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Foreign Commodity Production Forecasting

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MAXIMAL ANALYSIS LABELING PROCEDURE
(PRELIMINARY)

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MAXIMAL ANALYSIS LABELING PROCEDURE
(PRELIMINARY)

Job Order 74-422

This report describes Experiment Design activities of the Foreign Commodity Production Forecasting project of the AgRISTARS program.

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CONTENTS

TABLE

FIGURES

ACRONYMS

Ag/MET	agronomic and meteorological
AgRISTARS	Agricultural and Resources Inventory Surveys Through Aerospace Remote Sensing
CAMS	Classification and Mensuration Subsystem
FCPF	Foreign Commodity Production Forecasting
FLOCON	flow control
FY	fiscal year
LEMSCO	Lockheed Engineering and Management Services Company, Inc.
LACIE	Large Area Crop Inventory Experiment
LARS	Laboratory for the Applications of Remote Sensing
LIST	Label Identification from Statistical Tabulation
MAEP	Maximal Analysis Evaluation Procedure
MALP	Maximal Analysis Labeling Procedure
NASA	National Aeronautics and Space Administration
pixels	picture elements
TY	Transition Year

1. INTRODUCTION

1.1 RESPONSIBILITY

The Maximal Analysis Labeling Procedure (MALP) development will be implemented during fiscal year 1980 (FY80) as a part of the Agricultural and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) program. The Foreign Commodity Production Forecasting (FCPF) group is responsible for the technique development and experimental design of the maximal analysis.

1.2 OBJECTIVE

The objective of the FCPF project with respect to a maximal analysis procedure is to develop the methodology and implement the procedures required for evaluating area-estimation technology of the foreign regions of interest.

1.3 BACKGROUND

Adequate harvested area information for labeling, classification, and area-estimation evaluation is not available in some AgRISTARS regions. Therefore, it is necessary to explore alternative approaches for developing 'reference data" for those AgRISTARS regions for which adequate ground observed data cannot be obtained. For example, only planted area information is published in Australia. At-harvest area estimates that could be compared to satellite-based temporal analysis are not currently available. Similarly, for the U.S.S.R., reliable wheat/barley at-harvest area data are currently available only at the national level. In addition, the reliability of harvested area data at regional levels may be too poor for evaluation purposes. (Note: The regional level is the level for which exploratory and pilot studies will be developed during the AgRISTARS program.) Aware of the inadequate harvested area information, the FCPF project will develop reference data which will be used for the evaluation of (a) labeling, (b) of the classifier (both analyst and machine) accuracy, and (c) of the area-estimation performance (bias and variance).

The approach proposed for testing is to develop a set of "reference segments" in which crops have been identified through analyst interpretation and the labeling accuracies estimated with reasonably small and known error rates.

1.4 MAXIMAL ANALYSIS DATA REQUIREMENTS AND PREPARATION

The data requirements and preparation required for the maximal analysis exploratory testing are described in section 3 of this document.

1.5 THE MALP

The preliminary MALP's are described in section 4 of this document.

1.6 THE MAXIMAL ANALYSIS EVALUATION PROCEDURE (MAEP)

The MAEP will be reported in detail in a separate document. Of interest in this discussion on evaluation are the four types of picture elements (pixels) within a Landsat scene. They are:

a. Type A — pixels that are spatially interior for the category of interest and have spectral separability which is consistently evident among analysts.

b. Type B — pixels that are spatially interior for the category of interest and are lacking in distinctive spectral separation which produces inconsistent analyst labeling.

c. Type C — border or edge pixels that are partly within the category of interest.

d. Type D — pixels that have a category of interest smaller than the size of the pixel [e.g., 0.08094-hectare (1/5-acre) field].

Under the MAEP, each of these four types of pixels will have a labeling accuracy associated with it. The accuracy will vary with the confusion crops, meteorological influences, and acquisition history as well as other factors. Holding as many factors consistent as possible and determining if the labeling and/or classification accuracy of a segment can be predicted from the relative abundance of each type A, B, and C pixels are desired goals. (Segments with

type D pixels are excluded from this analysis.) Before beginning this work, a maximal analysis procedure must be specified that would enable estimating the relative abundance of type A, B, and C pixels. In terms of Landsat acquisitions, the best situation will be studied.

2. THE MALP OVERVIEW

In order to acquire maximum analysis of labeling, available remote sensing technology is utilized for the design and testing of a procedure for the evaluation of FCPF project multicrop output accuracies. The MALP procedure will be applied to assess foreign areas where ground observations are not available. The technique under development is based on an intensive analysis of Landsat reference-segment data by qualified analysts. These analysts have a wide range of operational experience including the Large Area Crop Inventory Experiment (LACIE) and the subsequent transitional year (TY) analyses.

Because the MALP should be designed to produce the most accurate analysis possible from Landsat data, it is imperative that the reference segments be optimal with respect to acquisition histories, image registration, and image quality. The criteria for the selection of reference segments are very stringent (section 3.1).

