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LARGE AREA CROP INVENTORY EXPERIMENT

CROP ASSESSMENT SUBSYSTEM

SOFTWARE REQUIREMENTS DOCUMENT

Contract NAS 9-1261

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Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

Approved by:

C. R. Davis
Facilities Support Office

D. H. Hay, Chief
Facilities Support Office

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Prepared by

AERONUTRONIC FORD CORPORATION
AEROSPACE AND COMMUNICATIONS OPERATIONS
SPACE INFORMATION SYSTEMS OPERATION
1002 GEMINI AVENUE
HOUSTON, TEXAS

FOREWORD

This document has been prepared jointly by the Facilities Support Office of the Earth Observations Division, Lyndon B. Johnson Space Center (JSC), Houston, Texas, and by the Computer Science Department of the Space Information Systems Operation (SISO), Aeronutronic Ford Corporation. It was published by SISO in accordance with EO-004N, Crop Assessment Subsystem (CAS) data system, of Contract NAS 9-1261, Schedule V.

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ACRONYMS AND ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
CAMS	Classification and Mensuration Subsystem
CAS	Crop Assessment Subsystem
CRT	Cathode Ray Tube
DAPTS	Data Acquisition, Preprocessing and Transmission Subsystem
DB	Data Base
DEC	Digital Equipment Corporation
DTL	Data Techniques Lab
EBCDIC	Extended Binary Coded Decimal Interchange Code
EOF	End Of File
IBM	International Business Machines Corporation
ICS	Interface Control Specifications
JSC	Lyndon B. Johnson Space Center
LACIE	Large Area Crop Inventory Experiment
LEOT	Logical End Of Tape
MCR	Monitor Control Routine
NASA	National Aeronautics and Space Administration
PIP	Peripheral Interchange Program
PIXEL	Picture Element
PPS	Probability-Proportional-To-Size

ACRONYMS AND ABBREVIATIONS (CONT'D)

RSX-11D	A Multiprogramming Operating System for the DEC PDP 11/45 Computer System
SISO	Space Information Systems Operation
UIC	User Identification Code
WMO	Worldwide Meteorlogical Organization
YES	Yield Estimation Subsystem

SECTION 1
INTRODUCTION

SECTION 1

INTRODUCTION

1.1 PURPOSE

This document describes the functional data processing requirements for the Crop Assessment Subsystem (CAS) of the Large Area Crop Inventory Experiment (LACIE). These requirements shall be used as a guide for software development and implementation. The software implementation plan will be described in a detailed design document to be published at a later date.

1.2 SCOPE

This document is limited in scope to requirements pertaining to the production processing software of the CAS. In general, these requirements include the following:

- Command input processing
- Processing and storage of data from external sources
- Wheat area, yield, and production estimation
- Computation of standard statistics associated with the crop estimates to assess the reliability of the estimates
- Aggregation of crop estimates to the various hierarchical elements of the active LACIE countries
- Generation of aggregation reports.

Paragraph 1.4 of this document presents a brief overview of the CAS software system components.

Section 2 describes the CAS/analyst interactions and defines the support software routines. Section 3 details the CAS applications software; Section 4 provides CAS data base requirements; and Section 5 describes Classification and Mensuration Subsystem (CAMS) processing.

1.3 APPLICABLE DOCUMENTS

The following document has been used for support data in the preparation of these requirements. It may be referenced by the reader for obtaining additional information in specific areas of interest.

Large Area Crop Inventory Experiment (LACIE) Level III Baseline Crop Assessment Subsystem (CAS) Requirements, LACIE-00200, Vol. IV, 16 December 1974.

1.4 SYSTEM OVERVIEW

The CAS software system shall be implemented in the multi-user environment provided by the Digital Equipment Corporation (DEC) RSX-11D Operating System on the PDP 11/45 Computer System in the DTL. The software may be exercised in both a batch mode and an interactive mode of operation. Each user of the CAS software will operate from either the master data files for a country or a working copy of the data files for that country on a non-interference basis. Access to the CAS software and its data files shall be restricted to authorized personnel via the standard RSX-11D user identification code (UIC) and password security features.

The CAS master data base is made up of multiple data files, one for each type of data for each active LACIE country for each crop year. The four data types are: 1) allocation data, 2) classification results, 3) wheat yield data, and 4) historical agricultural data. Each data type corresponds to an external data source. The allocation data shall be utilized to define the logical structure of the remaining data files and may not be updated on a casual basis. The remaining data files shall be routinely updated by data base initialization/preprocessing software as new data becomes available. Only the classification results data shall be preprocessed to yield an intermediate product.

Each application program within CAS is designed to operate on the data files for a single country. Thus, each CAS user must establish his definition of data files with respect to a single country and whether the master data files or a working copy of the data files are to be utilized. The data base management software shall then provide the means for the applications programs to retrieve, update, and store data.

The user may select to execute one of the following processors:

- Area/yield/production estimation/aggregation
- Report generator
- Data base change programs.

Control inputs shall be accepted, validated, and processed by either the interactive input command processor or by the batch input processor. After control is passed to the selected processor and processing is completed, output shall be generated via the display processor, a subset of the report generator. The relationship between the various software components of the CAS is illustrated in figure 1-1.

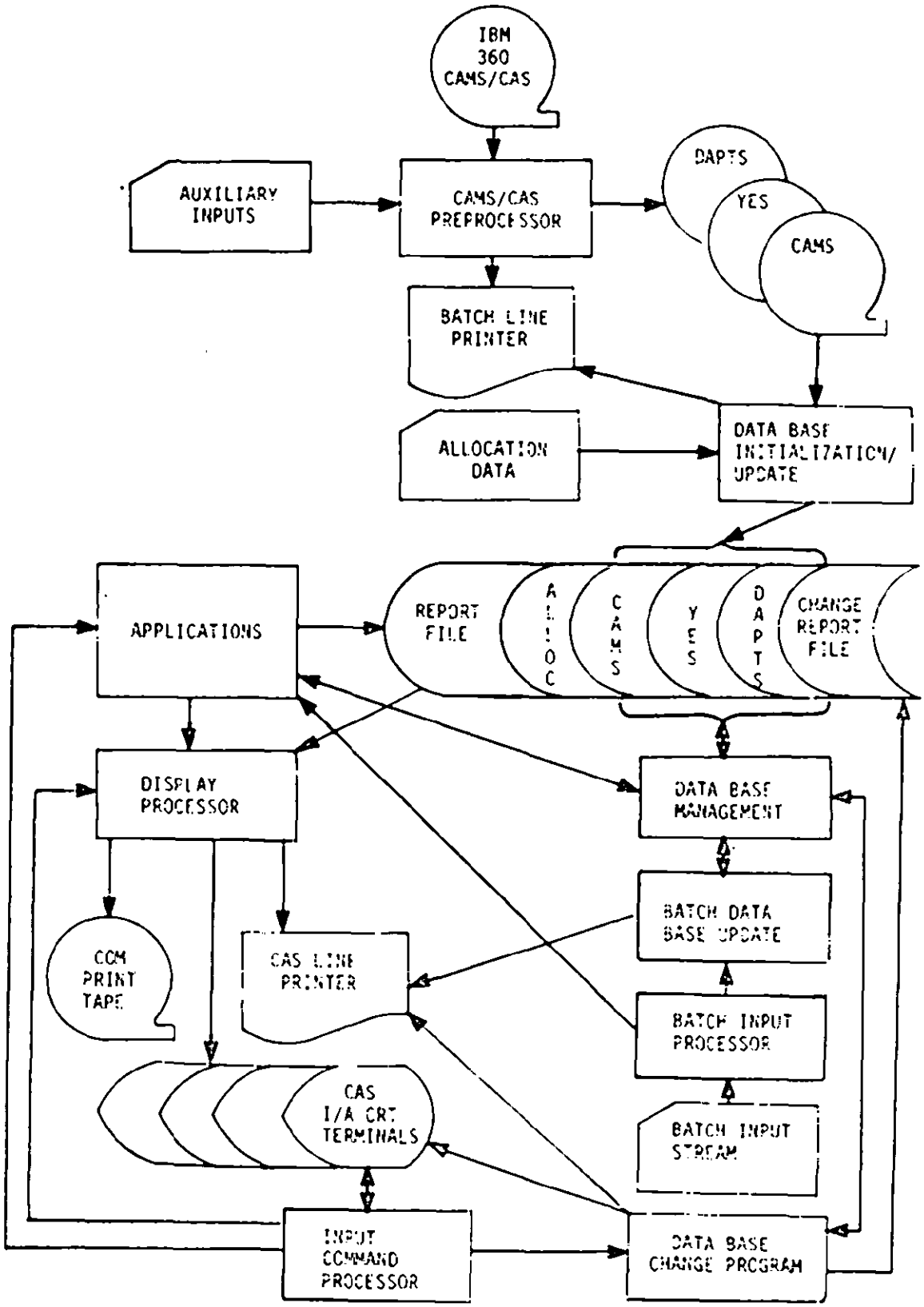

Figure 1-1 CAS Functional Data Flow

1.5 REVISIONS

Because this is a controlled requirements document, any required changes shall be submitted to the chairman of the Facilities Change Control Panel for review and approval.

SECTION 2
CAS SYSTEMS
SOFTWARE

SECTION 2

CAS SYSTEM SOFTWARE

2.1 GENERAL

The CAS system software shall comprise three major areas: interactive terminal software, system utilities, and support software. The interactive terminal software shall provide the interface between the analyst and the application program. The system utilities shall be provided to assist in the implementation of the CAS software system. The support software shall be provided as a library of routines in support of the application program.

2.2 INTERACTIVE TERMINAL SOFTWARE

The CAS interactive terminal software shall provide for terminal initialization, input query operations with the operator, and CAS report generation and display. Interactive software shall also provide operator interface to the Data Base Change Program.

2.2.1 CAS Input Processor. The CAS input processor shall initialize the terminal cathode ray tube (CRT) and process analyst input commands. The CAS input processor thus provides the interface between the analyst and CAS application programs.

2.2.1.1 Initialization. CAS terminal initialization shall be performed by the RSX Operating System. To initialize a CAS terminal, the analyst shall strike the control C key on the CRT terminal. This will activate the Monitor Control Routine (MCR) which shall display a prompter. The analyst shall now "sign-on" to the system by entering the HELLO command and a CAS UIC number. CAS files shall be protected and may be accessed only by use of the CAS UIC. The system shall now request that a password be entered, but the password shall not be echoed back to the CRT screen. The system shall validate the password. If the code is illegal, an error message shall be displayed and another request made for the password. If the password is accepted, the analyst shall be logged on to the system and may run any interactive CAS programs as well as other system programs.

2.2.1.2 Input Command Processor. To initialize or activate the CAS software system, the CAS analyst shall type CAS after the MCR prompter. This shall cause the CAS input command processor to be loaded into memory. The command processor is now ready to accept input commands from the analyst. A command menu (list) shall be displayed for the analyst to select the desired function by typing the appropriate three letter command name.

After the command is selected, the input command processor shall begin to request processing parameters by question and answer interaction with the analyst. The input command processor shall output a message to the analyst requesting a particular input parameter. A list of the appropriate input options may also be displayed for the analyst. The analyst shall transmit the input parameter back to the computer by typing the parameter on the next line. The input command processor shall validate the input and either display an error message or continue to the next parameter request. After all parameters are collected and validated, a run request shall be made to the selected application program. The input processing parameters shall be transmitted to the called program. Appendix A discusses a typical operator/CRT interaction.

