Web-Based Spatial Poultry Litter Decision Support System for Optimal Nutrient Management Planning in Alabama

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OUTLINE

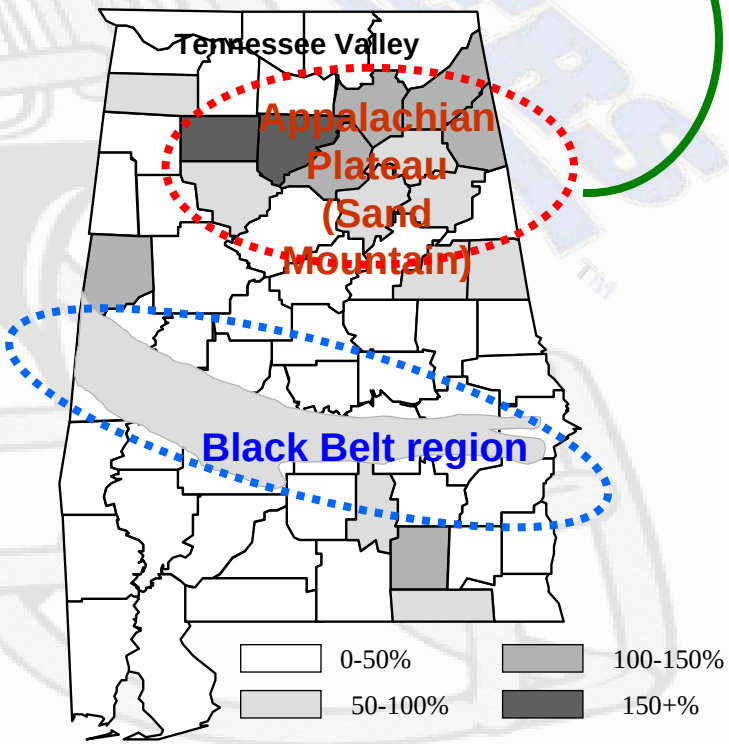
- Introduction
- Goal
- Nutrient Management Planning and P-Index
- ArcGIS Implementation
- Web-Based PLDSS
- PLDSS implementation in ArcGIS/Web
- Benefits
- Parting thoughts

INTRODUCTION

- Alabama ranks in top three in broiler production
- More than 1 billion birds with receipts of $2.41 billion
- About 500 CAFOs and 4000 AFOs; about 12,000 chicken houses
- Broiler litter production – 1.8 million tons/year
- Comprehensive Nutrient Management Plan (CNMP) – required for CAFOs; developed by County Conservation Districts
- AFO operators receive little help with their nutrient management planning

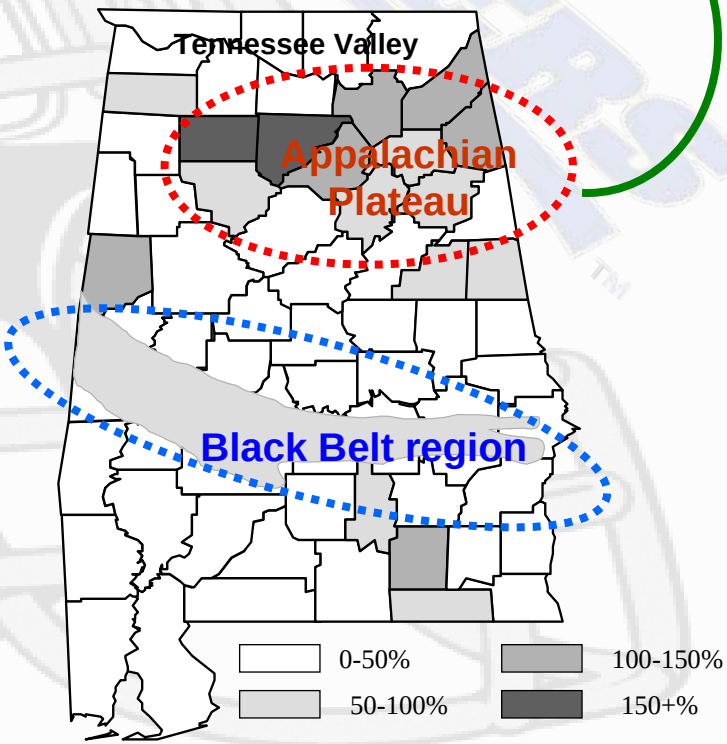
INTRODUCTION

- Most of the poultry production occurs in 5 counties in Appalachian Plateau (Sand Mountain region)
- Litter application at N rate has lead to build up of P in many pastures/hay fields
- Other pastures, hay, and cropland fields can still utilize poultry litter
- Appalachian Plateau region suffers from excessive nutrients application
- Black Belt region suffers from poor soil fertility in pasture



INTRODUCTION

- **Main Issues**
  - AFOs don't receive any help with nutrient management planning
  - Over-application of litter in concentrated production area
  - Sub-optimal transportation of litter
  - Continued (often increasing) threat to water quality in production area
  - Sub-optimal utilization of litter in nutrient deficit areas



GOAL

Develop a web-based spatial PLDSS for optimal management of poultry litter in Alabama

- Provides web-based nutrient management planning and P-index calculations for AFOs (and CAFOs)
- A spatial bulletin board to post litter availability and needs
- Conducts transportation analysis for cost-effective transportation of litter
- Keeps searchable record of all litter applications
- Provides a easy to use web-interface for farmers and CAWVs – give control in the hands of farmers

Alleviate water quality problems in the Appalachian Plateau Region and poor soil fertility problems in the Black Belt Region

Nutrient Management Planning

- USDA and EPA strategy to alleviate water quality and public health concerns arising from CAFOs/AFOs
- Alabama's NMP
  - Estimate poultry litter and compost production
  - Determine nutrient value of litter and compost
  - Map and calculate land area for spreading
  - Determine target crops and nutrient needs (N, P, and K)

P-Index

- **P-Index**
  - **Tool used to assess the selected application site and management practices with regard to the potential risks posed by phosphorus movement to near by surface waters**
  - **Indicates poultry litter application rates based on site vulnerability for P transport**
    - **Nitrogen rate (of crop needs)**
    - **3 x P (of crop needs)**
    - **2 x P (of crop needs)**
    - **1 x P (of crop needs)**
    - **No application allowed**

PLDSS/Modules

- **Spatial Bulletin Board**
  - Post litter availability and litter needs
- **Spatial Data Input Module**
  - Facilities to add poultry house, fields, and spreadable areas
  - Associated attributes
- **Poultry Litter and Compost Production Module**
  - Estimate poultry litter and compost production based on operation
  - Determine nutrient values of litter and compost
- **NMP/P-Index Module**
  - Helps develop simple NMP and P-index on a field-by-field basis
- **Land Application Module**
  - Allows record keeping of all litter activities and calculate excess litter

PLDSS/Modules

- **Transportation Analysis Module**
  - Helps figure out most effective (economical) transportation strategy
- **Database Management Module**
  - Database search, data management, and data analysis of all litter application activities
  - Record keeping

PLDSS/Framework

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NMP/P-index and Litter Application Modules

- Create NMP and calculate P-index
- Create record of all litter applications
- Calculate excess litter

Litter and Compost Production Module

- General information
- Total litter produced
- Total compost produced
- Nutrient Value

Transportation Module

- Finding the best route
- Finding the closet route
- Finding the optimal land application areas
- Transportation to fields in BlackBelt

