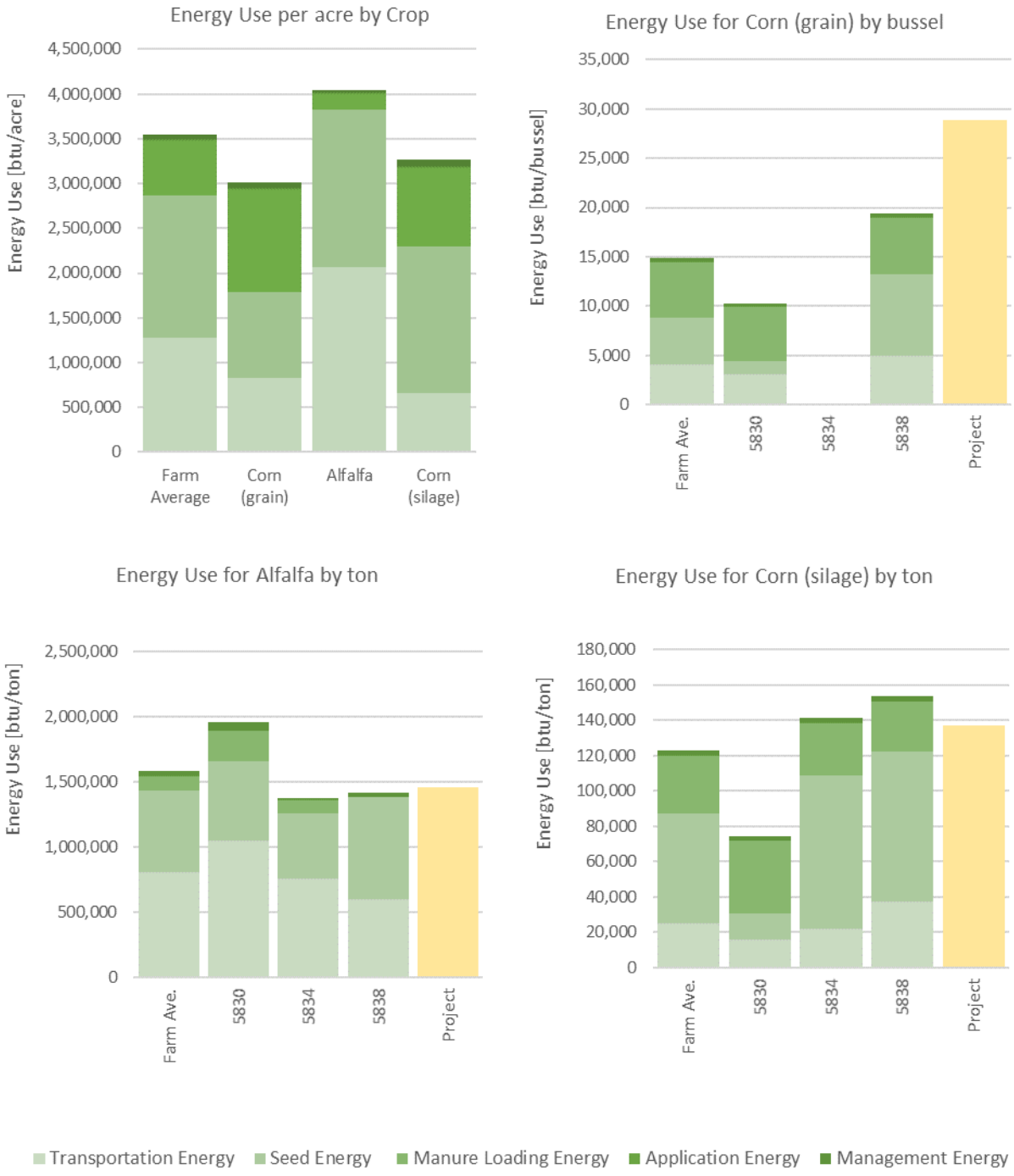


Figure 11. Average Energy Use for Three-Farm Group

LOCAL WATER RESOURCES

In addition to evaluating farm and field sustainability scores using the FPP, the LASA Pilot Sustainability Project also evaluated the impact on local water resources using a water quality tool referred to as the Prioritize, Target, Measure Application (PTMApp)**.** PTMApp was developed in Minnesota by HEI for the Minnesota Board of Water and Soil Resources (BWSR). It is a geographic information system (GIS) desktop and web application designed to improve the efficiency of local conservation projects and improve watershed planning through its ability to show the estimated pollution reductions of sediment, phosphorus, and nitrogen to local water resources.