Upon completion of the application function, control shall be passed to the display processor (see paragraph 2.2.2) to output the results of the application program. The input command processor shall once again receive control upon termination of display processor output. At this time the analyst may request additional processing or exit back to the operating system.

2.2.1.3 Termination. After the display processor has completed output of all requested reports, control is returned to the input command processor where the function or command menu is displayed. One of the commands available to the operator shall be an exit command; e.g., to terminate the CAS system, the operator shall type the three letter command EXT for exit. This shall return control to the RSX Operating System. At this point, the operator signs-off the terminal by typing the command BYE which completes the termination procedure. The only valid input command at this time is the HELLO command which is the first step of initialization (see paragraph 2.2.1.1).

2.2.2 Display Processor. The display processor shall standardize the techniques for generating a CAS report. The display processor is a user-oriented service program which shall generate a display based on input parameters supplied by the user. Multiple output devices shall be supported by the display processor; i.e., the reports may be displayed not only on the analyst's CRT terminal, but also may be output to the line printer and/or magnetic tape. The output devices to be used may be in any combination and shall be required input parameters to the display processor.

2.2.2.1 Modes of Operation. The display processor shall operate in either automatic or manual mode. In the automatic mode, only the line printer and/or magnetic tapes shall be utilized. Once started, the display processor shall output the requested report(s) to the appropriate device(s) without analyst intervention.

The manual mode is implied when the CRT is requested as an output device for the CAS reports. In the manual mode, the summary report shall be output to the CRT terminal and any other devices requested. The display processor then waits for the analyst to enter a command. At this point the analyst shall be able to request the next sequential report, to request a different report, or to exit the display processor (see paragraph 2.2.2.3). An exit request shall return control to the input command processor, which once again displays the input command menu.

2.2.2.2 Input Parameters. The CAS application programs shall exit, after storing all generated report data on disk, by scheduling the display processor. Two input parameters may be transmitted to the display processor at this time. The first parameter shall be the output device or devices. Valid output devices for CAS reports shall be the CRT terminal, line printer, magnetic tape, or any combination of these. The second parameter shall be an additional reports indicator and shall only be valid with the line printer and magnetic tape devices. This parameter shall also indicate that all individual reports are to be output in addition to the summary report which is automatic. This parameter shall not apply if the CRT output device has been selected, as the operator has the opportunity to request individual reports after the summary report has been displayed.

2.2.2.3 Display Commands. If the analyst selected the CRT terminal as an output device for the CAS reports, the display processor shall wait for an analyst response after output of the summary report. The analyst may respond with any valid display processor command. The three basic command functions are discussed in the following paragraphs.

A. Report Retrieval. To retrieve a CAS report, the analyst shall input one of the report retrieval commands. Each command shall be composed of a 3-letter command code and a report key number. The first letter (A, Y, or P) of the command code shall indicate whether the requested report is an area, yield, or production report. The next two letters shall indicate the report level to be retrieved. The following options shall be available:

- Summary
- Region
- Zone
- Strata
- Substrata.

The report key number is a 4-digit integer indicating the hierarchy element number. Each report contains the key numbers of hierarchy elements of the immediate lower level which were used to produce the report. (For explanation of CAS reports and report contents, see paragraph 3.5.)

B. Exit. To exit from the display processor, the analyst shall input the exit command (EXT). This command does not require any additional input parameters. The exit causes return to the CAS input command software.

C. Device Change. The device change command (DEV) shall allow the analyst to select a new device or combination of devices to be used for output of CAS reports. The analyst inputs the command DEV along with the device mnemonics. All subsequent requested reports shall be output to the new device(s).

2.2.3 Data Base Change Interactive Software. The data base change interactive software shall provide the interface between the operator and the Data Base Change Program. The interactive software shall accept input commands and display the results of the processed command.

2.2.3.1 Initialization. The data base change interactive software shall initialize the CRT terminal by displaying a request to enter a command. Retrieval and exit shall be the only valid commands at this time.

2.2.3.2 Data Base Change Command Processor. The data base change command processor shall accept command inputs from the analyst. The commands and any parameters shall be validated and the information passed to the Data Base Change Program for processing. If an invalid input is detected, an appropriate error message shall be output along with a request to re-enter the command.

An input command prompter shall be used to request an input from the analyst. The prompter shall display the valid input commands and the command codes. Command codes (see paragraph 2.2.3.3) shall be unique alpha characters.

2.2.3.3 Input Commands. The command processor shall accept five commands from the analyst. The following is a discussion of each of these commands.

A. Retrieval (RET). The retrieval command shall be used to retrieve requested data base information. This information shall be formatted and displayed on the analyst CRT terminal. Retrieval of the data base information is a prerequisite to performing a data base change. The retrieval command shall be a valid input at any time. Following input of the RET command, the command processor shall request input of parameters specifying the exact data base information being requested (see paragraph 4.4).

B. Change (CHA). The change command shall be used to input data base change information. The CHA command shall be a valid input following the RET command. The change information shall be displayed along with the information it is to replace. CHA does not cause the CAS data base to be updated; the actual change of the data base is accomplished by the store command.

C. Store (STR). The store command shall be used to write the change information to the CAS data base. The STR command initiates the update causing all change information to be written to the CAS data base. The command may be entered following a CHA command. After the command is entered, the command processor shall request store information from the analyst. This information shall include the reason for the change and the name of the analyst.

D. Exit (EXT). The exit command shall be used to exit the Data Base Change Program. Control shall be returned to the CAS input command software for subsequent display of the CAS command menu.

E. Page (PAG). The page command shall be used to request the next page of a multipage display. This command shall be valid following the RET command. No additional parameters shall be required. Additional inputs of the PAG command shall cause subsequent pages of the display to be output.

F. Back Page (BPG). The back page command shall allow the analyst to request the previous page of multipage display. This command shall be valid following the PAG command, and no additional parameters shall be required.

2.3 SYSTEM UTILITIES

The following system utilities shall be converted to augment those utilities provided by the RSX-11D Operating System.

2.3.1 Nonstandard Magnetic Tape Copy. This program shall copy an 800/1600 bpi, 9-track magnetic tape from one tape drive to another. The user shall specify the input and output tape drives. Optional parameters may be input to position the tape by file and record. The processing shall start by reading a block and checking for errors. If an error is detected, an appropriate message shall be printed with the block number and block size. Whether an error was detected or not, the record shall be written to the output magnetic tape. If an end of file (EOF) is detected, a message shall be written to the line printer, and an EOF written on the output tape. A check shall be made for three consecutive EOF's. When detected, a message shall be written to the line printer and processing terminated.

2.3.2 Nonstandard Magnetic Tape Dump. This program shall dump a 800/1600 bpi, 9-track magnetic tape to the line printer in octal, hexadecimal, and ASCII. Parameters may be input to position the tape by file and record. The processing for a block shall start by reading a record and checking for errors. If an error is detected, an appropriate message shall be printed. In any case, processing continues by printing the block number and size. This shall be followed by a check for EOF. Unless the block is an EOF mark, the contents of the record shall be dumped on the line printer. If the record is an EOF mark, an EOF message shall be printed and a check made for three consecutive EOF's indicating logical end of tape (LEOT). IF LEOT is not detected, the next block shall be processed. If LEOT is detected, a message shall be printed and processing terminated.

2.3.3 Tape Merge. This program shall merge a single file of a 800/1600 bpi, 9-track tape to a common merge tape. The merge program shall write the single file at the end of the merge tape and write three EOF's after the file. Error conditions shall be checked after each read and write. If an error occurs, an error message shall be printed and three EOF's written on the output tape and processing terminated. A summary message indicating total number of files on the merge tape shall be output at termination.

2.4 SUPPORT SOFTWARE

The following support software routines shall be provided.

2.4.1 Byte Swapping (BSWAP). BSWAP shall be provided to allow swapping the position of the bytes in words in an array. The address of the array in which the bytes will be swapped and the word length of the array shall be passed to BSWAP in the calling sequence. BSWAP shall swap the bytes in each word in the array, beginning with the first word in the input. The byte-swapped words shall be stored in an output array whose address is passed to BSWAP.

2.4.2 Byte Array Move from Packed Array (BMOV). BMOV is an assembly language routine which shall be provided to unpack data from one array (two bytes per word) into another array (one byte per word). The destination array must be dimensioned twice the source array. The high order byte of each word in the destination array shall be cleared. The number of bytes to be unpacked shall be an even number.

2.4.3 Byte Array Move from Unpacked Array (WMOV). WMOV is an assembly language routine which shall be provided to pack data from one array (one byte per word) into another array (two bytes per word). The number of bytes to be packed shall be an even number. The dimension of the source array must be twice that of the destination array.

2.4.4 Array Move (AMOV). AMOV is an assembly language routine which shall be provided to facilitate the moving of blocks of data very rapidly. The input parameters to AMOV shall be the source array, the destination array, and the number of words to be moved.

2.4.5 Zeros Array (ZERO). ZERO is an assembly language routine which shall be provided to zero an array. The routine shall accept a starting address and a count N. ZERO shall set to zero the N 16-bit words beginning at the starting address. To clear a real array, N must be twice the number of real values to be cleared.

2.4.6 Bit Extraction (IFLD). IFLD shall extract the desired bit string given the starting bit number, the number of bits to extract, and the 16-bit word to be accessed. The bits shall be numbered 0 through 15, counting left to right. The function result shall be returned right-justified, and remaining bits set to 0.

2.4.7 Bit Insertion (ISET). ISET shall be used to set bit strings into a 16-bit word. The user shall be required to pass the starting bit number and the number of bits to set in a given word. ISET shall be a function subroutine and shall not alter the contents of the calling arguments.

2.4.8 Julian Calendar Date Conversion (JDATE). JDATE shall provide data conversion which gives the user three options of conversion. These options are:

- Input a Julian date and output the Gregorian date and the Julian day of the year
- Input a Gregorian date and output the Julian date and the Julian day of the year
- Input the Julian day of the year and the Gregorian year and output the Julian date and the Gregorian month and day.

2.4.9 Formatted Tape Dump. Tape dumps shall be provided to dump the following tapes:

- Classification and Mensuration Subsystem (CAMS)/CAS interface tape
- CAMS input tape
- Yield Estimation Subsystem (YES) input tape
- Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS) input tape.

The user shall have the capability to select specific records and/or files on the input tape.

2.4.10 Matrix Multiplication (MATMUL). MATMUL shall provide the capability to multiply an array whose dimension is defined on input times another variably dimensioned matrix or vector. The routine shall compute any one of the following, depending on an option indicator:

- MATRIX * VECTOR
- MATRIX TRANSPOSE * VECTOR
- MATRIX * MATRIX
- MATRIX TRANSPOSE * MATRIX
- MATRIX * MATRIX TRANSPOSE
- MATRIX TRANSPOSE * MATRIX TRANSPOSE.

Inputs to MATMUL shall be:

- Input MATRICES (2) or MATRIX and VECTOR
- Output MATRIX or vector location
- Option code indicator.

2.4.11 Statistical Error Function (ERF). ERF is a routine which shall be provided to approximate the statistical error function that is mathematically defined as:

$$\mathrm{erf}\ (x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-z^2}\, dz$$

2.4.12 Matrix Inversion (MATINV). MATINV is a routine which shall be provided to determine the inverse of an N×N matrix M for $N \leq 50$. The inverse matrix, M^{-1}, is defined such that

$$M\, M^{-1} = I$$

where I = the identity matrix

$$\begin{matrix} 1 & 0 & 0 & . & . & 0 \\ 0 & 1 & 0 & . & . & 0 \\ 0 & 0 & 1 & . & . & 0 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & 0 & 0 & . & . & 1 \end{matrix}$$

2.4.13 Conversions (A2EBCD/EBCD2A). A2EBCD and EBCD2A are conversion routines which shall provide conversion from ASCII code to EBCDIC code and vice versa. The routines shall have the following calling parameters:

- Input array to be converted
- Output array that has been converted
- Number of characters to be converted (INPUT and OUTPUT)
- Status of the conversion (error detection).