PLDSS

- Graphical User Interface
- ArcObjects with VBA

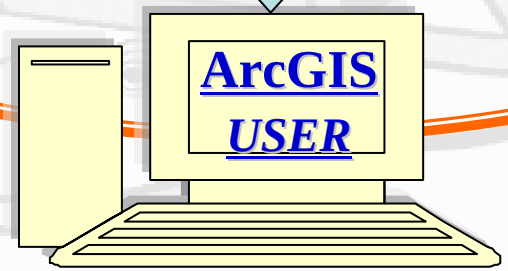
Integrated

Spatial Data Input Module

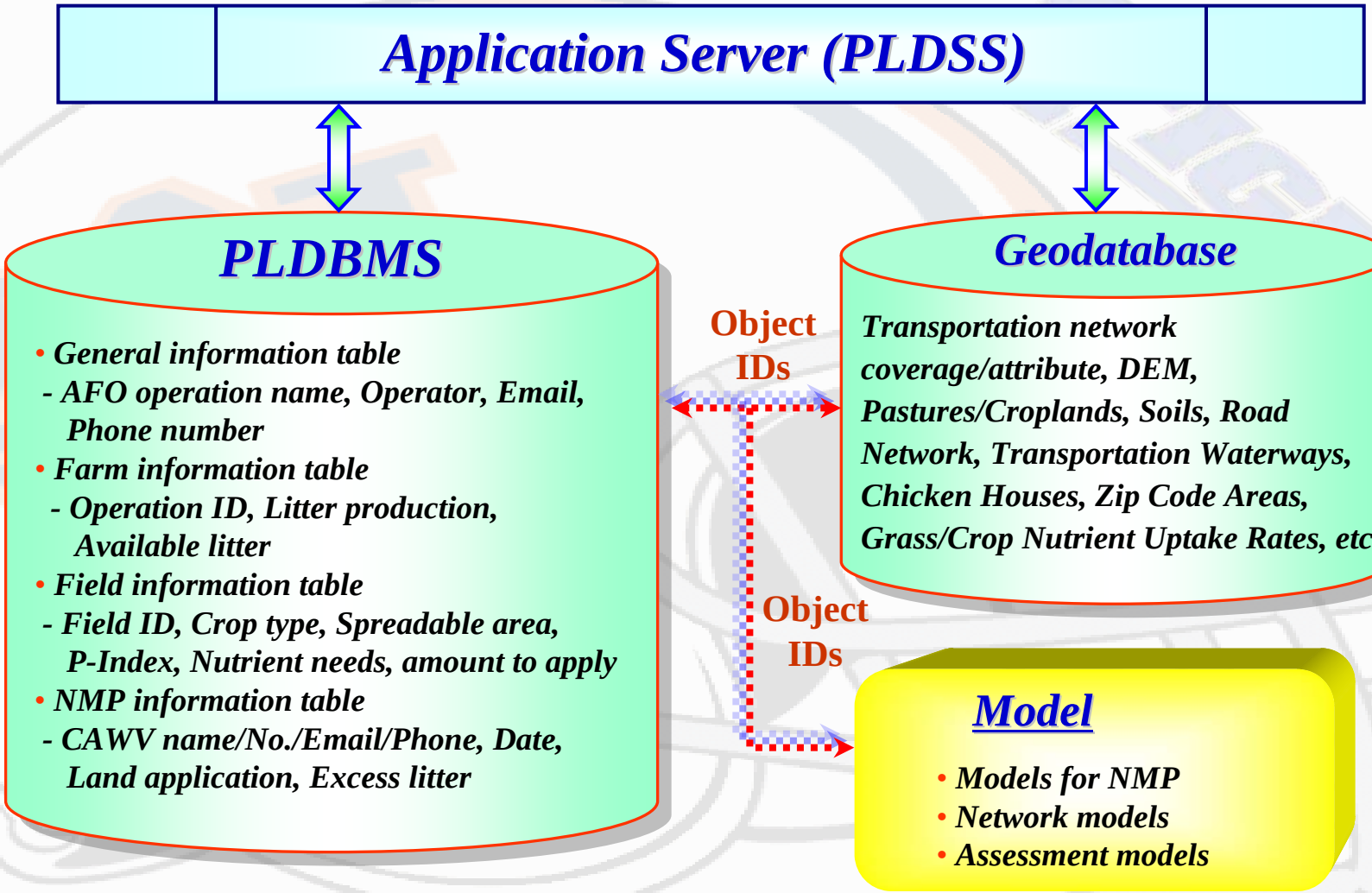
- Poultry House
- Fields and spreadable area
- Attributes

PLDBMS

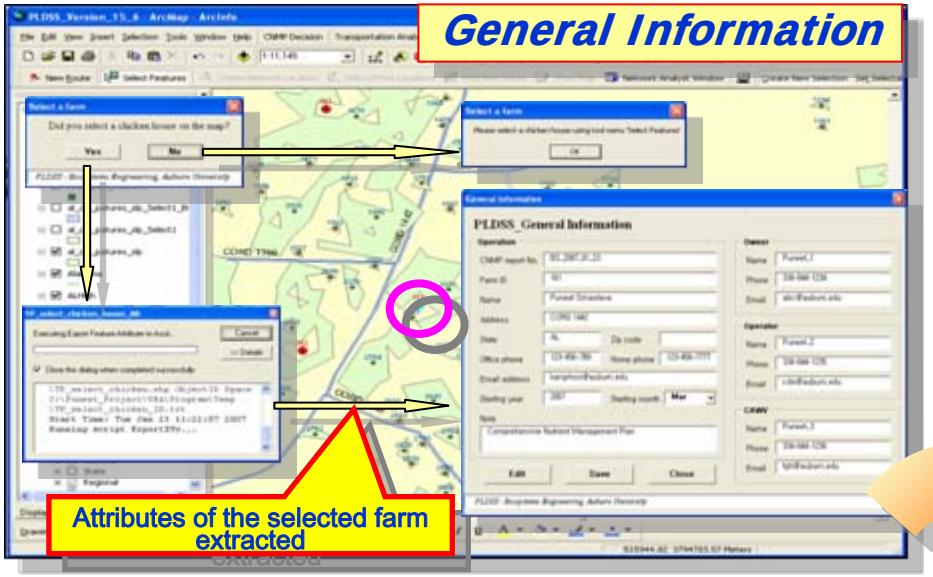
- MySQL Database
- Database search module
- Database management module

