LARS Contract Report 022781

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TECHNICAL INTERCHANGE PRESENTATION AND QUARTERLY REPORT

MARCH 23, 1981

CORN AND SOYBEAN SCENE RADIATION RESEARCH

M. BAUER, L. BIEHL, C. DAUGHTRY, M. HIXSON, D. HOLT, V. VANDERBILT
PURDUE/LARS

B. BLAD
UNIVERSITY OF NEBRASKA

E. MERRITT
EARTH SATELLITE CORP.

Crop Development Stage Estimation

I. Estimate planting date.

   A. Estimate planting date from meteorological data.

   B. Estimate planting date from meteorological plus spectral data acquired after planting.

II. Determine our ability to estimate the various corn and soybean development stages.

Background

- Crop yield models determine growth rate and development stage based on meteorological data
- Require a planting date as a starting point to begin calculations
  - Two approaches to determining planting date
    - Normal planting date
      - Statistically derived from historical data
      - Specific to latitude and climate
      - Cannot be universally applied over large area
    - Models based on meteorological events prior to and during the planting period
      - Assume optimum temperature threshold must be met
        - Ability to plant limited by field conditions
      - Yet to be tested for applicability to large areas

Background

Knowledge of crop development stage may be utilized in determining when a crop was planted

Three approaches:

- Normal or average phenology
  - Based on accumulation of calendar days between stages
  - Statistically derived from historical data
  - Specific for variety and climate
- Meteorological methods
  - Statistically derived from historic weather data
  - Require planting date as an initial starting point
- Spectral methods
  - Limited by the range of development stages which can be accurately identified
  - Limited by availability of data

DEVELOPMENT OF PLANTING DATA MODELS

NORMAL/METEOROLOGICAL MODEL

- USE THE NORMAL CROP CALENDAR AS STARTING POINT FOR CALCULATIONS
- USING METEOROLOGICAL DATA, DETERMINE A FUNCTION TO BOTH SHIFT THE CROP CALENDAR IN TIME AND CHANGE ITS SHAPE

SPECTRAL/METEOROLOGICAL MODEL

- USE THE DEVELOPMENT STAGE IDENTIFIED BY SPECTRAL DATA AS STARTING POINT FOR CALCULATIONS
- USING METEOROLOGICAL DATA, CALCULATE THE DAILY DEVELOPMENT OF THE CROP FROM THE PLANTING DATE TO THE STAGE IDENTIFIED BY SPECTRAL DATA
- DEVELOP AN EXPRESSION WHICH DETERMINES THE DATE WHEN THE CROP WAS PLANTED GIVEN THE DEVELOPMENT STAGE IDENTIFIED BY SPECTRAL INFORMATION

OBJECTIVES

LONG TERM

- DETERMINE AND MODEL THE RELATIONSHIP BETWEEN THE DEVELOPMENT STAGE OF A CROP AS IDENTIFIED BY SPECTRAL METHODS AND THE BIOMETEOROLOGICAL CROP CALENDAR

IMMEDIATE

- DETERMINE THE DATE AT WHICH A CROP WAS PLANTED GIVEN SPECTRAL, METEOROLOGICAL AND HISTORICAL DATA

- DETERMINE THE RATE AND PROGRESSION OF PLANTING FOR INDIVIDUAL LANDSAT SEGMENTS

ESTIMATE PLANTING DATE: SPECTRAL/MET MODEL

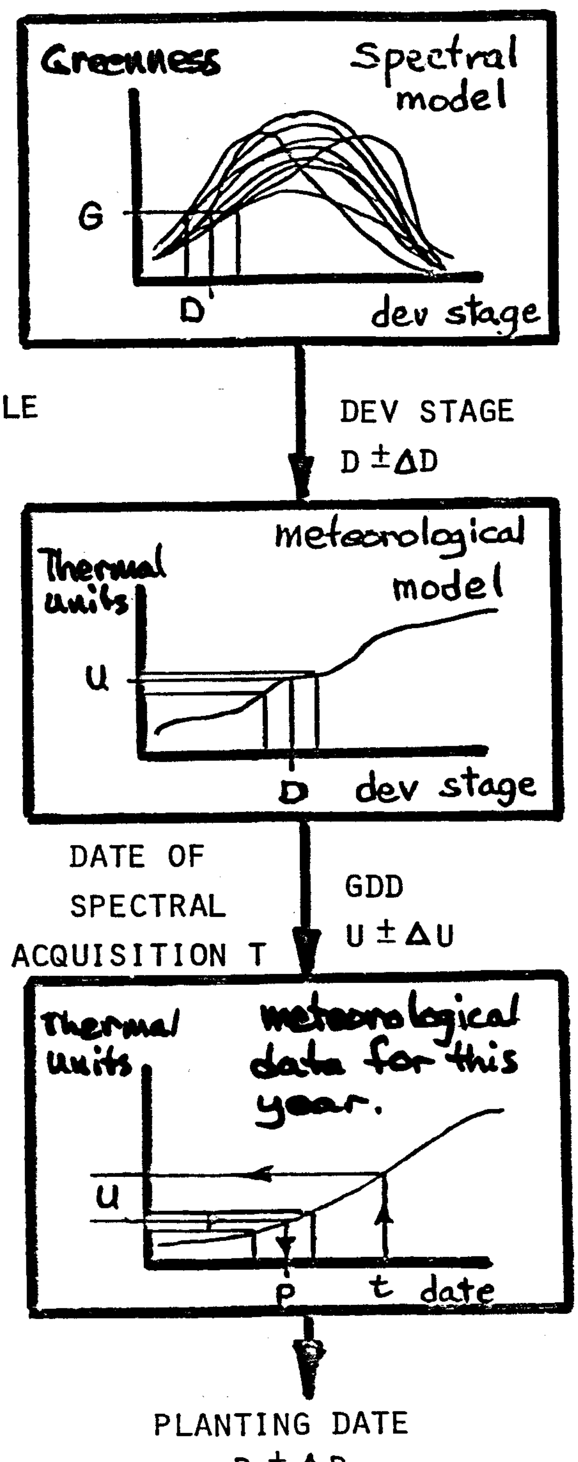
GIVEN FOR A FIELD

- SPECTRAL DATA (I.E., GREENNESS = G)
- DATE, T, OF SPECTRAL ACQUISITION

o ESTIMATE DEVELOPMENT STAGE, D ± ΔD, OF FIELD AT DATE T

o ESTIMATE PHOTO/THERMAL VARIABLE U ± ΔU FOR DEVELOPMENT STAGE D ± ΔD

o ESTIMATE PLANTING DATA P ± ΔP BACK CALCULATING U ± ΔU UNITS FROM DATE T OF SPECTRAL ACQUISITION



ESTIMATE PLANTING DATE: FORM OF METEOROLOGICAL MODEL

[PERCENT OF AREA PLANTED PER DAY] =

X [MAXIMUM PERCENT OF AREA THAT CAN BE PLANTED IN ONE DAY]

X [EARLIEST POSSIBLE PLANTING DATE FACTOR] X [SOIL MOISTURE FACTOR]

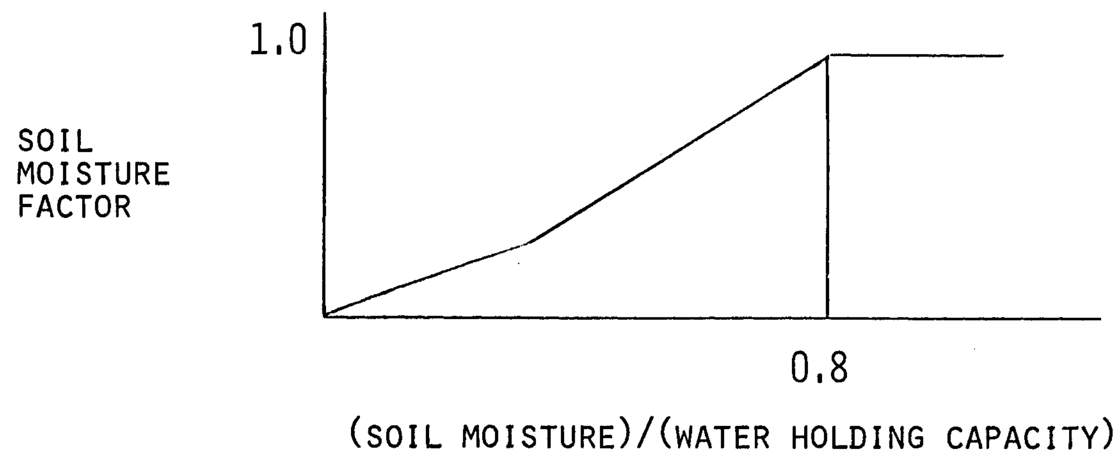
X [SOIL TEMPERATURE FACTOR] X [FARMER READINESS FACTOR]

X [COMPLETION FACTOR] X [CROP PRIORITY FACTOR]

X [SEED BED PREPARATION FACTOR]

ESTIMATE PLANTING DATE: MET MODEL

EACH OF THE FACTORS IN THIS MODEL VARIES IN VALUE BETWEEN 0.0 AND 1.0. FOR EXAMPLE,



THIS MODEL PREDICTS THE PLANTING OF EACH CROP USING THERMAL, SOIL MOISTURE AND MANAGEMENT INPUTS.

FUNCTION OF MODELS

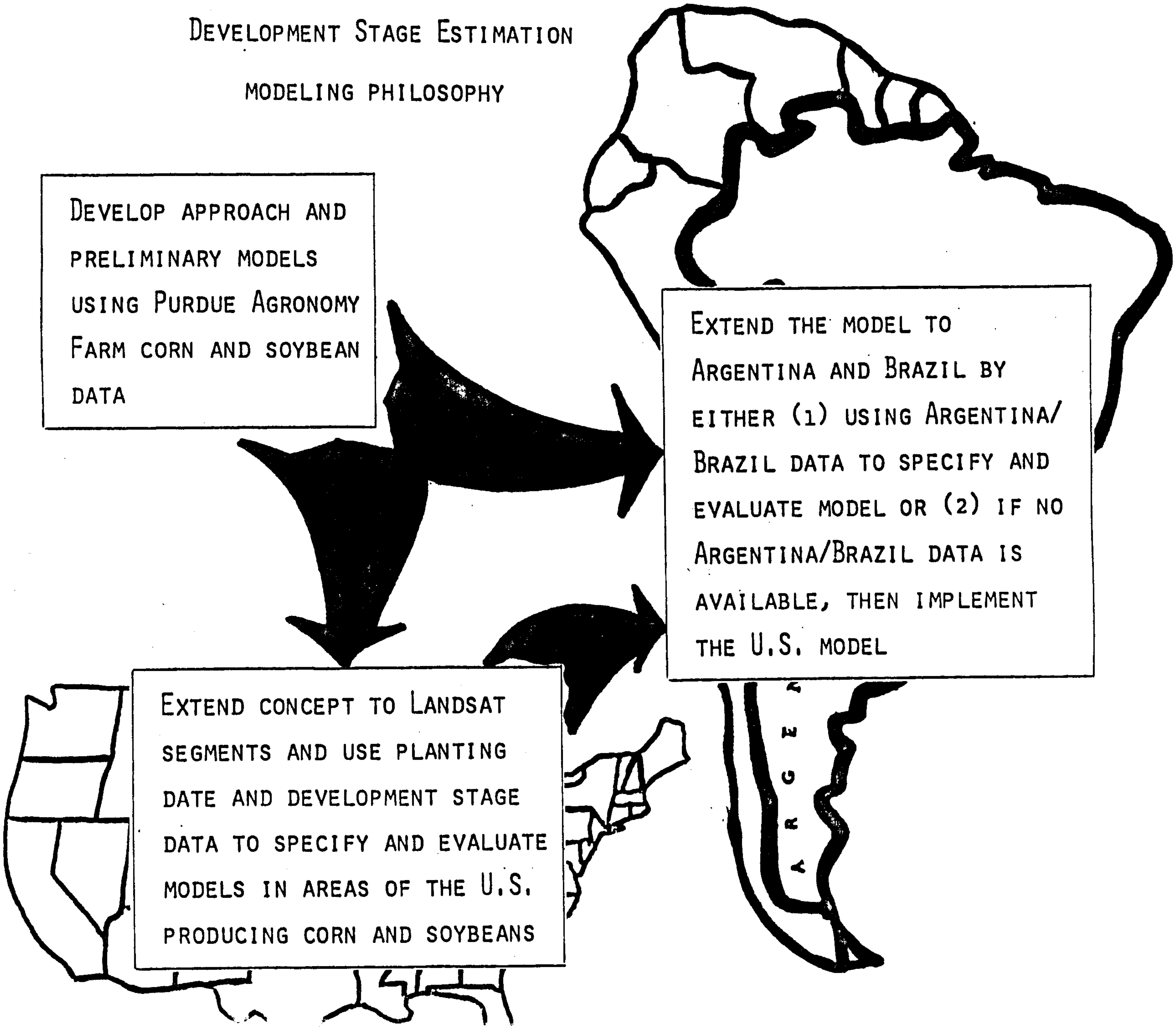
NORMAL/METEOROLOGICAL MODEL PREDICTS PLANTING DATE BEFORE PLANTING AND WHEN SPECTRAL DATA ARE UNAVAILABLE.

SPECTRAL/METEOROLOGICAL MODEL PREDICTS PLANTING DATE AFTER PLANTING AND ONLY WHEN SPECTRAL DATA ARE AVAILABLE. THE MODEL WILL ALLOW PREDICTION OF OTHER CROP DEVELOPMENT STAGES.

BOTH MODELS ARE SIMPLE AND REPRESENT A "FIRST CUT" AT THE LONG TERM PROBLEM OF ESTIMATING DEVELOPMENT STAGE. THEIR DEVELOPMENT AND EVALUATION SHOULD BOTH INCREASE OUR KNOWLEDGE OF THE PROBLEM AS WELL AS SUPPORT THE NEED FOR SUCH MODELS IN THE ARGENTINA PILOT PROJECT OF AGRISTARS.

