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QUARTERLY REPORT

Reporting Period: December 1, 1978 - February 28, 1979
Contract Number: NAS9-15466
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Research in Remote Sensing of Agriculture, Earth Resources, and Man's Environment

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16. Abstract

This report summarizes progress for the current quarter on the three tasks of the subject contract which are:

1. Agricultural Scene Understanding and Supporting Field Research
2. Processing Techniques Development
3. Computer Processing and Data Base Services

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1. Agricultural Scene Understanding and Supporting Field Research

The potential of remote sensing to provide information on the acreage, condition, and yield of crops has not been fully developed, particularly for corn, soybeans and grain crops other than wheat. An important first step in developing this potential is to obtain a quantitative understanding of the spectral characteristics of crops and soils in relation to their agronomic properties. Such information can best be obtained by field research methods and the results can provide the foundation on which larger scale experiments should be built.

This task includes four inter-related sub-tasks designed to increase our understanding of crops and soils and enhance our capability to acquire spectral measurements for field research. The tasks are: (A) Experiment design and data analysis, (B) Field research data acquisition and preprocessing, (C) Development of multiband radiometer system, and (D) Development of soils data base.

1A. Experiment Design and Data Analysis

This task has responsibility for developing the technical program for Multicrop Supporting Field Research which is to be conducted over the next several years, as well as performing major portions of the data analysis. The task is divided into three parts:

(1) design of multiyear supporting field research program,
(2) design initial (i.e. 1979) experiments in support of multiyear program, and
(3) conduct data analyses to result in quantitative, predictive relationships between agronomic and spectral characteristics of crops and soils.

1. Design Multiyear Supporting Field Research Program

I. Introduction

Field research is an essential component of the development of agricultural remote sensing. A sound field research program can provide the basis on which larger scale satellite experiments and operational systems are constructed. The overall objectives of field research should be to obtain a quantitative understanding of the radiation characteristics of agricultural crops and their soil backgrounds and to assess the capability of current, planned, and future satellite sensor systems to capture available useful spectral information. Field research is a particularly important component of developing remote sensing techniques for assessing crop condition and predicting crop yields.

As we look ahead to the development of a global food and fiber information system utilizing remote sensing techniques, it is critical to begin to conduct the field research required to understand the spectral characteristics of crops other than wheat, such as corn, soybeans, rice, cotton, and rangeland. A major distinction of the Multicrop Supporting Field Research and the previous LACIE Field Measurements Project is that Supporting Field Research data acquisition will be determined by the requirements of specific analysis objectives, whereas LACIE Field Measurements had the overall objective of acquiring and assembling a large general purpose data set and analysis objectives were largely defined after the data were collected.

II. Approach

The following are the major steps in the development of the multiyear plan:

1. Define Technical Objectives. Technical objectives of the program are to be defined first. LARS will make recommendations, but these must be reviewed and agreed to before data requirements and experiment designs can be established. Examples of possible objectives are:

- Evaluate the potential to identify biological-physical crop descriptors (e.g., biomass, LAI) and phenological stage at the time of initial detection of corn and soybean vegetation using present and future Landsat bands.

- Evaluate the potential for identifying crop biological-physical descriptors and phenological stage throughout the growing season using present and future Landsat bands.

-Evaluate the capability to predict Landsat spectral response from known crop growth and phenological variables.

-Determine the influence of stressed, normal, and better-than-normal crop growing conditions on the radiation patterns, spectral separability, and identification of corn, soybeans, wheat and barley.

-Identification and understanding of the environmental factors and agronomic practices which are the dominant controls of the observed spectral characteristics.

-To support the development of corn and soybean yield models which use as an input spectral response as a function of crop development stage under stressed and normal growing conditions.

-Evaluate the potential to determine soil tillage and surface conditions, and planting of corn and soybeans using present and future Landsat bands.

2. Define Experiment Designs and Data Requirements. Once the technical objectives are clearly defined, the next step will be to define the experiment design and data required to achieve the particular objectives. In general, we foresee the need to collect data at several sites over several years in the U.S. Corn Belt, Great Plains and other soybean, cotton, and rice producing areas in order to sample a number of crop-soil-weather situations and a need to acquire detailed measurements on controlled experiments and more general data on field in test sites. Depending on the particular experiment the sensor system(s) used may range from Landsat MSS to truck-or helicopter-mounted spectrometers.

3. Develop Data Acquisition and Preprocessing Procedures and Plans. This step represents planning the implementation of the experiment design/data requirements taking into account the availability of personnel, instrumentation, data processing systems, travel logistics, etc.

4. Develop Data Analysis Plans. Initial data analysis plans (objectives and approach) will be developed in conjunction with defining the technical objectives, experiment designs and data requirements. However, more detailed analysis plans should also be developed, although they may later be modified to fit the actual data collected.

5. Develop Management Plan. At the same time the technical plans are being developed, it is essential that plans be developed for the organization and management of the program. These plans should clearly define the responsibilities and authority of JSC/LARS, and any other participants. It is also clear we are considering a relatively complex program which will require good communication between organizations. The management plan will also contain schedules and resource requirements.

Current Status and Accomplishments

During the first quarter most attention on this task has been devoted to development of the field research plans for 1979; however, we have also made recommendations for the preliminary multicrop field research plan being developed. There is general agreement between LARS and JSC staff on the overall technical objectives and approach, although details of the plan are not yet completed.

2. Design 1979 Supporting Field Research Experiments

This phase of the task is the first year of the longer term, multiyear program described above. Its objectives and approach are therefore supportive of and consistent with the multiyear program, differing only in terms of scale, rather than the basic objectives. For example, what can be accomplished in 1979 is limited to a considerable degree by the availability of sensor systems; this situation should change beginning in 1980 when the multiband radiometer instrument systems become available. Secondly, sufficient resources are available to consider only Corn Belt crops in 1979.

The general outline of objectives and approach is described here. These ideas will need to be further developed and discussed with the JSC technical staff and final plans agreed to by March 15 in order to be ready for spring data acquisition to start by April 15.

I. Objectives

- To determine the reflectance and radiant temperature characteristics of corn and soybeans as a function of maturity stage and amount of vegetation present.

-To determine the effects of stresses including moisture deficits, nutrient deficiencies and disease on the reflectance and radiant temperature properties of corn, soybeans, and winter wheat.

-To determine the effect of important agronomic practices (e.g., planting date, plant population, fertilization) and environmental factors on the spectral characteristics of corn and soybeans.

-To support the development of corn and soybean yield models which use as an input spectral response as a function of crop development stage under stressed and normal growing conditions.

-To determine using present and future Landsat spectral bands the spectral separability of corn, soybeans, and other typical Corn Belt crops and cover types as a function of date and maturity stage and soil background conditions (color, texture, moisture, tillage).

These objectives will be pursued in the context of both crop identification and crop condition assessment and yield prediction. And, as part of the analyses the characteristics of alternate sensor systems (e.g. Landsat MSS and thematic mapper) will be compared and evaluated.

II. Approach

A brief summary of the approach (experiment design/data acquisition-preprocessing/data analysis) is presented here. More comprehensive and detailed plans are currently being developed for discussion with JSC in early March.

During 1978 experiments to investigate spectral characteristics of the corn and soybean crops were initiated at the Purdue Agronomy Farm. These experiments emphasized determination of the effects on the spectral responses of maturity stage, canopy variables such as leaf area index and biomass, stresses such as moisture and nutrient deficiencies, and cultural practices such as row spacing. These experiments,with some modification, are being continued to obtain additional years of data (1978 was an unusually good year with respect to weather although planting was late) and supplemented by experiments at other locations in order to sample a range of crop-soil-weather conditions. The primary experiments at Purdue are as follows:

Table 1A-1. Summary of Supporting Field Research Experiments to be conducted at the Purdue Agronomy Farm in 1979.

Corn Early Detection/Crop Calendar

4 Planting dates (May 1, 10, 20 and 30)
2 Plant populations (12,000 and 24,000 plants per acre)
2 Soil types (Chalmers (dark) and Russel (light)
2 Replications
8 Measurement dates at 5-10 intervals depending on growth stage

Corn Nitrogen Fertilization

4 Nitrogen Levels (0,60,120,180 pounds per acre)
2 Replications
6 Measurement dates

Corn Moisture Stress

3 Moisture levels
8 Measurement dates

Corn Disease

3 Leaf blight treatments (early infection, late infection, none)
2 Nitrogen fertilizer levels (0, 180 pounds per acre)
2 Replications
8 Measurement dates

Soybean Early Detection/Crop Calendar/Cultural Practices

3 Planting dates (May 1, May 20, and June 10)
2 Row spacings (10 and 30 inches)
2 Soil Types (dark and light)
2 Varieties (Bushy and narrow types)
2 Replications
8 Measurement dates

Winter Wheat Disease/Nitrogen Fertilization

3 Varieties (resistant, susceptable, susceptable sprayed with fungicide)
3 Nitrogen levels (0, 40, and 80 pounds per acre)
3 Replications
6 Measurement dates

Soil Background (Corn)

2 Soil types (dark and light)
2 Surface moisture levels (moist and dry)
2 Surface tillage conditions (rough and smooth)
2 Relications
3 Measurement dates (at corn heights of 3, 12 and 24 inches)

In addition to the experiments at the Purdue Agronomy Farm utilizing the Purdue/LARS instrument systems (Exotech 100 radiometer and Exotech 20C spectroradiometer), experiments are being planned for a second experiment station in the western Corn Belt and at intensive test sites at two locations. More ideally experiments would be performed at several ag experiment stations and several intensive test sites, but available instrumentation and other resources limit the number of sites.

The second experiment station is the Sandhills Agricultural Laboratory operated by the Nebraska Agricultural Experiment Station. Preliminary discussions have been held with Dr. Blaine Blad, University of Nebraska, with respect to cooperative efforts between NASA, Purdue, and the University of Nebraska in acquiring additional spectral measurements of the corn irrigation (moisture stress) experiments he is conducting.

Plans are being developed for measurements with Landsat MSS, aircraft MSS, and the helicopter spectrometer (FSS) at two intensive test sites. One site will be in the western Corn Belt (Webster County, Iowa). The second site will be in the Hand County, South Dakota and the measurements will be conducted in conjunction with the U.S./U.S.S.R. Bilateral project. Arrangements for acquisition of relatively detailed crop-soil-weather measurements at the sites are currently being made with Iowa State University and South Dakota State University.

3. Data Analysis Results

Data analyses being performed in 1979 include two components: analyses to be completed for wheat using data acquired during LACIE Field Measurements and analyses of corn and soybean data acquired during 1978.

I. Wheat Analyses

The data currently being analyzed includes both the helicopter spectrometer (FSS) and truck-mounted spectrometer data acquired during 1976 and 1977. The analysis topics are:

- Relation of crop descriptors (leaf area index, biomass, percent soil cover, plant water content) to reflectance and prediction of these variables from reflectance measurements.

- Effect of agronomic factors (soil moisture availability, planting date, fertilization, cultivar, and growth stage) on the reflectance of spring wheat.

- Relation of grain yield to reflectance as a function of growth stage.

- Effect of measurement variables (solar elevation and azimuth angles and zenith and azimuth of view angles) on the reflectance of spring wheat.

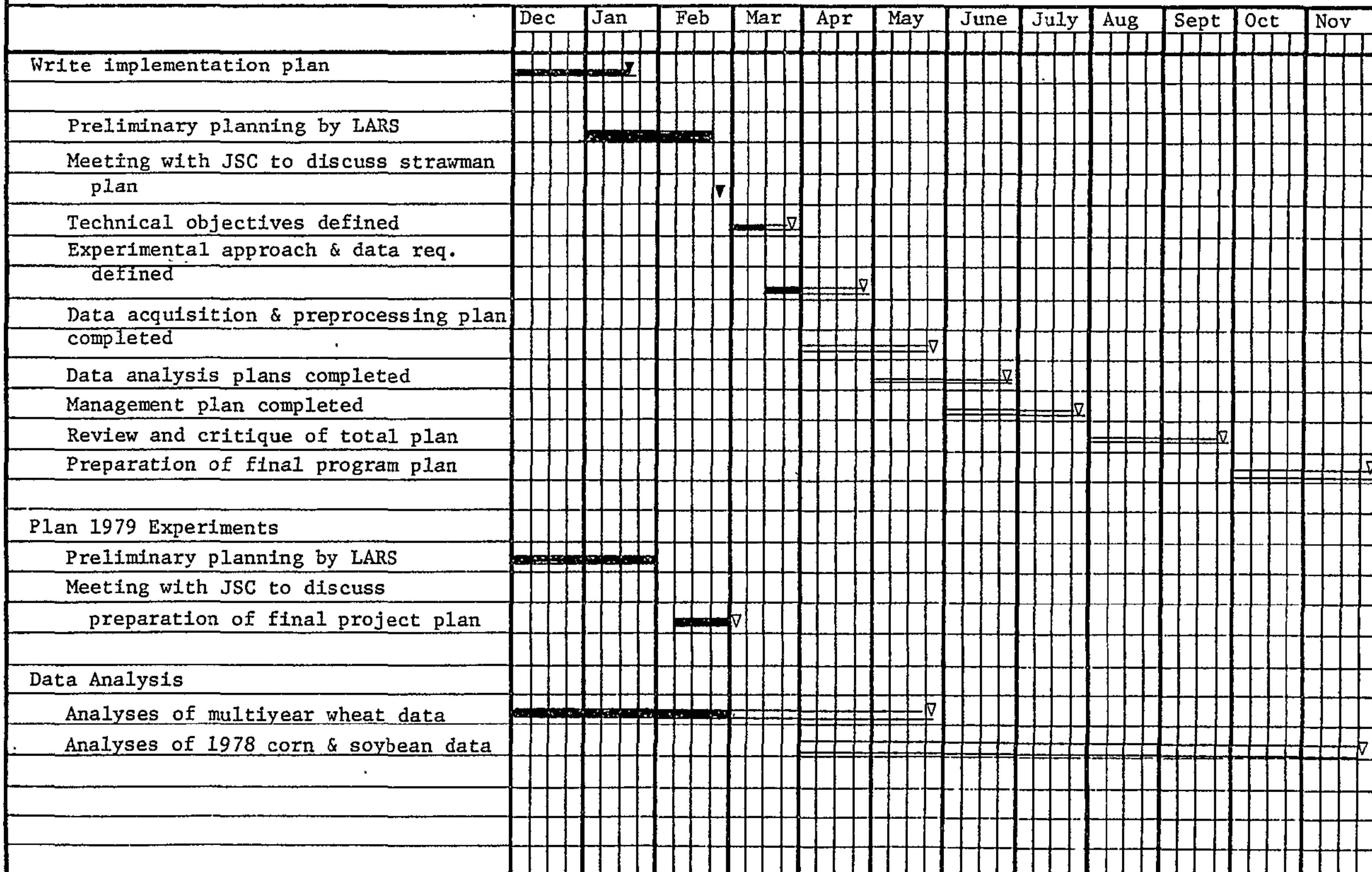
The analyses are being performed using both Landsat MSS and thematic mapper wavelength bands so that they can be compared. In several cases data from two or more years are now being included in the analyses in order to base the inferences on larger data sets including a wider range of conditions. One analysis, estimation of leaf area index and other agronomic characteristics of spring wheat canopies from reflectance measurements, has recently been extended to include both 1976 and 1977 data. The general approach was to develop predictive regression equations from each year and then to predict the other year.

