

LARS Technical Report 042382
NASA-Johnson Space Center
Contract No. NAS9-16528

Vegetation and Soils Field Research Data Base: Experiment Summaries

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**PURDUE,
touching
tomorrow
today**

Star Information Form

1. Report No.		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Vegetation and Soils Field Research Data Base: Experiment Summaries				5. Report Date May 1982, Dec. 1984	
				6. Performing Organization Code	
7. Author(s) L.L. Biehl, C.S.T. Daughtry, and M.E. Bauer				8. Performing Organization Report No. LARS 042382	
9. Performing Organization Name and Address Purdue University Laboratory for Applications of Remote Sensing 1291 Cumberland Ave. West Lafayette, IN 47906-1399				10. Work Unit No.	
				11. Contract or Grant No. NAS9-16528	
12. Sponsoring Agency Name and Address NASA Johnson Space Center Earth Resources Research Division Houston, TX 77058				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>Understanding of the relationships between the optical, spectral characteristics and important biological-physical parameters of earth-surface features can best be obtained by carefully controlled studies over fields and plots where complete data describing the condition of targets are attainable and where frequent, timely spectral measurement can be obtained. Development of a vegetation and soils field research data base was initiated in 1972 at Purdue University's Laboratory for Applications of Remote Sensing and expanded in the fall of 1974 by NASA as part of LACIE. Since then, over 250,000 truck-mounted and helicopter-borne spectrometer/multiband radiometer observations have been obtained of more than 250 soil series and 20 species of crops, grasses, and trees. These data are supplemented by an extensive set of biophysical and meteorological data acquired during each mission.</p> <p>The field research data form one of the most complete and best-documented data sets acquired for agricultural remote sensing research. Thus, they are well-suited to serve as a data base for research to: (1) quantitatively determine the relationships of spectral and biophysical characteristics of vegetation, (2) define future sensor systems, and (3) develop advanced data analysis techniques.</p>					
17. Key Words (Suggested by Author(s)) Remote sensing, data base, spectrometer, radiometer			18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price	

VEGETATION AND SOILS FIELD RESEARCH DATA BASE:

EXPERIMENT SUMMARIES

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July 1982

Revised December 1984

VEGETATION AND SOILS FIELD RESEARCH DATA BASE:

EXPERIMENT SUMMARIES

Major advancements have been made in recent years in the capability to acquire, process, and interpret remotely sensed multispectral measurements of the energy reflected and emitted from vegetation, soils, and other earth surface features. As a result of programs such as the Large Area Crop Inventory Experiment (LACIE) and AgRISTARS, the technology is moving rapidly toward operational applications. There is, however, a continuing need for more quantitative knowledge of the multispectral characteristics of vegetation and soils if further advancements in technology development and application are to be made.

Understanding of the relationships between the optical, spectral characteristics and important biological-physical parameters of earth surface features can best be obtained by carefully controlled studies over fields and plots where complete data describing the condition of targets are attainable and where frequent, timely spectral measurement can be obtained. It is these attributes which distinguish field research from other remote sensing research activities.

Development of a vegetation and soils field research data base was initiated in 1972 at Purdue University's Laboratory for Applications of Remote Sensing (LARS) and expanded in the fall of 1974 by NASA as part of LACIE. Spectral, agronomic, and meteorological measurements were made for three years at LACIE test sites in Kansas, South Dakota and North Dakota. The data were preprocessed into comparable formats, analyzed by researchers and stored in the NASA/JSC field research data base. The data base was expanded in 1978 to include data collected for corn and soybean experiments in Indiana, Iowa, and Nebraska, as well as from a major U.S. soils experiment. In 1980 the data base was expanded again to include data collected for spring wheat, barley, sunflowers, and soybeans in North Dakota and cotton, rice, and soybeans in Texas. Data were obtained for boreal forest species in 1983 and 1984. The remote sensing measurements include over 250,000 truck-mounted and helicopter-borne spectrometer/multiband radiometer observations and 400 flight lines of aircraft scanner data. These data are supplemented by an extensive set of biophysical and meteorological data acquired during each mission.