2.4.14 Metric/USA Conversion. Metric/USA units conversion shall be accomplished by multiplication with standard conversion constants. The following is a list of the conversion constants.

1 Acre	= 0.40468564 Hectares
1 Hectare	= 2.4710538 Acres
1 Bushel (wheat)	= 0.02721552 Metric Tons
1 Metric Ton	= 36.743740 Bushels
1 Bushel/Acre	= 0.67251015 Quintals/Hectare
1 Quintal/Hectare	= 1.4869664 Bushels/Acre

SECTION 5
CAS APPLICATIONS SOFTWARE

SECTION 3

CAS APPLICATIONS SOFTWARE

3.1 GENERAL

The CAS applications software shall provide the capability for area, yield, and production estimates with standard statistics for spring and winter wheat for each stratum, zone, region, and country in the LACIE. Also, the applications software shall be capable of generating reports of area, yield, and production estimates and statistics. Units for all computed parameters shall be in the metric system of measurement.

The software shall support batch or interactive operations by the CAS analyst. The analyst shall have the capability to permanently redefine the correlation between the elements of the sampling strategy hierarchy for region membership only.

3.2 AREA ESTIMATION AND AGGREGATION

The area applications software shall calculate area estimates and standard statistics from the input data (paragraph 3.2.4). The area estimates and variances shall be aggregated to the level specified by the process specification parameters (paragraph 3.2.3.3). The area and statistical information shall be output (paragraph 3.2.5) as requested in standard report formats.

3.2.1 Area Estimates. Wheat area estimation shall be performed at each defined area level of each country. Separate estimates shall be performed for spring and winter wheat.

The lowest subdivision (base level) of a country shall be either strata or substrata in all cases. Each of the elements of the base level shall be classified into one of three possible groups:

- Group I - Stratified
- Group II - Probability-Proportional-to-Size (PPS)
- Group III - Ratio.

The PPS group shall exist only if the base level is the substrata level.

3.2.1.1 Stratified Substrata/Strata. Stratified area estimation shall be performed on a base level of substrata (or strata) elements. The wheat area estimate shall be calculated by the following equations:

$$A_{1jk} = (N_{jk}R_{jk}/M_{jk}) \sum_{i=1}^{M_{jk}} A_{jki} \qquad (1)$$

$$A_{1j} = \sum_{k=1}^{L1} A_{1jk} \qquad (2)$$

Where:

A_{1j} - Combined estimate of all Group I subelements (substrata or strata) in the jth strata

L1 = Number of Group I subelements for which classification data is available

A_{1jk} = Estimate of the kth Group I subelement (substrata or strata) in the jth strata

N_{jk} = Number of agricultural segments (after exclusion) in the kth subelement in the jth strata

M_{jk} = Number of sample segments for which classification data is available in the kth subelement in the jth strata

R_{jk} = Ratio of the true subelement area to the gross pseudo subelement (before exclusion) area

A_{jki} = Estimated wheat area in hectares for the ith sample segment in the kth subelement in the jth strata.

Any subelements for which no classification data is available shall be accounted for by the Group III estimator.

3.2.1.2 Probability-Proportional-to-Size (PPS) Substrata. PPS area estimates shall be computed for the group of elements within a strata that is designated as PPS elements. The wheat area estimate shall be calculated using the following equation:

$$A_{2j} = 1/M_{2j} \sum_{k=1}^{M_{2j}} R_{jk} \, (W_j/W_{jk}) \, A_{jk} \, N_{jk} \tag{3}$$

Where:

A_{jk} - A_{jki} since only one sample segment may be allocated to any PPS subelement

W_{jk} = Epoch year wheat area for the kth subelement in the PPS group of the jth stratum

$W_j = \sum_{k=1}^{L2} W_{jk}$

M_{2j} = Number of sample segments in the PPS group of elements for which classification data are available

L2 = Number of PPS substrata in jth strata

N_{jk}, A_{jki}, and R_{jk} are as previously defined.

3.2.1.3 Total Strata Area Estimate. The wheat area estimate of each strata shall be computed as the sum of the Group I, Group II, and Group III component estimates which comprise the strata. The Group III component shall not be individually computed, but shall be accounted for in the ratio estimation for the strata as presented in the paragraph 3.2.1.4.

$$A_j = A_{1j} + A_{2j} + A_{3j} \tag{4}$$

If the strata does not contain a Group III element, the sum of the Group I and Group II components shall define the strata estimate.

$$A_j = A_{1j} + A_{2j} \tag{5}$$

3.2.1.4 Ratio Substrata/Strata. The area estimate for each stratum containing a Group III element shall be selected from one or more candidate estimates according to a minimum variance logic. Each of the candidate estimates shall be computed from a common algorithm which employs different input data sets. An estimate shall be computed for each hierarchical level element that contains the Group III element and also contains one or more observations.

Thus if the jth stratum contains observations and a Group III substrata, belongs to the ith zone, mth region, and nth country, then four variance estimates shall be computed using the four hierarchical spaces that contain the jth strata.

$$V(A_j^n) = f\left[A_1^n, V(A_1^n), W_1^n, A_2^n, V(A_2^n), W_2^n, W_3^j\right]$$

$V(A_j^m)$, $V(A_j^i)$, and $V(A_j^j)$ are similarly defined over the m, i, and j spaces, respectively

Where:

$V(A_j^n)$ = Variance of the area estimate for the jth strata computed from data belonging to the space n

A_1^n = Area estimate of a Group I element belonging to space n

$V(A_1^n)$ = Variance of A_1^n

W_1^n = Historical wheat area data of A_1^n

A_2^n, $V(A_2^n)$, and W_2^n are similarly defined

W_3^j = Historical wheat area data for the Group III component of the jth strata.

Variance estimates at the zone, region, and country levels may also be computed from spaces of which they are elements.

$V(A_\ell^{\,n})$; $V(A_\ell^{\,m})$; $V(A_\ell^{\,\ell})$ ~ Zone level

$V(A_m^{\,n})$; $V(A_m^{\,m})$ ~ Region level

$V(A_n^{\,n})$ ~ Country level

These variances are not an output but shall be used to select the strata estimate space.

The strata estimate space (s) shall correspond to either the strata (j), the zone (ℓ), the region (m), or the country (n) as determined by the following logic:

If $V(A_\ell^{\,\ell}) > \Sigma_{j\epsilon\ell}\, V(A_j^{\,j})$, then $s \sim j$

If $V(A_m^{\,m}) > \Sigma_{\ell\epsilon m}\, V(A_\ell^{\,\ell})$, then $s \sim \ell$

If $V(A_n^{\,n}) > \Sigma_{m\epsilon n}\, V(A_m^{\,m})$, then $s \sim m$

Otherwise $s \sim n$

Once the strata estimate space (s) has been chosen, both the area estimate and the variance estimate can be established.

$$A_j = A_j^{\,s}$$

$$V(A_j) = V(A_j^{\,s})$$

Exact equations for the strata estimates are:

$$A_j = A_{1j} + A_{2j} + r_j^{\,s}(A_1^{\,s} + A_2^{\,s}) \qquad (6)$$

Where:

$r_j^s = \Sigma W_3^j / (\Sigma W_1^s + \Sigma W_2^s)$

W_1^s = Historical wheat area of a Group I element belonging to s for the epoch year data

W_2^s = Historical wheat area of a Group II element belonging to s for the epoch year data

W_3^j = Historical wheat area of a Group III element belonging to strata j for the epoch year data.

3.2.1.5 Selection Criteria for Classification Results. Classification results shall be rated on a scale of 0 to 15, with the higher numbers representing the best results. A threshold number can be specified, and the most recent classification results which are equal to or greater than this threshold value shall be used for area estimations. Other threshold criteria, as specified in paragraph 3.2.3.3, shall be evaluated in the selection process.

3.2.1.6 Dynamic Regrouping of Group III Substrata/Strata. Each stratified base level element and each PPS-element group shall be dynamically and temporarily redesignated as Group III elements if no classification data is available for that element. However, if at least one sample segment classification is available, then the area for that element shall be computed according to the nominal grouping of the element.

3.2.2 Standard Statistics. The standard statistics for area estimation and aggregation are composed of standard deviation (σ), coefficient of variation (CV), 90 percent confidence limits (CL), and probability of achieving 10 percent error or less (Ω). Each statistic is a function of variance (V) as follows:

$$\sigma_s = \sqrt{V_s} \tag{7}$$

Where s = Any area element

$$CV_s = \sigma_s / A_s \tag{8}$$

Where A_s = Area estimate of the sth element

$$CL_s^{(+)} = A_s + (1.645)\ \sigma_s$$

$$CL_s^{(-)} = A_s - (1.645)\ \sigma_s \tag{9}$$

$$\Omega_s = \text{erf}\ \left\{(1/\sqrt{2})[1/(10CV_s)]\right\} \tag{10}$$

Where:

erf $(\theta/\sqrt{2})$ = Error function associated with normal probability curve

θ = Standardized random variable

3.2.2.1 Stratified Area Estimate Variance. The variance of wheat area for stratified (Group I) estimates is given by:

$$\text{Var}(A_{1j}) = V_{1j} = \sum_{k=1}^{L1} (1-f_{jk})\ R_{jk}^{\ 2}\ (N_{jk}^{\ 2}/M_{jk})\ S_{jk}^{\ 2} \tag{11}$$

Where:

L1 = Number of Group I elements for which classification data is available in the jth strata

$f_{jk} = M_{jk}/N_{jk}$

R_{jk} = Ratio of the true element area to the gross pseudo element (before exclusion) area for the kth element of the jth strata

N_{jk} = Number of agricultural segments (after exclusion) in the kth element of the jth strata

M_{jk} = Number of sample segments for which classification data is available in the kth element of the jth strata

$$S_{jk}^2 = \begin{cases} 1/M_{jk} \sum_{i=1}^{M_{jk}} \sigma_{jki}^2 & \text{if } SC_1^n = 0 \\ \text{or} & \\ 1/(M_{jk}-1) \sum_{i=1}^{M_{jk}} (A_{jki}-\bar{A}_{jk})^2 & \text{if } SC_1^n \neq 0 \end{cases} \tag{12}$$

If $S_{jk}^2 > C_1^2/4$, then $S_{jk}^2 = C_1^2/4$.

C_1 = Number of hectares per sample segment

A_{jki} = Estimated wheat area (in hectares) for the i*th* sample segment, k*th* element of the j*th* strata

$\bar{A}_{jk}$ = Mean wheat area for the sample segments in the k*th* element of the j*th* strata

SC_1^n = System constant for country n

= 0 for countries with detailed historical data (e.g., United States, Canada, Australia)

$\neq$ 0 for other countries.

$\sigma_{jki}^2 = \underline{\sigma_{jk}}^2 = [C]^{-1}\ \underline{D}$ (the bar below a symbol implies a vector)

[C] = An H × H matrix ($SC_2 \leq H \leq 50$) whose elements are:

$$C_{ii} = [1 - \underline{X_i}^T (X^T X)^{-1} \underline{X_i}]^2 \ ; \ i = 1,2,\ldots,H$$

$$C_{ih} = [\underline{X_i}^T (X^T X)^{-1} \underline{X_h}]^2 ; \ i = 1,2,\ldots,H \quad h = 1,2,\ldots,H \quad i \neq h$$

SC_2 = System constant designating the minimum number of sample segments over which to perform a regression. The nominal value for SC_2 will be 10.

$$H = M_{2j} + \sum_{k=1}^{L1} M_{jk}$$

If $H < SC_2$, the computations are done at the next highest level where the number of sample segments with classification data $\geq SC_2$.