DEVELOPMENT STAGE ESTIMATION

MODELING PHILOSOPHY



EXTENSION OF SPECTRAL/MET MODEL TO LARGE AREA

USING LANDSAT MSS DATA, IDENTIFY CROP DEVELOPMENT STAGE IN SPECIFIC FIELDS IN A LANDSAT SEGMENT

USE MODEL TO DETERMINE PLANTING DATE FOR THESE SPECIFIC FIELDS

DETERMINE FROM THESE RESULTS THE PLANTING DATE CALENDAR, THE RATE AND PROGRESSION OF PLANTING THROUGHOUT THE SEGMENT

EVALUATION OF MODEL

- COMPARE THE RATE AND PROGRESSION OF PLANTING IN AREA AS DETERMINED BY THE MODEL WITH ESTIMATED RATE AND PROGRESSION OF PLANTING REPORTED WITHIN CROP REPORTING DISTRICTS

WHICH DEVELOPMENT STAGES POTENTIALLY CAN BE ESTIMATED FROM SPECTRAL DATA?

BACKGROUND

MIDSEASON CORN AND SOYBEAN DEVELOPMENT STAGES CANNOT NOW BE ADEQUATELY ESTIMATED SOLELY FROM THE SPECTRAL VARIABLE, GREENNESS. THE QUESTION IS WHETHER USE OF ANY SPECTRAL VARIABLE PROVIDES ADEQUATE ESTIMATES OF DEVELOPMENT STAGE.

OBJECTIVE

TO DETERMINE THE PROBABILITY WITH WHICH DEVELOPMENT STAGES CAN BE ESTIMATED FROM SPECTRAL DATA

DISCRIMINANT ANALYSIS ....CORN 1979 & 1980.... PRIORS EQUAL
MATURITY GROUPS INCLUDE BOTH SOIL TYPES...ON ROW & OFF ROW NOT AVERAGED

15

DISCRIMINANT ANALYSIS CLASSIFICATION SUMMARY FOR CALIBRATION DATA: WORK.ONE

GENERALIZED SQUARED DISTANCE FUNCTION:

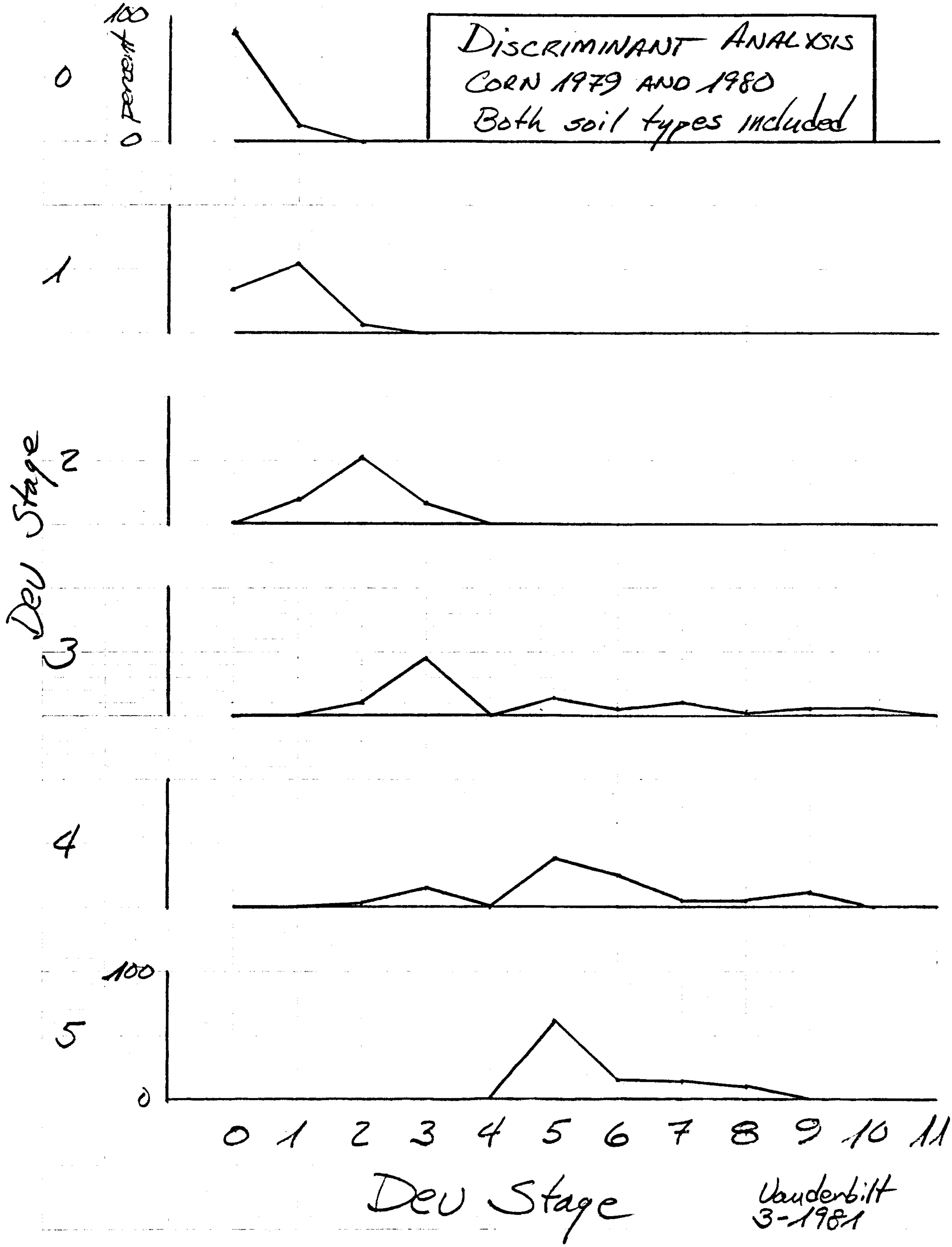
$$D_J^2(X) = (X-\bar{X}_J)' COV_J^{-1} (X-\bar{X}_J) + LN |COV_J|$$

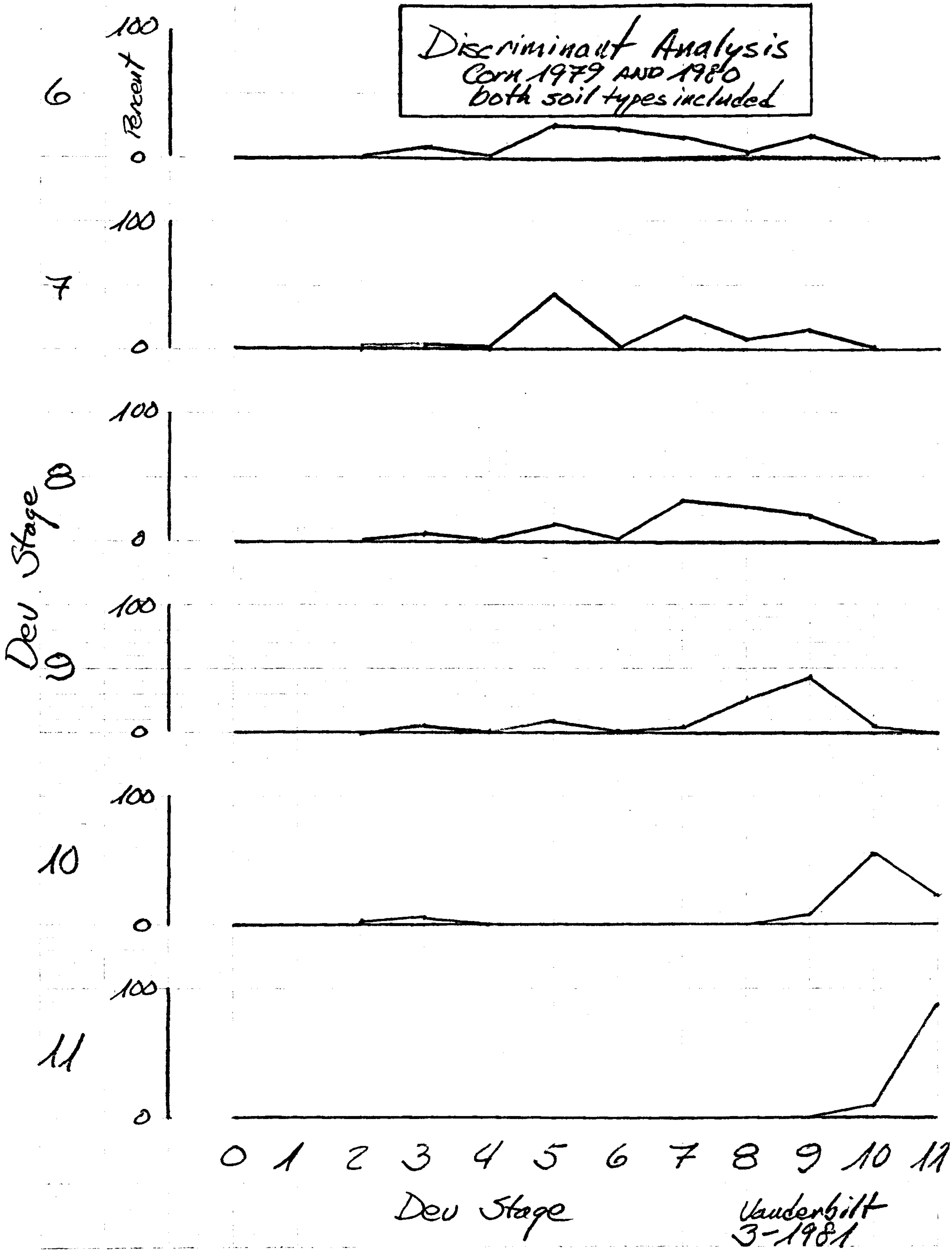
POSTERIOR PROBABILITY OF MEMBERSHIP IN EACH CLASS:

$$PR(J|X) = EXP(-.5\ D_J^2(X)) \ / \ \sum_K EXP(-.5\ D_K^2(X))$$

NUMBER OF OBSERVATIONS AND PERCENTS CLASSIFIED INTO CLASS:

FROM CLASS	AST30	BSTG1	CSTG2	DSTG3	ESTG4	FTASS	GSILK	HBLIS	IDOUG	JBDEN	KDENT
	15 2.59	119 21.36	75 13.46	80 14.36	7 1.26	67 12.03	32 5.75	43 7.72	28 5.03	34 6.10	19 3.41
ASTG0	143 87.20	21 12.80	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00
BSTG1	140 34.74	225 55.83	29 7.20	0 0.00	1 0.25	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	6 1.49
CSTG2	2 0.64	65 20.70	166 52.87	55 17.52	6 1.91	0 0.00	2 0.64	1 0.32	0 0.00	7 2.23	10 3.18
DSTG3	0 0.00	0 0.00	16 10.81	67 45.27	0 0.00	20 13.51	10 6.76	15 10.14	3 2.03	10 6.76	7 4.73
ESTG4	0 0.00	0 0.00	3 3.06	14 14.29	1 1.02	37 37.76	24 24.49	4 4.08	4 4.08	11 11.22	0 0.00
5 FTASS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	32 61.54	8 15.38	7 13.46	5 9.62	0 0.00	0 0.00
6 GSILK	0 0.00	0 0.00	2 3.70	5 9.26	1 1.85	15 27.78	12 22.22	8 14.81	2 3.70	9 16.67	0 0.00
7 HBLIS	0 0.00	1 1.47	0 0.00	2 2.94	0 0.00	29 42.65	0 0.00	18 26.47	6 8.82	10 14.71	2 2.94
8 IDOUG	0 0.00	0 0.00	2 1.34	10 6.71	1 0.67	20 13.42	0 0.00	47 31.54	40 26.85	29 19.46	0 0.00
9 JBDEN	0 0.00	0 0.00	0 0.00	6 5.66	2 1.89	10 9.43	2 1.89	5 4.72	29 27.36	46 43.40	6 5.66
10 KDENT	0 0.00	0 0.00	4 2.20	12 6.59	1 0.55	0 0.00	0 0.00	2 1.10	1 0.55	18 9.89	101 55.49
11 ULMATU	0 0.00	2 1.19	0 0.00	0 0.00	4 2.38	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	15 8.93
TOTAL PERCENT	300 12.18	433 17.56	297 12.06	251 10.19	24 0.97	230 9.34	90 3.65	150 6.09	118 4.79	174 7.06	166 6.74
PRIORS	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833	0.0833


Discriminant Analysis
Corn 1979 and 1980
Both soil types included
100
percent
0
0
1
2
3
4
5
100
0
Dev Stage
0 1 2 3 4 5 6 7 8 9 10 11
Dev Stage
Vanderbilt
3-1981


Discriminant Analysis
Corn 1979 AND 1980
both soil types included
Percent
100
0
6
7
8
9
10
11
Dev Stage
0 1 2 3 4 5 6 7 8 9 10 11
Dev Stage
Vanderbilt
3-1981

UNDERSTANDING SPECTRAL/AGRONOMIC FEATURE SPACE

BACKGROUND

OUR UNDERSTANDING OF THE GENERAL CHARACTERISTICS OF LANDSAT SPECTRAL SPACE IS WELL DEVELOPED AND BASED ON THE TASSELLED CAP TRANSFORMATIONS OF BRIGHTNESS, GREENNESS, YELLOWNESS, AND NONSUCH. DETAILED UNDERSTANDING OF THE AGRONOMIC PROPERTIES OF THE LANDSAT AND THEMATIC MAPPER (TM) SPECTRAL SPACES REMAINS TO BE DEVELOPED. ANALYSES TO DATE HAVE BEEN LIMITED OFTEN TO THE EXISTING TRANSFORMATIONS, GREENNESS AND BRIGHTNESS, TRANSFORMED VEGETATION INDEX, AND THE RATIO IR/RED.

UNDERSTANDING SPECTRAL/AGRONOMIC FEATURE SPACE

OBJECTIVES

- DEVELOP DETAILED UNDERSTANDING OF THE RELATIONSHIP BETWEEN LANDSAT AND TM SPECTRAL SPACES AND AGRONOMIC SPACE CONCENTRATING EFFORT INITIALLY ON THE AGRONOMIC VARIABLE, CROP DEVELOPMENT STAGE AND LATER ON LEAF AREA INDEX AND STRESS.