The field research data form one of the most complete and best documented data sets acquired for agricultural remote sensing research.

Thus, they are well-suited to serve as a data base for research to: (1) quantitatively determine the relationships of spectral and biophysical characteristics of vegetation, (2) define future sensor systems, and (3) develop advanced data analysis techniques. The data base, which became an integral part of AgRISTARS Supporting Research Project data base, is unique in the comprehensiveness of sensors and missions over the same sites throughout several growing seasons and in the calibration of all multispectral data to a common standard.

The specifications of the spectroradiometers and multiband radiometers used for obtaining the spectral data for the data base are summarized in Table 1. The vegetation for which spectral data have been acquired is given in Table 2. Additional spectral data, primarily Barnes 12-1000 data, have been acquired by researchers at the University of Nebraska, Kansas State University, Oregon State University, South Dakota State University, Texas A&M University, University of Minnesota, University of Kansas, and CIMMYT of Mexico as part of the AgRISTARS supporting research program.

The experiment summaries identify each experiment for which truck-mounted or helicopter-mounted spectroradiometer or multiband radiometer data were collected. See Table 3. The summary for an experiment includes:

- . Experiment Name and Number
- . Location
- . Spectral Instrument(s)
- . Library Tape(s)
- . Experiment description
- . Dates data collected
- . Number of spectral observations
- . Illumination conditions
- . LARSPEC Identification Record Codes

There are summaries for most experiments. Additional experiment summaries are added each year as new data are collected.

Since the entire report is quite voluminous, more than 400 pages, description and data for only one experiment (see Appendix, p. 15) are presented as an example of the information that is available. Complete description or information about other experiments listed in this report can be obtained by contacting Larry Biehl or Craig Daughtry at Purdue University/LARS, 1291 Cumberland Ave., West Lafayette, IN 47906-1399; ph. 317/494-6305.

RELATED REFERENCES

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Table 1. Summary of major non-imaging sensor systems used for acquisition of data for vegetation and soils scene radiation research data base.

Platform and Sensor	Spectral Range	Spectral Band Width	No. of Observations
	μm	μm	
Helicopter-mounted spectroradiometer			
NASA/JSC field spectrometer system (FSS)	0.40- 1.10 1.10- 2.40 8.00-14.00	0.02 0.05 0.50	204,605
Helicopter-mounted multiband radiometer			
NASA/JSC Barnes 12-1000 MMR	0.45-12.50	TM	9,300
Truck-mounted spectroradiometers			
Purdue/LARS Exotech 20C	0.40- 2.40	0.01	9,165
Purdue/LARS Exotech 20C	0.40- 0.63 0.44- 0.86 0.69- 1.36 1.28- 2.32	0.0007 0.0009 0.0015 0.0024	9,165
NASA/JSC Field Signature Acquisition System (FSAS)	0.40- 2.40	0.01	813
NASA/ERL Exotech 20D	0.40- 2.40	0.01	644
Truck-mounted multiband radiometers			
Purdue/LARS Exotech 100 (X100)	0.50- 1.10	MSS	31,680
Purdue/LARS Barnes 12-1000 (MMR)	0.45-12.50	TM	29,615
Laboratory Spectroradiometer			
Purdue/LARS Exotech 20C	0.40- 2.40	0.01	746
Purdue/LARS Exotech 20C	0.40- 0.63 0.44- 0.86 0.69- 1.36 1.28- 2.32	0.0007 0.0009 0.0015 0.0024	746

TM - Thematic Mapper bands plus 1.15-1.30 μm .

MSS - Landsat MSS bands.

Table 2. Summary of vegetation for which non-imaging spectral data have been acquired.

