LACIE-00723
JSC-13735

NASA NOAA USDA

LACIE TRANSITION PROJECT

TRANSITION YEAR CLASSIFICATION AND MENSURATION SUBSYSTEM (CAMS) DETAILED ANALYSIS PROCEDURES

National Aeronautics and Space Administration

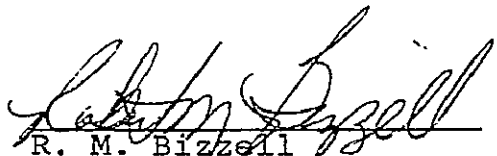
Lyndon B. Johnson Space Center
Houston Texas 77058

MARCH 1978

TRANSITION YEAR

CLASSIFICATION AND MENSURATION SUBSYSTEM (CAMS)

DETAILED ANALYSIS PROCEDURES

APPROVED BY: 

R. M. Bizzell
CAMS Subsystem Manager

ACKNOWLEDGMENTS

This document represents the work of personnel from Lockheed Electronics Company, Inc./Systems and Services Division, the National Aeronautics and Space Administration, and the U.S. Department of Agriculture. This work was performed under NASA Contract NAS 9-15200.

LACIE OPERATING PROCEDURES: TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER REV.
SUBJECT: CONTENTS	APPROVED:
	DATE:

CONTENTS

Section — Page

TABLES

FIGURES

ACRONYMS

AI	Analyst Interpreter
ASATS	Automatic Status and Tracking System
CAMS	Classification and Mensuration Subsystem
CAS	Crop Assessment Subsystem
CCIT	CAMS/CAS interface tape
CEF	CAMS Evaluation Form
CIR	color infrared
COM	computer output microfiche
CRD	Crop Reporting District
DAPTS	Data Acquisition, Preprocessing, and Transmission Subsystem
DEAF	Dell Foster deck
DO	designated other
DPR	data product request
DR	discrepancy report
DTERM	data terminal
DU	designated unidentifiable
ERIPS	Earth Resources Interactive Processing System
FLAP	final product
Flocon	Flow Control
GSFC	Goddard Space Flight Center
Image 100	Interactive Multispectral Image Analysis System
ISRRS	Information Storage, Retrieval, and Reformatting Subsystem
LACIE	Large Area Crop Inventory Experiment
Landsat	Land Satellite

LARS	Laboratory for Applications of Remote Sensing
LDSS	LACIE Data Systems Supervisor
LOS	LACIE Operations Supervisor
LPDL	LACIE Physical Data Library
MSS	multispectral scanner
OCC	Operation Control Center
ONC	Operational Navigation Chart
OPS	operations
PCC	percentage of correct classification
PFC	production film converter
pixel	picture element
PRF	Process Request Form
PTL	Photographic Technology Laboratory
QA	quality assurance
YES	Yield Estimation Subsystem

1. INTRODUCTION

This document presents the detailed processing procedures for estimating wheat acreages of Large Area Crop Inventory Experiment (LACIE) sample segments using data from the Land Satellite (Landsat) multispectral scanner (MSS). These processing procedures are collectively known as Procedure 1, a classification scheme developed as a solution to problems encountered during LACIE Phases I and II (ref. 1). Procedure 1 is a technique for processing an estimate in order to satisfy LACIE requirements. This procedure is as accurate as previous methods used in LACIE but not as time consuming for the analyst. It isolates those functions than can best be done by machine processing and frees the analyst from making certain decisions (unnatural statistical-spectral decisions) that are better made by machine.

In LACIE Phase III, Classification and Mensuration Subsystem (CAMS) analysts process either domestic or foreign segments. Within each area, an analyst processes both winter and spring small-grain segments, in addition to some mixed segments. Specifically, analysts identify winter and/or spring small grains as wheat category grains. Quality assurance (QA) personnel in each operational area ensure uniform application of these procedures and serve as a resource for answering analyst questions and as a guide in processing abnormalities and difficulties.

During peak work periods, aides are employed to assist the analysts in processing segments. These analyst aides are involved in the work that precedes and follows the segment interpretation and not in the actual interpretation of segments. (See sections 2.1 through 2.5 and section 8.)

2. PREPROCESSING

Preprocessing consists of the following six functions. Except for image screening, all preprocessing is performed by analyst aides.

a. Recording status information on the packet status form

b. Updating the checklist of the segment packet contents

c. Preparing imagery

d. Locating segments

e. Adjusting crop calendars

f. Screening images

2.1 PACKET STATUS FORM — ANALYST AIDE

Initially, when an Analyst Team is assigned segment packets, all pertinent information related to each packet should be recorded on a packet status form. The format of each team's form differs; but all forms should include segment and acquisition numbers, the date on which the team received the packet, and the location. All other information should be filled in upon occurrence of each event and upon completion of the packet. It is recommended that each analyst keep an individual status form in addition to the team form.

2.2 CHECKLIST OF SEGMENT PACKET CONTENTS — ANALYST AIDE

The following products are included in the sample segment packet, which is forwarded to the analyst from the LACIE Physical Data Library (LPDL).

a. Detailed crop calendar

b. Ancillary summary

c. Topographic map or maps (large scale when possible)

d. Film products for first acquisition in biowindow:

- Product 1 – false color infrared (CIR) composite (bands 4, 5, and 7)
- Product 2 – enhanced image (bands 5, 6, and 7)
- Product 3 – supplemental product

e. Previous classification of the current crop year, if applicable, including:

- CAMS Evaluation Form (CEF)
- Classification map
- Classification results
- Cluster maps
- Field overlays
- Dot overlays

If any of the above materials are missing, the analyst should consult with QA personnel regarding further processing of the segment packet. Copies of some materials, such as crop calendars, ancillary summaries, and topographic maps, may be readily obtainable. In some cases, it may be necessary to submit a discrepancy report (DR) to the Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS) to obtain the required data.

In an effort to reduce the bulk of the segment packet, the analyst aide should use the following checklist for the disposition of packet materials accumulated in previous LACIE phases.

a. Discard (place under packet flap when returning packet to QA):

- Previous year's classification printouts

- Previous year's Laboratory for Applications of Remote Sensing (LARS) products
- Previous year's delogs
- Any duplicate materials
- Any extraneous materials

b. Store in the LPDL [place in envelope, label, and leave under flap; see figure 1(a)]:

7373 Volgograd, U.S.S.R. WW

(a) For storing in LPDL.

Phase II CEF, Class map, Cluster map

(b) For retaining in packet.

Figure 1.— Storage packet labels.

- Latest microfiche products from previous year
- All unmounted imagery products from previous year
- All CEF's from previous year except latest one with estimate sent to the Crop Assessment Subsystem (CAS)

c. Keep in the packet [place first two items listed below in a small envelope and label them; see figure 1(b)]:

- Latest (best) previous-year classification (class) map on film or LACIE System* hardcopy maps and cluster maps
- Last CEF with estimate sent to CAS
- All *mounted* imagery

*The LACIE system was formerly called the Earth Resources Interactive Processing System (ERIPS), and some names retain the term ERIPS.

2.3 PREPARATION OF IMAGERY — ANALYST AIDE

All product 1's received by the analyst are annotated by scribing the following information on the acquisition (see fig. 2).

a. Segment number and location name obtained from packet label or ancillary summary

b. Biowindow obtained from the label on the envelope containing the acquisition

c. Julian date obtained from the header information on the product 1

d. Robertson scale adjustment obtained from the adjusted crop calendar on bottom

e. Wheat-small-grains percentage, which is recorded on the acquisition after processing on bottom

f. Line and picture element (pixel) numbers at grid line and pixel intersection

g. Analyst name on bottom

All product 3's are annotated by scribing segment number, biowindow, Julian date, "P.3" in upper right-hand corner, and line and pixels numbers.

2.4 LOCATION OF SEGMENT — ANALYST AIDE

2.4.1 PLOTTING MAPS

Segment boundaries should be plotted on one of the available map sheets using geographic coordinates extracted from the ancillary summary. When the segment center point has been located and plotted onto the map, a segment boundary grid template is positioned over this point. The analyst aide positions the template at an approximate angle, compensating for the direction of the satellite ground track. After this is accomplished, the analyst aide examines the sample segment imagery for natural or cultural features in order to precisely locate the boundaries of the segment of the map. The county or political division boundaries

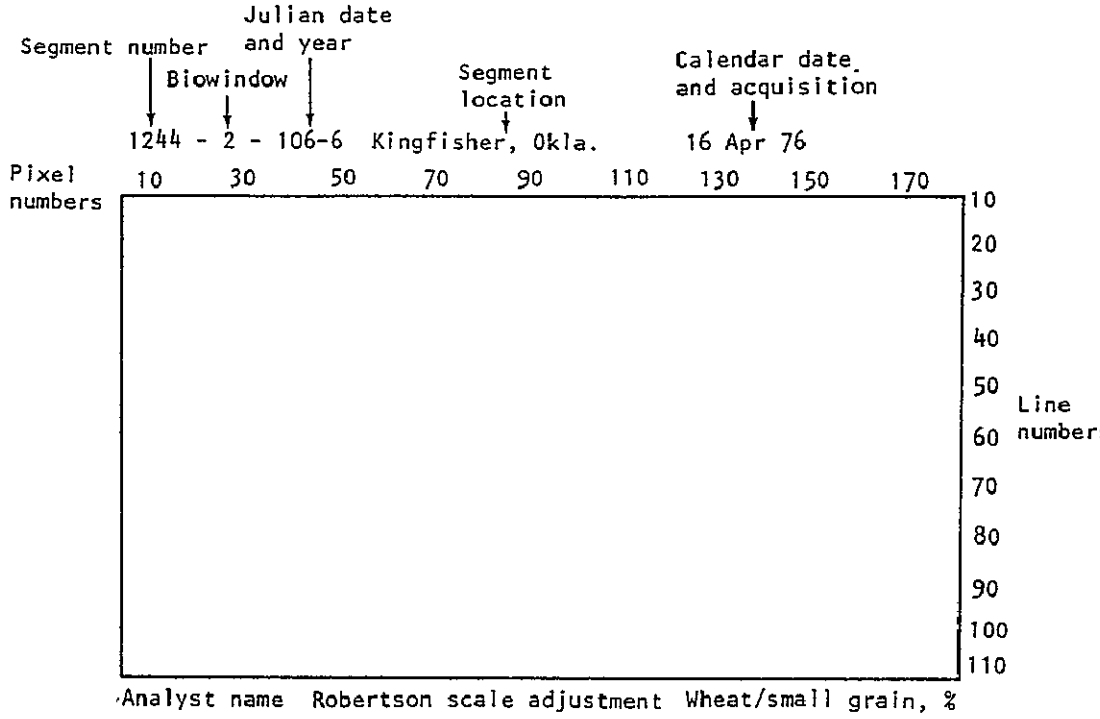


Figure 2.— Sample inscription on product 1 acquisitions.

are delineated on the map in order to assist the analyst in analyzing the ancillary data and in using the Landsat full-frame imagery.

The segment location is acceptable if it has a common area with the predicted sample segment area. A note should be made on the CEF indicating the segments which are acceptable but whose center points fall outside the intended political subdivision. In all other cases, the segment data are rejected on the basis of segment mislocation. Each team coordinator should keep a file which records each segment and the acquisition mislocated. The segments which were acceptable under the prior-year criteria but which deviate from the predicted location in the prior year and do not meet the above criteria are referred to QA for acceptance or rejection (see fig. 3).

2.4.2 PLOTTING FULL FRAMES — ANALYST AIDE

The following specific procedures for use of Landsat full-frame imagery apply directly to all U.S. sample segments. These procedures may be applied generally to all LACIE countries, but QA personnel should be consulted for instructions on modifying these procedures for use in other countries.

a. Locate the Landsat orbital footprint number for the segment you are working. Use the Caspan *Segment to Foot Prints* book (ref. 2) or the site map located near the QA area. If the site map is used, record the number at the top of the map and then the one crossing the map.

b. Record the footprint number of the segment on the ancillary summary near the segment center-point coordinates.

c. Pull the folder of full-frame (9- by 9-inch) imagery from the drawer near the site maps. Choose the best full-frame

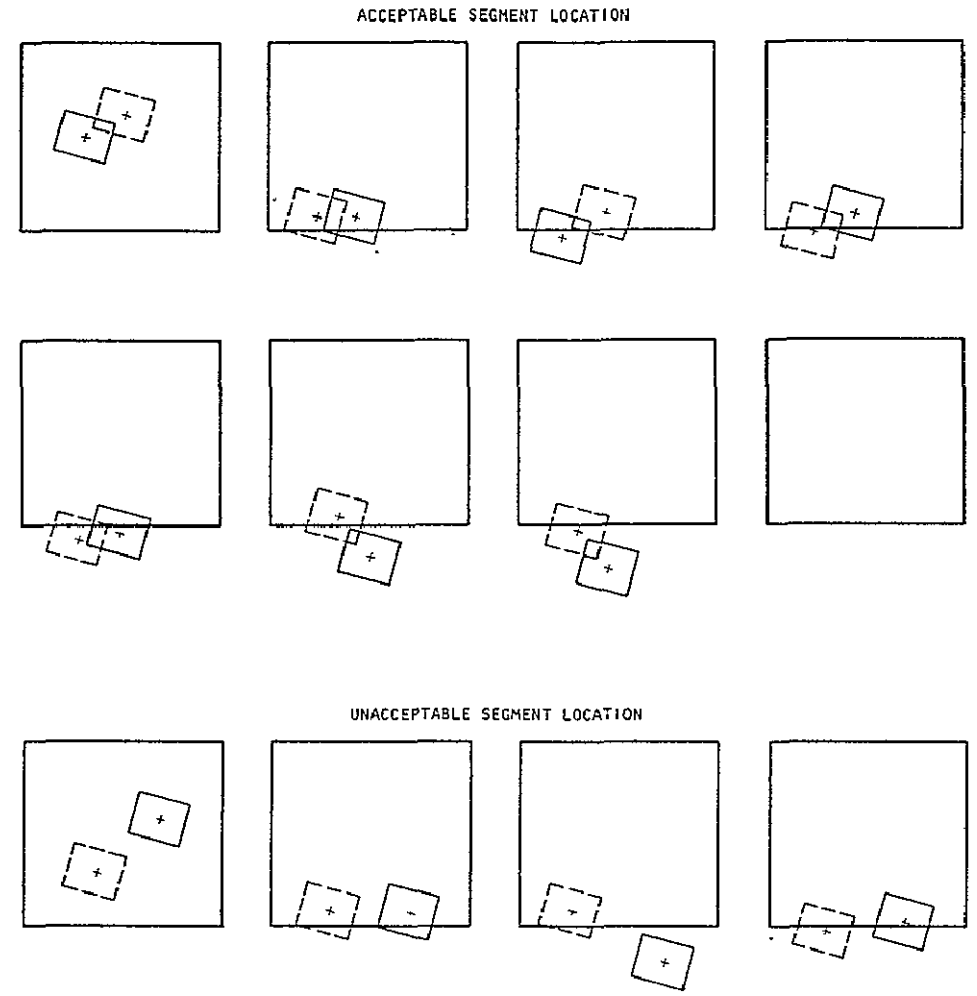


Figure 3.– Example showing acceptable and unacceptable sample segment locations.

scene from the folder (usually the one with the most recent date) on which to plot the counties and your segment. If the counties are plotted, proceed to plot your segment. If the counties are not already plotted, tape a full-size acetate overlay directly to the full-frame image and register it by tracing around lakes and/or rivers.

d. If the counties are not plotted on any of the 9 by 9's in the folder, they are plotted on the Operational Navigation Chart (ONC) 1:1 000 000-scale maps located near the site maps. If they have been plotted, trace their boundaries on the new acetate overlay.

e. Plot the sample segment on the small ONC located in the 9 by 9's folder with the help of the plot on the large ONC map. Visually locate the general segment location on the full-frame image. Place a segment boundary template over the general segment location and accurately aline it by using the 9- by 11-kilometer (5- by 6-nautical-mile) segment acquisitions as a guide. Delineate the segment boundaries on the acetate overlay.

f. Annotate the county names and segment number on the overlay.

g. Place the imagery in the packet.

Once these procedures have been completed, the Landsat full-frame image can be retrieved easily from the file and is ready for use in all subsequent analyses of the segment.

2.5 CROP CALENDARS – ANALYST AIDE

The Yield Estimation Subsystem (YES) provides biweekly crop calendar adjustments for the current crop year. The adjustment factor from YES is determined on the basis of temperature and day length. Because the factor is provided biweekly, the analyst must derive an adjustment factor for acquisition dates falling between

the dates of published adjustments (fig. 4). The adjustment is then applied to the crop calendar (fig. 5).

Two methods are available for adjusting the historical crop calendar. One method uses the adjustments published biweekly in the *Meteorological Summary* in the form of an isoline map (fig. 6, ref. 3). Locate the segment and extract and interpolate the Robertson scale value on the crop calendar. The second method is an adjustment from a computer listing – an automatically generated Robertson scale value published daily for those segments for which Landsat has acquired imagery on that day. Initially, both methods should be used and checked against each other; but eventually the automatic adjustment (when proved operationally reliable) should phase out the use of the manual adjustment.

NOTE: After the adjustment has been made, if the Robertson scale value is less than 2.0, no interpretation is necessary. Assign a code 07 (see section 8.1 for code explanations) and proceed to section 8.3.

2.5.1 ADJUSTMENT FROM METEOROLOGICAL SUMMARY

The following procedures are employed to adjust the crop calendar using the adjustment figure published biweekly in the *Meteorological Summary*.

a Locate (in the notebook containing the copies of the *Meteorological Summary*) the published crop calendar for the date closest to the date of the acquisition.

b. Find the location of the segment on the appropriate crop calendar adjustment page in the *Meteorological Summary*. Note the number identifying the line closest to the segment location. This number is the Robertson phenological stage

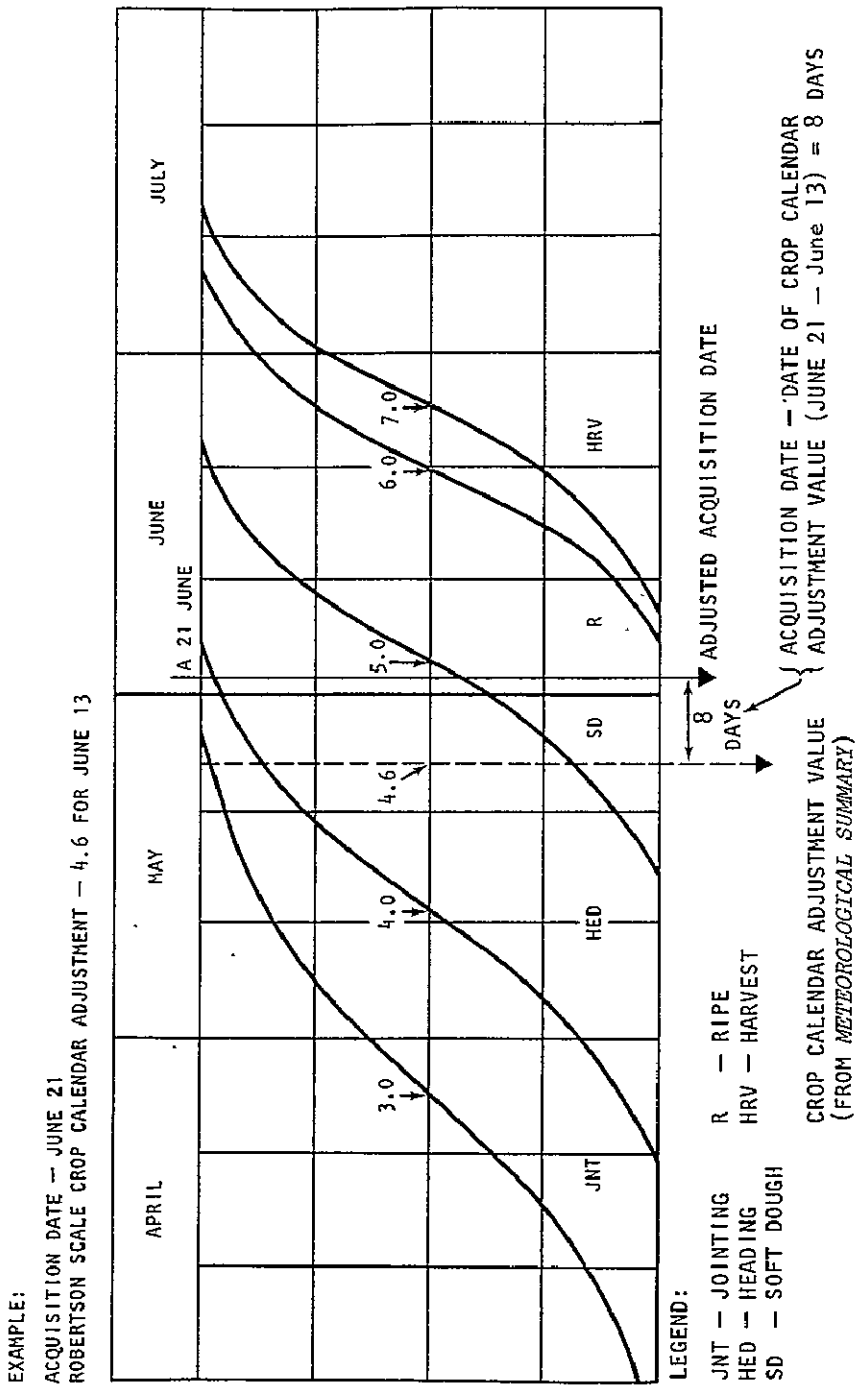


Figure 4.— Enlargement of a portion of the crop calendar illustrating the adjustment process.

ORIGINAL PAGE IS
OF POOR QUALITY

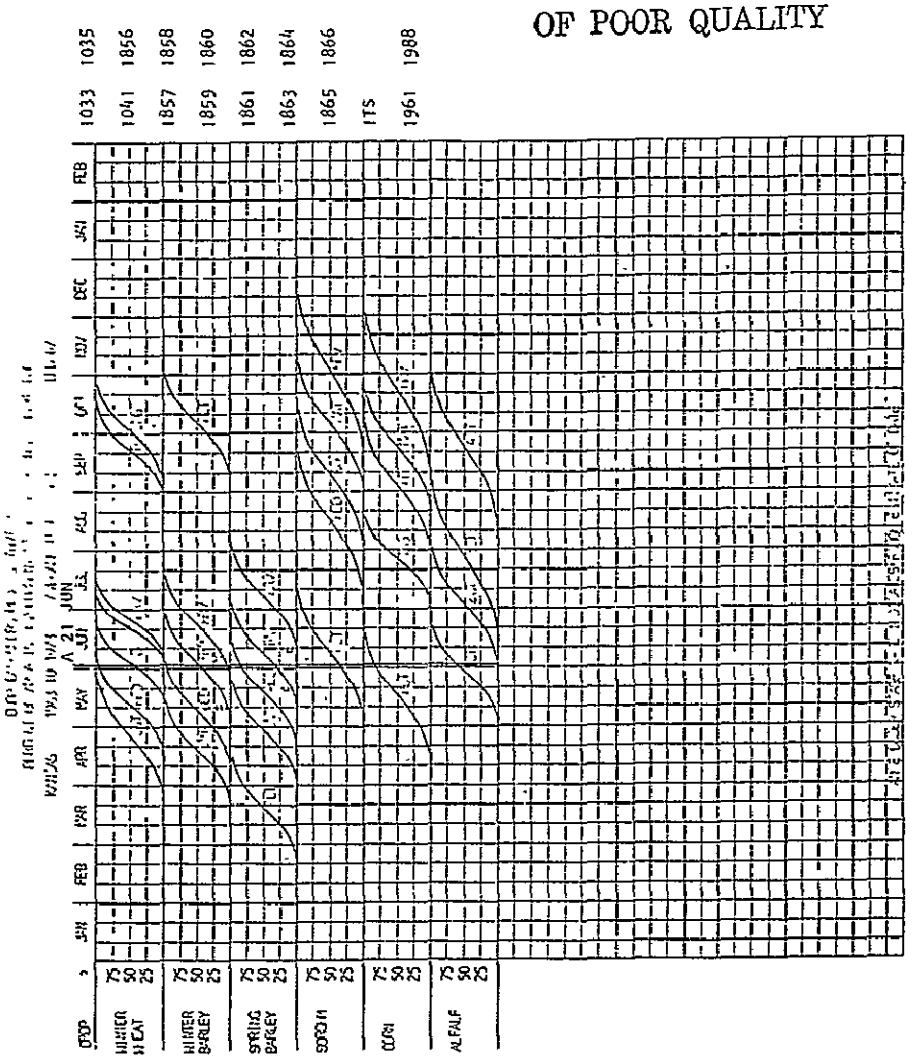


Figure 5.– Example of adjusted crop calendar.

