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AgRISTARS

A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

Domestic Crops and Land Cover Implementation Plan

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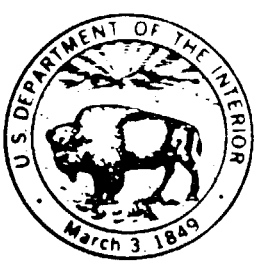
NASA



DOMESTIC CROPS & LAND COVER PROJECT

PROJECT IMPLEMENTATION PLAN

Prepared by:

GALEN HART

Level III Project Manager

Approved by:

Charles E. Caudill

C. E. Caudill, Chrm.
USDA

Date 10/28/79

W. E. Rice
NASA

Date 10/29/79

H. Yates
USDC

Date 11/16/79

A. Watkins
USDI

Date 11/2/79

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1.0 INTRODUCTION

Goal

Develop, test, and evaluate, the use of satellite data with conventional USDA/ground data sources for more precise, cost effective, and timely domestic crop and land cover acreage estimates and inventories at the state, CRD (Crop Reporting District), multicounty, and county levels in the United States.

Technical Objectives

1. Investigate and evaluate digital analysis procedures to classify crop types and other land cover as forest, rangeland, urban, water, etc., over a major portion of the United States.

2. Test and demonstrate the usefulness of data collected by Landsat and other advanced remote sensing systems when used with conventional USDA ground gathered data for improving the precision of domestic crop and land cover acreage determination at several levels such as counties, groups of counties, CRD's and entire states.

3. Investigate and determine the most efficient and cost effective method of storing and retrieving inventory information including the geographic location of change from one inventory to the next and the optimum size for the units of change, and develop a change monitoring system.

4. Develop and evaluate tailored and useful products derived from newly developed Landsat based EDITOR technology for use by farmers, agribusiness, marketers, government agencies, and planners.

5. Implement pilot experiments over two states starting in 1980, increasing the number to at least 10 states by the end of 1984 in large scale application tests.

6. LSAT activities will include the estimation of major domestic crop and land cover acreages at the state, CRD, multicounty, and county levels. These LSAT activities will proceed when RD&T outputs and USDA user evaluations suggest LSAT is appropriate. For domestic crop acreage estimation, current RD&T activities support LSAT activities beginning in 1984.

Information Needs

The USDA must obtain major domestic crop and land cover acreage estimates at the county, multicounty, CRD, state, and U.S. levels. Such a requirement is mandated by the USDA crop estimation program. Land cover information is an essential component of the resources, conservation, and commodity management baselines for various USDA agencies, e.g., FS, SCS, ESCS, and ASCS. The following is a general requirement summary subject to a more extensive evaluation included in one of the subsequent tasks.

1. Crop types - Major crops i.e., corn, soybeans, wheat, cotton, rice, barley, sorghum - acreage estimation.

2. Land Cover Types - Various key land cover parameters, e.g., forest, range, urban, crops, and sub-breakouts of these parameters - acreage estimation and mapping.

3. Coverage - Most USDA agencies concerned with land cover analysis and resource management need this information for the entire United States. Approximately 20-40 percent of the United States will be covered per year.

4. Timeliness - Requirements vary from semi-annual updates to periodic updates every 8 to 10 years, for all or part of the United States.

5. Aggregation Requirement - County, multicounty, CRD, state, regional, and country levels.

6. Cell Size Requirements - Rural 20-60 acres (crops and land use); urban 5-20 acres (land use); critical impact areas 1-5 acres (land cover).

7. Accuracy - To be determined.

8. Change Monitoring for Land Cover - Units of change for rural 20-40 acres; urban and critical areas 5-20 acres.

There is a high departmental priority for this type of information. Information on crop estimations and land cover is an essential component of the resources and commodity management baselines. Such information will serve SCS, FS, ESCS, and ASCS.

Most of the requirements for rural and urban/suburban areas can be accommodated by satellite coverage (30m - 80m). Critical impact areas, as well as detailed urban surveys, will be accommodated by aircraft photography (or other potential photography, e.g., Shuttle Large Format Camera).

Problems and Needs Addressed by the Project

1. Registration
   - Current Methods Time Consuming
   - Need for Multitemporal Analysis
   - Accommodating Master Data Processor (MPD) tape input

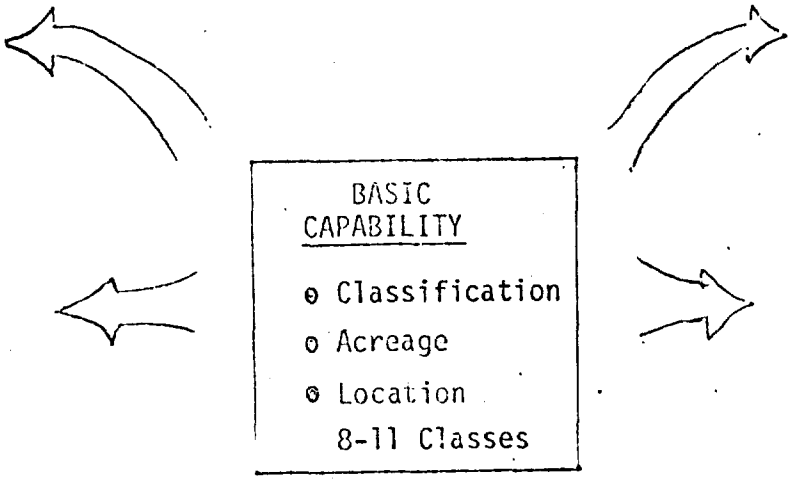
2. Preprocessing
    - Currently no preprocessing conducted
    - What corrections of potential value
        - Haze
        - Sun Angle
        - Banding
    - Partial Scene Correction
3. Clustering/Classification Algorithms
    - Expand to multitemporal analysis
    - Are there better algorithms available
    - Compatibility with increased land cover types
4. Product Use
    - How can the classifications and information be utilized (other than for area estimates by ESCS)
    - Various ways to present data
    - How to use Landsat classifications with other data types
    - Input to a geographic information system
5. Mapping/Location Specific
    - Strategies needed to improve "Percent Correct" without diminishing estimating capability
    - Best times and methods to classify certain cover types
6. Change Detection/Monitoring
    - Methods for detecting land cover change
    - How to update previous year classification to current year
    - Storage/retrieval

7. Sensor Evaluation/Requirements
    - Use of Thematic Mapper Data
        - Evaluate radiometric, spatial, and spectral characteristics
    - Future sensor needs

Project Description

The overall project framework is described in figure 1. The project is divided into two basic activities: (1) the on-going (on-line) activity and (2) the research and development (R&D) activity. The on-going activity will involve the implementation of the current ESCS "EDITOR" system (hardware/software/methodology and procedures) for providing crop acreage statistics for an increasingly greater number of states. The current system as it would be implemented in FY80 involves the use of Landsat data in the manner described in the Iowa study. The experience of implementing the current system will feed the R&D activity, but will not be altered except through following specific steps outlined later in this section. The R&D activity is divided into two basic elements: (1) current system improvement and (2) extended system capability. "Current system improvement" means making software/procedure changes to the current system for the purpose of improving cost efficiency in crop acreage estimation. "Extended system capability" means making changes to the current system that will allow the system to address applications, such as general land cover inventory and land use change detection, for which the system is not currently being used. Each R&D element will have various tasks as follows:

DOMESTIC CROP & LAND COVER ACREAGE ESTIMATION PROGRAM FRAMEWORK



CROPS

Parameters

Corn
Soybeans
Wheat
Etc.

Capability Desired

Classification
Acreage
Statistical Estimation

R&D (Exploratory)

Product Improvement
Expected Precision

R&D (Pilot Test)

2 - 8 States

LSAT

10 States

LAND USE

Parameters

Forestlands
Rangelands
Urban
Cropland
Water
Other

Capability Desired

Classification
Acreage
Change Monitoring
Location & Mapping

R&D (Exploratory)

Change Monitoring
Assess Existing Capability
Additional Land Use Classes
Multitemporal Application
Assess Pixel by Pixel vs. Sampling orCombinations
Product Improvement for Landsat D and Advanced Sensors

R&D (Pilot Test)

4 - 8 States

LSAT

10 States

Using Same Test Areas and Data Sets

FIGURE #1

Current System Improvement

1. Improve registration techniques
2. Improve clustering and classification algorithms and procedures
3. Improve preprocessing algorithms and procedures
4. Systems improvements/EDITOR Evaluation

Extended System Capability

1. Product Use
2. Land cover change detection and monitoring
3. Land cover inventory, location and mapping
4. Geographic information system interface
5. TM/sensor implementation and evaluation/requirements

Each task corresponding to the current system improvement element of the R&D activity will be implemented by following a series of specific steps. These steps are diagrammed in figure 2.

STEP 1: The first activity will be to ascertain the exact requirements for a technique as employed in the current system, and to determine how it may be employed in the extended utility system. This would involve some research personnel assigned to the task to receive orientation to the current use of the system.

STEP 2: In view of requirements defined in Step 1, various existing techniques for which the software and procedures have been fully documented will be examined. From those techniques examined, a selected number of techniques could be identified for additional evaluation.

STEP 3: Evaluate the selected techniques. This will be accomplished in an off-line mode. The evaluation results will be stated in terms of

