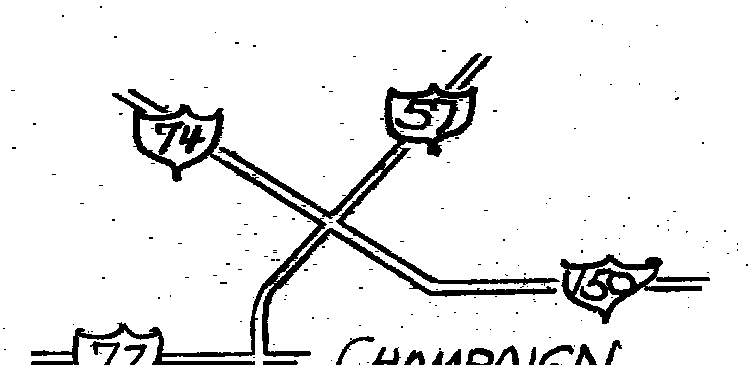
Section 4

Study Site and Measurement Plan for Agricultural Cropland (AGRO), Champaign, Illinois

AGRO

Directions to Site



From Champaign, Illinois

1. Take HWY 57 south of town to County HWY 18 (9 km south of junction with HWY 72)
2. Turn left and drive east on HWY 18 to County Rd. 900E (0.8 km)
3. Turn right on Rd. 900E and drive south to County Rd. 900N (1.5 km)
4. The BigFoot intensive sampling grid straddles County Rd. 900E about 175 m south of the intersection with County Rd. 900N

AGRO

Major Cover Types

Major cover types encountered in BigFoot study area

1. Corn
2. Soybean
3. Fallow

Cover type qualifiers

1. Time of planting

Cover type descriptions

Corn

Acronym:	CORN
Species:	corn
Architecture:	closed-canopy row crop growing >2 m tall by late summer
Comments:	Roughly half of the row crops planted on the site will be corn.

Soybean

Acronym:	SOYB
Species:	soybean
Architecture:	closed-canopy row crop growing 50 to 75 cm tall by late summer
Comments:	Roughly half of the row crops planted on the site will be soybean.

Fallow

Acronym:	FALO
Species:	hay, grasses
Architecture:	grassland of variable height
Comments:	Only a small proportion of the site (<5%) is fallow.

Cover type qualifiers and additional comments

The BigFoot extensive research plots will be stratified among many farms (see Figure 4.1), each of which may have unique planting and harvest dates. The timing of planting and harvest for each study plot will be recognized as a cover type qualifier since crop phenology (especially early in the season) influences vegetation cover, f_{APAR}, and LAI.

Figure 4.1. Land ownership at AGRO study site

1
4
4
6
1
2
3
5
4
2
2
3
3
1
6
TOLONO
Janice L. Fisher
Claude J. Fisher
Paul Mahorry
Gerald R
Judy E Henson
Stanley Reifsteck
Edna M. Dragoo
Gladys T. Mathews
Marcella Graves
Richard Reifsteck
Hatch Trust
Carl Krumm
Lowell J. Schroeder
Margaret Woodworth
Jack A. Hutchins
Edna B. Kelley
Doris E. Burnell
Harry Bretz
Orville E. Crist
Robert W. Bretz
Berty J. Rudd
Wm. E. Berbaum
Margaret Graves
Grand Prairie Co-op
Hoffs Hens
Sherman
Bank of Mahomet
Fin Mgmt
Strunk & Assoc.
Jo Anne & Dale Hollmann
Carl Barnhart
Barnhart
Krumm
Barnhart
Barnhart
Barnhart

AGRO

Plot Placement Rationale

Positioning of intensive sampling grid

The intensive sampling grid will consist of 80 individual plots (25 x 25 m) arranged in a systematic spatial cluster design. The 80-plot grid extends 925 m east to west and 550 m north to south. The purpose of the intensive sampling grid is to provide accurate characterization of vegetation characteristics for the tower footprint and determine the degree and scale of spatial autocorrelation among land cover types.