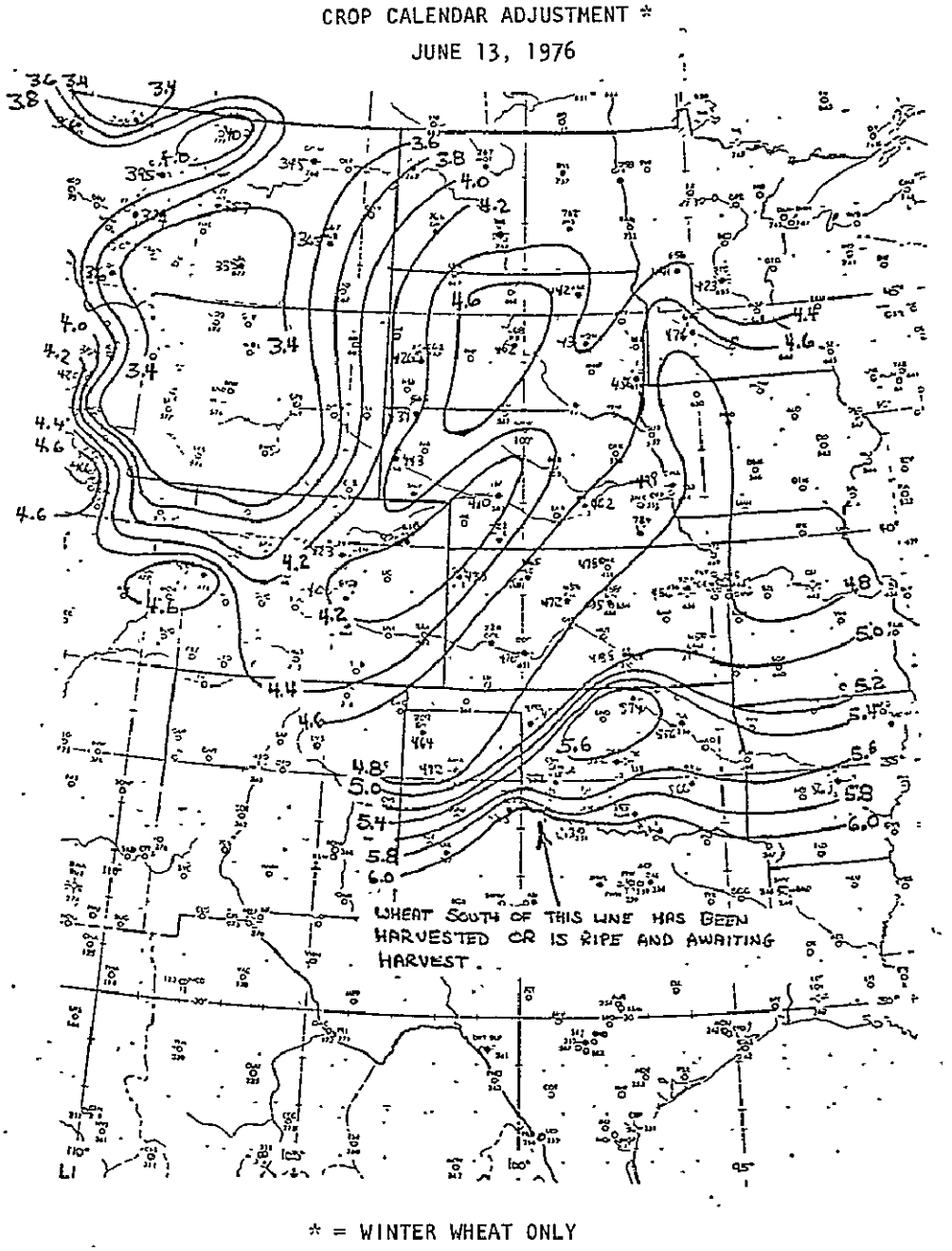


Figure 6.– Example of crop calendar adjustment (from reference 3).

of development for wheat in the vicinity of the line. This number is also the crop calendar adjustment value and will be used to adjust the historical crop calendar to the current year.

An example of this procedure follows.

The acquisition date is June 21, and the meteorological summary adjustment is 4.6 for June 13 (see fig. 6).

a. Note that the intersection of the horizontal centerline (50-percent line) of the crop calendar and each of the growth stage curves indicates the Robertson development stage at a whole value (e.g., 1.0, planting; 2.0, emergence; 3.0, jointing; 4.0, heading; and 5.0, soft dough).

b. Locate the value of the crop calendar adjustment for June 13. The value 4.6 is located six-tenths of the distance along the horizontal centerline between 4.0 and 5.0.

c. Note that the vertical lines of the historical crop calendar delineate 10-day increments. The acquisition date is 8 days past the meteorological summary adjustment date. Visually scale 8 days to the right of the value 4.6 on the historical crop calendar.

d. Draw a vertical line through this point on the crop calendar. Label this line as adjusted to June 21 (A 21 June) at the top of the crop calendar. This indicates it is the acquisition date adjusted for the development stage of wheat on that date in the current year. The adjusted Robertson stage to be scribed on the imagery is 4.9.

If the acquisition date had been prior to June 13 (the date of the meteorological summary adjustment), the adjustment on the crop calendar would have been to the left of 4.6. The number

of days to the left of 4.6 would have been determined by the number of days difference between the acquisition date and June 13.

2.5.2 ADJUSTMENT FROM COMPUTER LISTING

The automatic crop calendar adjustment method uses the same input parameters as the manual method. The methods differ only in that the automatic adjustment is generated bimonthly, the interpolation is already done, and the format is a computer listing (fig. 7).

a. At the top of the page, find the appropriate listing for the particular country/region, crop type (winter or spring wheat), and calendar date which matches the acquisition date of the image requiring an adjustment.

b. The first column (DATE) gives the acquisition date of the segment.

c. The second column (NBR) gives the segment number.

d. The third column (LOCATION) gives the latitude and longitude of the segment.

e. The fourth column (STRATA) gives the state and Crop Reporting District (CRD).

f. The fifth column (CROP DEV) gives the Robertson scale value for the phenological growth stage of wheat.

g. The sixth column (WEATHER) gives the minimum and maximum temperatures.

h. The last column gives the number of reporting meteorological stations from which the crop calendar adjustment was derived.

Once the adjustment figure is obtained for the acquisition date, it is applied directly to the historical crop calendar.

ORIGINAL PAGE IS OF POOR QUALITY

REPORT OF CROP DEVELOPMENT

DATE: 16 OCT 76 CENTRAL USA WINTER WHEAT GRID

ZONE: KAN PAGE: 1

SGMT* NO	LOCATION * LATI	LNGI *	CRD* NO* NO	COUNTY NAME	*DVLPMNT* *CPN HIS*	BIOWINDOW 1 :	BIOWINDOW 2 :	BIOWINDOW 3 :	BIOWINDOW 4
1016*N	3957	W10137*	*	CHEYENNE	*2.4	.0*761024 770504:770505	770521:770522	770613:770614	770724
1017*N	3935	W10036*	*	DECATUR	*2.3	.0*761024 770504:770505	770521:770522	770613:770614	770724
1851*N	3933	W09957*	*	GRAHAM	*2.3	.0*761024 770504:770505	770521:770522	770613:770614	770724
1019*N	3949	W10005*	*	NORTON	*2.3	.0*761024 770504:770505	770521:770522	770613:770614	770724
1020*N	3941	W10107*	*	RAWLINS	*2.3	.0*761024 770504:770505	770521:770522	770613:770614	770724
1021*N	3927	W10147*	*	SHERIDAN	*2.4	.0*761024 770504:770505	770521:770522	770613:770614	770724
1022*N	3919	W10023*	*	SHERMAN	*2.3	.0*761024 770504:770505	770521:770522	770613:770614	770724
1023*N	3915	W10054*	*	THOMAS	*2.4	.0*761024 770504:770505	770521:770522	770613:770614	770724
1024*N	3855	W10048*	*	GOVE	*2.3	.0*761018 770426:770427	770518:770519	770609:770610	770720
1025*N	3838	W10159*	*	GREELEY	*2.4	.0*761018 770426:770427	770518:770519	770609:770610	770720
1852*N	3830	W10026*	*	LANE	*2.3	.0*761018 770426:770427	770518:770519	770609:770610	770720
1027*N	3901	W10111*	*	LOGAN	*2.3	.0*761018 770426:770427	770518:770519	770609:770610	770720
1854*N	3630	W10041*	*	SCOTT	*2.3	.0*761018 770426:770427	770518:770519	770609:770610	770720
1032*N	3822	W10121*	*	WICHITA	*2.4	.0*761018 770426:770427	770518:770519	770609:770610	770720
1988*N	3810	W10043*	*	FINNEY	*2.3	.0*761022 770426:770427	770512:770513	770603:770604	770715

Figure 7.– Automatic crop calendar adjustment value.

2.6 IMAGE SCREENING – ANALYST TEAM

Prior to interpretation, each segment should be screened to determine if the acquisition is processable. (See appendix A for imagery quality control.) Any acquisition that cannot be processed because of meteorological interference (i.e., clouds, haze, or snow) or bad data should be passed as code 01 or code 03. Any acquisition that is not workable because of misregistration should be passed as code 04 or 06. (See section 8.1 for code explanations.) Proceed to section 8.3. If no such problems exist, proceed to section 3.

3. INTERPRETATION – ANALYST TEAM

The analyst studies the adjusted crop calendar, biweekly meteorological summaries, historical data, topographic map or maps, agricultural statistics, and Landsat full-frame imagery of the sample segment and then begins the interpretation for small-grain fields on the imagery. (NOTE: Segments will be designated on the packet as to whether they are spring, winter, or mixed grains.) Interpretation is totally an Analyst Team function.

3.1 ROBERTSON BIOSTAGES

The Robertson phenological development stages for wheat are based on the following seven stages of wheat development:

Robertson development stage	Growth stage	Description of growth stage
1.0	Planting	Seed in the ground.
2.0	Emergence	The first leaf has formed above the soil surface.
3.0	Jointing	The stalk starts elongating between joints. Joints can be seen easily.
4.0	Heading	The head has emerged from the leaf sheath.
5.0	Soft dough	Kernels are easily squeezed and deformed but do not exude milky fluid.
6.0	Hard dough	Kernels are firm.
7.0	Harvest	Grain is being combined or swathed.

The beginning of each biostage is when 50 percent of the stage has occurred; i.e., 2.0 means 50 percent of the crop has emerged.

3.2 USE OF ADJUSTABLE CROP CALENDAR

The crop calendar contained in segment packets shows seven stages of wheat growth based on the Robertson phenological development stages of wheat. The historical crop calendar is constructed from historical averages of wheat development in a given area, CRD's, in the United States. An adjustment to the crop calendar for the current year enables the analyst to determine the theoretical stage of development for wheat on the acquisition date in an absolute sense and also to determine the growth stages of other crops relative to wheat. Knowing the development stage of wheat and other crops on the acquisition date enables the analyst to interpret the signatures on the imagery more accurately. Wheat and other crops should resemble signatures characteristic of their particular stage of development on the adjusted date.

NOTE: The analyst should keep in mind that the adjusted Robertson stage indicates that temperature and day length have been sufficient to allow development to the indicated growth stage. For example, a farmer may or may not have planted early enough to take advantage of these two growth factors (temperature and day length). Therefore, wheat may not necessarily be emerged on the ground at the adjusted growth stage of 2.0.

3.3 USE OF LANDSAT IMAGERY

The analyst's use of the Landsat full-frame imagery includes the following:

a. The full-frame imagery may provide additional dates of coverage for the analysis of a segment. Because of processing methods at Goddard Space Flight Center (GSFC), acquisitions of 9- by 11-kilometer (5- by 6-nautical-mile) segments are not delineated on every full-frame image in which the segment is located. Use of the full frame can supplement

the 9- by 11-kilometer segment acquisitions in the packet and thereby assist the analyst in following the current crop progression and development and in the historical use of fields. For example, observing the use of summer fallow in some areas in the year preceding the planting of wheat and identifying alfalfa fields from the previous year can be accomplished using full-frame imagery.

b. The coverage of the full frame (185 by 185 kilometers or 100 by 100 nautical miles) can be used for better distinction between agricultural and nonagricultural patterns and signatures within the segment area and in the area surrounding the segment. Drainage patterns, streams, and areas of natural vegetation, such as rangeland in the U.S. Great Plains, are frequently easier to identify on full-frame imagery.

c. The agricultural statistics in the ancillary summary can be understood better when the political subdivisions to which they apply (e.g., counties in the United States) and the segment are viewed together after plotting on the full-frame image. In this manner, the analyst can observe how the segment compares to the remainder of the county with respect to the proportion of agricultural land in the county and in the segment. Also, certain crops may be grown in some areas of a county and not in others. For example, different crops may be grown along rivers and streams than on drier hillsides with poorer soil. Knowing the relationship of the segment to the county through analysis of the full-frame image and agricultural statistics can be a very important tool for the analyst.

3.4 USE OF ANALYST-INTERPRETATION (AI) KEYS

There are two volumes of *Analyst Interpretation Keys* currently available to the analyst. Volume I is designed to be used as

an operational overview of wheat and nonwheat signatures (ref. 4). Examples are relatively general, and nominal photophenology for wheat is illustrated. In addition, volume I gives examples of and causes for some of the variations in wheat signatures seen on Landsat imagery. It is used as a general training and information aid.

Volume II (Canada and U.S. Great Plains) is a regional key to be used as a guide in operations by production analysts (ref. 5). It is designed to lead to the correct identification of wheat-small-grain areas. Detailed instructions are found in the introduction to volume II.

3.5 USE OF SUPPLEMENTARY PRODUCT

The supplementary product (product 3) was developed for the specific purpose of providing the analyst with an aid to labeling when color distortion is apparent on the product 1 (ref. 6).

If there is no difference between the product 3 and product 1, proceed with analysis as usual. When they do not agree, use the product 1 for field delineation and detection of edge and border pixels and the supplement (product 3) for labeling. Apply the following guidelines:

a. Put a dot overlay on product 1 to eliminate edge and border pixels and designated other/designated unidentifiable (DO/DU) areas.

b. Place an overlay on supplementary product and label dots according to current interpretation logic.

c. Note on the CEF and the dot label forms that the supplementary product was used.

3.6 REVIEW OF IMAGERY FOR IDENTIFICATION OF WHEAT

The most critical aspect of the entire CAMS wheat estimation process is the proper identification of potential wheat signatures on Landsat imagery. All previous steps have led up to this one, and all that follow in the classification process build on decisions made at this point.

The analyst will have prepared all working materials and assimilated all pertinent background information in order to begin the interpretation process. In the interpretation process, the Analyst Team reviews the entire image systematically to identify all agricultural fields and their corresponding signatures as either wheat or nonwheat, using background information to aid the decision process. The use of multiple acquisitions and previous-year imagery in the interpretation process enables the analyst to follow the development of fields over a period of time. A review of all fields in the image is essential for the correct differentiation between wheat and nonwheat signatures. Use of the AI Keys will assist in the identification of signatures in specific regions.

a. Examine the imagery for field patterns and note the changes in the development patterns.

b. If the previous-year imagery is available, interpret the current imagery in conjunction with all earlier acquisitions. Note the change and progression of signatures in each field.

c. If small-grain signatures cannot be readily separated from confusion crops using the CIR imagery (product 1), the enhanced color imagery (product 2) may exhibit some difference in the confused signatures that is not evident on the product 1. Previous full-frame coverage may also be used in differentiating the signatures. If confusion still exists, consult the QA personnel for code 02 approval. (See section 8.1 for code explanations.)

d. Once the differentiation between signatures has been accomplished, the team should circle the complete range of wheat signatures, select the best acquisitions for processing, and delineate all DO/DU areas.

e. If the Analyst Team cannot agree on certain signatures, the QA personnel should be consulted. Consult the OPS Verification Team if a problem still exists.

The individual analyst then proceeds with the process of labeling the specific pixels to be used by the classifier.

4. PROCESSING

This section describes the criteria for selecting the best acquisition or acquisitions for estimating wheat when multiple acquisitions are in the packet and for selecting the segment processing mode.

4.1 DECISION FOR PROCESSING SEGMENT FOR INITIAL ESTIMATE IN BIOWINDOW 1 — ANALYST TEAM

The timing of the initial processing of LACIE segments in biowindow 1 is determined partially by examining CAS aggregation dates and CAMS throughput rates. For this reason, segments that have varying degrees of small-grain emergence may be assigned for processing. Figure 8 is a decision diagram that can be used to determine if small grains have emerged sufficiently to provide an estimate to CAS.

If a segment is processed for an initial small-grain estimate based on this decision diagram but the analyst believes the estimate may be incomplete because of later emerging wheat, a note indicating this should be made on the CEF.

NOTE: In instances of multiple acquisitions received in a packet, if one acquisition is evaluated as code 01, 02, 03, 04, 05, or 06, the remaining acquisitions may not be passed as code 09. Each of the remaining acquisitions must be assessed individually on the basis of this decision diagram to determine if a small-grain estimate can be given, and the appropriate evaluation code must be assigned.

4.2 CRITERIA FOR NONMACHINE PROCESSING — ANALYST TEAM

If an acquisition has confusion, degradation because of dormancy, preemergence, or fewer than 50 pixels of wheat-small grains, it will not be machine processed. Assign a code of 02, 05, 07, or 36,

respectively, and proceed to section 8.3. (See section 8.1 for an explanation of codes.)

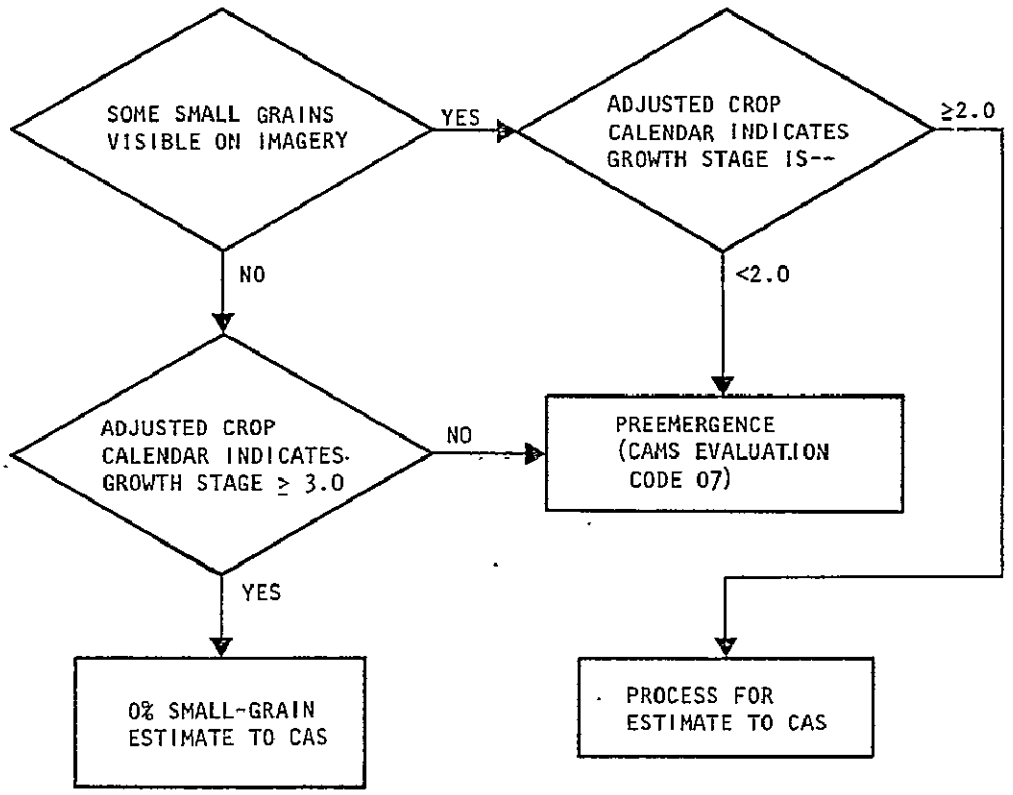


Figure 8.— Decision diagram on small-grain emergence.

4.3 MULTITEMPORAL CLASSIFICATION — ANALYST TEAM

If more than four processable acquisitions are in the packet the first time it is processed, select acquisitions from those included in the packet which seem to offer the greatest information content for achieving the most accurate wheat estimate. Be certain that all images are properly registered to within plus or minus one pixel. Be careful to select images which will maximize the separability of small-grain and nonsmall-grain signatures. Some general criteria used in the selection of a particular acquisition date include the following:

a. Degree of separability between spectral signatures; i.e., the value for which maximum separability between wheat and nonwheat crops seems likely.

b. Field definition; i.e., an image depicting fully emerged wheat would have better field definition (more ground cover) than an acquisition depicting only partial wheat emergence.

c. Absence of clouds, haze, or snow; i.e., all else being equal, it would be preferable to have no obscured fields and to avoid the possibility of signature distortion inherent in this type of imagery. If obscured areas do exist, they should not exceed 40 percent of segment.

d. Absence of poor image factors; i.e., data dropout, banding, and streaking.

e. Latest is best, if all else is equal; i.e., if equally good images are available, the most current information should offer the highest credibility to an estimate.

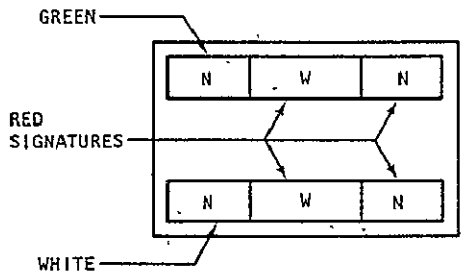
These criteria are intended only as guidelines and are not to be taken as an exhaustive list of considerations. In many cases, exceptions to the above criteria may exist, and the analyst must weigh the factors involved to arrive at a decision.

Another consideration should be noted. If the imagery of a segment contains confused areas (i.e., the same signature represents both wheat and nonwheat) that are within the operational tolerance of ±500 pixels, the segment should be processed for an estimate even if the confusion cannot be eliminated from classification as DO or through multitemporal processing. A maximum of four acquisitions can be used for processing, preferably one in each biowindow. The acquisitions to be used should be recorded on the Process Request Form (PRF). (See section 4.7.)

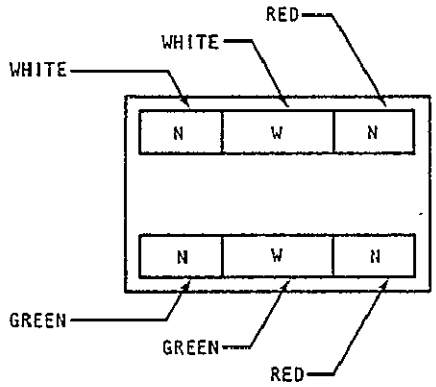
4.3.1 SIGNATURE IDENTIFICATION FOR MULTITEMPORAL CLASSIFICATION

The major difference between multitemporal classification and single-acquisition classification is in the separation of wheat and nonwheat signatures. A multitemporal classification to separate wheat from nonwheat is essentially based on the principle that wheat follows a typical growth pattern that is different from other vegetation and crops. The difference in growth patterns and development is evident in the differing spectral signatures over time, even though a spectral signature for wheat and some other vegetation (or possibly nonvegetation) may be the same on a single acquisition. For example, consider the case where a single acquisition displays all of the emerged wheat with distinct field patterns, but this same acquisition also includes nonwheat signatures spectrally similar to wheat at this particular stage in wheat development.

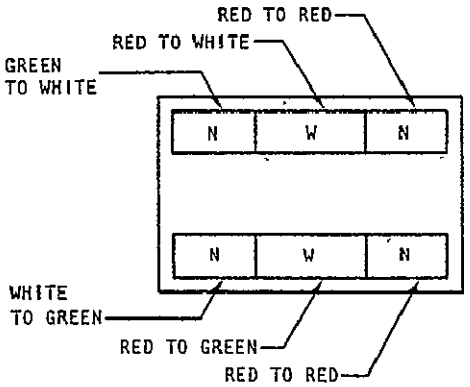
The method of identifying multitemporal signatures for purposes of spectrally separating wheat and nonwheat for the classifier is illustrated in figure 9.



(a) First acquisition. All emerged wheat having uniform and distinct field patterns but confusion of wheat/nonwheat.



(b) Second acquisition. When used with (a), eliminates wheat/nonwheat confusion.



Category	Signatures
W	Red to white
W	Red to green
N	Red to red
N	Green to white
N	White to green

(c) Combination of both acquisitions. Multitemporal (8-channel) signatures are accomplished by combining the two acquisitions.

Figure 9.— Method of selecting multitemporal signatures.

4.4 SELECTION OF EXCLUSION AREAS

The two types of exclusion areas are defined below.

a. DO — Field Type D.

1. Nonwheat areas that have a spectral signature similar to wheat should be DO. If a multitemporal classification is being done, this problem is usually eliminated since wheat is separable temporally from nonwheat (see fig. 9).