M_{2j} = Number of sample segments in the PPS group of elements for which classification data are available.

H is the total number of sample segments (stratified and PPS for which classification data is available in the smallest space containing the H observations).

X = An H × 2 matrix

$$\begin{bmatrix} 1, & X_1^* \\ 1, & X_2^* \\ & \vdots \\ 1, & X_H^* \end{bmatrix} = \begin{bmatrix} \underline{X}_1^T \\ \underline{X}_2^T \\ \vdots \\ \underline{X}_H^T \end{bmatrix}$$

$X_{ki}^* = W_k/(N_k R_k)$ for $i = 1,2,\ldots,M_{jk}$

W_k = Epoch year wheat area for the *kth* substrata in hectares

$$\underline{D} = [d_1^2, d_2^2, \ldots, d_H^2]$$

$$\underline{d} = \underline{A} - \chi\underline{\beta}$$

$$\underline{\beta} = (\chi^T\chi)^{-1}\chi^T\underline{A}$$

$$\underline{A} \approx A_{jki}$$

3.2.2.2 PPS Area Estimate Variance. The variance of wheat area for PPS (Group II) estimates is given by:

$$\text{Var } (A_{2j}) = V_{2j} \tag{13}$$

Where:

$$V_{2j} = \sum_{k=1}^{L2} R_{jk}^2 \, [1/(M_{2j}P_{jk})](N_{jk}^2 - N_{jk}) \, \sigma_{jk}^2 + V_{2j}'$$

$$V_{2j}' = \sum_{i=1}^{L2-1} \sum_{i'=i+1}^{L2} (\Pi_{ji}\Pi_{ji'} - \Pi_{jii'}) \left\{ [W_{ji}^{(\neq EY)}/\Pi_{ji}] - [W_{ji'}^{(\neq EY)}/\Pi_{ji'}] \right\}^2 \tag{14}$$

$V_{2j}' = 0$ if only 1 year of historical data is available

$$P_{jk} = [W_{jk}^{(EY)}/W_j^{(EY)}]$$

$$\Pi_{ji} = M_{2j}P_{ji}; \; P_{ji} = [W_{ji}^{(EY)}/W_j^{(EY)}]$$

$$\Pi_{ji'} = M_{2j}P_{ji'}; \; P_{ji'} = [W_{ji'}^{(EY)}/W_j^{(EY)}]$$

EY ~ epoch year historical data

$\neq$EY ~ the most recent year that is not the epoch year

$$W_j^{(EY)} = \sum_{k=1}^{L2} W_{jk}^{(EY)}$$

$$\begin{aligned}
\Pi_{jii'} = {} & [(M_{2j}-1)/M_{2j}]\, \Pi_{ji}\, \Pi_{ji'} + [(M_{2j}-1)/(M_{2j})^2] \\
& \cdot (\Pi_{ji}^2 \Pi_{ji'} + \Pi_{ji} \Pi_{ji'}^2) \\
& - [(M_{2j}-1)/(M_{2j})^3] \Pi_{ji} \Pi_{ji'} \sum_{\alpha=1}^{L2} \Pi_{j\alpha}^2 \\
& + [2(M_{2j}-1)/(M_{2j})^3]\, (\Pi_{ji}^3 \Pi_{ji'} + \Pi_{ji} \Pi_{ji'}^3 + \Pi_{ji}^2 \Pi_{ji'}^2) \\
& - [3(M_{2j}-1)/(M_{2j})^4]\, (\Pi_{ji}^2 \Pi_{ji'} + \Pi_{ji} \Pi_{ji'}^2) \sum_{\alpha=1}^{L2} \Pi_{j\alpha}^2 \\
& + [3(M_{2j}-1)/(M_{2j})^5]\, \Pi_{ji} \Pi_{ji'} \left(\sum_{\alpha=1}^{L2} \Pi_{j\alpha}^2 \right)^2 \\
& - [2(M_{2j}-1)/(M_{2j})^4]\, \Pi_{ji} \Pi_{ji'} \sum_{\alpha=1}^{L2} \Pi_{j\alpha}^3
\end{aligned}$$

$$\sigma_{jk}^2 = \begin{cases} \text{Equation 12 for PPS substrata with a segment or} \\ e^{(Y_{1j} + Y_{2j} X_{jk})} \text{ for PPS substrata without a segment.} \end{cases}$$

If $\sigma_{jk}^2 > C_1^2/4$, then $\sigma_{jk}^2 = C_1^2/4$, where C_1 = number of hectares per sample segment.

$$\gamma_{2j} = \frac{\sum_{h=1}^{H} (Z_{jh}X_{jh}) - \left[(1/H) \sum_{h=1}^{H} Z_{jh}\right]\left[\sum_{h=1}^{H} X_{jh}\right]}{\sum_{h=1}^{H} (X_{jh})^2 - (1/H)\left[\sum_{h=1}^{H} X_{jh}\right]^2} \quad (SC_2 \leq H \leq 50)$$

$$\gamma_{1j} = (1/H) \sum_{h=1}^{H} Z_{jh} - (\gamma_{2j}/H) \sum_{h=1}^{H} X_{jh} \quad (SC_2 \leq H \leq 50)$$

$$Z_{jh} = \ell og_e(\sigma_{jh}^2)$$

$$X_{jh} = \ell og_e \rho_{jh} + \ell og_e(1-\rho_{jh})$$

$\rho_{jh} = [W_{jh}^{(EY)}/N_{jh}]$ for each sample segment h in the $j th$ strata

$X_{jk} = X_{jh}$ for PPS subelements.

If $H < SC_2$, the computations are done at the next highest level where the number of sample segments with classification data, $H \geq SC_2$.

3.2.2.3 Total Strata Area Estimate Variance. The variance of the wheat area estimate of each strata that does not contain a Group III element shall be the sum of the Group I and Group II variance components.

$$V_j = V_{1j} + V_{2j} \quad (15)$$

If the strata contains a Group III element that is independent of the Group I and Group II components, the strata variance estimate shall be defined by the sum of the Group I, Group II, and Group III components.

$$V_j = V_{1j} + V_{2j} + V_{3j} \tag{16}$$

Otherwise, if the strata contains a Group III element that is dependent upon the Group I and Group II components of the strata, the Group III component is not individually computed, but shall be accounted for in the total strata variance computations in paragraph 3.2.2.4.

3.2.2.4 Ratio Area Estimate Variance. There are three categories into which the Group III data may fall, each producing a uniquely determined variance estimate for the strata. The first category shall include that Group III data which was estimated from the Group I and Group II elements within the strata. The second category shall include that Group III data which was estimated from all the Group I and Group II data within some space (zone, region, or country) as well as the Group I and Group II data within the strata. The third category shall consist of Group III data that was estimated from all the Group I and Group II data within some space (s) but no Group I or Group II data within the strata.

A. Category 1. Within Strata Variance:

$$V(A_j^{\,j}) \equiv V_j$$

and

$$V_j = (V_{1j}+V_{2j})\tau_j^{\,2} + 2(A_{1j}+A_{2j})^2\,\sigma_j^{\,2} \tag{17}$$

Where:

V_{1j} = Group I area estimate variance for the jth strata

V_{2j} - Group II area estimate variance for the jth strata

A_{1j} = Group I area estimate for the j*th* strata

A_{2j} = Group II area estimate for the j*th* strata

$$\tau_j^2 = (1/m) \sum_{\nu=1}^{m} (r_\nu^j + 1)^2$$

$$\sigma_j^2 = [1/(m-1)] \sum_{\nu=1}^{m} (r_\nu^j - \bar{r}^j)^2 \quad \text{if } m \geq 2$$

$$= 0 \text{ if } m = 1$$

m = number of years available

$r_\nu^j = [\Sigma W_3^j / (\Sigma W_1^j + \Sigma W_2^j)]$ for the ν*th* year

$$\bar{r}^j = (1/m) \sum_{\nu=1}^{m} r_\nu^j$$

The superscripts imply "computed from data belonging to that space."

B. <u>Category 2. Between Space Variance</u>:

$$V(A_j^s) \equiv V_j$$

and

$$V_j = (V_{1j} + V_{2j}) + 2(A_1^s + A_2^s)^2 (\sigma^s)^2$$

$$+ (V_1^s + V_2^s)(\tau^s)^2 + 2(V_{1j} + V_{2j}) \bar{r}^s \qquad (18)$$

Where:

$$V_1^s = V(A_1^s)$$

$$V_2^s = V(A_2^s)$$

$$(\tau^s)^2 = (1/m) \sum_{\nu=1}^{m} (r_\nu^s)^2$$

$$\sigma_j^2 = [1/(m-1)] \sum_{\nu=1}^{m} (r_\nu^s - \bar{r}^s)^2 \quad \text{if } m \geq 2$$

$$= 0 \text{ if } m = 1$$

$$\bar{r}^s = (1/m) \sum_{\nu=1}^{m} r_\nu^s$$

The space (s) includes all data within the level from which Group III estimate was obtained (i.e., zone, region, country).

C. <u>Category 3. Without Strata Variance</u>:

$$V(A_j^s) = V_j$$

and

$$V_j = (V_1^s + V_2^s)(\tau^s)^2 + 2(A_1^s + A_2^s)(\sigma^s)^2 \qquad (19)$$

The space (s) includes all data within the level from which the Group III estimate was obtained (i.e., zone, region, country) excluding the strata in question.

3.2.3 Aggregation Control Logic. Spring and winter wheat area estimates at the strata level shall be aggregated separately to the zone, region, or country level based upon user request. The associated variance of the area estimates shall be aggregated along with each area estimate.

The total wheat area estimate and the associated variance shall be computed as the sum of the spring and winter wheat components of the estimates for a given crop year (CY).

$$A_{TOTAL,\ CY} = A_{SPRING,\ CY} + A_{WINTER,\ CY} \tag{20}$$

$$V_{TOTAL,\ CY} = V_{SPRING,\ CY} + V_{WINTER,\ CY} \tag{21}$$

The standard statistics associated with a total wheat area estimate shall be computed as defined in paragraph 3.2.2 from the total variance estimate.

3.2.3.1 Area Aggregation to the Zone, Region, and Country Levels for a Spring/Winter Crop. Spring and winter wheat area estimates for a zone level element shall be obtained through aggregation of the area strata within the zone element of the appropriate crop type. The aggregation follows similarly for each element in the region and country levels. The computation used for the area estimate aggregation shall be as follows for both spring and winter wheat crop.

A. Area Estimate at Zone Level:

$$A_{nm\ell} = \sum_{j=1}^{n_Z} A_{nm\ell j} \tag{22}$$

Where:

n_Z = Number of strata in the ℓth zone, mth region, nth country

$A_{nm\ell j}$ = Area estimate of the jth strata, ℓth zone, mth region, nth country.

B. Area Estimate at Region Level:

$$A_{nm} = \sum_{\ell=1}^{n_R} A_{nm\ell} \tag{23}$$

Where:

n_R = Number of zones in the mth region, nth country.

C. Area Estimate at Country Level:

$$A_n = \sum_{m=1}^{r_C} A_{nm} \tag{24}$$

Where:

n_C = Number of regions in the nth country.