- BASED ON THIS UNDERSTANDING, DEVELOP LINEAR AND NON-LINEAR SPECTRAL DATA TRANSFORMATIONS TO IMPROVE OUR ABILITY TO PREDICT THESE AGRONOMIC VARIABLES.

UNDERSTANDING SPECTRAL/AGRONOMIC SPACE ANALYSIS FLOW CHART

DATA SET SELECTION

EMPHASIS ON CORN AND SOYBEANS

CANDIDATE DATA SETS:
- PURDUE AGRONOMY FARM 1978-1980
- WEBSTER COUNTY, IOWA 1979

INPUT DATA PREPARATION

LANDSAT SEGMENTS TBD DATA SET TO INCLUDE:
- PLOT IDENTIFICATION
- AGRONOMIC DATA
- REFLECTANCE DATA
  - 4 LANDSAT BANDS
  - 6 THEMATIC MAPPER BANDS (IF AVAILABLE)
- METEOROLOGIC DATA

PLOTTING SOFTWARE PREPARATION AND PROGRAM DEVELOPMENT

- INPUT DATA INTERFACE
- WINDOW SELECTION ALGORITHM
- PRINCIPLE COMPONENT ANALYSIS
- ELLIPSOID OF CONCENTRATION PLOTTING ROUTINE

GENERATE 3-D SPECTRAL DISPLAYS--SIMULATED STEREO PLOTS

TYPE	DESCRIPTION
A	FULL DISPLAY OF DEVELOPMENT STAGE TRAJECTORIES IN 3 SPECTRAL SPACE
B	DISCRETE SEGMENT PLOTS OF DEVELOPMENT STAGE IN 3 SPECTRAL SPACE
C	CLUSTER AND/OR ELLIPSOID OF CONCENTRATION PLOTS IN 3 SPECTRAL SPACE CODED BY DEVELOPMENT STAGE

EVALUATION OF INITIAL RESULTS

DELIVERABLE

REITERATION AS NECESSARY

DELIVERABLES

* IMPROVED UNDERSTANDING OF SPECTRAL SPACE DESCRIBED IN A REPORT

* STEREO PAIRS OF PLOTS OF SPECTRAL DATA ILLUSTRATING THE PROPERTIES OF SPECTRAL/AGRONOMIC SPACE VIS-A-VIS CROP DEVELOPMENT STAGE

* IMPROVED SOFTWARE CAPABILITY TO PLOT SPECTRAL DATA AS STEREO PAIRS

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VIEW     120.00   57.00  150.00
XYZDATA       4      2      6
STAGES      1.   10.
USET  NNUL.
UPSET  GRID(  2.00).
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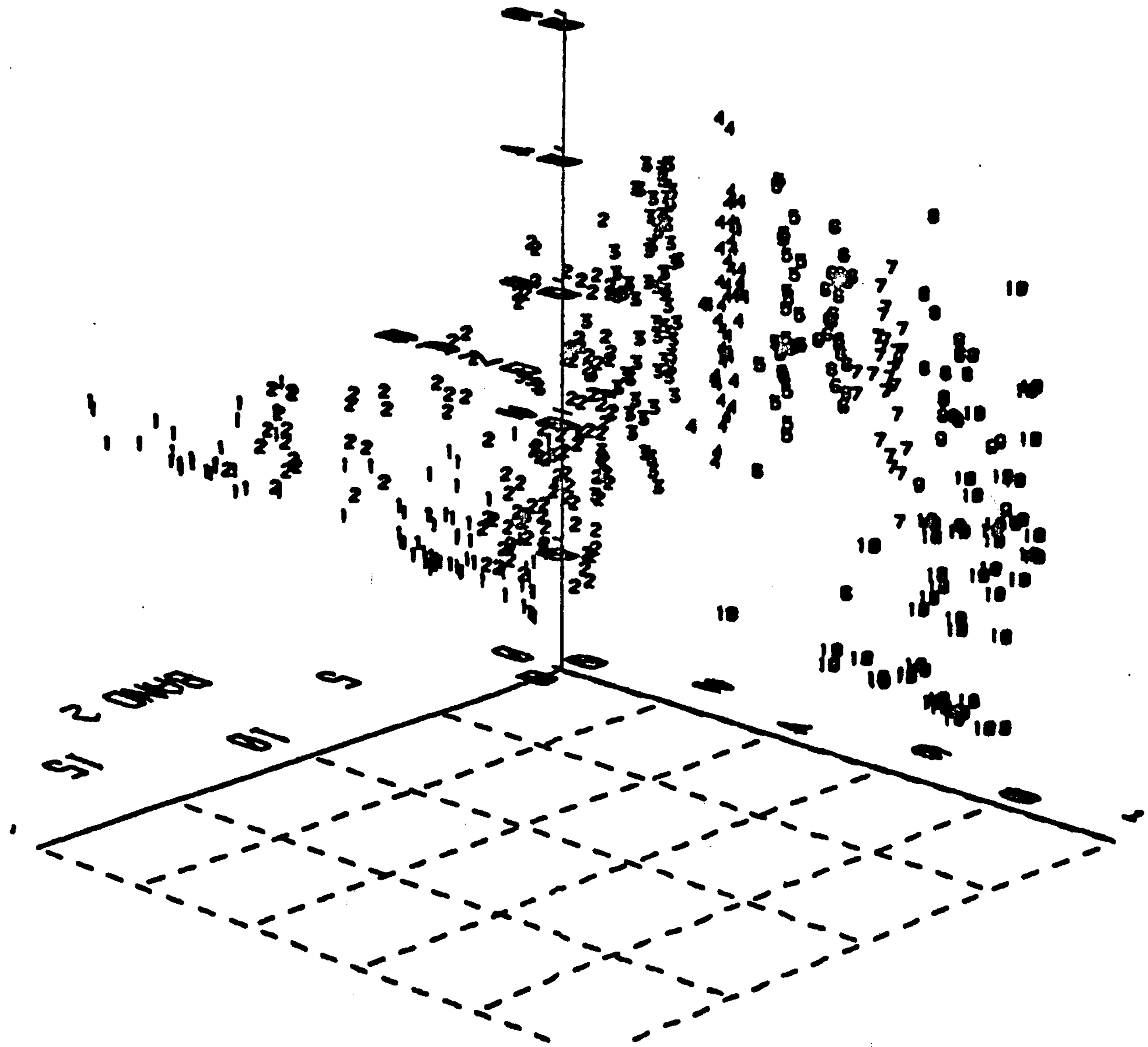


Estimating Canopy Characteristics with Spectral and Meteorological Data

Rationale

* If agronomic and canopy variables related to yield could be reliably estimated from multispectral satellite data, then crop growth and yield models could be implemented for large areas.

Overall Objective

* Evaluate spectral data as a source of information for crop yield models, i.e., estimates of leaf area index, percent cover, and intercepted solar radiation.

General Approach

* Identify important factors determining yield which potentially can be estimated from spectral data.
* Evaluate selected factors using spectral and agronomic data acquired in controlled experiments at agricultural experiment stations.
* Extend concepts to large areas using Landsat MSS data.
* Compare results with and without spectral data.

TASK 3. INTERCEPTED SOLAR RADIATION AS A VARIABLE IN YIELD MODELS

BACKGROUND

- SOLAR RADIATION AS AN ENERGY SOURCE FOR PLANTS AVAILABLE ONLY WHEN IT INTERACTS WITH LEAVES.
- THE PROPORTION OF TOTAL SOLAR RADIATION INTERCEPTED BY A CROP CANOPY IS AN ESTIMATE OF "USEFUL" ENERGY FOR CROP GROWTH AND YIELD.

OBJECTIVES

- VERIFY AND REFINE INITIAL MODELS FOR ESTIMATING THE PROPORTION OF SOLAR RADIATION INTERCEPTED (SRI) BY CORN CANOPIES.
- DEVELOP AND VERIFY INITIAL MODELS FOR SRI FOR SOYBEAN CANOPIES.

TASK 3.

APPROACH

1. EVALUATE THE ADEQUACY OF THE SRI MODEL DEVELOPED USING 1979 DATA TO DESCRIBE RELATIONSHIPS OF SPECTRAL VARIABLES AND CANOPY CHARACTERISTICS IN 1980 DATA.
   - CALCULATE STANDARD ERRORS OF ESTIMATES
   - EXAMINE RESIDUALS OF PREDICTED MINUS MEASURED VALUES OF SRI
   - REFINE MODEL TO ACCOUNT FOR PREVIOUSLY UNDEFINED VARIABILITY

2. ESTIMATE DAILY SRI AND ACCUMULATIVE SRI AND PREDICT GRAIN YIELDS USING ENERGY CROP GROWTH MODEL.

3. USE MODEL FORM DEVELOPED BY BADHWAR AND HENDERSON (1980) TO SMOOTH SPECTRAL DATA AND REDUCE VARIATION CAUSED BY INFREQUENT SPECTRAL DATA ACQUISITIONS.

4. EXTEND THE REFINED MODEL TO LANDSAT MSS DATA USING TECHNIQUES DEVELOPED IN TASK 2.

5. EVALUATE YIELDS PREDICTED BY MODELS WITH (LANDSAT MSS) AND WITHOUT SPECTRALLY-DERIVED SRI.
   - EXAMINE RESIDUALS OF PREDICTED YIELDS MINUS MEASURED YIELDS FOR PATTERNS.
   - REFINE MODELS TO ACCOUNT FOR UNDEFINED VARIABILITY.
   - EVALUATE MODELS IN TERMS OF ACCEPTABLE ERROR LIMITS DEFINED IN TASK 1.

6. MAKE RECOMMENDATION WHETHER ADDITIONAL LARGE AREA TESTING IS WARRANTED.

EFFECT OF ROW WIDTH
SOYBEANS 1979

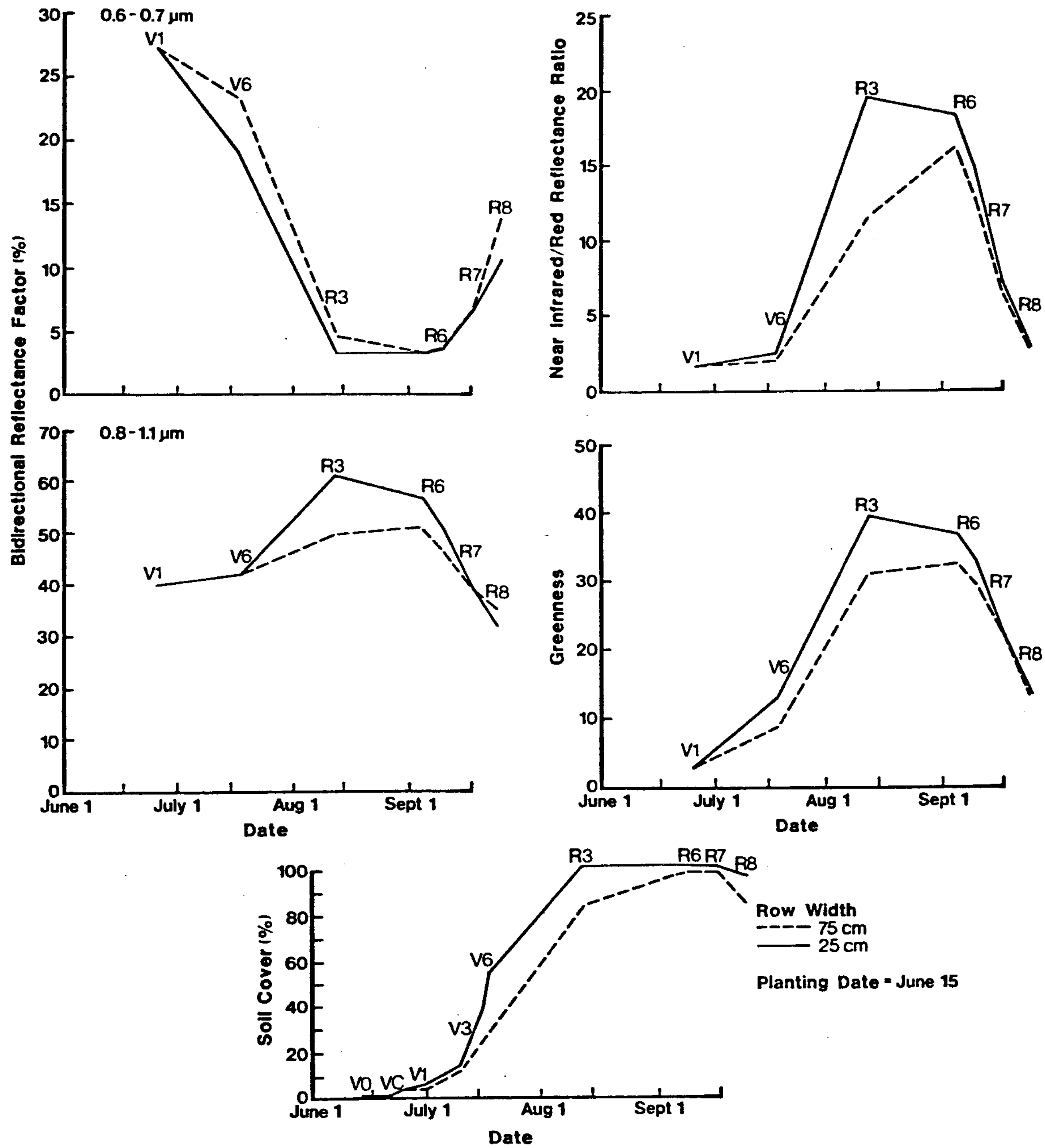


Figure 1.13. Seasonal changes in four spectral variables and percent soil cover for two row widths in 1979 for the June 15 planting date. Development stages (Fehr and Caviness, 1977) are indicated for each observation date. (Russell silt loam)