2. Nonagricultural areas have a tendency to be very mottled in signature. These areas should be DO to avoid a spotty classification map. Examples are lakes, swamps, forests, mountains, streams, cities, and airports.

3. Annotate by a set of 2 to 10 vertices. More than one set of vertices may be used if required. It is recommended that at least three vertices be used.

b. DU — Field Type U.

1. DU fields should be used when the areas that are not identifiable could possibly contain wheat. (Ground is obscured.) Examples are clouds, cloud shadows, flooded areas, snow-covered areas, and haze-covered areas.

2. Annotate by a set of 2 to 10 vertices. If required, more than one set of vertices may be used. It is recommended that at least three vertices be used.

4.4.1 BOUNDARY DELINEATION OF EXCLUSION AREAS

To delineate field boundaries, place "dots" within the field (at each corner) and then draw straight lines between the dots (see fig. 10). Assign a unique sequential identifier to each delineated field (i.e., 01 to 99, 0A to 9Z), prefaced by its category designation, and label it on the CIR primary overlay (D01, D02, D03). Initially, field numbers should be sequential beginning at the upper left portion of the image and progressing to the lower right corner.

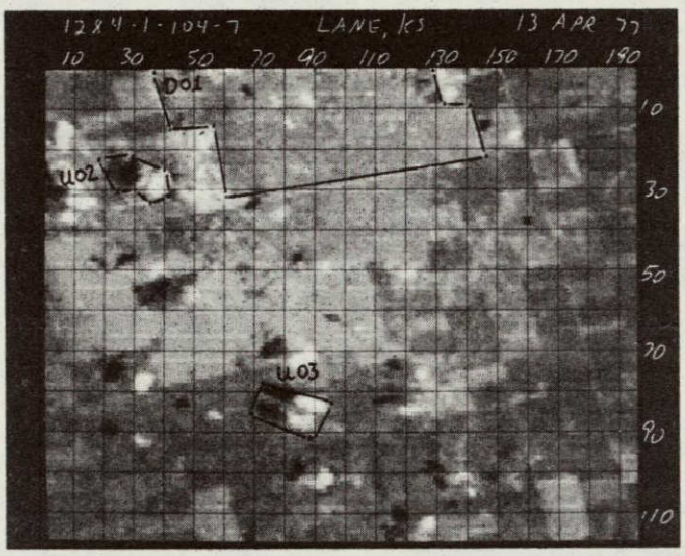


Figure 10.– Field boundary delineation with annotations. The dots with straight lines between them show the locations of the corner coordinates of the DO or DU field. Additional sequential identifiers prefaced by the category are shown. Note field numbering sequence is from upper left to lower right.

4.5 DOTS

4.5.1 DEFINITIONS

The identification of individual pixels is an integral part of Procedure 1. In order to perform this task satisfactorily, the following terms must be defined.

1. Border pixel – a pixel between a wheat and a nonwheat field that is difficult to label.
2. Edge pixel – a pixel clearly within a wheat field on one acquisition and clearly within a nonwheat field on another acquisition.
3. Pure pixel – a pixel that stays in the same category on all the acquisitions used in processing.
4. Type 1 dots – the pixels used in the clustering algorithm; they initiate and label the clusters.
5. Type 2 dots – the pixels used in the computation of the bias correction; this set of dots is completely separate from the type 1 dot set.

4.5.2 LABELING – ANALYST

The following categories may be used to label dots:

W – winter small grains including wheat

S – spring small grains including wheat

G – total grains (winter and spring)

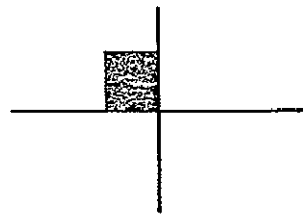
N – nonwheat

X – clouds, shadows, snow, etc.

NOTE: If a mixed wheat site is being worked and the winter and spring small grains are separable, label both types of dots W, S, or N. If they are not separable, label both types of dots G or N.

4.5.2.1 Type 2 Dots

Register the type 2 dot overlay to the base acquisition (the acquisition with which the wheat estimate will be associated). Label all circled grid intersections (an example of a pixel at the grid intersection is given below) except those in DO/DU fields and category X signatures. Label the pixels according to the field surrounding it unless it is anomalous. In that case, label it spectrally.



Pixel at grid intersection

If, after attempting to label all the circled grid intersections, at least 40 dots have not been labeled, attempt to label all the square grid intersections. If there are still less than 40 labeled dots, attempt to label all the triangle grid intersections.

NOTE: If a mixed wheat site is being worked and the winter and spring small grains are separable (W, S, and N are the categories used for processing), attempt to label all the type 2 dots and disregard the sequence.

If there are no type 2 small-grain dots after labeling at least 40 dots, the segment should be passed as 0 percent small grains and not machine processed.

4.5.2.2 Type 1 Dots

Register the type 1 dot overlay to the imagery and label the circled grid intersections according to the signature identifications determined in the interpretation process. Label all of the pixels on the overlay except pixels in DO/DU fields and border and edge pixels.

If, after attempting to label all the circled grid intersections, at least 30 dots have not been labeled or no dots were labeled wheat, attempt to label all the squares. If there are still less than 30 labeled dots or no dots were labeled wheat, attempt to label all the triangles. If there are still less than 30 labeled dots or no dots were labeled wheat, attempt to label the diamonds.

After exhausting the entire overlay, if there are no type 1 small-grain dots but some of type 2, compute the bias corrected estimate assuming a 100-percent nonwheat classification and pass it as satisfactory (see code 36, section 8.1). The segment is not machine processed.

NOTE: If there are less than 40 type 2 labeled dots and/or less than 30 type 1 labeled dots, the segment should still be submitted for machine processing.

4.6 DOT LABEL FORMS

Figures 11 and 12 are the dot label forms that correspond to the dot overlays. Fill in the top line and place category labels at the appropriate grid intersections. (Zero should be substituted for N to avoid confusion.) The comments section is provided for recording border and edge pixels and analyst comments. Staple the forms together.

4.7 PRE-BATCH SUBMITTAL VERIFICATION

To reduce reworks and ensure the best estimate possible with the available data, the following should be verified by another analyst or QA person.

a. Acquisition selection

b. Dot labels

c. DO/DU fields

TYPE 1 DOT LABEL FORM

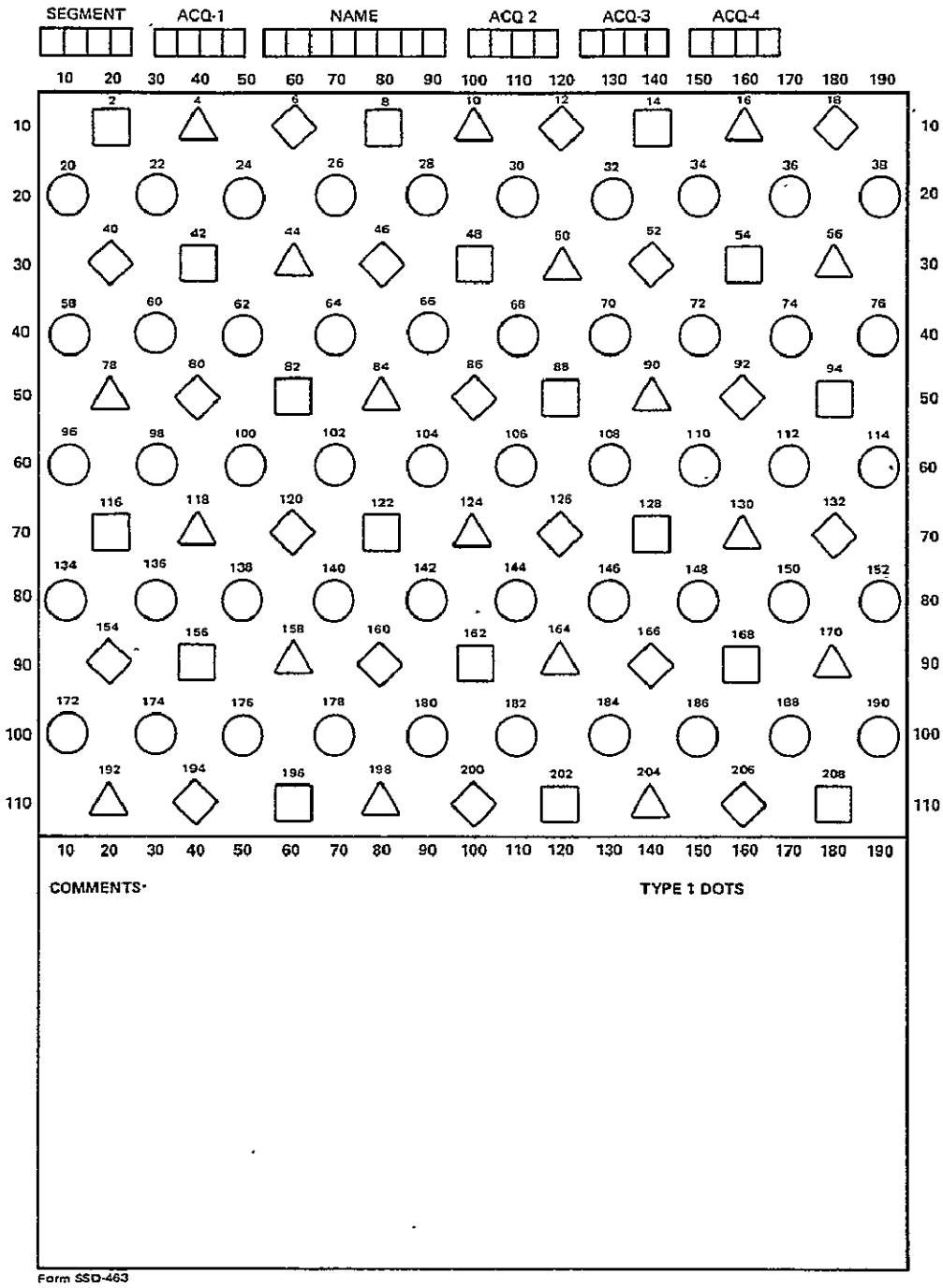


Figure 11.– Type 1 dot label form.

TYPE 2 DOT LABEL FORM

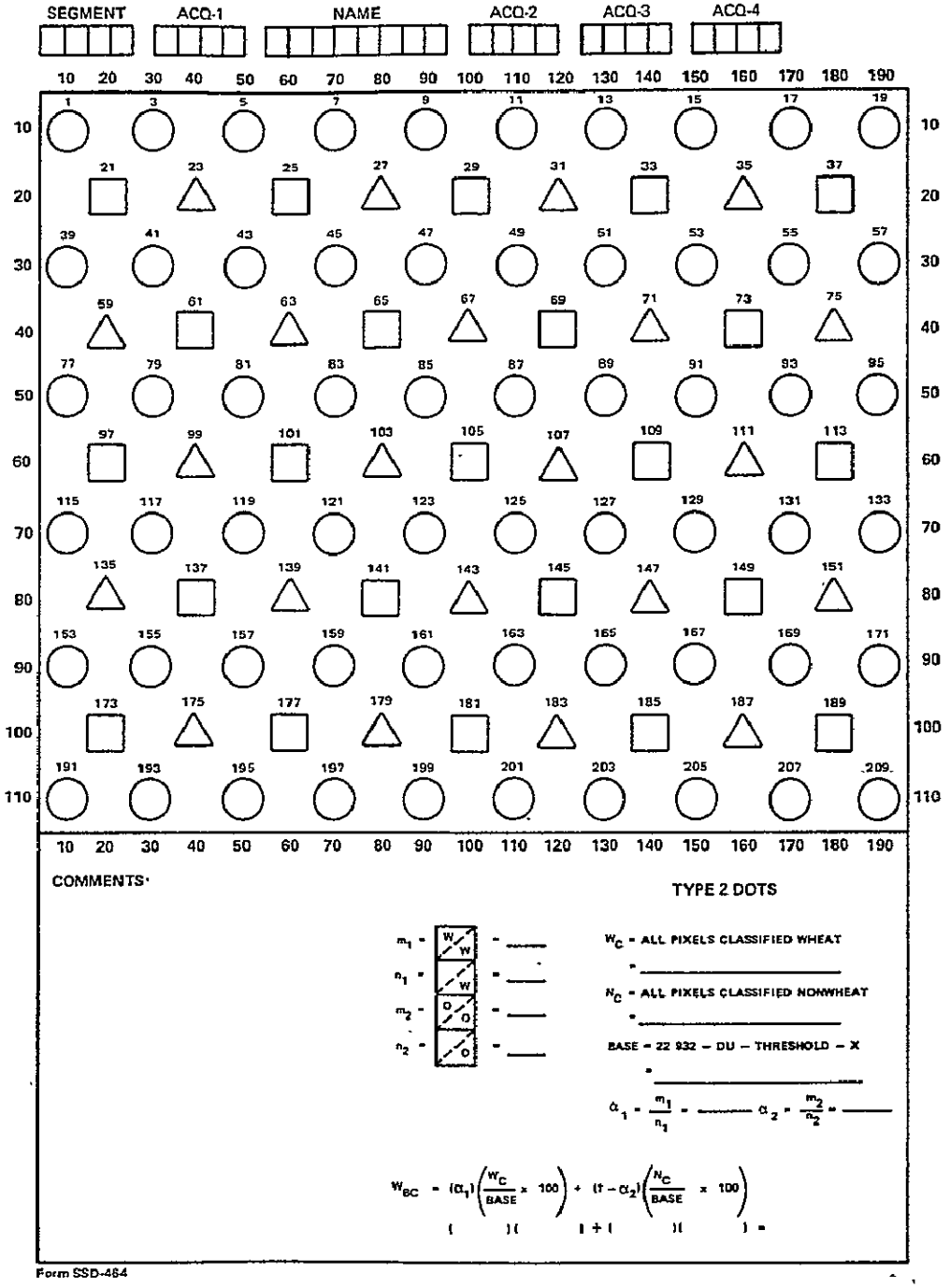


Figure 12.– Type 2 dot label form.

Any disagreements should be resolved before the job is submitted to batch.

4.8 PROCESS REQUEST FORM — ANALYST AIDE

A PRF (see fig. 13) will be completed and turned in to Flow Control (Flocon) personnel each time a segment is to be processed. The following information is recorded on the PRF under section 1, JOB DATA.

a. SEGMENT — Enter the segment number.

b. ACQ-1 — Enter the Julian date of acquisition (YDDD) for the base acquisition (for multitemporal classifications this must be the latest acquisition date to be classified).

c. NAME — Enter the team name.

d. ACQ-2 — Enter the Julian date of acquisition (YDDD) for an eight-channel classification.

e. ACQ-3 and ACQ-4 — Enter Julian date of acquisition (YDDD) for 12- and 16-channel classifications.

f. SYSTEM — Place an X in the appropriate box. For normal processing use Procedure 1. For ERIPS Interactive Multispectral Image Analysis System (Image 100) processing use Image-100. (Flocon requires these system codes in order to status the segment processing for the two independent analyses.)

g. JOB — Place an X in the appropriate box for data base transactions:

DOT	Dot data base transaction only.
FIELD	Field data base transaction only.
BATCH	Batch classification only.
CLLB	This box must be checked when the analyst needs to change cluster labels or delete clusters. All cluster label changes or deletions of clusters will be

PROCESS REQUEST FORM

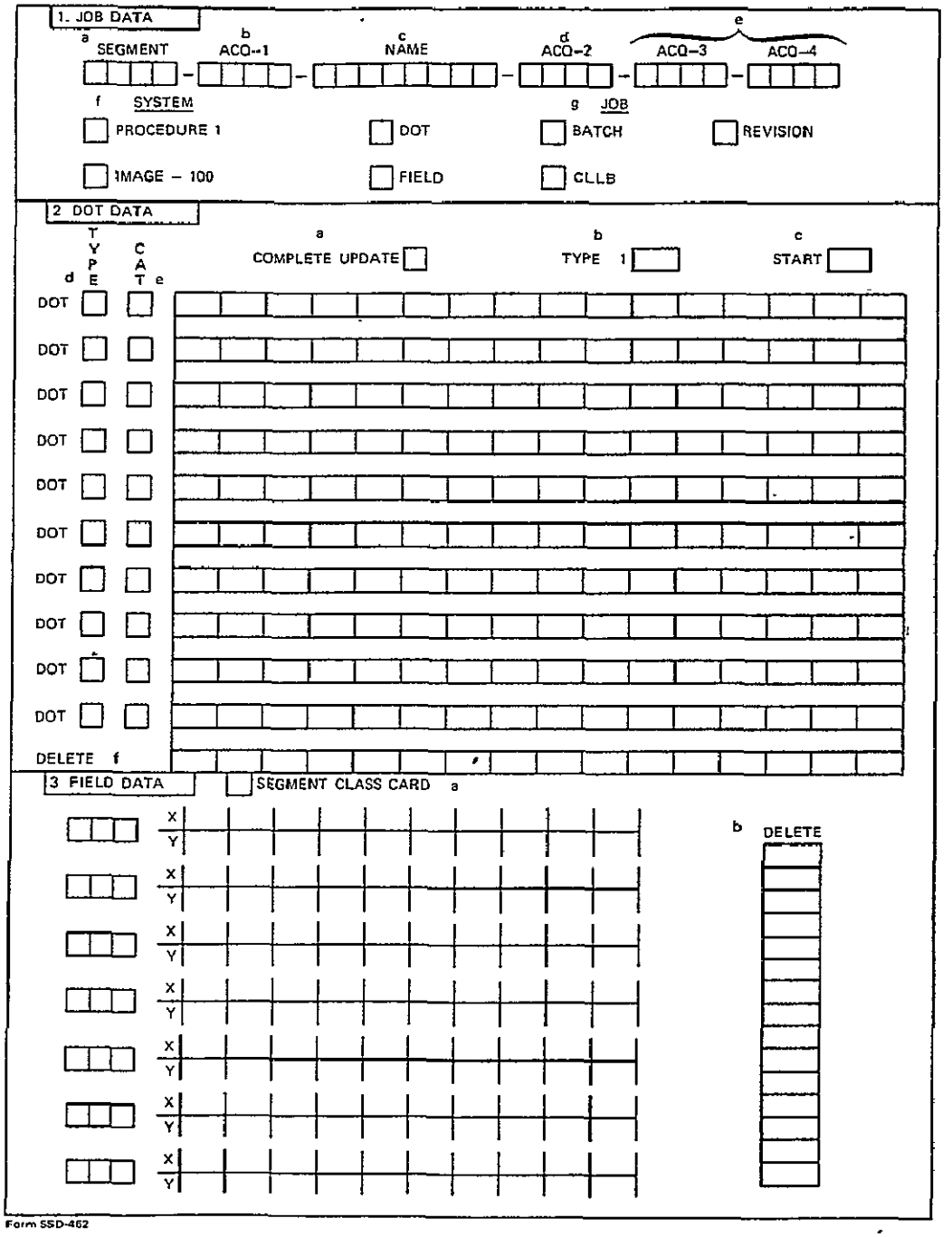


Figure 13.— Process request form.

done in batch mode. The analyst should submit a new PRF with the segment, acquisitions, and team information filled in exactly as on the original batch submittal. A computer card, punched by the analyst and containing the proper changes, accompanies the PRF. The format of the cluster label alteration card is described in section 7.

REVISION — This box must be checked when the latest rework classification information is not going to be used as the estimate; i.e., the wheat estimate obtained is not based on the most recent classification but is based on some previous classification. Should this occur, check the revision box and fill out the top line of the PRF to reflect the acquisitions used for the estimate to be passed. For example, acquisitions 6288, 6306, 7048, 7102, and 7156 are available for processing.

- Acquisitions 6288, 6306, 7048, and 7156 (base acquisition) are used for batch processing.
- Acquisitions 6288, 6306, 7048, and 7102 (base acquisition) are used for interactive rework processing.

If the analyst decides to pass the estimate using the set of acquisitions used for batch processing, he should complete a new PRF, checking the revision box.

REWORK — This box is checked when a PRF is submitted with a base date (ACQ-1) other than the latest date. When REWORK is indicated, Flocon is aware that the base acquisition, previously closed out with another code, needs to be reopened for work.

Under section 2, DOT DATA:

a. COMPLETE DOT UPDATE – If a complete update is needed, place an X in the YES box. If only a partial update or no changes are needed, place an X in the NO box.

b. TYPE 1 – To override the system defaults, input the number of type 1 dots in this box. (If left blank, the system default, 40, will be used.) This box is not used in current procedures; leave blank.

c. START – To override the system defaults, input the number of starting dots in this box. (If left blank, the system default, 40, will be used.) The number 50 should be placed in this box under current procedures.

d. TYPE – Enter 1 or 2 under the TYPE column.

e. CAT – Enter the appropriate category (W, S, G, N, or X) of the dots. The dot numbers are filled in to the right of CAT. For example,

	TYPE	CAT						
DOT	1	N	10	15	45	63	102	117

This indicates that dots 10, 15, 45, 63, 102 and 117 were labeled nonwheat and designated as type 1.

NOTE: To change an existing dot label on the data base, the dot line is completed with the new label.

f. DELETE – This box is checked, and dot numbers are input to the right to indicate those dots for which the analyst wishes to delete an existing label from the dot data base. This is not to be completed for dot label changes. When the DEL option is selected, no label will exist on the data base for that dot.

Under section 3, FIELD DATA, when exclusion areas are needed, record the X and Y coordinates, using the boxes for the numbers; i.e., 1 0, 0 3, etc.

a. SEGMENT CLASS CARD — Place an X in this box if the segment has never been worked using dot labels or if all existing fields are to be deleted.

b. DELETE — Record the DO/DU field numbers to be deleted.

5. FLOCON INTERFACE PROCEDURES

Flocon is the focal point of operational data flow and data processing activities for CAMS analysts. As such, segment packet assignment and tracking, batch processing submittal, and other data tracking and processing activities are accomplished through Flocon. The following procedures are for analyst guidance in preparation of material for Flocon.

5.1 BATCH CLASSIFICATION REQUESTS — ANALYST AIDE

Normally batch run request cards will be generated automatically by Flocon when the analyst aide submits a PRF. If batch products are not received by the analyst aide within 5 working days after a field update or a batch run submittal, the analyst should notify Flocon.

5.2 INTERACTIVE PROCESSING — ANALYST

CAMS ERIPS time is scheduled through the Flocon ERIPS scheduler.

A data product request (DPR) is required for all interactive processing on ERIPS. The analyst should obtain the DPR from LPDL one day prior to the scheduled processing time. The following information must be recorded on the DPR by the analyst: initials, telephone number, segment numbers, acquisitions processed, and an indication of whether the interactive processing of each segment is for training or for production. (See appendix B for detailed instructions on the completion of the DPR form.) After completion of the interactive session, three copies of the completed DPR are made and submitted to LPDL with the original.

If a CAMS interface report is required immediately upon the completion of interactive processing, the analyst must retrieve the CAMS/CAS interface tape (CCIT) from the LACIE Operations Supervisor (LOS) in Building 30, room 312. The tape must be delivered to Information Storage, Retrieval, and Reformatting Subsystem (ISRRS)

personnel who ensure that the tape is processed and that the resulting printed report is passed to the analyst. If the CCIT report is not required the same day as the interactive processing, the report is routinely delivered to the analyst the following morning.

5.3 NONPRODUCTION PROCESSING — ANALYST

Nonproduction dot updates and batch run requests are not submitted to Flocon. Field decks and batch run cards are submitted directly to the LPDL with the appropriate DPR. However, the last page of the batch run request DPR is given to Flocon so that Flocon personnel are aware that products have been requested. When the batch products arrive in the LPDL, Flocon personnel pick up the products and distribute them to the requesting analyst.

5.4 NOTIFICATION OF CHANGES

Periodically, changes or errors which may occur must be brought to the attention of Flocon. Examples of these changes are incorrect listings of acquisition dates, changes in evaluation codes, incorrect segment numbers, and changes in packet assignments. Flocon is to be notified of such changes or errors in order that proper corrections can be made. If a packet is not worked for any reason, such as the filing of a DR, Flocon must be notified.

6. EVALUATION

There are three parts to the evaluation process which is performed by the analyst. After machine processing, the analyst must first verify his dot labels using the imagery and spectral aids and then evaluate the results to determine whether they are satisfactory or unsatisfactory. If the segment is designated as a small-grain and/or mixed-wheat site and the machine results are evaluated as satisfactory, an attempt is made to separate the wheat and small grains.

6.1 PRODUCTS ESSENTIAL FOR EVALUATION/REWORK

The following products are generated for every batch run to be utilized for evaluation and/or rework.

a. Conditional cluster map

b. Unconditional cluster map

c. Classification map

d. Spectral aids

e. Microfiche of computer output microfiche (COM) tape

f. CCIT printout

6.2 PASS SELECTION

Because of the 16-channel limitation on classification using the ERIPS, pass selection is performed automatically during batch processing (ref. 7). This eliminates the least useful acquisition (where wheat and nonwheat are least separable). The best three acquisitions are the acquisitions with the smallest separability distance of all the three pass combinations. This information is in the Feature Selection Report on the microfiche and CCIT printout.