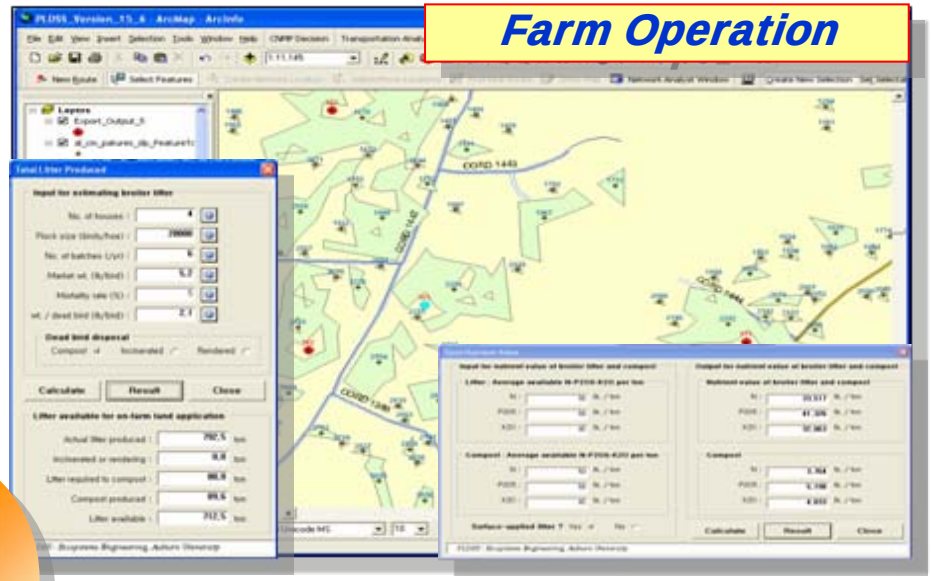


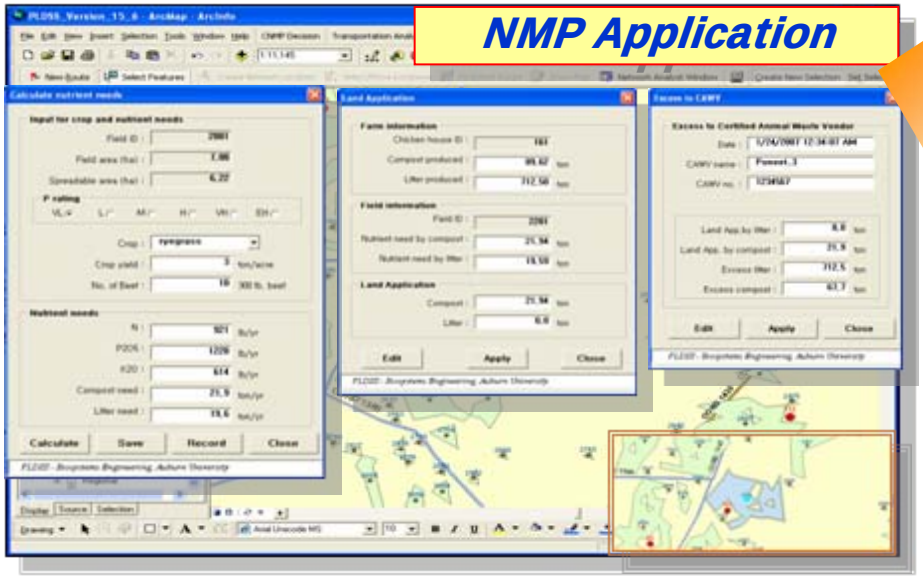
PLDSS/Database

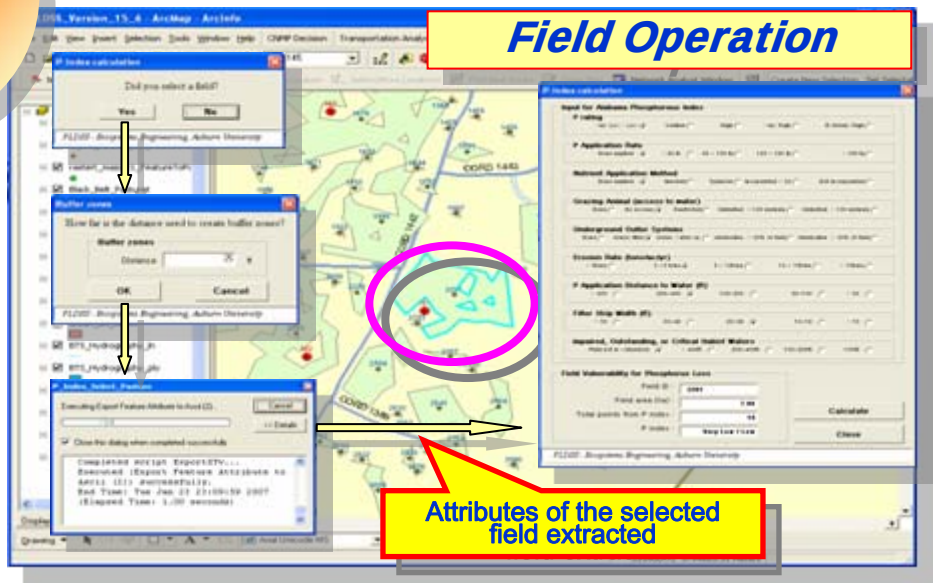


ArcGIS Implementation/Dialog Boxes

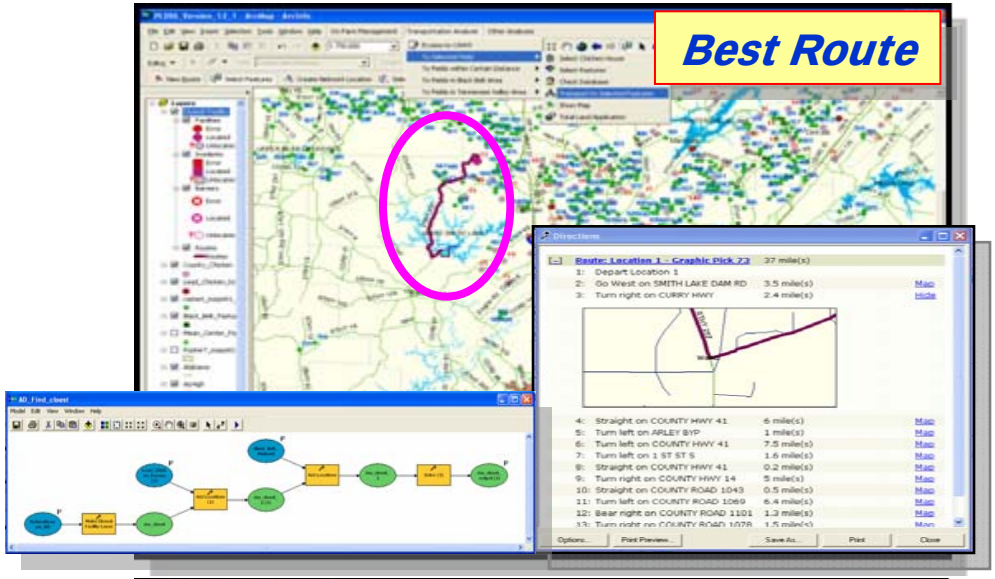


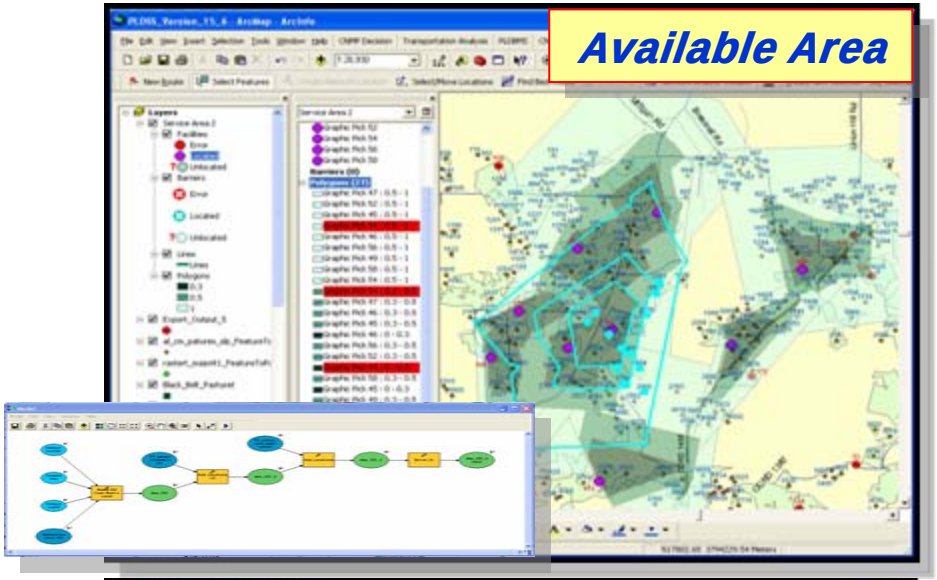


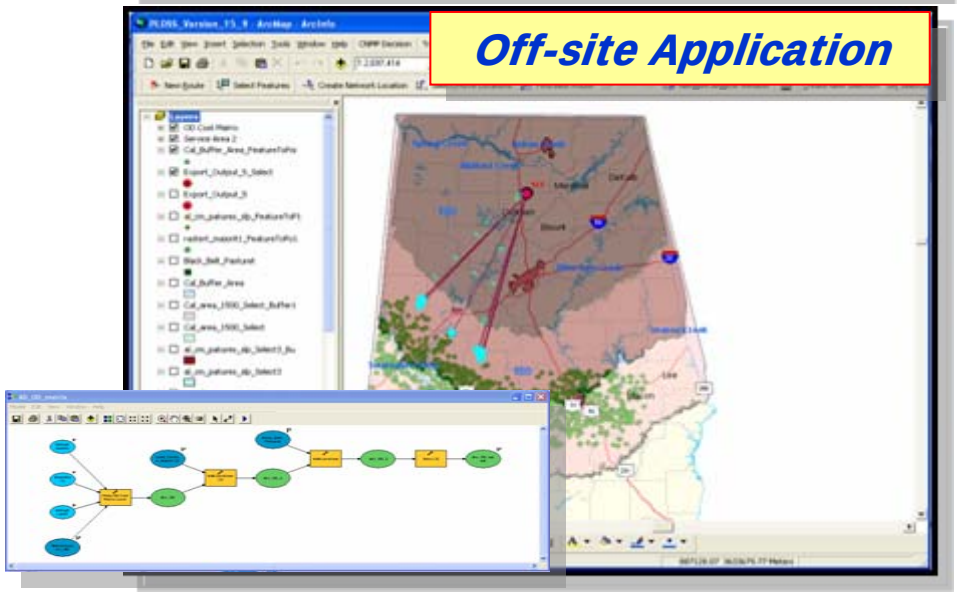


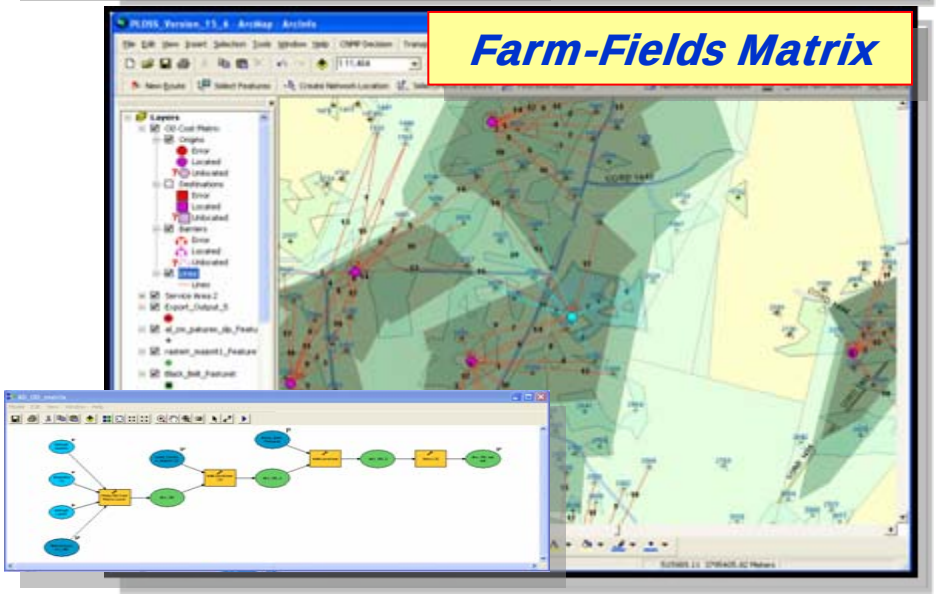


ArcGIS Implementation/Transportation Analysis



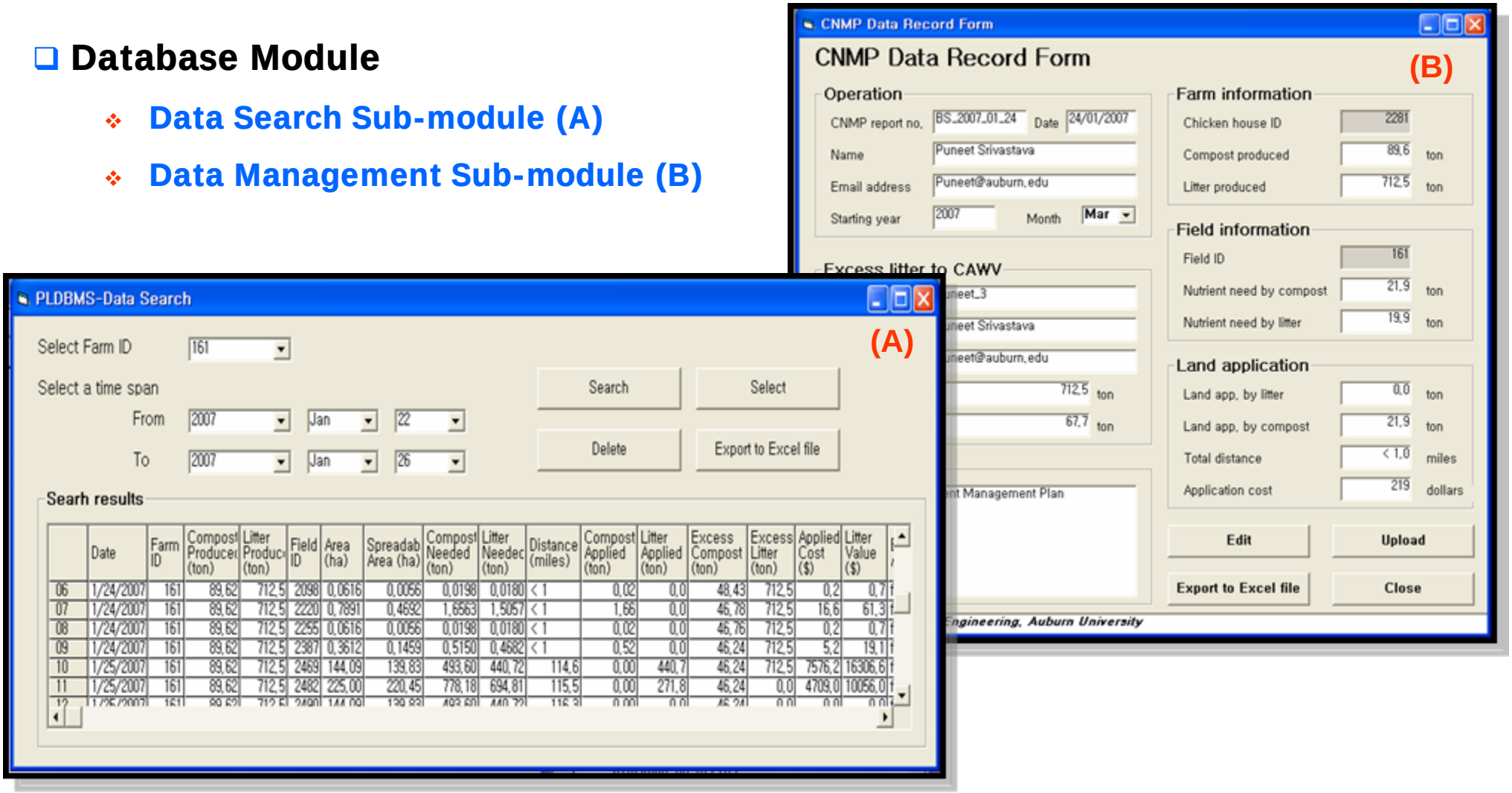