Although the final analyses and interpretations of the results have not been completed, the indications are that the independent year evaluations of the predictability of the agronomic variables are quite good. The correlations between predicted and measured values are nearly as high as when only single year data were used for both development and evaluation of the predictions. Further tests to complete and confirm these results are currently being performed.

4. Plans For Next Quarter

During the next quarter the plan for 1979 experiments will be completed, preliminary multiyear technical plans will be completed and reviewed, and analyses of 1976 and 1977 wheat data will be completed.

Implementation Schedule for Task 1A, Experiment Design and Data Analysis



1B. Field Research Data Acquisition and Preprocessing

The objectives of this task are to acquire and preprocess supporting field research data for the Multicrop Supporting Field Research. The specific objectives/tasks are:

(1) Plan and coordinate acquisition and preprocessing of field research data identified in the experiment design plans developed under Task 1A.

(2) Acquire 1979 Purdue Agronomy Farm field research data.

(3) Prepare and calibrate field reflectance standards for use in 1979.

(4) Complete preprocessing of Exotech 20C and Exotech 100 data and associated agronomic-meteorological data acquired in 1978.

(5) Preprocess field research data acquired in 1979 for experiments at the Purdue Agronomy Farm, as well as other sites.

Activities This Quarter

(1) Initial plans for the acquisition of data at the Purdue Agronomy Farm in 1979 have been completed (see Task 1A report for descriptions of experiments). Data collection is scheduled to start about April 15.

(2) Final processing of the 1978 Exotech 20C field spectrometer data collected at the Purdue Agronomy Farm is being worked on and is on schedule.

(3) The 1978 Exotech 100 data has been keypunched ready for final processing into spectrometer/radiometer format along with the agronomic and meteorological data.

(4) Processing software was completed and tested to efficiently update spectrometer identification records without having to reprocess the spectral data. This software provides the capability to process the EXOTECH 20C spectral data soon after it is collected without all the agronomic measurements. The agronomic measurement can be added to the spectrometer identification records later when they are available with little additional overhead costs.

<u>Plans for Next Quarter</u>

(1) The 1978 Exotech 20C data processing will be completed.

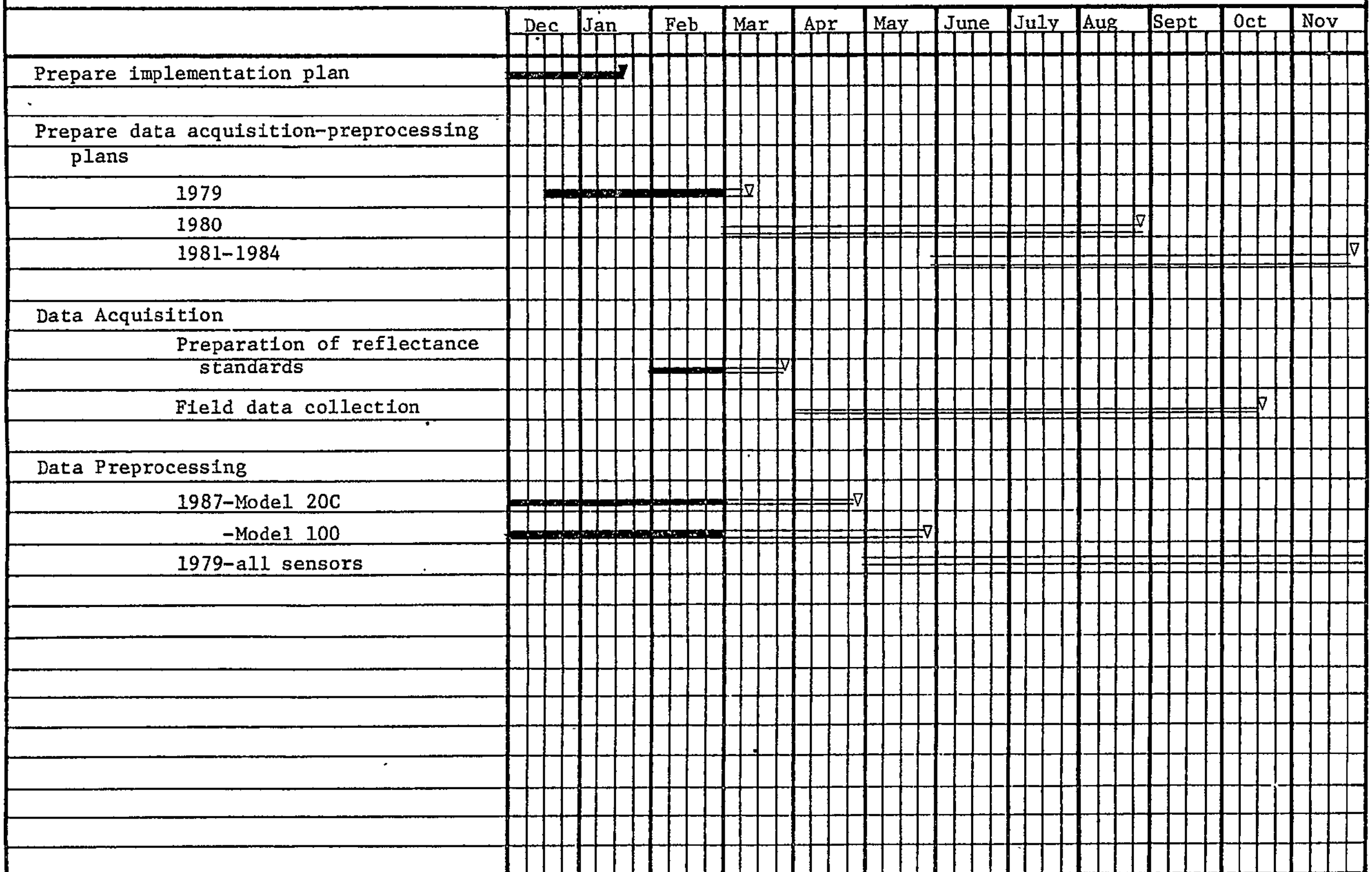
(2) The 1978 Exotech 100 data processing will be completed.

(3) Prepare and calibrate field reflectance standards.

(4) The 1979 data collection will be started.

(5) Complete data acquisition-preprocessing plan for 1979 field research.

Detailed implementation schedule for field research data acquisition and preprocessing



1C. Development of Multiband Radiometer System

I. Introduction

The remote sensing community has long needed a rugged, reliable visible-infrared sensor for field research. The objective of this subtask is to develop a multiband radiometer for agricultural research. The system is to be low-cost, simple to operate and adaptable to a variety of platforms.

II. Activities During This Quarter

1. The implementation plan was completed in early January.

2. The RFQ specifications for the radiometer and data logger were reviewed December 15, 1978 at Johnson Space Center. Additional specifications, modifications, and procurement details were requested by the technical monitor and it was suggested by the technical monitor that a consultant familiar with procurement be employed to facilitate the production of the final RFQ. Several consultants were contacted and two were employed. All formal reports from consultants will be completed in early March.

3. Plans for the system manual and, in particular the Fundamentals section are being discussed and a draft will be available at the end of this quarter.

4. Specifications for reformatting and storage of the multiband radiometer data in the field research data bank so that the data are compatible with the analysis system (EXOSYS) have been completed.

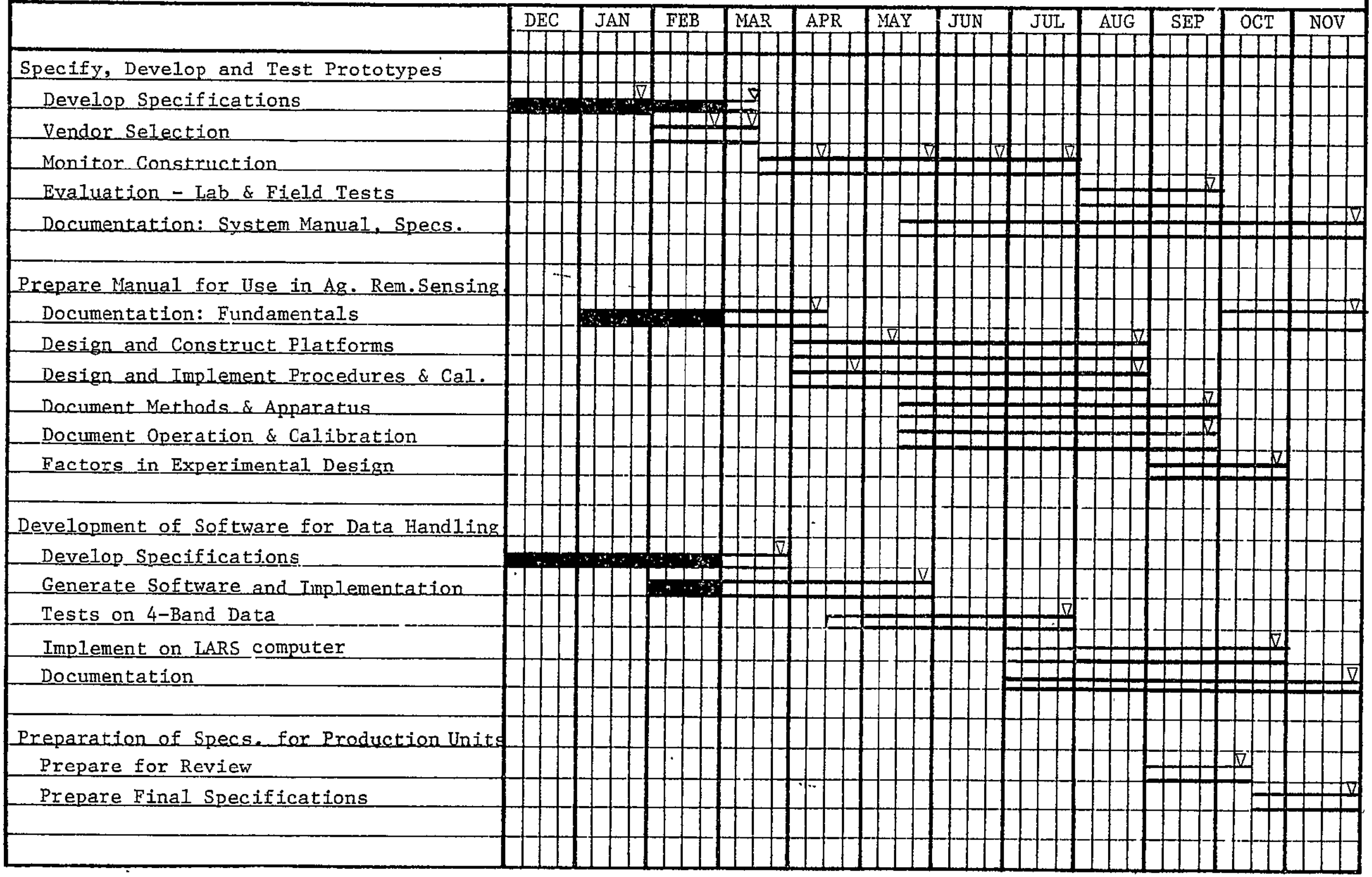
III. Plans for Next Reporting Period

1. Early in the period the revised RFQ will be discussed with the technical monitor, and following revision, will be issued by Purdue. Following the vendor response, the vendor will be selected.

2. Detailed outlines of the Multiband Radiometer System Manual and a preliminary outline of the Experimental Design Manual will be prepared. Personnel for the design and construction of mounting hardware will be identified and work begun.

3. The software for reformatting of the multiband radiometer will be completed and testing will begin.

Implementation Schedule For Development Of Multiband Radiometer System



1D. Soils Data Base

A. Work Accomplished During the Reporting Period

All of the activities originally scheduled during this quarter have either been completed, or are well under way. Measurement of soil organic matter content has been done for all 480 soil samples on hand. Iron oxide analysis has begun and is proceeding on schedule. Data base coding has been completed for all but the iron oxide measurements data. Additional data and corrections to the existing data set were edited as part of the header record for each spectroradiometric observation (Figure 1). Graphic display of duplicate soil curves has been completed for all 242 benchmark soil series. Soil spectra were plotted in alphabetical order of states with four soil series occupying each sheet. The resulting spectral plots (Figure 2) identify the soil series name, state, and moisture weight percent for each of the two soil samples that were collected in separate field locations. Sixty-one sheets were produced as part of the catalog of soil spectra. It is anticipated that a reduced, simplified version of the header record data (Figure 1) will accompany each sheet of soil spectra on a facing page in the catalog.

B. Technical Problems Encountered

Serious technical problems were encountered in the quality of plotted output products from the LARS/LITER electrostatic printer. This problem has not been resolved and has resulted in a large waste of computer resources and analyst time.

C. Plans for Next Reporting Period

Compilation of the catalog of soil spectra will be completed early in the next period. Statistical analysis will begin later in the period and interpretation of the results will follow. Preparation of a final report should be completed near the end of the period.

RUN SEQUENCER	99	DATE DATA COLLECTED	8/29/78
JULIAN DAY	241	OBSERVATION NUMBER	48
SERIAL NUMBER	6	TIME DATA COLLECTED	202600
EXPERIMENT NUMBER	78100701	EXPERIMENT NAME	SOIL STUDY
PRINCIPAL INVESTIGATOR	STONER, ERIC	SCENE TYPE	SAMPLE 32
LOCATION	LARS W.LAFAYETTE	REFORMATTING DATE	10/20/78
REFORMATING CALIBRATION CODE	1	LATEST ID UPDATE DONE	2/14/79
NUMBER OF SAMPLE GROUPS	1	CALIBRATION OBSERVATION	46
CALIBRATION TABLE NUMBER	2	ILLUMINATION	GE DXW
IRRADIANCE ZENITH ANGLE (DEGREES)	10	IRRADIANCE AZIMUTH ANGLE (DEGREES)	90
VIEW ZENITH ANGLE (DEGREES)	0	VIEW AZIMUTH ANGLE (DEGREES)	0
DISTANCE TO GROUND (METERS)	2.44	FOCAL DISTANCE (METERS)	2.44
LOCATION LATITUDE	402500N	LOCATION LONGITUDE	865500W
ORDER	OLL	SUBORDER	UST
GREAT GROUP	HAPL	PARTICLE SIZE CLASS	12
CONTRASTING PARTICLE SIZE CLASS	0	MINERALOGY CLASS	1
OTHER MODIFIERS	0	TEMPERATURE REGIME	THERMIC
MOISTURE ZONE	SUBHUMID	DRAINAGE CLASS	4
SLOPE CLASS	1	EROSION PHASE	0
PHYSIOGRAPHIC POSITION	1	PARENT MATERIAL	54
SUBGROUP NAME	CUMULIC	SOIL SERIES NAME	FRIO
YEAR SOIL SAMPLE COLLECTED	78	STATE ABBREVIATION	TX
COUNTY CODE	99	MULTIPLE SAMPLING NUMBER	2
CONSECUTIVE SAMPLING NUMBER	2	HORIZON	AP
SOIL TESTING LAB NUMBER	531	ORGANIC CARBON (PERCENT)	2.20
CALCIUM (MEG/100G)	32.8	MAGNESIUM (MEG/100G)	1.4
SODIUM (MEG/100G)	0.0	POTASSIUM (MEG/100G)	1.1
EXTRACTABLE ACIDITY (MEG/100G)	0.0	CATION EXCHANGE CAPACITY	35.4
BASE SATURATION (PERCENT)	100	SOIL MOISTURE TENSION (BARS)	0.10
WATER CONTENT (PERCENT)	41.90	MUNSEL COLOR (MOIST)	10.0YR3.0/2.0
MUNSEL COLOR HUE1 (MOIST)	10.0	MUNSEL COLOR HUE2 (MOIST)	YR
MUNSEL COLOR VALUE (MOIST)	3.0	MUNSEL COLOR CHROMA (MOIST)	2.0
TEXTURAL CLASS	SILTY CLAY LOAM	SAND CONTENT -USDA- (PERCENT)	18.2
SILT CONTENT -USDA- (PERCENT)	44.4	CLAY CONTENT -USDA- (PERCENT)	37.4
VERY COURSE SAND -USDA-	0.0	COARSE SAND -USDA- (PERCENT)	0.2
MEDIUM SAND -USDA- (PERCENT)	1.1	FINE SAND -USDA- (PERCENT)	5.5
VERY FINE SAND -USDA- (PERCENT)	11.4	COARSE SILT -USDA- (PERCENT)	21.2
FINE SILT -USDA- (PERCENT)	23.2	LIQUID LIMIT	46
PLASTIC LIMIT	18	PLASTICITY INDEX	28
SHRINKAGE LIMIT	12	SHRINKAGE RATIO	1.9
VOLUMETRIC SHRINKAGE	83.6	LINEAR SHRINKAGE	18.3
COMPRESSION INDEX	0.324	SPECIFIC GRAVITY (G/CU CM)	2.53
UNIFIED SOIL CLASSIFICATION	CL	EXPERIMENTER'S PARAMETER 01	182.00
DATA QUALITY FACTOR 1	(0.55, 0.0738)	DATA QUALITY FACTOR 2	(0.65, 0.0383)
DATA QUALITY FACTOR 3	(1.05, 0.0242)	DATA QUALITY FACTOR 4	(1.65, 0.0142)
DATA QUALITY FACTOR 5	(2.20, 0.0262)	FACILITY NAME	PURDUE / LARS
INSTRUMENT NAME	EXOTECH MOD 20C	SCAN RATE	0.25
HIGH SQUARE WAVE LEVEL (VOLTS)	4.995	LOW SQUARE WAVE LEVEL (VOLTS)	0.002
FIELD OF VIEW (DEGREES)	0.75		