The area aggregation for the spring and winter wheat crops shall be performed separately.

3.2.3.2 Variance Aggregation. The estimate of error (variance) associated with each area estimate at the strata level shall be aggregated in parallel with each area estimate aggregation so that there is a variance associated with each estimate at all hierarchical levels. The associated variance shall be used to compute the standard statistics as defined in paragraph 3.2.2 at each hierarchical level.

A. Variance Aggregation to the Zone Level. The variance of the strata area estimate shall be aggregated to the zone level in one of two ways depending upon the existence and source of Group III data. If there is at least one strata within the zone in question that has a Group III element which was estimated from region or country data, then the variance of the area estimate of the zone shall be calculated as follows:

$$V(A_{nm\ell}) = V_{nm\ell}$$

and

$$V_{nm\ell} = V_{nm\ell}^{s1} + \sum_{t=1}^{M} [(V_{1,t}^{s2} + V_{2,t}^{s2})(\tau_t^{s3})^2$$

$$+ 2(A_{1,t}^{s2} + A_{2,t}^{s2})^2 (\sigma_t^{s3})^2] \qquad (25)$$

Where:

s1 = Space containing all the Group I and Group II elements within the ℓth zone and all Group III elements that were not estimated by a region or country ratio (i.e., 'reduced zone')

s2 = Space containing all strata within the ℓth zon except the th strata (i.e., that strata being estimated)

s3 = Space containing all Group I and Group II elements not in the ℓth zone but within the level (mth region or nth country) from which the Group III element in the th strata was estimated

$V_{nm\ell}^{s1}$ = Variance of the 'reduced zone' (s1) of the ℓth zone, mth region, nth country

M = Number of Group III elements within the ℓth zone that were estimated from data outside the ℓth zone

$V_{1,t}^{s2}$ = Variance of $A_{1,t}^{s2}$

$V_{2,t}^{s2}$ = Variance of $A_{2,t}^{s2}$

$$(\tau_t^{s3})^2 = (1/m) \sum_{\nu=1}^{m} (r_{\nu,t}^{s3})^2$$

m = Number of years of historical data available

$$r_{\nu,t}^{s3} = [W_3^{\ell}/(W_1^{s3}+W_2^{s3})] \text{ for } \nu th \text{ year}$$

$A_{1,t}^{s2}$ = Group I area estimates from the space s2 (does not contain the $t th$ strata)

$A_{2,t}^{s2}$ = Group II area estimates from the space s2 (does not contain the $t th$ strata)

$$(\sigma_t^{s3})^2 = [1/(m-1)] \sum_{\nu=1}^{m} (r_{\nu,t}^{s3}-\bar{r}_t^{s3})^2 \text{ if } m \geq 2$$

$$= 0 \text{ if } m = 1$$

$$\bar{r}_t^{s3} = (1/m) \sum_{\nu=1}^{m} r_{\nu,t}^{s3}$$

The term $V_{nm\ell}^{s1}$ is obtained as follows:

1. If

$$\sum_{t\epsilon E1} W_3^{t} \geq F \sum_{t\epsilon E2} W_3^{t}$$

Where:

F = System constant scale factor (default = 1)

E1 = Space containing Group III elements estimated from within the ℓth zone

E2 = Space containing Group III elements estimated from without the ℓth zone

Then

$$V_{nm\ell}^{s1} = \sum_{j=1}^{N1} V_{nm\ell j}^{s1} \tag{26}$$

Where:

$V_{nm\ell j}^{s1}$ = Variance of the area estimate in the jth strata of the space s1 in the ℓth zone, mth region, nth country

N1 = Number of strata in the 'reduced zone" (space s1).

2. If

$$\sum_{t \in E2} W_3^t < F \sum_{t \in E2} W_3^t$$

Then

$$V_{nm\ell}^{s1} = (V_{1,nm\ell}^{s1} + V_{2,nm\ell}^{s1})(\tau^{s1})^2$$

$$+ 2(A_{1,nm\ell}^{s1} + A_{2,nm\ell}^{s1})^2(\sigma^{s1})^2 \tag{27}$$

Where:

$V_{1,nm\ell}^{s1}$ = Group I variance of the 'reduced zone' (space s1) ℓth zone, mth region, nth country

$V_{2,nm\ell}^{s1}$ - Similar Group II variance

$A_{1,nm\ell}^{s1}$ = Group I area estimate of the 'reduced zone' (space s1) of the ℓth zone, mth region, nth country

$A_{2,nm\ell}^{s1}$ = Similar Group II area estimate

$$(\tau^{s1})^2 = (1/m) \sum_{\nu=1}^{m} (r_\nu^{s1}+1)^2$$

$$(\sigma^{s1})^2 = [1/(m-1)] \sum_{\nu=1}^{m} (r_\nu^{s1}-\bar{r}^{s1})^2 \text{ if } m \geq 2$$

$$= 0 \text{ if } m = 1$$

$$r_\nu^{s1} = (W_3^{s1})/(W_1^{s1}+W_2^{s1})$$

$$\bar{r}^{s1} = (1/m) \sum_{\nu=1}^{m} r_\nu^{s1}$$

Otherwise, if there are no Group III elements within the zone that were estimated based upon data from outside the zone, the variance of the area estimate of the zone shall be calculated as follows:

$$V_{nm\ell} = \sum_{j=1}^{N2} V_{nm\ell j} \tag{28}$$

Where:

$V_{nm\ell j}$ = Variance of the area estimate of the jth strata, ℓth zone, mth region, nth country

N2 = Number of strata in the ℓth zone, mth region, nth country.

B. Variance Aggregation to the Region and Country Levels. The variance aggregation to the region and country levels shall be performed as follows:

1. For variance at the region level:

$$V_{nm} = \sum_{\ell=1}^{n_R} V_{nm\ell} \tag{29}$$

2. For variance at the country level:

$$V_n = \sum_{m=1}^{n_C} V_{nm} \tag{30}$$

The between zone variance component shall be considered as negligible.

3.2.3.3 Process Specification Parameters. Program parameters shall be entered which will govern the processing performed and the outputs generated. The following subsections define the program parameters which may be entered interactively or in batch mode.

A. Country. One of the LACIE countries must be selected.

B. Spring/Winter/Total. A designation of the crop type (spring/winter/total) shall be required to identify the desired processing.

C. Crop Year. The crop year of data to be processed must be specified.

D. Level/Element. Both the hierarchical level (strata, zone, region, country) to which aggregation is to be performed and the specific element within that level for which aggregation is to be performed must be specified.

E. Classification Results Criteria. A threshold level of classification results may be entered (range 0-15).

F. Individual/Group Report. Output of results may be an individual report for the highest level of aggregation or a group of reports for the highest level of aggregation and all interim aggregations.

G. Data Suppression Flag. Optional suppression of the supportive and historical report data from being output may be requested. If no specification is made, the default of no suppression shall be assumed.

H. Output Device(s). The CAS line printer, CRT, or a magnetic tape may be designated as an output device for report purposes.

I. Biostage Threshold. This entry shall define the upper level and lower level of the biological stage(s) of the crop within a crop year for the data to be processed.

J. Acquisition Date Threshold. This entry shall define the upper level and lower level of the acquisition date(s) within a crop year of the LANDSAT data to be processed.

3.2.4 Input Requirements. Input data necessary to support the area estimation, aggregation, and reporting requirements shall consist of historical data, classification data, and allocation data.

3.2.4.1 Classification Data. The following data shall be required:

- Estimated wheat area per sample segment in hectares
- Sample segment identification number
- Percentage classified as wheat
- Percentage classified as other
- Percentage classified as unidentifiable
- Percentage thresholded

- Identification as spring or winter wheat sample segment
- Biological stage of each acquisition
- Date of LANDSAT acquisition(s)
- Date of classification
- Classification evaluation code
- Crop year
- Number of acquisitions used in classification.

3.2.4.2 Historical Data. The following historical data shall be required: Spring and winter historical wheat area for the last 15 years for each substrata/strata, zone, region, and country. One of the 15 years must be the epoch year for each country.

3.2.4.3 Allocation Data. The CAS data base shall require the following data to support the CAS estimation and aggregation formulations.

A. For the lowest hierarchical element of each country:

- Identification number
- Number of agricultural segments
- Nominal allocation of element - Group I, II, or III
- Number and identification of sample segments allocated to the element
- Ratio of true element area to gross pseudo-element area
- Indicator of whether spring, winter, or both spring and winter wheat is grown in the element.

B. For each LACIE country:

- Identification and correlation of hierarchical elements (regions, zones, strata, substrata)
- Indicator of density of historical data (bilevel)
- Identification of epoch year data (data used in the allocation process).

3.2.5 Output Requirements. The wheat area estimates and standard statistics at the base level and succeeding levels as a result of area aggregation shall be stored for future reference and reported to the output device(s).

3.2.5.1 Report Generation. The area estimates and standard statistics on the strata, zone, region, and country levels shall be available for presentation in conjunction with historical data for all elements within the requested aggregation level. These reports may be generated on a batch device and/or CRT terminal. The contents for area estimate reports are specified in paragraph 3.5. In addition, auxiliary reports may be generated containing substrata area estimate information.

3.2.5.2 Results Storage. Interim storage of wheat area estimates and associated variances at the strata level shall be done for use by the wheat production processing phase.

3.3 YIELD ESTIMATION

Yield estimates, along with their associated variances, shall be given at the strata level for all strata. The yield estimate for any higher element in the hierarchy shall be computed from the area and production estimates for that element. These yield estimates, along with the associated historical and statistical information, shall be output as requested in standard report formats.

The input data shall consist of wheat area and production estimates, yield data, historical data, and allocation data. The output reports shall contain yield estimates with statistics as specified in paragraph 3.3.5.

3.3.1 Yield Estimates. Wheat yield estimation shall be computed at the zone, region, and country levels for each LACIE country as requested. Separate estimates shall be performed for the spring and winter wheat crop, while no total wheat yield estimate is produced.

3.3.1.1 Yield Estimates at Strata Level. Yield estimates shall not be computed at the strata level since these data are provided monthly by the Yield Estimation Subsystem (YES). These estimates shall be used in production estimate and variance computations on the strata level (paragraphs 3.4.1.1 and 3.4.2.1) and shall be reported unchanged.

3.3.1.2 Yield Estimates at Zone, Region, and Country Levels. The yield estimates for each element (e) within the zone, region, and country levels shall be computed as follows:

$$Y_e = P_e/A_e \tag{31}$$

Where:

e = Any zone, region, or country

A_e = Area estimate for element e

P_e = Production estimate for element e (as defined in paragraph 3.4).

3.3.2 Standard Statistics. The standard statistics for yield estimation are composed of standard deviation (σ), coefficient of variation (CV), 90 percent confidence limits (CL), and probability of achieving less than 10 percent error (Ω). Each statistic is a function of variance V as follows:

$$\sigma_s = \sqrt{V_s} \tag{32}$$

Where s = Any area element.

$$CV_s = \sigma_s / Y_s \tag{33}$$

Where Y_s = Yield estimate of the sth element.

$$CL_s^{(+)} = Y_s + (1.645)\ \sigma_s$$

$$CL_s^{(-)} = Y_s - (1.645)\ \sigma_s \tag{34}$$

$$\Omega_s = \text{erf}\ \left\{(1/\sqrt{2})[1/(10CV_s)]\right\} \tag{35}$$

Where:

erf $(\theta/\sqrt{2})$ = Error function associated with the normal probability curve

θ = Standardized random variable.