FIGURE 2

DOMESTIC CROPS AND LAND COVER
OPERATING FRAMEWORK

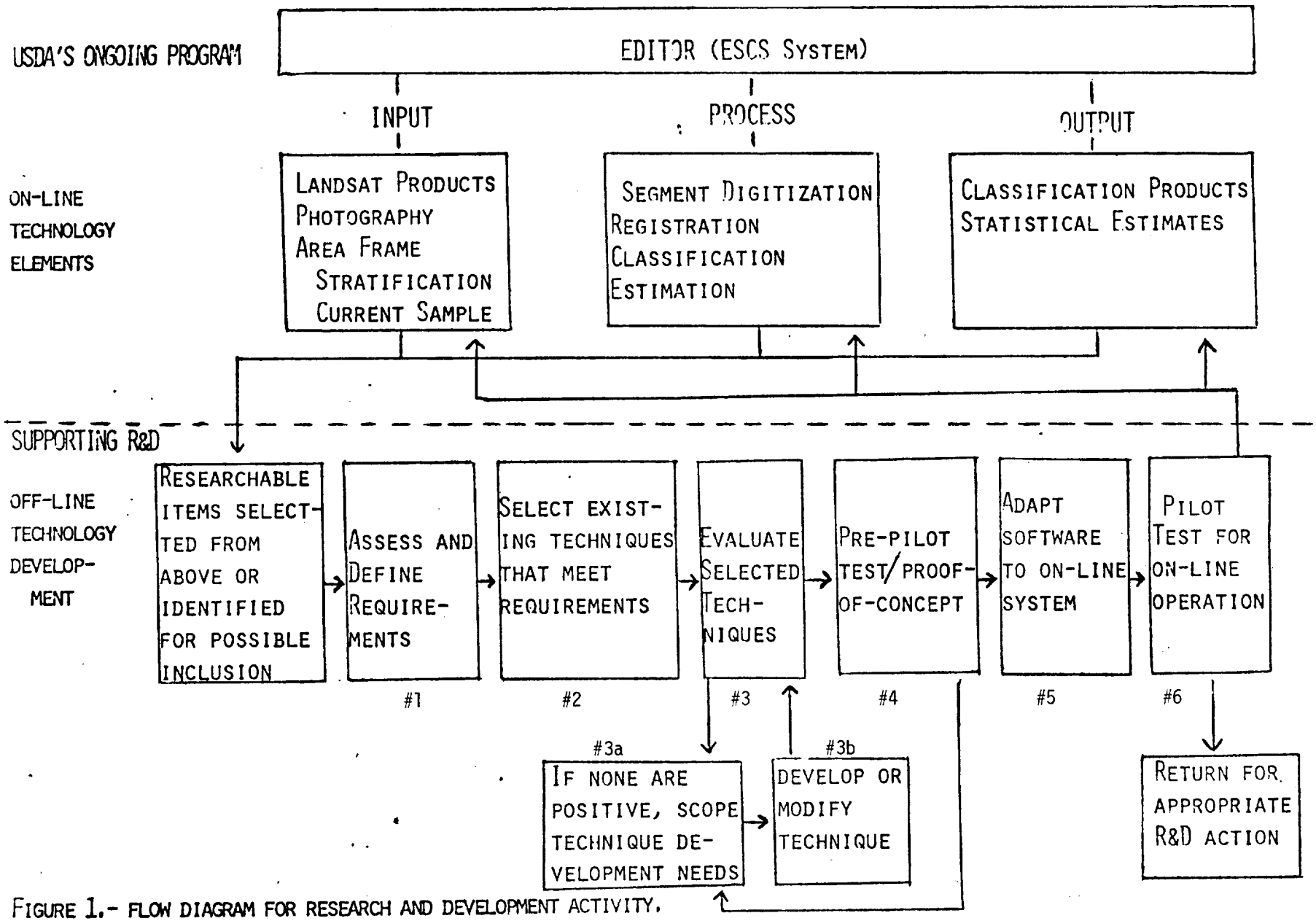


FIGURE 1.- FLOW DIAGRAM FOR RESEARCH AND DEVELOPMENT ACTIVITY.

operating cost and performance as compared to the operating cost and performance of the technique utilized in the on-line system. In the process of conducting technique evaluation tests, no technique other than the technique being tested will be altered so that any differences in results will relate solely to the differences in the techniques being evaluated. The end result of this step will be to determine which, if any, of the techniques showed the greatest improvement over the current on-line technique, and whether or not the improvement was of a sufficient magnitude to justify additional testing in subsequent steps.

STEP 3A: If none of the evaluated techniques show sufficient improvement over the technique employed in the on-line system, the experience in steps 1, 2, and 3 will be utilized to determine whether additional technique development (or modification) is feasible. If not, the task will be terminated.

STEP 3B: If another technique is defined in Step 3A, technique development would take place and the technique will be evaluated as in Step 3.

STEP 4: The technique receiving the most favorable evaluation in Step 3 will be subjected to a pre-pilot test. This test, as the evaluation in Step 3, will be conducted off-line. However, as opposed to Step 3 evaluation tests which will be conducted with a small Landsat data set, the pre-pilot test in Step 4 will encompass a sufficiently large area to be evaluated by independent methods or information. The results will be evaluated by comparing the cost and performance of the technique with the cost and performance of the on-line technique. If not satisfactory, a decision will be made as to the feasibility of reverting to Step 3A.

STEP 5: If satisfactory, software for the technique will be adapted to the computer being used for the on-line system, and procedures associated with the software will be fully documented.

STEP 6: A large pilot test will be performed for a "large" area, or if feasible, an entire state. This test will be conducted in a quasi-operational mode. The term "quasi-operational" implies that the data utilized would pertain to the current growing season and that the activities would be conducted on a time schedule dictated by the operational requirements. The pilot test would be conducted at the same time that the same state was being addressed by the current system.

As the on-going activity proceeds through use of the current system, various techniques that offer potential for improving or extending the capability of the current system will be advanced through the selection, evaluation, and pilot test stages of the research and development activity. Each improved or extended capability technique will be subjected to an individual pilot test. Software associated with any new technique that receives a positive evaluation will be adapted to the appropriate host computer in the on-line system for pilot testing. Each year, beginning with completion of the first successful software adaptation to a on-line computer, a pilot test will be conducted. The pilot test will be conducted in a quasi-operational mode for a "large area", an entire state if feasible. The area will be a part of the on-going activity, and the data processing for the pilot test will be conducted currently with data processing through the current system. If the results of the pilot test are favorable, then, the technique

applied in the test will become part of the current system during the next crop year processing cycle.

The first LSAT is scheduled for FY84. As a minimum, it will include several techniques. During FY85, the LSAT will encompass all improved techniques for preprocessing, registration, and classification, and involve extension of the system capability to produce land cover statistics and classification products. The system will accommodate Landsat TM data input.

MAJOR ELEMENTS ADDRESSED BY THE PRODUCT

The following major elements and associated tasks are addressed in sections 3 and 4.

Current Area Estimation for Major Crops

(2 states/yr)

Registration

Scene-to-scene/multemporal

Scene-to-map

Systems Improvements

Editor Evaluation/Immediate Improvements

Future Design

Classification/Clustering

Crop Area Estimation

Cover Mapping

Consolidated Procedures

Product Use

Land Cover Inventory and Mapping

Requirements

Area Estimation, Location, and Mapping

Change Detection

Information Systems

TM/Sensor Implementation

TM Procedures

Other Sensor

Sensor Requirements

Preprocessing

1.1.0 STATEMENT OF PROJECT OBJECTIVES

1.1.1 FY80 Objectives

1. Provide state and substate acreage estimates of major crops by combining probability ground and LANDSAT data for two states (Iowa and Kansas). The technical approach to be used in 1980 is the use of LANDSAT data as an auxiliary variable in a regression estimator as in the previous ESCS projects. This approach has reduced relative sampling errors associated with the June Enumerative Survey on the order of two to fourfold. A major thrust will be a timely result capability.

2. Develop a multitemporal procedure to register scene to scene LANDSAT images without altering the radiometric properties of the data. Such a multitemporal procedure will entail a set of algorithms (automatic and/or semi-automatic) that will work across the U.S. This approach can substantially improve our ability to separate crop types and reduce the present bottleneck in the registration and processing of LANDSAT data.

3. Determine how the current EDITOR system used for crop acreage estimation (using ground and LANDSAT data) can be improved and select those improvements to be implemented in FY81. These improvements will be an upgrade of the current system to better perform the proposed Domestic Crops and Land Cover Research Program tasks.

4. Assess clustering/classification technology for improving crop area estimation and land cover location and mapping. The best suited algorithms will be selected for further modifications and testing.

5. Modify and/or further develop a selected algorithm for improved classification to be used in the ESCS procedure for calculating LANDSAT-based crop area estimates.

6. Evaluate current USDA crop and land cover inventory requirements, inventory methods, and data systems to identify possible uses of LANDSAT data in inventory efforts, potential multiple use between agencies, potential for combination of inventories, and information needs and remote sensing requirements efforts. Results from this objective will provide input and definition to other tasks.

7. Assess current technology for land cover estimation and mapping (both the EDITOR system and other technologies with regard to level of land cover mapping obtained, accuracy, omission/commission errors, processing techniques classification algorithms, procedures, sampling methodologies, systems thru-put, etc. The product of the assessment will identify improvements needed and a basic framework for an overall experiment design and performance criteria in FY81.

8. Investigate existing change detective/monitoring technology. Identify improvements needed and begin to develop an overall experiment design and performance criteria for FY81 to perform change monitoring and update of USDA inventories.

9. Collect TM simulator data over selected sites within two states. Begin an assessment of TM simulator data to determine separability of major crops, small fields and land cover units, separation of various land cover types, area estimation, and mapping accuracies. This will help lay the groundwork for developing TM procedures.

10. Investigate and select procedures for using atmospheric/sensor correction algorithms and automated cloud masking techniques. Currently ESCS uses no preprocessing procedures. The thrust will be to determine if preprocessing can improve crop and land cover classifications in a cost effective manner.

1.1.2 FY81 Objectives

1. Expand state and substate crop acreage estimates to four states (Iowa, Kansas and two additional states). Improvements, i.e., multitemporal registration, preprocessing, classification, and other improvements developed under FY80 tasks will be pilot tested.

2. Conduct proof of concept testing of the developed multitemporal registration algorithm (FY80 objective #2) and adapt procedure to the on-line EDITOR system. Pilot testing will occur late in FY81.

3. Initiate development of automatic procedures for scene to ground registration. Determine the feasibility of using library process.

4. Upgrade and test the EDITOR system based on selected improvements outlined in FY80 objective #3. Initiate design study for long range implementation and projected large-scale use (operational).

5. Adapt to on-line EDITOR system the developed classification algorithm for crop acreage estimation (from FY80 objective #5). Conduct pilot test inconjunction with four state expansion objective.

6. Modify and/or further develop a selected classification algorithm for land cover location and mapping. Considerable attention will be given to achieve high percent correct classification and minimizing omission/commission errors.

7. Complete the experiment design and performance criteria for developing an integrated satellite/ground system to provide land cover inventory and mapping information at state and county levels.

8. Initiate the development of a land cover inventory and mapping capability. Develop integrated procedures using various components selected from other tasks e.g., classification, registration.

9. Complete the experiment design for developing a change detection and monitoring capability.

10. Begin the development of a change detection/monitoring capability by modifying current techniques and procedures.

11. Assess the requirements and evaluate the various uses of geographic information systems within the USDA. Initiate the development of procedures for input and interface of remotely sensed data to various geographic information systems. Select application/management models for evaluating the utility of information systems.

12. Complete the assessment and evaluation of TM simulation data. Initiate the development of TM procedures for integration in the inventory and mapping process of crops and land cover. Assess the utility of side looking radar data and LANDSAT RBV data applied to this process.

13. Adapt atmospheric/sensor correction and cloud masking procedures to on-line EDITOR system and perform pilot testing.

1.1.3 A summary of responsibilities for the various tasks are listed in Table 1. This table depicts the agency which is responsible for specific task elements and does not show the coordination and interactions that will occur between the agencies. This cooperation can be seen in the tables containing the consolidated resources. In most tasks, NASA and USDA are combining funds and man year equivalents to accomplish task objectives.