Vegetation Cover	Sensor System					
	FSS	20C	FSAS	20D	X100	MMR
Alfalfa	X	X	X	X	X	X
Barley	X	X	X	X	X	-
Corn	X	X	X	-	X	X
Corn, sun-view	-	-	-	-	-	X
Dry Bean	X	-	-	-	-	-
Durum Wheat	X	X	-	-	-	-
Flax	X	-	-	-	-	-
Millet	X	-	-	-	-	-
N. Dakota Native Grass	-	X	-	-	-	-
Oats	X	X	-	-	X	-
Pasture	X	-	-	-	-	-
Rye	X	-	X	X	-	-
Safflower	X	-	-	-	-	-
'Skylight'	-	X	-	-	-	X
Soil	X	X	X	-	X	-
Soil Residue	-	-	-	-	X	X
Sorghum (grain)	X	X	X	-	X	X
Sorghum, sun view polarization	-	-	-	-	-	X
S. Dakota Native Grass	X	-	-	-	-	-
Soybeans	X	X	X	X	X	X
Soybeans, sun view	-	-	-	-	X	-
Spring Wheat	X	X	-	-	X	-
Spring Wheat, sun view	-	X	-	-	-	-
Spring wheat, sun view polarization	-	X	-	-	-	-
Sudan Grass	X	-	-	-	-	-
Sugar Beets	X	X	X	X	-	-
Sunflower	X	X	-	-	X	X
Trees, Aspen	-	-	-	-	-	X
Trees, Balsam Fir	-	-	-	-	-	X
Trees, Black Spruce	-	-	-	-	-	X
Trees/Brush	X	-	-	-	-	-
Trees, Hardwood	X	-	-	-	-	-
Triticale	-	-	X	X	-	-
Winter Wheat	X	X	X	X	X	-
Winter Wheat, sun view	-	-	-	-	-	X

Table 3. Field Research Experiment Summary Table of Contents. The fourth and fifth digits of the experiment number identify the spectral sensor system:

00:	Exotech 20C	03:	FSAS
01:	Exotech 20D	04,05:	Exotech 100
02:	FSS	09-24:	Barnes 12-1000

Experiment Number	Experiment	'Chapter'
1972 Experiments		
72100201	Purdue Agronomy Farm Ground Cover	1
72100202	Purdue Agronomy Farm Corn Blight	2
72100203	Purdue Agronomy Farm Nitrogen Study	3
72100301	Soil Series	4
72300101	Hydrology	5
1973 Experiments		
73100201	Purdue Agronomy Farm Ground Cover	7
73100203	Purdue Agronomy Farm Nitrogen Study	8
73300101	Hydrology	9
1974 Experiments		
74100201	Purdue Agronomy Farm Ground Cover	11
74100203	Purdue Agronomy Farm Nitrogen	12
74100204	Purdue Agronomy Farm Planting Date	13
74100205	Purdue Agronomy Farm Moisture Stress	14
74100205	Garden City, Kansas Irrigation-Fertility	15
74100205	Garden City, Kansas Irrigation-Variety	16
74100205	Garden City, Kansas Other Crops	17
74100205	Garden City, Kansas Residue Management	18
74100206	Garden City, Kansas Sun Angle	19
74100207	Garden City, Kansas Helicopter Field	20
74100301	Boyd Soil	21
74100402	Soil Study U.S.A.	22
74100601	Bob Beck Soil	23
74600201	Goniometric Test	25
74600203	Purdue Agronomy Farm Wheat Canopy Reference	26