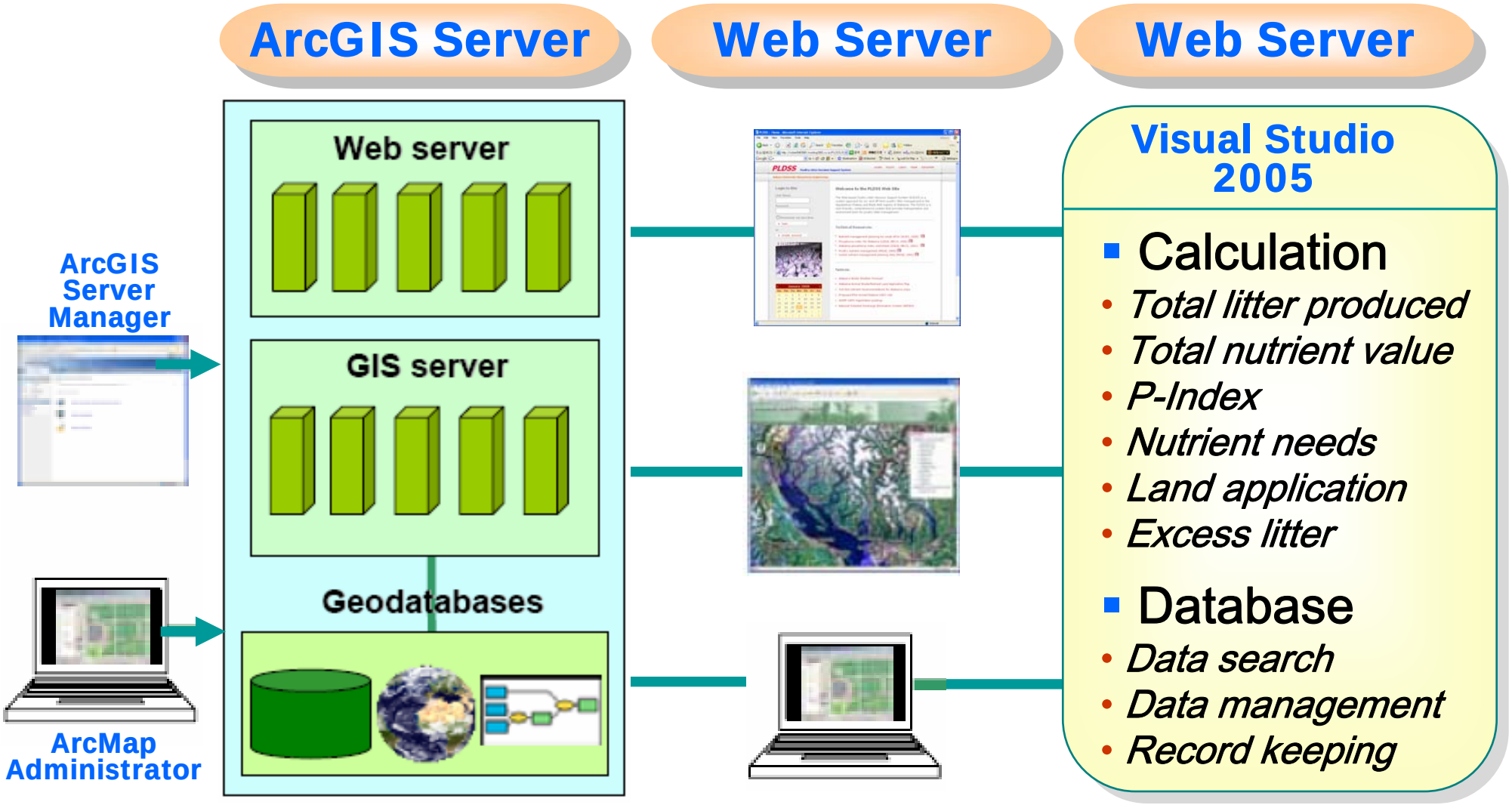
ArcGIS Implementation/Transportation Analysis

- **Database Module**
  - Data Search Sub-module (A)
  - Data Management Sub-module (B)



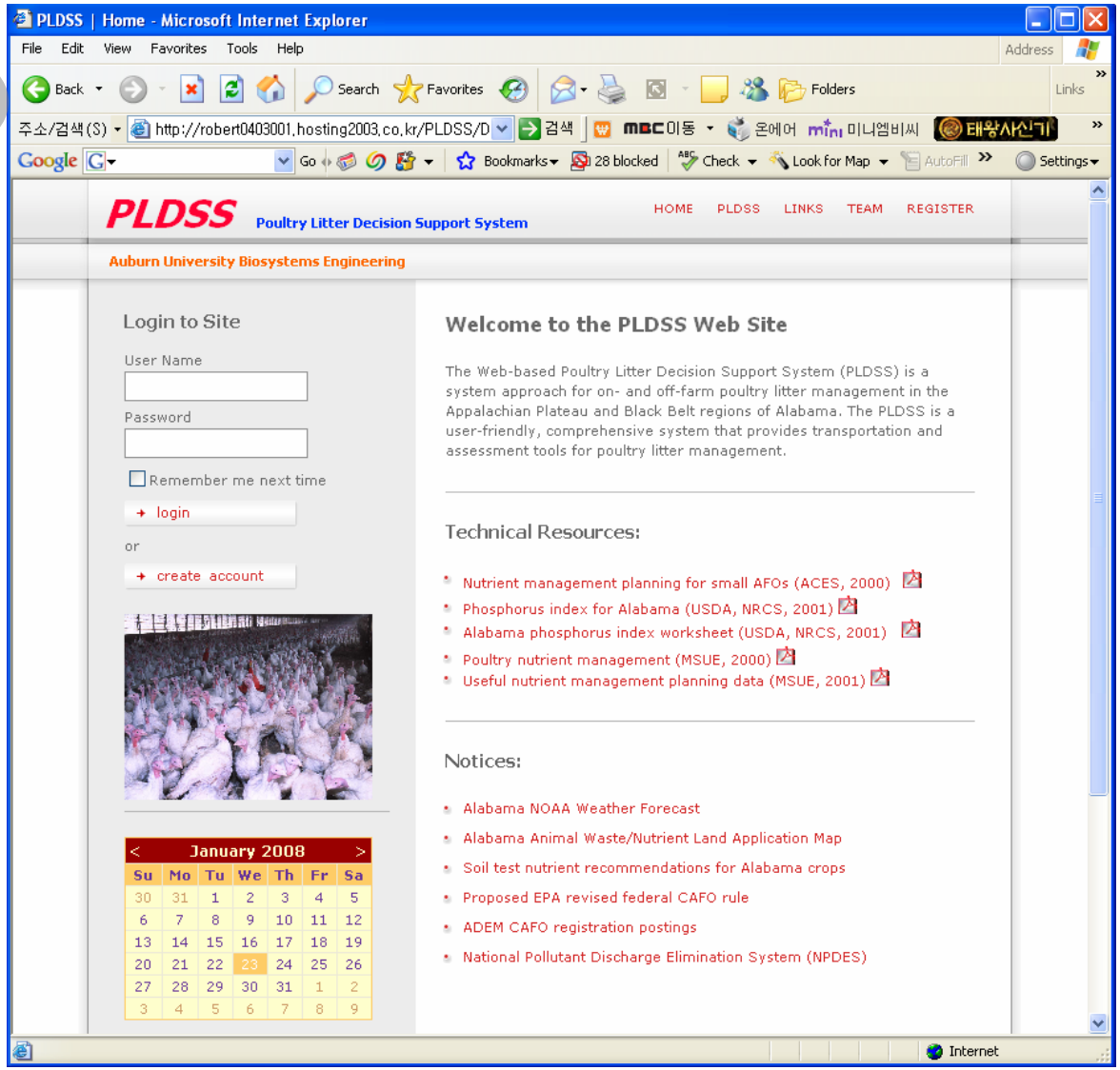
Kang, M.S., P. Srivastava, T. Tyson, K. Yoo, J. Fulton, and W.F. Owsley. 2007. GIS-based decision support system for poultry litter management. Computers and Electronics in Agriculture (Accepted with revision)