NASA's primary responsibility is to conduct research and development, in an off-line mode, to meet task objectives. USDA will maintain an on-line capability, which will be used by USDA analysts to obtain state crop area estimates. USDA will also be responsible for adapting on-line those technologies, developed and tested in the off-line mode, which lend improvement to the on-line capability.

TABLE 1

1.3.0 Summary of Responsibilities

Element/Task	Task Mgr.	Assess Tech.	Provide Remotely Sensed Data	Provide Ground Truth	Procedure Development	Proof-of Concept Testing	Adapt on Line	Establish Performance Criteria	Pilot Test
Major Crop Area Estimates									
• 2,4,6,8,10 states/year starting in 1980	USDA	-	USDA	USDA	-	-		USDA	USDA
Registration	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
Systems Improvements	USDA	NASA USDA	-	-	-	-	USDA	-	-
Clustering/Classification									
• Crop Area Estimation	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• Land Cover Mapping	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• Estimation & Mapping	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
Product Use	USDA	USDA	USDA	USDA	USDA	USDA	USDA	USDA	USDA
Land Cover Mapping									
• USDA Needs Requirements	USDA		-	-	-	-		-	-
• Area Estimates, Location and Mapping	USDA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• Change Detection/ Monitoring	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• Geographic Info. Systems	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
Sensors									
• Thematic Mapper	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• RBV, LFC, etc.	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA
• Future Sensor Requirements	NASA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	-	-	-
Preprocessing	USDA	NASA USDA	USDA NASA	USDA	NASA USDA	NASA USDA	USDA	USDA	USDA

NASA Center assignments to the various, tasks are given in each of the detailed task definitions (Section 4).

2.0 RESOURCE SUMMARY

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2.1.1 CATEGORIZATION OF AVAILABLE RESOURCES ($) ***

	FY80	FY81	FY82	FY83	FY84
USDA	*** 1525K	*** 2140K	-	-	-
o Civil Servants	750				
o Inhouse Contract	0	TBD	TBD	TBD	TBD
o University Contract	0				
o Government Agency Contract	(400K) (NASA) (35K) (USDI)	(850K) (NASA) (70K) (USDI)			
o Private Industry	(150K)	(380K)			
o Inhouse Misc. **	(190K)	(300K)			
NASA	450K	1140K	-	-	-
o Civil Service	0	0			
o Inhouse Contract	(275K)	(870K)	TBD	TBD	TBD
o University Contract	(90K)	(100K)			
o Government Agency Contract	(10K) (USDI	(10K) (USDI)			
o Inhouse Misc. **	(75K)	(160K)			

** Inhouse Miscellaneous - Data processing, services, etc.

***These are approximate numbers. Final numbers will be available when task planning is complete

2.2.0 SUMMARY OF STAFFING RESOURCES

	FY80	FY81	FY82	FY83	FY84
USDA	21.6	26.25	31.75	35.9	36.0
NASA	5.0	9.9	5.05	3.75	2.3

3.0 SUMMARY OF PROJECT ELEMENTS AND ASSOCIATED TASKS TO BE COMPLETED

3.0 SUMMARY OF ELEMENTS AND ASSOCIATED TASKS TO BE COMPLETED

Although the FY80 and FY81 objectives have been outlined in Section 1.0, the tasks for the Domestic Crop and Land Cover Program are more general and active beyond FY81 through FY84. This section will describe separately each element and associated tasks in conjunction with their particular emphasis for both FY80 and 81.

3.1 General Element and Task Descriptions (FY80 - FY81)

1. Current Area Estimates for Major Crops

   o Task 1/Full State Crop Estimates (2 states/year)

   Improve state and substate acreage estimates of major land covers by combining probability ground and LANDSAT data. Estimate current season major crop acreages at state and substate levels (CRD's, county grouping and counties) each year (FY80 - 84) for 2 states/year accumulating to 10 states in FY84. The timeframe for the estimates will be for the late-growing season to mid-December.

Emphasis FY80

- Crop estimates for 2 states (Kansas and Iowa) will be made.
- Timely result capability

Emphasis FY81

- Successful expansion to 4 states (major crops)
- Systems improvements - in particular registration, classification

Resources

FY 80				FY 81			
$		CS		$		CS	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
400	0	14	0	800	0	18	0

2. Registration

- Task 1/Multitemporal scene-to-scene
- Task 2/Scene to map/ground

Manual registration in ESCS has been a bottleneck in their estimation process and single time imagery is not adequate for separating many of the crop types. Therefore the major thrust of this effort is to develop full frame multitemporal mapping algorithms for the United States and to achieve overall registration accuracy of 40 meters RMS. In addition, determine effect of different re-sampling algorithms on classification, develop seed point selection methods to utilize easily remotable TTY compatible devices, and develop techniques for automatic image to image matching of geo-graphically location features. A second phase of the effort beginning late FY80 will be to develop a capability to register current scenes to ground by means of previously registered scenes.

Emphasis FY80

- Review previous multitemporal research and select possible approaches
- Find mapping algorithms that will work over entire United States
- Find algorithms that are independent of seasonal variations

Emphasis FY81

- Determine requirements and methods for automatic image to image matching of seed points
- Conduct a pilot test for the multitemporal registration algorithms
- Determine feasibility of using library of base images to automatic scene-to-ground by using the multitemporal process.

Resources

FY 80				FY 81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
100	200	.75	1.75	100	150	.75	1.5

3. Systems Improvement

o Task 1/Editor Evaluation and Analysis (immediate improvements)

o Task 2/Future Systems Design Study

The current system was developed mostly on an Ad Hoc research basis. The overall task description is to determine how the current system could be improved and select areas for research toward improvement. This is phase 1 and continues through 81. Candidate improvement research must take into account the existing systems constraints and potential for future systems implementation. The second phase beginning in FY81 is to decide what type of system is needed for future use (operational use).

Emphasis FY80

- Develop general rules and directions for future system development.
- Review current system and provide a report indicating areas of possible improvement
- Select the specific areas for improvement

Emphasis FY81

- Initiate design study for long range implementation for large scale use
- Implement improvements (immediate)

Resources

FY 80				FY 81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
50	25	2.0	.25	100	50	1	.75

4. Classification/Clustering Algorithm Development

Objectives of the Domestic Crops and Land Cover Program include reliable crop area estimates at county level as a major target. For land cover mapping at the county level, a high % correct classification is desired. The task is to develop, test, and evaluate classification algorithms for providing improved area estimates and mapping of crops and land cover. Subtasks include:

Task 1 - improve classification capabilities for crop area estimation;

Task 2 - Develop/modify algorithms for land cover mapping;

Task 3 - Develop procedures for obtaining both area estimates and quality land cover maps in a cost-effective manner.

Emphasis FY80

- Assess current and state-of-the-art classification algorithms for improving crop area estimates
- Develop, modify and test procedures based on assessment
- Initiate assessment of algorithms needed for land cover mapping

Emphasis FY81

- Adapt and pilot test algorithms and procedures for crop area estimates
- Begin development and modification of algorithms for land cover mapping

FY80				FY81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
100	175	.25	1.75	100	250	.5	2.0

5. Product Use

o Task 1/Develop user participation/product evaluation

The major users of the crop-area estimates would be USDA's Crop Reporting Board and ESCS's State Statistical Offices. The Crop Reporting Board and SSO's would consider the LANDSAT regression estimates along with current survey results to arrive at official USDA estimates. Any benefit in accuracy would thus be passed on to the conventional users of USDA crop-area statistics, such as farmers, marketers, economist, agri-business government agencies and planners, etc. The overall task would seek to include legitimate users to spread "core" processing costs. The task would:

(a) Identify likely public interests (national, regional, state);

(b) Review present system and procedures (major crop cover estimation;

(c) Invite participation;

(d) Create tailored products for participant evaluation; and

(e) Refine and seek on-going participation.

Emphasis FY80

- Invite participation
- Identify user needs and research needs
- Provide limited test procedures

Emphasis FY81

- Create tailored products
- Develop product evaluation procedure and feed-back mechanism

Resources

FY 80				FY 81			
$		CS		$		CS	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
50	0	1	0	100	0	2	0

6. Land Cover Inventory, Location and Mapping

Within USDA there are many land cover user needs not being adequately met. This overall task is to develop, test, evaluate, and implement an integrated satellite/ground capability for land cover inventory, location and mapping. The tasks include:

Task 1 - Identify and evaluate current USDA inventories, data systems, and requirements;

Task 2 - Investigate and develop procedures to modify current EDITOR system to accommodate needs (area estimates) and develop a capability for location and mapping;

Task 3 - Investigate and develop a change detection/monitoring capability; and

Task 4 - Evaluate the utility and develop a capability to integrate remote sensing data to geographic information systems.

Emphasis FY80

- Intensive assessment to identify and evaluate current USDA requirements and inventories
- Investigate and assess both EDITOR and the state-of-the-art technology for land cover inventory, and mapping, and change detection.
- Experiment design

Emphasis FY81

- Procedure development to modify EDITOR
- Begin procedure development for providing land cover mapping and change detection
- Assess the utility of geographic information systems to accept remotely sensed data.

Resources

FY80				FY81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
75	50	3.0	1.0	200	390	3.0	3.5

7. Thematic Mapper/Sensor Implementation and Evaluation

Understanding and evaluations for improving crop and land cover classification and acreage estimation are required for Thematic Mapper (TM), Symthetic Aperture Radar (SAR) and Large Format Camera (LFC). Future sensor requirements within the domestic crops and land cover program will also be investigated.

The tasks will include:

Task 1 - Evaluate and develop procedures for using TM to improve crop acreage estimation and land cover mapping;

Task 2 - Determine the utility and develop procedures for using other sensors (e.g., SAR, PBV, LFC, etc., as an integral part of the estimation and mapping process;

Task 3 - Determine the utility and understand the improvements contributed by future sensors, e.g., MRS; and develop sensor needs/requirements for future crops and land cover programs through program/research experiences.

Emphasis FY 81

- TM technology assessment to lay groundwork for development of TM procedures
- Collect TM simulation data - temporary procedures to be developed for TM evaluation
- Assess the utility of SAR and RBV

Resources

FY80				FY81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
0	0	.5	.25	150	200	.75	1.9

8. Preprocessing

o Task 1/Preprocessing Procedures

Currently there is no preprocessing conducted for the LANDSAT data processing within the crop area estimate process. The task is to determine if preprocessing can improve crop and land cover classifications in a cost effective manner. Areas considered are atmospheric and sensor corrections and cloud masking procedures.