EFFECT OF PLANTING DATE
SOYBEANS 1979

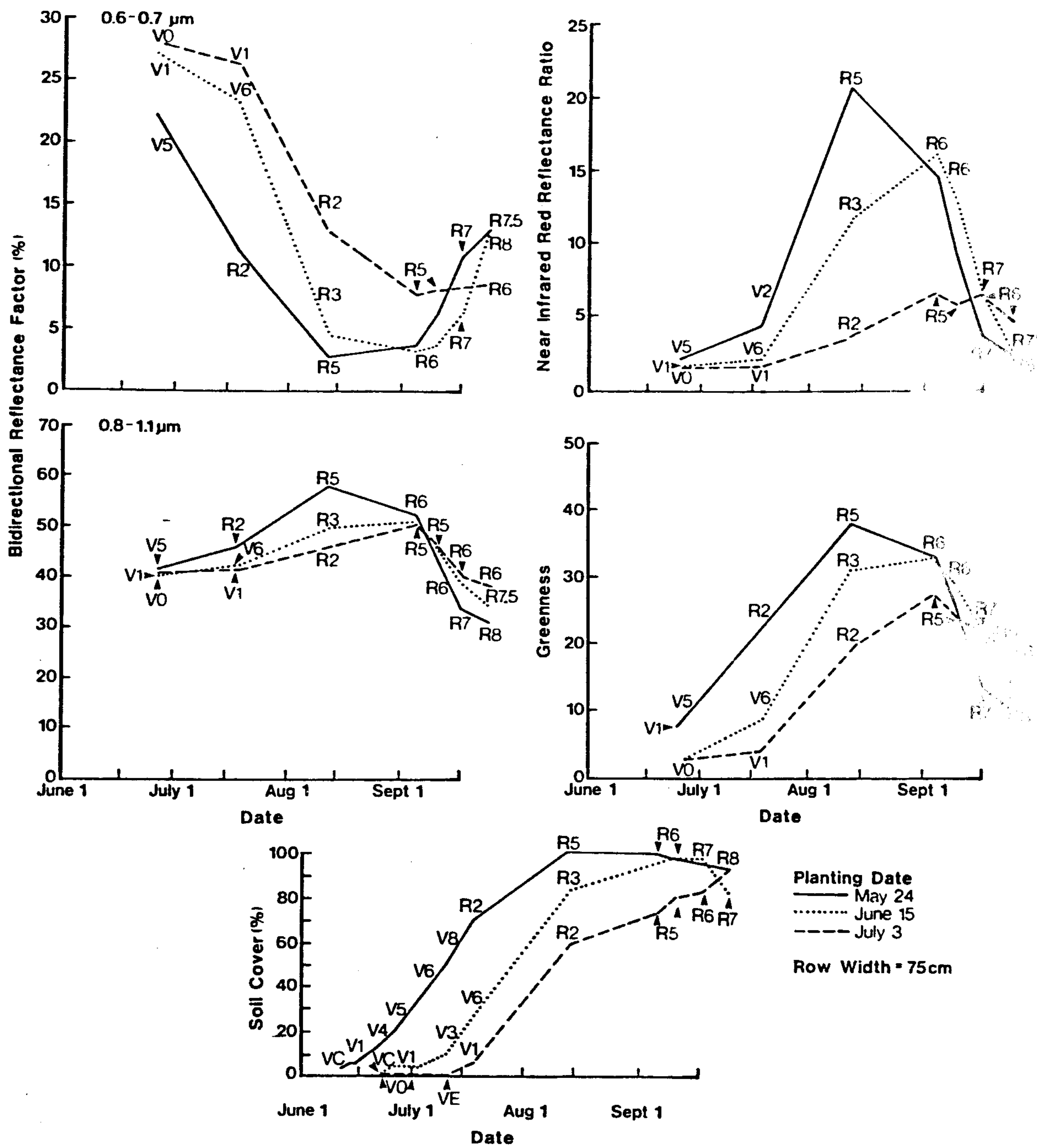
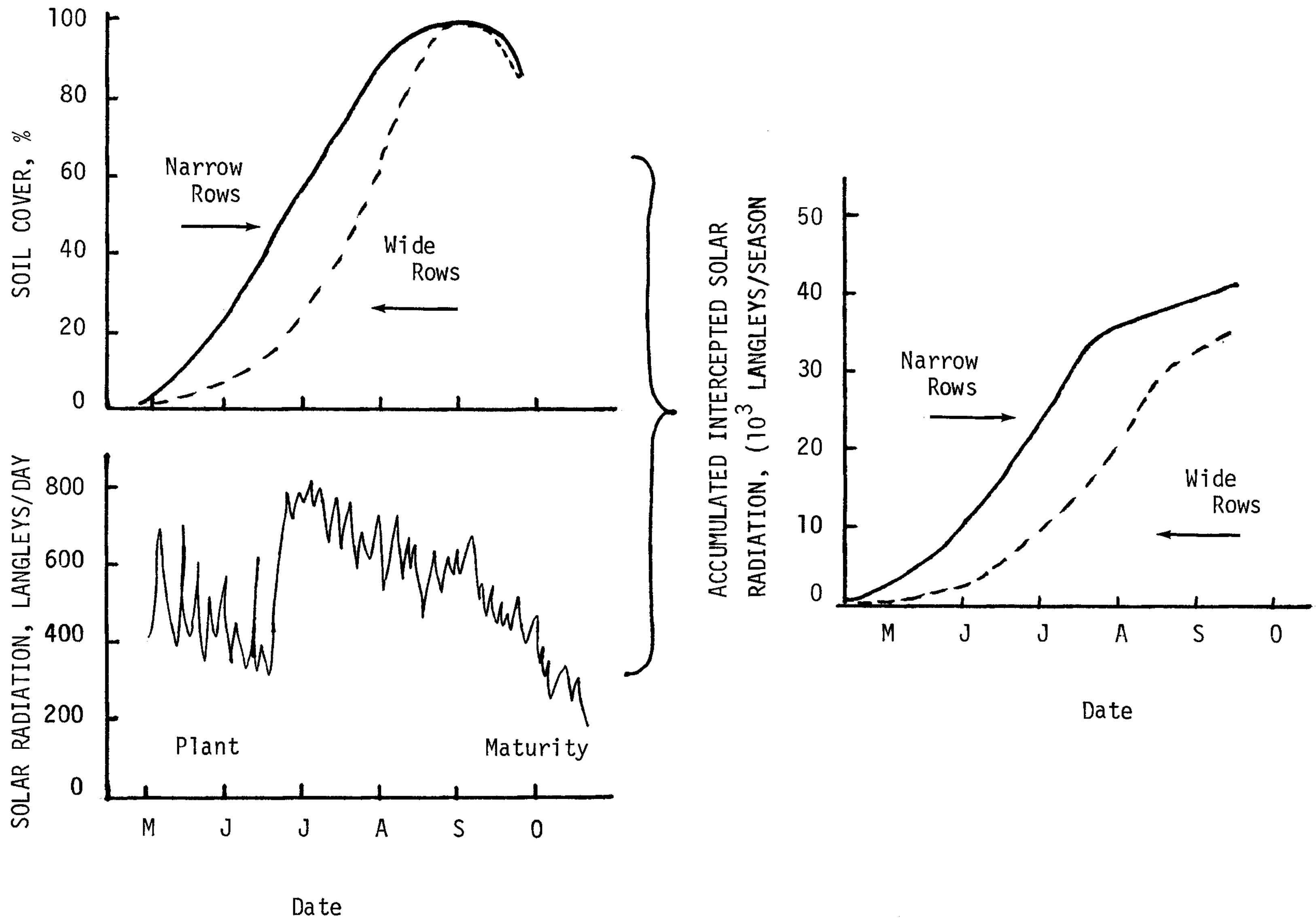
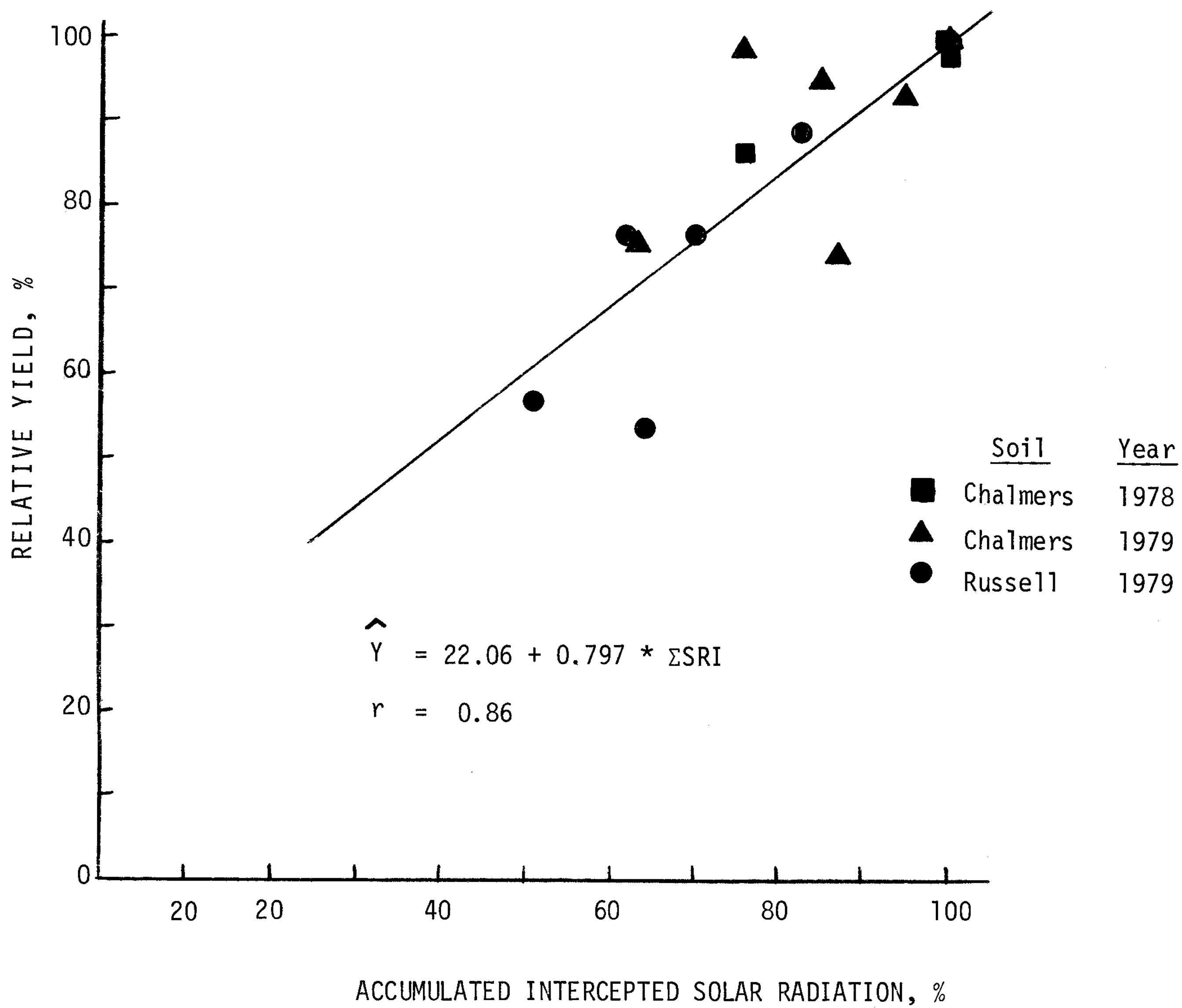


Figure 1.14. Seasonal changes in four spectral variables and percent soil cover for three planting dates in 1979 for 75 cm wide rows. Development stages (Fehr and Caviness, 1977) are indicated for each observation date. Arrows indicate development stages that are unique for that planting date. (Russell silt loam)

SOLAR RADIATION INTERCEPTED BY SOYBEANS



RELATIVE YIELDS OF SOYBEANS AS A FUNCTION
OF ACCUMULATED INTERCEPTED SOLAR RADIATION



Task 4. Effects of Major Cultural Practices on Spectral Properties of Crops

Background

- Crop production practices influence growth, development, yield and spectral response of crops.

- Cropping practices typically varied in corn and soybean fields are cultivar, plant population, row spacing, planting date, irrigation, fertility, and method of cultivation.

Objectives

- Determine the effects of cropping practices, soil background, and environmental factors on the reflectance of corn and soybean canopies.

- Determine which cropping practices can be identified from spectral data, particularly Landsat MSS data.

TASK 4. APPROACH

1. VERIFY QUALITATIVE ASSESSMENTS OF THE VARIATION IN SPECTRAL DATA ASSOCIATED WITH CULTURAL PRACTICES USING AN ADDITIONAL YEAR OF DATA FROM AGRONOMY FARM.

2. VERIFY THE MAGNITUDE OF THE VARIATION ASSOCIATED WITH EACH TREATMENT FACTOR USING ANOVA AND ANCOVA.

   - ANOVA DETERMINES THE PERCENTAGE OF TOTAL VARIATION IN SPECTRAL DATA ASSOCIATED WITH EACH FACTOR.
   - ANCOVA EVALUATES THE VARIABILITY DUE TO TREATMENTS AFTER ADJUSTMENTS FOR VARIATIONS IN LAI, % COVER, AND DEVELOPMENT STAGE.