Prior to labeling, experts in agronomy and meteorology provide important inputs into the analysis by developing indepth scenarios for the reference segments on cropping practices, crop conditions, and climatological effects throughout the growing season.

The MALP consists of (a) a review of all the agronomic and meteorological ancillary data, (b) a series of interpretations including an independent analysis, (c) machine processings, and (d) final consensus labeling. The maximal analysis task flow is shown in figure 2-1.

The independent analysis is conducted by three analysts individually performing the Landsat labeling tasks. These labels will be compared later in order to establish which pixel labels the analysts have agreed or disagreed upon. Recent testing indicates that these labels, if derived independently through use of established procedures, have exceptionally high accuracies when the analysts agree.

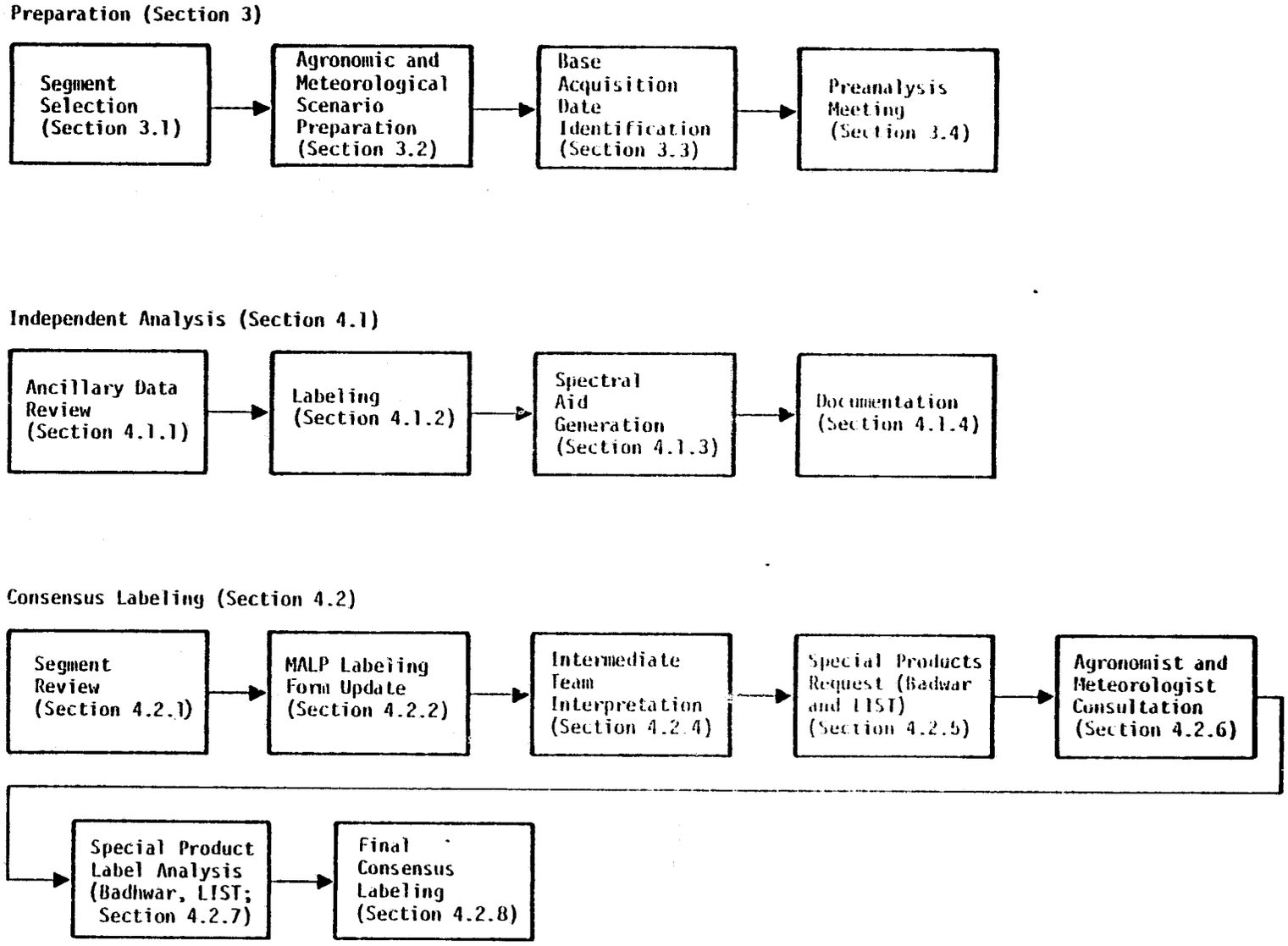

Figure 2-1.— Maximal analysis procedure task flow.

Concurrent with the independent analysis, the reference segments are submitted for machine processing. Current technology is used to generate spectral aids, trajectory plots, and specialized labeling products. Upon receipt of these specialized products, the three analysts (working as a team) review and evaluate all of the available data giving particular attention to the labels for which they have disagreed. Through discussions, the analyst team determines the final consensus labels for the reference segments.