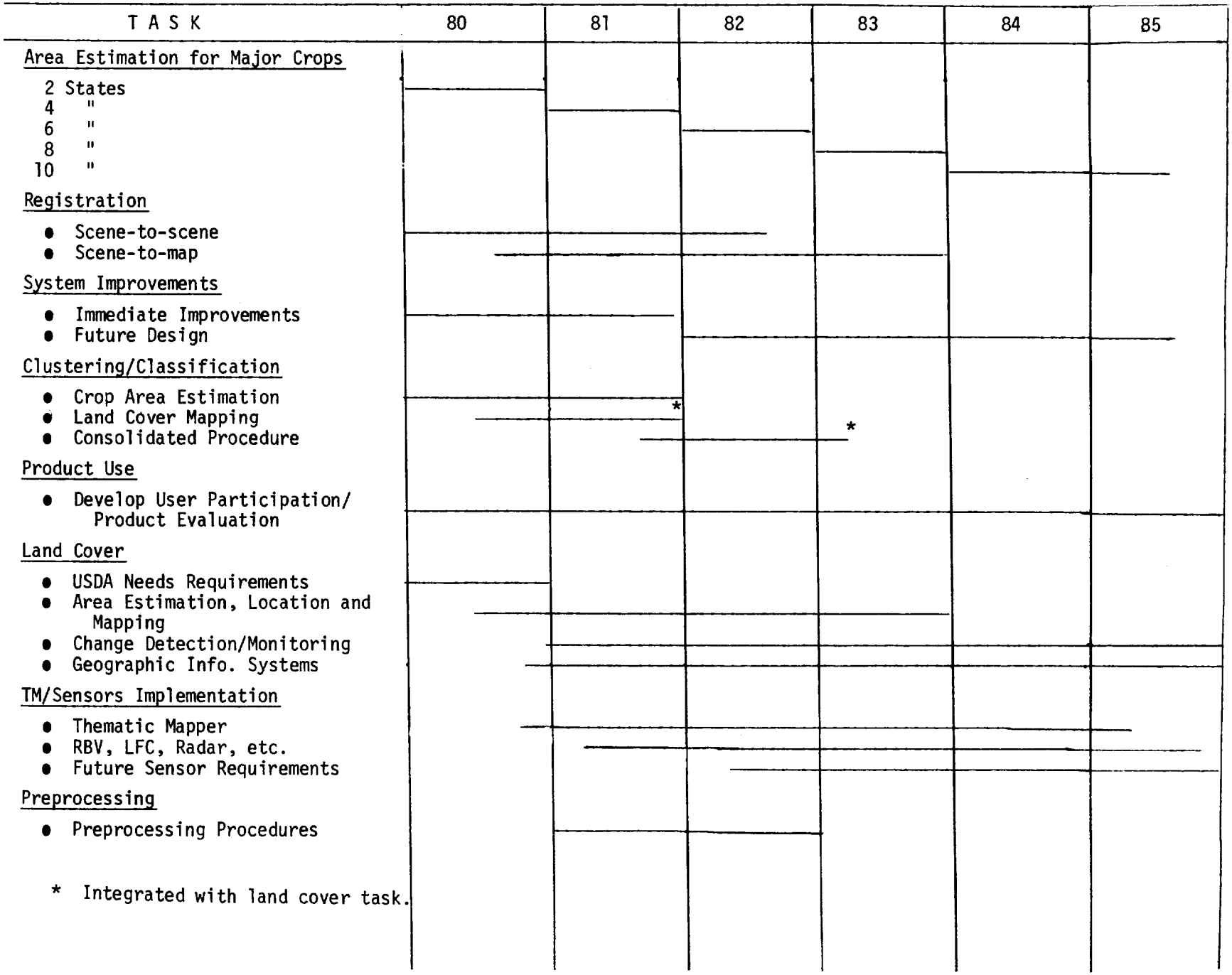
Emphasis FY81

- Investigate and assess currently available haze correction and sensor correction algorithms
- Investigate the utility of existing automated cloud masking procedures

Resources

FY80				FY81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
0	0	.1	0	50	100	.25	.25

3.2.0 Consolidated Schedule



DOMESTIC CROPS AND LAND COVER
TASKS AND RESOURCES BY AGENCY

	FY80				FY81			
	$		MYE		$		MYE	
	USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
Current Area Estimation for Major Crops								
o Full State Crop Est. (2 state/year)	400	0	14	0	800	0	18	0
Registration								
o Scene-to-scene/Multitemporal	100	150	.75	1.25	100	100	.5	1.0
o Scene-to-map	0	50		.5	0	50	.25	.5
Systems Improvements								
o EDITOR Evaluation Immediate Improv.	50	25	2.0	.25	75	0	.75	.25
o Future Design					25	50	.25	.5
Classification/Clustering								
o Crop Area Estimation	100	125	.25	.75	50	50	.2	.5
o Cover Mapping	0	50	0	1.0	50	150	.2	1.0
o Consolidated Proced.				.5	0	50	.1	.5
Produce Use								
o Product Eval/User Participation	50	0	1	0	100	0	2	0
Land Cover Inventory & Mapping								
o Requirements	0		2.5	.1				
o Area Estimation, Location & Mapping	75	50	.3	.6	120	170	2.0	1.5
o Change Detection	0		.1	.2	50	170	.5	1.5
o Information Systems	0	0	.1	.2	20	50	.5	.5
TM/Sensor Implementation								
o TM Procedures	0	0	.5	.25	125	100	.5	.8
o Other Sensor					25	100	.15	1.0
o Sensor Requirements					0	0	.1	.1
Preprocessing	0	0	.1	0	50	100	.25	.25

4.0 DETAILED TASKS DEFINITIONS

4.0 DETAILED PROJECT ELEMENT AND TASK DEFINITIONS

4.1 Project Element - Implementation of Current Area Estimations for Major Crops

4.1.0 Task 1 - Full State Crop Estimates (2 states/year)

.06 .01 .01 .02 .00 .120400 .010XXX .010 XXX
.030 XXX
.990 XXX
.140XXX .250 XXX

4.1.1 Description of Task

Based on previous ESCS research in Illinois (1975), Kansas (1976); California (1976, 1977), and Iowa (1978) the objective in 1980 will be crop-area estimation in two states (Kansas and Iowa). Technical objectives are to substantially reduce the sampling errors for crop-area estimates at the state and substate levels compared to conventional USDA/ESCS estimates. The LANDSAT data is to be used as an auxiliary variable along with ESCS's conventional ground survey data collected during the June Enumerative Survey. Beginning in 1981, two states per year will be added to this task. In 1985, a LSAT will be conducted over ten states. Detailed documentation of ESCS's previous research experience is available.

The scope of the task in 1980 is to complete the crop-area estimation for both Kansas and Iowa. It is intended that these estimates be available as a supplement to other current survey estimates for USDA Crop Reporting Board and USDA/ESCS State Statistical Offices official estimates.

The task would begin with preparation for ground data collection in November 1979 and end with crop-area estimation by December 15, 1980.

*Gleason, C., Starbuck, R., Sigman, R., Hanuschak, G., Craig, M., Cook, P., and Allen, R., "The Auxiliary Use of LANDSAT Data in Estimating Crop Acreages: Results of the 1975 Illinois Crop Acreage Experiment," Statistical Reporting Service, U.S. Department of Agriculture, Washington, D.C., October 1977.

4.1.2 RESEARCH TO BE CONDUCTED

The technical approach to be used in 1980 is the use of LANDSAT data as an auxiliary variable in a regression estimator as in the previous ESCS projects. The procedures used to accomplish this task comprise the on-line capability, which is referenced several places throughout this document. This approach has reduced relative sampling errors associated with the June Enumerative Survey on the order of twofold to fourfold. Anticipated results are crop-area estimates for winter wheat in Kansas and corn and soybeans in Iowa at the state and substate levels. These estimates are anticipated to be a supplement to current survey estimates for use by USDA's Crop Reporting Board and ESCS's Kansas and Iowa State Statistical Offices. All data security procedures of USDA/ESCS will be enforced.

After 1980, two additional states per year will be added to the estimation task and analyzed using the on-line capability. This task will include other land cover types and additional techniques which were developed and tested in the off-line, R&D mode.

4.1.3 ORGANIZATION/RESPONSIBILITY

This task will be the primary responsibility of USDA/ESCS's Statistical Research Division. The task Manager will be William Wigton of USDA/ESCS/SRD.

**Craig, M., Sigman, R., and Cardenas, M., "Area Estimates by LANDSAT: Kansas 1976 Winter Wheat", Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture, Washington, D.C., August 1978.

***Hanuschak, G., Sigman, R., Craig, M., Ozga, M., Luebbe, R., Cook, P., Kleweno, D., Miller., "Crop-Area Estimates from LANDSAT: Transition from Research and Development to Timely Results", Proceedings of the 1979 Symposium on Machine Processing of Remotely Sensed Data. Purdue University, West Lafayette, Indiana.

4.1.4 RESOURCES

	1980		1981	
	$	MYE	&	MYE
USDA	400	14	800	18
NASA	0	0	0	0

USDA will select and acquire all LANDSAT data, collect ground truth, and analyze all data. NASA will not be involved in this on-line capability. except for interfacing the on-line/off-line modes, which is discussed in 4.1.6.

4.1.5 ELEMENTS OF THE TASK FOR FY80 AND THE SCHEDULE ARE AS FOLLOWS:

Element	Location	Kansas	Iowa
Prepare for Ground Data Collection	ESCS/SRD,DCB	11/79-4/80	11/79-4/80
Ground Data Collection	ESCS/SSO's	3/80-6/80	5/80-7/80
Ground Data Editing	ESCS/SSO's	3/80-6/80	6/80-7/80
Segment Digitization	ESCS/SSO's	7/80	7/80-8/80
Acquire LANDSAT Data CCT's & B&W Transparencies	ESCS/SRD	4/80-7/80	7/80-9/80
Register LS Scenes	ESCS/SRD	6/80-7/80	10/80
Analyze LS Data and Calculate Regression Estimates	ESCS/SRD	8/80-9/80	11/80-12/80
Write-up Research Report	ESCS/SRD	10/80-2/81	1/81-3/81

MILESTONES ARE AS FOLLOWS:

The delivery to USDA/ESCS from USDI/EROS of LANDSAT CCT's and high contrast B&W transparencies (all four bands) two weeks after acquisition.

Registration of LANDSAT scene to map one week to ten days after receipt of the data (CCT and transparencies) by ESCS.

Analysis of LANDSAT data and calculation of crop-area estimates two weeks after registration is complete using ILLIAC IV for full frame classification.

Submission of crop-area estimates in a timely fashion to ESCS's Crop Reporting Board and State Statistical Offices.

Write up of pilot test results.

