Conservation Effects Assessment Project (CEAP)

USDA
AGRICULTURAL RESEARCH SERVICE

Using Remote Sensing to Describe Nutrient Uptake by Cover Crops on Maryland's Eastern Shore

Winter Cover Crops in the Chesapeake Bay Watershed

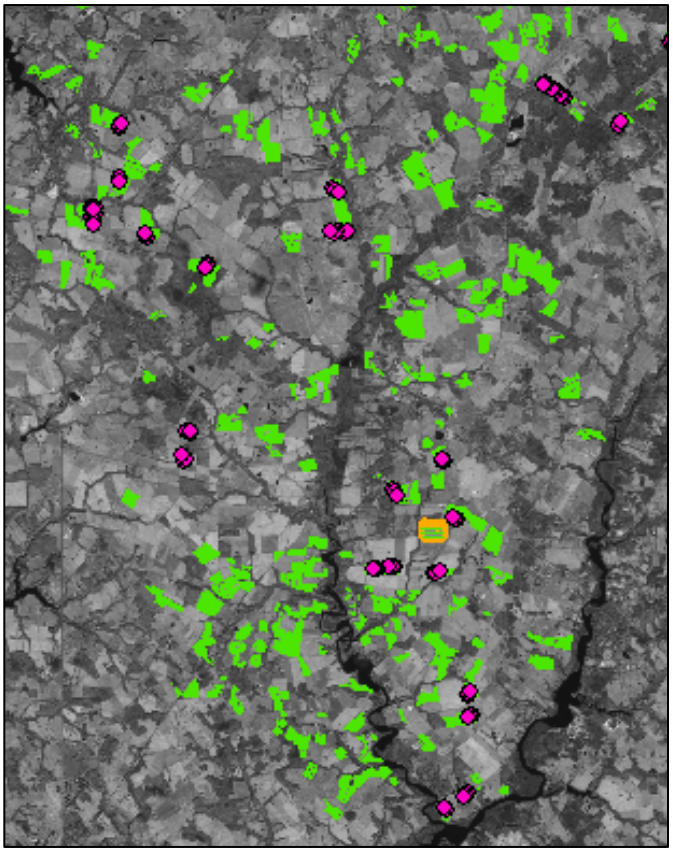
Throughout the Chesapeake Bay area, a strong emphasis has been placed on the use of winter cover crops to reduce the loss of excess agricultural nutrients following the growing season. State cost-share funds are available to compensate farmers for the cost of planting cover crops. Additionally, new programs support implementation of commodity cover crops (grain crops grown for market without fall fertilizer application) and the cultivation of hulless barley for ethanol production. However, current understanding of the cover crop effectiveness relies upon small-plot experimental data and implementation acreage sums, rather than upon landscape analysis.

Study Description & Goals

This project, a collaboration between the **USDA Agricultural Research Service and** the **Maryland Department of Agriculture**, combines farm program records, satellite remote sensing, and on-farm sampling to estimate the amount of nitrogen sequestered in cover crop biomass on farms enrolled in state cover crop cost share programs. This innovative methodology allows the direct evaluation of agronomic factors affecting cover crop productivity (e.g., species choice, planting date and method) using data derived from real-world, real-time observation of practices employed by participating farms. By utilizing remotely sensed data, the project can estimate cover crop efficiencies at the landscape scale, accounting for the effects of spatial variability (watershed position, soil type, hydrology) as well as agronomic factors. Sampling began in December 2005, and is scheduled to continue through 2007.

Expected Outcomes

- **Identification of optimum cover crop production methods and critical implementation parameters that maximize biomass production and nutrient uptake.**
- **Transfer of methodologies and recommendations to state and federal conservation personnel.**
- **Presentation of results and recommendations at local farmer field days and meetings to promote the adoption of effective environmental cover cropping methods.**



Distribution of cover cropped fields within the study area (green) with field sampling locations (pink) and on-farm trials (orange)