These three acquisitions should be used the next time the segment is processed. The feature selection decision can be overriden with QA approval. The reason should be documented on the CEF.

6.3 SPECTRAL AIDS

Scatter plots and trajectory plots generated for each batch classification are utilized to aid the analyst in verifying the consistency of dot labels. Consistency should be checked after each processing.

6.3.1 GENERAL DESCRIPTIONS

6.3.1.1 Scatter Plots

A scatter plot is a graphic representation of MSS data which contain agricultural information. The typical scatter plot is triangular in shape with the base of the triangle containing the bare soil pixels. The distance of a pixel from the base is a measure of the vegetation on the pixel. A scatter plot is generated for each acquisition.

In relationship to CIR imagery, in figure 14, point A would be dark green, point B would be red, and point C would be light green.

Scatter plots aid in maintaining labeling consistency and are most useful on acquisitions when the wheat and nonwheat are visually separable (i.e., fall acquisitions for winter small-grain sites). The scatter plots provide less separability information when all the wheat is not emerged (biowindow 1) or when it is ready for harvest (biowindow 4) because the wheat is mixed with other soil signatures.

6.3.1.2 Trajectory Plots

A trajectory plot, sometimes referred to as a time trace, displays a spectral pattern for one particular point over a period of time. It uses the same axis and information as a scatter plot, but it contains information from more than one acquisition (see fig. 15).

A wheat trajectory plot goes up (becomes redder on CIR film product) between biowindows 1 and 2 and goes down (turns green on CIR film product) between biowindows 3 and 4.

In general, wheat in biowindow 1 can range from the bare-soil line to some degree of greenness. It is greener (higher on the plots) in biowindows 2 and 3 than in biowindows 1 and 4, and it returns to the soil line in biowindow 4.

NOTE: If two biowindows 4 are plotted, one ripe or harvested, the next may have some vegetation coming up again so that an upward trend between the third and fourth points is sometimes seen.

A nonwheat trajectory is always different from the wheat trajectory. For example, natural vegetation would go up, rather than down, in biowindow 4 because it gets greener (redder on imagery) in the summer. Fallow fields may green up a little, but they normally stay very close to the soil line all year. In general, the trajectories are correlated to the visual pattern derived from viewing a particular signature over several acquisitions. Wheat dots that deviate from the wheat trends on these plots do so for one of three reasons: (1) abnormal wheat development, (2) misregistration – border and edge pixels, or (3) mistakes in labeling.

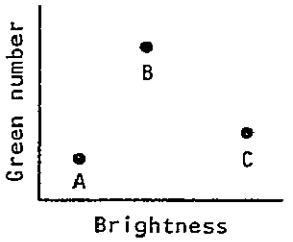
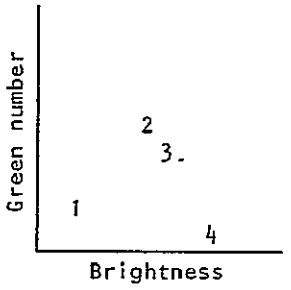


Figure 14.— Sample scatter plot.



Point 1

Acquisition	Biowindow	CIR
1	1	Pink
2	2	Red
3	3	Yellow-orange
4	4	Green

Wheat (?)

Point 2

Acquisition	Biowindow	CIR
1	1	Red
2	2	Green
3	Early 4	Red
4	Late 4	Red

Alfalfa (?)

Figure 15.— Sample trajectory plots.

6.3.2 SPECIFIC DESCRIPTIONS

6.3.2.1 Scatter Plots

For each batch processing job, three plots are generated for each acquisition in the green number versus soil brightness plane. These plots are of all dots (1) showing analyst labels and flagging unlabeled dots, (2) showing machine classification labels and (3) showing multiple hits.

The following symbols will be used in batch processing:

+	Background grid	&	DU and X
*	Unlabeled dots	W	W
•	N	S	S
/	DO		

Multiple hits are plotted on the unlabeled plot with a numeral, 2 through 9, indicating the number of dots plotted in that position. If more than nine dots plot into the same position, an equals sign (=) is plotted. Multiple hits are not plotted on the labeled plots (analyst and classifier); instead, the last label is plotted. Saturated points are plotted on the edge where the saturation occurred. The plots are in chronological order by acquisition, with all plots relating to the same acquisition together.

6.3.2.2 Trajectory Plots

Trajectory plots are generated for each of the 209 grid intersection dots whenever more than one acquisition is used in batch classification. As many as four acquisitions are plotted chronologically with the relative acquisition number displayed on the plot (see fig. 16). If multiple hits occur, a plus (+) is displayed. The first page is annotated with segment number, acquisition dates, and headings for individual plots. Each plot has

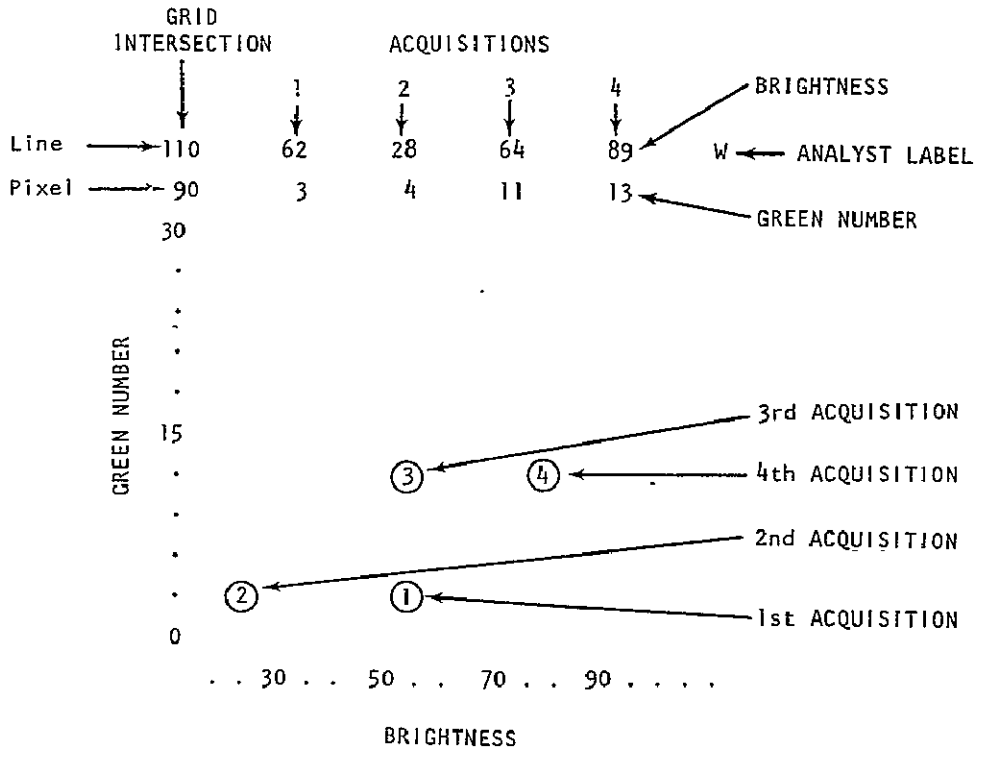


Figure 16.— Trajectory plot printout with annotations.

the spatial coordinates, the brightness/green number for each acquisition, and analyst labels.

Two reports are generated, and their formats are displayed in tables I and II. In the table II format, if two or more dots have the same green number, they will be ordered by brightness.

6.3.3 USES OF SPECTRAL AIDS

6.3.3.1 Scatter Plots

All scatter plots should be checked to see if the categories are grouping in the way the analyst expects. For example, using the biowindow 2 or 3 spectral plot (analyst labels), the analyst can expect the wheat pixels to be above a certain green line. This line is estimated on the plot by the analyst. If any nonwheat dots are above that line and nonwheat is not expected to be green on that acquisition, the labels are verified by referring to the imagery. If they still are labeled nonwheat, then some nonwheat is green on that acquisition and those dots should be located on the other acquisitions to make sure that the signatures can be separated from wheat. If only one acquisition was used for processing and the dot represents a nonwheat signature, DO fields should be considered. Any wheat dots below the line and all dots near the line should also be verified and checked for separability in the other acquisitions. It should be verified that all the wheat dots have returned to the soil line on the spectral plot of the biowindow 4 acquisition. Information on mislabeled, border, and edge dots should be recorded on the dot label form.

6.3.3.2 Trajectory Plots

Trajectory plots are easier to use than scatter plots if more than one acquisition is used for processing. Some of the pure wheat and nonwheat trajectories should be looked at first so the analyst can get a feel for what he is looking at. Then all

TABLE I.- FORMAT OF REPORT ORDERED BY DOT NUMBER

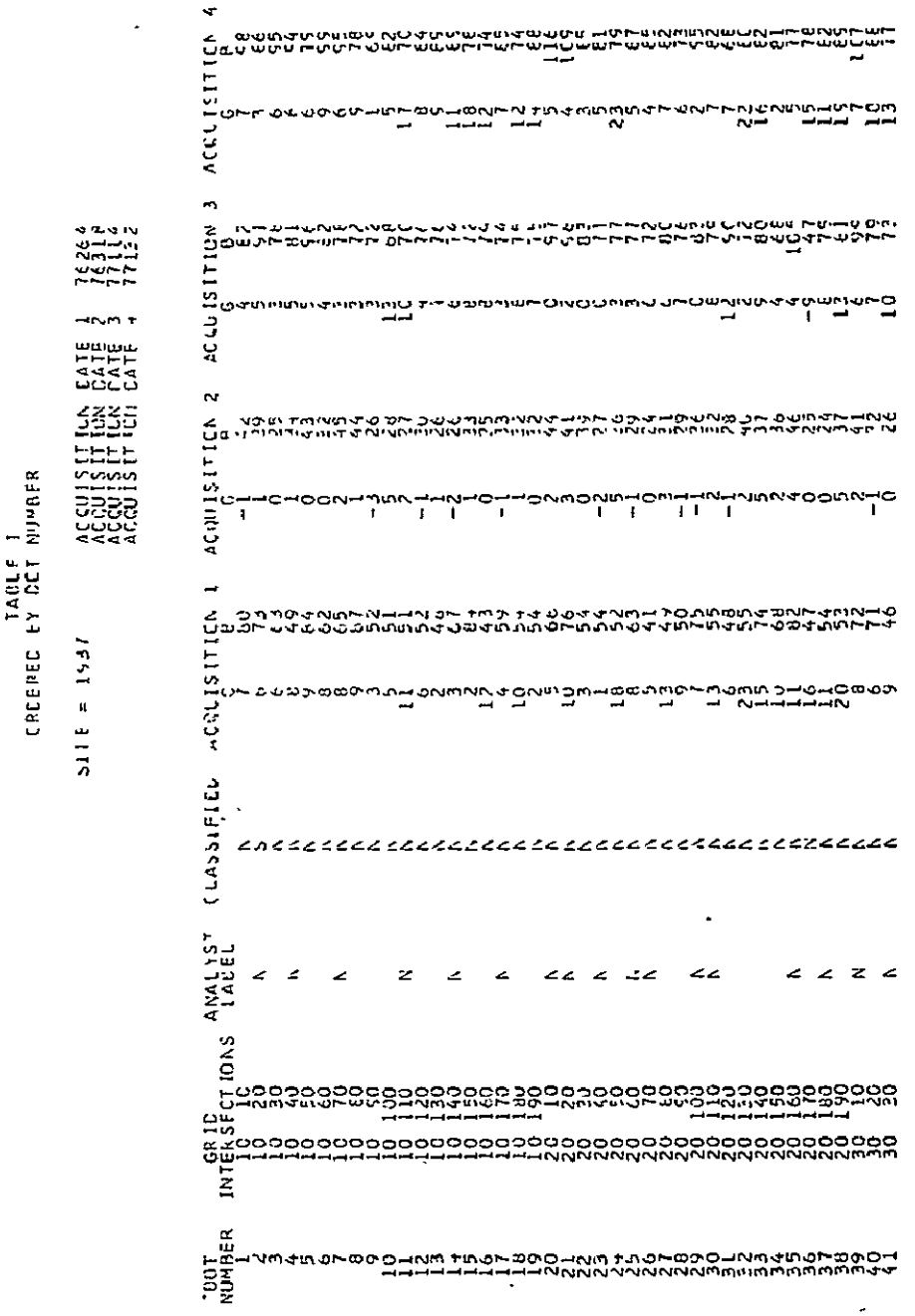
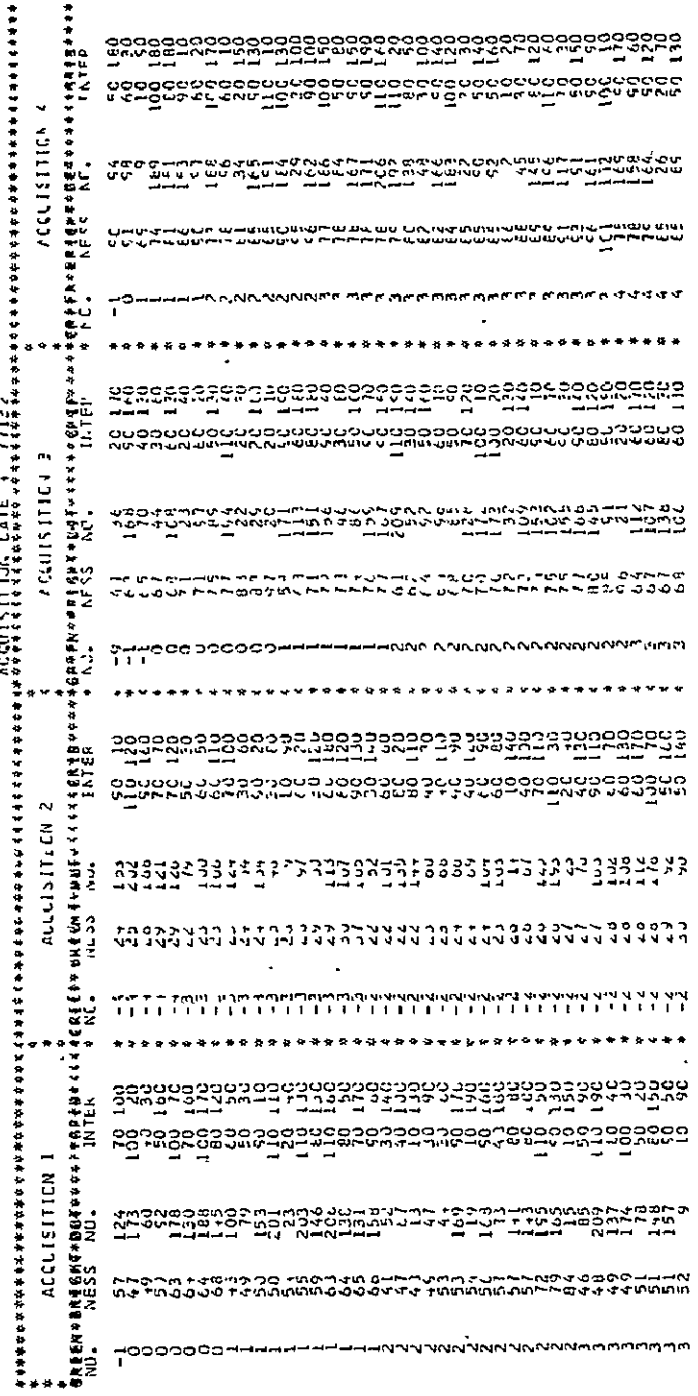


TABLE II.- FORMAT OF REPORT ORDERED BY GREEN NUMBER



the labeled trajectories should be looked at. If any of the trajectories look unusual, use the imagery to verify their labels. If any dots need relabeling, new dot label forms are completed with label changes in red. Dots to be deleted are recorded in red in the comments section. This occurs when the labeled type 1 dots are detected as border or edge pixels by using the trajectory plots. If any type 1 dot labels are changed, recompute the percentage of correct classification (PCC). If many type 1 dots are mislabeled, the labels should be corrected and the job resubmitted for batch processing.

If any type 2 dots need relabeling, recompute the bias-corrected estimate, the PCC, the variance (if necessary), and the random sample estimate before evaluation.

NOTE: The evaluation section of the timeline on the CEF should be used to record the time spent using the spectral aids.

6.4 EVALUATION FLOW

Figure 17 displays the evaluation flow. If the PCC of both type 1 and type 2 dots is greater than or equal to 70 and the variance of the bias-corrected estimate is less than or equal to 27, then the segment is considered satisfactory. If not, the rework guidelines are followed (section 7).

6.5 EARLY SEASON ESTIMATE PROCEDURE

Early in the crop year, estimates are required before all of the small grains have completely emerged. This procedure was designed to identify those small-grain pixels which are not visually emerged on the film products, but minimal growth is detected on the spectral aids.

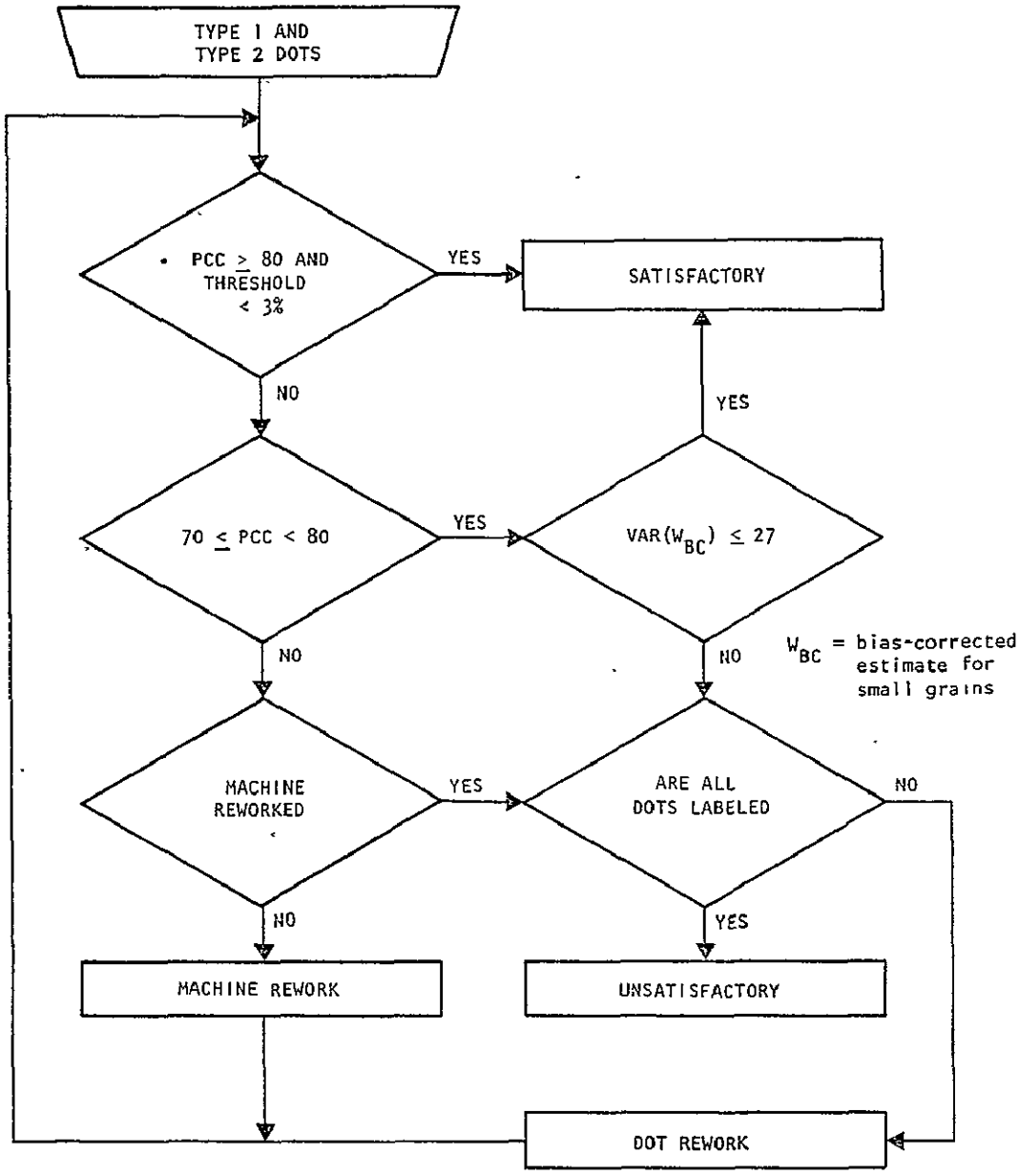


Figure 17.— Evaluation flow.

Ideally, a preemergence acquisition should be available to run multitemporally with the partially emerged acquisition; however, two partially emerged acquisitions can be used.

NOTE: If only one processable acquisition is available, this procedure should not be attempted and an 02 code should be assigned to the acquisition.

If two processable acquisitions are available, currently documented procedures should be followed for dot labeling (only emerged small grains are labeled W for both types of dots), batch submittal, evaluation, and rework.

After the emerged estimate is evaluated as satisfactory, the scatter and trajectory plots should be used to identify those pixels which have a wheat-like trajectory and could be, spatially, a small grain. (See section 6.2 for guidelines on spectral aids usage.) Label those pixels with wheat-like growth on the spectral aids as I. Those pixels that fall in partially emerged small grains fields, but do not have a trajectory similar to wheat on the spectral aids should be labeled B, if they are not anomalous pixels.

The bias-corrected and random estimates are then recomputed by adding the I,B:W into the W:W count and the I,B:N into the W:N count. It is not necessary to recompute the PCC or variance or reevaluate the new results in any way.

NOTE: The evaluation section of the timeline on the CEF should be used to record the time spent using this procedure.

6.6 MIXED WHEAT

This procedure applies only to segments specifically designated as mixed wheat sites. If a segment is processed using W, S, and N for dot labels and the results are satisfactory, the machine has corrected estimates which should be passed to CAS. If the estimates are not satisfactory, manually recompute the bias-corrected estimate at the small-grain level and evaluate that estimate. If the manually computed small-grain estimate or machine runs with G and N dot labels are satisfactory and a previous run is available with a satisfactory (accurate) winter-small-grain estimate, subtract the winter estimate from the small-grain estimate to get the spring estimate and pass the results to CAS. If a satisfactory winter-small-grain estimate is not available, pass the small-grain estimate to CAS. If the small-grain estimate is not satisfactory, it can be reworked a maximum of two times following the rework guidelines (section 7). Figure 18 shows the processing flow for mixed wheat.

6.7 WHEAT-SMALL GRAINS SEPARATION

For the Transition Year the wheat will be separated from the other small grains in the United States before the estimate is passed to CAS. Small-grains estimates will be passed to CAS for U.S.S.R. segments.

6.7.1 U.S. WINTER WHEAT

Statistically, an insignificant amount of other small grains are planted in the winter-wheat growing areas of the United States. Therefore, the estimate obtained after following current procedures should be treated as winter wheat instead of winter small grains. See section 8.4 for specific porta-punch card procedures.

6.7.2 U.S. SPRING WHEAT

Procedures for processing spring wheat are still in the development stage.

