

Long-Term Agroecosystem Research: The Potential for Sunflower to Provide Multiple Ecosystem Services in Diverse Cropping Systems



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Introduction

- The Northern Great Plains Research Laboratory (NGPRL) was established in 1912. In 2012, NGPRL was designated as one of 18 Long-Term Agroecosystem Research (LTAR) Network sites across the country.
- The LTAR network was initiated to sustain a land-based infrastructure for research, education, and outreach that enables understanding and forecasting of our capacity to provide agricultural commodities and other agro-ecosystem goods and services under changing conditions (Walbridge and Schafer, 2011).
- The Area IV Soil Conservation Districts (SCD) Cooperative Research Farm was established in 1983 as a cooperative agreement between NGPRL and several SCD's to conduct long-term field-scale research.
- Previous and ongoing research activities at the Area IV farm align with the focus of the LTAR network.



Ecosystem Service Measurements

- In 2015, eddy covariance systems were installed on two 25 ha fields on the Area IV farm: Fields represented future locations for ASP and BAU treatments, with the former planted to sunflower.
- Measurements conducted focused on select management priorities, including production and profitability, efficient use of water, nutrients and energy, greenhouse gas mitigation, erosion resistance, and climate resilience/resistance.

Carbon Balance and Water Use

Half-hourly CO₂ & H₂O fluxes in sunflower, 7/24/2015

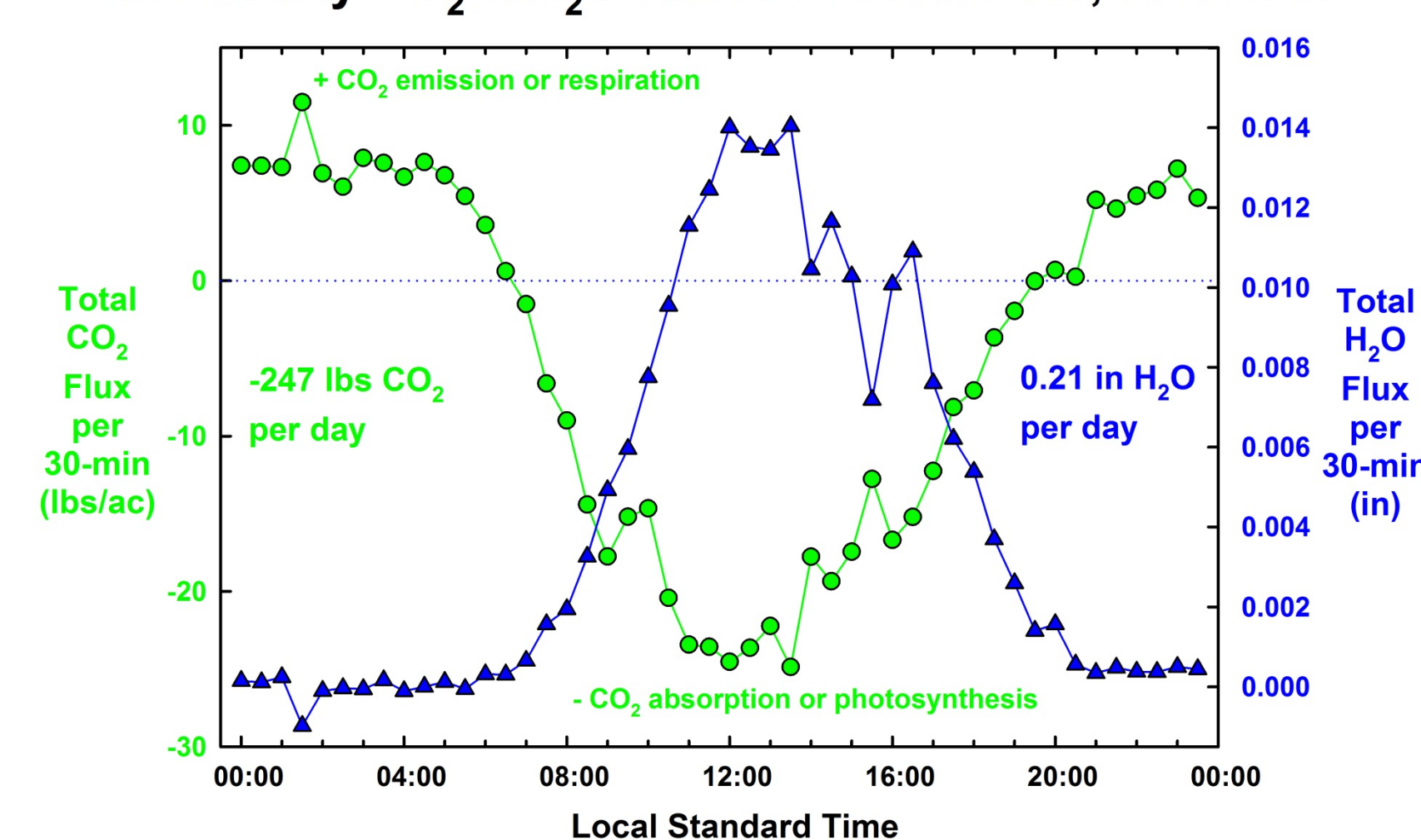
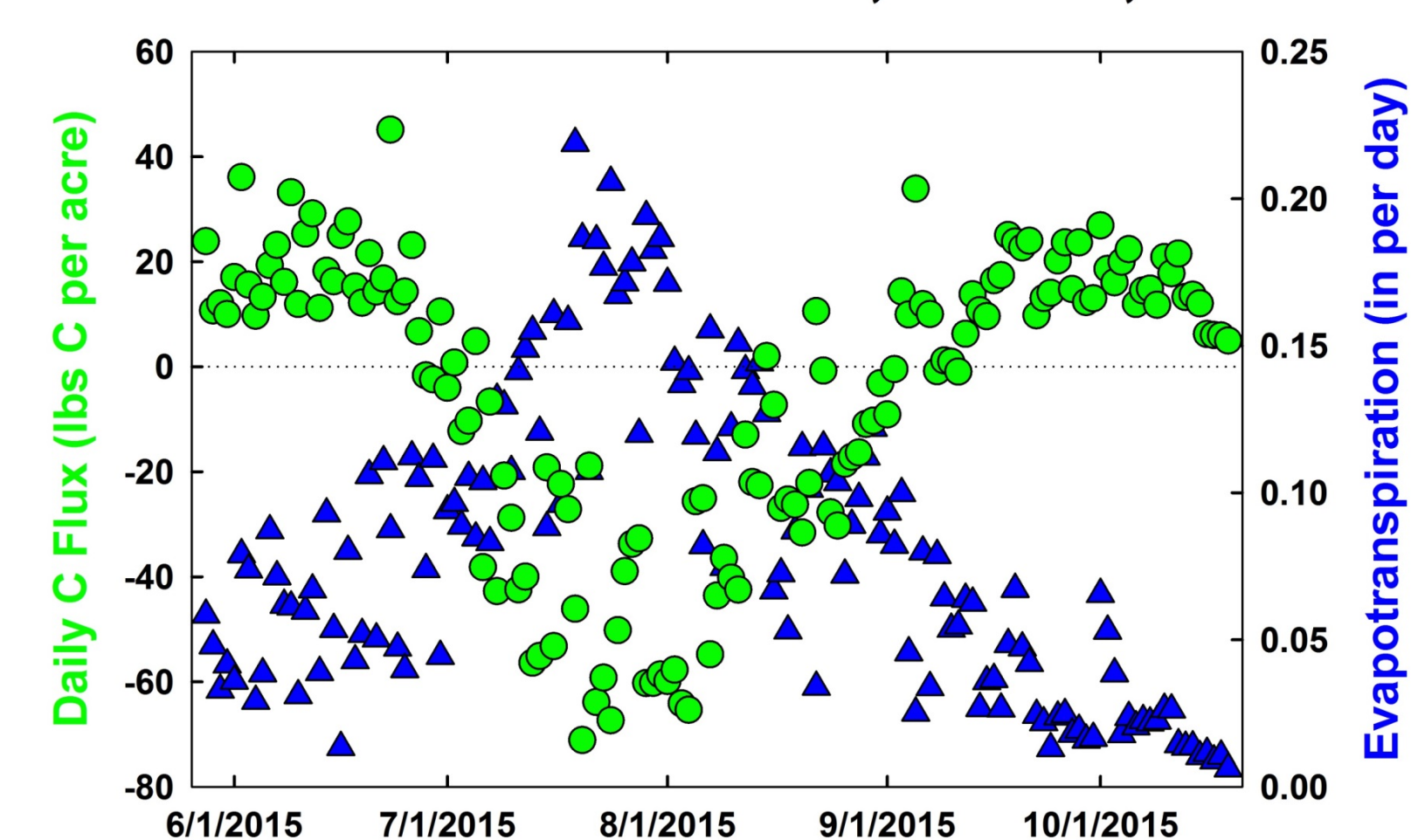