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Experiment Number	Experiment	Chapter
1975 Experiments		
75100211	Exotech 20C Calibration North Dakota	27
75100212	Small Grain North Dakota	28
75100213	Spring Wheat North Dakota	29
75100214	Seeding Rate North Dakota	30
75100215	Other Crops North Dakota	31
75100216	Angle Modeling North Dakota	32
75101201	Calibration Kansas	34
75101202	Small Grain Kansas	35
75101203	Irrigation Kansas	36
75101204	Other Crops Kansas	37
75101205	Wheat Variety Kansas	38
75101206	Residue Management Kansas	39
75102207	Kansas Intensive Test Site 1960	40
75102217	North Dakota Intensive Test Site 1966	41
75600210	Reference Panel Calibration	42
1976 Experiments		
76100211	Exotech 20C Calibration North Dakota	43
76100212	Small Grain North Dakota	44
76100213	Spring Wheat North Dakota	45
76100214	Seeding Rate North Dakota	46
76100215	Other Crops North Dakota	47
76100216	Angle Modeling North Dakota	48
76102207	Kansas Intensive Test Site 1988	49
76102217	North Dakota Intensive Test Site 1966	50
76102227	South Dakota Intensive Test Site 1987	51
76103201	FSAS Calibration Kansas	52
76103202	Small Grain Kansas	53
76103203	Dryland Winter Wheat Kansas	54
76103203	Irrigated Winter Wheat Kansas	55
76103204	Other Crops Kansas	56
76600131	Calibration LARS	57
76600231	Reference Panel Calibration	58

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Experiment Number	Experiment	'Chapter'
1977 Experiments		
77100211	Exotech Model 20C Calibration North Dakota	59
77100212	Small Grain North Dakota	60
77100213	Spring Wheat North Dakota	61
77100215	Other Crops North Dakota	62
77100701	Eric Stoner Soil	63
77102207	Kansas Intensive Test Site 1988	64
77102217	North Dakota Intensive Test Site 1966	65
77102227	South Dakota Intensive Test Site 1687	66
77103201	FSAS Calibration Kansas	67
77103202	Small Grains Kansas	68
77103203	Dryland Winter Wheat Kansas	69
77103203	Irrigated Winter Wheat Kansas	70
77105211	Exotech Model 100 Calibration	71
77105212	Small Grain North Dakota	60
77105213	Spring Wheat North Dakota	61
77105215	Other Crops North Dakota	62
77600201	Reference Panel Calibration	72
1978 Experiments		
78100701	Eric Stoner Soils	79
78100702	Eric Stoner Soils Calibration	80
78100801	Purdue Agronomy Farm Corn Moisture Stress	81
78100802	Purdue Agronomy Farm Corn Nitrogen	82
78100803	Purdue Agronomy Farm Corn Potassium and Phosphorous	83
78100804	Purdue Agronomy Farm Soybean Potassium and Phosphorous	84
78100805	Purdue Agronomy Farm Soybean Management	85
78100806	Purdue Agronomy Farm Calibration	86
78100807	Purdue Agronomy Farm Corn Canopy/Soil	87
78105801	Purdue Agronomy Farm Corn Moisture Stress	81
78105802	Purdue Agronomy Farm Corn Nitrogen	82
78105803	Purdue Agronomy Farm Corn Potassium and Phosphorous	83
78105804	Purdue Agronomy Farm Soybean Potassium and Phosphorous	84
78105804	Purdue Agronomy Farm Soybean Management	85
78105806	Purdue Agronomy Farm Calibration	86
78105807	Purdue Agronomy Farm Corn Canopy/Soil	87
78102227	South Dakota Intensive Test Site 1687	88
78600201	Reference Panel Calibration	91