The intensive sampling grid will be positioned at the AGRO site such that most of the plots will occur in John Reifsteck's farm (NW corner of sec. 22 T18N, R8E). This meant centering the grid N/S in the above-mentioned quarter section. Because the E/W dimensions of the grid do not fit into a quarter section, the grid was shifted west such that grid columns 0, 1, and 2 occur in Roger Woodworth's farm (NE corner of sec. 21 T18N, R8E). County Highway 900E runs N/S evenly between grid columns 2 and 3. Positioning of the intensive sampling grid in this manner will not place any plots too close to the flux tower (nearest plot >50 m away).

Positioning of extensive sampling plots

The extensive sample plots will consist of 20 individual plots (each measuring 25 x 25 m) randomly stratified throughout a 5 x 5 km study area. The extensive sample plots will be used to verify that land cover type-specific characteristics hold over multi-kilometer distances and to address surface features that influence the 25-km^2 MODIS surface but are not necessarily present within the tower footprint.

Placement of the extensive plots is somewhat restricted at the AGRO site because all the land is privately owned. The 5 x 5 km study area will be centered on the intensively sampled Reifsteck farm. In addition, we have received permission to work on 11 other farms within the 5 x 5 km study area (see Figures 4.1 and 4.2; Table 4.1). The 20 external plots will be subjectively stratified throughout these farms to maximize the distance between any two plots and the overall extent. Each field plot will be placed just far enough off the access road to avoid edge effect (70 m in most cases).

Figure 4.2. Location of study plots in the AGRO BigFoot study site.

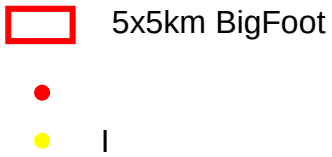


Image produced from USGS digital orthoquad (DOQ).

Table 4.1. AGRO plot locations and descriptions

Plot number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity	Comments
00	389295.40	4429570.60		2	Woodworth farm
01	389320.40	4429570.60		2	Woodworth farm
02	389395.40	4429570.60		2	Woodworth farm
03	389645.40	4429570.60		2	Riefsteck farm
04	389695.40	4429570.60		1	Riefsteck farm
05	389820.40	4429570.60		2	Riefsteck farm
06	389845.40	4429570.60		2	Riefsteck farm
07	389920.40	4429570.60		2	Riefsteck farm
08	390170.40	4429570.60		2	Riefsteck farm
09	390220.40	4429570.60		1	Riefsteck farm
10	389295.40	4429545.60		2	Woodworth farm
11	389320.40	4429545.60		2	Woodworth farm
12	389395.40	4429545.60		2	Woodworth farm
13	389645.40	4429545.60		2	Riefsteck farm
14	389695.40	4429545.60		2	Riefsteck farm
15	389820.40	4429545.60		2	Riefsteck farm
16	389845.40	4429545.60		2	Riefsteck farm
17	389920.40	4429545.60		2	Riefsteck farm
18	390170.40	4429545.60		2	Riefsteck farm
19	390220.40	4429545.60		2	Riefsteck farm
20	389295.40	4429495.60		2	Woodworth farm
21	389320.40	4429495.60		2	Woodworth farm
22	389395.40	4429495.60		2	Woodworth farm
23	389645.40	4429495.60		2	Riefsteck farm
24	389695.40	4429495.60		2	Riefsteck farm
25	389820.40	4429495.60		2	Riefsteck farm
26	389845.40	4429495.60		2	Riefsteck farm
27	389920.40	4429495.60		2	Riefsteck farm
28	390170.40	4429495.60		2	Riefsteck farm
29	390220.40	4429495.60		2	Riefsteck farm
30	389295.40	4429345.60		2	Woodworth farm
31	389320.40	4429345.60		2	Woodworth farm
32	389395.40	4429345.60		2	Woodworth farm
33	389645.40	4429345.60		2	Riefsteck farm
34	389695.40	4429345.60		2	Riefsteck farm
35	389820.40	4429345.60		1	Riefsteck farm
36	389845.40	4429345.60		2	Riefsteck farm
37	389920.40	4429345.60		2	Riefsteck farm
38	390170.40	4429345.60		1	Riefsteck farm
39	390220.40	4429345.60		2	Riefsteck farm
40	389295.40	4429245.60		2	Woodworth farm
41	389320.40	4429245.60		2	Woodworth farm
42	389395.40	4429245.60		2	Woodworth farm
43	389645.40	4429245.60		2	Riefsteck farm
44	389695.40	4429245.60		2	Riefsteck farm
45	389820.40	4429245.60		2	Riefsteck farm