Web-based Application



Web-based Application

What's the PLDSS

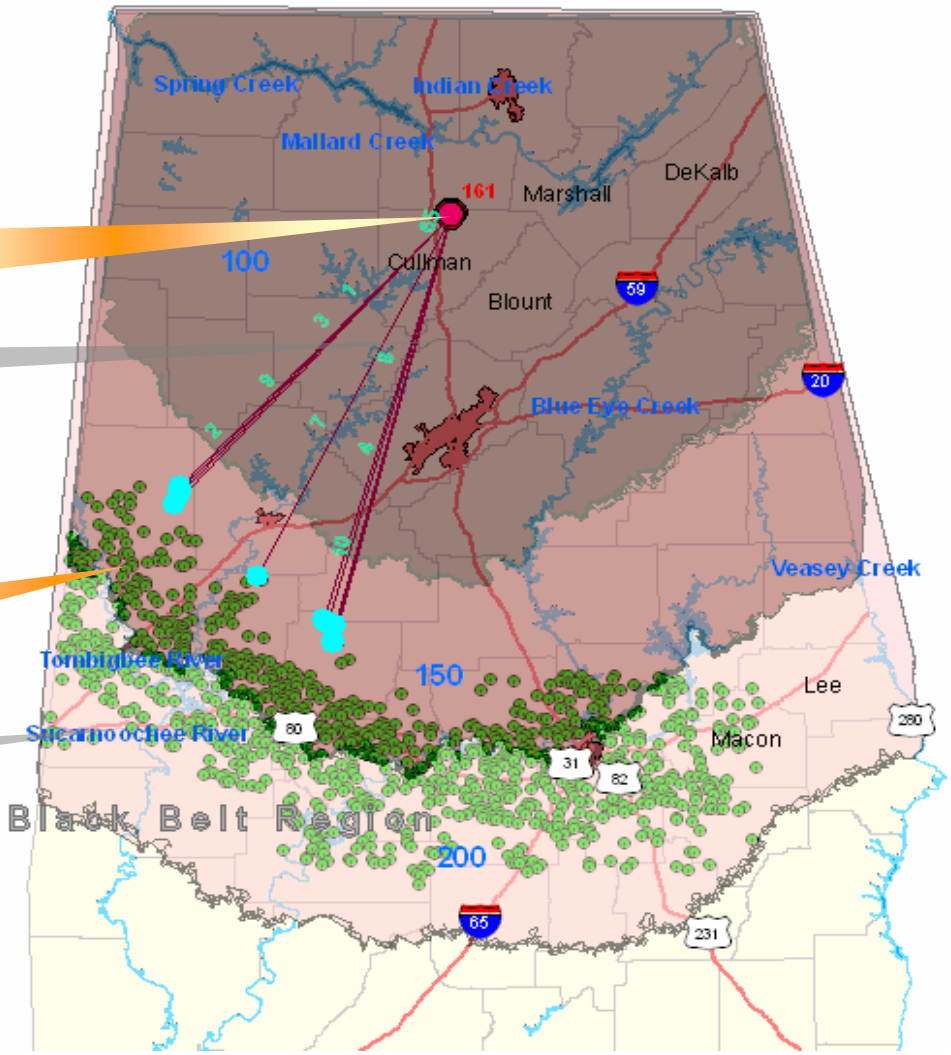


Web-based Application

Spatial Bulletin Board

Available
Amount: 700 tons
N: 60 lb/ton
P2O5: 60 lb/ton
K2O: 40 lb/ton
Name
Contact Information

Litter Needed
Amount: 200 tons
N: 50 lb/ton
P2O5: 50 lb/ton
K2O: 40 lb/ton
Name
Contact Information



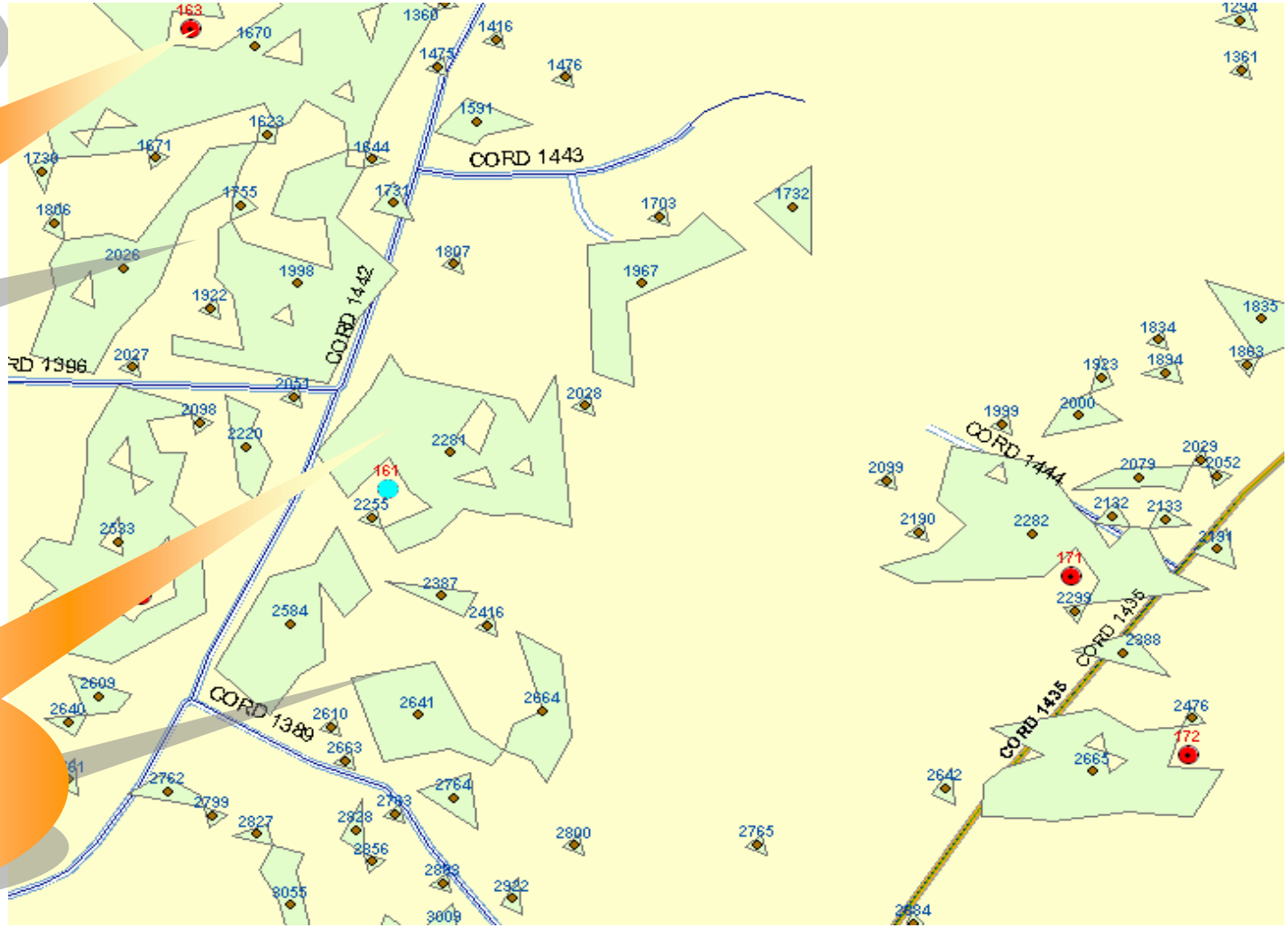
Nutrient Equivalency Calculator

Web-based Application

Spatial Input Module

Tools for adding and editing locat ion of poultry houses and associated attributes