3. PREPARATION FOR THE MALP AND DATA REQUIREMENTS

3.1 SEGMENT SELECTION

The responsibility for the selection of the reference segments belongs to the maximal analysis task coordinator, the assigned agronomist, and a representative from the accuracy assessment group. Proper selection of reference segments is crucial to the success of the MALP; therefore, careful adherence to the segment selection requirements is an important responsibility. The use of current technology to identify segments that meet all of the requirements necessary to perform the most accurate and representative full-season analysis is a major objective.

3.1.1 ACQUISITION HISTORY AND REQUIREMENTS

The reference segment should have a good acquisition history from planting through emergence and harvest for all crop types that are to be labeled. However, the requirements of individual reference segments may vary depending on labeling hierarchy, confusion crops, region, climate, or episodal factors. The reference segments will probably have as many or more total acquisitions than any of the other segments within the region.

3.1.1.1 Small-Grains Acquisition Requirements

For winter or spring small-grains analysis, a minimum of one acquisition in each biostage is required (biostage 1 through 4).

3.1.1.2 Direct Wheat Acquisition Requirements

In addition to the small-grain requirements, the separation of barley from spring small grains in a direct wheat procedure requires one acquisition during the wheat biostage 4.7 to 6.0. Imagery from a second satellite is often utilized in order to meet barley separation requirements.Separation is based on the assumption that barley ripens and is usually harvested before spring wheat. Successive acquisitions from late jointing through harvest will usually result in more accurate identification of barley than is possible with a single acquisition in the separation window.

3.1.1.3 Corn and Soybean Acquisition Requirements

The minimum data required for identifying corn and soybeans are stated in reference 1. For maximal analysis, the minimum image data set requirement is one acquisition in each of the corn soybean biowindows A, B, and C where:

a. Biowindow A is planting and preemergence for corn and soybeans.

b. Biowindow B is the date when most of the corn is in the denting stage and most of the soybeans is in the full-pod stage.

c. Biowindow C is the data when the corn and soybeans are harvested.

3.1.1.4 Machine Processing Acquisition Requirements

In addition to crop-specific acquisition requirements for manual analysis, other requirements may exist for optimal machine processing. For example, the G. Badhwar Accuracy Assessment Profile Comparison Program is most successful if five acquisitions from postemergence to preharvest are available to characterize the crop of interest growth curve.

3.1.1.4.1 Badhwar Acquisition Requirements

For ideal usage of the Badhwar classification, five acquisitions in the postemergence to preharvest growth stages should be available. However, classification should be successful if there are four acquisitions available in this period. The acquisition distribution must be adequate to define the curves which specify the crop profile in each channel. Cloudy and hazy acquisitions should be avoided. The method used to assess the adequacy of acquisition coverage and the method for determining the final choice of acquisitions will be documented by the Supporting Research project (ref. 2).

3.1.1.4.2 Label Identification from Statistical Tabulation (LIST) Acquisition Requirements

Four acquisitions are required in order to use LIST successfully (ref. 3). They should be distributed between the planting and harvest stages for LIST processing.

3.1.2 OTHER DATA REQUIREMENTS

3.1.2.1 Registration Requirements

Image registration between acquisitions that will be required for machine processing must be within plus or minus one pixel. Plus or minus three pixels can be considered a variable limit for manual labeling.

3.1.2.2 Image Quality Requirements

Imagery that is key for maximal analysis should be free of clouds, haze, and technical problems (see ref. 1, appendix F).

3.1.2.3 Crop Proportion and Field Size Criteria

The reference segments selected must be representative of the region with respect to crop types, proportions, field sizes, and shapes. This responsibility is assigned to the agronomist whose training and experience in the region are of great influence in this evaluation process. A complete review of the Landsat imagery and a review of the ancillary cropping practice data by the agronomists are further preparation for the evaluation responsibilities.

3.1.2.4 Ancillary Data Requirements

Ancillary summaries, containing information on soils, climate, cropping practices, and agricultural statistical data, will be available for each maximum analysis reference segment (see ref. 4, paragraph 5.1.3.4).

3.1.2.5 Crop Calendar Requirements

A mean historical crop calendar for each reference segment will be provided to assist the analyst in image interpretation. On each calendar will be a discription of the progress of the crop of interest and all other crops which (taken together) constitute at least 95 percent of the cultivated area for which information is available.

Updates to these calendars shall be provided to indicate early or late attainment of various growth stages for the predominant crops in response to meteorological data for the crop year being analyzed (see ref. 4, paragraphs 5.1.3.5 and 5.1.4.1).

3.1.2.6 Topographic Map Requirements

Topographic maps must be available for each reference segment as detailed in reference 4, paragraph 5.1.3.2.