Table 4.1 (continued)

Plot Number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity	Comments
46	389845.40	4429245.60		2	Riefsteck farm
47	389920.40	4429245.60		2	Riefsteck farm
48	390170.40	4429245.60		2	Riefsteck farm
49	390220.40	4429245.60		2	Riefsteck farm
50	389295.40	4429220.60		2	Woodworth farm
51	389320.40	4429220.60		2	Woodworth farm
52	389395.40	4429220.60		2	Woodworth farm
53	389645.40	4429220.60		2	Riefsteck farm
54	389695.40	4429220.60		2	Riefsteck farm
55	389820.40	4429220.60		2	Riefsteck farm
56	389845.40	4429220.60		2	Riefsteck farm
57	389920.40	4429220.60		2	Riefsteck farm
58	390170.40	4429220.60		2	Riefsteck farm
59	390220.40	4429220.60		2	Riefsteck farm
60	389295.40	4429145.60		2	Woodworth farm
61	389320.40	4429145.60		2	Woodworth farm
62	389395.40	4429145.60		2	Woodworth farm
63	389645.40	4429145.60		2	Riefsteck farm
64	389695.40	4429145.60		2	Riefsteck farm
65	389820.40	4429145.60		2	Riefsteck farm
66	389845.40	4429145.60		2	Riefsteck farm
67	389920.40	4429145.60		2	Riefsteck farm
68	390170.40	4429145.60		2	Riefsteck farm
69	390220.40	4429145.60		2	Riefsteck farm
70	389295.40	4429020.60		2	Woodworth farm
71	389320.40	4429020.60		2	Woodworth farm
72	389395.40	4429020.60		2	Woodworth farm
73	389645.40	4429020.60		2	Riefsteck farm
74	389695.40	4429020.60		1	Riefsteck farm
75	389820.40	4429020.60		2	Riefsteck farm
76	389845.40	4429020.60		2	Riefsteck farm
77	389920.40	4429020.60		2	Riefsteck farm
78	390170.40	4429020.60		2	Riefsteck farm
79	390220.40	4429020.60		1	Riefsteck farm
80	389449.76	4431831.61		2	Riefsteck 9 SE
81	389317.63	4431555.49		2	Riefsteck 9 SE
82	389649.01	4431261.14		2	Fisher 15 NW
83	389850.40	4431235.15		2	Fisher 15 NW
84	389639.21	4431080.13		2	Fisher 15 NE
85	389178.27	4428900.30		2	Fisher 14 SE
86	389274.53	4428716.25		2	Brewer 23 NW
87	389588.71	4427427.81		2	Stierwalt 23 NE
88	389736.87	4427440.06		2	Brewer 23 SW
89	389454.17	4427069.31		2	Stierwalt 23 SE

Table 4.1 (continued)