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Experiment Number	Experiment	'Chapter'
1979 Experiments		
79100801	Purdue Agronomy Corn Moisture Stress	92
79100802	Purdue Agronomy Farm Corn Nitrogen	93
79100804	Purdue Agronomy Farm Soybean Cultural Practices	103
79100805	Purdue Agronomy Farm Corn Leaf Blight	94
79100806	Purdue Agronomy Farm Winter Wheat	95
79100808	Purdue Agronomy Farm Calibration	96
79100809	Purdue Agronomy Farm Other Crops	97
79102227	South Dakota Intensive Test Site 1687	100
79102237	Iowa Intensive Test Site 0893	101
79105803	Purdue Agronomy Farm Corn Cultural Practices	102
79105804	Purdue Agronomy Farm Soybean Cultural Practices	103
79105806	Purdue Agronomy Farm Winter Wheat	95
79105807	Purdue Agronomy Farm Soil Background	104
79105808	Purdue Agronomy Farm Calibration	96
79105809	Purdue Agronomy Farm Other Crops	97
79105810	Purdue Agronomy Farm Soybean Row Direction	105
79105811	Purdue Agronomy Farm Instrument Altitude	106
79108808	Purdue Agronomy Farm Calibration	96
79108812	Purdue Agronomy Farm Corn Leaf Nitrogen	107
79600201	Reference Panel Calibration	108
1980 Experiments		
80100805	Purdue Agronomy Farm Winter Wheat Disease	111
80100806	Purdue Agronomy Farm Winter Wheat	112
80100808	Purdue Agronomy Farm Calibration	113
80102237	Webster Co., Iowa Intensive Test Site 0893	116
80102247	Cass Co., N. Dakota Intensive Test Site 0817	117
80104802	Soybean Sun-View Angle	118
80105803	Purdue Agronomy Corn Cultural Practices	119
80105804	Purdue Agronomy Farm Soybean Cultural Practices	120
80105806	Purdue Agronomy Farm Winter Wheat	112
80105808	Purdue Agronomy Farm Calibration	113
80105809	Purdue Agronomy Farm Other Crops	121
80105810	Purdue Agronomy Farm Soybean Row Direction	122
80105812	Purdue Agronomy Farm Soybean Variety	123
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81102247	Cass Co., N. Dakota Intensive Test Site 0817	129
81105801	Purdue Agronomy Farm Corn Hybrid	130
81105803	Purdue Agronomy Farm Corn Cultural Practices	131
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81105805	Purdue Agronomy Farm Wheat Disease	133
81105806	Purdue Agronomy Farm Soybean Varieties	134
81105807	Purdue Agronomy Farm Sunflower Cultural Practices	135
81105808	Purdue Agronomy Farm Sorghum Cultural Practices	136
81105809	Purdue Agronomy Farm Calibration	137
81109803	Purdue Agronomy Farm Corn Cultural Practices	131
81109804	Purdue Agronomy Farm Soybean Cultural Practices	132
81109805	Purdue Agronomy Farm Wheat Disease	133
81109806	Purdue Agronomy Farm Soybean Varieties	134
81109807	Purdue Agronomy Farm Sunflower Cultural Practices	135
81109808	Purdue Agronomy Farm Sorghum Cultural Practices	136
81109809	Purdue Agronomy Farm Calibration	137
81109810	Purdue Agronomy Row Direction	138
81112237	Webster Co., Iowa Intensive Test Site 0893	128
81112247	Cass Co., N. Dakota Intensive Test Site 0817	129
81112277	Texas Test Site	139
81600201	Reference Panel Calibration	141

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Experiment Number	Experiment	Chapter
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82105804	Purdue Agronomy Farm Soybean Cultural Practices	143
82105805	Purdue Agronomy Farm Corn SRI	144
82105807	Purdue Agronomy Farm Sunflower Cultural Practices	145
82105808	Purdue Agronomy Farm Sorghum Cultural Practices	146
82105809	Purdue Agronomy Farm Calibration	147
82105901	Purdue Agronomy Farm Soil Residue	148
82109803	Purdue Agronomy Farm Corn Cultural Practices	142
82109804	Purdue Agronomy Farm Soybean Cultural Practices	143
82109805	Purdue Agronomy Farm Corn SRI	144
82109807	Purdue Agronomy Farm Sunflower Cultural Practices	145
82109808	Purdue Agronomy Farm Sorghum Cultural Practices	146
82109809	Purdue Agronomy Farm Calibration	147
82109901	Purdue Agronomy Farm Soil Residue	148
82112247	Cass Co., N. Dakota, Intensive Test Site 0817	149
82122802	Purdue Agronomy Farm Corn Sun-View Angle	150
82600201	Reference Panel Calibration	152
82605201	Reference Panel Calibration	152
82609201	Reference Panel Calibration	152