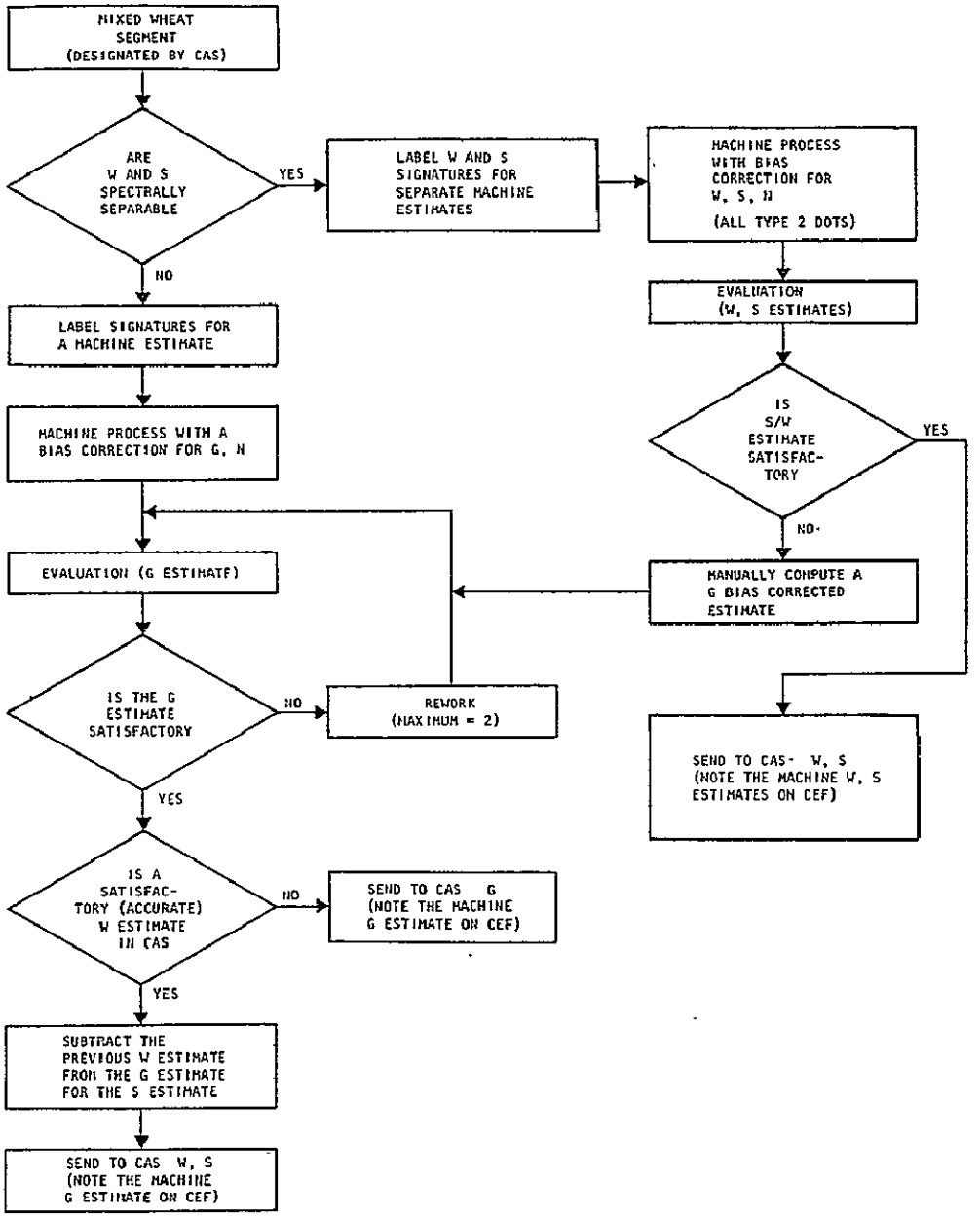


Figure 18.— Processing flow for mixed wheat.

7. REWORK

Segments are reworked by two methods, either by machine processing or by labeling more dots and computing a new bias-corrected estimate.

NOTE: All time spent doing machine and/or dot reworks, including reevaluation, should be recorded in the rework section of the CEF timeline.

7.1 MACHINE REWORK – ANALYST

A machine rework is performed when the PCC is less than 70 percent. Under this condition, a very poor correlation usually exists between the classification map and the imagery. Basically, there are two problem areas when machine rework is needed; i.e., mislabeled clusters or mixed clusters. If mislabeled clusters are easily detectable, it is necessary only to change the category assigned to that cluster. For mixed clusters, the problem can usually be corrected by deleting the cluster.

If clusters need to be relabeled or deleted, the following card should be keypunched by the analyst and submitted to Flocon with a PRF:

Column 1

CLLB=NN,X,NN,X,...NN,X

where NN is the cluster number and X is the new category label or an * to delete the cluster.

A maximum of 60 clusters can be changed. As many continuation cards as needed may be used by ending the last input with a comma, skipping column 79, inserting a nonblank character in column 80, and starting the new card with CLLB= in column 1.

The analyst's name and the segment number should be written on all cluster label cards submitted to Flocon.

NOTE: The CLLB box should be checked on the PRF.

7.2 DOT REWORK – ANALYST

A dot rework is done manually by labeling the remaining unlabeled type 2 dots and recomputing the PCC's, variance (if needed), bias-corrected estimate, and random sample estimate.

NOTE: If all the type 2 dots have already been labeled, label the unlabeled dots on the type 1 overlay, treating them like type 2 dots (label all dots except DO, DU, and X and add them into type 2 tallying).

DO NOT put dot rework dot labels on the new PRF to update the dot data base for the next batch job.

8. POSTPROCESSING

8.1 CAMS EVALUATION CODES

The CAMS evaluation codes are used to transform the satisfactory and unsatisfactory ratings and nonprocessed acquisitions to a numerical representation that is interpretable by CAS personnel for their purposes.

The following codes were developed in response to requests by CAMS, CAS, and Project Management personnel for a more detailed set of codes that would better cover the various criteria used within CAMS to evaluate and process Landsat data. These codes were also developed to meet certain CAS requirements for evaluating the CAMS data used for CAS area aggregations and for ease of machine processing of data.

Two sets of criteria were followed in developing these codes.

a. The codes would serve as a method of tracking and retrieving CAMS evaluation data by segment.

b. The codes would serve as a method of accounting for data not processed because of technical problems, ground problems, redundancy, etc.

A detailed explanation of the codes follows:

Code 01: Not machine processed — clouds, haze, snow, etc. The acquisition cannot be processed through the system because clouds, haze, etc., make interpretation and analysis impossible. Haze spread evenly and lightly over an acquisition is not in itself grounds for using this code if field patterns and signatures are discernible and identifiable.

Code 02: Not machine processed — crop confusion or other interpretation problems. This code should be used when an acquisition cannot be processed because of interpretation difficulties, especially when confusion between wheat-small grains and other crops is such that a wheat-small-grains estimate cannot be determined.

Code 03: Not machine processed — technical problems. In this case, the acquisition cannot be processed because of technical problems arising from bad photoprocessing, excessive scan line drop, etc.

Code 04: Not machine processed — misregistration. Registration is within 3 pixels with respect to the reference scene but inadequate for multitemporal processing.

Code 05: Not machine processed — dormancy. This code is used in cases where recognition is a problem because the crop is in a state of dormancy. The code can only be used in those cases where wheat has been visible on the imagery and an estimate was previously passed to CAS; otherwise, code 07 is used until biostage 3.0.

Code 06: Not machine processed — unacceptable registration. This code is used when misregistration is greater than 3 pixels with respect to the established reference scene.

Code 07: Not machine processed — preemergence. This code is used in instances where wheat-small grains have not emerged. This code can be used until biostage 3.0.

Code 09: Not machine processed — multiple acquisitions. Code 09 should never be used in place of other legitimate codes (i.e., codes 01, 02, 03, 04, 05, 06, 07). Code 09 is used to designate those acquisitions that have been reviewed and are workable but were not processed because

another acquisition or acquisitions available at the same time contained more and/or better information.

Code 10: Unsatisfactory – machine-processed single acquisition. This code is used for any acquisition that has been processed through the system and, based on the CAMS evaluation procedures, is designated unsatisfactory.

Code 14: Unsatisfactory – reworked, reevaluated segment. This code is used when an acquisition, which was previously passed to CAS with any code, is reprocessed; it makes no difference whether it is a single or multitemporal acquisition.

Code 18: Unsatisfactory – machine-processed multitemporal classification. This code is applied when more than one acquisition date is used to produce a proportion estimate that is unsatisfactory based on the CAMS evaluation criteria.

Code 30: Satisfactory – machine-processed single acquisition. This code is used for any acquisition that has been processed through the system and is designated satisfactory based on the CAMS evaluation procedures.

Code 34: Satisfactory – reworked, reevaluated acquisition. This code is applied when an acquisition, which was previously passed to CAS with any satisfactory or unsatisfactory code, is reprocessed for an estimate.

Code 36: Satisfactory – estimate that was not machine processed. This code can be used for a 0-percent estimate (1) when wheat has not emerged by biostage 3.0, but some agriculture is present; (2) when there are 50 or less wheat pixels in the segment; and (3) when no type 2 dots are labeled wheat.

This code can be used for a non-zero percent estimate when there are no type 1 wheat dots and a manual

bias-corrected estimate is computed. In case 2, this code can be used at any time including after an estimate has been passed to CAS if a later acquisition shows the amount of wheat present to be 50 pixels or less.

Code 38: Satisfactory — machine-processed multitemporal classification. This code is applied when more than one acquisition date is used to produce a proportion estimate that is satisfactory based on CAMS evaluation criteria.

Code 40: Not machine processed — nonagricultural segment. This code is applied when the acquisition is evaluated as having no agriculture; i.e., no discernible field patterns.

NOTE: Acquisitions in an agricultural area that have a 0-percent proportion estimate are to be designated code 36.

Code 60: Not machine processed — absence of new, useful information in post-harvest data. This code is legitimate when a good reliable estimate already exists for a segment and can be verified (with or without processing) by a new acquisition at or beyond 6.0 on the Robertson scale. Discretion is advised in the use of this code as it will shut down processing for the current growing season for that particular segment.

8.2 CAMS EVALUATION FORM (CEF) — ANALYST

A CEF is completed each time a classification is performed on a segment or a wheat estimate is to be passed to CAS. The following is a description of the information recorded on the CEF (see fig. 19).

a. SEGMENT — Enter the segment number.

CAMS EVALUATION FORM

a ☐☐☐☐ SEGMENT b LOCATION _____ c RESULTS _____ d ___/___/___ MM/DD/YY

e DPR NUMBER _____

ACQUISITIONS (YDDD)	j ADJUSTED GROWTH STAGE W	j ADJUSTED GROWTH STAGE S	k ANALYST'S GROWTH STAGE W	k ANALYST'S GROWTH STAGE S
_____ Latest f				
_____ Classified g				
_____ First visible h				
_____ Turning i				

l ☐ INTERACTIVE

m W _____
n N _____
o DO _____
p THRSH _____
q X _____
r DU _____

s ☐ FEATURE SELECTION _____

t ☐ STATISTICS MANIPULATION _____

	TYPE 1	TYPE 2
u PCC		
v VAR		
Rand est w		
Mach est x		

y

TIME LINE	Date	Hr	Min
Preprocessing			
Interpretation and labeling			
Evaluation			
Rework			
Postprocessing			

z COMMENTS

Form SSD-465

Figure 19.— A sample of the CAMS Evaluation Form (CEF).

b. LOCATION – Enter the physical location of segment (e.g., county/state, district/province, etc.).

c. RESULTS – Enter the code from the CAMS evaluation codes.

d. M/D/Y – Enter the date (month/day/year) the analyst completes evaluation for the specified acquisition or acquisitions.

e. DPR – Enter the DPR number from machine processing.

f. LATEST – Enter the Julian date of the most recent acquisition in packet.

g. CLASSIFIED – Enter the acquisition dates used to derive the estimate (Julian date).

h. FIRST VISIBLE – Enter the acquisition date showing the first visible sign of emerged small grains (Julian date).

i. TURNING – Enter the acquisition date showing the initial turning of wheat-small grains (Julian date).

j. ADJUSTED GROWTH STAGE – Enter the Robertson scale development stage for the acquisition dates entered in items f, g, h, or i for either winter (W) or spring (S) small grains.

k. ANALYST'S GROWTH STAGE – Enter the Robertson scale development stage determined by the analyst if the analyst detects a difference between the published growth stage and the small grains development visible on the imagery.

l. INTERACTIVE – Check if interactive processing was used for classification.

m. W – Enter the bias corrected wheat percentages. The following formula is used to figure the bias corrected wheat percentage for one category of wheat.

$$W_{bc} = \left(\frac{W_c}{\text{base}} \times 100\right)\left(\frac{m_1}{n_1}\right) + \left(1 - \frac{m_3}{n_3}\right)\left(\frac{N_c}{\text{base}} \times 100\right)$$

where

W_{bc} = bias-corrected wheat percentage.

W_c = all pixels classified wheat.

N_c = all pixels classified nonwheat.

m_1 = type 2 wheat dots that were classified wheat.

m_3 = type 2 nonwheat dots that were classified nonwheat.

n_1 = all labeled type 2 dots that were classified wheat (winter or spring).

n_3 = all labeled type 2 dots that were classified nonwheat.

base = 22 932 – DU pixels – X pixels – threshold pixels.

To figure the bias-corrected wheat percentage for two categories of wheat (winter and spring), the following formulas are used.

$$W_{bc} = \left[\alpha_{11}\left(\frac{W_c}{base}\right) + \alpha_{21}\left(\frac{S_c}{base}\right) + \alpha_{31}\left(\frac{N_c}{base}\right)\right] \times 100$$

$$S_{bc} = \left[\alpha_{12}\left(\frac{W_c}{base}\right) + \alpha_{22}\left(\frac{S_c}{base}\right) + \alpha_{32}\left(\frac{N_c}{base}\right)\right] \times 100$$

where

W_{bc} = bias-corrected winter wheat percentage

S_{bc} = bias-corrected spring wheat percentage

W_c = all pixels classified winter wheat

S_c = all pixels classified spring wheat

N_c = all pixels classified nonwheat

base = 22 932 – DU pixels – X pixels – threshold pixels

$$\alpha_{11} = \frac{\text{W labeled bias correction dots classified } W_c}{\text{bias correction dots classified } W_c}$$

$$= \frac{W{:}W}{W{:}W + S{:}W + N{:}W}$$

$$\alpha_{21} = \frac{\text{W labeled bias correction dots classified } S_c}{\text{bias correction dots classified } S_c}$$

$$= \frac{W:S}{W:S + S:S + N:S}$$

$$\alpha_{31} = \frac{\text{W labeled bias correction dots classified } N_c}{\text{bias correction dots classified } N_c}$$

$$= \frac{W:N}{W:N + S:N + N:N}$$

$$\alpha_{12} = \frac{\text{S labeled bias correction dots classified } W_c}{\text{bias correction dots classified } W_c}$$

$$= \frac{S:W}{W:W + S:W + N:W}$$

$$\alpha_{22} = \frac{\text{S labeled bias correction dots classified } S_c}{\text{bias correction dots classified } S_c}$$

$$= \frac{S:S}{W:S + S:S + N:S}$$

$$\alpha_{32} = \frac{\text{S labeled bias correction dots classified } N_c}{\text{bias correction dots classified } N_c}$$

$$= \frac{S:N}{W:N + S:N + N:N}$$

n. N — Enter the percentage of nonwheat.

$$N\% = 100 - W_{bc} - S_{bc}$$

o. DO — Enter the percentage of DO.

$$DO\% = \frac{\text{number of DO pixels} \times 100}{22\,932}$$

p. THRSH — Enter the percentage of threshold.

$$THRSH\% = \frac{\left(\begin{array}{c}\text{sum number of pixels thresh-} \\ \text{olded at category level}\end{array}\right) \times 100}{22\,932}$$

q. X — Enter the percentage of meteorological interference.

$$X\% = \frac{\left(\begin{array}{c}\text{all pixels classified as} \\ \text{meteorological interference}\end{array}\right) \times 100}{22\ 932}$$

r. DU — Enter the percentage of DU.

$$DU\% = \frac{\text{number of DU pixels} \times 100}{22\ 932}$$

s. FEATURE SELECTION — This box is checked if a subset of channels is used in classification: the channels used are noted.

t. STATISTICS MANIPULATION — If any changes are made to the fields which are on the data base, or if any diversions are made from the nominal classification flow, sufficient information should be noted so that the run might be duplicated.

u. PCC — Enter the probability of correct classification for type 1 and type 2 dots. If the PCC is computed manually, the following general equation is used for type 1 and type 2 dots

$$PCC = \left(\frac{\begin{array}{c}\text{number of W + N + X dots that} \\ \text{were correctly classified}\end{array}}{\text{total number of dots labeled}}\right) \times 100$$

For one category of wheat, the formulas for type 1 and type 2 dots, respectively, are:

$$PCC = \frac{W{:}W + N{:}N + X{:}X}{\text{total type 1 dots}} \times 100$$

$$PCC = \frac{W{:}W + N{:}N}{\text{total type 2 dots}} \times 100$$

For two categories of wheat, the formulas for type 1 and type 2 dots, respectively, are:

$$PCC = \frac{W{:}W + S{:}S + N{:}N + X{:}X}{\text{total type 1 dots}} \times 100$$

$$PCC = \frac{W{:}W + S{:}S + N{:}N}{\text{total type 2 dots}} \times 100$$

v. VAR — Enter the variance of the bias corrected estimate $[V(W_{bc})]$. For one category of wheat,

$$V(W_{bc}) = \left[\frac{W_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_1(1 - \alpha_1)}{n_1 - 1}\right] + \left[\frac{N_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_2(1 - \alpha_2)}{n_3 - 1}\right]$$

where

$\alpha_1 = m_1/n_1$, the PCC estimate for wheat

$\alpha_2 = m_3/n_3$, the PCC estimate for nonwheat

For two categories of wheat, use Cochran's equation (an exact computation based on percentages).

$$V(W) = \left[\frac{W_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{11}(1 - \alpha_{11})}{n_1 - 1}\right] + \left[\frac{S_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{21}(1 - \alpha_{21})}{n_2 - 1}\right] + \left[\frac{N_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{31}(1 - \alpha_{31})}{n_3 - 1}\right]$$

$$V(S) = \left[\frac{W_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{12}(1 - \alpha_{12})}{n_1 - 1}\right] + \left[\frac{S_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{22}(1 - \alpha_{22})}{n_2 - 1}\right] + \left[\frac{N_c}{base} \times 100\right]^2 \times \left[\frac{\alpha_{32}(1 - \alpha_{32})}{n_3 - 1}\right]$$

where

n_1 = all bias correction dots classified W = W:W + S:W + N:W

n_2 = all bias correction dots classified S = W:S + S:S + N:S

n_3 = all bias correction dots classified N = W:N + S:N + N:N

w. RAND. EST. — Enter the random sampling estimate for the percentage of wheat (W_{rs}). For one category of wheat,

$$W_{rs} = \left(\frac{W{:}W + W{:}N}{\text{Total type 2 dots}}\right)\left(\frac{W_c + N_c}{\text{base}}\right) \times 100$$

For two categories of wheat,

$$W_{rs} = \left[\frac{W{:}W + W{:}S + W{:}N}{\text{total type 2 dots}}\right]\left[\frac{W_c + S_c + N_c}{\text{base}}\right] \times 100$$

$$S_{rs} = \left[\frac{S{:}S + S{:}W + S{:}N}{\text{total type 2 dots}}\right]\left[\frac{W_c + S_c + N_c}{\text{base}}\right] \times 100$$

x. MACH EST. — Enter the percentage of wheat.

$$W\% = \frac{W_c}{\text{base}} \times 100$$

NOTE: If early season estimate procedures were followed, the machine bias-corrected estimate should be recorded under the machine estimate.

y. TIME LINE — Chart the flow of each packet. Enter the day and time of each function.

z. COMMENTS — Record any comments regarding the interpretation and classification. For example, for the initial segment processing in biowindow 1, the analyst should note if there may be late emerging small grains in the segment that could not be identified as small grains on this classification.

8.3 DATA ACQUISITION/EVALUATION RECORD — ANALYST AIDE

This record is attached under the flap on each segment packet and is completed for every segment acquisition. A reproduction of this form is shown in figure 20. This form is of particular importance because it contains the evaluation codes on the segments for which a new wheat estimate is not made to CAS via the CEF.

When acquisitions are received in CAMS for interpretation, Flocon personnel write the acquisition dates on the form prior to distributing the packet. After the analyst completes his evaluation, he fills in the evaluation code and completion date blocks and writes the team name in the block titled "Initials." The packet is then forwarded to the QA team, who verifies that the information is correct. When Flocon receives the packet from the QA team, they extract the necessary information for the daily report to be passed to CAS.

8.4 KEYPUNCH TRANSMITTAL/PORTA-PUNCH CARDS — ANALYST AIDE

A porta-punch card accompanies the packet the analyst aide receives. The card has the segment number and the acquisition dates for all acquisitions to be processed. The rest of the information is recorded by the analyst aide.

The following is an explanation of the data columns (see fig. 21).

a. CC — CAMS evaluation code: 07, 36, 30, etc.

b. W-RS — Winter wheat Robertson stage taken from a computer listing or an adjusted crop calendar.

c. S-RS — Spring wheat Robertson stage taken from a computer listing or an adjusted crop calendar. Should the Robertson stage not be available, a 09 should be placed in this column. If the Robertson stage is less than 1.0, place a 09 designation in the column.

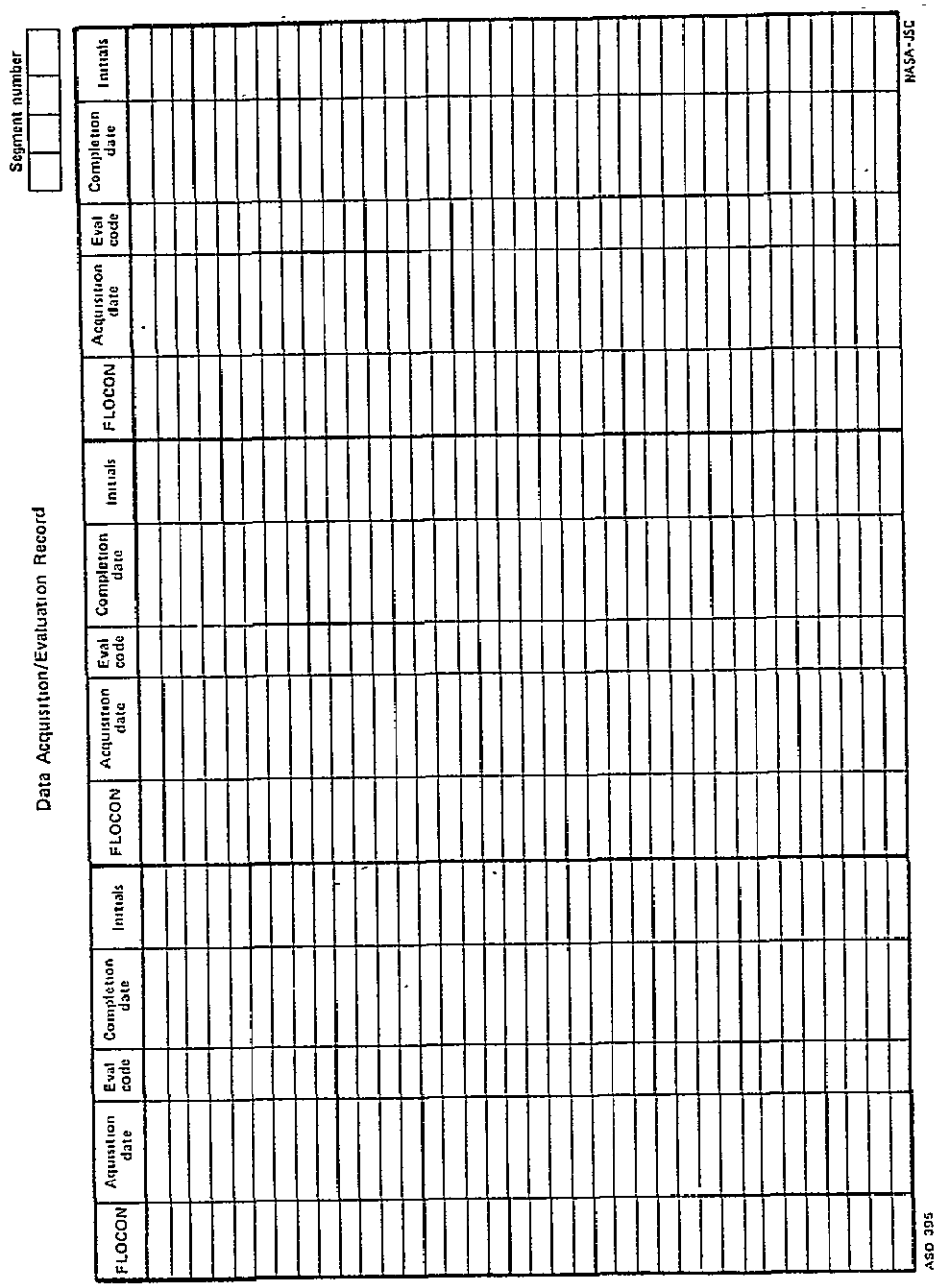


Figure 20.— A sample of the Data Acquisition/Evaluation Record.