Plot Number	Plot center UTM easting*	Plot center UTM northing*	Cover type	Sampling intensity	Comments	
90	389350.62	4427044.78		2	Woodworth	21 SW
91	390429.16	4426795.86		2	Woodworth	21 SW
92	to be determined	to be determined		2	Fisher	22 SW
93	390654.26	4428232.05		2	Fisher	22 SE
94	to be determined	to be determined		2	Stierwalt	28 SE
95	391219.13	4429550.22		2	Stierwalt	28 SE
96	391221.50	4429209.01		2	Brewer	27 NW
97	to be determined	to be determined		2	Brewer	27 NW
98	392021.94	4429528.52		2	Brewer	27 NE
99	392006.37	4429795.91		2	Riefsteck	27 SE
AGRO Base	389521.28	4431541.29				
AGROSEC1	391943.74	4429677.49				
AGROSEC2	390597.37	4429718.91				

* UTM (Universal Transverse Mercator) NAD (North American Datum) 83 zone 16.

AGRO

Sampling Intensity Among Plots

According to the BigFoot sampling design (Figure 4.3), each of the 25 x 25 m plots will be sampled at one of three levels of intensity. At the AGRO site, however, there is no distinction between 2nd- and 3rd-order plots because aboveground biomass equals aboveground productivity. The assignment of sampling intensity among plots is as follows:

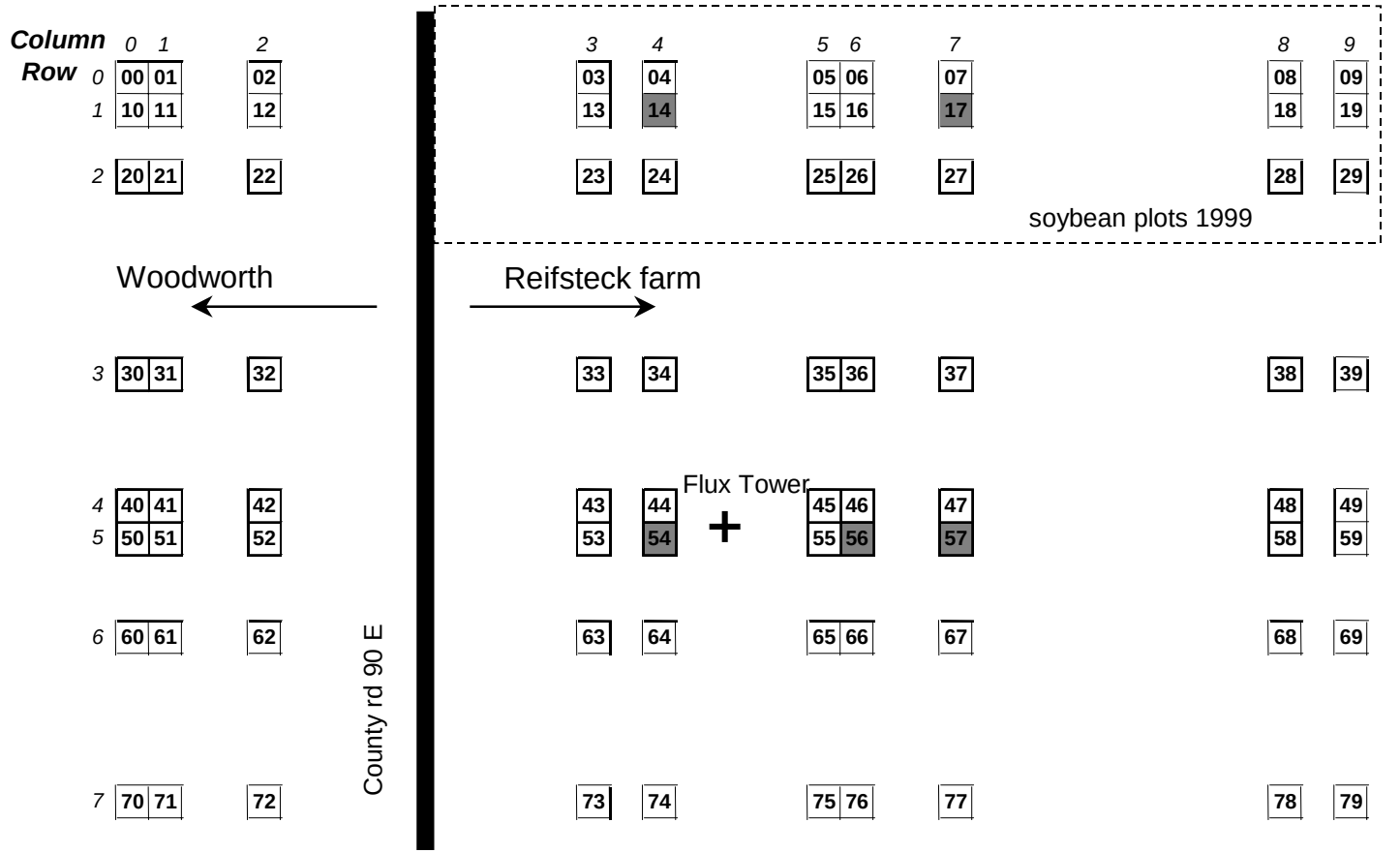
Sampling intensity	Parameters quantified	Number of plots (of 100 total plots)
3rd order	Vegetation cover, species composition, plant biomass, LAI, and f_{APAR}	0
2nd order	NPP_A	94
1st order	Net primary productivity (NPP_A + NPP_B)	6