4.1.6 INTERFACES

The actual operation of the on-line capability will require no interfaces. But, the structure of the domestic crops and land cover program requires numerous interfaces between the on-line and off-line mode. Many of the R&D tasks will use the data sets established for crop estimation. Also, proven technology developed and tested in off-line will be transferred and adapted to the on-line capability.

4.1.7 DATA ACQUISITION

Data acquisition is crucial to the accomplishment of this task. LANDSAT CCT's (not HDT's) and high contrast B&W transparencies (only high contrast band) are needed two weeks after satellite acquisition.

Full frame data (single data) is required for complete coverage (minus clouds) of both states during the optimum time period for the crops of interest. This will be approximately 35 LANDSAT scenes. The number of scenes will increase 20-35 scenes per year through 1984.

Aircraft high altitude photography will be required for segment verification and assist overall verification of proposed tests. 100 segments (1x1 mile) will need coverage in each of the 2 states flown each year. Specific constraints will be identified each year through the NASA Airborne Instrumentation Research Project Office.

A computer capability equivalent to ILLIAC IV must be maintained and provided by NASA through FY83. Thereafter a capability must be provided by USDA. The USDA will provide funds to NASA/ARC for ILLIAC processing costs applied to this task and other related tasks within the Domestic Crops and Land Cover Project.

4.2 Project Element - Registration

4.2.0 Task 1 Multitemporal/Scene-to-Scene Procedures

.06 .02 .01 .01 .00 .120100 .130100 .020100

.200150 .050150 .020150

Task 2 Scene to Map/Ground Procedures

.06 .02 .02 .01 .00 .120000 .130000 .990000
.200050 .050050 .020050

4.2.1 Description of Tasks

Scene-to-scene registration is the process whereby LANDSAT image(s) is made to overlay another LANDSAT image of the same area taken at a different time. Of most value are those dates of images for different seasons which allow greater spectral separability of the crops under analysis. Successful completion of this task will allow more rapid and accurate scene-to-scene registration than is presently possible.

Scene-to-map/ground registration will address the question of creating procedures to obtain scene to map registration. Details of this task are currently not available and will be defined in FY80.

1. Objectives

The objectives of these tasks are to develop algorithm(s) which do scene-to-scene registration equally well across the United States and still maintain the radiometric properties of the LANDSAT data. Selection of seed points should work within the EDITOR system format (i.e., no CRT) with accuracies of 40 meters RMS for a uniformly distributed control network of 200 points containing at least 85% of the scene. Means of using

the header annotation records to obtain geographic locations of matching control points should be developed. A second phase of this project element is a scene-to-map registration utilizing base images previously registered to a map.

2. Scope

Conduct a literature review and assess the currently available methods and algorithms. Execute a test to compare mathmatical and statistical algorithms. A registration procedure will be established and a report written by NASA detailing the algorithms and elements of the procedure.

3. Probable Duration of the Task

Completion of this project element will be achieved by the end of FY82 with the algorithm development coming in FY80 and testing in FY81. Additional improvements and development of a scene-to-scene map capability will be done in Phase II during FY82-84.

4.2.2 Research to be Conducted

The research effort should be targeted at providing mapping algorithms of wide applicability so that they may be used in cropland, forested areas, urban areas, and deserts. It should include comparisons and evaluations of the methods developed by NASA/ERL, LARS of Purdue University and the Canadian Center for Remote Sensing. Research will include the testing of at least three sampling procedures, including nearest neighbor, bi-linear interpolation and cubic convolution. Technique development will include the selection of control points without the use of CRTS, a test of the feasibility of obtaining registration through the use of the tape header annotation, and an examination of the possibility of more accurate registration (to 30 meters RMS).

The ERL, LARS, and Canadian registration method will be performed on Landsat scenes from three sites for each terrain/land cover category (see list).

Two dates of data will be selected in each case from among the four seasons as most representative for use in that type of region. This will require the use of 36 LANDSAT scenes.

After selection of the best registration method, further testing will continue using the various resampling methods combined with the selected registration method. This phase will require selected analysis areas containing USDA/ESCS ground data and associated LANDSAT scenes. An analysis of percent correct classification and the overall correlation between classified pixels and ground data acreage would then determine which resampling method is best. This testing will require a study of three sites with two dates of imagery for each - i.e., a total of six(6) LANDSAT scenes for each registration/resampling algorithm combination to be evaluated.

Additionally, in each case, a visual examination of the overlay by each method will be made. Any method not giving good visual correlation will not be used in the further analysis using ground data.

The second task of the element will address the question of creating a method to obtain scene-to-map registration through the use of a library of base LANDSAT images registered to map. Later, LANDSAT scenes over the same area would be related to map

coordinates through a scene-to-scene registration to the base images. Details of Task 2 will be developed during 1980.

The final product of this project will be a full report detailing the mathematical and statistical formulae necessary to implement the multi-temporal registration as well as whatever computer programs are needed to achieve the aforementioned goals.

4.2.3 Responsibility

1. The overall task manager will be at NASA/NSTL-ERL.
2. NASA will provide:
   a. Technical and contract management of their assigned work within the task.
   b. Technical integrity for task.
   c. Assessment of technology.
   d. Experiment design.
   e. Development of procedures.
   f. Proof-of-concept test and evaluation.
   g. Support to pilot test accuracy assessment and performance evaluation.
   h. Support technology adaption.

3. USDA will:

   a. Conduct Pilot Test.

   b. Perform Pilot Test accuracy assessment and performance evaluation.

   c. Support the assessment, experiment design, procedure development, and proof-of-concept testing.

   d. Establish performance criteria.

   e. Decide go-no-go for technology adaption to on-line.

   f. Perform technology adaption.

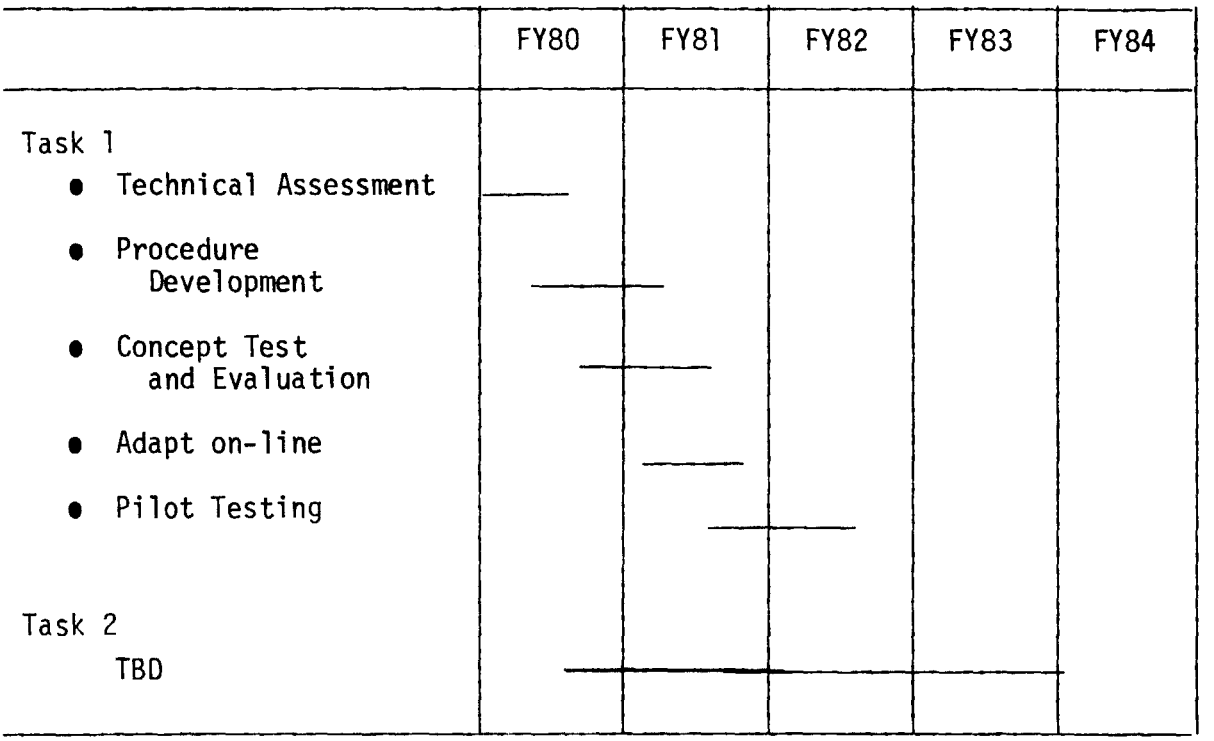
4.2.4 Resources

	FY80		FY81	
	$	MYE	$	MYE
USDA	100	.75	100	.75
NASA	200	1.75	150	1.5

NASA/ERL civil service manpower will be predominately for technical and contract management for their assigned work. Most of the NASA dollars will be for contracts (both in-house and outside). These dollars allow for NASA data processing costs from procedure development through proof-of-concept testing.

USDA civil service manpower will support directly their assigned work and provisions for technical management. Their dollars allow for USDA data processing costs involved for Pilot Testing and the adaption of procedures to on-line. USDA will provide supporting funds to NASA assigned work, i.e., assessment/experiment design, procedure development, and proof-of-concept testing. The level and split of funding will be determined as the task is better defined.

4.2.5 Schedule for Multitemporal Registration



4.2.6 Interfaces

Registration is required by other AgRISTARS projects, therefore, some interfacing is anticipated.

4.2.7 Data Requirements

USDA/ESCS will provide necessary funding to purchase the required LANDSAT scene for the selected analysis areas. The data should be obtained in a timely manner. Much of the data can be used from the "Current Crop Estimation in 2 States/Year" task . .

1. Acquisition

LANDSAT CCT's and ground data for the selected areas will be provided by USDA/ESCS.

2. Preprocessing

The NASA facility will determine what, if any, data preprocessing requirements must be met.

4.3 PROJECT ELEMENT SYSTEM IMPROVEMENTS AND DEVELOPMENT

4.3.0 Task 1 EDITOR Evaluation and Analysis (immediate improvements)

.06 .03 .01 .04 .00 .120050 .140050 .380035
.390015
.200025 .040025 .250025

Task 2 Future Design

.06 .03 .02 .04 .00 .120000 .990000 .990000

.200000 .050000 .990000

4.3.1 Descriptions of Tasks

The EDITOR system has been primarily developed as an R&D system. Some elements of this system could be revised and updated which would increase the efficiency of the overall system. EDITOR also needs to be examined and evaluated in accordance with future needs to determine how to meet future processing requirements.

1. Objective

   There are four objectives of this task:

   - Decide the overall purpose and philosophy of the future system.
   - Critique the current system in view of future development objectives and data processing techniques.
   - Select the necessary improvements and determine an implementation plan.
   - Implementation of a revised system to produce agricultural estimates from LANDSAT data.