3.3.2.1 Yield Estimate Variance at Strata Level. The variance of the yield estimates at the strata level are not computed since these data shall be provided monthly by the Yield Estimation Subsystem (YES). These estimates shall be used in production variance computations on the strata level (paragraph 3.4.2.1) and are reported unchanged.

3.3.2.2 Yield Estimate Variance at Zone, Region, and Country Levels. The variance estimate associated with each element (e) above the strata level is computed as follows:

$$V(Y_e) = \frac{Y_e^2}{L}\left[\frac{\sum_{j=1}^{L} V(P_{ej})}{\left(\sum_{j=1}^{L} P_{ej}\right)^2} + \frac{\sum_{j=1}^{L} V(A_{ej})}{\left(\sum_{j=1}^{L} A_{ej}\right)^2} - 2\,\frac{\sum_{j=1}^{L}\left[Y_{ej}\ V(A_{ej})\right]}{\left(\sum_{j=1}^{L} A_{ej}\right)\left(\sum_{j=1}^{L} P_{ej}\right)}\right] \qquad (36)$$

Where:

Y_e = Yield estimate for element e

L = Number of strata (j) within the area element e

P_{ej} = Production estimate of the *jth* strata in element e

$V(P_{ej})$ = Variance of P_{ej} (as defined in paragraph 3.4.2.1)

A_{ej} = Area estimate of the *jth* strata in element e

$V(A_{ej})$ = Variance of A_{ej}

Y_{ej} = Yield estimate of the *jth* strata in element e

3.3.3 Process Specification Parameters. In order to govern the processing performed and the outputs generated, certain program parameters shall be entered. The following paragraphs define those program parameters.

A. Country. One of the LACIE countries must be selected.

B. Spring/Winter. A designation of the crop type (spring/winter) shall be required to identify the desired processing.

C. Crop Year. The crop year of data to be processed must be specified.

D. Level/Element. Both the hierarchical level to which processing is to be performed and the specific element to process within that level must be specified.

E. Classification Results Criteria.* A threshold level of classification results may be entered (range 0-15).

F. Individual/Group Report. Output of results may be an individual report for the highest level processed or a group of reports for the highest level processed and all subelements of the requested element.

G. Data Suppression Flag. Optional suppression of the supportive and historical report data from being output may be requested. If no specification is made, the default of no suppression shall be assumed.

H. Output Device(s). A CRT and/or batch device may be designated as an output device for report purposes.

I. Biostage Threshold.* This entry shall define the upper level and lower level of the biological stage(s) of the crop within a crop year for the data to be processed.

J. Acquisition Date Threshold.* This entry shall define the upper level and lower level of the acquisition date(s) within a crop year of the LANDSAT data to be processed.

K. Yield Estimate Date Threshold. This entry shall define the upper and lower level date, within a crop year, of the yield estimate data at the strata level to be used in processing.

3.3.4 Input Requirements. Input data necessary to support the yield estimation and reporting requirements shall consist of yield data, historical data, allocation data, and area and production estimate data.

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*These parameters shall be checked to assure that the associated area and production estimate data are of the same type as that requested for the yield estimates.

3.3.4.1 Yield Data. The following data shall be required at each area strata:

- Strata identification number
- Spring/winter wheat crop indicator
- Acquisition date
- Crop year
- Yield estimate value for specified wheat crop
- Variance of yield estimate for specified wheat crop.

3.3.4.2 Historical Data. Spring and winter historical wheat yield for the last 15 years for each strata, zone, region, and country shall be required.

3.3.4.3 Allocation Data. Identification and correlation of hierarchical elements (regions, zones, strata) for each LACIE country shall be required.

3.3.4.4 Area Production Estimate Data. The following data shall be required for every zone, region, and country element:

- Area estimate
- Variance of area estimate
- Production estimate
- Variance of production estimate.

These area and production estimates shall have been specified in the same manner as that requested for the yield estimate (paragraph 3.3.3).

3.3.5 Output Requirements. The wheat yield estimates and standard statistics shall be stored for future reference and reported per request to the output device(s). These estimates shall be presented at the strata level and succeeding levels as a result of yield data processing.

3.3.5.1 Report Generation. The yield estimates and standard statistics shall be available for presentation in conjunction with historical data for all elements below the requested processing level. These reports may be generated on a magnetic tape, line printer, and/or CRT terminal. The contents of the yield estimate reports are specified in paragraph 3.5.

3.3.5.2 Results Storage. Interim storage of wheat yield estimates and associated variances at the strata level shall be done for use by the wheat production processing phase.

3.4 PRODUCTION ESTIMATION AND AGGREGATION

The production applications software shall calculate production estimates and standard statistics from the input data (paragraph 3.4.4). The production estimates and variances shall be aggregated to the level specified by the process specification parameters (paragraph 3.4.3.3). The production and statistical information shall be output (paragraph 3.4.5) as requested in standard report formats. The input data shall consist of area and yield estimate data, historical data, and allocation data.

3.4.1 Production Estimates. Wheat production estimation shall be calculated at the strata level from area and yield estimates. Separate estimates shall be performed for spring and winter wheat.

Production estimation shall be performed on a base level of strata elements. The production estimate shall be calculated by the following equation.

$$P_j = A_j Y_j \tag{37}$$

Where:

A_j = Wheat area in the j*th* strata

Y_j = Wheat yield in the j*th* strata

3.4.2 Standard Statistics. The standard statistics for production estimation and aggregation are composed of standard deviation (σ), coefficient of variation (CV), 90 percent confidence limits (CL), and probability of $\leq$ 10 percent error (Ω). Each statistic is a function of variance (V) as follows:

$$\sigma_s = \sqrt{V_s} \tag{38}$$

Where s = Any hierarchical element

$$CV_s = \sigma_s / P_s \tag{39}$$

Where P_s = Production estimate of the s*th* element

$$CL_s^{(+)} = P_s + (1.645)\ \sigma_s$$

$$CL_s^{(-)} = P_s - (1.645)\ \sigma_s \qquad (40)$$

$$\Omega_s = \text{erf}\ \left\{(1/\sqrt{2})[1/(10CV_s)]\right\} \qquad (41)$$

Where:

erf $(\theta/\sqrt{2})$ = Error function associated with the normal probability curve

θ = Standardized random variable

3.4.2.1 Strata Level Production Estimate Variance. The variance of wheat production estimates at the strata level is given by:

$$V_j = V(P_j) = V(A_j)\ [V(Y_j) + Y_j^2] + [V(Y_j)\ A_j^2] \qquad (42)$$

Where:

$V(A_j)$ = Variance of wheat area in the jth strata

$V(Y_j)$ = Variance of wheat yield in the jth strata

A_j and Y_j are as previously defined.

3.4.3 Aggregation Control Logic. Spring and winter wheat production estimates at the strata level shall be aggregated separately to the zone, region, or country level based upon user request. The associated variance of the production estimates shall be aggregated along with each production estimate.

The total wheat production estimate and the associated variance shall be computed as the sum of the spring and winter wheat components of the estimates for a given crop year (CY).

$$P_{TOTAL,\ CY} = P_{SPRING,\ CY} + P_{WINTER,\ CY} \tag{43}$$

$$V_{TOTAL,\ CY} = V_{SPRING,\ CY} + V_{WINTER,\ CY} \tag{44}$$

The standard statistics associated with a total wheat production estimate shall be computed as defined in paragraph 3.4.2 from the total variance estimate.

3.4.3.1 Production Aggregation to the Zone, Region, and Country Levels. Spring and winter wheat production estimates for a zone level element shall be obtained through aggregation of the production strata within the zone element of the appropriate crop type. The aggregation shall follow similarly for each element in the region and country levels. The computation used for the production estimate aggregation shall be as follows for both spring and winter wheat crops.

A. Production Estimate at the Zone Level:

$$P_{nm\ell} = \sum_{j=1}^{N_z} P_{nm\ell j} \tag{45}$$

Where:

N_z = Number of strata in the ℓth zone, mth region, nth country

$P_{nm\ell j}$ = Production estimate of the jth strata, ℓth zone, mth region, nth country

B. Production Estimate at the Region Level:

$$P_{nm} = \sum_{\ell=1}^{N_R} P_{nm\ell} \tag{46}$$

Where:

N_R = Number of zones in the mth region, nth country

C. Production Estimate at the Country Level:

$$P_n = \sum_{m=1}^{N_c} P_{nm} \tag{47}$$

Where:

N_c = Number of regions in the nth country

The production aggregation for the spring and winter wheat crops shall be performed separately.

3.4.3.2 Variance Aggregation to the Zone, Region, and Country Levels. The estimate of error (variance) associated with each production estimate at the strata level shall be aggregated in parallel with each production estimate aggregation so that there is a variance associated with each estimate at all hierarchical levels. The associated variance shall be used to compute the standard statistics as defined in paragraph 3.4.2 at each hierarchical level.

The variance aggregation to the zone, region, and country levels shall be performed as follows for both spring and winter wheat crops.

A. Production Variance at the Zone Level:

$$V_{nm\ell} = V(P_{nm\ell}) = \sum_{j=1}^{N_z} V_{nm\ell j} \tag{48}$$

Where:

N_z = Number of strata in the ℓth zone, mth region, nth country

$V_{nm\ell j}$ = $V(P_{nm\ell j})$ Variance of the production estimate of the jth strata, ℓth zone, mth region, nth country

B. Production Variance at the Region Level:

$$V_{nm} = \sum_{\ell=1}^{N_R} V_{nm\ell} \tag{49}$$

Where:

N_R = Number of zones in the mth region, nth country

C. Production Variance at the Country Level:

$$V_n = \sum_{m=1}^{N_C} V_{nm} \tag{50}$$

Where:

N_c = Number of regions in the nth country

3.4.3.3 Process Specification Parameters. The following paragraphs define the process specification parameters which may be entered interactively or in batch mode. The process specification parameters shall be used to define the processing that is required and the output products that are generated.

A. Country. One of the LACIE countries must be selected.

B. Spring/Winter/Total. A designation of the crop type (spring/winter/total) shall be required to identify the desired processing.

C. Crop Year. The crop year of data to be processed must be specified.

D. Level/Element. Both the hierarchical level (strata, zone, region, country) to which aggregation is to be performed and the specific element within that level for which aggregation is to be performed must be specified.

E. Classification Results Criteria.* A threshold level of classification results may be entered (range 0-15).

F. Individual/Group Report. Output of results may be an individual report for the highest level of aggregation or a group of reports for the highest level of aggregation and all interim aggregations.

G. Data Suppression Flag. Optional suppression of the supportive and historical report data from being output may be requested. If no specification is made, the default of no suppression shall be assumed.

H. Output Device(s). A CRT and/or a batch device may be designated as an output device for report purposes.

I. Biostage Threshold.* This entry shall define the upper level and lower level of the biological stage(s) of the crop within a crop year for the data to be processed.

J. Acquisition Date Threshold.* This entry shall define the upper level and lower level of the acquisition date(s) within a crop year of the LANDSAT data to be processed.

K. Yield Estimate Date Threshold.* This entry shall define the upper and lower level date, within a crop year, of yield estimate data at the strata level to be used in processing.

3.4.4 Input Requirements. Input data necessary to support the production estimation and reporting requirements shall consist of wheat area data, yield data, historical data, and allocation data.

3.4.4.1 Area and Yield Estimate Data. Wheat area and yield data shall be required to compute the production estimates and variances.

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*These parameters shall be checked to assure that the associated area and yield estimate data are of the same type as that requested for the production estimates.

The area and yield data shall be checked for compliance with the process specification parameters listed in paragraph 3.4.3.3. The following data shall be required:

- Estimated area per strata
- Estimated yield per strata
- Area estimate variance per strata
- Yield estimate variance per strata.