Assignment of first-order plots

Fine root NPP will be measured in only six plots with first-order status because of the large labor costs. Three separate plots will be sampled to estimate fine root NPP for each of the two major vegetation types. In choosing the first-order plots we will attempt to maximize their independence from each other.

At the AGRO site, three plots will be located in corn crop areas and three plots in soybean crop areas. Five minirhizotrons will be installed in each of the replicate plots. Which of the plots will be first-order plots will not be determined until the row crops are planted.

Figure 4.3. Location of intensive study plots surrounding AGRO flux tower.



Flux Tower: 389,745 E 4,428,918 N (UTM NAD 27; zone 16)

Plot 00 center: 389,297.11 E 4,429,358.84 N

□ 2nd-order plots (LAI, f_{APAR}, and NPP_A)

■ 1st-order plots (NPP_B) see sampling intensity subsection

N

MN 01º W 1999

0 100 200 300 m

□ 25 x 25 m plots drawn to scale

AGRO

Vegetation Characteristics to be Measured

Vegetation cover, LAI, f_{APAR}, and aboveground biomass will be estimated for each 25 x 25 m plot; and NPP_A and NPP_B will be estimated for a subset of plots. The diversity of plant growth forms present in the other BigFoot sites makes it necessary to compartmentalize these characteristics into multiple components and apply a unique measurement technique to each. However, the AGRO site is composed of annual monoculture crops (corn and soybean), greatly simplifying the measurement approach.

Below is a list of the 10 vegetation characteristics to be measured in the AGRO plots, followed by Table 4.2, describing the protocol for taking each of the measurements.

Biomass and NPP Components

1. Crop stems per unit area
2. Aboveground mass of crop plant per stem
3. Belowground mass of crop plant per stem
4. Fine root NPP

Canopy Characteristics

5. LAI (measured optically)
6. LAI (measured directly)
7. f_{APAR} (measured optically)
8. Specific leaf area
9. Leaf nitrogen content
10. Vegetation cover