SURFACE CONDITION -- GRAIN SORGHUM

COMMENTS -- 1CMI SE OF GATESVILLE IN FLOOD PLAIN OF LEON RIVER

Figure 1-D. Example of header record information for one spectroradiometric observation.

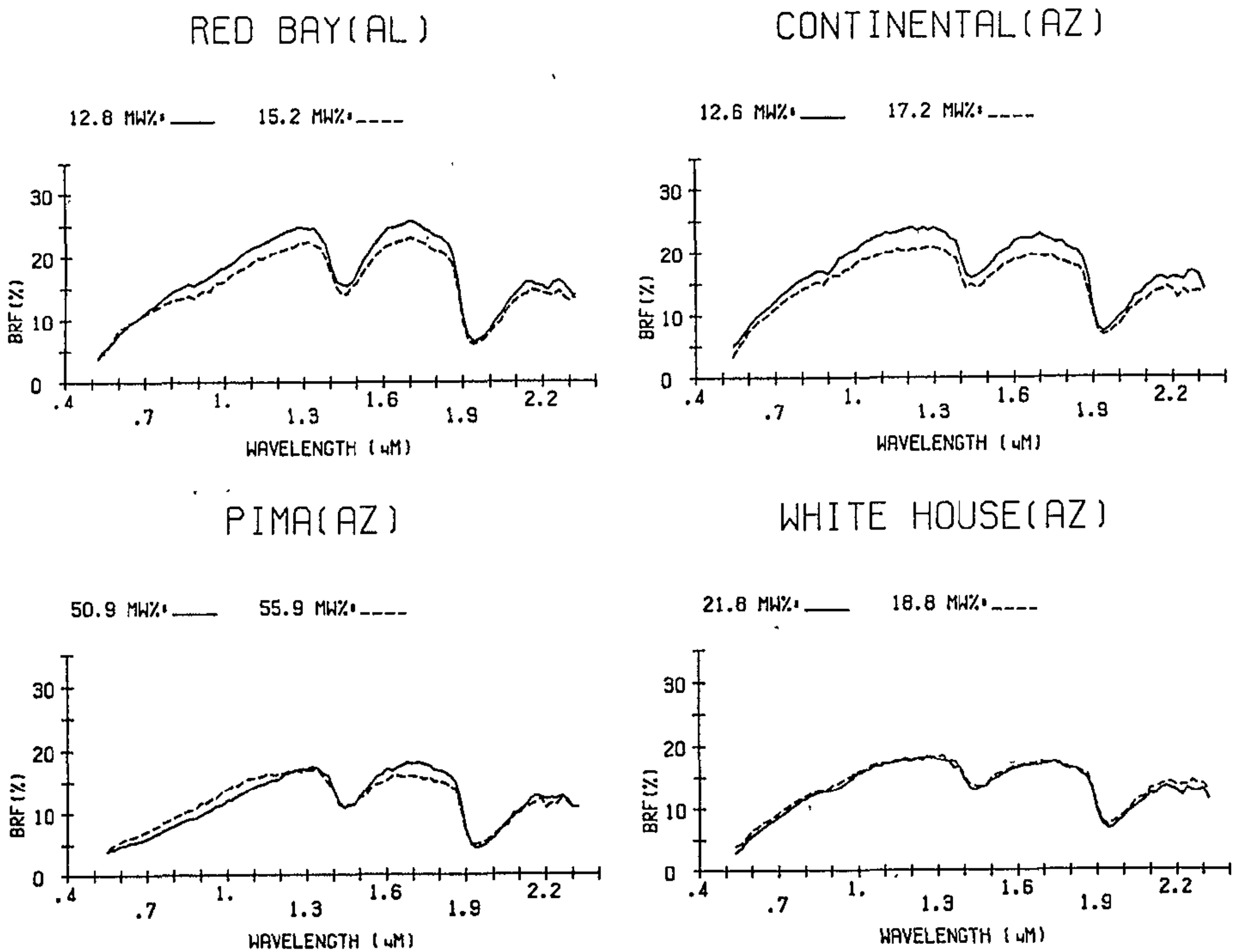
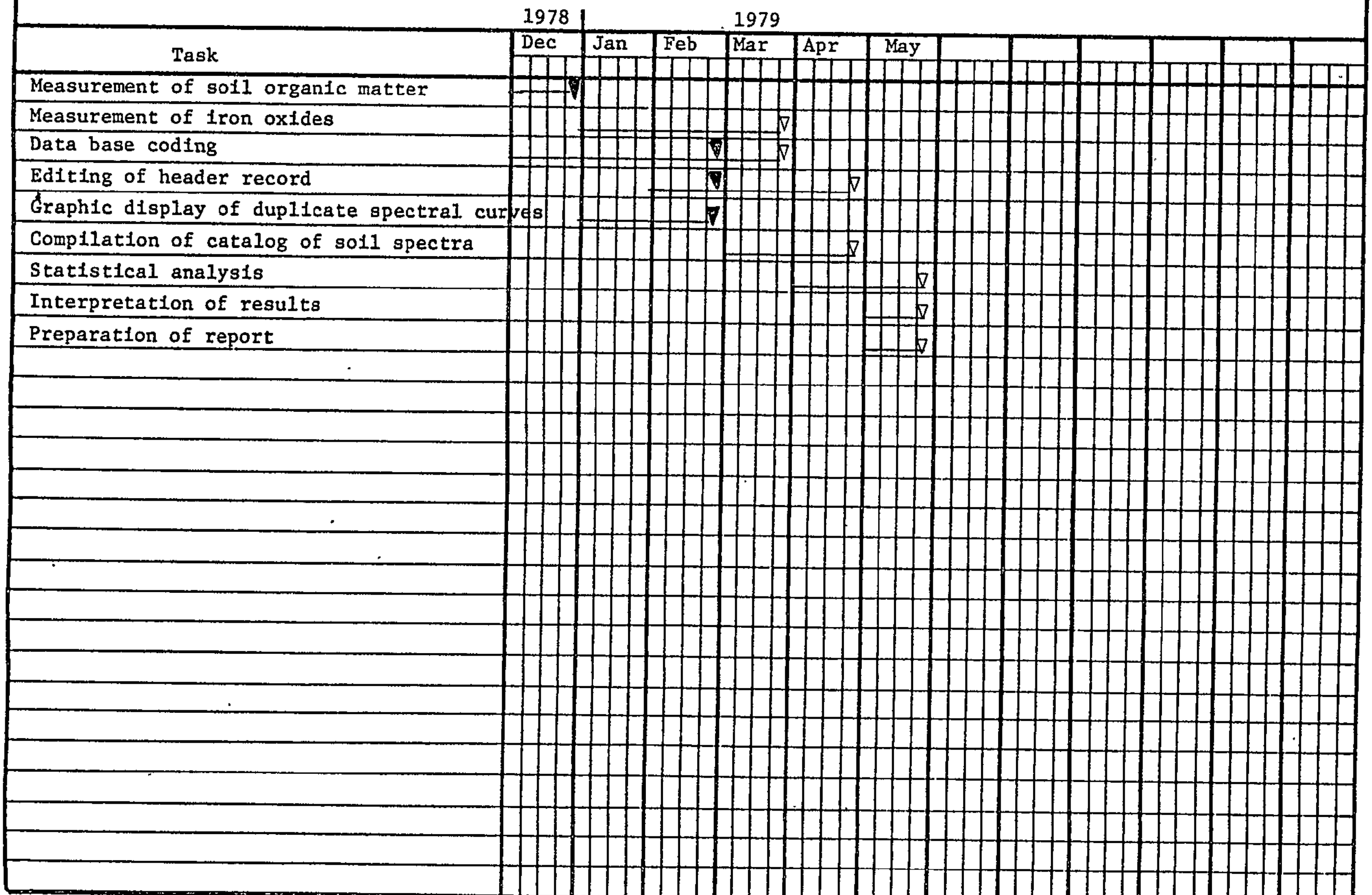


Figure 2-D. Example of sheet from catalog of soil spectra.

Figure 1D-A. Detailed implementation schedule for Task 1D.



2A. Application and Evaluation of Landsat Training, Classification, and Area Estimation Procedures For Crop Inventory.

Introduction

This task is the second year of a specific two-year LARS task, resulting from a proposal in response to the Applications Notice. It is also part of the second year of effort in a larger, multi-year, multi-organizational effort to extend LACIE-like technology into crops other than the small grains. The accuracy and precision of area estimates obtained from Landsat data are affected by the combination of training, classification, and area estimation procedures used. Several types of agricultural scenes in the U.S. Corn Belt will be investigated to assess the scene dependent differences in optimal choices of training, classification, and area estimation procedures.

OBJECTIVES

- ASSESS THE EFFECT OF SAMPLING IN TRAINING AND CLASSIFICATION ON AREA ESTIMATES.
- ASSESS THE ACCURACY OF EARLY SEASON ESTIMATES.
- COMPARE SEVERAL METHODS FOR OBTAINING TRAINING STATISTICS.
- ASSESS THE ABILITY OF SEVERAL CLASSIFIERS (INCLUDING THE SUM OF DENSITIES CLASSIFIER USED IN PROCEDURE 1, MULTISTAGE DECISION PROCEDURES SUCH AS THE LAYERED OR CASCADE CLASSIFIERS, AND SPECTRAL/SPATIAL CLASSIFIERS SUCH AS ECHO) TO PROVIDE ACREAGE ESTIMATES OF CORN AND SOYBEANS IN SEVERAL REGIONS OF THE CORN BELT.
- ASSESS THE EFFECT OF SEPARATING THE FUNCTIONS OF SAMPLING FOR TRAINING AND SAMPLING FOR AREA ESTIMATION.

PROGRESS THIS QUARTER

- IMPLEMENTATION PLAN WRITTEN
- DATA REQUESTS SUBMITTED
- DATA SET PREPARATION
- PROGRAMMING LARSYS/P1 COMPATIBILITY

IMPLEMENTATION PLAN

- AN IMPLEMENTATION PLAN FOR THIS TASK WAS WRITTEN AND SUBMITTED TO JSC IN MID-JANUARY.
- DISCUSSIONS OF THE PLAN HAVE TAKEN PLACE WITH NASA PERSONNEL BOTH AT LARS AND AT JSC.
- THE PLAN HAS NOT YET BEEN FINALIZED.

  SOME CHANGES IN CONTENT ARE BEING CONSIDERED.

  SOME CHANGES MAY NEED TO OCCUR DUE TO DATA RECEIPT SCHEDULES.

  SOME CHANGES IN AMOUNT OF ANALYSIS PERFORMED MAY BE NECESSARY DUE TO THE HIGH COST OF COMPUTER ANALYSIST.

APPROACH

- THE PROPOSED APPROACH CONSISTS OF FOUR SUBTASKS, EACH OF WHICH ADDRESSES SEVERAL ASPECTS OF THE GENERAL CLASSIFICATION PROBLEM.

1. INVESTIGATE METHODS FOR INCREASING THE MACHINE EFFICIENCY OF ANALYSES WITHOUT ADVERSELY AFFECTING THE QUALITY OF ESTIMATES. CONSIDER CLUSTERING AND CLASSIFYING A SAMPLE OF DATA USING A SUBSET OF LANDSAT CHANNELS.

2. IN CONSIDERING THE PROBLEM OF SAMPLING ACQUISITIONS, THREE SPECIFIC ISSUES WILL BE ADDRESSED:

   HOW DOES PERFORMANCE VARY ACCORDING TO THE NUMBER OF ACQUISITIONS USED IN THE ANALYSIS?

   WITH A GIVEN DISTRIBUTION OF ACQUISITIONS, HOW ACCURATELY CAN CORN AND SOYBEANS BE IDENTIFIED?

   AT A GIVEN POINT IN THE GROWING SEASON, HOW ACCURATE ARE ESTIMATES BASED ON ACQUISITIONS ACQUIRED UP UNTIL THAT TIME?

3. THIS EXPERIMENT DESIGN PERMITS AN INTEGRATED STUDY OF SAMPLING, TRAINING, AND CLASSIFICATION, ALLOWING FOR INTERACTIONS AMONG THE COMPONENTS OF THE PROCEDURE. SAMPLING METHOD FOR TRAINING, CLUSTERING ALGORITHM, AND CLASSIFICATION ALGORITHMS WILL BE VARIED. EFFECTS OF SITE LOCATION AND SEGMENTS WILL BE ASSESSED.

4. THE OBJECTIVE OF THE FINAL STUDY IS TO ASSESS THE EFFECT OF SEPARATING THE FUNCTIONS OF SAMPLING FOR TRAINING AND SAMPLING FOR AREA ESTIMATION. UNITEMPORAL FULL-FRAME DATA WILL BE USED WITH A MULTISEGMENT TRAINING PROCEDURE.

DATA REQUESTS

- DATA TO BE FURNISHED BY NASA FOR THIS INVESTIGATION AND REQUESTED SCHEDULES FOR DELIVERY TO LARS WERE DETAILED IN LETTERS TO THE TASK MONITOR.
- DATA SET TO BE EMPLOYED IS THE 80 HIGH DENSITY MULTICROP SAMPLE SEGMENTS.
- DATA TO BE SUPPLIED INCLUDE:

  MULTITEMPORALLY REGISTERED LANDSAT MSS DATA FOR ALL 1978 CROP YEAR ACQUISITIONS.