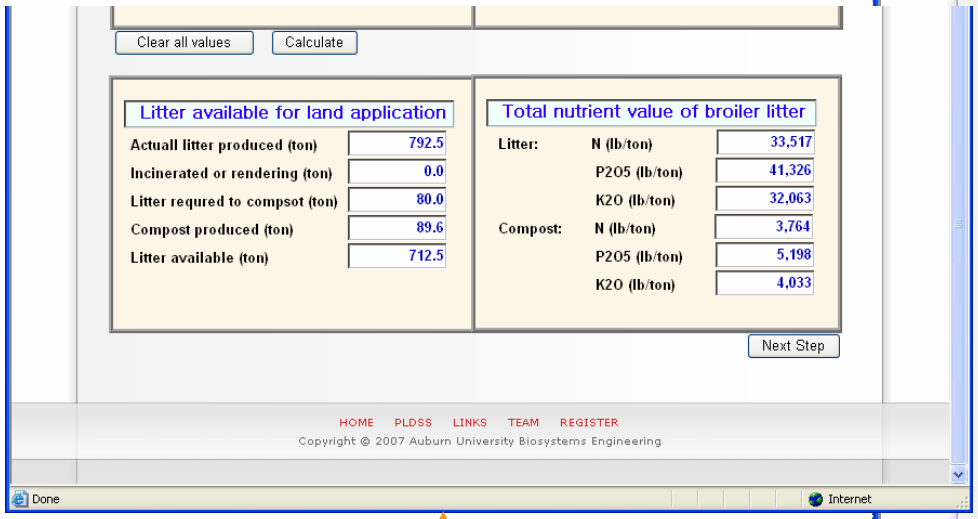
Tools for adding and editing fields and spr eadable areas and a ssociated attributes

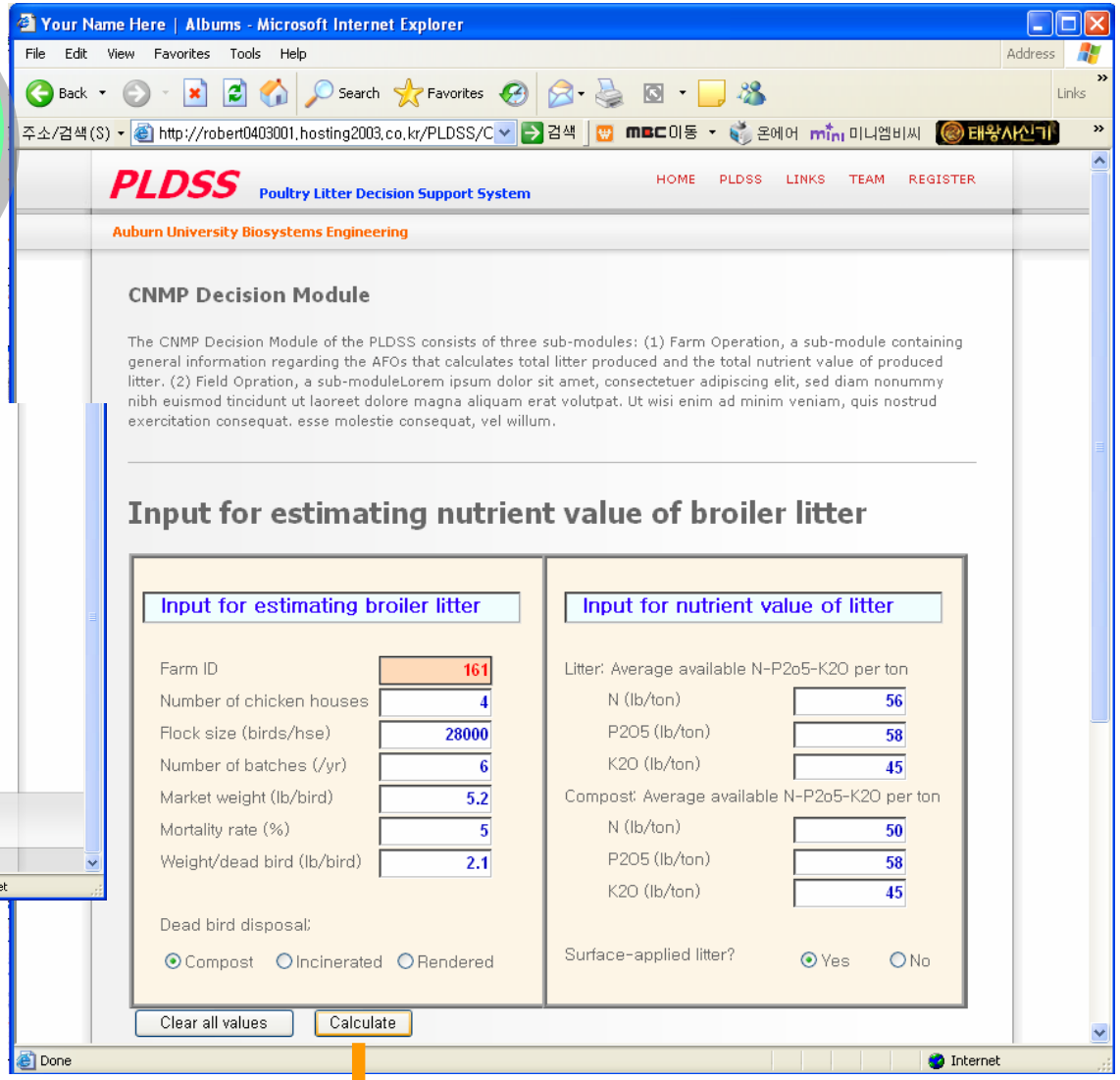


Web-based Application

Litter and Compost Production Module

Input and result for estimating litter production, compost production and nutrient value