3.1.2.7 Meteorological Summary Requirements

Weekly updates of the weather experienced in the regions of interest must be made available to the analysts (see ref. 4, paragraph 5.1.4.2). The weather updates should be similar to that provided for the United States in the Weekly Weather and Crop Bulletin.

3.1.2.8 Digitized Ground-Truth Requirements

As part of the testing of the MALP, the U.S. ground data sites will be used for establishing error rates for extension to similar foreign regions. Therefore, these U.S. segments must have digitized ground truth available.

3.2 AGRONOMIC AND METEOROLOGICAL (Ag/MET) SCENARIO PREPARATION

A detailed description of all the Ag/MET data that can be utilized in a maximal analysis will be researched. The significance of the Ag/MET data collected at the various hierarchial levels will be extrapolated to the specific reference segments. This is accomplished through a correlation process between the ancillary data and soils maps, and the multiple year Landsat imagery of the segment (both full-frame and LACIE format).

Ag/MET correlations will be conducted by professionals skilled in these disciplines. Sufficient time will be scheduled at the "front end" to allow the research to be completed prior to commencement of the analyst labeling. The findings will be documented as a briefing scenario for each of the maximal

analysis reference segments. Each scenario will include the following if possible.

a. A summary of the Landsat acquisitions that are acquired during the analysis year (growing season), including image dates and biostages, image holidays, and crop signature descriptions for each date. Descriptions of the effect of missing acquisitions on crop signature progressions will be included (see figure 3-1).

b. Dates of possible crop abandonment.

c. Dates of episodal events such as hail, insect damage, or flooding.

d. Segment-specific updates of crop calendars.

e. Most recent crop statistics available with reliable estimators for segment-level analysis.

f. Anticipated confusion crops with the most likely separation dates for the segment.

g. Segment-specific cropping practices and crop rotation systems.

3.3 BASE ACQUISITION DATE IDENTIFICATION

Prior to the commencement of the maximal analysis labeling, a base acquisition date must be identified. This will ensure that all analysts are labeling the same ground area. Criteria for the selection of the base date follow.

a. If the reference segment is a ground data site, the acquisition used as a base date for ground-truth labeling will also be used as the MALP base date. This will permit accurate error analysis of the MALP.

b. Otherwise, the base acquisition will be the date that shows the greatest separation between the crop or crops of interest and other crops.

Responsibility for the base acquisition date identification belongs to the MALP team coordinator. (The coordinator will also be responsible for the proper transfer of labels to the cartographic/accuracy assessment base date if there is a discrepancy in base dates.)

Date of acquisition, 1979	Julian day		Robertson biostage	Information
April 28	118		0.7	
	127			
May 16	136		2.2	
	145			
June 3	154		2.9	
	163			Missing: the emerging acquisition for late-planted spring grains and the planting acquisition for summer crops
	172			
	181			
July 9	190		3.8	
July 18	199		4.0	Hail damage
July 27	208		4.5	
August 5	217		5.2	Barley separation date
	226			Missing: the fill-ripe and early-harvest acquisition for small grains
August 24	235		6.0	
	244			
	253			
September 20	262		7.0+	
	271			Missing: the harvest acquisition for late-planted spring small grains
	•			
	•			
	•			
	•			

Figure 3-1.- An example of segment acquisition history, Segment 1461, Pierce, North Dakota.

3.4 PREANALYSIS MEETING

Prior to the commencement of the maximal analysis, the participants will be fully briefed on all aspects of the task. The analysts, task corrdinator, an agronomist, a meteorologist, and machine processing personnel will attend the preanalysis meeting.

The following agenda will be covered in sufficient detail to ensure complete understanding of all facets necessary for the performance of the task.

3.4.1 INTRODUCTION AND TASK OBJECTIVES

The presentor will be the MALP task coordinator. The reference segment to be analyzed will be identified at this time.

3.4.2 SEGMENT DESCRIPTION

The agronomist and meteorologist assigned to the MALP task will present the segment description. A complete review of all information found in the development of the Ag/MET scenario will be given.

3.4.3 LABELING CATEGORY DEFINITION

The MALP task coordinator is responsible for presenting the labeling category definition. A list of the labeling categories to be used for the specific reference segment will be provided at the preanalysis meeting.

3.4.4 PROCEDURE DEFINITION

Details of the MALP will be reviewed by the task coordinator. Segment-specific guidelines will be detailed as applicable.

3.4.5 IDENTIFICATION OF BASE ACQUISITION DATE

The base acquisition date will be identified by the MALP task coordinator.

3.4.6 MACHINE PROCESSING REQUIREMENTS

The MALP task coordinator and a machine processing representative will present the machine processing requirements. The requirements, data handling, and schedules for machine processing requests will be reviewed.

3.4.7 SCHEDULES

The MALP task coordinator and an accuracy assessment representative will present the schedules. Start and completion milestones and estimated man-hour requirements for each subtask will be discussed.

4. MALP

4.1 INDEPENDENT ANALYSIS

4.1.1 ANCILLARY DATA REVIEW

Each analyst will study the Ag/MET briefing scenario and all ancillary data.