Table 3. Field Research Experiment Summary

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Experiment Number	Experiment	'Chapter'
1983 Experiments		
83105805	Purdue Agronomy Farm Corn SRI	154
83105806	Purdue Agronomy Farm Soybean SRI	155
83105807	Purdue Agronomy Farm Alfalfa	156
83105808	Purdue Agronomy Farm Sorghum	157
83105809	Purdue Agronomy Farm Calibration	158
83109601	Purdue Agronomy Farm Balsam Fir Turntable	159
83109805	Purdue Agronomy Farm Corn SRI	154
83109806	Purdue Agronomy Farm Soybean SRI	155
83109807	Purdue Agronomy Farm Alfalfa	156
83109808	Purdue Agronomy Farm Sorghum	157
83109809	Purdue Agronomy Farm Calibration	158
83113601	Purdue Agronomy Farm Balsam Fir Turntable	159
83113802	Purdue Agronomy Farm Wheat Sun-View Practices	160
83212201	Louis Co., Minnesota, Forest Biomass	161
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1984 Experiments		
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84105805	Purdue Agronomy Farm Corn SRI	166
84105806	Purdue Agronomy Farm Soybean SRI	167
84105807	Purdue Agronomy Farm Grass/Legume	168
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84109601	Purdue Agronomy Farm Balsam Fir Turntable	170
84109803	Purdue Agronomy Farm Corn Row Spacing	165
84109805	Purdue Agronomy Farm Corn SRI	166
84109806	Purdue Agronomy Farm Soybean SRI	167
84109807	Purdue Agronomy Farm Grass/Legume	168
84109809	Purdue Agronomy Farm Calibration	169
84113601	Purdue Agronomy Farm Balsam Fir Turntable	170
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APPENDIX

119. 1980 Purdue Agronomy Farm Corn Cultural Practices Experiment:

Experiment Number: 80105803

Experimenter: Craig Daughtry

Location: Purdue Agronomy Farm
West Lafayette, Indiana

Instrument: Purdue/LARS Exotech 100

Library Tapes: 4857, 4868

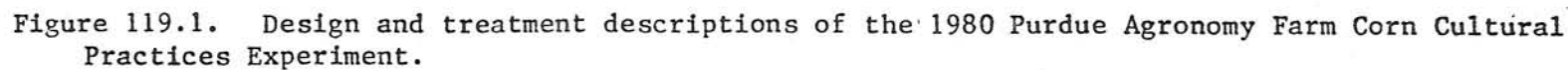
Purpose of Experiment

1980 is the second year for this experiment (see 79105803, Table 3, Page 10). The objectives of this experiment are to determine (1) the threshold of early season spectral detection of corn; (2) the spectral response of corn as a function of growth stage and amount of vegetation; and (3) the effect of soil background differences, particularly soil color, on the spectral response and early detection of corn. The treatments were as follows:

- 7 Planting Dates (May 7, 16, 22, 29; June 11, 18; and July 2
- 3 Plant Populations (25,000, 50,000, and 75,000 plants per hectare)
- 2 Soil Types (Chalmers, darker; Fincastle, lighter)

A split-plot design with two replications was used (Fig. 119.1). Spectral measurements, along with agronomic characterizations of the canopies and surface soil, were made at approximately weekly intervals throughout the growing season.

The spectral reflectance measurements were made with a Landsat band radiometer (Exotech Model 100). Radiant temperatures and overhead color photographs of the canopies were obtained simultaneously with the reflectance measurements. The major agronomic measurements of the plots included growth stage, percent soil cover, height, leaf area index, biomass, and surface soil moisture and condition. Grain yields were measured at harvest time.