Table 4.2. Vegetation sampling methodology for AGRO

Measurement	Example	Method	Sample number	Timing	Comments
1) Density of crop stems	Corn or soybean	Count the number of stems per 5 m of crop row and the number of crop rows per 25 m	4 counts per field	Once after sprouting and once after spring mortality	
2) Aboveground mass of crop per stem	Corn or soybean	A single stem will be removed from soil w/ roots, dried, separated from roots, and weighed	4 stems per plot	6 times over the season	A total of 24 stems will be removed from each 25 x 25 m plot over the entire growing season
3) Belowground mass of crop per stem	Corn or soybean	Roots separated from above-mentioned sample will be weighed	Same 4 stems per plot	6 times over the season	
4) Fine root NPP	Corn or soybean	The minirhizotrons are periodically viewed with a digital camera. Gross increase in area of fine roots seen in images is scaled to mass/area using gravimetric constants	5 tubes per plot (2-D images totaling 30 cm each)	6 times over the season	Only 6 of 100 plots will receive minirhizotrons
5) LAI (optical)	½ total leaf area in canopy per unit ground area	Measured at points in plot using LAI 2000 (LAI computed from sunlight attenuation as it passes through canopy)	5 points	6 times over the season	

Table 4.2 (continued)

Measurement	Example	Method	Sample number	Timing	Comments
6) LAI (allometry)	½ total leaf area in canopy per unit ground area	Before drying, leaves from the harvested plant will be sent through a leaf area meter to determine average ½ leaf area per stem. This value will be scaled to plot using the stems per plot values	Same 4 stems per plot	6 times over the season	
7) f_{APAR}	Fraction of PAR absorbed by canopy	Measured at points in plot using LAI 2000 (computed from same measurement as LAI)	5 points	6 times over the season	
8) Vegetation cover	Vertical projection of vegetation to ground-cover	Mean crown completeness using digital true-color camera	5	1 m^2	
9) Specific leaf area	Leaf area per unit leaf mass by species	Fresh leaves are weighed and measured with a leaf area meter			Sitewide averages will be determined by taking leaf samples only at selected plots
10) Leaf nitrogen concentration	% nitrogen by mass of leaves from dominant tree species	Fresh leaves are dried, digested by Kjeldahl incubation, and colormetrically analyzed for nitrogen		3 times seasonally	Sitewide averages will be determined by taking leaf samples only at a selected few plots

AGRO

Subplot Placement

The 25 x 25 m plot is the experimental unit. In our final analyses each plot will yield only *one* value for each vegetation characteristic. Where appropriate, multiple fixed-area subplots will be sampled within each plot to better characterize spatial heterogeneity. The subplots are positioned in the 25 x 25 m plot such that

1. they are spatially stratified throughout the plot and not clustered in one area,
2. they are simple and convenient to deploy in the field, and
3. they do not interfere with each other.

The subsamples will be located in a regular pattern in each plot based on the cardinal compass directions. The protocol for the subplot placement of subsamples at AGRO is illustrated in Figure 4.4 and described in Table 4.3.

Figure 4.4. Placement of AGRO subsamples.