3. EVALUATE THE INTERACTION OF YEARS X TREATMENT IN ANOVA AND ANCOVA.

4. EVALUATE THE POTENTIAL OF USING SPECTRAL DATA, PARTICULARLY LANDSAT MSS DATA, TO CHARACTERIZE THE CROPPING PRACTICES OF A REGION

   - IDENTIFY IRRIGATED FIELDS TO REFINE SOIL MOISTURE MODELS
   - IDENTIFY FIELDS WHERE DOUBLE CROPPING MAY OCCUR, IE.E, WHEAT FOLLOWED BY SOYBEANS
   - ASSESS THE PROGRESS OF FIELD OPERATIONS, I.E., HARVESTING AND LAND PREPARATION

Corn Cultural Practices Expt 1979

PERCENT OF VARIATION (R^2) EXPLAINED BY TREATMENTS

DATE	VARIABLE	SOIL	PLANTING DATE	PLANT POPULATION
6/4	RED	93	1	0
	IR	88	6	1
	GREENNESS	1	71	9
	LAI	1	67	13
7/10	RED	15	25	15
	IR	2	25	48
	GREENNESS	0	34	51
	LAI	0	28	62
9/4	RED	9	10	16
	IR	0	36	14
	GREENNESS	0	43	13
	LAI	1	20	45

Corn Cultural Practices Expt 1980

PERCENT OF VARIATION (R^2) ASSOCIATED WITH TREATMENTS

DATE	VARIABLE	SOIL	PLANTING DATE	PLANT POPULATION
6/11	RED	56	12	-
	IR	51	24	1
	GREENNESS	16	39	1
	LAI	-	55	24
7/15	RED	25	38	8
	IR	21	25	33
	GREENNESS	-	61	31
	LAI	-	60	24
8/22	RED	3	7	22
	IR	5	14	36
	GREENNESS	2	9	47
	LAI	16	27	35
9/26	RED	2	53	-
	IR	-	76	4
	GREENNESS	-	82	2
	LAI	-	-	-

Soybean Cultural Practices Expt 1979

PERCENT OF VARIATION (R^2) EXPLAINED BY TREATMENTS

DATE	VARIABLE	PLANTING DATE	CULTIVAR	ROW WIDTH	PC	PR
JUNE 4	RED	36	10	4	14	5
	IR	43	6	1	5	—
	GREENNESS	75	—	2	4	4
	% COVER	52	7	2	17	4
JULY 18	RED	66	—	12	—	8
	IR	40	8	33	7	7
	GREENNESS	54	4	30	4	3
	% COVER	53	—	34	1	3
AUGUST 12	RED	27	1	1	2	3
	IR	14	2	44	3	27
	GREENNESS	16	1	43	3	27
	% COVER	30	—	25	6	25
SEPT 4	RED	43	—	—	16	—
	IR	14	16	6	27	8
	GREENNESS	18	15	43	27	7
	% COVER	8	—	14	13	8
SEPT 24	RED	45	13	4	13	—
	IR	53	19	—	—	4
	GREENNESS	55	18	—	14	3
	% COVER	14	19	4	27	5

Soybean Cultural Practices Expt 1980

PERCENT OF VARIATION (R^2) ASSOCIATED WITH TREATMENTS

DATE	VARIABLE	SOIL	PLANTING DATE	CULTIVAR	ROW WIDTH	PC	PR
6/18	RED	13	13	1	8	-	16
	IR	15	44	2	2	1	3
	GREENNESS	2	82	-	-	-	2
	% COVER	-	88	-	-	-	7
7/17	RED	15	63	-	-	-	1
	IR	11	69	-	5	-	6
	GREENNESS	-	90	-	4	-	3
	% COVER	-	88	-	7	-	2
8/22	RED	-	52	6	9	1	13
	IR	-	10	16	29	4	28
	GREENNESS	-	12	16	29	5	28
	% COVER	-	35	1	19	1	35
	RED	-	87	-	-	10	-
	IR	-	85	10	1	2	-
	GREENNESS	-	87	8	-	3	-
	% COVER	-	66	5	-	15	-

PRELIMINARY
SUMMARY AND CONCLUSIONS

- PREVIOUS QUALITATIVE ASSESSMENTS OF THE VARIATIONS IN SPECTRAL DATA ASSOCIATED WITH CULTURAL PRACTICES CORN AND SOYBEANS WERE VERIFIED WITH AN ADDITIONAL YEAR OF DATA.

- EFFECTS OF PLANTING DATES AND PLANT POPULATIONS (ROW WIDTH) ARE MANIFESTED BY CHANGES IN LAI, SOIL COVER, AND DEVELOPMENT STAGE.

- VARIATION IN REFLECTANCE IS STRONGLY ASSOCIATED WITH

  * SOIL COLOR - EARLY IN SEASON
  * PLANTING DATE - EARLY TO MID-SEASON
  * PLANT POPULATION (ROW WIDTH) - MIDSEASON TO NEAR MATURITY
  * CULTIVAR - NEAR MATURITY

- SOIL COLOR AFFECTED VISIBLE AND NEAR IR REFLECTANCES BUT NOT GREENNESS

- GREENNESS IS MOST SENSITIVE TO AMOUNT OF GREEN VEGETATION

1981 Corn and Soybean Field Research Experiments

Technical Issues Being Addressed

- Development stage determination
- Estimation of LAI and solar radiation interception
- Moisture stress assessment
- Effects of and sensitivity to soil background
- Effects of and sensitivity to cultural practices and environmental factors
- Differences between U.S. (dent) and Argentina (flint) corn
- Thematic mapper data
- Extension of results/relationships from plot experiments to fields and radiometers to Landsat

RESEARCH SITES

- PURDUE AGRONOMY FARM
- WEBSTER CO., IOWA TEST SITE
- SANDHILLS AGRICULTURAL LABORATORY

Experiments at Purdue

Corn

2 Soil types (dark, light)
3 Planting dates (May 1, 15, 30)
3 Plant populations (25, 50, 75,000 plants/ha)
2 Hybrids (dent, flint)
2 Replications

Soybeans

2 Soil types (dark, light)
3 Planting dates (May 10, 30, June 10)
2 Row widths (25, 75 cm)
3 Cultivars (maturity groups II, III, IV)
2 Replications

DATA ACQUISITION

SPECTRAL

- MULTIBAND RADIOMETER, 8-SPECTRAL BANDS (.45 - 12.4 μm)

AGRONOMIC

- DEVELOPMENT STAGE
- LAI
- PLANT HEIGHT, % SOIL COVER
- SURFACE SOIL MOISTURE AND CONDITION
- NOTES ON STRESS, WEEDS, ETC.
- PHOTOGRAPHS, VERTICAL AND OBLIQUE VIEWS

FREQUENCY

- WEEKLY INTERVALS (WEATHER PERMITTING) FROM PLANTING TO HARVEST

Webster County, Iowa Test Site

Objectives

- Obtain measures of variation within and among fields
- Test relationships of development stage and LAI
- Evaluate simulated thematic mapper data

Data Acquisition

- Inventory of planting dates, and other agronomic data (USDA)
- Periodic observations of development stage, plant height, etc. (USDA)
- Detailed agronomic measurements (Purdue)
  - 10 corn and 10 soybean fields
  - development stage
  - LAI
- Grain yield estimates (USDA)
- Spectral data (NASA)
  - helicopter spectrometer (FSS)
  - aircraft scanner (NS001)
- Temperature and precipitation

Corn and Soybean Moisture Stress Research Plans

Blaine Blad and John Norman
University of Nebraska

Background/Rationale

- Differences in moisture availability and stress are major sources of variation in yields of corn and soybeans

- While it's generally known that moisture stress affects spectral characteristics of vegetative canopies, as well as growth and yield, relatively little research on moisture stress effects and relationships has been conducted and relatively little use is made of remotely sensed spectral measurements to assess crop condition

Description of Research Site and Facilities

- Sandhills Agricultural Laboratory
  - West central Nebraska, sandy soils, 15-20" precipitation annually
  - High probability of developing moisture deficits

- Irrigation System and Treatments
  - System designed to produce linearly decreasing amount of water with increasing distance from line source
    - Water gradient from full-water to dryland can be developed across a plot
  - Treatments will include amount (gradient) and timing (during vegetative, flowering and grain-fill periods) of irrigation

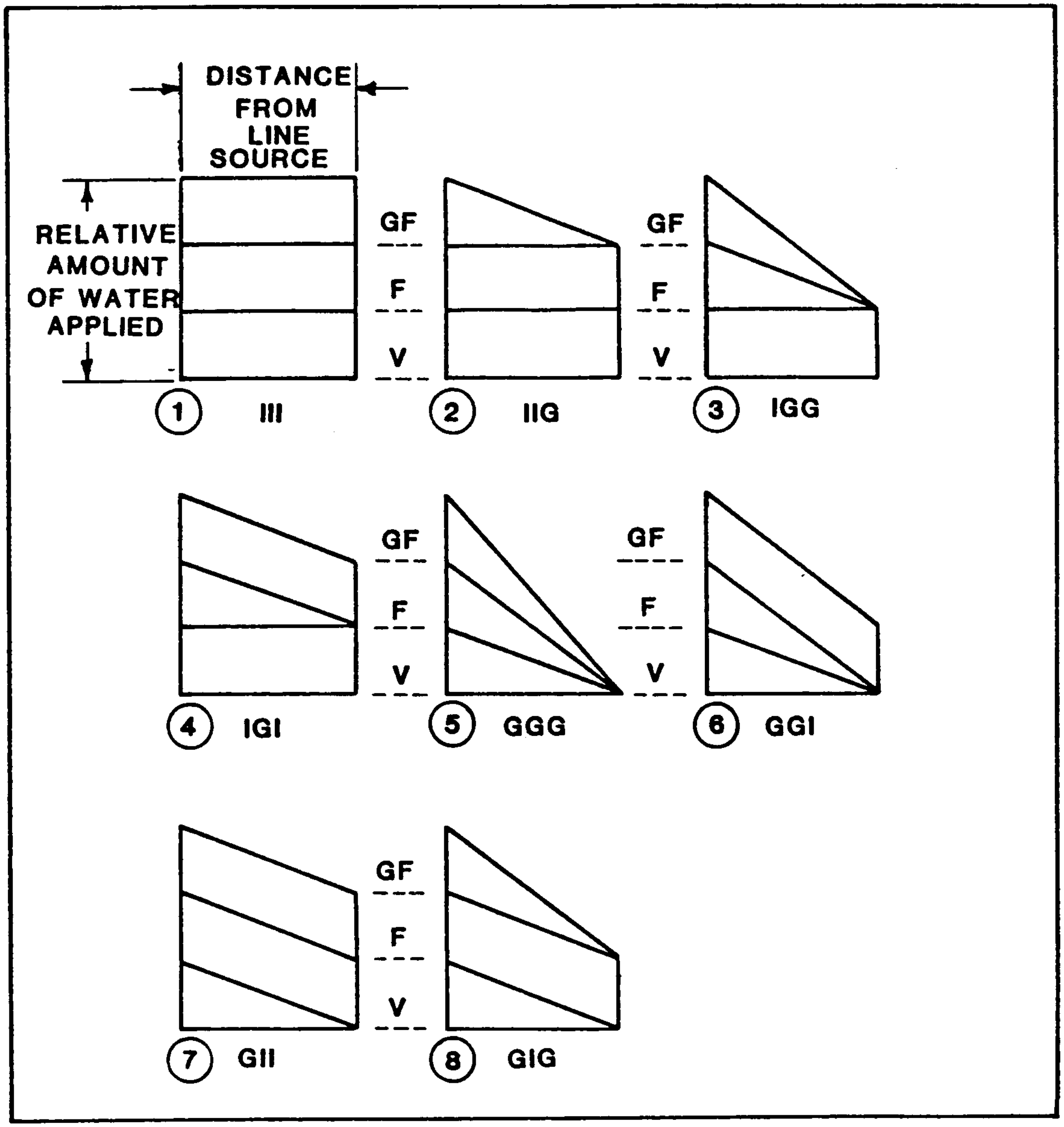
Overall Objective

- Determine how various plant and environmental factors affect the radiance from corn and soybean canopies so that remotely sensed spectral measurements can be correctly interpreted with a minimum of ancillary data

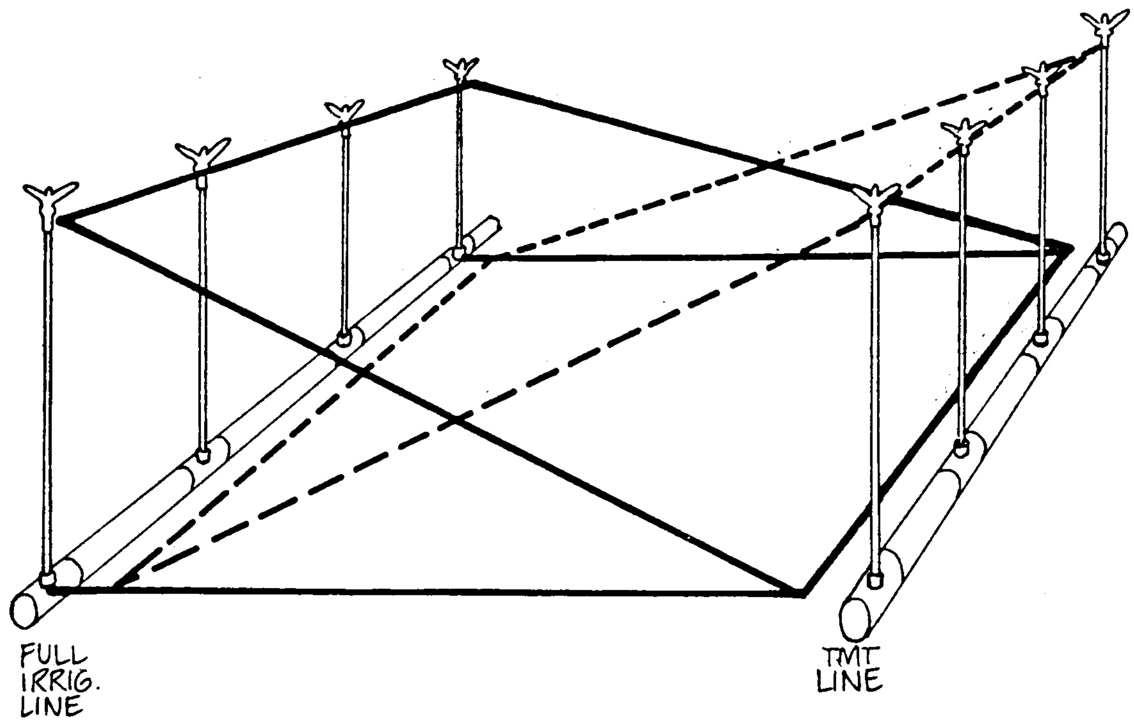
General Approach

- Use field measurements and plant-environment modeling to quantitatively assess factors, particularly moisture stress, affecting plant canopy radiance

- Develop model requiring minimum essential variables to interpret remotely sensed spectral response of vegetation



Seasonal accumulation of water applied through irrigation using a modified line source system. Water treatments applied during the vegetative (V), flowering (F) and grain-fill (GF) periods. With a gradient treatment (G), plants on the left side of each diagram receive full irrigation; those on the right receive no irrigation.