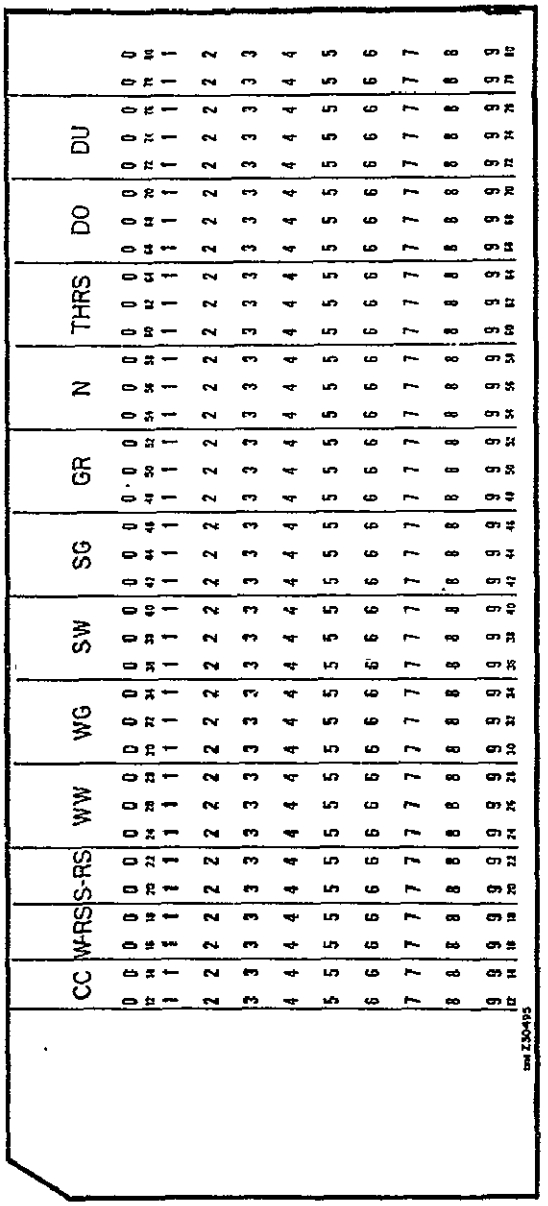


Figure 21.— Example of porta-punch card.

These spaces are to be filled in with the appropriate percentages from the classification results.

d. WW — Winter wheat only

e. WG — Winter small grains including wheat

f. SW — Spring wheat

g. SG — Spring small grains including wheat

h. GR — Total grains

i. N — Nonwheat

j. THRS — Threshold

k. DO — Designated other

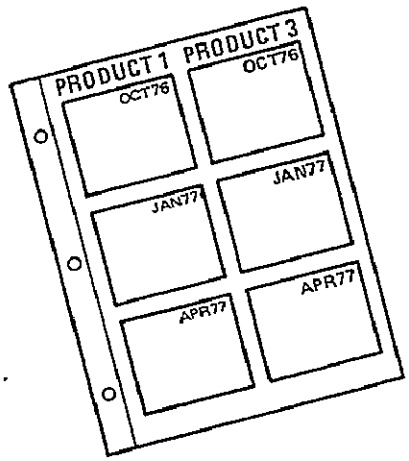
l. DU/X — Designated unidentifiable or meteorological interference

NOTE: A true zero estimate is recorded by punching zeros in all three columns. Where no estimate is available, the columns should be left blank.

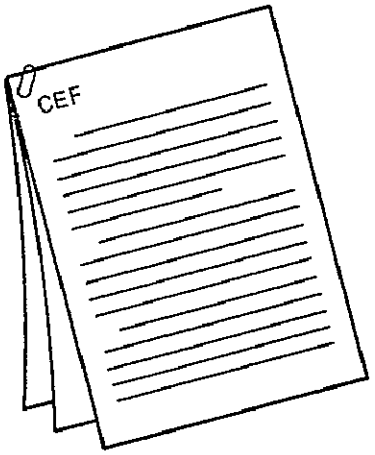
The preceding information is put into a CAMS data base for internal storage and retrieval. It is anticipated that the CAMS data base will replace the CEF.

8.5 POSTINTERPRETATION PROCEDURES — ANALYST AIDE

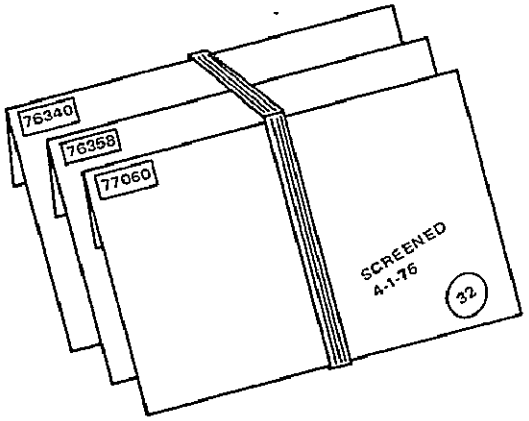
Once the analyst is finished interpreting the imagery and evaluating products (if applicable) for the given acquisition, the CAMS packet maintenance procedures (see fig. 22) should be followed before the segment packet is given to QA personnel. The purpose of these procedures is to standardize the CAMS packet organization in order to eliminate unnecessary time spent searching for materials by QA personnel or the next analyst reviewing the packet.



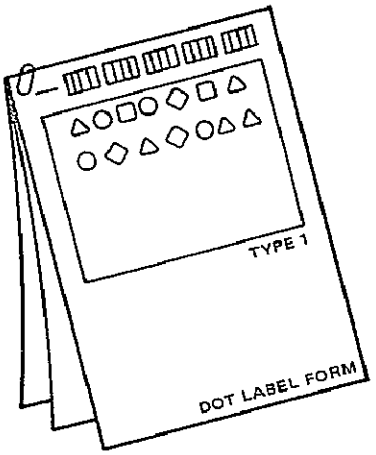
(a) Mount scribed images in chronological order.



(b) Place latest CEF on top.



(c) Bundle annotated imagery envelopes in chronological order.



(d) Place latest dot label forms on top.

Figure 22.— Illustration of postinterpretation procedures.

a. Scribe and mount in chronological order product 1 and product 3 images, six per document protector.

b. Attach CEF's with a paper clip; always place the most recent date processed on top.

c. Bundle manila imagery envelopes with a rubberband. Mark each with the code assigned that acquisition and the date processed. Arrange envelopes in chronological order with the most recent one on top. Include classification products, additional imagery, etc., inside the appropriate image envelope.

d. Attach dot label forms, stapled by acquisition, with a paper clip; always place the most recent date processed on top.

e. Attach PRF's with a paper clip; always place the most recent on top.

f. Keep the most current set of spectral aids in the packet. Previous ones may be discarded.

g. Make sure that all required forms (e.g., CEF and Data Acquisition/Evaluation Record) are complete and accurate.

h. Make a final check to ensure that all materials that arrived with the packet have been returned to the packet. This includes all imagery, maps, ancillary data, etc.

9. QUALITY ASSURANCE

Along with verifying wheat signatures at team consultations, the QA personnel are responsible for the final verification of dot labels and wheat estimates. This process is completed after dot label verification by the analyst and before reworks are performed.

a. Verify correctness of packet materials – Analyst Team function

- Maps
- CAMS Evaluation Form (CEF)
- Porta-punch cards
- Imagery preparation, etc.
- Process Request Forms (PRF's)
- Data Acquisition/Evaluation Form

b. Verify wheat on imagery – QA function

- Identify wheat/nonwheat on imagery
- Determine if the BCE represents the proportion of wheat on the image. If not, identify the problem that led to the error.

c. Verify dot labels – QA function

- Verify all type 2 dot labels. If there is disagreement that the QA feels is significant in obtaining an accurate wheat estimate, the labels should be changed and the bias-corrected estimate recomputed.
- Override evaluation criteria

  If, for any reason, the QA feels the code determined by the evaluation criteria is invalid, the verification operations group will be responsible for making the final decision.

d. Forward the packet to Flocon.

10. UPDATE OF SUBSEQUENT ACQUISITIONS

Upon receipt of the packets from Flocon, the analyst aide scribes the imagery and adjusts the crop calendar according to sections 2.3 and 2.5, respectively. The acquisition is then screened and interpreted according to sections 2.6 through 3.

All previously processed acquisitions should be used with the new processable acquisition. If a minimum of four acquisitions have already been processed, the procedures in section 6.2 should be followed.

If the new acquisition is determined to be processable, it becomes the base acquisition and the dot labels should be verified with all acquisitions selected for processing. Type 2 dot labels should be determined with respect to the base acquisition. Changes, if any, are recorded on a new PRF and new dot label forms.

Sections 5 through 9 should then be followed, as required, for batch submittal, evaluation, rework, postprocessing, and QA.

APPENDIX A

IMAGERY QUALITY CONTROL

APPENDIX A

IMAGERY QUALITY CONTROL

Imagery quality is monitored for every segment acquisition in addition to a weekly review of a standard segment image generated by the production film converter (PFC) and processed by the Photographic Technology Laboratory (PTL), NASA/JSC. Sample segment 1065 (Haskell County, Kansas) is the current reference standard used in the weekly review. The following parameters must be checked by the analyst for every segment acquisition, especially the ones chosen for training field selection. This task is performed during the Image Review Procedure. If any of the following problems are thought to exist, the analyst will consult with QA personnel over the possibility of submitting a DR on the imagery.

A.1 HISTOGRAM PROBLEMS

Correct gain and bias values of the scaling factors determine the color and tonal range of the composite products 1 and 2 images. If any unusual coloration is apparent, such as purple or black imagery, this malfunction should be noted. Occasionally, color problems can be confirmed by checking the numerical values located near the bottom of the header information block. The values are identified by the titles B, S, and 2ND BIAS which refer to the bias, scale factor, and second bias settings of the MSS channels used to generate the composites. These values vary considerably because of spectral reflectivity and scene brightness, and no "correct" range of values exists against which to check.

A.2 PIXEL DEFINITION

Each pixel should be distinct. Any defocusing or merging of dissimilar signatures should be noted as a pixel definition problem. Partial pixels indicate a problem.

A.3 ABUTMENT PROBLEMS

Abutment problems are identified by noncontiguous scan lines which appear as fine gaps or overprints in the image. This problem may occur repeatedly or only once in a sample segment.

A.4 DATA DROPOUTS AND/OR SKIPS

Data dropouts and/or skips appear as intermittent pixel losses in the scan line direction. Sometimes an entire scan line is missing from one of the image products. If the problem occurred as a result of PFC processing, a small arrow is visible in the margin alongside the missing scan lines. This imagery is rejected. If the problem is in the original data from GSFC, the acquisition may be worked. Landsat-1 striping (every sixth line) should be considered normal.

A.5 GRID PROBLEMS

Grid problems manifest themselves in the displacement of the 10- by 10-pixel grid superimposed on the image. This displacement results in training field coordinate errors and should be rectified before working.

A.6 TOTAL NUMBER OF PIXELS AND SCAN LINES

The total number of pixels and scan lines (196 by 117, respectively) must be checked when annotating the pixel and scan line numbers on the imagery.

A.7 PHOTOGRAPH PROCESSING AND FILM PROBLEMS

Photoprocessing and film problems in the form of chemical stains, emulsion pinholes, and film fog shall be rejected and reordered via a DR form (fig. A-1).

LACIE OPERATING PROCEDURES: TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER A REV.
SUBJECT: A.7 PHOTOGRAPH PROCESSING AND FILM PROBLEMS	APPROVED:
	DATE:

DISCREPANCY REPORT/PROGRAM CHANGE AUTHORIZATION — REPORT NO. 011980

1. ORIGINATOR NAME/ORG/PH NO: Richard Hinkle, CAMS	2. REPORTED IN REAL TIME: ☐ YES ☐ NO	REPORTED TO: NAME/ORG/PH NO	
3. TYPE OF PROBLEM: ☐ PCA ☐ HARDWARE ☐ SOFTWARE ☐ PROCEDURES ☒ OTHER: Misregistration of PFC images		4. TYPE OF ACTIVITY/RUN NO/CONFIG NO: LACIE Operations	
5. RESPONSIBLE AREA: ☐ CDC ☐ IBM ☐ LEC ☐ NASA ☐ CYBER ☐ UNIVAC ☐ OTHER			
6. DATE/TIME PROBLEM OCCURRED: 08/05/75	7. LOCATION BLDG/ROOM: Bldg. 17	8. PROJECT/APPLICATION: LACIE	9. COMP SYSTEM/EQPT SYSTEM
10. SOFTWARE SYSTEM/VERSION	11. SOFTWARE SUBSYSTEM/VERSION	12. OTHER SYSTEM/VERSION	13. PROBLEM IMPACT: ☐ CRITICAL ☐ MAJOR ☐ MINOR
14. CORE DUMP REEL NO	15. RESTART TAPE REEL NO.	16. LOG TAPE REEL NO	17. ATTACHED DOCUMENTATION: Polaroids of current and misregistered images.

18. PROBLEM DESCRIPTION

1. PROBLEM: Registration of segment 1623-30. When compared to the first acquisition, this segment was found to be misregistered by:

upper left corner	Up 2 pixels	Left 10 lines
upper right corner	Up 2 pixels	Left 10 lines
lower right corner	Up 2 pixels	Left 10 lines
lower left corner	Up 2 pixels	Left 10 lines
center	Up 2 pixels	Left 10 lines

2. ADVERSE EFFECTS: Prevents multitemporal classification.

3. RECOMMENDATIONS: Reregistration by GSFC or registered imagery within the same biophase.

FOR MANAGEMENT USE ONLY

19. DR CLASSIFICATION: ☐ CRITICAL ☐ MAJOR ☐ MINOR	20. TESTED WITH: VERSION ____ UPDATE TAPE NO. ____	21. DEVELOPMENT PLAN REF: SUBSYSTEM ____ ITEM ____	22. SPECIAL COORD REQUIRED: ☐ YES ☐ NO EXPLAIN BELOW
23. ASSIGNED TO: NAME/DATE	24. APPROVED BY: NAME/DATE	25. APPROVED BY: NAME/DATE	26. MODS SUBMITTED FOR: MODULE NAME/CSECT NAME
27. PROBLEM DIAGNOSES/ACTION TAKEN			
28. RESPONSIBLE AREA DR COORDINATOR	29. CLOSED BY NAME/ORG/PH NO		DATE

JSC Form 1541 (Rev Jun 75) PREVIOUS EDITIONS ARE OBSOLETE. ☆ U.S. GOVERNMENT PRINTING OFFICE 1975—671 549/57

Figure A-1.— Example of a DR.

A.8 VERIFICATION OF TEMPORAL REGISTRATION

Imagery acquisitions received subsequent to the reference segment are registered by comparing identifiable features in both images. The new image is superimposed over a reference image which is known to be properly registered.

A comparison is then made of how closely the locations of ground features match between the two images. If all points or features match to within one pixel between the two images, the registration is considered good. When one or more points are shifted in either the pixel or line direction by more than one pixel, the distance is recorded and transmitted to DAPTS via a DR form.

A.9 CLOUDS, SHADOWS, AND HAZE EVALUATION CRITERIA

The evaluation criteria for determining what to do with an acquisition when it contains clouds, shadows, or haze are as follows.

a. Determine whether previous imagery exists for segment.

b. If so, does the imagery provide sufficient data to determine if agriculture may possibly exist in the obscured area.

c. If the obscured area is determined to be a nonagricultural area such as rangeland, it is DO and the training field selection procedure may begin.

d. The last criterion to be considered is the amount of obscured wheat potential area. If the obscured area is equal to or less than 40 percent, the acquisition is considered workable. If not, reject the acquisition.

LACIE OPERATING PROCEDURES: TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER A REV.
SUBJECT: A.10 DR FOR REPORTING FILM PROCESSING PROBLEMS	APPROVED:
	DATE:

A.10 DR FOR REPORTING FILM PROCESSING PROBLEMS

If an acquisition is rejected, based on the criteria listed in this appendix, a DR must be submitted to the Operations Control Center (OCC). The DR must include the Landsat scene number, tape number, and acquisition date, along with a brief description and a photograph to document the malfunction. A sample DR of a discrepancy, which precludes interpretation by the analyst, is depicted in figure A-2. The completed DR is submitted to the CAMS DR coordinator.

LACIE OPERATING PROCEDURES: TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER A REV. _
	APPROVED:
SUBJECT: A.10 DR FOR REPORTING FILM PROCESSING PROBLEMS	DATE:

DISCREPANCY REPORT/PROGRAM CHANGE AUTHORIZATION — REPORT NO 011981

1. ORIGINATOR NAME/ORG/PH NO: A. Arro/CAHS/x4761
2. REPORTED IN REAL TIME: [X] YES [ ] NO
REPORTED TO: NAME/ORG/PH NO.
3. TYPE OF PROBLEM: [ ] PCA [ ] HARDWARE [ ] SOFTWARE [ ] PROCEDURES [X] OTHER PFC Image Quality
4. TYPE OF ACTIVITY/RUN NO/CONFIG NO: LACIE Operations
5. RESPONSIBLE AREA: [ ] CDC [ ] IBM [ ] UNIVAC [ ] NASA [ ] SISO [ ] UNIVAC [ ] OTHER
6. DATE/TIME PROBLEM OCCURRED: 12/01/75
7. LOCATION - BLDG/ROOM: Bldg. 17/Room 235
8. PROJECT/SUBPROJECT: LACIE
9. COMP SYSTEM/EQPT SYSTEM:
10. SOFTWARE SYSTEM/VERSION:
11. SOFTWARE SUBSYSTEM/VERSION:
12. OTHER SYSTEMS/VERSIO.:
13. PROBLE IMPACT: [ ] CRITICAL [ ] MAJOR [ ] MINOR
14. CORE DUMP/REEL NO.:
15. RESTART TAPE REEL NO:
16. LOG TAPE REEL NO.:
17. ATTACHED DOCUMENTATION: Polaroid of imagery

18. PROBLEM DESCRIPTION

1. PROBLEM: LACIE sample segment 7129-10-295-5 generated from tape ID; A53012 has poor image quality due to incorrect scaling and bias values.

2. ADVERSE EFFECTS: Imagery products 1, 2, and 4 are unusable and precludes interpretation.

3. RECOMMENDATION: Regenerate the imagery using the correct scaling and bias values.

FOR MANAGEMENT USE ONLY

19. DR CLASSIFICATION: [ ] CRITICAL [ ] MAJOR [ ] MINOR
20. TESTED WITH: VERSION ____ UPDATE TAPE NO. ____
21. DEVELOPMENT PLAN REF: SUBSYSTEM ____ ITEM ____
22. SPECIAL COORD REQUIRED: [ ] YES [ ] NO EXPLAIN BELOW
23. ASSIGNED TO: NAME/DATE
24. APPROVED BY: NAME/DATE
25. APPROVED BY: NAME/DATE
26. MODS SUBMITTED FOR: MODULE NAME/CSECT NAME
27. PROBLEM DIAGNOSIS/ACTION TAKEN
28. RESPONSIBLE AREA DR COORDINATOR
29. CLOSED BY NAME/ORG/PH NO
DATE

JSC Form 1541 (Rev Jun 75) PREVIOUS EDITIONS ARE OBSOLETE. ☆ U.S. GOVERNMENT PRINTING OFFICE: 1975—671 549/57

Figure A-2.— Sample DR depicting a discrepancy which precludes interpretation.

APPENDIX B

INTERACTIVE DATA PRODUCT REQUEST (DPR) PROCEDURE

C-2

LACIE OPERATING PROCEDURES TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER B REV.
SUBJECT: APPENDIX B INTERACTIVE DATA PRODUCT REQUEST (DPR) PROCEDURE	APPROVED: DATE

APPENDIX B

INTERACTIVE DATA PRODUCT REQUEST (DPR) PROCEDURE.

Figure B-1 shows the LACIE Data Product Request form for the 1977 crop year. There are four copies to this form. Copy 1 goes to the LACIE Operations Supervisor. Copy 2 is returned to the originator with the products. Copy 3 is forwarded to the LACIE Physical Data Library, and copy 4 is retained by the originator.

Flocon personnel provide the following information:

77 CROP YEAR

C09DPA-7109---08-A100R

LACIE DATA PRODUCT REQUEST

NAME ABOTTEEN

KEYPUNCH & LIST _____ ☐ NON-LACIE

DATA BASE UNLOAD _____

DATA BASE UPDATE _____ HIST _____ FIELDS _____ PRO CONT _____ VIA CARDS _____ TAPE _____

DATA BASE QUERY _____ HIST _____ FIELDS _____

BATCH PRODUCTION _____

PFC FILM REQUEST _____

INTERACTIVE JOB ✓ SCHEDULE TIME: FROM 0400 TO 0800 DATE 20 APR 77

77 CROP YEAR

LACIE DATA PRODUCT REQUEST

NAME _____

KEYPUNCH & LIST _____ ☐ NON-LACIE

DATA BASE UNLOAD _____

DATA BASE UPDATE _____ HIST _____ FIELDS _____ PRO CONT _____ VIA CARDS _____ TAPE _____

DATA BASE QUERY _____ HIST _____ FIELDS _____

BATCH PRODUCTION _____

PFC FILM REQUEST _____

INTERACTIVE JOB _____ SCHEDULE TIME: FROM _____ TO _____ DATE _____

INPUT TAPE NO.		FILE NO.	SAMPLE SEGMENTS TO BE PROCESSED				
	OR						
	OR						
	OR						
	OR						
	OR						
	OR						

COMMENTS

EOD DATA MANAGER /DATE

PFC PRODUCTS		COM PRODUCTS	OTHER
CODE NAME	7. COLOR ALL 4 CHANNELS	1 CAMS REPORT	1. CARD LISTING
1. COLOR IR	8. B & W CLASS MAP	2. CAMS DELOG	2. TRANSACTION REPORT
2. ENHANCED COLOR	9 COLOR CLUSTER	3. INDEXED DATA REPORT	3 JSC INTF TAPE
3. TEMPORAL COLOR COMPOSITE	10. LINEAR COMB B & W	4. CLASS CHAR MAP	4. FLDS DEF TAPE
4 B&W, ALL 4 CHANNELS	11. LINEAR COMB COLOR	5. CLASS CLUS MAP	
5 SINGLE B&W SCREENING	12. B & W FB OVERLAY		
6 COLOR CLASS IMAGE ENGINEERING IMAGE			

DPCA SPECIAL INSTRUCTIONS

DPCA APPROVAL _____

LACIE OPS SUPV.

TO PFC

NO. _____ DATE _____

NO. _____

TO COMF

NO _____ DATE _____

NO. _____

TO DDC

FICHE _____ ACC NOS. _____

TAB _____

TAPE _____

FILM _____

COMPLETE EOD D/ M _____ DATE _____

JSC Form 1529G (Rev AUG 76)

COPY 1 — LOS COPY

Figure B-1.— LACIE Data Product Request form.

The primary analyst adds the information shown.

77 CROP(a) YEAR

_ _ _ _ _ _ - _ _ _ - K M A - _ _ - _ _ _ _

LACIE DATA PRODUCT REQUEST (b)

NAME _____ 5102

KEYPUNCH & LIST _____ ☐ NON-LACIE

DATA BASE UNLOAD _____

DATA BASE UPDATE _____ HIST _____ FIELDS _____ PRO CONT _____ VIA CARDS _____ TAPE _____

DATA BASE QUERY _____ HIST _____ FIELDS _____

BATCH PRODUCTION _____

PFC FILM REQUEST _____

INTERACTIVE JOB _____ SCHEDULE TIME: FROM _____ TO _____ DATE _____

INPUT TAPE NO.	FILE NO.		SAMPLE SEGMENTS TO BE PROCESSED				
7108	KA OR P	1350	77082	76286			
(c)	WD OR P	1298	77010				
	WD OR N	1084	77003	76254	76365		
	DY OR P	7681	76363	76214			
	(d) OR (e)	(f)		(g)			
	OR						

COMMENTS:

EOD DATA MANAGER /DATE

a. Enter your initials

b. Enter your telephone number.

c. Request the log input tape number from the machine operator when signing on the terminal and enter it on the DPR.

d. Enter the initials of the other analysts in column two in order to facilitate the sorting of products if you are doing reworks.

e. Enter P for production and N for nonproduction.

f. Fill in the segment number.

g. Fill in the acquisitions used. Put the most current date first, if done multitemporally.

B.1 DELOG REQUEST

If you request a delog on the terminal (see figs. B-2 and B-3) do not put anything on your DPR. Simply tell the LACIE Data Systems Supervisor (LDSS) if you are going to pick it up in Building 30 or ask him to send it with the courier.

If you did not request a delog on the terminal but want one, put the following on your DPR. If you do not request a paper delog under COMMENTS, you will get microfiche.

INPUT TAPE NO.	FILE NO.	SAMPLE SEGMENTS TO BE PROCESSED
Log Tape 7108	OR	Console number
	OR	
	OR	
	OR	
	OR	
	OR	

COMMENTS: Paper delog PR reports.

EOD DATA MANAGER /DATE

PFC PRODUCTS		COM PRODUCTS	OTHER
CODE NAME	7. COLOR ALL 4 CHANNELS	1. CAMS REPORT	1. CARD LISTING
1. COLOR IR	8. B & W CLASS MAP	2. CAMS DELOG X	2. TRANSACTION REPORT
2. ENHANCED COLOR	9. COLOR CLUSTER	3. INDEXED DATA REPORT	3. JSC INTF TAPE
3. TEMPORAL COLOR COMPOSITE	10. LINEAR COMB B & W	4. CLASS CHAR MAP	4. FLDS DEF TAPE
4. B&W, ALL 4 CHANNELS	11. LINEAR COMB COLOR	5. CLASS CLUS MAP	
5. SINGLE B&W SCREENING	12. B & W FB OVERLAY		
6. COLOR CLASS IMAGE ENGINEERING IMAGE			

LACIE OPERATING PROCEDURES: TRANSITION YEAR CAMS DETAILED ANALYSIS PROCEDURES	NUMBER B REV.
SUBJECT: B.1 DELOG REQUEST	APPROVED.
	DATE.