3.4.4.2 Historical Data. Spring and winter historical wheat production data for the last 15 years for each strata, zone, region, and country shall be required for report purposes.

3.4.4.3 Allocation Data. Production estimation and aggregation shall require data which identifies each LACIE country's hierarchical elements (region, zone, strata).

3.4.5 Output Requirements. The wheat production estimates and standard statistics at the base level and succeeding levels as a result of production aggregation shall be stored for future reference and reported to the output device(s).

3.4.5.1 Report Generation. The production estimates and standard statistics on the strata, zone, region, and country levels shall be available for presentation in conjunction with historical data for all elements within the requested aggregation level. These reports may be generated on a batch device and/or CRT terminal. The contents of the production estimate reports are specified in paragraph 3.5

3.4.5.2 Results Storage. Interim storage of wheat production estimates and associated variances at each level shall be done for use by the wheat yield processing phase.

3.5 REPORT DATA REQUIREMENTS

Reports which were generated through the area, yield, or production estimate processing phase may be displayed on the requested output device(s). The available devices are CRT, magnetic tape, and line printer as defined in the System Software Section (section 2). The estimation reports are presented in either metric or USA units based upon user request at input command time (paragraph 2.2.1). Following is a cross-reference of the unit specifications that are presented for each data type. Separate reports shall be generated for spring, winter, and total crop types.

Data Type	Metric	USA
Area	Hectares	Acres
Yield	Quintals/Hectare	Bushels/Acre
Production	Thousand Metric Tons	Thousand Bushels

Additional reports containing yield strata data or Worldwide Meteorlogical Organization (WMO) position data may be output per a request at input command time (paragraph 2.2.1). All report data that is available in the data base shall be presented in each of the report requests.

3.5.1 Spring/Winter/Total Wheat Area Estimation Reports. The area estimation reports shall be output as strata, zone, region, or country reports. The parameters required for each report are specified in the following paragraphs.

3.5.1.1 Strata. Each strata area estimation report shall consist of the following information:

A. Heading

1. Strata number

2. Crop year

3. Units of measure

4. Thresholds applied on the report data
   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range
5. Associated zone, region, country
6. Title
7. Spring or winter or total.

B. Security Block

1. CAS monthly report date - user input
2. Date through which maximum protection must be retained
3. Date through which restricted access must be retained
4. Date of report generation.

C. Area Estimate for Strata

1. Area estimate of strata
2. Estimated standard deviation
3. Probability of achieving 10 percent or less error
4. Coefficient of variation
5. 90 percent confidence limits.

D. Supportive Data*

1. Number of sample segments allocated
2. Number of sample segments used in estimate
3. ID's of sample segments used in estimate.

*Output if base hierarchical level is strata.

E. Supportive Data*

1. Number of Group I substrata and ID's

2. Number of Group II substrata and ID's

3. Group I estimate and standard deviation

4. Group II estimate and standard deviation

5. Group III estimate.

F. Historical Area Data

1. Number of years of data

2. Maximum area and year

3. Minimum area and year

4. Mean area

5. Standard deviation.

G. Commentary - 160 characters of commentary narrative.

3.5.1.2 Zone. The zone area estimation report shall consist of the following information:

A. Heading

1. Zone number

2. Crop year

3. Units of measure

4. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range
- Acquisition date range

*Output if base hierarchical level is substrata.

5. Associated region and country

6. Title

7. Spring or winter or total.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Area Estimate for Zone

1. Area estimate of zone

2. Estimated standard deviation

3. Probability of achieving 10 percent or less error

4. Coefficient of variation

5. 90 percent confidence limits.

D. Supportive Data (for each stratum in the zone)

1. Strata ID

2. Area of strata

3. Standard deviation of strata

E. Historical Data

1. Number of years of data

2. Maximum area and year

3. Minimum area and year

4. Mean area

5. Standard deviation.

F. Commentary - 160 characters of commentary narrative.

3.5.1.3 Region. Each region area estimation report shall consist of the following information:

A. Heading

1. Region name

2. Crop year

3. Units of measure

4. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range
- Acquisition date range

5. Country

6. Title

7. Spring or winter or total.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Area Estimate for Region

1. Area estimate of region

2. Estimated standard deviation

3. Probability of a 10 percent or less error

4. Coefficient of variation

5. 90 percent confidence limits.

D. Supportive Data (for each zone in the region)

1. Zone ID

2. Area of zone

3. Standard deviation of zone

E. Historical Data

1. Number of years of data

2. Maximum area and year

3. Minimum area and year

4. Mean area

5. Standard deviation

F. Commentary - 160 characters of commentary narrative.

3.5.1.4 Country. Each country area estimation report shall consist of the following information:

A. Heading

1. Country name

2. Crop year

3. Units of measure

4. Thresholds applied on the report data

   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range

5. Title

6. Spring or winter or total.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Area Estimate for Country

1. Area estimate of country

2. Estimated standard deviation

3. Probability of achieving 10 percent or less error

4. Coefficient of variation

5. 90 percent confidence limits.

D. Supportive Data (for each region in the country)

1. Region ID

2. Area of region

3. Standard deviation of region.

E. Historical Data

1. Number of years of data

2. Maximum area and year

3. Minimum area and year

4. Mean area

5. Standard deviation.

F. Commentary - 160 characters of commentary narrative.

3.5.2 Spring/Winter Wheat Yield Estimation Reports. The yield estimation results shall be output as separate spring wheat or winter wheat crop reports at the strata, zone, region, or country levels. The parameters to be presented in each report are specified in the following paragraphs.

3.5.2.1 Strata. Each strata yield estimate report shall consist of the following information:

A. Heading

1. Title

2. Strata number

3. Strata name

4. Zone, region, and country to which the strata belongs

5. Crop year

6. Crop type (spring or winter)

7. Units indicator

8. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range

- Acquisition date range
- Yield estimate acquisition date range

B. Security Block

1. CAS monthly report date - user input
2. Date through which maximum protection must be retained
3. Date through which restricted access must be retained
4. Date of report generation.

C. Yield Estimate for Strata

1. Strata yield estimate
2. Standard deviation of yield estimate
3. Coefficient of variation of yield estimate
4. Upper and lower confidence limits of yield estimate
5. Probability of achieving less than 10 percent error in yield estimate.

D. Historical Yield Data

1. Number of years of historical data available
2. Maximum historical yield for the strata with the associated year
3. Minimum historical yield for the strata with the associated year
4. Mean historical yield for the strata
5. Standard deviation of historical yield.

E. Commentary - 160 characters of user input commentary.

3.5.2.2 Zone. Each zone yield estimate report shall consist of the following information:

A. Heading

1. Title

2. Zone number

3. Zone name

4. Region and country to which the zone belongs

5. Crop year

6. Crop type (spring or winter)

7. Units indicator

8. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range
- Acquisition date range
- Yield estimate acquisition date range

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Yield Estimate for Zone

1. Zone yield estimate

2. Standard deviation of yield estimate

3. Coefficient of variation of yield estimate

4. Upper and lower confidence limits of yield estimate

5. Probability of achieving less than 10 percent error in yield estimate.

D. Supportive Data

1. Zone area estimate

2. Zone area standard deviation

3. Date of zone area estimate calculation

4. Zone production estimate

5. Zone production standard deviation

6. Date of zone production estimate calculation.

E. Historical Yield Data

1. Number of years of historical data available

2. Maximum historical yield for the zone with the associated year

3. Minimum historical yield for the zone with the associated year

4. Mean historical yield for the zone

5. Standard deviation of historical yield.

F. Commentary - 160 characters of user input commentary.

3.5.2.3 Region. Each region yield estimate report shall consist of the following information:

A. Heading

1. Title

2. Region number

3. Region name

4. Country to which the region belongs

5. Crop year

6. Crop type (spring or winter)

7. Units indicator

8. Thresholds applied on the report data

   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range
   - Yield estimate acquisition date range.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Yield Estimate for Region

1. Region yield estimate

2. Standard deviation of yield estimate

3. Coefficient of variation of yield estimate

4. Upper and lower confidence limits of yield estimate

5. Probability of achieving less than 10 percent error in yield estimate.

D. Supportive Data

1. Region area estimate

2. Region area standard deviation

3. Date of region area estimate calculation

4. Region production estimate

5. Region production standard deviation

6. Date of region production estimate calculation.

E. Historical Yield Data

1. Number of years of historical data available

2. Maximum historical yield for the region with the associated year

3. Minimum historical yield for the region with the associated year

4. Mean historical yield for the region

5. Standard deviation of historical yield.

F. Commentary - 160 characters of user input commentary.

3.5.2.4 Country. Each LACIE country yield estimate report shall consist of the following information:

A. Heading

1. Title

2. Country number

3. Country name

4. Crop year

5. Crop type (spring or winter)

6. Units indicator

7. Thresholds applied on the report data

   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range
   - Yield estimate acquisition date range.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Yield Estimate for Country

1. Country yield estimate

2. Standard deviation of yield estimate

3. Coefficient of variation of yield estimate

4. Upper and lower confidence limits of yield estimate

5. Probability of achieving less than 10 percent error in yield estimate.

D. Supportive Data

1. Country area estimate

2. Country area standard deviation

3. Date of country area estimate calculation

4. Country production estimate

5. Country production standard deviation

6. Date of country production estimate calculation.

E. Historical Yield Data

1. Number of years of historical data available

2. Maximum historical yield for the country with the associated year

3. Minimum historical yield for the country with the associated year

4. Mean historical yield for the country

5. Standard deviation of historical yield.

F. Commentary - 160 characters of user input commentary.

3.5.3 Spring/Winter/Total Wheat Production Estimation Reports. The production estimate results shall be output as separate spring, winter, or total wheat crop reports at the strata, zone, region, or country levels. The parameters to be presented in each report are specified in the following paragraphs.

3.5.3.1 Strata. Each strata production estimate report shall consist of the following information:

A. Heading

1. Title

2. Strata number

3. Strata name

4. Zone, region, and country to which the strata belongs
5. Crop year
6. Crop type (spring, winter, or total)
7. Units indicator
8. Thresholds applied on the report data
   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range
   - Yield estimate acquisition date range.

B. Security Block

1. CAS monthly report date - user input
2. Date through which maximum protection must be retained
3. Date through which restricted access must be retained
4. Date of report generation.

C. Estimate for Strata

1. Strata production estimate
2. Standard deviation of production estimate
3. Coefficient of variation of production estimate
4. Upper and lower confidence limits of production estimate
5. Probability of achieving less than 10 percent error on production estimate.

D. Supportive Data

1. Strata area estimate

2. Strata area standard deviation

3. Date of area estimate calculation

4. Strata yield estimate

5. Strata yield standard deviation.

E. Historical Production Data

1. Number of years of historical data available

2. Maximum historical production for the strata with the associated year

3. Minimum historical production for the strata with the associated year

4. Mean historical production for the strata

5. Standard deviation of historical production.

F. Commentary - 160 characters of user input commentary.

3.5.3.2 Zone. Each zone production estimate report shall consist of the following information:

A. Heading

1. Title

2. Zone number

3. Zone name

4. Region and country to which the zone belongs

5. Crop year
6. Crop type (spring, winter, or total)
7. Units indicator
8. Thresholds applied on the report data
   - Minimum classification evaluation code
   - Biological stage range
   - Acquisition date range
   - Yield estimate acquisition date range.

B. Security Block

1. CAS monthly report date - user input
2. Date through which maximum protection must be retained
3. Date through which restricted access must be retained
4. Date of report generation.