2. Scope

   This project element will be carried out in two phases. Phase I will occur in 1980 and 1981. During this time the current system will be examined

for areas of immediate improvement. Elements selected for upgrading the system will be implemented in 1981. During Phase II, beginning in 1981, studies will be underway to determine specifications and decisions that will need to be made concerning what type of system is needed for future use. Implementation of the system will be completed in 1984, prior to LSAT.

4.3.2 Definition of Research to be Conducted

The research effort will be directed at providing a more responsive data processing system that better suits the needs of USDA/ESCS. It will address the processing to be performed, the way in which the processing is performed, man machine interfaces, CPU demands, file structures, research verses production needs, and future expansion.

Specifically USDA/ESCS will define its needs, requirements, expectations, timeliness, remote processing locations, equipment at remote sites, back-up facilities, final and intermediate products.

Currently and during Phase I, NASA will perform a critique of the existing "EDITOR" system to learn how it is put together, and its current capability. Given the USDA/ESCS expectations for this system, NASA will make recommendations as to how the USDA should proceed through the R&D phase of the project.

USDA with NASA support will determine which improvements would add capability to the EDITOR system. Selected improvements will be implemented in 1981. These improvements would be immediate solutions and would not consider newly developed design and major hardware and software changes.

Phase II will initiate a design study outlining how an EDITOR type system should be constructed to achieve future USDA/ESCS goals. The basis for this system design is the LSAT and eventual operational use which will begin with ten states. This number will increase as USDA incorporated additional states into remote sensing analysis. Phase II will include a series of design reviews, hardware/software proposals, and the implementation of selected components as the Domestic Crops and Land Cover Program progresses from R&D through LSAT and to operational use.

4.3.3 Responsibility

USDA will:

- Define Requirements
- Establish performance criteria
- Decide go-no-go for technology adaption
- Perform technology adaption and implementation

NASA will:

- Perform future design studies
- Perform study analysis and evaluations of EDITOR system
- Recommend design and proposed implementation
- Provide technical and contract management of their assignment work within the task.
- NASA ARC will manage task 1 and NASA/ERL will manage task 2.

4.3.4 Resources for Project

Task 1

	FY80		FY81	
	$	MYE	$	MYE
USDA	50	2.0	75	.75
NASA	25	.25	0	.25

Task 2

	FY80		FY81	
	$	MYE	$	MYE
USDA	0	0	25	.25
NASA	0	0	50	.5

4.3.5 Schedule for Project

	FY80	FY81	FY82	FY83	FY84
Task I					
• Requirements Definition	—				
• Critical Analysis		—			
• Selection of Improvements			—		
• Implementation				—	
Task II					
• Design Study			—	—	
• Equipment Proposals				—	—
• Implementation					—

4.3.6 Interfaces Required to Complete Task

These tasks do not interfere with other tasks.

4.3.7 Data Requirements

4.3.7.1 Data Acquisition

USDA/ESCS will determine the system requirements. The resulting report will be made available to NASA. USDA/ESCS will provide the NASA facility copies of existing "EDITOR" comments required for the critique.

4.3.7.2 Data Distribution and Retention Requirements

All final and intermediate documents, software, etc. will be distributed to and retained by USDA/ESCS.

4.4 PROJECT ELEMENT - CLUSTERING/CLASSIFICATION ALGORITHMS

4.4.0 SUMMARY

4.4.0.1 BACKGROUND:

Accurate area estimation and mapping of crops and other land cover types at the county level, is the overall objective of the domestic crops and land cover program. Currently, ESCS classification algorithms are structured to produce high correlations between pixel counts of a land cover type to the acreage estimate from ground truth. This procedure does not result in good land cover maps, and the area estimate obtained from the procedure is inadequate at the county level. This element was created so that current and future classification needs can be obtained. The tasks/objectives are listed in prioritized order.

1. Improve current on-line classification capabilities for crop area estimation.
2. Develop/modify algorithms for land cover mapping.
3. Develop consolidated procedures for obtaining both area estimation and quality land cover maps in a cost-effective manner.

4.4.0.2 SCOPE:

Following an assessment of the current technology in classification, a selection of the best suited algorithms will be made. These algorithms will be modified to meet domestic crop and land cover needs. Procedures for using the algorithms will be developed, tested, and evaluated in a proof-of-concept. The area estimation algorithm (objective I) will be adapted on-line and pilot tested. The land cover algorithm

(objective 2 and 3) will be pilot tested under the land cover mapping task.

Each of the objectives will be treated as a task with technical approaches, resources, schedules, etc.

4.4.0.3 RESOURCES

See table

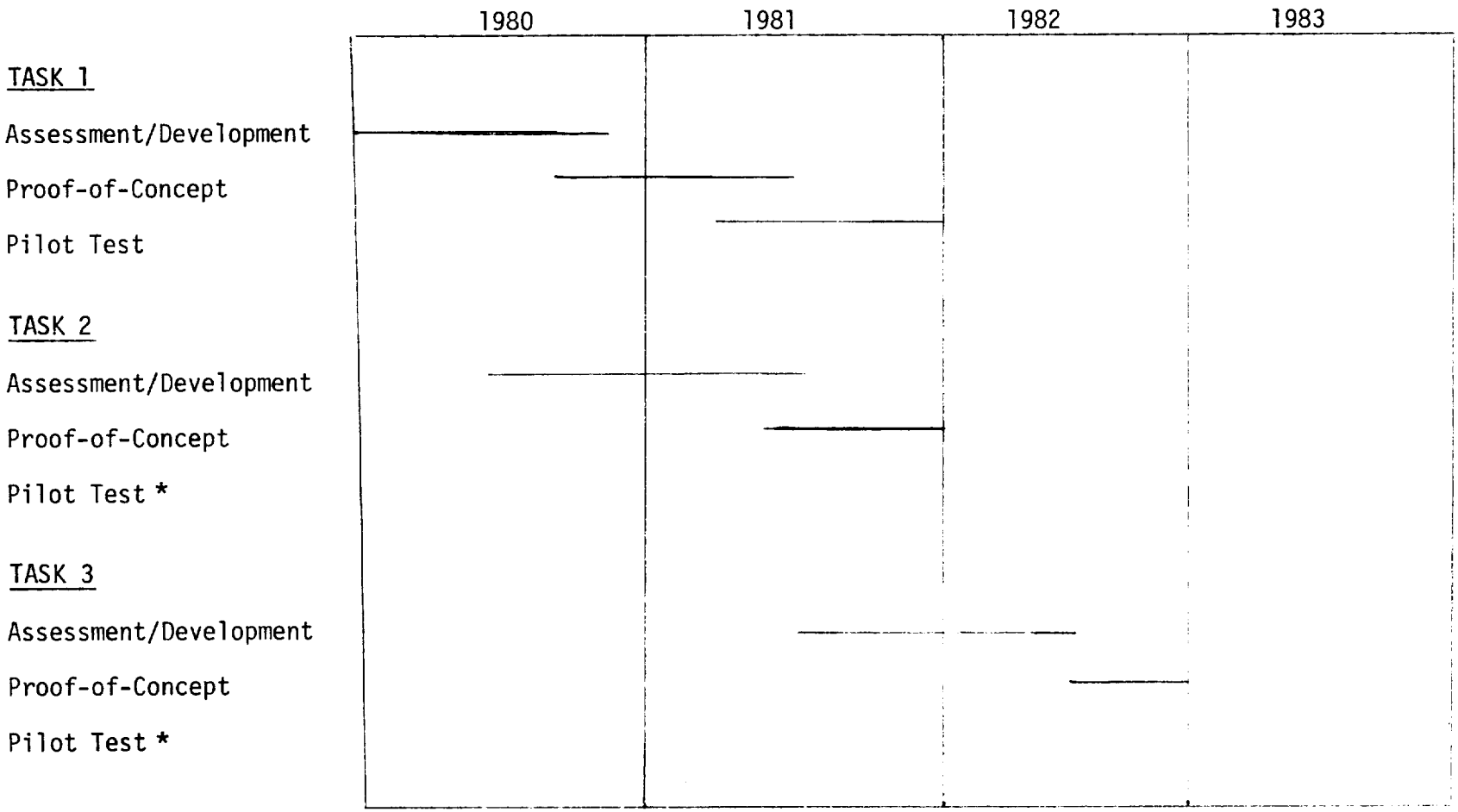
4.4.0.4 SCHEDULE

See table

4.4.0.5 MANAGEMENT

The overall responsibility for these tasks will be NASA/ERL. However, NASA/JSC will be task manager for Task 1. Tasks managers for Task 2 and 3 will be NASA/ERL.

CLUSTERING/CLASSIFICATION CONSOLIDATED SCHEDULE



* Integrated with Land Cover Task

CLUSTERING/CLASSIFICATION RESOURCES SUMMARY

	1980		1981	
	$	MYE	$	MYE
USDA	100	.25	100	.5
NASA	175	1.75	250	2.0

4.4.1 TASK 1 - Improve Classification Capability for Crop Area Estimation

.06 .04 .01 .01 .00 .120100 .130100 .020100
.200125 .020125 .020125

4.4.1.1 DESCRIPTION OF TASK

1. Objectives

a. Calculate discriminant functions which give the smallest possible variance in crop area estimates.

b. Examine other mathematical functions of satellite data (called "information functionals" by Anuta and Bauer[1]) as candidate auxiliary variables for regression-based crop-area.

c. Determine the improvements, if any, that such alternate auxiliary variables have over ESCS's current use in discriminant analysis.

2. Scope

To assess the state-of-the-art in classification for area estimation, and to implement selected improvements to current on-line capability.

4.4.1.2 RESEARCH TO BE CONDUCTED

Several technical approaches will be investigated in the first objective. A candidate is the modification of Belcher and Minter's LACIE analysis[2] to ESCS's regression methodology which minimizes a

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[1]Anuta, P. and M. Bauer. LARS Information Note 110873. Purdue University, West Lafayette, Indiana, 1973, pp. 6-7.

[2]Belcher, W.M. and T.C. Minter, "Selecting Class Weights to Minimize Classification Bias in Acreage Estimation." Symposium on Machine Processing of Remotely Sensed Data. Purdue University, 1976, pp. 3A11-3A15.

a risk function using the Davidson-Fletcher-Powell (DFP) algorithm. A second approach is the application of decision theory results developed by Bolshev and Lom[3], which finds a Bayes-error problem whose solution requires equations involving analytic expressions of misclassification probabilities. These expressions will be evaluated by Mobasseri's ACAP (Analytic Classification Accuracy Prediction) computer program[4] and by classical distributional approximations to quadratic forms of Gaussian random variables.