4.1.2 LABELING PROCEDURES

Using the MALP procedures outlined in section 4, each analysts will processes the segment independently. Modifications of operational procedures which are necessary to accomodate maximal analysis requirements are discussed in the following paragraphs.

Current analysis procedures will be adheared to with regard to segment-location determination, full-frame utilization, crop calendar updates, Landsat imagery, and supplemental product utilization (ref. 1).

4.1.2.1 Dot Labeling Sequence

Machine classifications (estimates) will not be required. (Initially, the products of the MALP are dot labels only.) Therefore, the Type-1 and Type-2 dot labeling procedures as described in reference 1 will not be necessary. Instead, all 209 dots will be labeled sequentially.

4.1.2.2 Dot Labeling Forms

A special form is being prepared for recording dot labels. Meanwhile, the label forms for Type-1 and Type-2 operational dots will be used.

4.1.2.3 Dot Labeling Base Date

Labeling will be referenced to the base date identified by the MALP task coordinator.

4.1.2.4 Anomalous Pixels

The pixel will be labeled according to the field surrounding it unless it is anomalous. For example, a pixel in a partially emerged or spotty field is labeled the category of the field; however, if the pixel falls on a small pond in a field, it is labeled water.

4.1.2.5 Border Pixels

All dots except border pixels will be labeled. A border pixel is a pixel located between two fields with each field classified in a different category on the base date. Thus, difficulty in labeling the dots occurs in this spectrally mixed pixel. A "B" will be recorded on the dot-labeling form for border pixels.

4.1.2.6 Edge Pixels

Edge pixels, pixels clearly within a field of one category on one acquisition and within a different field on another acquisition (misregistration), will be labeled according to the base acquisition date (see ref. 1, fig. 4-2).

4.1.2.7 Recording Edge Dots

Record edge dots on the dot-labeling forms with a small letter "e" beside the dot label.

4.1.2.8 Crop Labeling Codes

Crop labeling codes will be as specified in reference 1 for the particular crop of interest (e.g., small grains, wheat/barley separation, and corn/-soybeans).

4.1.2.9 Interpretation Methodology and Decision Logic

Analyst-interpretation methodology and decision logic will be as described in reference 1 for the crop categories of interest.

4.1.2.10 Certain Dot Label Recording

Accuracy assessment personnel are interested in the dot labels in which the analysts have very high confidence. These high confidence dot labels are being referred to as "certain" dots. If the analyst is certain in the accuracy of a dot label, the crop label will be recorded twice. For example, a "certain" spring-wheat pixel will be recorded S/S, a "certain" nonwheat pixel (or noncategory-of-interest pixel) would be recorded N/N. If the analyst has any doubts concerning accuracy of the label, a single labeling code (e.g., S, N, and B) will be recorded.

4.1.2.11 Analyst Code Names

The MALP task coordinator will provide each analyst with his or her own discrete code to be used instead of individual names. Names of individual analysts will not be placed on the dot labeling forms or any spectral data requests.

4.1.3 SPECTRAL AIDS GENERATION AND UTILIZATION

Spectral aids that will be generated and utilized during the independent analysis are:

a. Scatter plots

b. Trajectory plots

    1. Time plots

    2. Green number versus brightness trajectory plots

The mechanics for submitting requests for scatter plot generation are the same as provided in reference 1, paragraphs 3.4 and C.1.2.2.

Procedures for the submission of requests for trajectory plot generation (without machine classification) are being determined in conjunction with flow control (FLOCON).

Guidelines for using scatter plots and trajectory plots are presented in reference 1, paragraphs 3.4, C.1.2.2, and C.2.2.

4.1.4 INDEPENDENT ANALYSIS DOCUMENTATION

Each analyst will make two xerox copies of the dot-labeling forms for submittal to the MALP task coordinator for filing. The original forms will be retained by each analyst for reference during the consensus labeling.

4.2 CONSENSUS LABELING

Consensus labeling is a process whereby the analysts working as a team jointly label the 209 dots. Through discussions and by reviewing the independent analysis labels as well as all available input data, the analyst team reaches agreement on labels of the 209 dots.

4.2.1 SEGMENT REVIEW

Prior to the commencement of the consensus labeling, a segment review will be conducted. Attendees will be the analysts, agronomist, meteorologist, a machine processing support specialist, and the MALP task coordinator. Findings from the independent analysis will be discussed. Additional requirements from the agronomist and meteorologist will be defined, if necessary. The MALP coordinator will review the consensus labeling procedures as detailed in this section. The schedule for the consensus labeling task will be updated and presented by the MALP coordinator at this time. Requirements for special machine labeling products in support of the consensus labeling will be reviewed and the schedule updated as required.

4.2.2 MALP LABELING FORM

The analysts will transfer the independent analysis dot labels for each analyst on to a master form (MALP Form, figure 4-1, columns 1, 2, and 3). The "certain" dots from the independent analysis will be recorded twice (e.g., S/S, B/B, and N/N) on the MALP labeling form.