C. Estimates for Zone

1. Zone production estimate
2. Standard deviation of production estimate
3. Coefficient of variation of production estimate
4. Upper and lower confidence limits of production estimate
5. Probability of achieving less than 10 percent error in production estimate.

D. Supportive Production Data (for each strata within the zone)

1. Strata number
2. Strata name

3. Strata production estimate

4. Standard deviation of strata production estimate.

E. Historical Production Data

1. Number of years of historical data available

2. Maximum historical production for the zone with the associated year

3. Minimum historical production for the zone with the associated year

4. Mean historical production for the zone

5. Standard deviation of historical production.

F. Commentary - 160 characters of user input commentary.

3.5.3.3 Region. Each region production estimate report shall consist of the following information:

A. Heading

1. Title

2. Region number

3. Region name

4. Country to which the region belongs

5. Crop year

6. Crop type (spring, winter, or total)

7. Units indicator

8. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range

- Acquisition date range
- Yield estimate acquisition date range.

B. Security Block

1. CAS monthly report date - user input
2. Date through which maximum protection must be retained
3. Date through which restricted access must be retained
4. Date of report generation.

C. Estimates for Region

1. Region production estimate
2. Standard deviation of production estimate
3. Coefficient of variation of production estimate
4. Upper and lower confidence limits of production estimate
5. Probability of achieving less than 10 percent error in production estimate.

D. Supportive Production Data (for each zone within the region)

1. Zone number
2. Zone name
3. Zone production estimate
4. Standard deviation of zone production estimate.

E. Historical Production Data

1. Number of years of historical data available
2. Maximum historical production for the region with the associated year

3. Minimum historical production for the region with the associated year

4. Mean historical production for the region

5. Standard deviation of historical production.

F. Commentary - 160 characters of user input commentary.

3.5.3.4 Country. Each LACIE country production estimate report shall consist of the following information:

A. Heading

1. Title

2. Country number

3. Country name

4. Crop year

5. Crop type (spring, winter, or total)

6. Units indicator

7. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range
- Acquisition date range
- Yield estimate acquisition date range.

B. Secuity Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Estimates for Country

1. Country production estimate

2. Standard deviation of production estimate

3. Coefficient of variation of production estimate

4. Upper and lower confidence limits of production estimate

5. Probability of achieving less than 10 percent error in production estimate.

D. Supportive Production Data (for each region within the country)

1. Region number

2. Region name

3. Region production estimate

4. Standard deviation of region production estimate.

E. Historical Production Data

1. Number of years of historical data available

2. Maximum historical production for the country with the associated year

3. Minimum historical production for the country with the associated year

4. Mean historical production for the country

5. Standard deviation of historical production.

F. Commentary - 160 characters of user input commentary.

3.5.4 Auxiliary Reports. In addition to the area, yield, and production estimation reports, auxiliary reports may be optionally requested. These auxiliary reports shall consist of the area substrata reports, yield strata reports, and WMO position reports.

3.5.4.1 Area Substrata Reports. The area substrata data shall be obtained only for those countries whose base level is substrata. Each substrata area estimate report shall consist of the following information:

A. Heading

1. Title

2. Substrata number

3. Substrata name

4. Strata, zone, region, and country to which the substrata belongs

5. Crop year

6. Crop type (spring or winter or total)

7. Units indicator

8. Thresholds applied on the report data

- Minimum classification evaluation code
- Biological stage range
- Acquisition date range.

B. Security Block

1. CAS monthly report date - user input

2. Date through which maximum protection must be retained

3. Date through which restricted access must be retained

4. Date of report generation.

C. Area Estimate for Substrata

1. Substrata area estimate

2. Standard deviation of area estimate

3. Coefficient of variation of area estimate

4. Upper and lower confidence limits of area estimate

5. Probability of achieving less than 10 percent error in area estimate.

D. Supportive Area Data

1. Number of agricultural segments in the substrata

2. Number of sample segments within the classification threshold for aggregation vs. number of sample segments allocated to the substrata

3. Parameters for each sample segment within the substrata

- Sample segment number
- Percent classified as wheat
- Percent other
- Percent unidentifiable
- Percent thresholded
- Classification evaluation code
- Biological stage
- Acquisition date(s).

E. Historical Area Data

1. Number of years of historical data available.

2. Maximum historical area for the substrata with the associated year

3. Minimum historical area for the substrata with the associated year

4. Mean historical area for the substrata

5. Standard deviation of historical area.

F. Commentary - 160 characters of user input commentary.

3.5.4.2 Yield Strata Reports. Each yield strata estimate report shall consist of the following information:

A. Heading

1. Date of report generation

2. Title

3. Yield strata number

4. Country to which the yield strata belongs

5. Crop year

6. Crop type (spring or winter)

7. Units indicator.

B. Yield Strata Data

1. Yield strata estimate

2. Variance of yield strata estimate

3. Parameters for each area strata within the yield strata

- Area strata number
- Area strata name.

3.5.4.3 WMO Position Reports. Each WMO report shall consist of the following information:

A. Heading

1. Date of report generation
2. Title
3. Country.

B. WMO Data (parameters for each WMO station within the country)

1. WMO station number
2. Latitude of WMO station
3. Longitude of WMO station
4. Yield strata number within which the WMO station is located.

3.5.4.4 Auxillary Report Data Requirements. In order to support the auxillary reports, the following data shall be required in the CAS data base:

A. Yield Strata Data

- Country ID
- Yield strata number
- Crop year
- Units indicator
- Yield estimate

- Variance of yield estimate
- Area strata numbers which belong to the yield strata.

B. WMO Position Data

- Country ID
- WMO station number
- Latitude
- Longitude
- Yield strata number to which the WMO station belongs.

3.5.5 Report Options. The options for report output are request for intermediate aggregation reports and the output device(s) for the reports. Reference the display processor (paragraph 2.2.2) for further explanation.

3.5.5.1 Intermediate Aggregation Reports. In addition to the final aggregation report, all the interim aggregation reports that support the final report may be output.

3.5.5.2 Auxiliary Reports. Each of the auxiliary report types may be output for a country per a request at input command time. Reference input command processor (paragraph 2.2.1) for further explanation.

3.5.5.3 Output Devices. Any combination of the batch devices or CRT may be specified as the output device(s) for report generation. The batch devices include a magnetic tape and a line printer.

3.5.5.4 Data Suppression Flag. At any time during report display, the suppression of the output of supportive and historical data may be requested or overridden.

CAS DATA BASE
SOFTWARE

SECTION 4

CAS DATA BASE SOFTWARE

4.1 GENERAL

Requirements for CAS data base software have been segregated into three main functional areas. Paragraph 4.2 addresses requirements for data base management services to define, initialize, and update CAS data bases in the batch environment. Paragraph 4.3 defines requirements for interfacing with CAS applications software (section 3). Paragraph 4.4 defines requirements for interfacing with the CAS Data Base Change Program.

4.2 CAS DATA BASE MANAGEMENT

The data base management software shall provide all services necessary to construct and maintain CAS system data bases. Required services shall include capabilities to define, initialize, and load CAS data bases and to modify selected data base contents both in a batch environment and through terminal inputs (application) processing. All parameters in the data base that contain wheat values for area, yield, and production shall be in metric units.

The following paragraphs address basic data base management functions required for data base definition, initialization, and batch mode processing of raw data inputs received from external sources. Descriptions of the media, format, and transmission of each external data source input reflect those defined in appendix C.

4.2.1 External Data Sources. An external data source is defined here to mean any source which generates data inputs for the CAS at facilities other than the PDP 11/45 configuration located in Building 17 at the JSC.

External data sources are defined as inputs from the Classification and Mensuration Subsystem (CAMS), Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS), Yield Estimation Subsystem (YES), and LACIE allocation data.

A. CAMS Data. Raw CAMS data inputs shall be received on a daily basis for initial processing by a CAS preprocessor (see section 5). Subsequent data base updating shall be performed by appropriate CAS data base management services upon receipt of a preprocessor-generated magnetic tape of sample segment classifications.

B. DAPTS Data. DAPTS inputs shall be provided to the CAS sys tem on a yearly basis. Data provided by DAPTS shall inclu spring and winter wheat values for acreage, yield, and pro duction by substrata, strata, zone, region, and country as applicable to a given country. CAS shall provide storage and retrieval facilities for a maximum of (the latest) 15 years of DAPTS data. DAPTS data shall be provided to CAS in the form of 9-track computer-compatible magnetic tapes.

C. YES Data. YES data shall be provided to the CAS on a monthly basis. Yield strata-correlated data such as yield strata coefficients and WMO stations as well as meterological data shall be provided to CAS. Up to 15 entries of yield estimate data per crop type shall be stored on disk for a given crop year. YES data shall be provided to CAS in the form of magnetic tape and punched cards.

D. Allocation Data. Allocation data shall be provided on a crop year basis for each LACIE country. Allocation data shall define each level which comprises a country hierarch

4.2.2 Data Base Structuring/Design. Data base structuring/desig capabilities shall include provisions for data base security, ini tialization, and hierarchical definition of required CAS data base(s). The CAS data base shall be sized to hold a minimum of 2 crop years of data for each data type.

4.2.2.1 Data Base Security. The integrity and security of CAS data bases shall be accomplished by operationally controlling access to the data base and by utilization of the standard securi features offered by the RSX-11D Operating System. Protection of programs and data shall be provided by the utilization of a User Identification Code (UIC) and passwords.

4.2.2.2 Initialization. The process of data base initialization includes those preliminary functions which must occur before a data base can be considered available for user access. Functions involved in this process may require utilization of certain maintenance capabilities such as data base purging (either a complete data base or selective data within a given data base); data base definition processing; data base loading (e.g., from a previous dump or checkpoint tape); and initialization of internal tables, indices, pointers, etc.

All terminal users must be signed off from the affected data base prior to initialization processing and, once processing begins, shall be locked out from accessing that data base until initialization is completed.

4.2.2.3 Data Base Definition/Hierarchy. The CAS data base shall consist of multiple data files. A data file shall be defined for each LACIE country for each data type (CAMS, YES, DAPTS) for each crop year. Allocation data shall be provided to the CAS each crop year for each of the LACIE countries. Allocation data shall define the geographical hierarchy employed in CAS data acquisition and shall be utilized as the logical structure definition of CAS data files. Allocation data shall also be stored on disk for use by application and display generation software.

The data base management software shall utilize a step-down concatenation of allocation ID's to perform data storage and retrieval operations within a given data file. The actual physical organization of a data file shall be transparent to applications interfacing with the data base management software.

The following paragraphs address storage and retrieval conventions of CAS data files for each data type.

A. CAMS Data Files. For a given crop year, a data file shall be defined for each LACIE country for storage/retrieval of CAMS-only data. A physical record within a CAMS data file shall be referenced through the concatenation of the following allocation identifiers as applicable to a given country.

- Country ID
- Region ID

the allocation hierarchy. Each logical record shall contain values for the following parameters:

- Epoch year
- Crop (harvest) year
- Spring/winter wheat designator
- Historical wheat area
- Historical wheat yield
- Historical wheat production.

The storage/retrieval of DAPTS data shall occur at each of the following hierarchical levels as applicable to a given country.

- Country
- Region
- Zone
- Strata
- Substrata.

C. YES Data Files. A data file shall be defined for each LACIE country for storage/retrieval of yield estimate data for each crop year. Each physical record of yield estimate data shall contain logical records of monthly estimate data for a single area stratum. A physical record of yield estimate data shall be referenced through the concatenation of the following allocation identifiers as applicable to a given country.

- Country ID
- Region ID

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