By using PTMApp, the LASA Pilot Sustainability Project was able to quantify the estimated benefit from both current and planned conservation practices to local water resources, which could not otherwise be done without the use of sophisticated water quality models. Once completed, the PTMApp data products and Desktop Toolbar will be accessible to the Lafayette County Land Conservation Department and other natural resource managers. It will serve as a new means to target outreach, technical assistance, and financial assistance to farms and fields where adoption of conservation practices and land management systems will produce cost-effective land treatment.

Detailed information on the results of this part of the LASA Pilot Sustainability Project will be available in the project Year One Report, which is expected to be released in June of 2021.

Overall, PTMApp is a tool that can help shape the conversation around conservation by demonstrating where sediment and nutrients are most likely to be coming from and the benefit of the conservation already adopted and implemented. It is also able to project the potential, additional benefit of local water resources from implementing new conservation by farmers and landowners in the watershed/project area.

CONCLUSION

The overall conclusion from this evaluation and assessment is that—used together—FARM ES and FPP can provide valuable, holistic information of a farm's environmental sustainability using energy use and greenhouse gas emissions metrics. This approach can also demonstrate additional benefits to parties in the food supply chain by linking the additional environmental sustainability metrics of land use, water quality, soil carbon, soil conservation, biodiversity, and irrigation water use to greenhouse gas emissions and energy use.

DATA PRIVACY

Data presented in this report has been aggregated and anonymized according to data privacy and confidentiality requirements of the two assessment/evaluation tools used.

SOURCES:

Environmental Stewardship Continuous Improvement REFERENCE MANUAL 2017

FARM Environmental Stewardship Version 2 Update

Harnessing Sustainability Insights & Unleashing Opportunity - Leveraging Data to Deliver Operational Efficiencies & Build Consumer Trust

FIELD TO MARKET SUSTAINABILITY METRICS DOCUMENTATION Version 1.0 – Published September 2018

Appendix A – Eight Farm FPP Evaluation Results

The following is a summary of the average FPP metric values for water quality, soil carbon, greenhouse gas, and energy use values presented for the eight dairy farms participating in the LASA Farmer Pilot Sustainability Project. **Figure A-1** shows four of the eight FPP metrics that were determined to be important to the LASA Pilot Sustainability Project and Grandee Cheese. It provides a comparison the of the three farms evaluated in this report with the aggregated metric scores of the 12 farms that participated in the 2019 crop year FPP evaluation.