  PFC PRODUCTS 1 AND 3.

  COLOR IR PRINTS OF AERIAL PHOTOGRAPHY WITH GROUND TRUTH OVERLAYS.

  DOT FILES FOR SEGMENTS DIGITIZED AT JSC.

- DATA REQUESTED WHEN AVAILABLE:

  DIGITAL GROUND TRUTH TAPES.

  MULTITEMPORALLY REGISTERED LANDSAT FULL-FRAME DATA COVERING THE TEST SITES.

  COLOR IR AERIAL PHOTOGRAPHY COVERING THE AREA BETWEEN SEGMENTS.

DATA SCHEDULE

- LANDSAT MSS DATA HAS BEEN RECEIVED FOR 38 SAMPLE SEGMENTS. THE RETRO-ORDER DATA FOR THESE SEGMENTS WILL BE SUPPLIED AS SOON AS IT IS RECEIVED AT JSC. DATA FOR THE REMAINING SEGMENTS WILL BE PROVIDED WITHIN 3-4 MONTHS.
- PFC PRODUCT 1 HAS BEEN RECEIVED ON THE SAME SEGMENTS AS ABOVE. THE SAME COMMENTS APPLY FOR THE REMAINDER OF PRODUCT 1. PRODUCT 3 SHOULD BE SUPPLIED IN THE NEAR FUTURE.
- AERIAL PHOTOGRAPHY AND WALL-TO-WALL INVENTORIES HAVE BEEN SUPPLIED FOR 17 SEGMENTS. DELAYS OF OTHERS DUE TO THEIR CURRENT USE AT JSC.
- DOT FILES WERE RECEIVED FOR 6 HIGH DENSITY SEGMENTS.

DATA SET PREPARATION

LANDSAT MSS DATA

REFORMATTING RUNS RECEIVED FROM UNIVERSAL TO LARSYS FORMAT

MERGING SELECTED RUNS FOR ANALYSIS

REFERENCE DATA

OUTLINED FIELD BOUNDARIES

OBTAINED INFORMATION ON COORDINATE TRANSFORMATIONS

EXAMINED ADDITIONAL SEGMENTS AT JSC TO PRIORITIZE ORDER

IMAGERY

PFC PRODUCT 1 FILED BY SEGMENT AS RECEIVED

PRODUCT 1 SCREENED FOR CLOUD AND HAZE PROBLEMS

FULL-FRAME IMAGERY AVAILABLE AT JSC EXAMINED TO DETERMINE FEASIBILITY OF UNITEMPORAL LARGE AREA CLASSIFICATION.

PROGRAMMING SUPPORT

- PROGRAMS TO CONVERT P-1 TO LARSYS FORMAT AND LARSYS TO P-1 FORMAT FOR STAT DECKS ARE NEARLY COMPLETE.
- INVESTIGATION OF COMPATIBILITY OF LARSYS AND P-1 RESULTS FILES IS UNDERWAY.
- ADDITIONAL CHANGES TO INCREASE COMPATIBILITY ARE BEING CONSIDERED.

  ADD CAPABILITY TO LARSYS FOR HANDLING IRREGULAR FIELD BOUNDARIES.

  PERMIT LARSYS TO READ EITHER LARSYS OR UNIVERSALLY FORMATTED DATA TAPES.

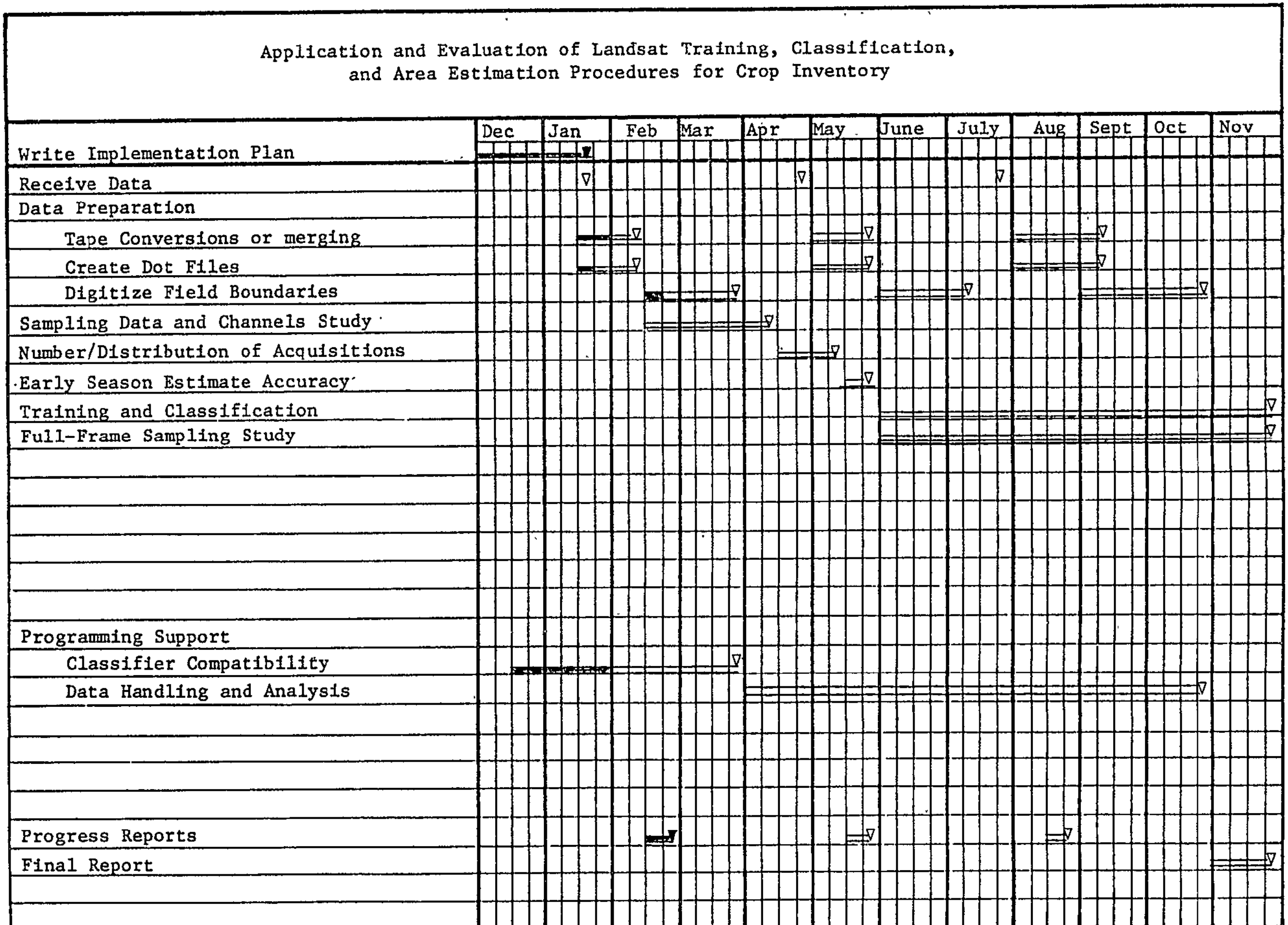
PLANS FOR NEXT QUARTER

- FINALIZATION OF IMPLEMENTATION PLAN
- CONTINUE DATA PREPARATION AS DATA IS RECEIVED
- COMPLETE CLASSIFIER COMPARISON STUDY
- COMPLETE SUMMARIZATION OF PROCEDURE 1 PARAMETER STUDY
- STUDY EFFECT OF SAMPLING DATA ON CLUSTERING AND CLASSIFICATION RESULTS
- STUDY ACQUISITION HISTORY NEEDED FOR ESTIMATION
- COMPLETE PROGRAMMING OF COMPATIBILITY OF STATISTICS DECKS AND RESULTS FILES

Conclusions

This quarter has been spent primarily in data preparation and initial studies. The progress which occurred during the quarter is shown in Figure 1. The analysis is slightly behind schedule due to delays in receipt of data and information as well as the fact that the data preparation is taking longer than anticipated.

Figure 1. Detailed implementation schedule.



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Task 2B. Initial Development of a Spectromet Yield Models for Corn.

A. INTRODUCTION

As world demand for food continues to expand, increased pressures are placed on our agricultural systems to supply timely and accurate crop production information. The benefits of improved crop information include: (1) more optimal utilization of storage, transportation and processing facilities, (2) more reliable crop production forecasts which allow decision-makers to plan policy better, and (3) increased price stability resulting from more accurate crop estimates.

Even at high levels of technology currently employed by most U.S. farmers, weather remains the most important uncontrolled variable affecting crop production and is the major cause of season-to-season variations in food production (Decker et al., 1976). During the past several decades numerous studies have attempted to develop models of the complex interactions between corn production and weather and technology. For simplicity, these studies generally considered weather and technology as independent factors in multiple-curvilinear regression models (Nelson and Dale 1978a). While these statistical models explained much of the variability in long-term crop production, they could not handle severe and unusual weather conditions or pest outbreaks (Nelson and Dale 1978b). The Thompson-approach corn models and the CCEA wheat models of LACIE are examples of statistical regression models.

Several alternative approaches to crop yield estimates have been developed which describe crop development and yield in physiological logic. These models are designed to simulate responses of basic plant processes and, ultimately, yields to the environment. Some of these simulation models are too complex and detailed for large area crop yield estimations while others appear to be applicable and are currently being developed by Purdue University in conjunction with industry. Examples of complex crop simulation models are SIMED (Holt et. al., 1975) and CORN-CROPS (Reetz, 1976).

Intermediate to the classical statistical regression approaches and the causal physiological approaches are several models which rely on physiological logic to interpret the effects of weather on crop yields. These intermediate models tend to be less complex than physiological simulations like CORN-CROPS but more complex than CCEA models. The Energy Crop Growth model (Dale and Hodges, 1975) and Purdue Soybean Simulator (Holt et. al. 1978) are examples of approaches which seek to condense the effect of weather into a single weather index which can be related to yields.

Considerable evidence indicates that remote sensing can provide information about crop condition and thus yield potential (Bauer, 1975). If this spectral information about crops can be combined effectively with meteorological and ancillary data, then potentially much better information about crop production could be gained.

B. OBJECTIVES

The overall objective of this task represents a multiyear research effort to integrate the best mix of spectral, meteorological, and ancillary data into a crop information system for estimating crop condition and expected yield during the growing season. Specifically this task will:

- identify important factors in determining and predicting corn yields.
- determine how these factors can be observed or estimated from alternate sources of data.
- define long-term data requirements for continued model development.
- select and further develop several candidate approaches for corn yield modeling.
- identify and obtain data required for these yield models.
- conduct initial calibrations and tests of models using spectroradiometer data from controlled experiments and using Landsat MSS data from selected 5 x 6 nm Multicrop segments.

C. APPROACH

The development of a system capable of providing accurate information on crop response to its environment will start with a review of related literature and evaluation of current crop modeling approaches and of the spectral, meteorological, and ancillary factors which are important to corn growth and development. Methods of directly acquiring or indirectly estimating these factors from available data will be examined. Indirect methods may include using biomass or leaf area index estimates derived from spectral data or estimating plant available water derived from soil moisture budget models (Stuff and Dale, 1978).

Spectrometer data acquired at the Purdue Agronomy Farm in 1978 will be analyzed to determine basic spectral characteristics of corn, to assess how agronomic treatments (e.g. soil color, tillage, biomass, maturity) affect these spectral characteristics, and to examine inter-relationships among spectral, meterorological, and ancillary data sources. Once these relationships are developed using data from controlled experiments at the Purdue Agronomy Farm, they will be extended to and examined with Landsat MSS data over commerical corn fields. Spectrally-derived information potentially can provide (1) estimates of crop development and condition (e.g. maturity, biomass, stand quality) which can be used to verify and/or adjust model performance during the season, (2) estimates of corn acreage within specific soil associations which have different productivity indices, and (3) estimates of area and severity of crop stresses.

Several of the current crop modeling approaches which may be adapted to use spectral information will be selected for further development and testing. Typical candidate approaches to crop modeling which are in the literature include: (1) statistical regressions with yield as a function of weather and technology variables (e.g. Thomspon, 1968) or as a function of transformed weather variables (e.g. Leeper, Runge and Walker, 1974); and (2) physiological simulations of crop development with yield as a function of weather variables (e.g. Holt et al. 1975, Reetz 1976).

Once the particular candidate approaches are selected, their data requirements will be identified and the data acquired. Initially these models will be calibrated and tested without the use of spectral data to establish their baseline performance in a bootstrap approach. The models will be calibrated using historical county average yields from USDA-ESCS but will be tested using average yields in 10 corn fields per test site in the county in 1978.

After modification to include spectrally-derived information these models will be calibrated and tested if possible. Because long-term data sets exist for corn yields and weather variables but not for spectral data, complete sets of test data probably exist only for selected sites in 1978. This lack of long-term data will hamper conventional statistical tests of these models' performance with and without spectral data, but by normalizing corn yields for soil productivity and substituting locations for years, some tests and inferences about model performance can be made. More years of complete data sets (yield, spectral, meterological, and ancillary data) will be required for adequate evaluation of these models.

D. Activities During this Quarter.

1. The implementation plan was written and submitted for approval. Revisions are in progress.

2. A literature review to assess previous work in this area was initiated in December and is in progress.

3. Landsat MSS digital and ground observations data from 10 Multicrop test sites were delivered to this task in February.

4. Support to Task 1A in design of experiments for 1979 Supporting Research program was given.

E. Plans For Next Quarter

1. Continue literature review and examination of current crop modeling approaches.

2. Select candidate crop modeling approaches which appear to be best suited for incorporating spectral information.

3. Assemble required spectral, meteorological, soil, and ancillary data sets. The data set from Purdue Agronomy Farm, which is in-house, will be assembled first and the data set for the Multicrop test sites will be assembled as it is received. Meteorological data will be ordered from National Climatic Center in Ashville, N.C. and soil maps, productivity indices, and other data will be requested from each state.

4. Support Task 1A for analysis of 1978 spectral, meteorological and agronomic data acquired at Purdue Agronomy Farm. These analyses will examine:

   -basic spectral characteristics of corn as functions of biomass and maturity

   -effects of agronomic treatments (e.g. soil color, tillage, fertility) on spectral characteristics

   -interrelationships among information sources.