Segment_____

Base Acquisition_____

Maximal Analysis Procedure Labeling Form

Dot number	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
	Independent Analysis			Agreement and disagreement dots	Intermediate team interpretation	Agronomist and meteorologist labels	Special product label (Badhwar)	Special product label (LIST)	Final consensus label
	Analyst A	Analyst B	Analyst C						
1									
2									
3									
4									
5									
6									
7									
8									
6									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

Figure 4-1.- The MALP Form.

4.2.3 AGREEMENT AND DISAGREEMENT DOTS

The fourth column of the MALP Form will be used for recording those dot labels whereby all three analysts were in agreement on the independent analysis. Dots that are not labeled in the fourth column are, by default, the disagreement dots.

4.2.4 INTERMEDIATE TEAM INTERPRETATION

The analysts, working as a team, will reinterpret the segment. Particular attention will be given to the labels if there were disagreement among the three analysts on the independent analysis. Procedures will be identical to those used during the independent analysis. All ancillary data will be reviewed and additional spectral aids will be generated if required. Ground truth from past years will be reviewed in addition to the blind site segments documented in the Analyst Interpretation Keys (refs. 5 and 6). Emphasis will be placed on usage of full frames for the replacement of segment acquisitions not acquired. Labels from previous years will be studied for normal year to year variability. Regionalization will be achieved by reviewing other segments within the same refined strata or agrophysical unit for signature trends (ref. 7). Team consensus labels will be assigned to each of the 209 dots as the interpretations are concluded. Note that the objective is to assign the most accurate label possible to each dot (or the field in the case of anomalous dots).

There is no provision against changing the agreement labels determined during the independent analysis if the team believes another label is more appropriate. The team records the interpretation labels in the fifth column of the MALP Form (fig. 4-1). In all probability, there will still be disagreement among the analysts on some of the dot labels even though intermediate consensus labels have been assigned. These disagreement dots will be circled on the MALP Form (fig. 4-1) in column 5 for special attention during the final analysis stage.

The team labeling as described (paragraph 4.2.4) is an intermediate labeling task. Final consensus labeling will occur after the special products analysis and after a final team review with the agronomist and meteorologist.

4.2.5 SPECIAL PRODUCTS REQUEST

In conjunction with the intermediate interpretations, the teams will submit requests for any special labeling aids that could be incorporated into the maximal analysis decision process.

4.2.5.1 Badhwar Labeling

The analyst team will choose three fields from each category of interest based on the following criteria:

a. The fields will be as homogeneous as possible (free of roads and free of border, edge, and mixed pixels).

b. The maximum field size will be 80 pixels; the minimum field size will be 20 pixels.

c. Training fields will be free of clouds and haze.

d. A minimum of five acquisitions will be selected between postemergence and preharvest.

The analyst team will record selected fields by line and pixel corner coordinates. The MALP task coordinator will submit the selected fields to the appropriate personnel for machine processing.

4.2.5.2 LIST Approach

The MALP task coordinator will verify that the segment is acceptable for LIST processing. Assuming that it is, the team will select the four acquisition dates that provide the maximum separation for the crops of interest. One analyst will record responses to the LIST options on coding forms using LIST procedures. The MALP task coordinator will forward the forms to the Supporting Research Branch for key punching and processing on the Laboratory for Applications of Remote Sensing (LARS) system(ref. 3).

4.2.5.3 Other Labeling Techniques

As they become available, new special labeling techniques will be considered for use in the maximal analysis. Approval for their use must be obtained on an individual basis from the NASA SF-4 Management prior to implementation.

4.2.6 AGRONOMIST AND METEOROLOGIST CONSULTATION

The analyst team will have a final consultation with the assigned agronomist and meteorologist to assist in the interpretation of any disagreement dots. These experts will study the Landsat imagery and offer opinions on crop signatures and probable labels with particular emphasis given to areas of disagreement. The analysts will record the opinions (labels) of the agronomist and meteorologist for each disagreement dot in column 5 of the MALP Form (fig. 4-1).

4.2.7 SPECIAL PRODUCT LABEL ANALYSIS

The analyst team will analyze the special label products as they are received from machine processing. The accuracy of the special product labels will vary depending on numerous factors that cannot be quantified. Nevertheless, the team will have to establish some sort of confidence level for these products before they can be incorporated into the maximal analysis decision process. How this is accomplished may vary, but it is the team's responsibility to develope indicators of reliability prior to using these data. One approach follows.

The analysts will record the special product labels in columns 7 and 8 of the MALP Form (fig. 4-1). They will compare the agreement dots from the independent analysis in column 4 of the form with the special product labels. Then they will tabulate the agreement between column 4 and columns 7 and 8 and calculate the percentage values of agreement for the special product labels for each label category. High percentages would indicate high confidence levels when applying the special product labels to the "uncertain" dots in the team decision process.