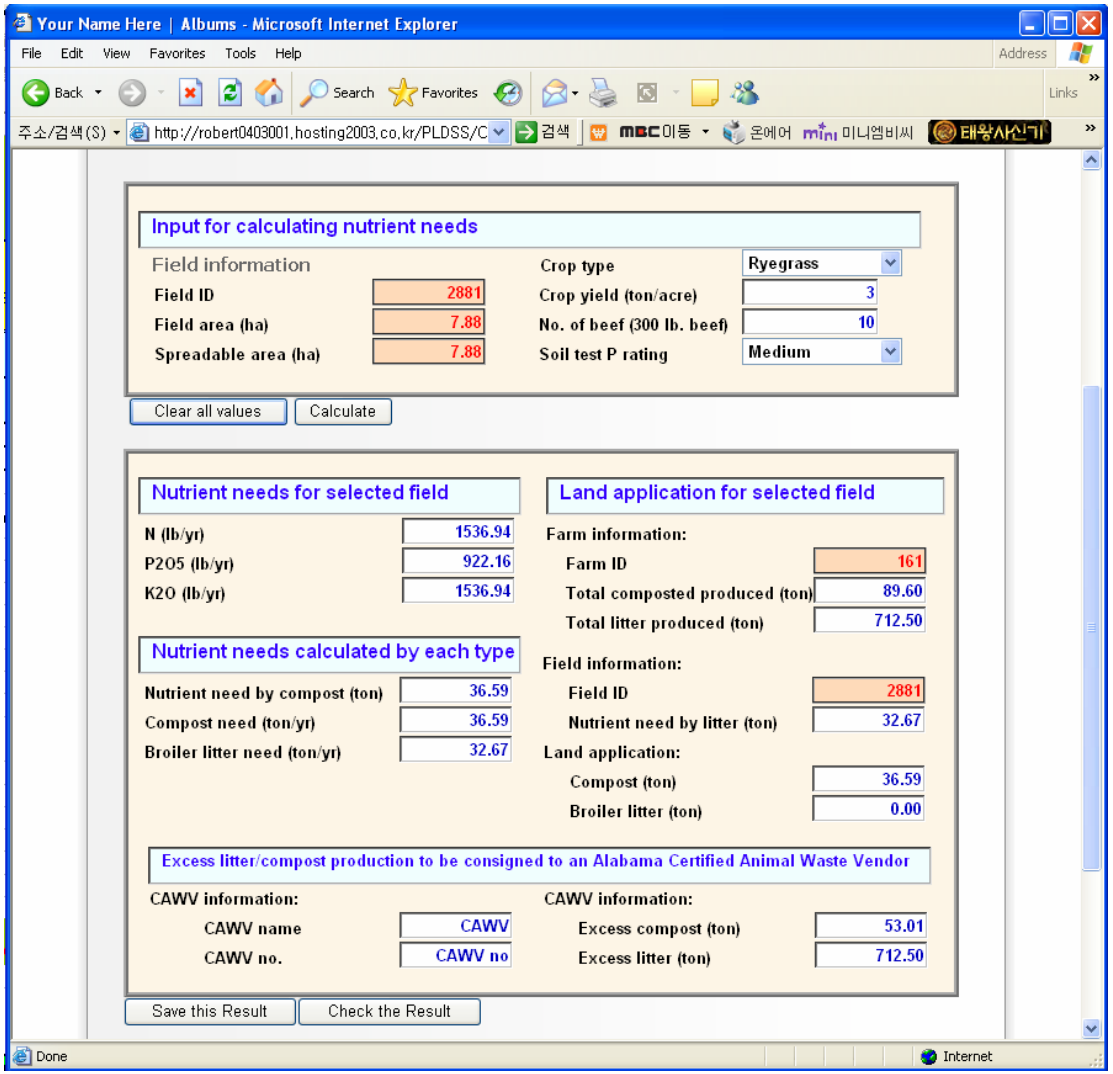




Web-based Application

NMP/P-Index Module

NMP for each spreadable area



Web-based Application

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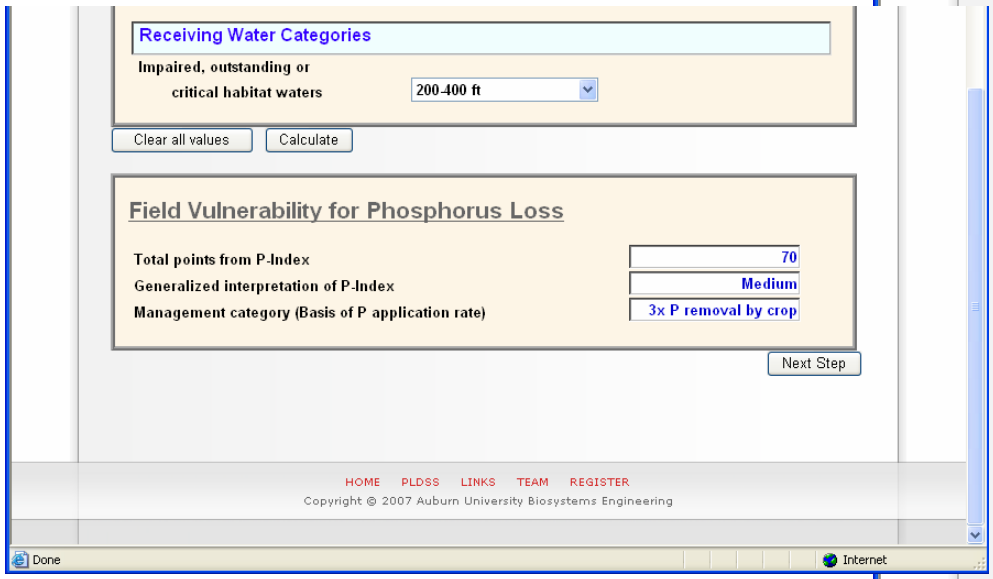
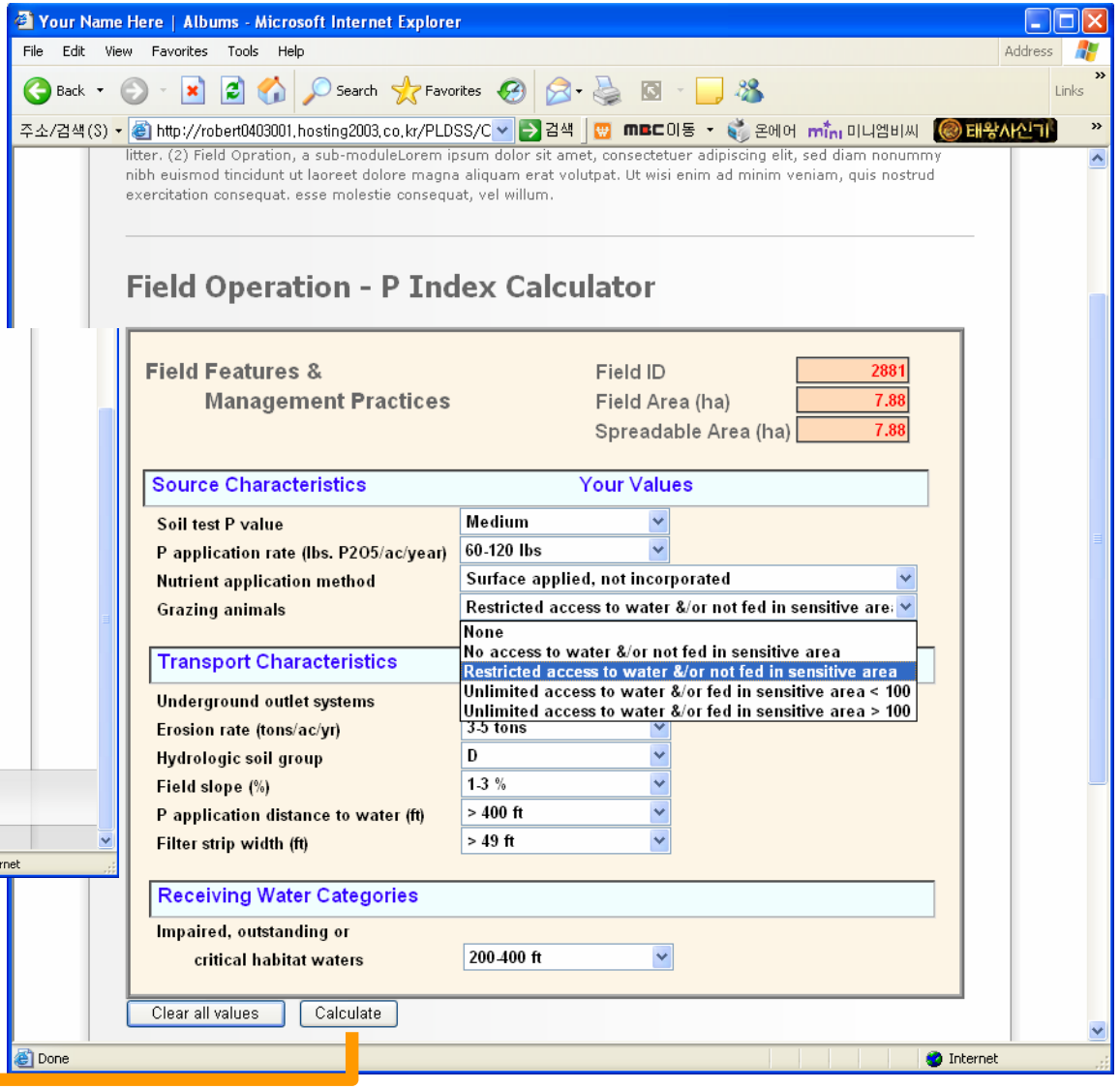
NMP/P-Index Module