5. Formulate initial crop response models.

F. REFERENCES

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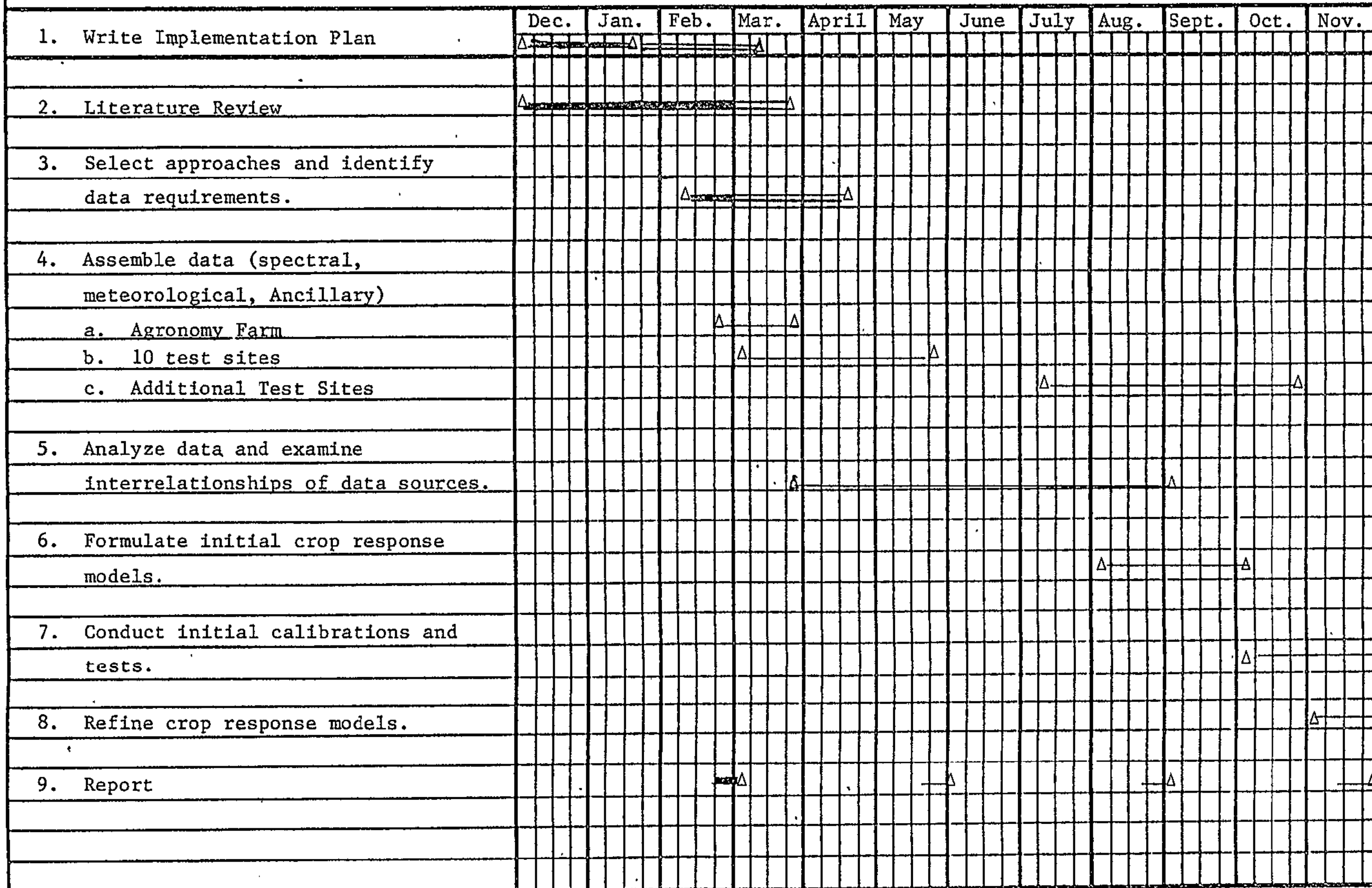
Figure 1. Detailed Task Schedule.-Task 2B. Initial Development of Spectral-Meteorological Crop Response Information System For Corn.



2C. Multispectral Data Analysis Research

The general objective of this task is to extend the development of pattern recognition techniques for earth resources data analysis, utilizing data of increasing complexity and from multiple sources.

2C1. Multistage Classification

I. Introduction

A number of different types of classifiers are now in routine use in remote sensing. With the emergence of more complex data sets, however, the need has been recognized for more sophisticated classifiers providing higher performance and lower cost. The objective of subtask 2C1 is to continue progress towards the development of such advanced classification techniques, focusing on methods for design, implementation and application of layered and cascade classifiers.

II. Activities During This Quarter

1. The implementation plan was completed in early January.

2. A literature study has been in progress since January to assess earlier work in this area and to assemble a bibliography.

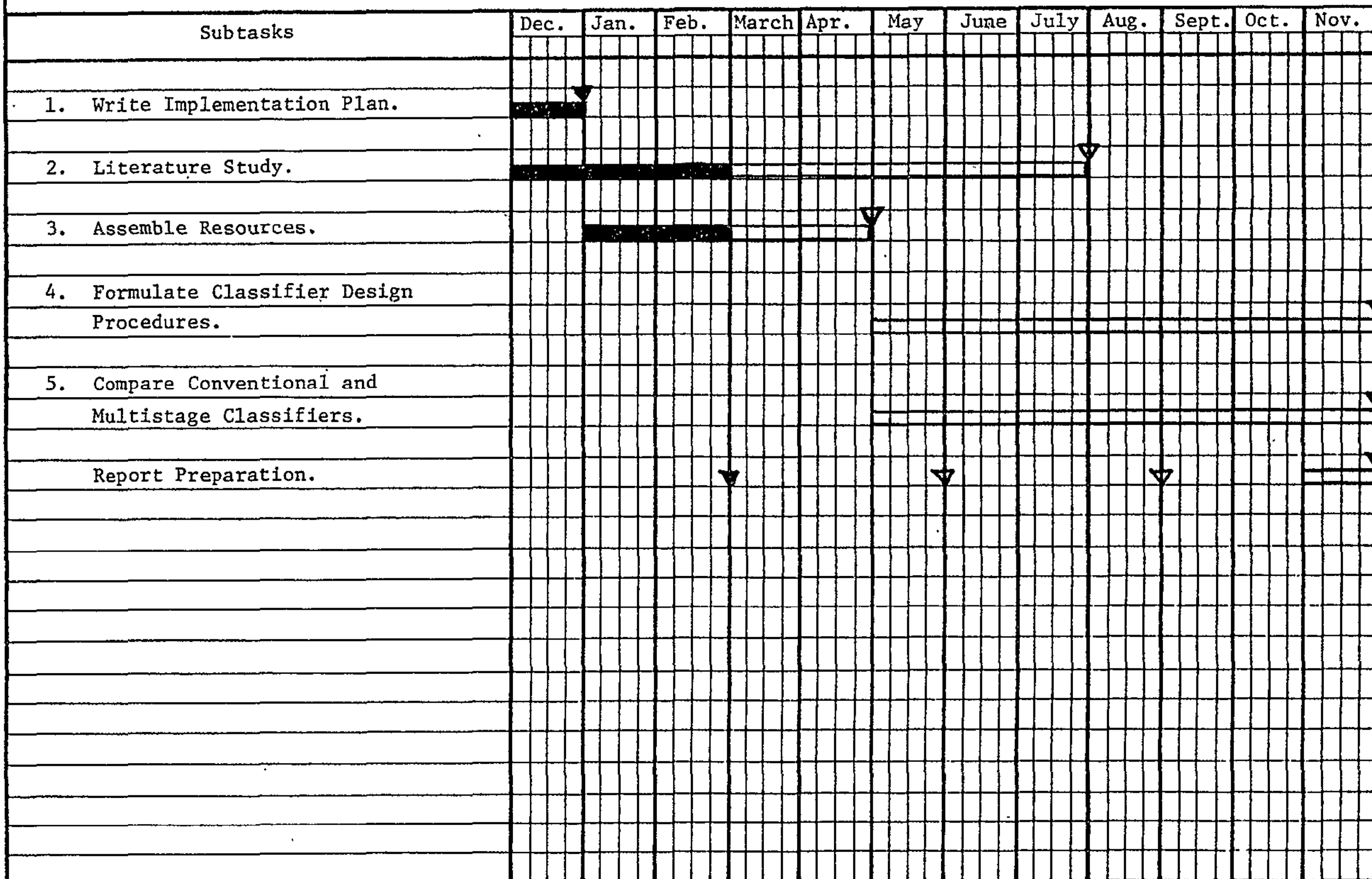
3. Copies of available software from previous studies are being examined and tested. There are some problems being encountered with the algorithms, and efforts are being made to correct them.

III. Plans for Next Reporting Period

1. The continuation of the literature survey process towards the assembling of a bibliography summary.

2. The completion of familiarization of staff members with the available software from previous studies, together with correction of any problems with the software and testing it.

Figure 2C-1. Detailed Implementation Schedule for Task 2C1.



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3. The identification and assembling of suitable data sets for use in design and test tasks.

4. The beginning of formulation of classifier design procedures.

2C2. Contextual Classification

I. Introduction

As noted in the Implementation Plan, recent investigations have shown that statistical context information can be used to significantly improve machine classification accuracy when using multispectral remote sensing data. The objectives of subtask 2C2 are (1) to develop and test methods of determining and representing the contextual information in a given scene (an input to the context classifier), (2) to analyze the context classifier algorithm with respect to effective multiprocessor implementation, and (3) to implement the context algorithms on a CDC Cyber-Ikon System, a multiprocessor system specifically designed for image processing applications.

II. Activities During This Quarter

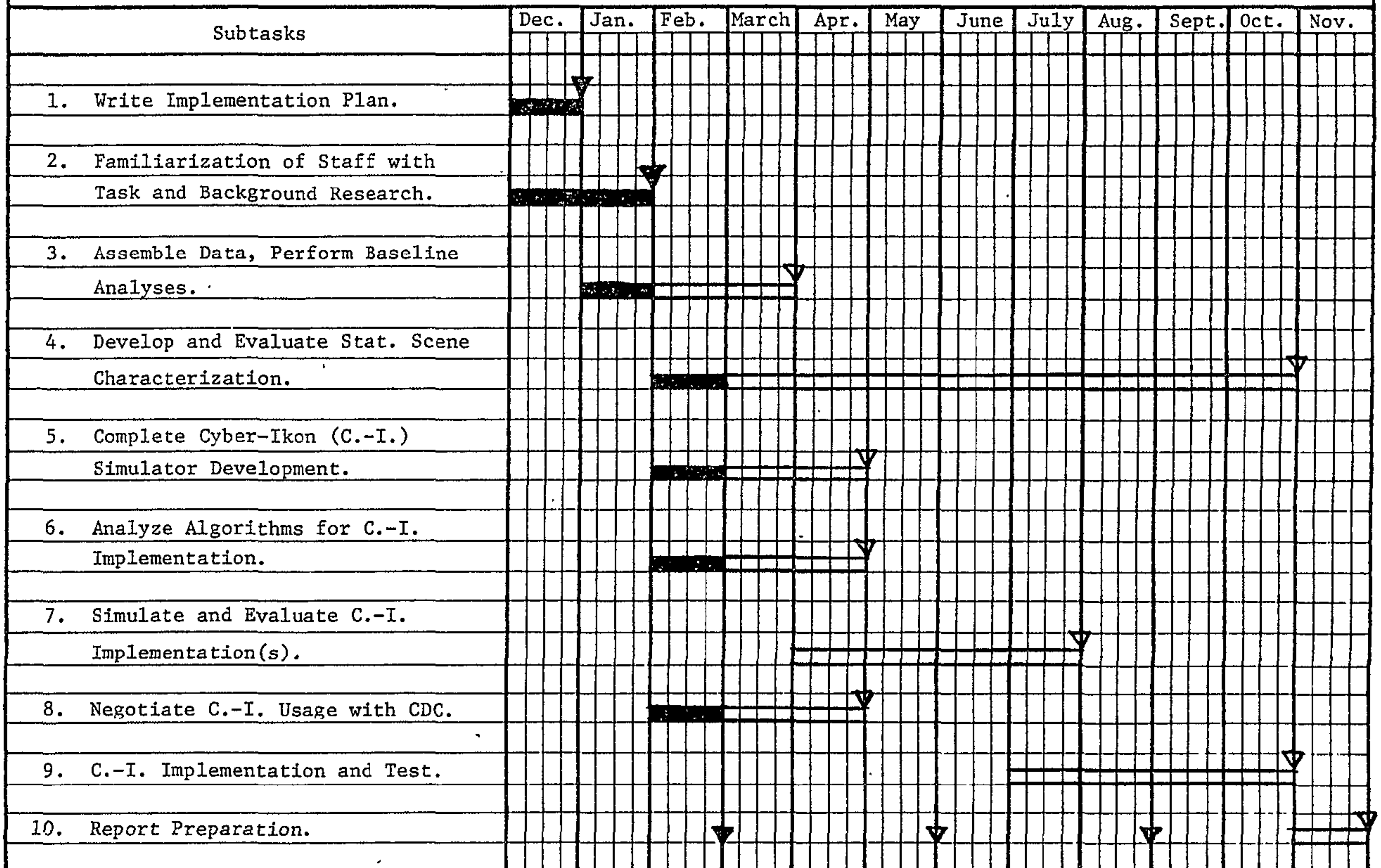
1. The implementation plan was completed and submitted.

2. Previous work on context classification was reviewed, including a previously written context classification algorithm. To verify our understanding of this software, context classifications have been carried out reproducing previously reported results.

3. Recently updated documentation for the Cyber-Ikon System was obtained and is being digested. The Cyber-Ikon Flexible Processor (FP) simulator and assembler, written by a previous student at Purdue, were reactivated and the simulator was modified in line with the new documentation.

4. Transfer of all software from campus computers to a LARS system was initiated. This primarily required bringing up a UNIX operating system on

Figure 2C-2. Detailed Implementation Schedule for Task 2C2.



the LARS PDP-11/34, which is now in process. This transfer is necessary to facilitate future progress of the research.

5. Implementation of a conventional maximum likelihood classifier on the Cyber-Ikon simulator was initiated. This will exercise and test both the simulator software and our understanding of it.

6. A formal "request for quotation" was sent to Control Data Corporation concerning use of the Cyber-Ikon system in Minneapolis. In the course of this, it developed that their current system has been put under wraps due to classified defense-related work on the machine. The impact of this development on our project is as yet unclear.

III. Plans for the Next Reporting Period.

1. Assemble data, perform baseline analyses using conventional maximum likelihood classification.

2. Begin development and evaluation of statistical scene characterization. Iterative context estimation will be investigated, starting with context estimation from a conventional maximum likelihood classifier. An alternative approach based on deriving statistics from scenes of similar content will also be considered.

3. Begin analysis of algorithms for Cyber-Ikon Implementation. Develop alternative parallel/pipelined formulations of the context classifier, candidates for efficient implementation on the Cyber-Ikon.

4. Complete software transfer to the LARS PDP-11/34.

5. Complete debugging and exercising of the Cyber-Ikon simulator through implementation of a conventional maximum likelihood classifier.

6. Pursue negotiations with Control Data Corporation relative to use of the Cyber-Ikon system at Minneapolis.

IV. Problems Encountered

The software transfer to LARS from campus machines where the earlier research was accomplished has not proved more problematical than anticipated. However, unforeseen problems could slow progress at some time in the future.

Control Data Corporation is currently working toward establishment of a commercial branch of their digital image processing organization. They are projecting to have a Cyber-Ikon available through this branch by mid-summer. Delay in this respect will delay our real machine implementation, but we will still be able to assess the potential effectiveness of such an implementation through work with the simulator.

2D. Multisensor, Multidate Spatial Feature Matching Correlation, Registration and Information Extraction

The following pages contain quarterly report material for this task as presented in the oral briefing. These overheads summarize the task and the work accomplished in the first quarter.

The key achievement was the receipt and registration of matching Landsat data for the June 1977 SAR data. With this data set complete, the analysis of the many aspects of the SAR/Landsat combined data utilization problem could begin. The second overhead lists the specific accomplishments in the quarter.