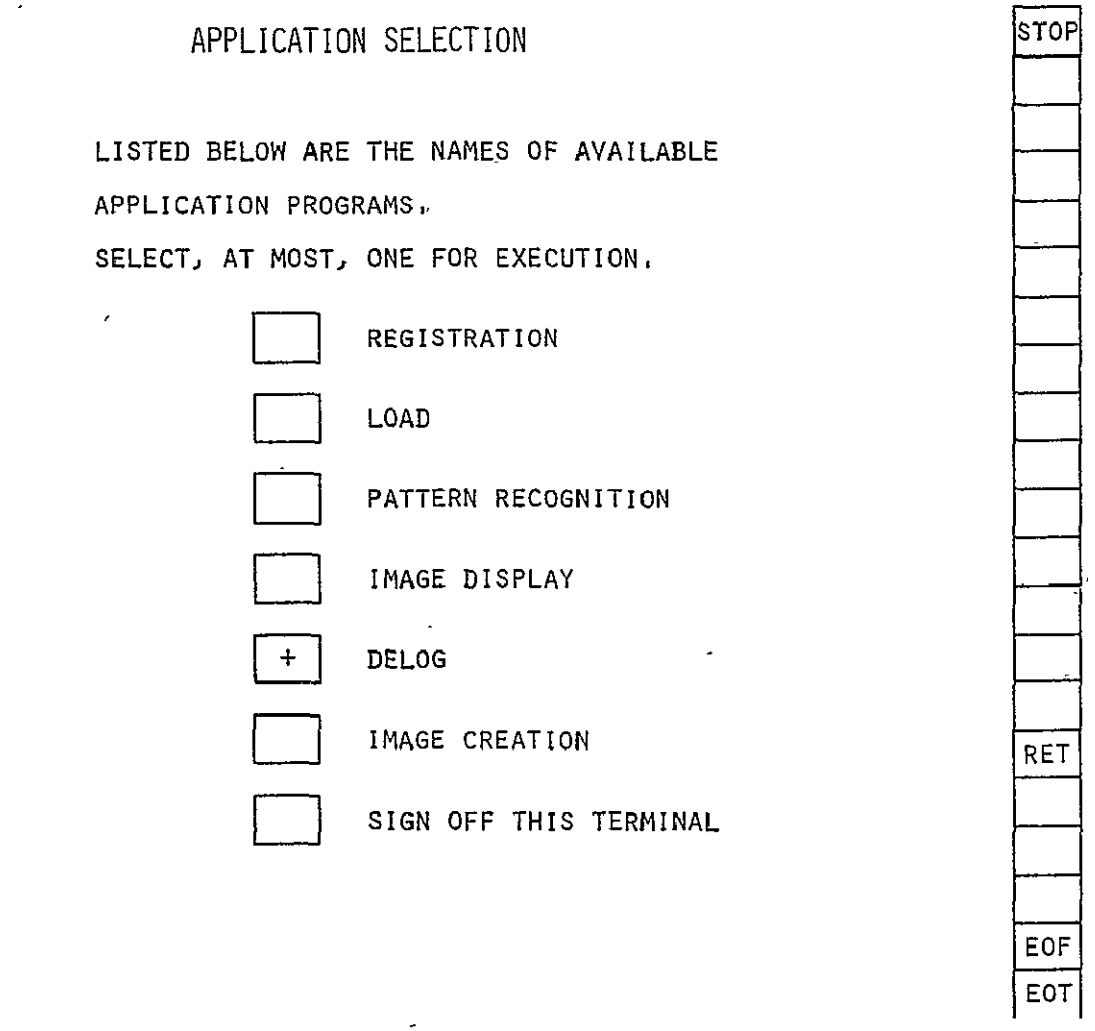


Figure B-2.— Terminal request for delog.

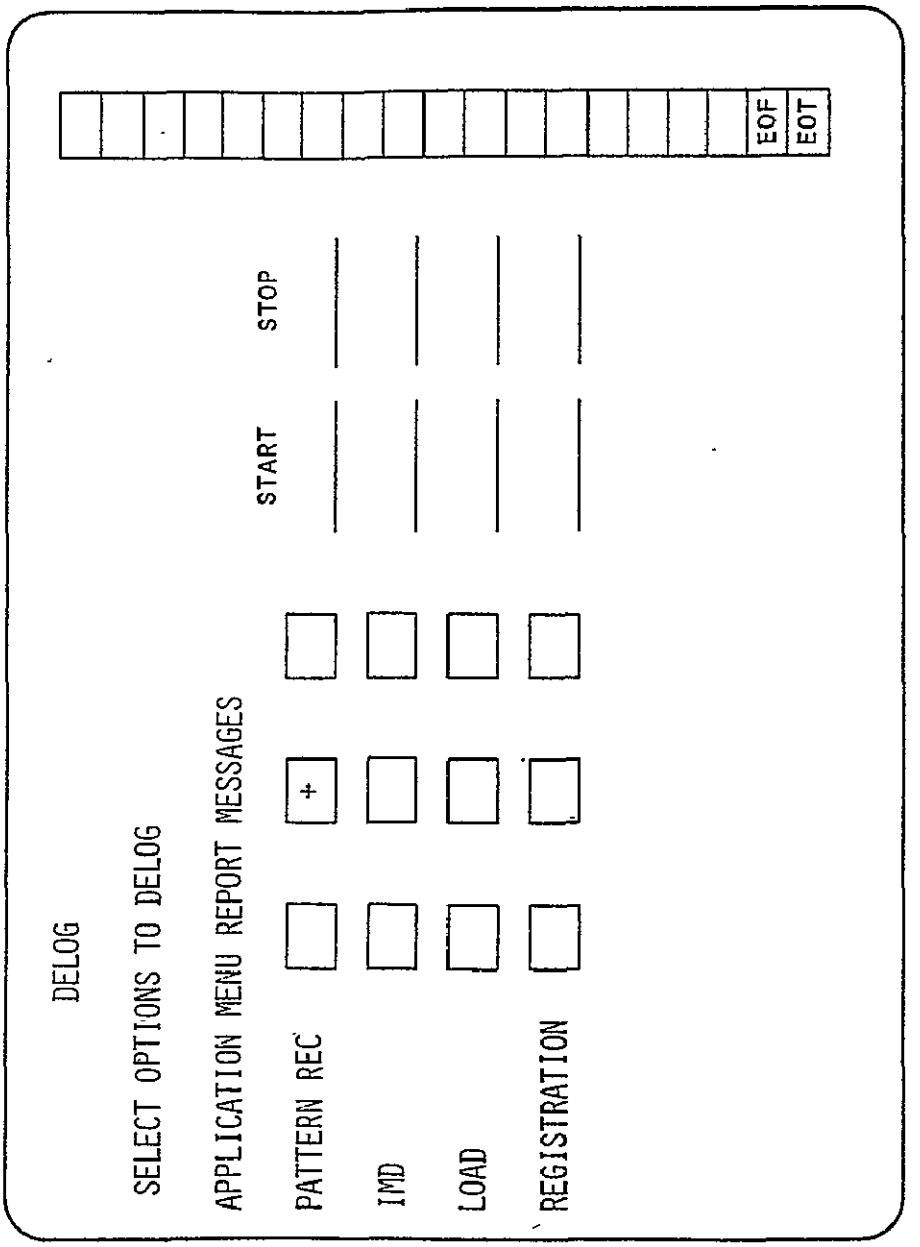


Figure B-3.— Delog menu.

B.2 FILM PRODUCT REQUEST

If you have generated a tape for cluster and/or class map PFC products (see figs. B-4 through B-7), put the following on the DPR.

PFC PRODUCTS		COM PRODUCTS	OTHER
CODE NAME 1. COLOR IR _____ 2. ENHANCED COLOR _____ 3. TEMPORAL COLOR COMPOSITE _____ 4. B&W, ALL 4 CHANNELS _____ 5. SINGLE B&W SCREENING _____ 6. COLOR CLASS IMAGE _____ ENGINEERING IMAGE _____	7. COLOR ALL 4 CHANNELS _____ 8. B & W CLASS MAP X 9. COLOR CLUSTER X 10. LINEAR COMB B & W _____ 11. LINEAR COMB COLOR _____ 12. B & W FB OVERLAY _____	1. CAMS REPORT _____ 2. CAMS DELOG _____ 3. INDEXED DATA REPORT _____ 4. CLASS CHAR MAP _____ 5. CLASS CLUS MAP _____	1. CARD LISTING _____ 2. TRANSACTION REPORT _____ 3. JSC INTF TAPE _____ 4. FLDS DEF TAPE _____
DPCA SPECIAL INSTRUCTIONS: Send C30010 to PFC for processing.		DPCA APPROVAL: _____	

a. Request the data terminal (DTERM) tape number (C30010 in this example) from the machine operator after the first "image tape input" is made.

b. Check PFC product 8 and/or 9, whichever is applicable.

There is a separate DTERM tape for each terminal. The DTERM tape remains mounted until you sign off or the system crashes.

If the system crashes, ask the machine operator for the new log tape number. If you generate more maps for the PFC you can also have another DTERM tape number (request from operator).

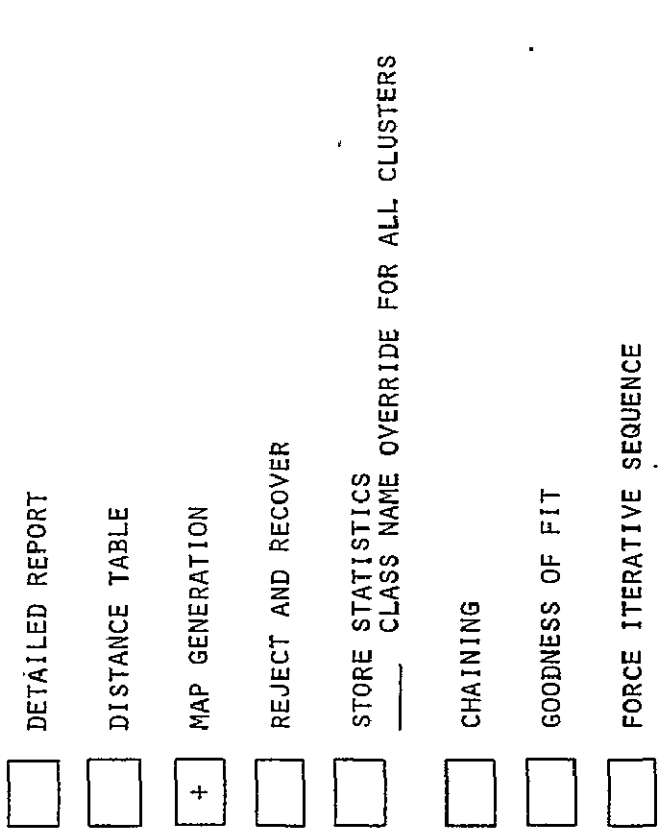


Figure B-4.- Clustering options menu.

CLUSTERING OUTPUT MENU

INDICATE TYPE OF CLUSTERING OUTPUT

1 CHARACTER MAP
2 COLOR IMAGE
3 COLOR IMAGE (64)
4 IMAGE TAPE +
5 GRAY LEVEL IMAGE
6 CONDITIONAL MAP

Figure B-5.— Clustering output menu.

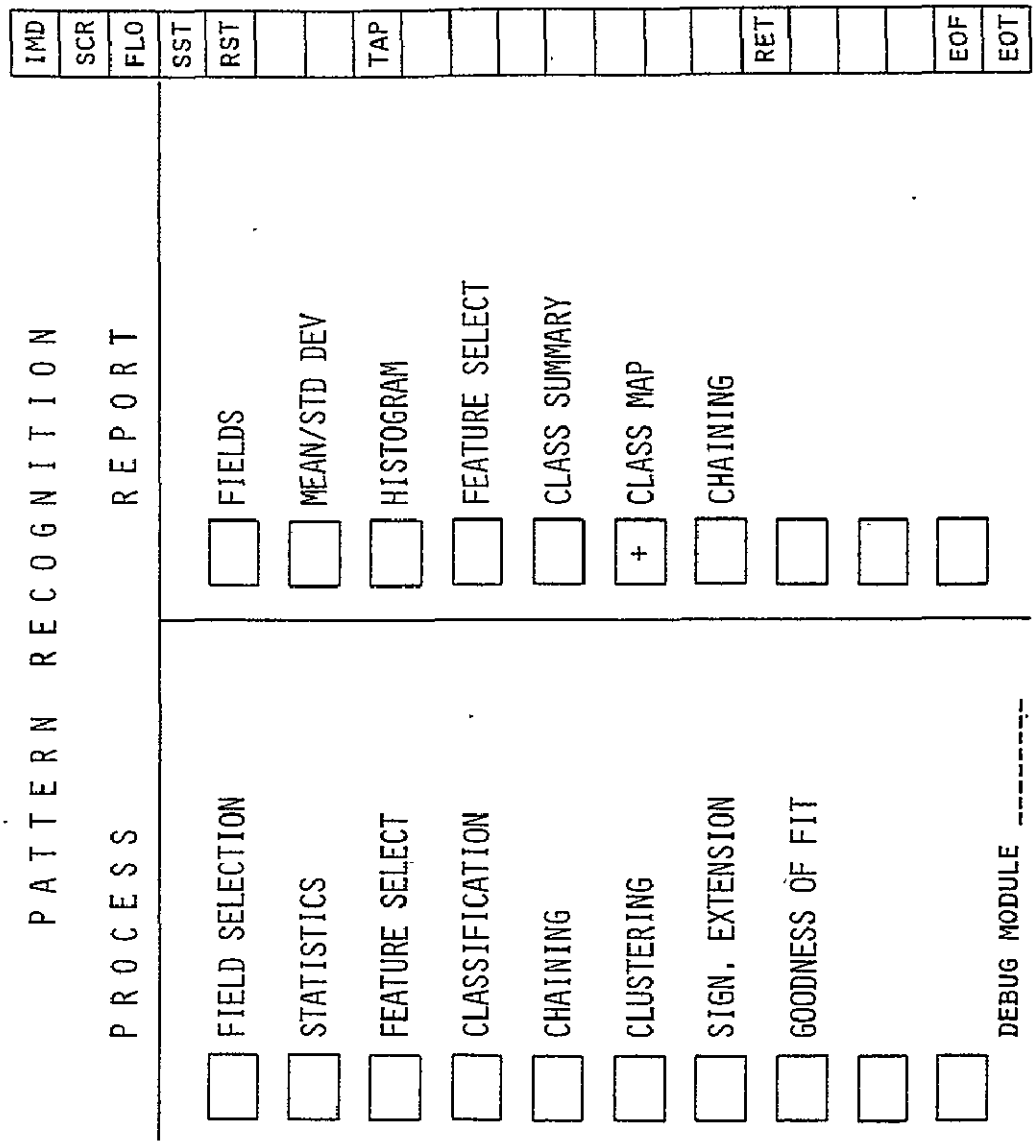


Figure B-6.- Pattern recognition menu.

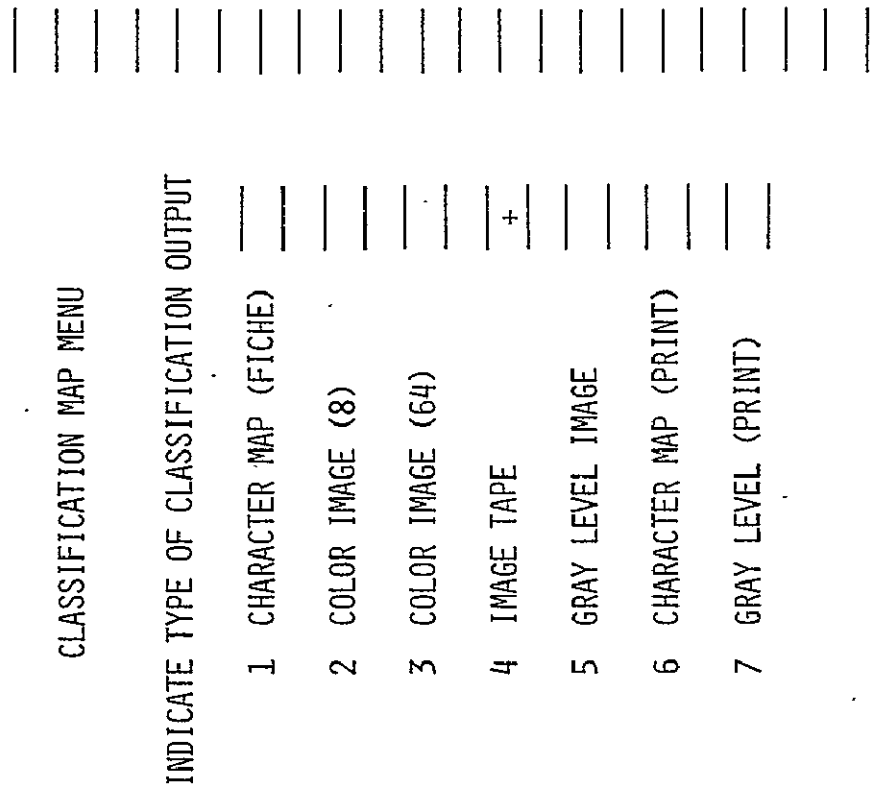


Figure B-7.- Classification map menu.

B.3 CAMS/CAS INTERFACE TAPE PRINTOUT REQUEST

No CAMS/CAS interface tape information should be put on your DPR. Just check the "CAS Interface" box on the class summary menu (see figs. B-8 and B-9).

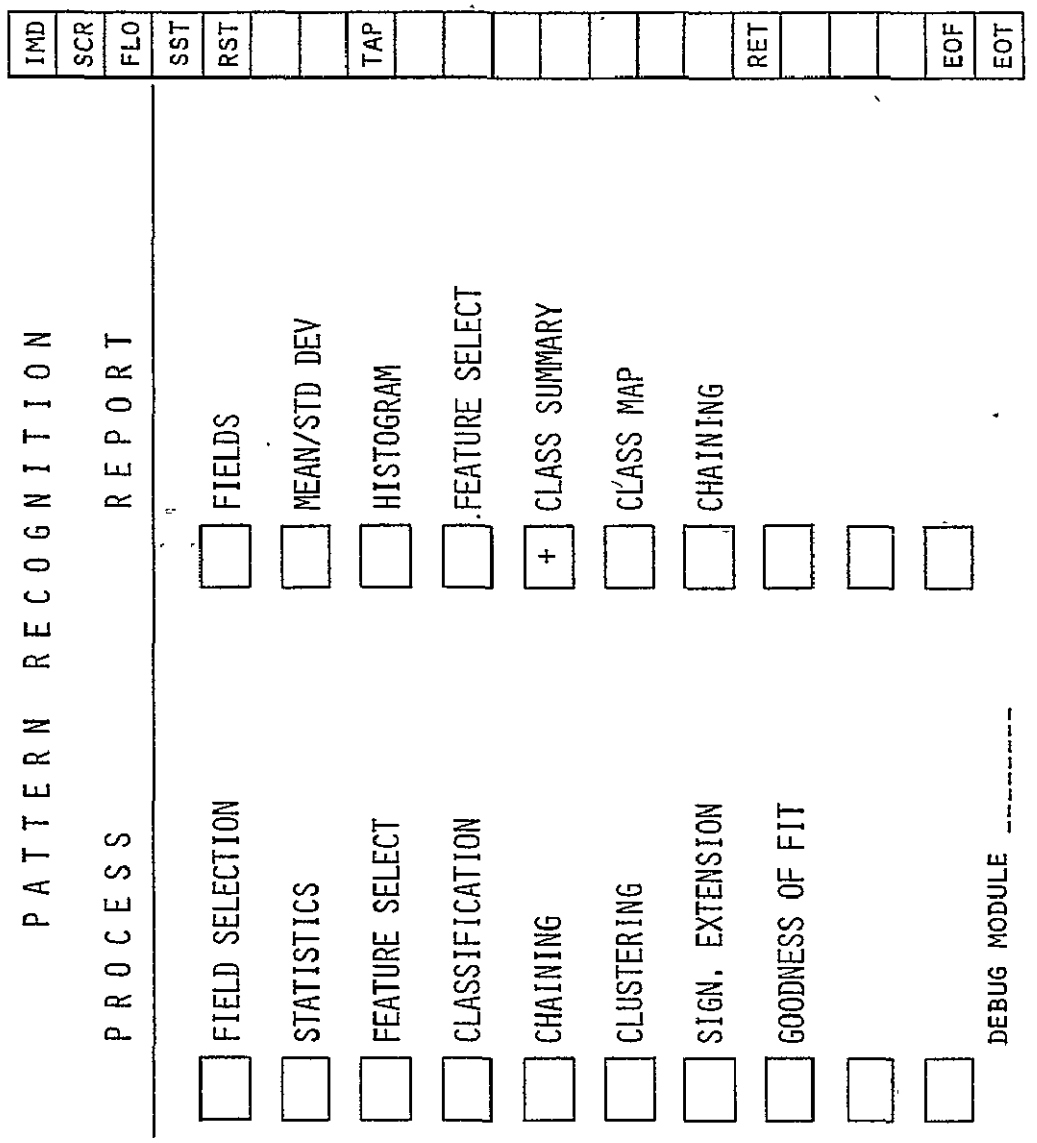
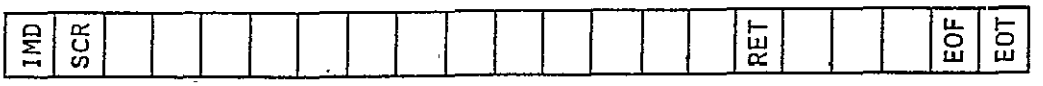


Figure B-8.— Pattern recognition menu.



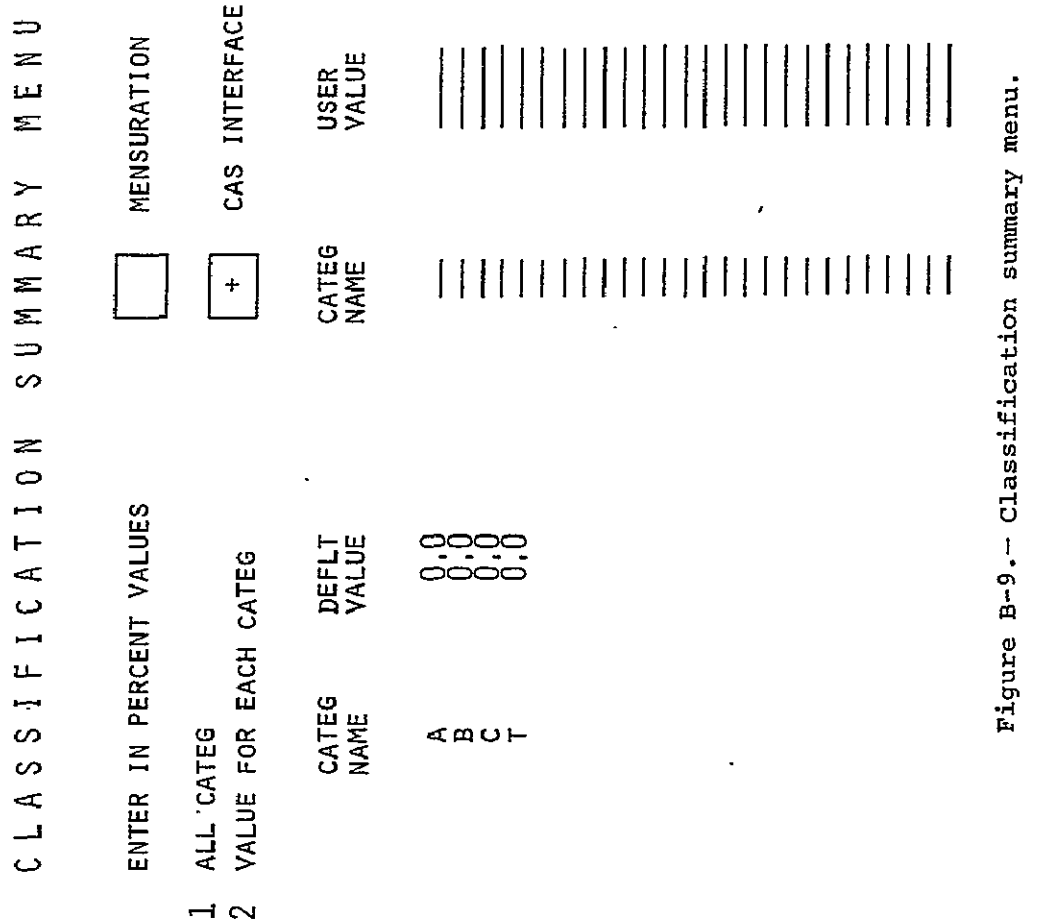


Figure B-9.- Classification summary menu.