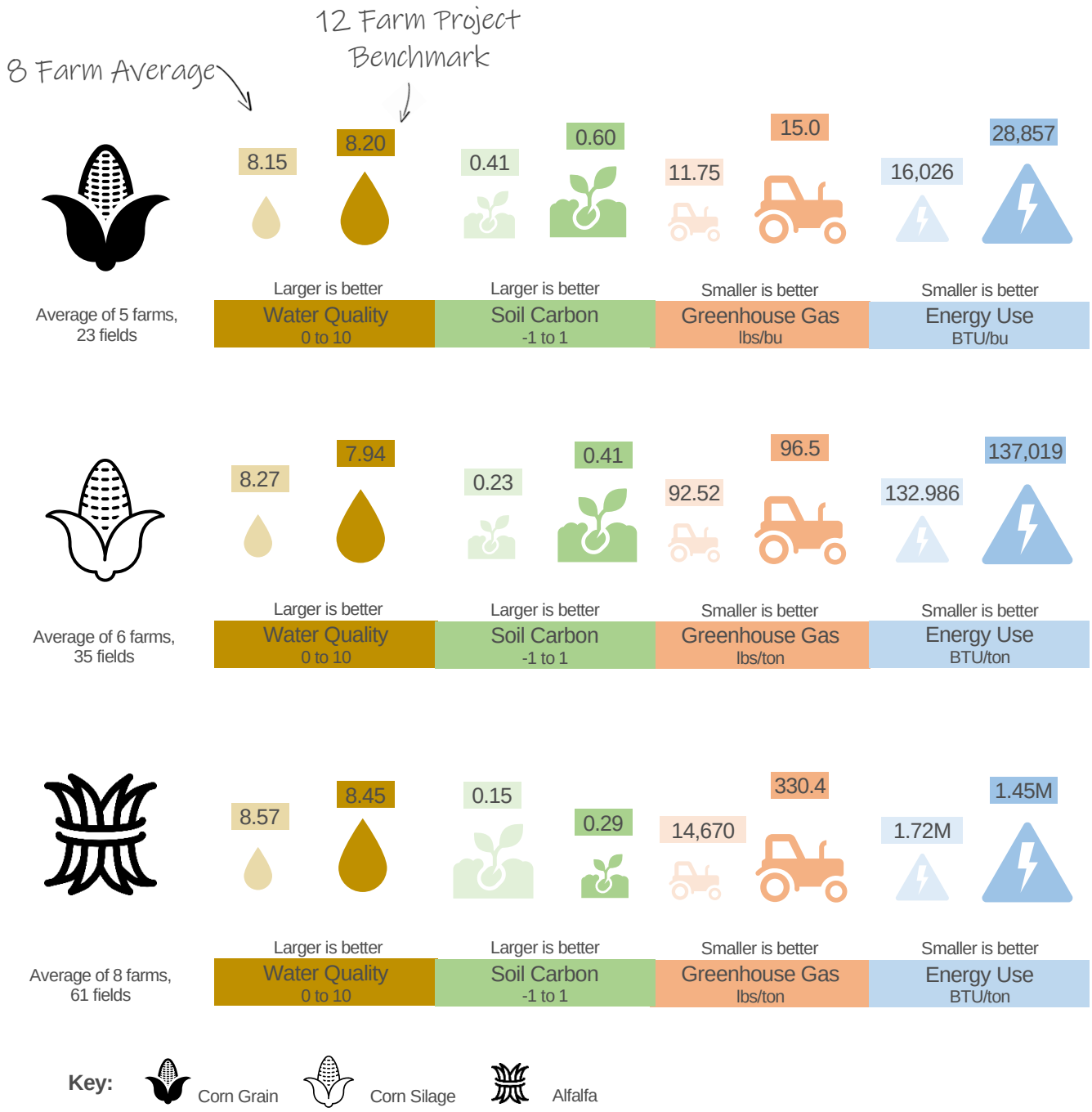


Figure A-1. FPP LASA pilot sustainability project select metrics summary for three-farm group

Figure A-2 shows the greenhouse gas emissions of each of the eight farms.