Several potential benefits of the SAR emerged and are listed on the next overhead. The concept of using a high resolution image (e.g., SAR) to locate precise field boundaries and accurately delineate urban and other DO (designated other) categories and a lower resolution spectral sensor to identify the contents of the fields appears attractive. Figures D-1 and D-2 show a comparison of Landsat and SAR for a 4 by 5 mile block of fields near Phoenix. Note the clear delineation of fields and the positive identification of all housing and urban areas.

A classification result using pixel classification with and without SAR is presented next. Nominally a 10% improvement in class accuracy is noted when the SAR is added. This is a preliminary run and no conclusion should be taken from this result. Problems and plans are listed in conclusion.

TASK 2D. MULTISENSOR, MULTIDATE SPATIAL FEATURE MATCHING, CORRELATION, REGISTRATION AND INFORMATION EXTRACTION

OBJECTIVE

DEVELOP TECHNOLOGY FOR UTILIZING MULTIPLE DATA TYPES AND ANCILLARY DATA TO ENHANCE PERFORMANCE OF REMOTE SENSING DATA ANALYSIS FOR EARTH RESOURCE SURVEYS.

PROCEDURE

- ACQUIRE TEST DATA SETS WITH GROUND TRUTH: LANDSAT, A/C MSS, A/C SAR, SEASAT SAR AND ANCILLARY DATA.
- DEVELOP CORRELATION AND REGISTRATION METHODS FOR MSS AND SAR AND PRODUCE TEST REGISTERED DATA SETS.
- INVESTIGATE IMAGE ENHANCEMENT AND PRESENTATION METHODS FOR USING SAR DATA TO AID ANALYST.
- INVESTIGATE INFORMATION EXTRACTION METHODS FROM COMBINED SAR LANDSAT DATA SETS.

ACCOMPLISHMENTS IN QUARTER

- LANDSAT MSS DATA ORDERED IN APRIL 78 RECEIVED DEC. 22, 78 FOR SAR/LANDSAT TEST SITE IN ARIZONA. LANDSAT/SAR REGISTRATION COMPLETED.
- GROUND TRUTH FIELD LOCATION IN DATA SET COMPLETED. CLASSES REPRESENTED ARE: COTTON, ALFALFA, BARLEY, ORANGE TREES, WHEAT, ONIONS, RESIDENTIAL, BARE SOIL, WOODS, WATER, SOYBEANS.
- INFORMATION EXTRACTION ANALYSIS BEGUN. PIXEL CLASSIFICATION CARRIED OUT ON ALL FIELDS.
- SAR/LANDSAT IMAGE CORRELATION ANALYSIS BEGUN. ENHANCEMENT METHODS STUDIED TO AID IN IMPROVING SIMILARITY OF THE TWO DATA TYPES.
- IMAGE ANALYSIS OF SAR VS. LANDSAT CARRIED OUT TO ASSESS BENEFITS OF SAR IN CROP CLASSIFICATION AND AREA ESTIMATION.

POTENTIAL SAR BENEFITS UNDER STUDY

- AVAILABILITY OF ALL WEATHER HIGH RESOLUTION IMAGE OF SEGMENT AT REGULAR INTERVALS.
  1. PRECISE LOCATION OF ALL FIELD BOUNDARIES AS EARLY IN SEASON AS THEY ARE VISIBLE.
  2. TEMPORAL VARIATION OF FIELD BACKSCATTER AT REGULAR INTERVALS AS A COVER CLASSIFICATION METHOD.
  3. RECOGNITION OF URBAN AND OTHER CULTURAL AREAS WITH HIGH ACCURACY TO ELIMINATE CONFUSION PIXELS.
- USE OF SAR BACKSCATTER AS FEATURE IN CROP CLASSIFICATION.
- HIERARCHICAL APPROACH USING SAR FIELD BOUNDARIES AND CENTER FIELD SPECTRAL PIXELS FOR CLASSIFICATION AND AREA ESTIMATION.

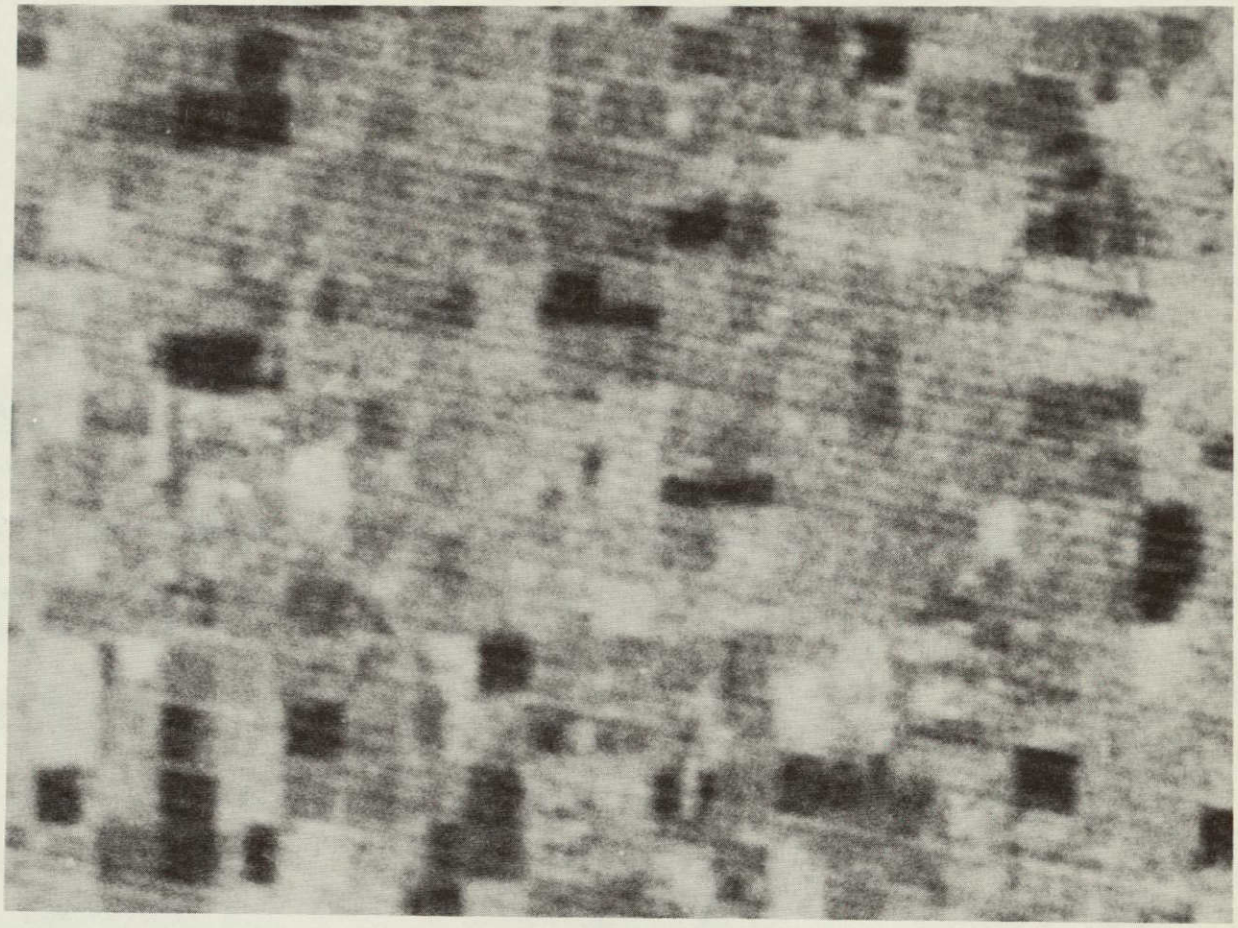


Figure D-1. Image of Landsat MSS data from band 5 of frame 792-16152, June 19, 1977 for 4 by 5 mile area in test site near Phoenix, Arizona.

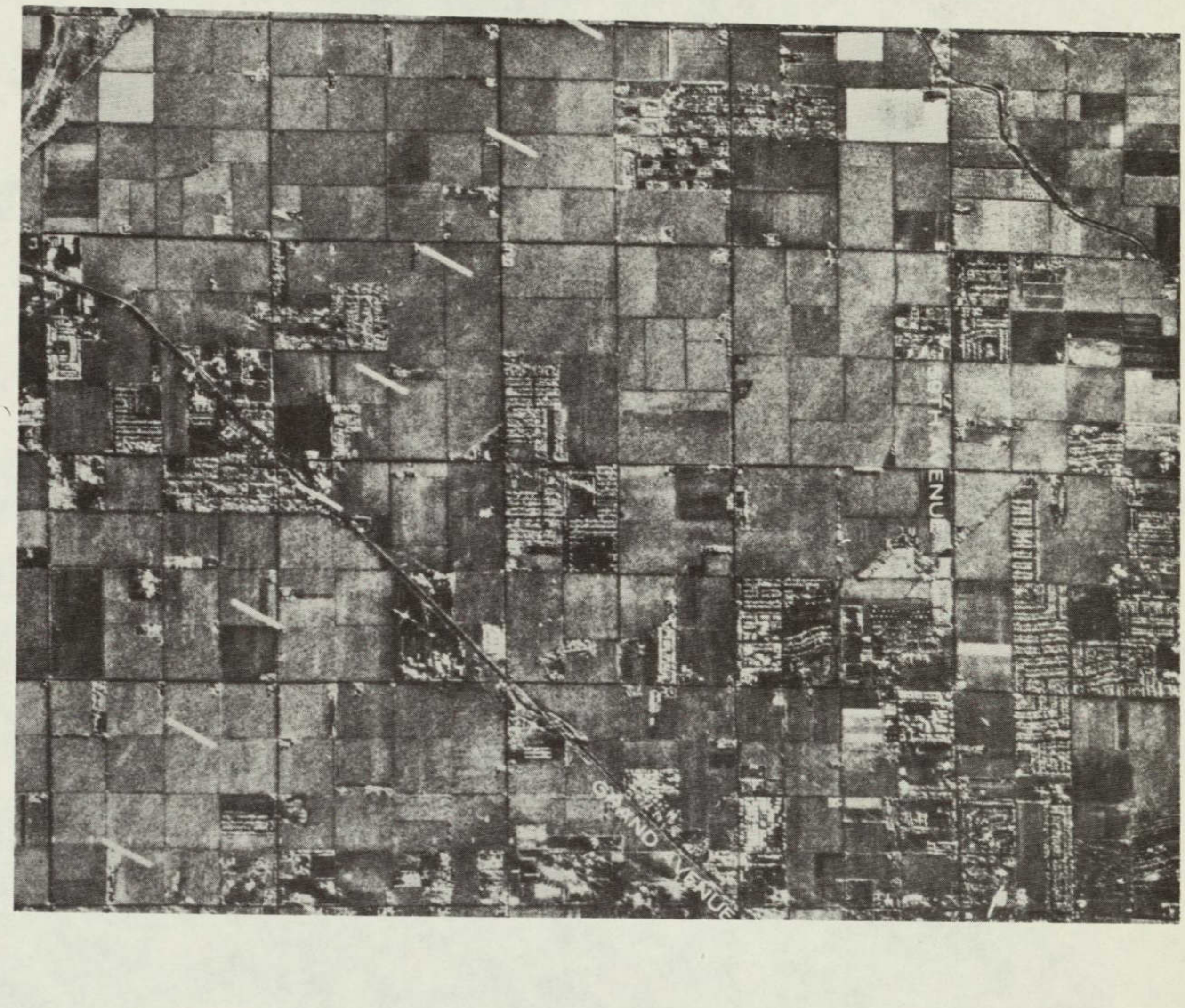


Figure D-2. Image of Aircraft Synthetic Aperture Radar data for same area as in D-1 imaged on June 17, 1977. Look direction is from upper left. Data is registered to Landsat to 1.5 pixel R.M.S. error at a 25 m pixel size.

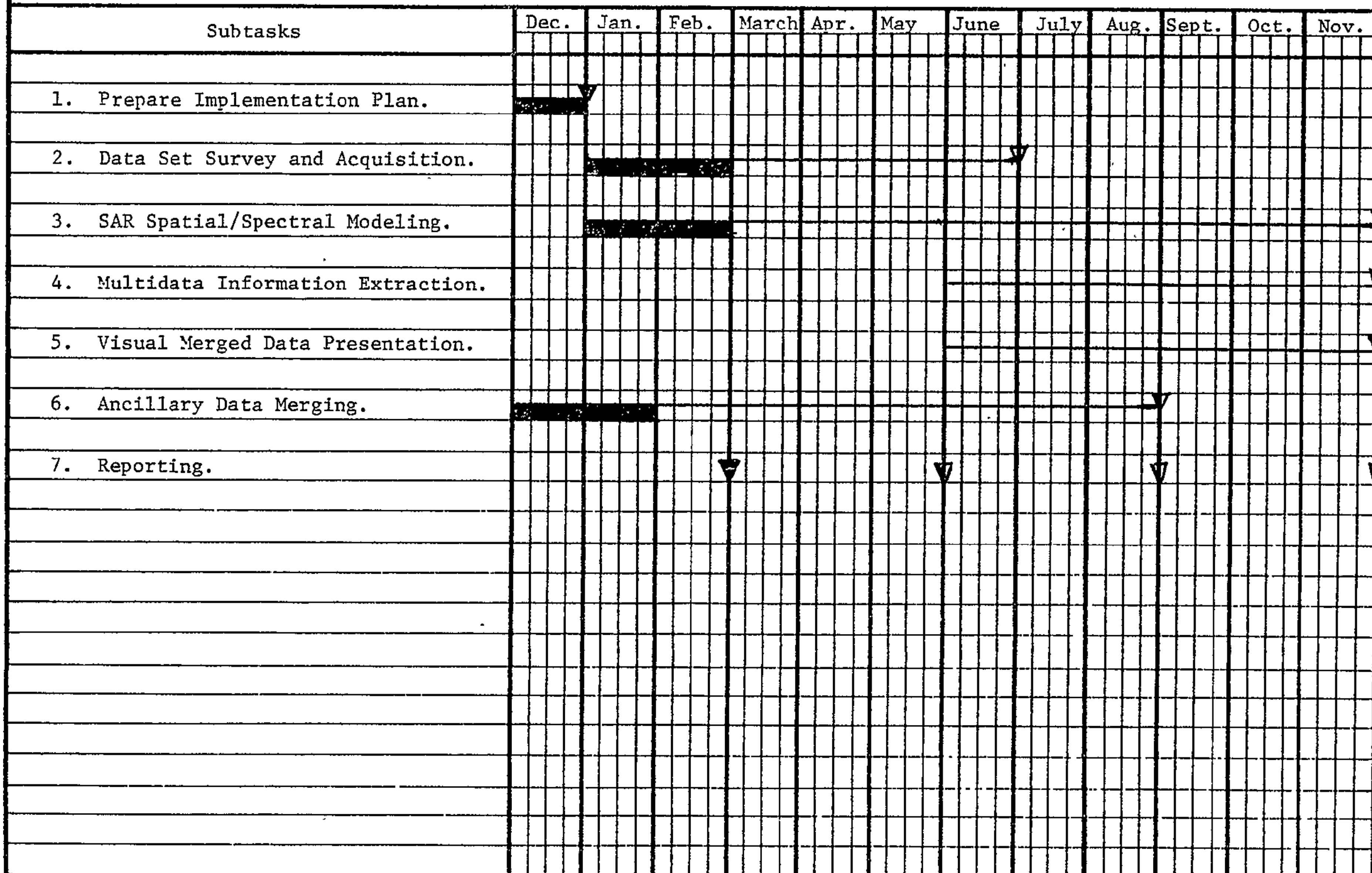
PROBLEMS

- FIVE SEGMENTS IN KANSAS WERE SELECTED AND A SEARCH OF THE GOODYEAR SAR DATA BASE WAS ORDERED. WE WERE INFORMED THAT THE AIR FORCE IS REVIEWING DISTRIBUTION PROCEDURES AND THIS DATA IS NOT CURRENTLY AVAILABLE.
- TAPE DRIVE COMPATIBILITY PROBLEMS HAVE DELAYED PROCESSING OF ANCILLARY DATA DIGITIZED BY TECHNICOLOR AT JSC.