P-index for each spreadable area



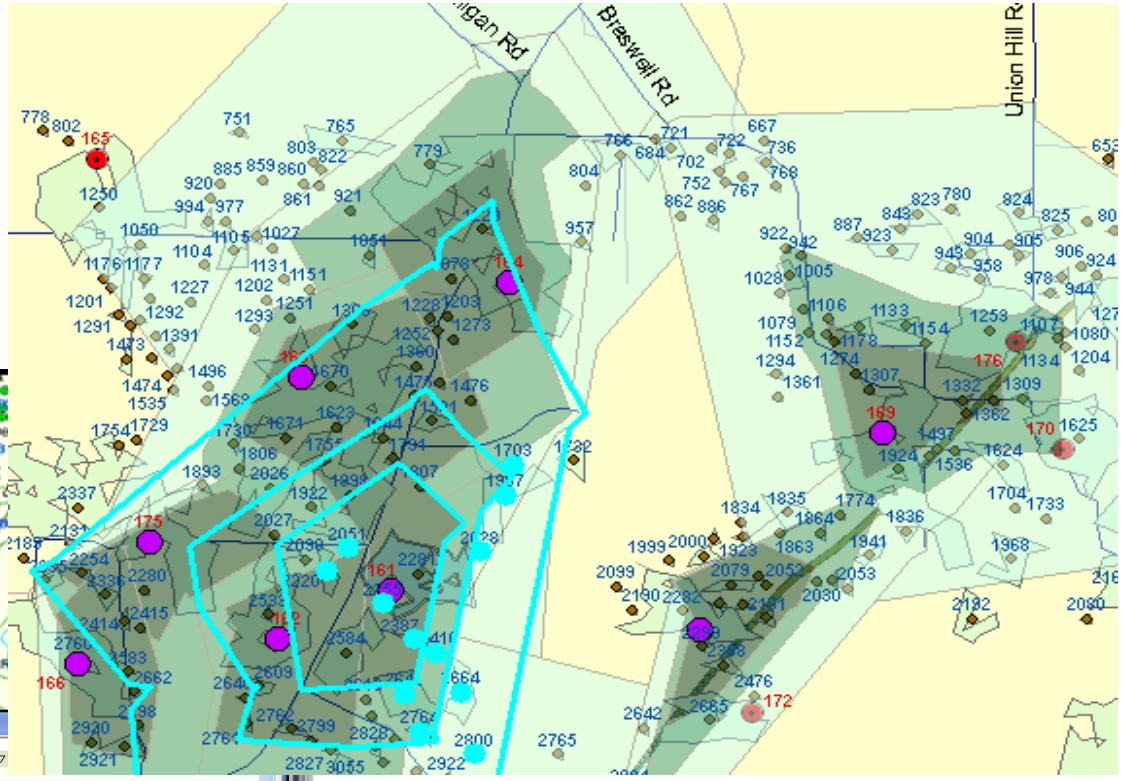


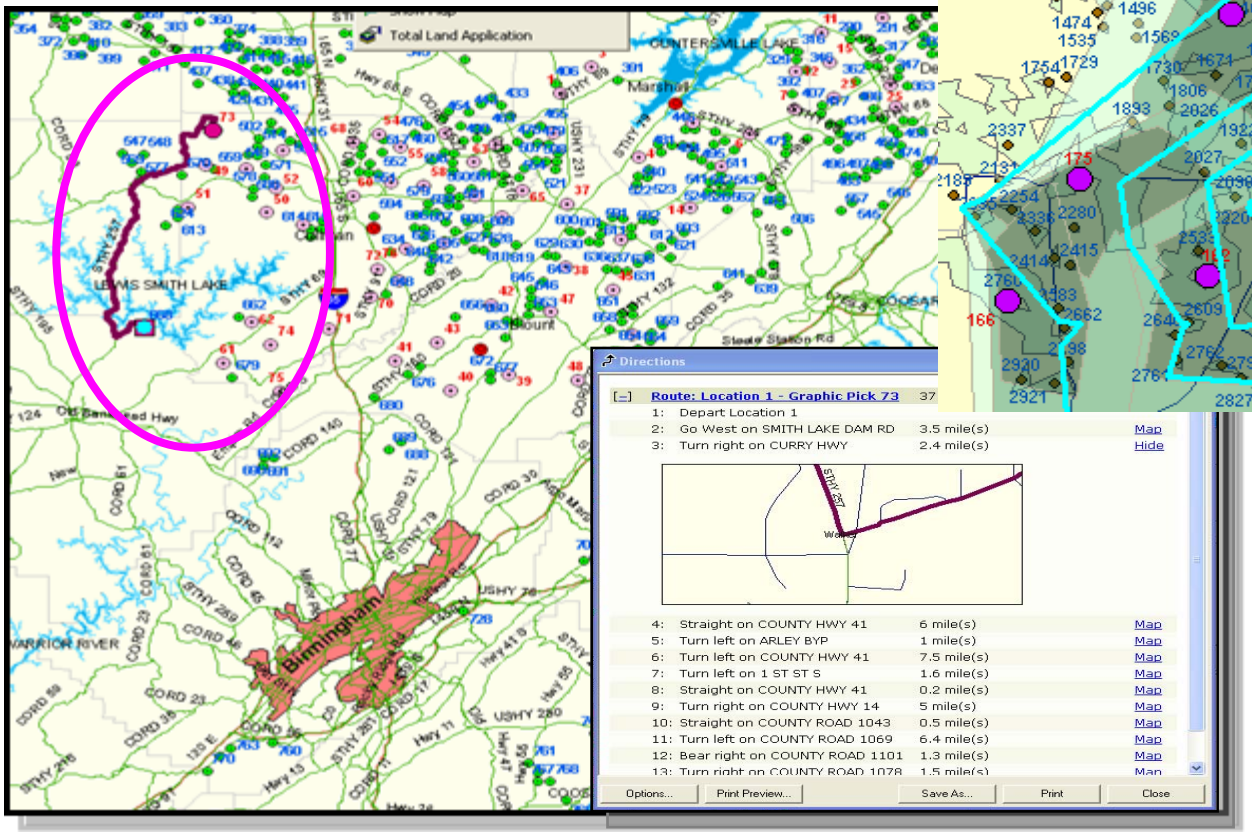
Web-based Application

Transportation Module

Most economical route

Potential transportation areas





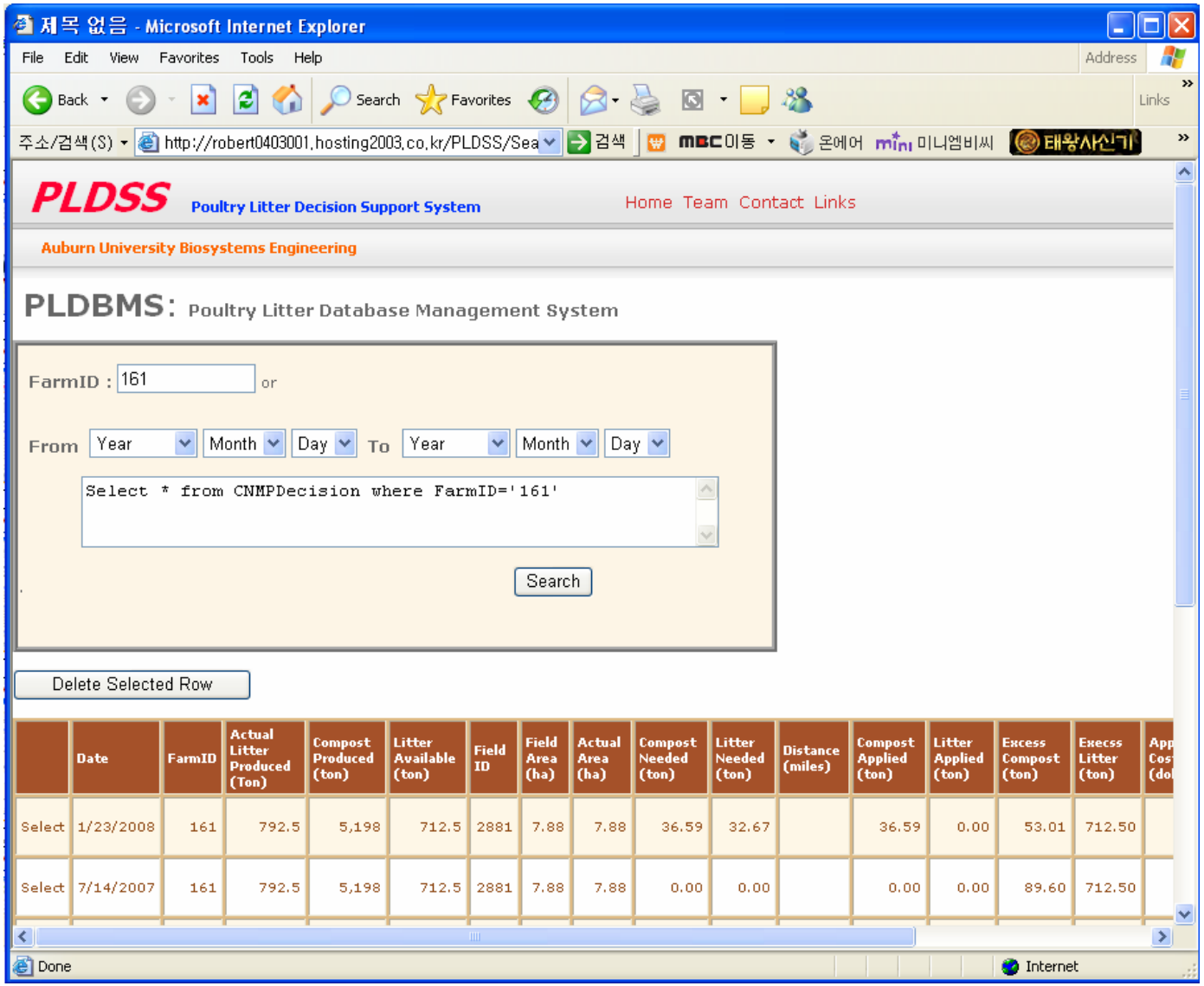
Web-based Application

Database Management Module

Check data

Data search

Data management



	Date	FarmID	Actual Litter Produced (Ton)	Compost Produced (ton)	Litter Available (ton)	Field ID	Field Area (ha)	Actual Area (ha)	Compost Needed (ton)	Litter Needed (ton)	Distance (miles)	Compost Applied (ton)	Litter Applied (ton)	Excess Compost (ton)	Execss Litter (ton)	App Cos (do
Select	1/23/2008	161	792.5	5,198	712.5	2881	7.88	7.88	36.59	32.67		36.59	0.00	53.01	712.50	
Select	7/14/2007	161	792.5	5,198	712.5	2881	7.88	7.88	0.00	0.00		0.00	0.00	89.60	712.50	

BENEFITS

Appropriate application of web-based PLDSS will

- Protect water quality in the Appalachian Plateau regions
- Minimize transportation costs
- Improve soil fertility in the Black Belt region
- Help with nutrient cycling so that nutrients in poultry litter is land-applied to corn fields, and corn is then fed to chickens, thus maintaining a nutrient balance.
- Help AFO operators and farmers to develop NMP and distribute excess litter
- Result in increased utilization of NMP/P-Index
- Provide a user interface for poultry litter management through a web browser

=> Hence, this study will help alleviate water quality problems in the Appalachian Plateau region and poor soil fertility problems in the Black Belt region

BENEFITS

Facilitating other interesting analyses

- Provide a database (spatial and temporal) of litter application to pastures, hay fields, and cropland fields
- Will help evaluate the watershed level water quality protection provided by P-index
- Will help truly quantify watershed-level water quality impact (nutrient, pathogens, etc.) of long-term animal waste application

PARTING THOUGHTS

- Poultry (broiler) litter needs to be transported from concentrated production areas for
  - Water quality protection
  - Nutrient management
  - Bioenergy production
- We need to allow CAWVs and AFO operators to handle their own NMP through web browser
- Litter transportation costs needs to be optimized for litter transportation to work