Approach

Methods

1. *Obtain cover crop cost-share program enrollment data (field locations, planting date, method, species, previous crop)*
2. *Acquire satellite imagery (December, March)*
3. *On-farm sampling of cover crop biomass and nitrogen content on select fields (calibration data)*
4. *Correlate satellite-derived vegetation index (NDVI) with on-farm biomass measurements to calibrate the image interpretation*
5. *Estimate cover crop performance on all fields participating in the cost-share programs*
6. *Calculate cover crop nutrient uptake on a landscape / watershed basis*

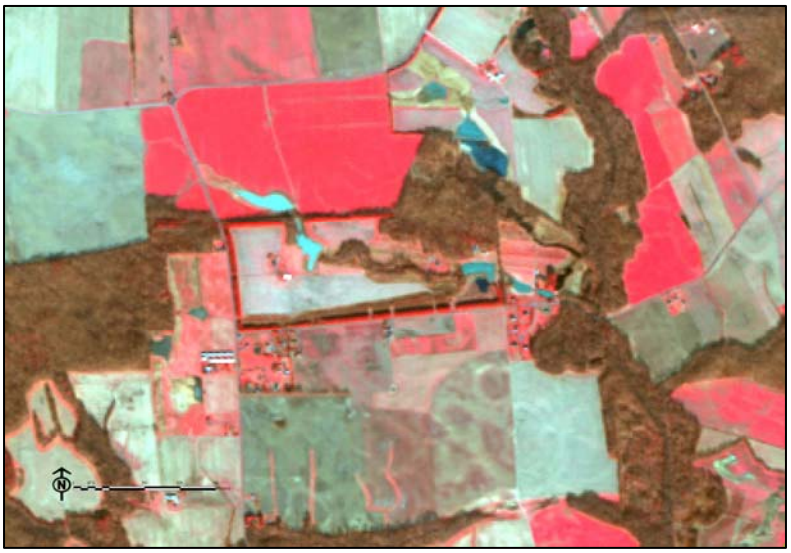
Objectives

- Estimate the nutrient uptake efficiency of cover crops and commodity cover crops on a landscape basis, using remote sensing and field sampling
- Evaluate the effect of agronomic factors on cover crop performance (species, planting date, planting method, previous crop, soil fertility)
- Identify and address obstacles to producer adoption of cover cropping practices
- Incorporate results into water quality modeling efforts by the Conservation Effects Assessment Project

Biomass Sampling

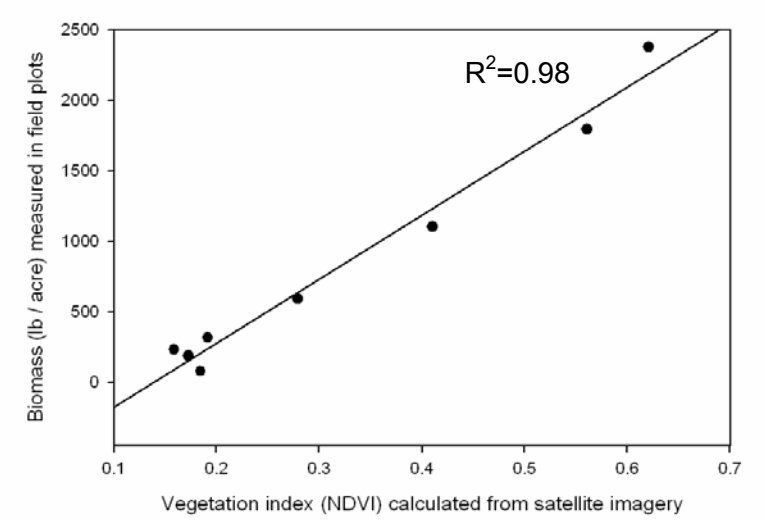
On-farm sampling of a subset of cover cropped fields (calibration data). Measurements include cover crop biomass, nitrogen content, chlorophyll content, and residual soil nitrogen.