A thorough understanding of the way these products are generated will be helpful. The MALP task coordinator will arrange an interview for the analysis team with the Supporting Research Branch personnel who are most cognizant of the specialized procedure being utilized. Any questions concerning the labeling products will be resolved at this time.

4.2.7.1 Badhwar Products

The Badhwar output is a map printout of the 22,932 segment pixels, and it has category labels rather than a tabular listing of the 209-dot intersections (fig. 4-2). The first step is to transcribe a grid line 10- by 10-pixel onto the printout. Transfer the Badhwar labels for the pixels at the 209-dot intersections to column 7 of the MALP Form (fig. 4-1).

Coding on the printout is a letter symbol for the crop of interest (e.g., S, W, C, and B), a T for thresholded pixels, and a blank for noninterest categories.

A problem develops when using the Badhwar product if more than one category of interest exists; e.g., as in the case of barley separation for direct wheat labeling (ref. 1, appendix C). With two categories of interest, a separate printout is generated for each category. If this is done, care must be taken when recording the Badhwar labels because of contradictions (both real and apparent) between the two printouts. Team judgements may be required on the validity of individual pixel labels. In table 4-1 are the label combinations for a direct wheat analysis using the Badhwar printouts.

4.2.7.2 LIST Products

The LIST labels for the 209 dots are provided in the Type-1 and Type-2 operational dot format (figures 4-3 and 4-4). The analyst's label precedes the LIST label for each dot (e.g., ... S/N). The analysts flag disagreements between the analyst's starting labels and the LIST labels for later reference. Then they record the 209 LIST labels in column 8 of the MALP Form (fig. 4-1).

TABLE 4-1.— BADHWAR DIRECT WHEAT LABELING FOR BARLEY AND SPRING-WHEAT PRINTOUTS WITH CORRESPONDING MALP LABELS

Badhwar		MALP Form
Spring-wheat printout	Barley printout	Column 7
Blank	Blank	Noncategory
Spring wheat	Blank	Spring wheat
Blank	Barley	Barley
Spring wheat	Barley	[a](small grains)
Thresholded	Thresholded	Thresholded

[a]Barley and spring wheat are not separated. The next hierarchical category is spring small grains.