Two classes of information functionals will be investigated with respect to the second objective: (1) logistic regression estimates of the posterior probability that a pixel is from the crop of interest and (2) model based prediction of the proportion of a pixel contained within a field of the crop of interest. Logistic regression parameters will be estimated both by maximum likelihood and least squares, and comparisons of the efficiency and calculation ease of the two parameter estimation methods will be made. The model-based prediction approach will employ both spectral and spatial information.

Algorithms selected from the above investigation and evaluation will be adapted on-line for pilot testing.

This task will increase ESCS efficiency in calculating LANDSAT-based crop area estimates. This increase in efficiency will be of two types: increased statistical efficiency resulting from the anticipated greater precision of task-developed estimation procedures and increased procedural

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[3]Bolshev, A.I. and R.S. Lom. "Hypothesis Descrimination with Loss Functions the Depend on Decisions." Problems of Information Transmission. 1976, v. 12, pp. 116-119.

[4]Mobasseri, B.G.; D.J. Wiersma; E.R. Wiswill; D.A. Landgrebe; C.D. McGillem; and P.E. Anuta. LARS Contract Report 11278. Purdue University, 1978

efficiency resulting in minimal analyst involvement in the current ESCS procedure for calculating LANDSAT-based crop-area estimates. A report describing the methodology and performance of developed procedures, and the computer programs for performing required calculations will be the products from this task.

4.4.1.3 ORGANIZATION

NASA/JSC - Task Manager

USDA/ESCS/New Techniques - support

1. The overall task manager will be NASA/JSC
2. NASA will provide:
   a. Technical and contract management of their assigned work within the subtask.
   b. Technical integrity for subtask.
   c. Assessment of classification/clustering technology.
   d. Experiment design.
   e. Development of procedures.
   f. Proof-of-concept test and evaluation.
   g. Support to pilot test accuracy assessment and performance evaluation.
   h. Support technology adaption.
3. USDA will:
   a. Conduct Pilot test.
   b. Perform Pilot test accuracy assessment and performance evaluation.
   c. Support the assessment, experiment design, procedure development, and proof-of-concept testing.

d. Establish performance criteria.

e. Decide go-no-go for technology adaption to on-line.

f. Perform technology adaption.

Further, USDA will oversee all aspects of this subtask to insure that it remains within the needs and framework of the current on-line capability. USDA will determine which techniques they will adapt on-line and pilot test.

RESOURCE REQUIREMENTS

1980				1981			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
100	125	.25	.75	50	50	.2	.5

NASA civil service manpower will be predominately for technical and contract management for their assigned work. The NASA dollars will be for in-house contracts. These dollars allow for NASA data processing costs from procedure development through proof-of-concept testing.

USDA civil service manpower will support directly their assigned work and provisions for technical management. Their dollars allow for USDA data processing costs involved for Pilot testing and the adaption of procedures to on-line. USDA will provide supporting funds to NASA assigned work, i.e., assessment/experiment design, procedure development, and proof-of concept testing. The level of funding and associated funding mechanisms will be negotiated on a case by case basis and when tasks are better defined.

4.4.1.5 SCHEDULE

See table 1

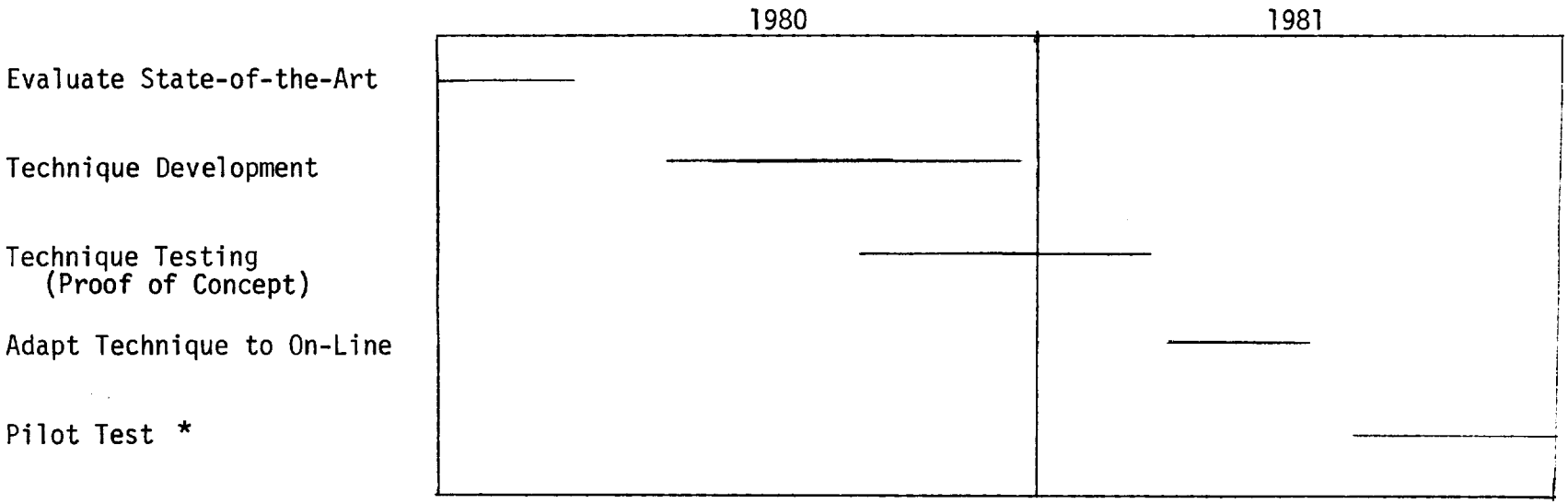
4.4.1.6 INTERFACES

1. It is anticipated that this subtask may require some interfacing with AgRISTARS Supporting Research to exploit similar activities within that program.

2. The technology developed under this subtask will become an integral component of the land cover inventory and mapping task

3. The pilot test for this task will occur under the "current estimation for major crops (2 states/yr)" task.. Data acquisition, ground truth, processing, evaluation, and accuracy assessment activities will be concurrent with this task, thus avoiding duplicate costs.

CLASSIFICATION FOR CROP AREA ESTIMATIONS



* Pilot testing of this subtask will occur concurrently with the "2 state/yr current Major Crop Estimation" task.

4.4.1.7 Data Requirements

1. Acquisition

Landsat and ground truth data sets compiled by ESCS during 1978 and 1979 crop years will be used for technique development. Most of the data for pilot testing will be provided through the Estimation of Major Crops (2 states/year) Task. Additional scenes may be required, not more than 10 per year. The format for MSS data will be CCT's and B/W images (high contrast from 1 band).

2. Data Preprocessing

None

3. Data Distribution

TBD

4.4.2 Task 2 Land Cover Mapping Classification Algorithm

.06 .04 .02 .01 .00 .200050 .050050 .020050

4.4.2.1 Description of Task

1. Objective

Produce a classification algorithm that can meet land cover mapping requirements. Emphasis will be to obtain high percent correct classification and minimize omission/commission errors.

2. Scope

Modify area estimation algorithms, or develop a new classification algorithm for land cover mapping.

Various techniques, such as multipass classification runs, layered classification approach, and vegetative index models (VI) will be examined. VI models could also play an integral part in other

areas of the domestic crops and land cover, such as change detection.

The Transformed Vegetation Index (TVI), Perpendicular Vegetation Index (PVI), Differing Vegetation Index (DVI), Ashburn Vegetation Index (AVI), Kauth Vegetation Index (KVI), and Leaf Area Index (LAI) will be assessed with respect to their current uses, testing and evaluation reports, and run costs. Based on this assessment one or two VI's will be selected for further investigation. The methodology will be transferred or developed for using these models in the following areas:

1. Classification algorithm
2. Masking approach
    - o native vegetation mask
    - o urban mask
    - o cloud mask
3. Spectral stratification within scene
4. Change detection

RESEARCH TO BE CONDUCTED

The following steps are the technical approach for this task.

1. Assess sampling strategy and ground truth methods of ESCS and other USDA/non-USDA agencies
   - Sampling requirements
   - Ground truth needs
   - Frequency of ground truth collection (crops vs. forests vs. urban, etc.)
2. Assess requirements against land cover mapping technology and sensor platforms.
3. Establish what requirements may be met using current sensor platforms and what requirements will need future platforms.
4. Modify current classification algorithms with respect to meeting mapping requirements using Landsat data.
5. Test and evaluate modified algorithm (proof of concept).
6. If positive test results, this algorithm will become an integral component of the Land Cover Task.
7. If negative results, determine future research needs in developing a new algorithm.
8. Develop and test algorithm.

The anticipated results from this task is a classification algorithm that satisfies land cover mapping requirements using LANDSAT data. Land cover maps with known scales and map accuracies will be the major product. This task will probably have some overlap with task 3. For example, vegetative indices may be used in a masking approach, which could be incorporated into the land cover mapping procedures.

4.4.2.3 ORGANIZATION/RESPONSIBILITIES

1. The overall task manager will be NASA/ERL.
2. NASA will provide:
   a. Technical and contract management of their sssigned work within the subtask.
   b. Technical integrity for task.
   c. Assessment of Land Cover Classification Technology.
   d. Experiment design.
   e. Development of procedures.
   f. Proof-of-concept test and evaluation.
   g. Support technology adaptation.
3. USDA will:
   a. Support the assessment, experiment design, procedure development, and proof-of-concept testing.
   b. Establish performance criteria.
   c. Decide go-no-go for technology adaption to on-line.
   d. Perform technology adaption.
   e. Ground truth acquisition.

USDA will oversee all aspects of this subtask to insure that it remains within the needs and framework of the current on-line capability.