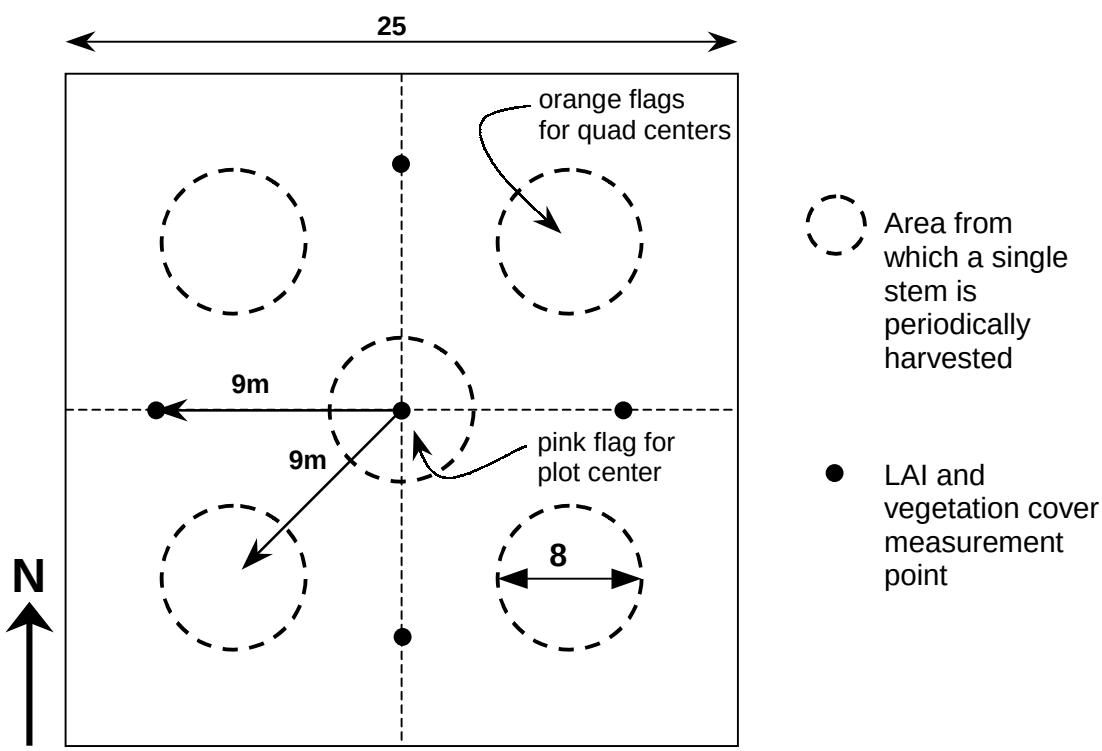


Table 4.3. Subplot placement protocol for AGRO

Subplot	Number of subplots	Position in 25 x 25 m plot
Stem clip location	4	One stem in each of four fixed-area regions centered at points 9 m N, S, E, and W from plot center
LAI and vegetation cover sample points	5	One positioned near plot center and four more positioned 9 m N, S, E, and W from plot center
Minirhizotrons (1st-order plots only)	5	One positioned near plot center and four more positioned 9 m N, S, E, and W from plot center (or anywhere they can be installed)

A tentative field schedule is provided on the following page.

AGRO

Tentative 1999 Field Calendar

Month	Week	Day of year	Measurements
April	2	106	Survey in plots and install minirhizotron tubes just after crops are planted
May	3	136	Take LAI, take root images, and harvest sample plants (1 of 7 times in season)
June	1	151	Take LAI, take root images, and harvest sample plants (2 of 7 times in season)
June	3	166	Take LAI, take root images, and harvest sample plants (3 of 7 times in season)
July	1	181	Take LAI, take root images, and harvest sample plants (4 of 7 times in season) Peak tassel anticipated
July	4	204	Take LAI, take root images, and harvest sample plants (5 of 7 times in season)
Aug.	3	235	Take LAI, take root images, and harvest sample plants (6 of 7 times in season)
Sept.	3	263	Take LAI, take root images, and harvest sample plants (7 of 7 times in season); remove minirhizotron tubes just prior to harvest

These dates are dependent on the farmers' planting schedule, which in turn is dependent on the weather.

Measurements will be repeated in 2000 on or near the same dates.

AGRO

Contact People

Primary Landowner of Flux Tower Site
Mr. John Reifsteck
1007 County Rd 900 E
Champaign, Illinois 61822
Phone: 271-359-5856
Fax: 217-398-5608
john@reifsteck.com

Flux Tower Scientist
Dr. Tilden P. Meyers
NOAA/ATDD
P.O. Box 2456
Oak Ridge, Tennessee 37831-2456
Phone: 423-576-1245
Fax: 423-576-1327
meyers@atdd.noaa.gov

Site Meteorologist
Dr. Steven E. Hollinger
Agricultural Meteorologist
Office of Applied Climatology
Illinois State Water Survey
Illinois Dept. of Natural Resources
22204 Griffith Dr.
Champaign, Illinois 61820-7495
Phone (217) 244-2939
Fax (217) 244-2939
TDD (217) 782-9157
hollingr@uiuc.edu