PLANS FOR SECOND QUARTER

- CONTINUE CLASSIFICATION AND IMAGE STUDIES OF PHOENIX SITE 1.
- REGISTER SAR/LANDSAT DATA FOR AREA SOUTHEAST OF PHOENIX WHICH CONTAINS ADDITIONAL FIELDS WITH GROUND TRUTH.
- CLASSIFY AND EVALUATE DIGITIZED COLOR ANCILLARY DATA MAP TO FURTHER EVALUATE THIS METHOD.
- PURSUE ACQUISITION OF SEASAT SAR AND A/C SAR IMAGERY.

2D. Multisensor Multidate Spatial Feature Matching, Correlation, Registering, Resampling and Information Extraction



3A. Computer Processing Support

The objective of this task is to provide JSC and its associated research community, the environment necessary for the implementation of a shared data processing system for research of remote sensing. Purdue's support includes a computer and supporting hardware, software, data, personnel, procedures, and training.

I. Introduction

The eventual goal of this effort is to develop a shared data processing and communication system providing JSC and its associated research community:

* The opportunity to better mold key, geographically dispersed, research groups into a more informed and coordinated research team.
* A mechanism for efficient transfer of information between research centers, NASA, and other participating government agencies.
* Faster, less redundant software development.
* Faster transfer of newly developed analysis techniques and research results to and from participating research groups.
* Concentration of systems programming support, data acquisition, data library, and certain computer services at the system's central site.

During the past year progress has been made toward the establishment of a data processing system:

- An additional remote job entry station to the Purdue/LARS computer was implemented at JSC with a new tape transfer capability.
- Additional keyboard terminals were installed at JSC.
- Implementation of the RT&E data base at Purdue was begun.
- The EOD LARSYS Procedure 1 analysis system was implemented on the Purdue machine.

- Batch machines were designed and implemented for the support of JSC processing needs.
- Computer usage by JSC users increased from 10 hours in January 1978 to roughly 100 hours in August 1978.
- Users from other SR&T sites began to gain limited access to the centralized computer through dial-up terminals.
- Several consulting visits, education, training and information exchange activities have been conducted by both JSC and LARS for the benefit of sharing technology.

Progress made on this task reflects significant effort and mutual support by the organizations making use of the system (during 1978, primarily LARS and JSC). Future progress is predicated on the same levels of effort, commitment and support by all organizations utilizing the system.

LARS proposes to continue to support the development of an Earth Resources Data Processing and Communication System by:

- Housing and designing means to access the current and historical SR&T data base (field measurements, digital, Landsat data, digital blind site ground observations data, etc.).
- Making available certain earth resources analysis systems which are viewed as "standard" (LARSYS Procedure 1, LARSYS Procedure 2, etc.) for the SR&T users accessing the LARS system.
- Supporting the active use of JSC software systems such as FLOCON, Accuracy Assessment, System Verification, etc.
- Supporting data distribution activities.
- Preparing to aid those SR&T research sites which currently do not have access to the shared data processing system with an identification of the hardware, software and procedures necessary to gain access to the system.
- Providing on-going computational support for users of the Data Processing and Communication System.

The goals and objectives for Computer Processing Support Task can be organized into Computer Systems Support, Consulting Support and Techniques Interchange, and Data Base Management.

Computer Systems Support

To provide access to the applications of software needed for an effective remote sensing data processing research environment and to prepare to provide upgraded access to the LARS computational facility to JSC research community, system hardware alterations are required. In addition, additional system software capabilities are necessary for the effective use of some JSC applications software.

Consulting Support and Techniques Interchange

For effective use of the LARS computer system by members of JSC's research community, information must be provided in a responsive manner about a wide range of subjects. In addition, examples of certain system features and information exchange sessions outlining the use of software systems and computer utilities were recognized as valuable. Consequently, personnel were assigned to secure and disburse information about software systems, computer resources, computer products, programming support and training activities.

In order for the capability for operational use of a new analysis technique to be transferred from one organization to another, several things are necessary. The recipient of the new technique must have:

* Access to a software implementation of the technique,
* Access to hardware which will support the software implementation,
* Access to data, and
* An understanding of the concepts behind the technique and how to use its software implementation.

Being accessible to a large portion of the research community, the LARS system is in a position to provide immediate access to software, processing hardware and data. Development of a system for exchange of newly developed analysis techniques by members of JSC's research community utilizing the LARS system will be supported.

Data Management

In order to apply the integrated analysis software becoming available on the LARS computer to useful analysis problems, data must be available for analysis. The volume, need for access, and diversity of the data present a significant data management problem. Since the field measurements data base already resides at Purdue, and since the current and historical imagery data bases and the blind site ground truth data base are being implemented at Purdue, it makes sense for LARS to support future data distribution.

II. Activities During This Quarter

1. An implementation Plan was completed and submitted.
2. Purdue's IBM 370/148 and its communications controller were altered to support replacement of the IBM 2741 terminals at JSC by Trend Data terminals supporting a higher baud rate.
3. A 1200 baud clock has been ordered to replace the 134.5 baud clock required by the 2741 terminals. This change will provide for future hardware operating at a faster data transfer rate.
4. The CSMP software package has been acquired from IBM. IBM has been hired to implement this package under OS on the LARS system while Purdue personnel concentrate on converting CSMP to CMS. This task is behind schedule.
5. The programming tasks necessary to provide a third shift to JSC have been identified. Documentation of a desire to acquire the third shift is a prerequisite to implementation of these programs.
6. Programming tasks for upgrades to the CMS370 batch machines have been identified.
7. In response to heavy usage during July-January, capped by exceptionally heavy usage by JSC during January, the rate for basic CPU time has been reduced from $250 to $200/hour.
8. During the week of February 5, three Purdue computer specialists visited JSC and presented a short course/workshop on the use of the LARS system and some of its software features.

9. An investigation into the acquisition of an IBM 3031 with 2 megabytes of memory was conducted. This machine would provide roughly twice the computational power of the 370/148 at about a 10% increase in cost to Purdue. A presentation was made to JSC outlining the costs, benefits, and evidence of support requested of JSC.

10. Landsat Data was received for the LACIE Phase I segments. Part of this data set was improperly formatted with more than half the data for a segment missing from some tapes. For those tapes which arrived in tact, data has been entered in the segment catalog.
11. Ten tapes containing ground truth data for the blind sites in Kansas have been received. These tapes have been copied to 1600 bpi, placed in the tape library, and are being used to design the data entry software for the ground truth portion of the segment catalog.
12. A notebook containing the LARSYS Version III programming and documentation standards has been prepared for input to JSC.
13. A program was written for Dave Pitts to convert data tapes he will be receiving into a usable format.

III. Plans for the Next Quarter

1. Purdue's IBM 370/148 and its communications controller will be altered to support the replacement of the IBM 2780 terminal by a Data 100 terminal, functioning in HASP mode on the HOUSTON link. Like the terminal on the JSCTEXAS port, this new terminal will also have a tape drive attached.
2. The 3705 emulator program will be altered, a statistical multiplexor installed, a 9600 baud modem installed, and a 1200 baud clock acquired to upgrade the data transfer rate for users at JSC.
3. CSMP installation under OS and later CMS will be completed.
4. Acquisition of a color output device for use by remote sites will be investigated.

5. Alterations to the CP and User Group accounting reports will be made in anticipation of a third shift sale.
6. To make the CMS370 batch machines more usable the following programming tasks will be initiated:
   * All spoolable devices must be closed either before a job starts or after a job ends.
   * BATCH TIME must be fixed.
   * If a job is submitted from terminal with the 'NOHEADER' option, then BATCH should ignore the header card.
   * Allow all BATCH control card options to be on one card.
   * BATCH machines with shorter time limits.
   * Implement an EXEC for generating the batch decks.
   * If a BATCH job dies, print out the console output automatically. (temporary solution to error reporting).
   * Write and distribute BATCH documentation.
   * Set default GLOBAL's and FILEDEF's.
   * If operator must cancel a job, the operator's message should be appended to print out.
7. The CMS compatible version of SAS will be ordered during March.
8. Version 8 of SPSS will be installed during March.
9. The 3330 disk system with 350 megabytes of usable disk storage will be installed during March.
10. The tape transfer software will be upgraded based on experience with the initial implementation, the new Data 100 protocal upgrades since the initial software implementation, and any demand which the additional tape drive available on the HOUSTON port may place on the system.
11. Responsibility for the EOD/LARSYS prompting EXEC will be transferred from LARS to the EOD/LARSYS librarian at JSC during a visiting consultant trip in April.
12. Work to establish a standard training course will begin in conjunction with support from JSC. Initiation of this task was delayed to pursue the investigation of the opportunity to acquire an IBM 3031.

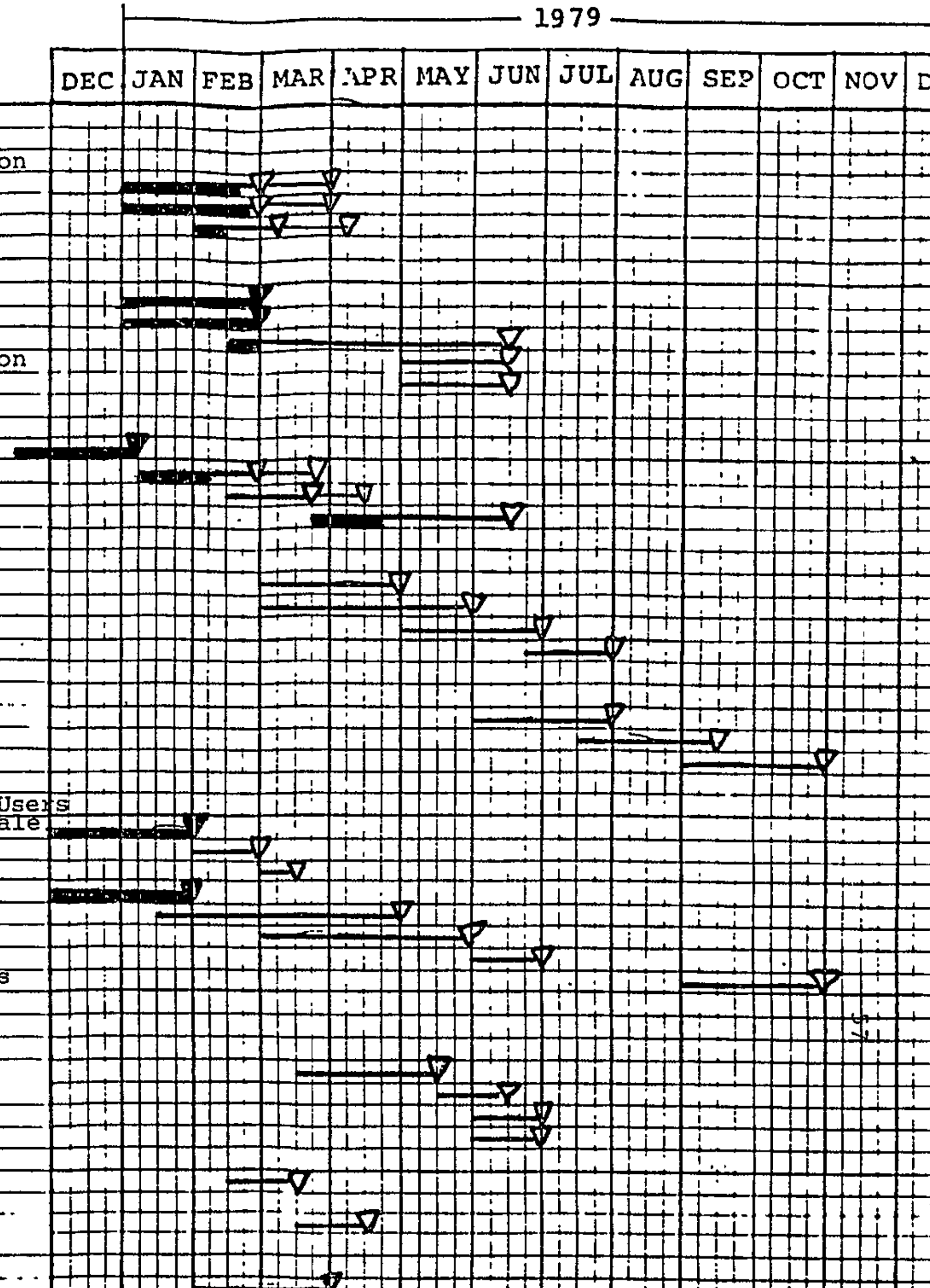
13. The investigation of procedures to interchange technology using the LARS system was also delayed due to the 3031 investigation. Work on this task should begin during this quarter.
14. The LACIE Transition Year Landsat data base is expected to be received and entered in the tape library during April.
15. Transition Year data should be added to the segment catalog during May.
16. Software for access and searching the ground truth data associated with the LACIE Phase II and Phase III data bases should be completed during May.
17. A recommendation will be made as to how NOAA may best implement their weather data base on the Purdue computer.
18. Support ERIM's use of the LARS system for field measurement activities.