Satellite Imagery



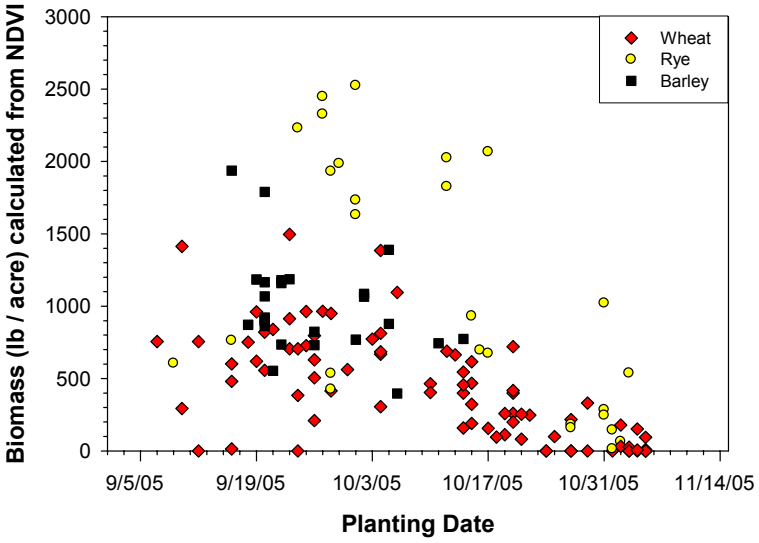
Close-up of a December satellite image with apparent differences in plant biomass attributable to variation in land use. Red indicates growing vegetation (e.g., cover cropped fields), brown deciduous forest, and grey-blue bare fields.

Satellite Data versus Biomass Measurements



The vegetation index (NDVI) calculated from satellite imagery was well correlated to on-farm biomass measurements, indicating that the method

Factors Influencing Biomass



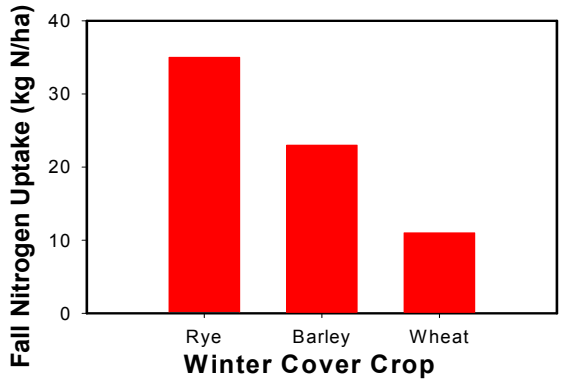
Cover crop biomass in fields participating in state cover crop cost share programs. Cover crop success was influenced by species choice (symbol color), planting date (x-axis), and planting method (not shown), with early-planted drilled rye crops achieving the greatest nutrient uptake.

Findings

- An innovative combination of remote sensing and field sampling was successfully employed to derive real-time estimates of cover crop biomass production and nitrogen uptake on farms participating in cover crop cost share programs designed to protect Chesapeake Bay water quality.
- Planting date significantly influenced fall biomass production, with early-planted cover crops sequestering up to 60 lb/acre of nitrogen. Late-planted cover crops had much less biomass.
- Rye exhibited the highest average fall nitrogen uptake (35 lb/acre) compared to barley (23) and wheat (11).
- Under dry soil conditions in 2005, planting methods associated with better seed-soil contact (drilled; broadcast and disked) outperformed aerial seeding.
- Use of this efficient monitoring technology for cover crops will allow program and watershed managers to optimize implementation of this important best management practice at watershed and regional scales.

Conclusions

- This innovative methodology allows the direct evaluation of cover crop productivity in the agricultural landscape.
- Effects of species choice, planting date, and planting method on cover crop success were apparent, indicating the potential to select the most efficient cover crop implementation strategies.
- Results of our research will be transferred directly to state and federal programs, to achieve a more effective implementation of cover crop programs for water quality protection.



Comparison of average fall nitrogen uptake by different cover crops

Further Research

- Airborne hyperspectral data and Landsat imagery are being investigated as additional remote sensing tools for this project.
- On-farm strip trials were established at four locations in the fall of 2006 to compare the effect of commodity cover crops vs. conventional small grain management (+/- fall fertilization) on wheat biomass production, nutrient uptake, yield, and profitability.
- The methodology developed by this project will also be used to evaluate the implementation of bioenergy cover crops with potential for multiple environmental benefits (nutrient capture, ethanol production, crop diversification).

Partners

Local farmers on the Eastern Shore

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