Dates Spectral Data Collected:

Plot Number	5/27	5/28	6/9	6/11	6/18	6/21	6/29	7/15	7/20
←———— Number of Observations —————→									
31	2	2	4	4	2	2	2	2	2
32	2	2	4	4	2	2	2	2	2
33	2	2	4	4	2	2	2	2	2
34	2	2	4	4	2	2	2	2	2
35	2	2	4	4	2	2	2	2	2
36	2	2	4	4	2	2	2	2	2
37	2	2	4	4	2	2	2	2	2
38	2	2	4	4	2	2	2	2	2
39	2	2	4	4	2	2	2	2	2
40	2	2	4	4	2	2	2	2	2
41	2	2	4	4	2	2	2	2	2
42	2	2	4	4	2	2	2	2	2
43	2	2	4	4	2	2	2	2	2
44	2	2	4	4	2	2	2	2	2
45	2	2	-	4	2	2	-	2	2
46	2	2	-	4	2	2	-	2	2
47	2	2	-	4	2	2	-	2	2
48	2	2	-	4	2	2	-	2	2
49	2	2	-	4	2	2	-	2	2
50	2	2	-	4	2	2	-	2	2
51	2	2	-	4	2	2	-	2	2
52	2	2	-	4	2	2	-	2	2
53	2	2	-	4	2	2	-	2	2
54	2	2	-	4	2	2	-	2	2
55	2	2	-	4	2	2	-	2	2
56	2	2	-	4	2	2	-	2	2
57	2	2	-	4	2	2	-	2	2
58	2	2	-	4	2	2	-	2	2
59	-	2	-	4	2	2	-	2	2
60	2	2	-	4	2	2	-	2	2
61	-	2	-	4	2	2	-	2	2
62	-	2	-	4	2	2	-	2	2
63	2	2	-	4	2	2	-	2	2
64	-	2	-	4	2	2	-	2	2
65	-	2	-	4	2	2	-	2	2
66	-	2	-	4	2	2	-	2	2
67	2	2	-	4	2	2	-	2	2
68	2	2	-	4	2	2	-	2	2
69	-	2	-	4	2	2	-	2	2
70	-	2	-	4	2	2	-	2	2
71	-	2	-	4	2	2	-	2	2
72	2	2	-	4	2	2	-	2	2
73	-	2	-	4	2	2	-	2	2
74	-	2	-	4	2	2	-	2	2
75	-	2	-	4	2	2	-	2	2
76	2	2	-	4	2	2	-	2	2

Dates Spectral Data Collected (con't.)

Plot Number	7/24	8/22	8/23	9/3	9/18	9/26	10/2	10/7
Number of Observations								
31	2	2	2	2	2	2	2	2
32	2	2	2	2	2	2	2	2
33	2	2	2	2	2	2	2	2
34	2	2	2	2	2	2	2	2
35	2	2	2	2	2	2	2	2
36	2	2	2	2	2	2	2	2
37	2	2	2	2	2	2	2	2
38	2	2	2	2	2	2	2	2
39	2	2	2	2	2	2	2	2
40	2	2	2	2	2	2	2	2
41	2	2	2	2	2	2	2	2
42	2	2	2	2	2	2	2	2
43	2	2	2	2	2	2	2	2
44	2	2	2	2	2	2	2	2
45	2	2	2	2	2	2	2	2
46	2	2	2	2	2	2	2	-
47	2	2	2	2	2	2	2	2
48	2	2	2	2	2	2	2	2
49	2	2	2	2	2	2	2	2
50	2	2	2	2	2	2	2	2
51	2	2	2	2	2	2	2	2
52	2	2	2	2	2	2	2	2
53	2	2	2	2	2	2	2	2
54	2	2	2	2	2	2	2	2
55	2	2	2	2	2	2	2	2
56	2	2	2	2	2	2	2	2
57	2	2	2	2	2	2	2	2
58	2	2	2	2	2	2	2	2
59	2	2	2	-	2	2	2	2
60	2	2	2	-	2	2	2	2
61	2	2	2	-	2	2	2	2
62	2	2	2	-	2	2	2	2
63	2	2	2	-	2	2	2	2
64	2	2	2	-	2	2	2	2
65	2	2	2	-	2	2	2	2
66	2	2	2	-	2	2	2	2
67	2	2	2	-	2	2	2	2
68	2	2	2	-	2	2	2	2
69	2	2	2	-	2	2	2	2
70	2	2	2	-	2	2	2	2
71	2	2	2	-	2	2	2	2
72	2	2	2	-	2	2	2	2
73	2	2	2	-	2	2	2	2
74	2	2	2	-	2	2	2	2
75	2	2	2	-	2	2	2	2
76	2	2	2	-	2	2	2	2