TASK 3A: COMPUTER PROCESSING SUPPORT DETAILED SCHEDULE

Computer Capabilities Milestone Chart

Figure 2

DETAILED IMPLEMENTATION SCHEDULE



I. COMPUTER SYSTEMS SUPPORT

Support Replacement of JSC 2780 Remote Job Entry Station
- Reconfigure communications controller
- Alter RSCS
- Document system

Support Upgrade of Keyboard Terminals at JSC
- Alter 3705 emulator program for different baud rate
- Alter CP
- Install 1200 baud clock
- Upgrade 3705 emulator program for 1200 baud operation
- Install new modem/multiplexor

CSMP Installation
- Order software package
- Install under OS
- Document for User
- Install under CMS

Investigate Interactive Color Device for Remote Usage
- Investigate market alternatives
- Investigate user needs
- Confer with JSC
- Make proposal to JSC

Upgrade Support for other SR&T Sites
- Contact sites, review needs & available equipment
- Identify equipment & other resource upgrades needed
- Propose support to sites, JSC

Improve Potential Computing Dollar Efficiency for JSC Users
- Investigate necessary components of a Third Shift Sale
- Negotiate 3rd shift sale with JSC
- Propose 3rd shift sale
- Assess major batch problems
- Improve usability of JSC batch machines
- Document new batch machine characteristics
- Present a seminar on new batch capabilities
- Transfer responsibility for batch support to systems group

SAS Installation
- Order CMS Version of SAS
- Install SAS
- Document Access to SAS
- Present seminar on SAS use

Install SPSS Version 8

Install New Disk System

Upgrade Tape Transfer Software
- Improve software reliability

TASK 3A: COMPUTER PROCESSING SUPPORT DET[illegible]ED SCHEDUL[illegible]

Computer Capabilities Milestone Chart

II. CONSULTING SUPPORT & TECHNIQUES INTERCHANGE

Make Visiting Consultant Trips

Present Short Course on LARS System
- Prepare course on CMS370, LARS system characteristics
- Present course at LARS
- Present course at JSC

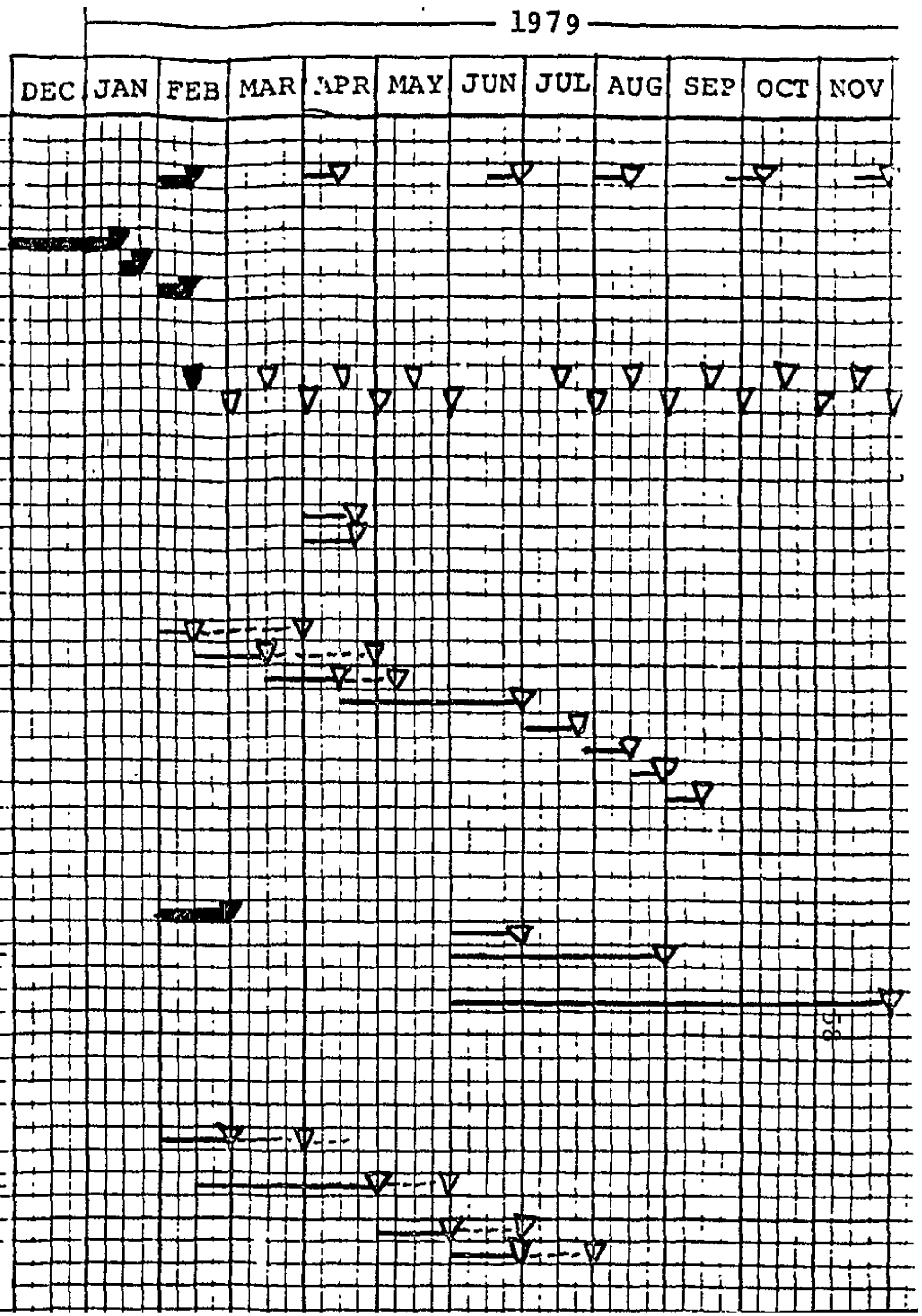
Document System Upgrades & News in LARS' SCANLINES
- Collect SCANLINES input
- Distribute Newsletter

Transfer Responsibility for EOD/LARSYS Prompting EXEC to EOD/LARSYS Librarian
- Deliver Prompting EXEC documentation
- Provide detailed instruction in EXEC maintenance

Establish Standard Training Course
- Identify course goals
- Identify course components
- Identify organizational responsibility for components
- Assemble materials for LARS areas of responsibility
- Integrate course components
- Present course at JSC
- Review contents for omissions
- Upgrade course

Support Development of Programming, Documentation and Techniques Delivery Standards
- Provide LARSYS Version III Standards as input to JSC
- Publicize Standards through SCANLINES, SRTNEWS, etc.
- Standardize software delivered under Computer Processing Task
- Aid LARS researchers in standardization of future software

Investigate Procedures to Interchange Technology using the LARS System
- Analyze the current Technology Transfer procedures used in the JSC research community
- Identify perceived organizational roles and responsibilities for techniques interchange
- Identify problem areas
- Propose a system for interchange of technology within the research community



TASK 3A: COMPUTER PROCESSING SUPPORT DETAILED SCHEDULE

Computer Capabilities Milestone Chart

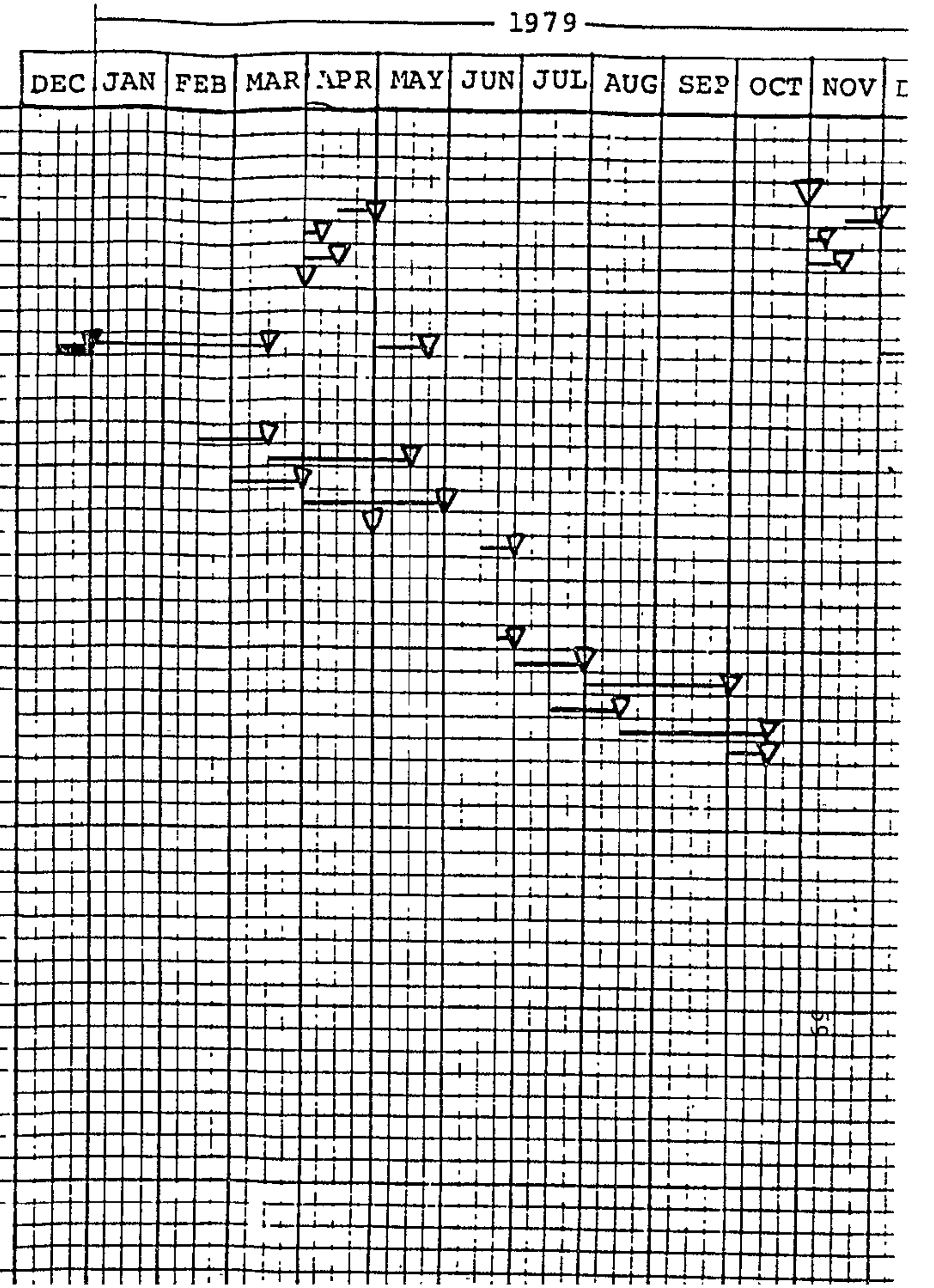
III. DATA BASE MANAGEMENT

Receive Landsat Data Bases
- Receive tapes
- Label, forward/rewind, enter on tape racks
- Communicate data receipt
- Copy to 1600 bpi
- Receive new copies of unusable tapes

Catalog Landsat Data in Segment Catalog

Implement Data Base (Ground Truth Data)
- Design data entry software
- Implement data entry software
- Design data maintenance software
- Implement data maintenance software
- Receive GT data from JSC
- Present seminar at JSC

Implement Data Base (Dot Label File)
- Have meeting to determine software specifications
- Design data entry software
- Implement data entry software
- Design data maintenance software
- Implement data maintenance software
- Present seminar at JSC



3B. Field Research Data Base Management and Distribution

The overall objective of this task is to assure the timely availability to researchers of the Johnson Space Center field research data stored at Purdue/LARS. The specific objectives are:

A. Distribute field research data for all approved requests.

B. Maintain and update present field research data base.

C. Incorporate 1978 Purdue Agronomy Farm data into data base.

D. Incorporate 1978 Hand County, South Dakota data into data base.

E. Revise and update field research data catalogs.

F. Document calibration and correlation of the spectral data in the data base.

G. Determine feasibility of using computer data base management system.

H. Incorporate available 1979 Field Research Data into data base.

I. Incorporate soil data of Task 1D into data base.

I. Activities This Quarter

A. The implementation plan was completed in early January.

B. Field Research data were distributed to General Electric during the later part of December.

C. The 1978 Hand County, South Dakota data are being entered into the field research library and the data are being prepared for final processing of 1978 FSS data.

D. A computer data base management system (RAMIS) is being reviewed for its applicability to the field research data base.

E. Productivity parameters (e.g. yield and test weight) are being examined for inclusion in the field research spectrometer identification records stored on magnetic tape.

II. Plans for Next Reporting Period

A. The computer data base management system review will be completed.

B. The 1978 Exotech 20C spectrometer data collected at the Purdue Agronomy Farm will be made available for researchers.

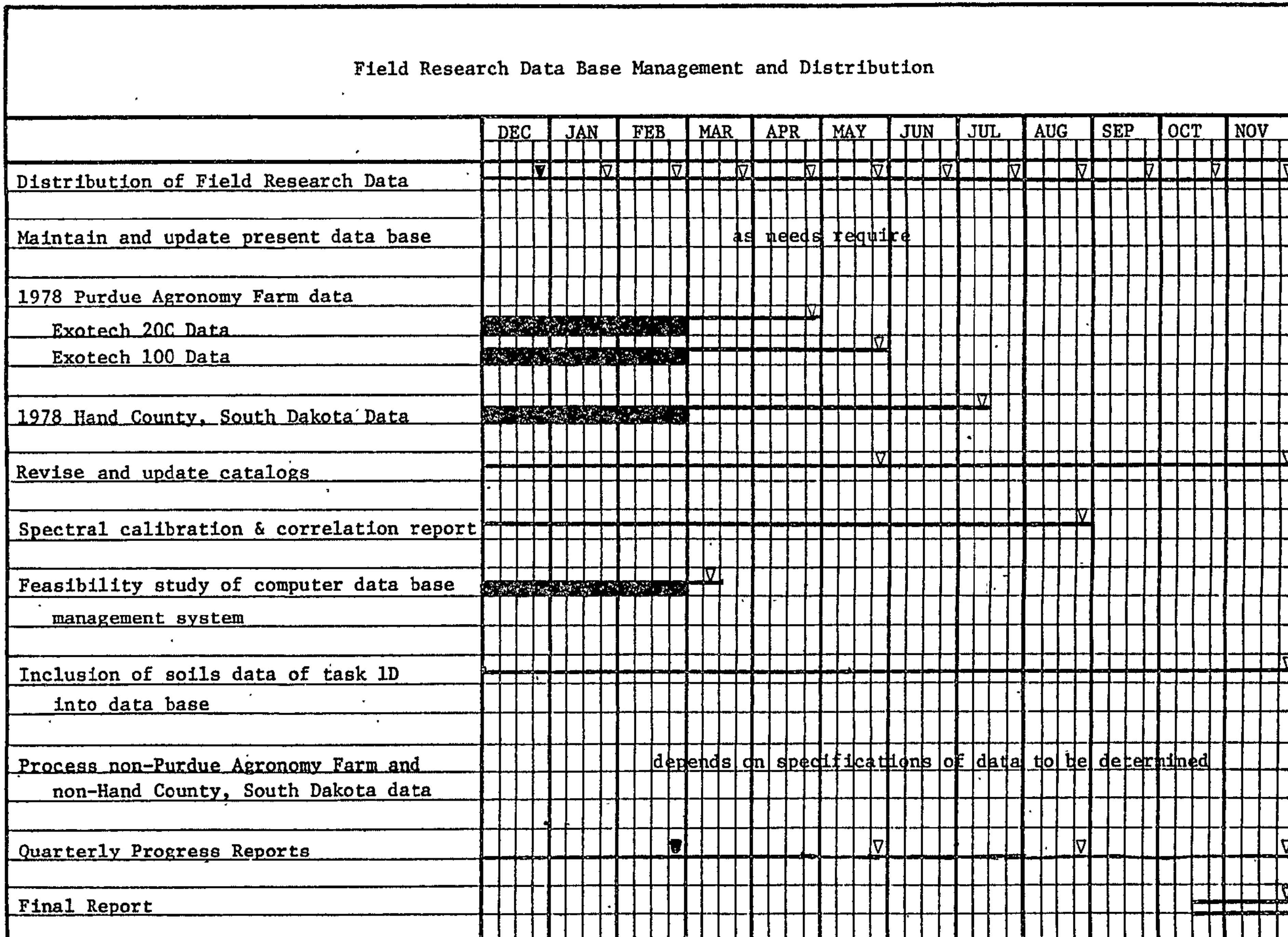
C. The field research catalogs will be revised and updated.

D. Analysis for the calibration and correlation report will begin again.

III. Data Needed

The 1978 summer crop inventory is needed for final processing of the 1978 Hand County, South Dakota FSS data.

Figure 3B-1. Detailed Implementation Schedule for Task 3B



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