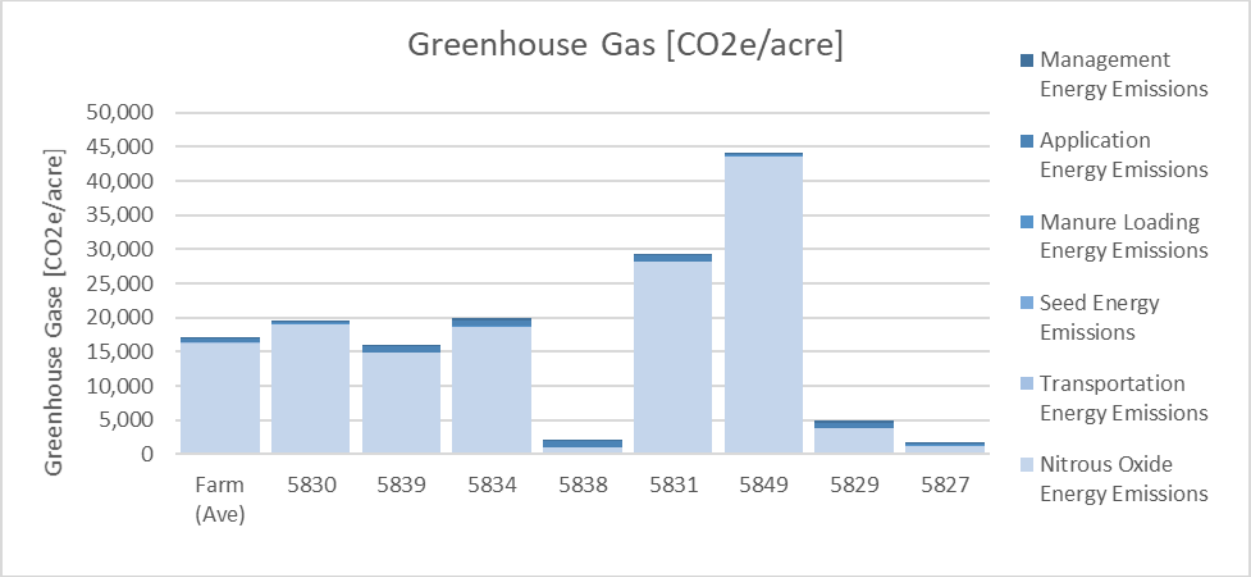


Figure A-2. Greenhouse Gas summary for Large Farm (Eight Farms) Group.

Figure A-3 shows the energy of each of the eight farms.

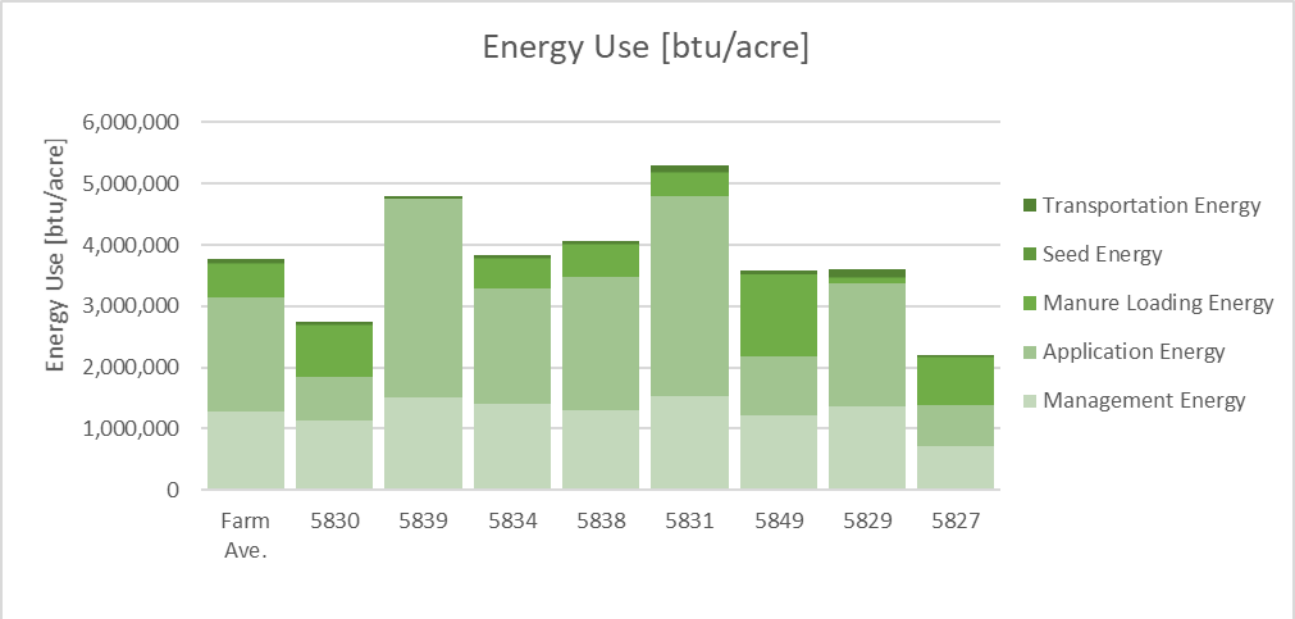


Figure A-3. Energy Use summary for Large Farm (Eight Farms) Group.