Schematic of "full" and "treatment" sprinkler lines and the water application pattern resulting from the operation of individual lines. Total water application is the sum of the amounts from the individual patterns.

- Description of Plant-Soil-Atmosphere Model (CUPID)
  - Inputs: solar radiation, air temp., soil temp., vapor pressure, precipitation, wind, soil moisture, stomatal diffusion resistance, LAI, Leaf angle distribution, plant hieght
  - Description: physical-physiological model which considers turbulent transfer in, above and below the canopy, radiative transfer in the canopy, and heat and water movement in the soil
    - Predicts individual leaf processes and then integrates results to predict canopy characteristics
  - Outputs: canopy reflectance and temperature evapotranspiration and photosynthesis

FIELD MEASUREMENTS

- CANOPY REFLECTANCE AND RADIANT TEMPERATURE
- SOLAR IRRADINACE
- METEOROLOGICAL VARIABLES: TEMPERATURE, WIND, PRECIPITATION, ETC.
- CANOPY VARIABLES: LAI, LEAF ANGLE DISTRIBUTION, ETC.
- LEAF PHOTOSYNTHESIS AND TRANSPIRATION

DATA ANALYSIS

- FIELD MEASUREMENTS AND MODEL PREDICTIONS COMBINED TO
  - RELATE SPECTRAL MEASUREMENTS TO CROP WATER STATUS
  - COMPARE MODEL OUTPUTS TO CANOPY MEASUREMENTS OF RADIANCE
  - RELATE RADIANCE MEASUREMENTS TO CANOPY MICROENVIRONMENT AND PHYSIOLOGICAL CHARACTERISTICS
- MULTISPECTRAL MEASUREMENTS ANALYZED TO
  - DETERMINE MOST USEFUL SPECTRAL BANDS
  - DEVELOP SPECTRAL RESPONSE-PLANT WATER STATUS RELATIONSHIP
- USE MODEL TO STUDY SEPARATE AND COMBINED MICROCLIMATE, SOIL, AND PLANT CHARACTERISTICS ON CANOPY RADIANCE
- USE MODEL TO PREDICT CANOPY SPECTRAL CHARACTERISTICS
- DEVELOP MODEL REQUIRING MINIMUM ESSENTIAL VARIABLES TO INTERPRET REMOTELY SENSED SPECTRAL RESPONSE OF VEGETATION

Evaluation of Landsat Spectral Inputs to Crop Growth and Yield Models

Overall Objective

To evaluate the utility of satellite-acquired spectral data in conjunction with meteorological and soils data to estimate crop development stage, condition, and yield.

Background/Rationale

- Field research has shown that spectral data can improve meteorologically-based estimates of crop development stage, condition, and yield.
- Spectral research has been conducted primarily at the plot or field level.
- Integration of spectral and meteorological variables for prediction needs to be evaluated over a wider range of agronomic and environmental conditions.

General Approach

- The CROPCAST system developed by EarthSat will be used as a test-bed.
- Sensitivity of the CROPCAST model to potential spectrally-derived variables will be assessed.
- Spectral inputs developed in the supporting field research activity will be tested.
- Statistical experiments will enable
  - Evaluation of addition of individual spectral variables to CROPCAST
  - Evaluation of several spectral variables jointly in the prediction model
  - Evaluation of the model both with and without spectral inputs
- The sensitivity of the model to spectral inputs and missing spectral data will be assessed.

Specific Objectives

- Determine the sensitivity of the yield estimates produced by CROPCAST to changes in factors which may have spectral inputs:
  - Planting date
  - Development Stage
  - Evapotranspiration (ET)
  - Potential evapotranspiration (PET)

- Evaluate the utility of spectrally-derived crop development stage information in AgRISTARS yield prediction:
  - Assess the effect of using spectral information in the CROPCAST development stage submodel on development stage estimates
  - Assess the effect of using spectral information in the CROPCAST development stage submodel on yield estimates

SPECIFIC OBJECTIVES (CONT.)

- EVALUATE THE UTILITY OF SPECTRALLY-DERIVED VARIABLES ON ESTIMATES OF ET AND PET USED BY CROPCAST
  - TEST AND EVALUATE AN ET SUBMODEL UTILIZING SPECTRALLY-GENERATED LAI ESTIMATES IN THE CROPCAST FRAMEWORK
  - TEST AND EVALUATE AN ET SUBMODEL UTILIZING SPECTRALLY-GENERATED SRI ESTIMATES IN THE CROPCAST FRAMEWORK
- EVALUATE THE DIRECT ADDITION OF SPECTRAL DATA TO THE YIELD PREDICTION RATHER THAN ONLY THROUGH THE ET AND PET SUBMODELS
  - USE OF SPECTRAL DATA PREDICTION AS CONFIRMATION TO THE METEOROLOGICAL MODEL
  - USE OF SPECTRALLY-DERIVED VARIABLES AS COVARIATES IN THE YIELD EQUATION

Specific Objectives (cont.)

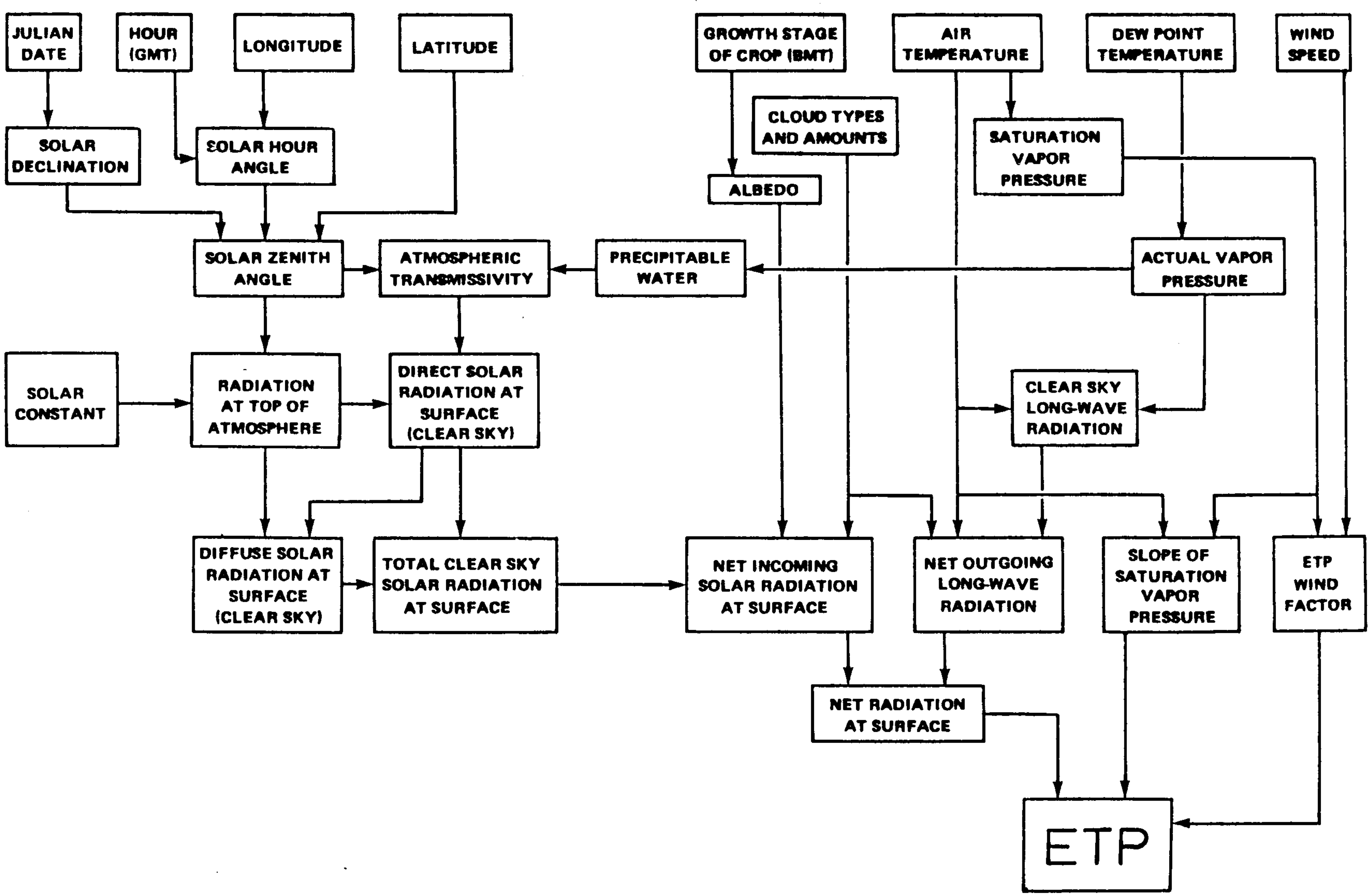
- Use spectral techniques to identify drought-stressed regions using Landsat data and compare stress assessments obtained in this way with those generated by the CROPCAST submodel.

  - Detect stress-induced spectral patterns in Landsat segment data and compare the locations and times of these events with similar events identified by CROPCAST
  - Assess the effect of overriding CROPCAST stress estimates by spectrally-derived stress estimates

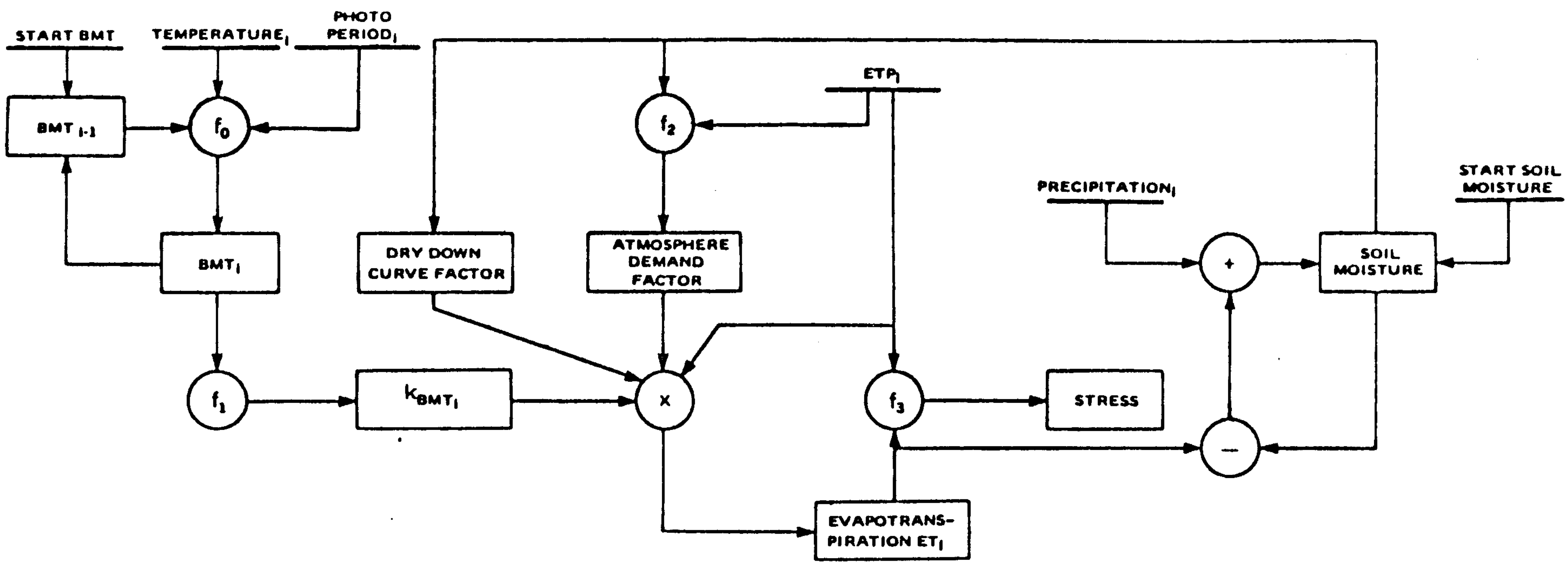
- Identify major cultural practices and land use (e.g., irrigation, fall plowing, double cropping, harvest operations)

  - Assess percent of cropland being irrigated to refine CROPCAST soil moisture estimates and weight yield estimates for irrigated and non-irrigated areas
  - Identify harvest-related patterns in multispectral data and develop algorithms to assess harvest progress
  - Assess utility of spectral data in determination of field preparation

CROPCAST PREDICTION OF POTENTIAL EVAPOTRANSPIRATION



CROPCAST PLANT GROWTH MODEL



CROPCAST YIELD PREDICTION

- COMPUTE STRESS TERM FOR EACH DAY BASED ON ET AND ETP

$$STRS_i = 1.0 - \alpha\,(ETPBASE - ETP_i) - \beta \ln(ET_i/ETP_i)[0.1]$$

$STRS_i$ - effective daily stress on day i

ETPBASE - climatic variable which usually is maximum ETP

ET_i - total ET on day i

- COMPUTE CUMULATIVE YIELD LOSS TO DATE OF PREDICTION

Cumulative loss

$$LOSS = \sum_{i=1}^{N} STRS_i * MAXLOSS_i$$

$MAXLOSS_i$ - maximum daily yield loss in percent

- COMPUTE PREDICTED YIELD FOR A REGION

$$YIELD_{cell} = MAXYIELD*(1 - LOSS/100)$$

MAXYIELD - estimated local yield attainable if all factors (weather, etc.) are ideal

RESULTS EVALUATION

- RESULTS WILL BE EVALUATED BASED ON
  - ACCURACY
  - SPATIAL RESOLUTION
  - TIMELINESS OF OBSERVATION
- ACCURACY OF YIELD ESTIMATES WILL BE DETERMINED BY
  - EVALUATION ON OBSERVED FIELDS IN SEGMENT DATA
  - COMPARISON WITH USDA/ESCS STATISTICS AT COUNTY AND HIGHER LEVELS (OR FOREIGN EQUIVALENT)
- ACCURACY OF AG VARIABLES (E.G., DEVELOPMENT STAGE, ET)
  - COMPARISON OF DEVELOPMENT STAGE WITH GROUND OBSERVED SEGMENT DATA AND USDA REGIONAL ESTIMATES
  - EVALUATION OF ET WITH CROP MOISTURE INDEX (USDA)
  - EVALUATION OF CULTURAL PRACTICES BASED ON SEGMENT INVENTORY DATA

Progress Last Quarter

- Presented implementation plans at JSC
- Initial contact and planning with EarthSat

Plans for Next Quarter

- Refinement of approach when EarthSat is under contract
- Design of spectral data interfaces with CROPCAST
- Initiation of sensitivity analyses

FIELD RADIOMETER ACQUISITION

SPECIFIC OBJECTIVE:

TO ACQUIRE FIELD RADIOMETERS, DATA LOGGERS, AND INSTRUMENTATION BOOMS NECESSARY TO AUGMENT THE SUPPORTING FIELD RESEARCH GROUND DATA ACQUISITION.