Figure 1. The eddy covariance method is used to measure continuously the half-hourly fluxes of CO₂ and H₂O, which are used to compute total carbon (C) and and evapotranspiration (ET) on a daily basis. Positive values of CO₂ flux denote ecosystem respiration, while negative values of CO₂ flux denote CO₂ uptake via photosynthesis.



Sunflower at ARS-NGPRL, Mandan, ND



Sunflower at ARS-NGPRL, Mandan, ND

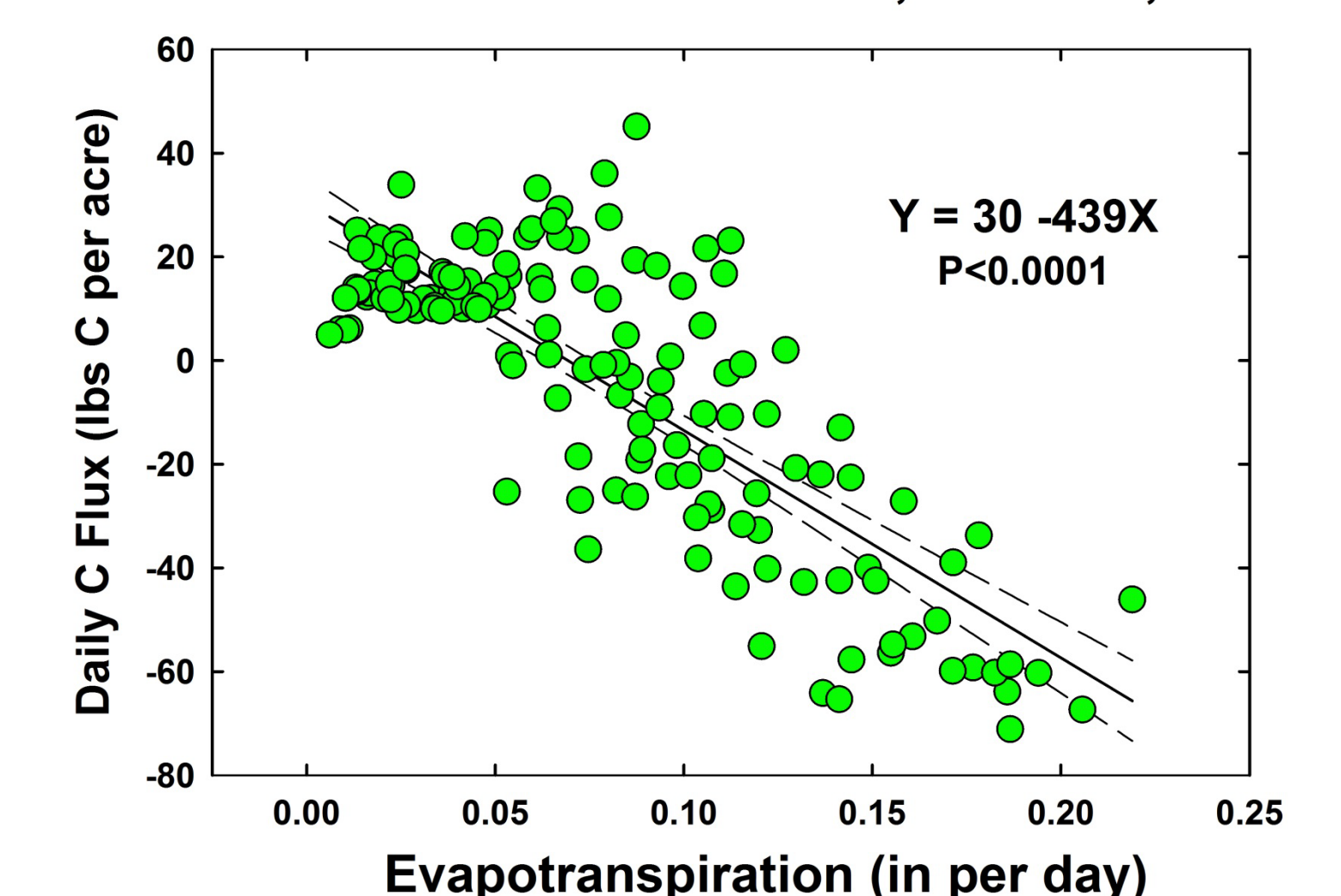


Figure 2. Daily total fluxes of carbon (C) and water (evapotranspiration) from seeding (May 28, 2015) to harvest (October 19, 2015) of sunflower.

Figure 3. Daily total fluxes of Carbon (C) as a function of daily evapotranspiration (ET). Water use efficiency can be inferred from the slope of the linear regression (i.e., 439 lbs C/ac assimilated per inch of ET).

Long-Term Research

- As part of LTAR Common Experiment, "aspirational" (ASP) and "business as usual" (BAU) production systems will be established and compared for their effects on multiple ecosystem services.
- BAU refers to traditional practices on predominant cropping systems, whereas ASP production systems that deliver site-prioritized ecosystem services.
- Both LTAR treatments are designed to be dynamic, in that they will be reviewed periodically and potentially change based on new technology, agronomic inventions, and socioeconomic change.



Table 1. Cumulative carbon (C) and H₂O (ET) flux from May 28, 2015 (planting) to October 19, 2015 (harvest) in a sunflower field in Mandan, ND.

C (lbs/ac)	ET (in)	Yield (lb/ac)	Net C Input*
712.9	11.7	1667.0	46.1

*Calculated based on a conservative estimate of 40% C content sunflower seeds.

Other Potential Ecosystem Services

- Sunflower has the potential to provide multiple ecosystem services in dynamic and diverse cropping systems.
- Pollinator services are important in the Northern Great Plains, and especially in North Dakota, where the majority of honey bee colonies that pollinate U.S. crops reside much of the year.
- Land use conversion from grassland to agricultural production, primarily corn and soybean, is a phenomenon that has altered the landscape throughout the Northern Great Plains. While considered a low quality forage, sunflower can provide forage for wild and honey bees in agriculture-dominated landscape that may not otherwise be available.
- Sunflower is an effective nutrient and water "scavenger", thereby providing potential benefits to ecosystem services related to nutrient cycling and water regulation.
- Resistance to wind erosion can vary considerably with different cropping practices. To address this important ecosystem service metric, the LTAR ASP treatments will serve as a site for the National Wind Erosion Research Network.