APPENDIX C

SMALL FIELD PROCEDURE

APPENDIX C

SMALL FIELD PROCEDURE

The following procedure was developed primarily as a solution to the existing problem of processing segments with unusually small fields; thus, it carries the small field name. This is not meant to imply that the procedure cannot or should not be used for segments with large fields. The small field procedure utilizes a supervised clustering technique to develop statistics for classification as opposed to using training fields to generate statistics with the traditional method of maximum likelihood classification used in LACIE.

C.1 PREPROCESSING

The analyst reviews and utilizes maps, crop calendars, all available imagery, meteorological summaries, AI keys, and ancillary data according to procedures as outline previously in this document. Guidelines for imagery preparation, wheat/small grains decision criteria, processing mode selection (four channel or multitemporal), and data handling procedures are the same as described in sections 2-4, unless exceptions are listed specifically in the following procedures.

There are several significant changes from current procedures that are implemented with the small field procedure. First, the "no significant change" criterion is no longer applicable for Phase III. If no previous estimate for a segment has been derived using the small field procedure, each segment must be processed for an estimate whenever there is a "processable" acquisition available. A processable acquisition is defined as one where the following conditions are met.

a. Wheat has reached the appropriate growth stage to give an estimate (see fig. C-1).

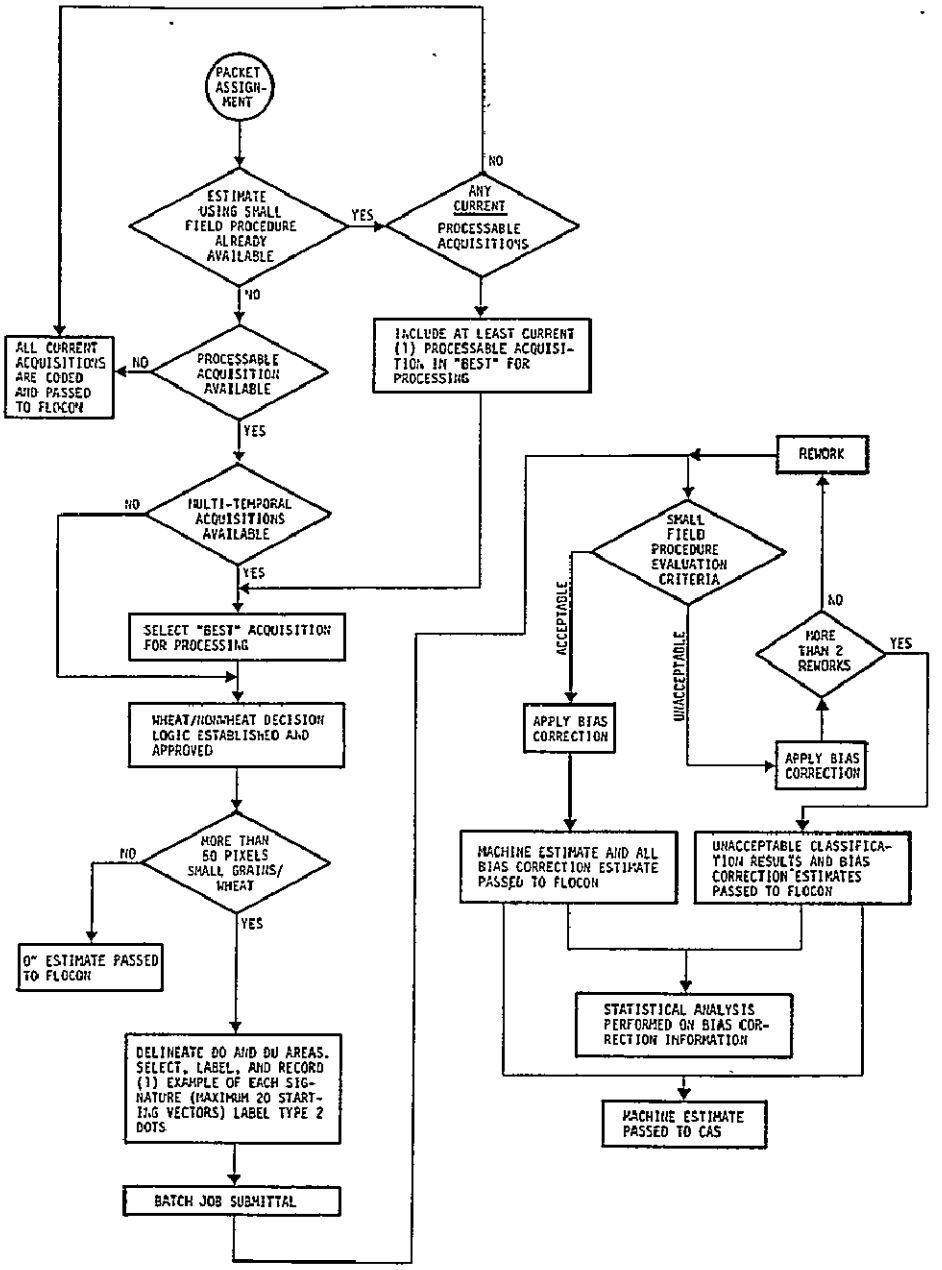


Figure C-1.— Small field procedure segment processing.

b. Wheat and nonwheat can be labeled with the aid of this acquisition and all other available information sources.

c. There is no excess of clouds, haze, and snow on the imagery.

d. There are no technical problems with the imagery.

If an initial estimate has already been derived using the small field procedure and the packet is assigned with new acquisitions, the segment must be processed for an estimate using at least one of the current processable acquisitions. If none of the current acquisitions are processable, there is no need to submit an updated estimate.

Another significant change from current procedure emphasizes that a machine estimate is derived using multitemporal processing unless conditions prohibit the use of more than one acquisition of data (i.e., only one date is available; clouds, haze, and snow on the image; misregistration or other technical problems). If consecutive acquisition dates are the only processable acquisitions available, they need not be processed multitemporally. The analyst should keep in mind when selecting acquisitions for processing that the ultimate goal of processing for a new or current estimate is to give the "best" possible estimate to date. If new information (i.e., improved labeling logic) is gained even from a current unprocessable acquisition, the segment should be processed for an updated estimate, if possible, using available processable acquisitions and taking advantage of the new information. When multiple acquisitions are available, the analyst should use the guidelines as described in section 4.3, (Multiple Acquisition Image Screening) for proper selection of acquisitions for processing.

NOTE: A visual estimate or handcount is not submitted, except in the case where there is absolutely no (0 percent) potential small grains in the segment. Segments in which

wheat has reached greater than or equal to 3.0 on the Robertson scale model and have less than 50 pixels of potential wheat are passed to CAS as a 0-percent wheat estimate.

C.2 SUBCLASS STARTING VECTOR SELECTION

As the first step in machine processing, two-vertice line fields – four pixels from the left vertex to the right vertex – must be selected by the analyst to serve as starting vectors for clustering. This step in the small field procedure replaces training field selection in the LACIE traditional method, because it is the point where the analyst makes his input to the computer for purposes of labeling wheat and nonwheat.

NOTE: Before starting vectors are physically selected, the analyst's wheat and nonwheat decision logic must be approved, using current team procedures.

C.2.1 VECTOR SELECTION

The following guidelines should be used to select the vectors:

a. Delineate DO and DU areas.

b. Select one example of each spectral signature outside of DO or DU areas.

c. An "X" signature (unidentifiable) can be selected if it is impossible to designate all appropriate unidentifiable areas.

d. A maximum of 20 signatures may be selected.

e. A signature should be represented by a four-pixel, spectrally homogeneous line field.

f. No test fields are selected.

C.2.2 SUBCLASS VECTOR RECORDING

Subclass starting vectors are recorded and labeled using essentially the same procedures and format that are outlined for recording of training fields in the *CDAP Handbook*, unless specific exceptions are mentioned as follows.

a. Each individual example of a spectral signature should be placed in a unique subclass.

b. Designate only one class of nonwheat. (Place agriculture and nonagriculture in the same class but in a unique subclass.)

c. The subclass for each vector should agree with the field number. This expedites the procedure (i.e., W01-B1, N02-A2, W03-B3).

As an option to the current method for recording fields, the following procedures can be used to record the starting vectors. This method has proven to be faster for some analysts to record four-pixel starting vectors. If the current method is not used by the analyst, the steps for this alternate procedure are as follows:

a. To expedite the process, coordinates for the vectors should be extracted from the imagery and recorded on paper by the analyst before going to the H. Dell Foster Digitizer.

b. Make sure X and Y coordinates of the H. Dell Foster Digitizer are in the proper format for use as described in the *CDAP Handbook*. It is not necessary to tape and register the imagery to the grid lines on the cursor of the H. Dell Foster Digitizer.

c. Manipulate the cursor of the H. Dell Foster Digitizer until the manually derived coordinates of the field being recorded are displayed, then record. (The Dell Foster is used strictly

as a quick means for keypunching the required Dell Foster deck (DEAF) card deck for Laboratory for Applications of Remote Sensing (LARS) reformatting.)

C.3 BATCH SUBMITTAL

The LARS final product (FLAP) deck generation and BATCH job submittal are the same for the small field procedure as those described in the *CDAP Handbook* for the LACIE traditional method except that one additional card must be added to the deck in order to initiate the clustering and automatic labeling technique. Individual teams have the cluster card keypunched and filed for 32 possible variations of the parameters. The batch cluster card has the following format with the asterisks being the variable parameters.

Standard Format (identical keywords used for all segments)

Standard Format (parameters dependent upon segment processing characteristics)

```
ITER = AUTO (/RSEG/,-        /DF=* ,/W,N,**/,/DODU/,/***/)
                                        If They Exist
```

*Fixed Set of Default Cluster Parameters	**Should be used only if "X" category is used in the segment	***Thresholded Distance Value
*2- 4 ch	**X-if unidentifiable training category used in classification	***TBD- 4 ch
4- 8 ch		TBD- 8 ch
6-12 ch		TBD-12 ch
8-16 ch		TBD-16 ch

***Note: If this parameter is not determined prior to implementation of this procedure, the parameter is defaulted and no conditional cluster map is generated. In event of this case, the analyst should use the unconditional cluster map to verify the automatic cluster labels.

The analyst is responsible for selection of the appropriate card from the team files that correspond to the classification run submitted. The analyst's last name, the segment number classified, and the team name must be written across the front of the card. Place this card in front of the card protector on the FLAP deck.

C.4 CLASSIFICATION PRODUCTS

Classification products are the same, with the addition of the following products, which are automatically generated in BATCH.

a. Unconditional Cluster Map – Assigns each cluster generated a unique color. Exclusion areas (DO, DU) are black.

b. Conditional Cluster Map – Assigns the color green to clusters which are closer to a wheat match than the threshold distance; assigns the color green to clusters closer to nonwheat match than the threshold distance; and assigns each cluster whose distance is greater than the threshold distance a unique color. Exclusion areas are black.

c. Cluster Statistics – Statistics are generated for each cluster.

d. Cluster Labels – Each cluster generated is labeled automatically (wheat and nonwheat) based on the distance from the cluster center to the closest starting vector.

C.5 SMALL FIELDS EVALUATION CRITERIA

C.5.1 ACCEPTABLE RATING

The criteria that a classified segment must fulfill to obtain a rating of acceptable are given on the next page. All of the following must be satisfied.

a. The classification map should show definite correlation to the original imagery. (Those areas felt to be wheat on the imagery are classified as wheat, and those areas felt to be nonwheat on the imagery are classified as nonwheat.)

b. No more than two clusters used for classification are automatically mislabeled (wheat and nonwheat).

c. The mislabeled cluster used for classification is insignificant. (A cluster is insignificant if the size of the cluster is less than 500 pixels.)

d. The percentage thresholded for the entire segment should not exceed 3 percent and should consist mainly of nonagricultural areas.

e. If statistics from any significantly large cluster ($\geq$2000 pixels) are such that at least 30 percent of the cluster (600 pixels) is indicated to be a category other than that of the automatic label (defined as a mixed cluster), it should not be used for classification purposes.

f. All classes of starting vectors should have 80 percent accuracy by category.

C.5.2 UNACCEPTABLE RATING

If a segment does not meet the criteria to be acceptable, it is given an unacceptable rating.

C.5.3 BIAS CORRECTION

To improve the estimate achieved by the above procedure and simultaneously reduce the amount of machine rework required, a bias correction was derived. This correction is computed for every machine estimate. If a segment is felt to be unacceptable based on the above evaluation criteria, the segment should be reworked interactively based on rework guidelines outlined in the following section. The bias correction is computed both before and after

rework. In order to perform the bias correction, approximately 100 pixels, located according to a fixed random grid sequence, are labeled wheat (W) or nonwheat (0). These pixels are referred to as type 2 dots or bias correction vectors. The only type 2 dots that are not labeled are those falling in DO and DU areas. Those falling on "suspect" or "border" pixels must be labeled wheat or nonwheat. If the segment is being processed using more than one acquisition of data, one date must be chosen as a reference for labeling. (This accounts for a type 2 dot that might be misregistered between two or more acquisitions.) The labels of the pixels should be entered, prior to classification, on the form shown in figure C-2. In this form, the upper left-hand corner is reserved for the analyst label and the lower right-hand corner is reserved for the computer label. The acquisition used as a reference for labeling (if applicable) should be circled.

Type 2 dots that are thresholded from the classification should not be used in the computation of the bias correction. The bias correction utilizes the type 2 dots to estimate the percentage of correct classification for each category and adjusts the estimate accordingly. Currently, this calculation must be done manually. The bias correction is as follows.

$$P_w = \frac{m_1}{n_1}\left(\frac{N_1}{\text{base}} \times 100\right) + \left(1 - \frac{m_2}{n_2}\right)\left(\frac{N_2}{\text{base}} \times 100\right)$$

where

m_1 = wheat type 2 dots that were classified wheat

n_1 = all type 2 dots that were classified wheat

N_1 = all pixels classified wheat

base = 22 932 - DU - X - threshold

m_2 = nonwheat type 2 dots classified as nonwheat

n_2 = all type 2 dots classified nonwheat

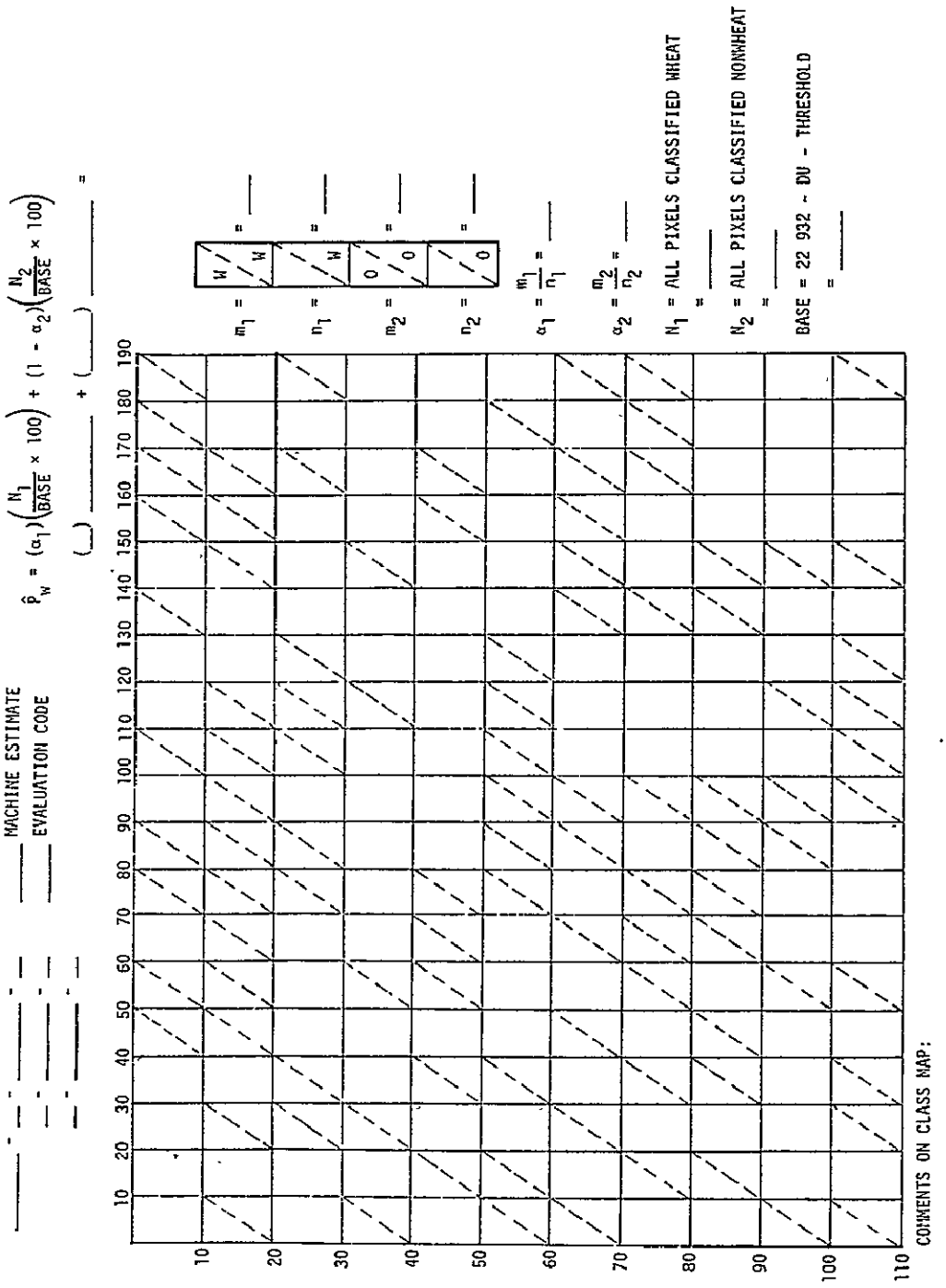


Figure C-2.— Pixel label form. (Enter prior to classification.)

N_2 = all pixels classified nonwheat

$\frac{m_1}{n_1}$ = referred to as α_1 and estimates the percentage of correct classification for wheat

$\frac{m_2}{n_2}$ = referred to as α_2 and estimates the percentage of correct classification for nonwheat

Assuming correct analyst labeling, this correction should converge to zero bias for large n_1 and n_2 and correct classification bias. In addition, it is used with interactive rework methods in small fields processing for purposes of comparing results of the two methods in order to assess the performance of each; and also, it serves the purpose of familiarizing operational analysts with a concept to be used operationally in the future. The following criteria should be used to evaluate the bias corrected estimate. The bias corrected estimate is acceptable if:

a. $0.6 < \alpha_1 < 1$ and $0.9 < \alpha_2 < 1$
   $< \alpha_1 < 1$ and $0.6 < \alpha_2 < 1$
   $< \alpha_1 < 1$ and $0.8 < \alpha_2 < 1$

b. The classification map shows some correlation to the original imagery

If the above criteria are not satisfied, the corrected estimate is unacceptable.

C.6 REWORK GUIDELINES

The classification map, cluster map, conditional cluster map, cluster labels, and cluster statistics should be used as analytical tools for rework. The cluster labels, cluster statistics, and cluster distance information are located on the CAMS report. Reworks are scheduled through the designated ERIPS operators for the week. Instructions for each rework should be documented

and submitted to a scheduled operator for processing. The classification products may be used in the following manner for diagnostic purposes:

a. Conditional Cluster Map – Study the "suspect" clusters, the clusters which are given unique colors. Because the distances are far away from a match, these clusters have a high probability of being mislabeled. Also, they could be indicators for placement of additional starting vectors.

b. Cluster Labels – Verify all cluster labels. Ensure that all clusters are determined to be wheat or nonwheat correctly by the computer. If not, the segment should be reworked interactively to override the computer labeling.

c. Mixed Cluster – If, as in section C.3, a significantly large cluster is mixed (wheat/nonwheat), the statistics for the clusters should not be used for classification. Multitemporal processing or strategic placement of DO areas might help to differentiate pixels within this cluster.

d. Cluster Statistics – These statistics are used in small field processing in the same manner that subclass statistics are used as described in the *CAMS Detailed Analysis Procedures*.

e. Classification Map – Use spatial information to determine the amount as well as area of misclassification error (if any).

APPENDIX D

GLOSSARY

APPENDIX D

GLOSSARY

Al Keys (Wheat Identification Aid) – a crop identification manual that provides a comparison of different crops and their corresponding signatures on the Landsat color composites (refs. 4 and 5).

Analyst Team – two to five analysts who do all automatic, interpretive, and evaluative processing of a sample segment. A Regional Analyst is also a member of the team on a consulting basis.

Biological Stage – an external morphological growth development, usually measured on a scale from 1 to 9.

Biophase – biostage.

Biowindow – the dates, according to the nominal crop calendar, between which a particular growth stage is expected. Currently, the growing season is divided into four biowindows as defined by the *CAMS Requirements Document* (ref. 8).

Character Map – an alphanumeric representation of the assignment of pixels by the classification algorithm or the clustering algorithm.

Classification Acquisitions – those acquisitions for which training fields are selected and/or are processed through the automatic system.

Classification Map – a black and white film product which reflects the spatial relationship of the pixels of wheat/nonwheat/unidentifiable/threshold as assigned by the classification algorithm.

Classification Summary – a detailed report reflecting the performance of each field defined. For each field, the number of pixels classified into and thresholded from each category, class, and subclass is listed. For the entire segment, the number of pixels is altered to account for exclusion areas. A classification accuracy for each field is given on the subclass level and for the entire segment at the category level.

Classifier – the algorithm by which a pixel on a LACIE sample segment is assigned to a subclass, class, and category. The term may also be used to describe the entire automatic data processing system.

Class Match – the subclass to which cluster statistics are closest based on a statistical distance measurement.

Cluster Map – a color film product which shows the spatial representation of the assignment of pixels to clusters based on the iterative clustering algorithm.

Color IR – Simulated false color image produced from channels 1, 2, and 4. (Also known as product 1.)

Confusion – a nonwheat signature on which one acquisition appears the same as one of the wheat signatures in the scene.

Crop Calendar – a calendar depicting the period of the growth-development of biological stages of the major crop types within

a specified region during a calendar year. The seedbed preparation, planting, and harvest are included on the calendar.

Crop Calendar Adjustment – identifying the correct phenological stage of wheat band on the Robertson model. The model predicts the growth stage from the maximum and minimum daily temperature and this is translated into plus or minus days from the nominal crop calendar.

Data Quality – physical or technical characteristics of the imagery.

Designated Other – an area which is determined to be nonwheat but is spectrally similar to wheat.

Designated Unidentifiable – an area which has been obscured by natural phenomena such as clouds, haze, or snow.

Interpretable Image – an acquisition which is free of technical and physical difficulties so that a judgment can be made on the processability of that acquisition.

Landsat Data Set – the film products produced on a particular acquisition of a sample segment for the purpose of identifying wheat.

Positive-Negative Imagery – a multiband color composite image produced by adding together positively and negatively polarized bands. (Also known as product 2.)

Primary Overlay – the overlay keyed to the CIR imagery; contains the final field boundary delineations.

Process – to estimate and forward to CAS the percentage wheat on a given acquisition of a sample segment.

Processable – an acquisition which has been determined to contain information which would enhance the wheat estimate for that sample segment.

Product 1 – a simulated CIR composite using bands 4, 5, and 7.

Product 2 – an enhanced image using bands 5, 6, and 7.

Review Image – Landsat acquisitions that are interpreted for potential value as classification acquisitions.

Screening Imagery – Landsat data set.

Test Film – product used for a weekly quality assurance check on the PFC imagery.

APPENDIX E

REFERENCES

APPENDIX E

REFERENCES

1. Abotteen, K.; and Sumner, C.: Procedural Design Test. Lockheed Electronics Company, Inc., LEC-10016, May 1977.

2. Union of Soviet Socialist Republics Listing from Segment to Foot Prints. Caspan Co., Houston, Texas, LACIE-T0090.

3. Weekly Meteorological Summary of the United States. NOAA, USDA, NASA, internal memorandum with limited distribution to LACIE personnel.

4. Analyst Interpretation Keys: Wheat/Small Grains Inventories. NASA, vol. 1, JSC-12555.

5. Analyst Interpretation Keys: United States and Canadian Great Plains Regional Keys. NASA, vol. 2, parts 1 and 2, JSC-12556.

6. Kraus, Gary L.: Description of the Kraus Product Imagery Technique. To be published.

7. Havens, K.: Evaluation of the Procedure 1 Pass Selection Technique. Lockheed Electronics Company, Inc., LEC-10533, June 1977.

8. CAMS Requirements Document. LACIE-C0020 (JSC-11330), vol. II, rev. C, Jan. 1977.

☆ U.S. GOVERNMENT PRINTING OFFICE 1978—771-083/8 28