Accomplishments for this Quarter

1. Majority of hardware specified and ordered
2. Plans made for modification of pick-up trucks
3. Purdue data logger streamlined from prototype
4. Plans for helicopter system begun

Plans for next Quarter

1. Install booms on pick-up trucks
2. Install polycorder data loggers and other instrumentation - using Model 100 sensors

EQUIPMENT ACQUISITION

15	Barnes Model 12-1000 modular multiband radiometers
12	Omnidata polycorder data loggers (truck operations)
4	Purdue data loggers (helicopter operation & back-up)
5	Nikon/Purdue 250 frame 35mm motor drive cameras
4	Nikon 36 frame 35mm motor drive cameras
2	Long boom with pick-up truck modifications
1	Short boom with pick-up truck modifications
2	Short booms
10	Calibration panels

1981 DEPLOYMENT

SITE	SENSOR	BOOM	MODIFY TRUCK	LOGGER	CAMERA	CAL PANEL	DATE
PURDUE	MMR	LONG	YES	POLY PURDUE	250MD	2	APRIL
KANSAS STATE	MMR	LONG	YES	POLY	36MD	3	APRIL
S. DAKOTA STATE	MMR	SHORT	YES	POLY	36MD	2	JUNE
NEBRASKA	MMR	LONG	YES	POLY	250 MD	2	MAY

DESCRIPTION OF DATA LOGGERS

ITEM	PURDUE LOGGER	POLYCORDER LOGGER
DATA CHANNELS	15	10
DYNAMIC RANGE	0 TO 5 VOLTS	0 TO 5 VOLTS
ACQUISITION INTERVAL	0.8 MILLISECONDS, ALL DATA	40 MILLISECONDS, 8 CHANNELS
RESOLUTION	12 BITS	12 BITS
ACCURACY (TOTAL)		
LINEARITY AND NOISE (25 C)	± 1 BIT	± 1 BIT
TEMP CO	± 0.05 BIT/C^{0}	± 0.04 BIT/C^{0}
MEMORY CAPACITY		
10 CHANNELS + HOUSEKEEPING	4096 OBSERVATIONS	400 OBSERVATIONS
15 CHANNELS + HOUSEKEEPING	3120 OBSERVATIONS	N/A
MEMORY RETENTION	30 DAYS	30 DAYS
DIGITAL OUTPUT	16 BIT PARALLEL	RS232C
	H.P. 975	4 BCD DIGITS
POWER	12V @ MA	INTERNAL PRIMARY & BACK-UP
SIZE	12 x 13.25 x 9.19' IN^3	8 x 4.75 x 3 IN^3
	30 x 33.7 x 23.3 CM^3	20.3 x 12.1 x 7.62
MASS	EST 8.2 K G	1.5 KG

TRAINING AND COORDINATION OF RADIOMETER USERS

OVERALL OBJECTIVE:

TRAIN AND COORDINATE NEW INVESTIGATORS IN THE USE OF FIELD RADIOMETER SYSTEMS

SPECIFIC OBJECTIVES:

- IDENTIFY AND SELECT USERS
- PREPARE AND DISTRIBUTE MANUALS DESCRIBING SYSTEM OPERATION, DATA HANDLING, MAINTENANCE, AND CALIBRATION
- CONDUCT ON SITE TRAINING SESSIONS

ACCOMPLISHMENTS FOR THIS QUARTER

USERS IDENTIFIED (TENTATIVE) IN CONCERT WITH TECHNICAL MONITOR

1981 INVESTIGATORS IDENTIFIED AND PLANS FOR IMPLEMENTATION BEGUN

- PURDUE
- KANSAS STATE
- S.D. STATE
- NEBRASKA

FIELD RESEARCH DATA ACQUISITION, PREPROCESSING AND MANAGEMENT

OVERALL OBJECTIVE

ACQUIRE, PREPROCESS, AND MANAGE THE REQUIRED DATA (SPECTRAL, AGRONOMIC, METEOROLOGICAL, AND OTHER ANCILLARY DATA) TO SUPPORT THE CROP IDENTIFICATION, AREA ESTIMATION, AND CONDITION ASSESSMENT FIELD RESEARCH TASKS IDENTIFIED IN THE AGRISTARS SUPPORTING FIELD RESEARCH PROGRAM TECHNICAL PLAN.

Specific Objectives for 1981 (with completion or target completion date)

1. Experiment Design

Define and coordinate 1981-82 field research experiments with corn-soybean, small grains, and cotton-rice research teams

- Development stage
- Estimation of LAI, percent cover, etc.
- Crop stress
- Cultural practices
- Soil background effects

SPECIFIC OBJECTIVES FOR 1981 (WITH COMPLETION OR TARGET COMPLETION DATE) CON'T.

2. DATA ACQUISITION

(1) PREPARE AND CALIBRATE FIELD REFLECTANCE STANDARDS (5/30/81)

(2) ACQUIRE 1981 PURDUE AGRONOMY FARM FIELD RESEARCH DATA USING EXOTECH 100 AND/OR BARNES 12-1000 (10/15/81)

*(3) ACQUIRE DETAILED AGRONOMIC MEASUREMENTS FOR SELECTED FIELDS AT WEBSTER CO., IA TEST SITE (10/15/81)

(4) COLLECT FSS DATA OVER GRAY PANELS AND GREEN COLOR PANEL (9/1/81)

(5) DETERMINE, ACQUIRE, AND/OR ASSEMBLE FIELD RESEARCH SOILS AND/OR CROP INFORMATION FOR ARGENTINA AND BRAZIL (9/1/81)

*(6) ACQUIRE LEAF AREA METERS FOR USE AT CORN/SOYBEAN TEST SITES (5/1/81)

(7) COORDINATE ACQUISITION AND PREPROCESSING OF 1981 WEBSTER CO. AND CASS CO. FIELD RESEARCH DATA WITH NASA/JSC (5/1/81)

* CANCELLED

Specific Objectives for 1981 (with completion or target completion date) con't.

3. Data Preprocessing

(1) Preprocess 1980 Purdue Agronomy Farm Exotech 20C Data (Completed 1/27/81)

(2) Preprocess 1980 Purdue Agronomy Farm Exotech 100 Data (Completed 1/12/81)

(3) Update 1980 Purdue Agronomy Farm agronomic data (Completed 2/27/81)

(4) Complete 1979 FSS data preprocessing (Completed 3/16/81)

(5) Preprocess 1980 FSS data (7/1/81)

(6) Preprocess 1980 aircraft NS001 multispectral scanner data (7/1/81)

(7) Preprocess 1980 aircraft radar data (9/1/81)

(8) Complete preprocessing of 1979 corn leaf spectra (Completed 1/22/81)

(9) Preprocess 1981 Exotech 20C data (1/1/82)

(10) Preprocess 1981 Exotech 100 data (1/1/82)

(11) Preprocess 1981 Barnes 12-1000 data (1/1/82)

(12) Preprocess 1981 FSS data (4/1/82)

(13) Preprocess 1981 aircraft scanner data (3/1/82)

(14) Preprocess 1981 radar data (7/1/82)

SPECIFIC OBJECTIVES FOR 1981 (WITH COMPLETION OR TARGET COMPLETION DATE) CON'T.

4. DATA BASE MANAGEMENT

DISTRIBUTION

(1) - DISTRIBUTE DATA FOR ALL APPROVED REQUESTS

MAINTENANCE

(1) - CORRECT ERRORS IN 1979 PURDUE AGRONOMY FARM DATA (6/1/81)

(2) - CONVERT 1974-79 FSS TAPES TO NEW TAPE FORMAT, ADD ADDITIONAL AGRONOMIC DATA, AND DO WAVELENGTH CORRECTION. (10/1/81)

(3) - ADD ADDITIONAL AGRONOMIC DATA WITH NORTH DAKOTA AND KANSAS 1975-77 AGRICULTURE EXPERIMENT STATION DATA (11/1/81)

(4) - STORE COPY OF SPECTROMETER/MULTIBAND RADIOMETER DATA IN A VAULT (11/1/81)

(5) - DETERMINE PROCEDURE FOR INCLUDING SMALL GRAINS AND COTTON/RICE FIELD RESEARCH DATA INTO FIELD RESEARCH DATA BASE STORED AT LARS (6/1/81)

SPECIFIC OBJECTIVES FOR 1981 (WITH COMPELTION OR TARGET COMPLETION DATE) CON'T.

4. DATA BASE MANAGEMENT (CON'T.)

DOCUMENTATION

(1) - UPDATE EXPERIMENT SUMMARIES (4/1/81)

(2) - PUBLISH COPY OF SPECTROMETER/RADIOMETER TAPE FORMAT (LARS PUBLICATION AND/OR NASA PUBLICATION) (5/1/81)

(3) - PUBLISH COPY OF SPECTROMETER/MULTIBAND RADIOMETER DATA RECORD FORMS AND INSTRUCTIONS (6/1/81)

(4) - UPDATE FIELD RESEARCH CATALOG (11/1/81)

VERIFICATION

(1) - PRODUCE DOCUMENT CONTAINING RECORD OF FSS DATA COLLECTED OVER CALIBRATION PANEL (12/1/81)

(2) - PRODUCE DOCUMENT CONTAINING SUMMARY OF FSS DATA COLLECTED OVER FIELDS (2/1/82)

SPECIFIC OBJECTIVES FOR 1981 (WITH COMPLETION OR TARGET COMPLETION DATE) CON'T.

4. DATA BASE MANAGEMENT (CON'T.)

SOFTWARE SUPPORT

(1) - IMPLEMENT WAVELENGTH CORRECTION OF 1975-79 DATA IN LARSPEC (4/15/81)

(2) - IMPLEMENT CAPABILITY TO PLOT DATA WITH DIFFERENT WAVELENGTH RESOLUTIONS ON THE SAME GRAPH IN LARSPEC, EG. MULTIBAND RADIOMETER AND FSS DATA (4/15/81)

(3) - UPDATE LARSPEC DOCUMENTATION (10/1/81)

(4) - IMPLEMENT REQUIRED GRAPHICS ROUTINES TO SUPPORT CROP DEVELOPMENT STAGE AND CROP VEGETATION TASKS. (WORKING SYSTEM COMPLETED 1/31/81)

(5) - IMPLEMENT WESTINGHOUSE VERSION OF GCS INCLUDING CONTOUR PLOTS, SURFACES PLOTS, HIGH LEVEL GRAPHIC ROUTINES (5/1/81)

(6) - IMPLEMENT NON-UNIFORM BAND AVERAGES IN LARSPEC (9/1/81)

(7) - IMPLEMENT SPECTROMETER/MULTIBAND RADIOMETER SEARCH SOFTWARE (EQUIVALENT TO SUBSET FOR R, T & E DATA BASE) (12/1/81)

(8) - COMPLETE IMPLEMENTATION OF SOFTWARE TO READ MULTIBAND RADIOMETER DATA FROM DATA LOGGER THRU THE PDP 11 (10/1/81)

(9) - IMPLEMENT CAPABILITY TO STORE AGRONOMIC OBSERVATIONS FOR PLOTS WHICH HAVE NO SPECTRAL DATA (11/1/81)

Accomplishments For This Quarter

1. Data Preprocessing

(1) Preprocessing of 1980 spectral and agronomic data collected at Purdue Agronomy Farm completed for all experiments:

Wheat Disease
Winter Wheat Fertilization
Corn Cultural Practices
Soybean Cultural Practices
Soybean Sun View Angle
Soybean Row Direction

(2) Last available dates of 1979 FSS data completed. 10/25 & 11/2.

(3) 1979 corn leaf spectra completed

ACCOMPLISHMENTS FOR THIS QUARTER (CON'T.)

2. DATA BASE MANAGEMENT

   (1) AIRCRAFT MSS AND FSS DATA DISTRIBUTED TO GODDARD INSTITUTE FOR SPACE STUDIES

   (2) EXPERIMENT SUMMARIES COMPLETED FOR 1980 PURDUE AGRONOMY FARM EXPERIMENTS.