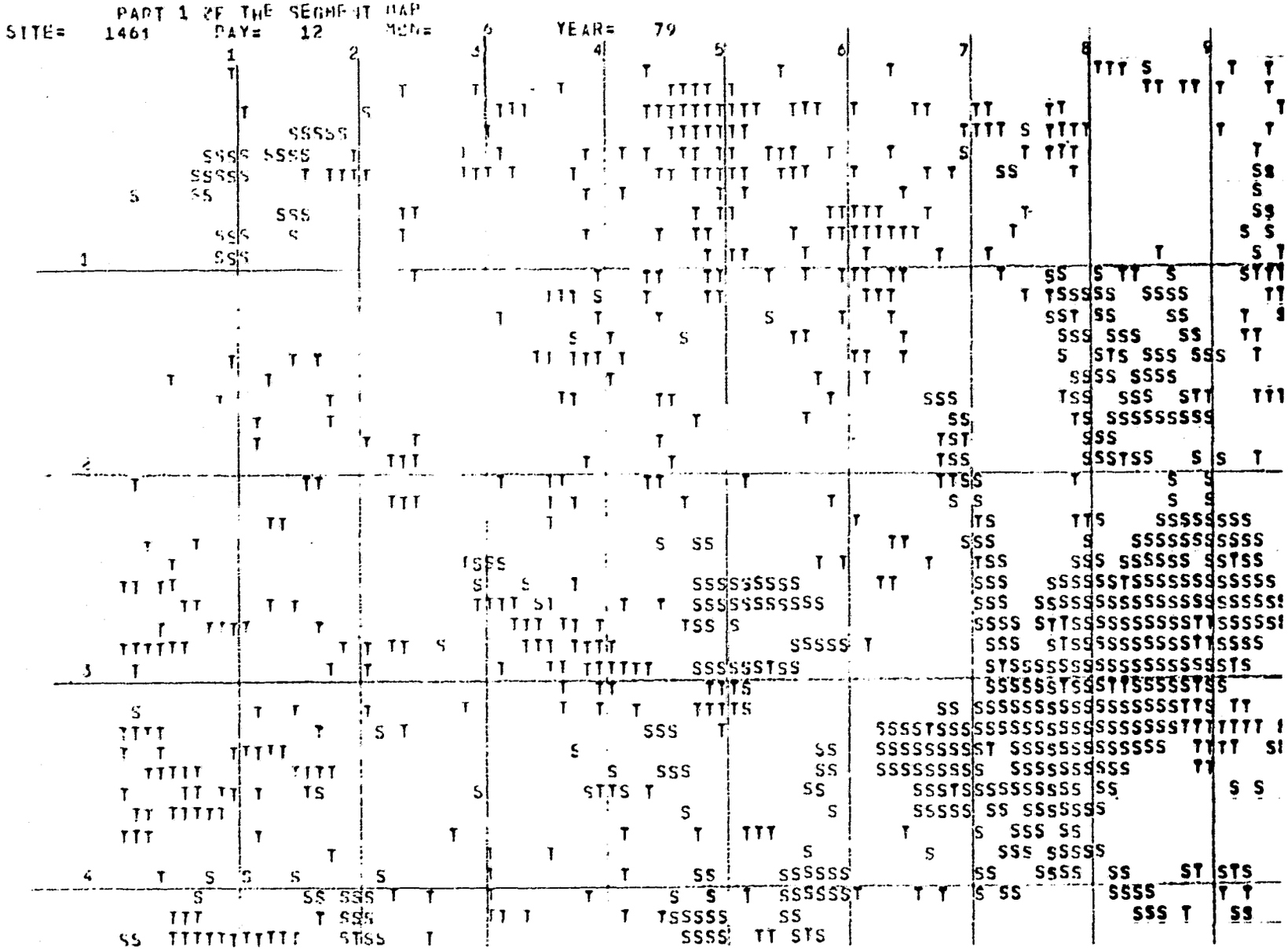

Figure 4-2.— Portion of Badhwar map printout with 10 x 10 line/pixel grid.

TYPE_1 DOT CLASSIFICATION

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
10		D/N		D/N		D/N		N/N		N/N		D/N		D/N		D/N		M/N	
20	D/N		D/N		M/N		S/N		N/N		D/N		D/N		S/N		S/N		N/N
30		D/N		D/N		D/N		D/N		D/N		N/N		N/S		D/N		D/N	
40			D/N		D/N		N/N		D/N		D/N		D/S		M/N		M/N		D/N
50		D/N		D/N		D/N		D/N		D/N		D/N		D/N		D/N		N/N	
60	D/N		D/N		D/N		D/N		D/N		D/N		D/N		N/N				
70		N/N		D/N		D/N		D/N		D/N		D/N		D/N					
80	D/N		S/N		N/S		D/N		D/N		D/N		D/N		N/N		D/N		
90		N/S		M/N		N/N		N/N		D/N		D/N		D/N		M/N		M/N	
100	N/N		D/N		D/N		D/N		D/N		D/N		D/N		D/N		D/N		M/N
110		D/N		N/N		N/S		N/N		D/N		N/N		D/N		D/N		D/N	

Figure 4-3.— Analyst-interpreted labels versus classified labels (LIST labels), type 1 dots.

TYPE_2 DOT CLASSIFICATION

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
10	D/N		D/N		D/N		D/N		S/N		D/S		D/N		D/N		N/N		M/N
20		D/N		D/N		D/N		N/N		S/N		N/N		D/N		N/N		S/N	
30	D/N		N/N		D/N		D/N		D/N		D/N		M/N		D/N		D/N		D/N
40		N/N		D/N		D/N		D/N		D/N		D/N		N/N		N/S		D/N	
50	D/N		D/N		D/N		D/N		D/N		D/N		D/N		N/N		M/N		D/N
60		D/N		D/N		D/N		D/N		D/N		D/N		D/N					
70	N/N		N/N		D/N		D/N		D/N		D/N		D/N		D/N				
80		S/S		N/N		D/N		D/N		D/N		D/N		D/N		D/N			
90	N/N		M/N		D/N		D/S		D/N		D/N		N/N		D/N		N/N		N/N
100		D/N		D/N		D/N		D/N		D/N		D/N		D/N		D/N		D/N	
110	D/N		D/N		D/N		N/N		D/N		D/N		D/N		D/N		D/N		D/N

Figure 4-4.— Analyst-interpreted labels versus classified labels (LIST labels), type 2 dots.

4.2.7.3 Other Special Product Labels

It is anticipated that other special labeling techniques will be incorporated for use in the MALP later in the FCPF. The methodology for utilizing this data will be developed as it becomes available.

4.2.8 FINAL CONSENSUS LABELING

Column 9 of the MALP Form is for recording the analyst teams' final consensus labels. A history of the maximal analysis labels for each dot can be determined from left to right across the form. The team will consider all evidence and through discussions will make decisions as to the most correct label for each of the 209 dots. If additional inputs are still desired, requests will be submitted via the MALP task coordinator.

At the conclusion of the final labeling of dots, the completed MALP Form and all other working materials used during this task will be given to the MALP task coordinator.

5. REFERENCES

1. Detailed Analysis Procedures for the Transition Project (FY79). LACIE-00724, JSC-13756, May 1979.

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4. Classification and Mensuration Subsystem (CAMS) Requirements. LACIE-00200, JSC-11330, May 1979.

5. Analyst Interpretation Keys: Wheat/Small Grains Inventories. National Aeronautics and Space Administration, Vol. 1, JSC-12555, May 1979.

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7. Payne, Robert: Description of the Transition Year Integrated Procedure, LEMSCO-14385, January 1980.