Figure A-3 shows the greenhouse gas emissions per acre as well as for corn, alfalfa, and corn silage of each of the eight farms.

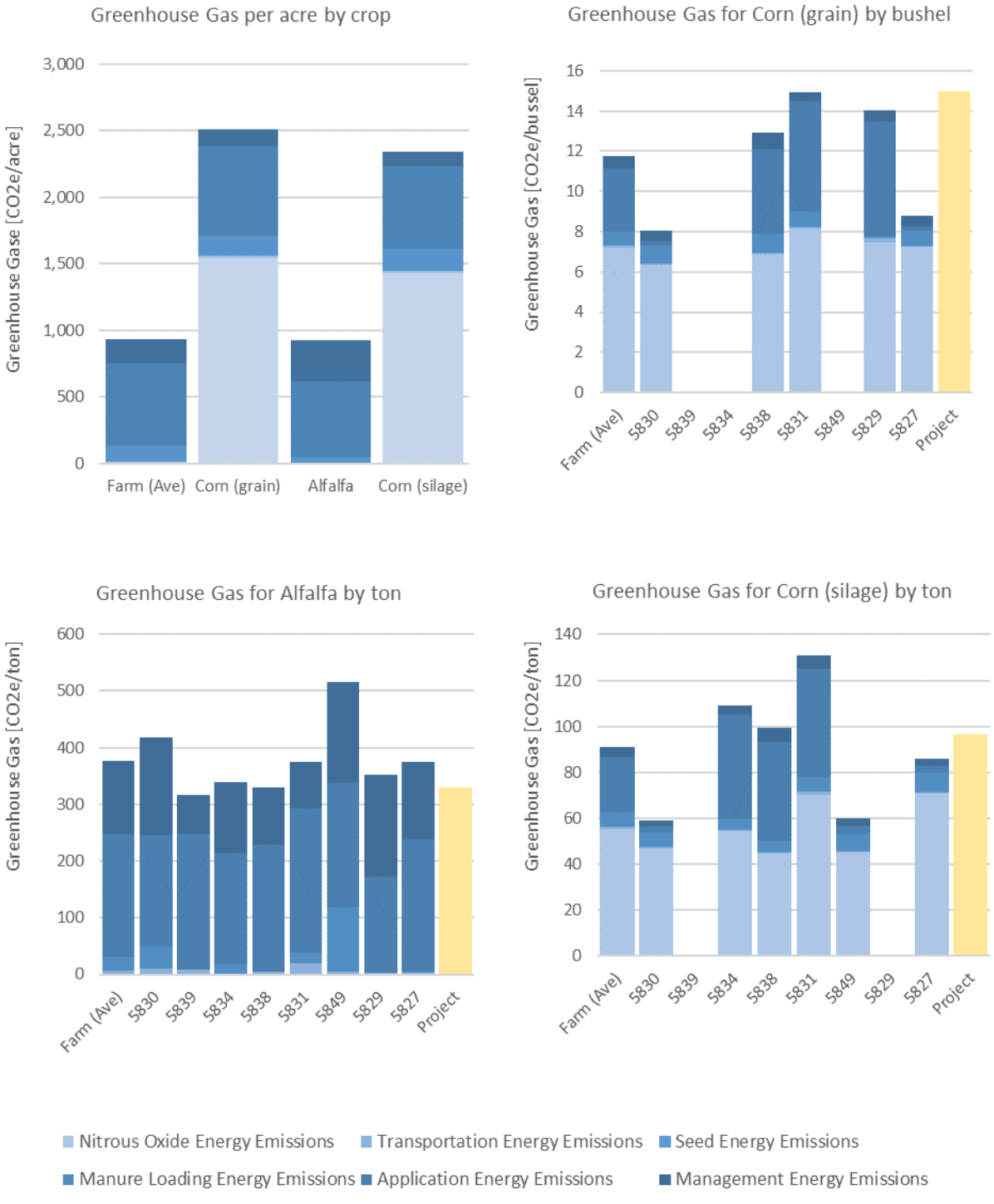


Figure A-4. Average Greenhouse Gas Emissions for Large Farm Group (Eight Farms).