Dates Spectral Data Collected:

Plot Number	5/27	5/28	6/9	6/11	6/18	6/21	6/29	7/15	7/20
	← Number of Observations →								
77	-	2	-	4	2	2	-	2	2
78	-	2	-	4	2	2	-	2	2
79	2	2	-	4	2	2	-	2	2
80	-	2	-	3	2	2	-	2	2
81	-	2	-	5	2	2	-	2	2
82	-	2	-	4	2	2	-	2	2
83	-	2	-	4	2	2	-	2	2
84	-	2	-	4	2	2	-	2	2
85	2	2	-	4	2	2	-	2	2
86	2	2	-	4	2	2	-	2	2

Plot Number	7/24	8/22	8/23	9/3	9/18	9/26	10/2	10/7
	← Number of Observations →							
77	2	2	2	-	2	2	2	2
78	2	2	2	-	2	2	2	2
79	2	2	2	-	2	2	2	2
80	2	2	2	-	2	2	2	2
81	2	2	2	-	2	2	2	2
82	2	2	2	-	2	2	2	2
83	2	2	2	-	2	2	2	2
84	2	2	2	-	2	2	2	2
85	2	2	2	-	2	2	2	2
86	2	2	2	-	2	2	2	2

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Illumination Conditions for Spectral Data Collection

Date	Day of Year	Time Period		Solar Zenith Angle Range		Solar Azimuth Angle Range	Cloud Cover
		Start	Stop	max	min - max		
		GMT		degrees		degrees	%
5/27	148	20:17	21:10	37 - 47		251-262	?
5/28	149	16:18	17:56	27 - 19 - 19		129-188	15
6/9	161	14:47	15:06	42 - 38		101-105	10
6/11	163	15:06	16:39	38 - 23		105-135	0-1
6/18	170	15:00	16:01	39 - 28		103-119	0
6/21	173	18:13	18:54	18 - 22		198-223	1
6/29	181	19:30	19:40	27 - 29		238-241	5
7/15	197	15:29	16:35	36 - 25		111-133	2
7/20	202	18:24	19:27	21 - 28		200-232	0
7/24	206	18:26	19:38	22 - 30		200-235	20-30
8/22	235	17:45	19:30	29 - 29 - 36		177-224	30-50
8/23	236	15:48	17:00	40 - 31		128-155	0
9/3	247	17:45	18:17	33 - 33 - 34		179-193	15
9/18	262	16:53	17:52	40 - 39 - 39		161-184	5
9/26	270	17:44	18:52	41 - 45		182-206	10-15
10/2	276	17:06	18:19	44 - 44 - 45		169-195	0-20
10/7	281	19:12	20:21	51 - 59		212-230	0

LARSPEC Identification Record Codes

1. Level of Factor Codes

Factor		Level	
Code	Description	Code	Description
1:	Planting date	0:	Bare Soil
		1:	May 7, 1980
		2:	May 16, 1980
		3:	May 22, 1980
		4:	May 29, 1980
		5:	June 11, 1980
		6:	June 18, 1980
		7:	July 2, 1980
2:	Plant population	0:	Bare Soil
		1:	25,000 plants/ha
		2:	50,000 plants/ha
		3:	75,000 plants/ha
3:	Soil	1:	Chalmers silty clay loam - "darker soil"
		2:	Fincastle silt loam - "lighter soil"
4:	Block or replication	1:	First block
		2:	Second block

2. Experiments Parameters

Experimenter parameter 09: Air temperature as measured by a probe attached to the boom supporting the multiband radiometer in degrees Celsius.

Experimenter parameter 10: Radiant temperature as measured by a precision radiation thermometer (PRT-5) obliquely viewing the top surface of the canopy in degrees Celsius.