ORGANIZATIONS INVOLVED IN ACQUISITION OF 1981 CORN/SOYBEAN FIELD RESEARCH DATA

- NASA/JOHNSON SPACE CENTER
- PURDUE/LABORATORY FOR APPLICATIONS OF REMOTE SENSING
- UNIVERSITY OF NEBRASKA

CORN/SOYBEAN TEST SITES

- TIPPECANOE CO., INDIANA
- MCPHERSON CO., NEBRASKA
- WEBSTER CO., IOWA

SUMMARY OF CORN/SOYBEAN FIELD RESEARCH TEST SITES AND MAJOR CROPS IN DATA BASE

Test Site State County	Major Crop	Crop Years
Indiana, Tippecanoe	Corn & Soybeans	1978-1980
	Winter Wheat	1979-1980
Iowa, Webster	Corn & Soybeans	1979-1980
Nebraska, McPherson	Corn	1979-1980
*'U.S. & Brazil'	250 Soil Types	1978

*Applicable for all Field Research teams

Summary of Small Grains Field Research Test Sites and Major Crops in Data Base

Test Site State County	Major Crop	Crop Years
Kansas, Finney	Winter Wheat	1975-1977
North Dakota, Cass	Spring Wheat Barley Sunflowers Soybeans	1980
North Dakota, Williams	Spring Wheat	1975-1977
South Dakota, Hand	Spring Wheat Winter Wheat	1976-1979

SUMMARY OF COTTON/RICE/SORGHUM FIELD RESEARCH TEST SITES AND MAJOR CROPS IN DATA BASE

Test Site State County	Major Crop	Crop Years
Texas, Wharton	Cotton Rice Soybeans	1980

Summary of NASA/JSC Field Research Data Base

Instrument/Data Type	Crop Year(s) 1975-1980
Landsat MSS Whole Frame CCT (Frames	124
Aircraft Multispectral Scanner (Dates/flightlines)	54/335
Helicopter Mounted Field Spectrometer (Dates/observations)	
Field Averages	89/7769
Individual Scans	89/131,009
Truck Mounted Field Spectrometer (Dates/observations)	
NASA/JSC FSAS	45/813
Purdue Exotech 20C	141/8489
NASA/ERL Exotech 20D	45/645
Truck Mounted Field Multiband Radiometer (Dates/observations)	
Purdue Exotech 100	95/24,491

PLANS FOR NEXT QUARTER

1. Experiment Design

   - Complete planning of 1981 Experiments

2. Data Acquisition

   - Prepare and calibrate field standards
   - Begin acquisition of Purdue Agronomy Farm data

3. Data Preprocessing

   - Complete 1980 Cass Co., & Webster Co. NS001 data

4. Data Management

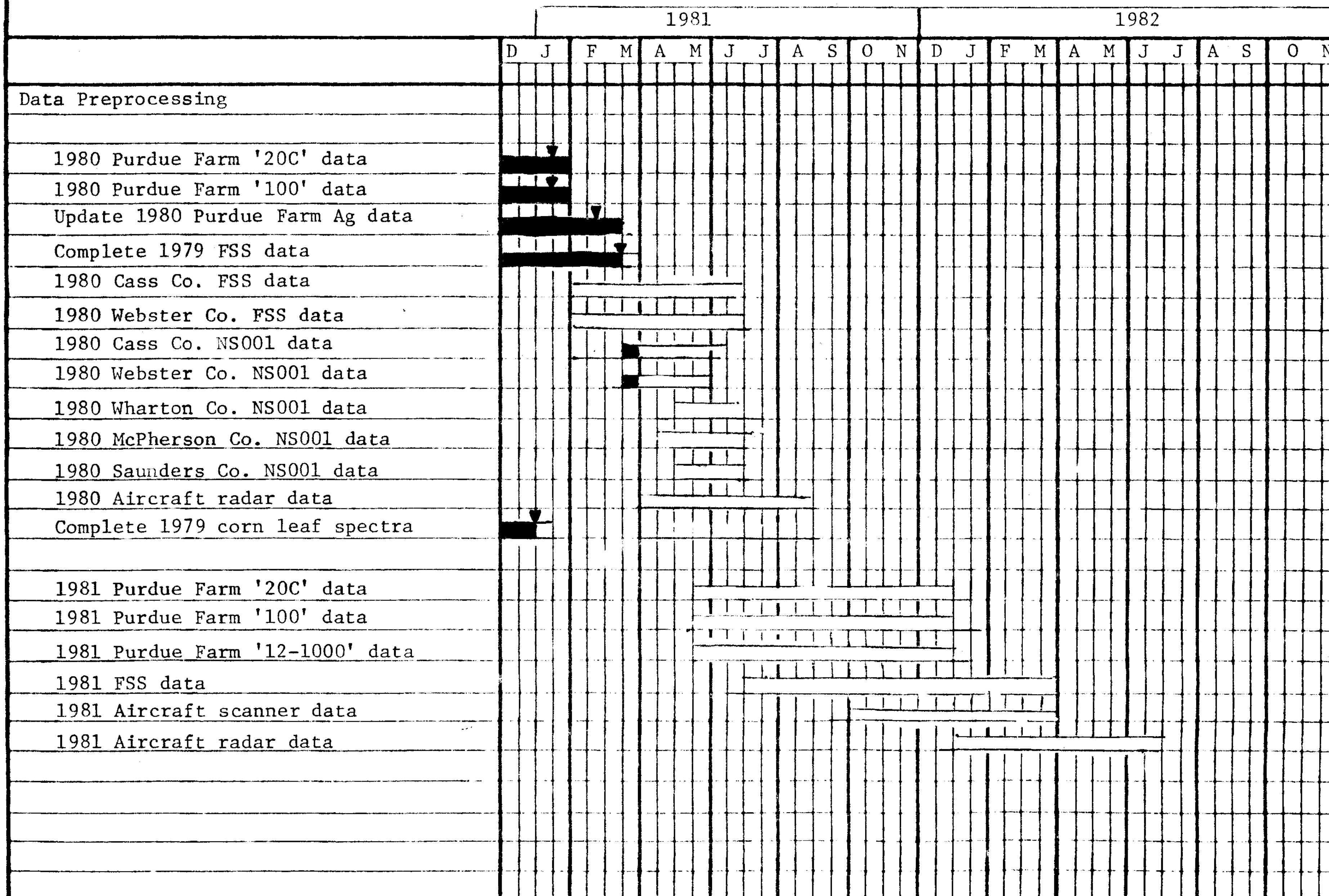
   - Correct errors in 1979 Purdue Agronomy Farm Ag Data
   - Determine method for including small grains/cotton/rice data into data base
   - FSS wavelength correction implemented in LARSPEC

5B. Supporting Field Research Data Acquisition, Preprocessing and Management

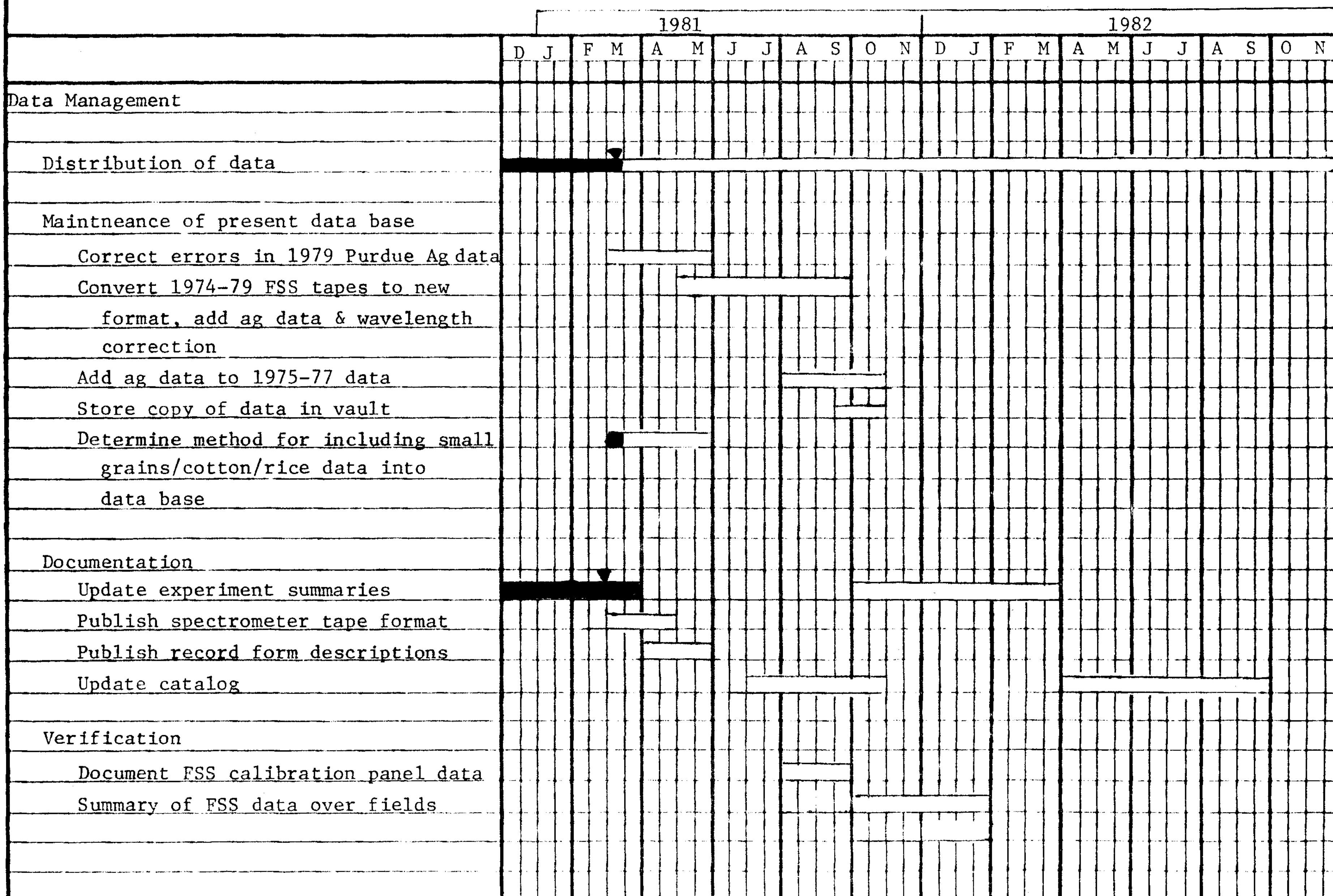
	1981						1982					
	D J	F M	A M	J J	A S	O N	D J	F M	A M	J J	A S	O N
Prepare Implementation Plan												
Quarterly Progress Reports												
Final Report												
Experiment Design												
1981-82 Corn/Soybean Plan												
1982-83 Corn/Soybean Plan												
Assist Small Grains/Cotton/Rice Groups												
Data Acquisition												
Prepare & calibrate field standards												
Acquire Purdue Agronomy Farm data												
*Acquire corn/soybean ITS ag meas.												
Acquire FSS data over panels												
*Acquire Leaf area meters												
Assemble Argentina/Brazil F.R. data												
Coordinate acquisition of corn/soybean ITS data with JSC												

* Cancelled as of 3/16/81

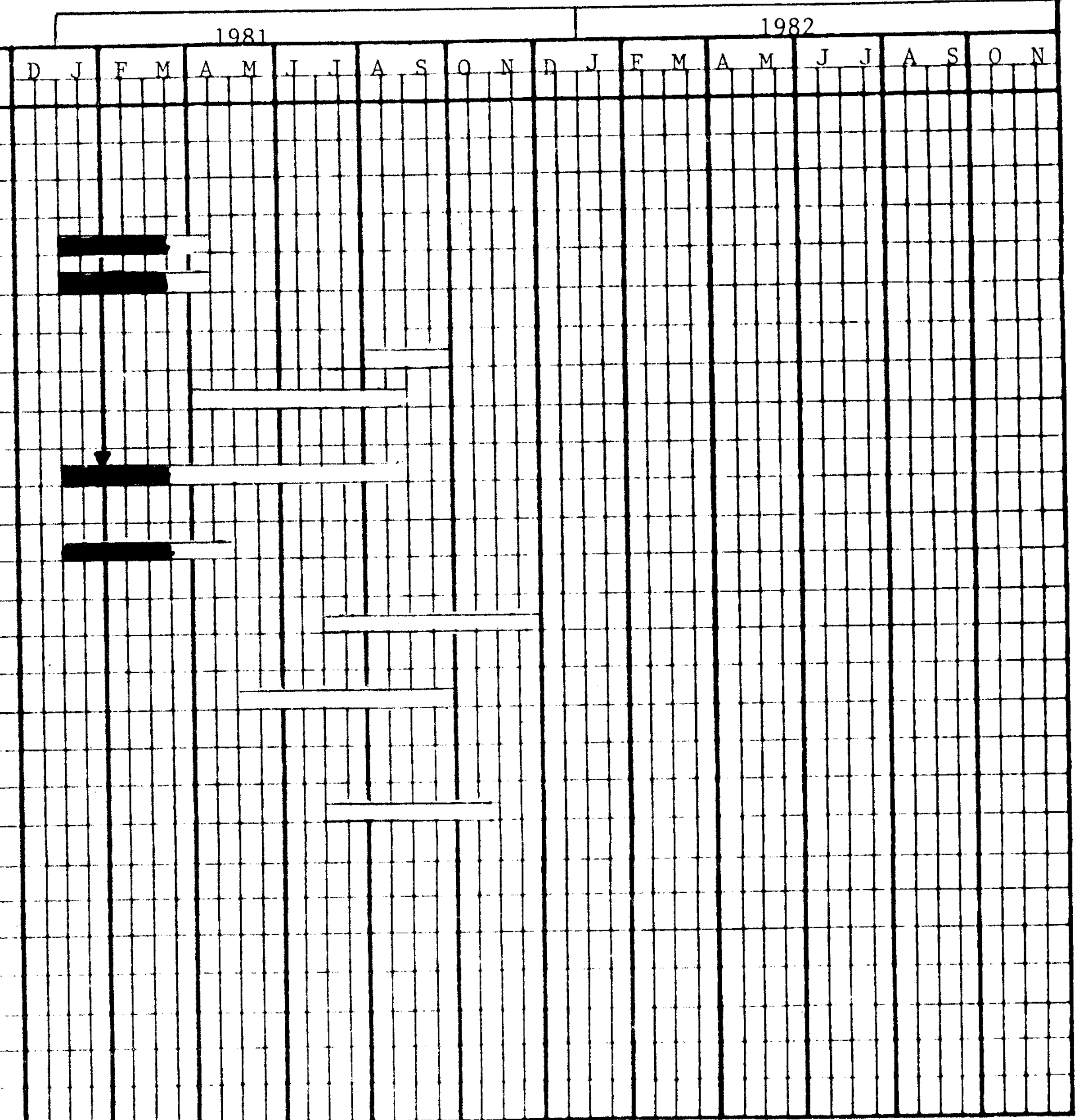
Supporting Field Research Data Acquisition and Management (con't.)



Supporting Field Research Data Acquisition, Preprocessing, and Management (con't.)



Supporting Field Research Data Acquisition, Preprocessing, and Management (con't.)



Data Management (con't.)

Software Support

- FSS λ correction in LARSPEC
- Plot different λ resolutions (LARSPEC)
- Update LARSPEC documentation
- Non-uniform band averages (LARSPEC)
- Growth stage graphics software
- Implement Westinghouse CCS
- Spectrometer search software
- Complete software to read radiometer thru PDP11
- Implement capability to store Ag data with no spectral data