Figure A-4 shows the energy use per acre as well as for corn, alfalfa, and corn silage of each of the eight farms.

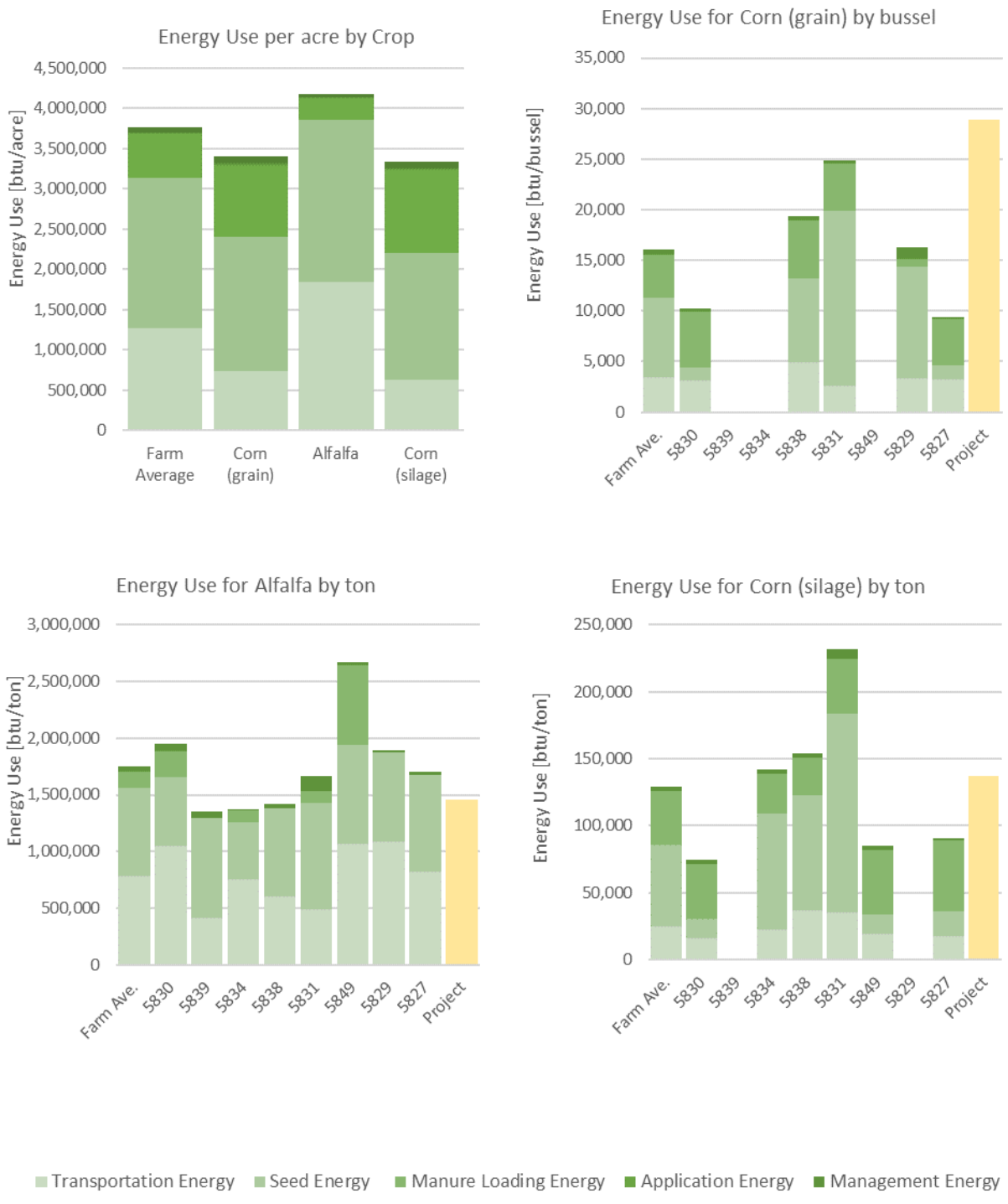


Figure A-5. Average Energy Use for Large Farm Group (Eight Farms).