4.4.2.4 RESOURCES REQUIREMENTS

FY80				FY81			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
0	50	0	1.0	50	150	.2	1.0

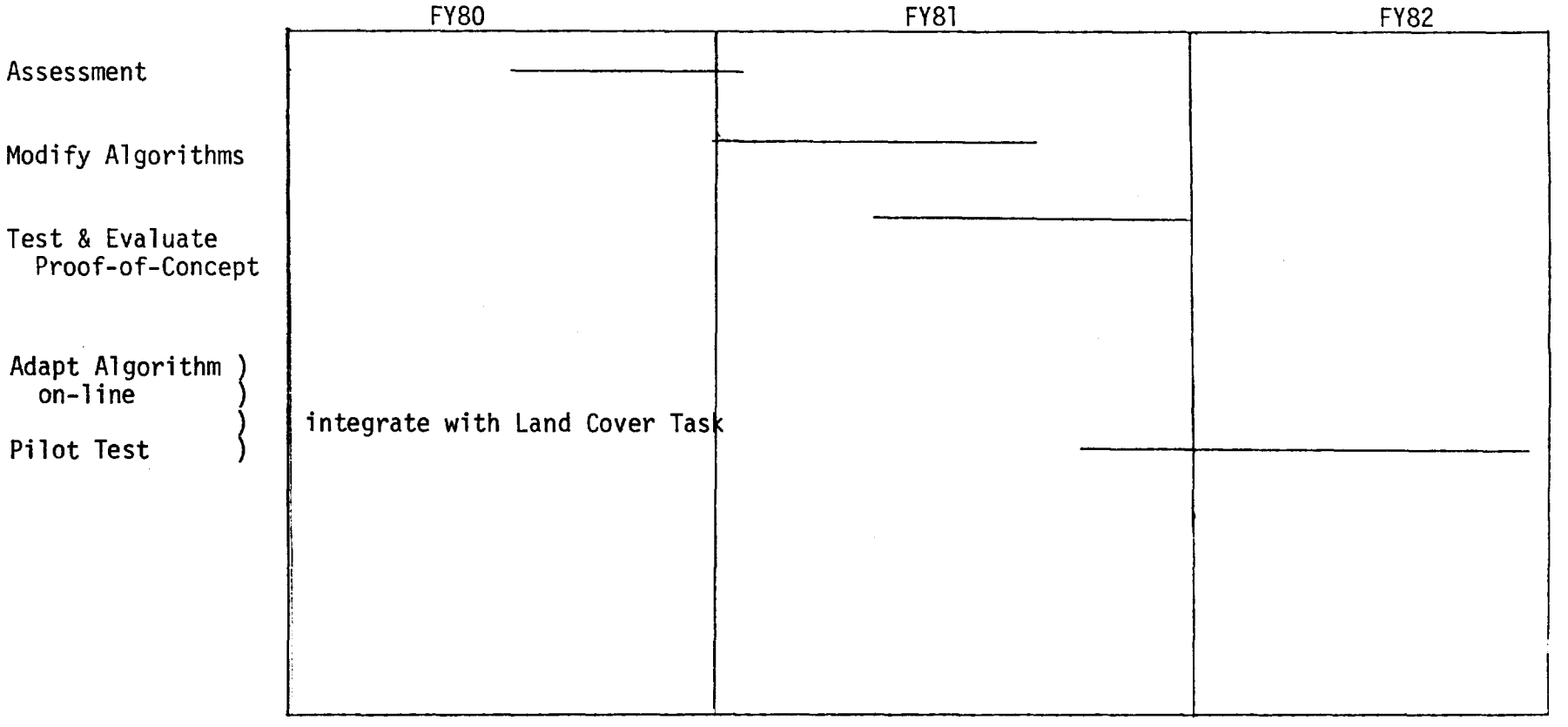
NASA civil service manpower will be predominately for technical and contract management for their assigned work. Most of the NASA dollars will be for contracts (both in-house and outside). These dollars will also support proof-of-concept testing.

USDA civil service manpower will support directly their assigned work and provisions for technical management. Their dollars allow for USDA data processing costs involved for Pilot testing and the adaption of procedures to on-line. USDA will provide supporting funds to NASA assigned work, i.e. assessment/experiment design, procedure development, and proof-of-concept testing. The level and split of funding will be determined on a case-bycase basis when the task is better defined.

4.4.2.5 SCHEDULES

See Table 2

TASK 2 - CLASSIFICATION FOR LAND COVER MAPPING



4.4.2.6 INTERFACES

1. Land cover requirements will be obtained from the assessment done within the "Land Cover Inventory and Mapping Task."
2. The results from this task will become an integral component of the Land Cover Task and will provide the basic classification algorithm for Land Cover Mapping.
3. Pilot testing of this classification algorithm will occur as an integral component of the Land Cover Mapping Pilot Test.
4. This classification/clustering task will provide inputs to this task for change interpretation and classification.

4.4.2.7 DATA REQUIREMENTS

1. Data Acquisition

   Most of the data ground truth and Landsat will be provided through the Estimation of Major Crops (2 states/year) Task. Additional scenes may be required, not more than 10 per year. The format for both MSS and TM data will be CCT's and B/W images (High contrast from 1 band).

2. Data Pre-Processing

   None

3. Data Distribution

   N/A

4.4.3 TASK 3 - Consolidated Procedures for Area Estimation and Mapping

.06 .04 .03 .01 .00 .200000 .050000 .020000

4.4.3.1 Description of Task

1. Objectives

   a. Develop a cost effective set of procedures for meeting both area estimation and mapping requirements.

b. Determine if vegetative index models (VI) can be utilized to improve classification capabilities.

2. Scope

Modify procedures developed in tasks 1 and 2 into a single set of cost effective procedures.

4.4.3.2 Research to be Conducted

This task is dependent upon the results obtained from tasks 1 & 2. It is hypothesized that both estimation and mapping can be accomplished using one set of procedures and not two independent sets. Major emphasis of this task will be to assess task 1 and 2 and to incorporate various techniques for the purpose of obtaining a cost-effective set of procedures.

After a set of procedures for area estimation and mapping is obtained, it will be tested over a limited data set. This proof-of-concept will produce land cover maps and land cover area estimates with known percent correct, omission/comission errors, variance of the estimate, sampling error and run costs.

4.4.3.3 RESPONSIBILITIES

1. The task manager will be NASA/ERL.
2. NASA will provide:
   a. Technical and contract management of their assigned work within the task.
   b. Technical integrity for task.
   c. Assessment of vegetative index modeling technology
   d. Experiment design.
   e. Development of procedures.
   f. Proof-of-concept test and evaluation.
   g. Support technology adaptation.

3. USDA will:

   a. Support the assessment, experiment design, procedure development, and proof-of-concept testing.

   b. Establish performance criteria.

   c. Decide go-no-go for technology adaptation to on-line

   d. Perform technology adaptation.

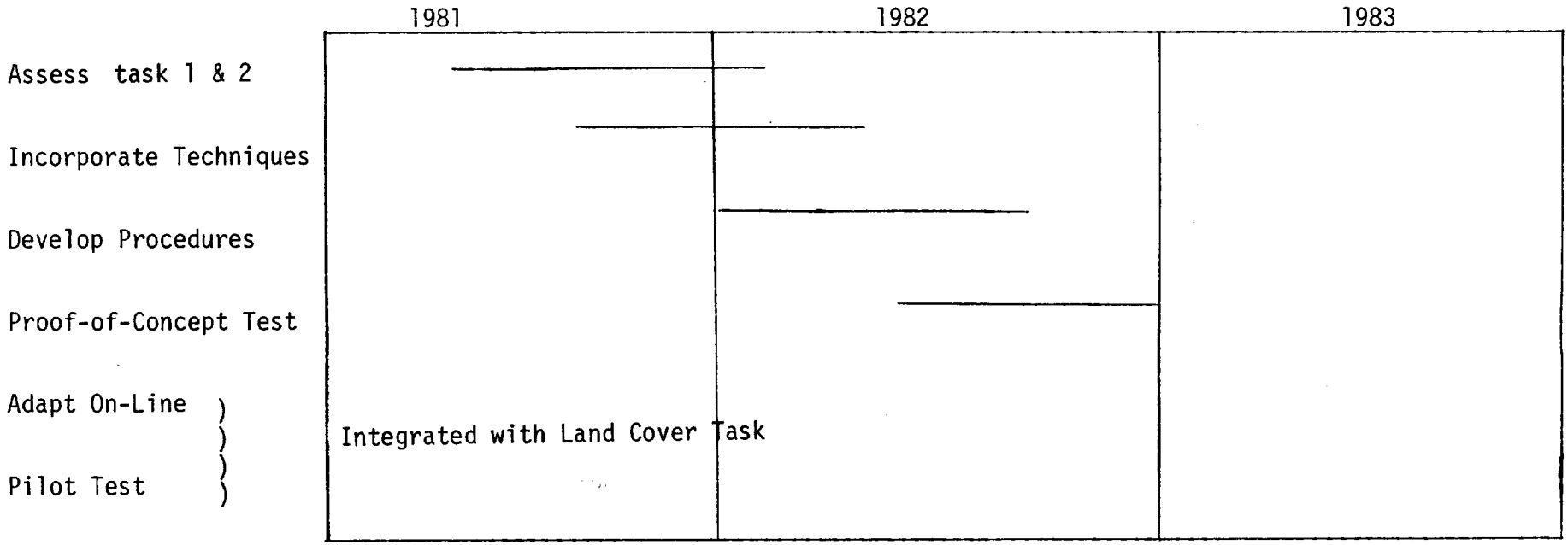
4.4.3.4 RESOURCE REQUIREMENTS

1980				1981			
$		MYE		$		MYE	
USDA	NASA	USDA	NASA	USDA	NASA	USDA	NASA
0	0	0	0	0	50	.1	.5

NASA civil service manpower will be predominately for technical and contract management for their assigned work. Most of the NASA dollars will be for contracts (both in-house and outside). These dollars allow for NASA data processing costs from procedure development through proof-of-concept testing.

USDA civil service manpower will support directly their assigned work and provisions for technical management. Their dollars allow for USDA data processing costs involved for Pilot testing and the adaptation of procedures to on-line. USDA will provide supporting funds to NASA assigned work, i.e., assessment/experiment design, procedure development, and proof-of-concept testing. The level and split of funding will be determined when the task is better defined.

TASK 3 - CONSOLIDATED PROCEDURES



4.4.3.5 SCHEDULE

See Table

4.4.3.6 INTERFACES

1. An interface will be established with early warning and crop condition assessment to allow the transfer of the equations of various VI models and algorithm developed to perform the calculations. Domestic crops will also take advantage of the VI testing conducted by Early Warning.

2. Within the domestic crops program, this task will interface with the preprocessing, classification/clustering development and change detection tasks. VI models is not considered a stand-alone task, but rather a tool that could be used in the above tasks.

3. Results from the VI work and the consolidated procedures will become an integral component of the land cover task prior to pilot testing.

4.4.3.7 DATA REQUIREMENTS

1. Acquisition

   It is anticipated that data sets developed in tasks 1 and 2 can be used.

2. Pre-Processing

   Will be required for incorporation of VI models.

3. Distribution/Retention

   N/A

4.5 Project Element - Product Use

4.5.0 Task 1 - User Participation and Evaluation of Product Use

.06 .05 .01 .02 .00 .120050 .990050 .990050

4.5.1 Task Description

1. Objective:

Increase LANDSAT Product Use to spread primary costs and improve potential cost-benefit ratio. Identify likely public interests, (National, Regional, State and Local) who may be, or may become, legitimate users of LANDSAT processed data. Each additional use developed increases the value (utility) of the LANDSAT effort. If the additional users pay an appropriate share for material and processing, cost to the primary user is reduced. If the secondary users do not reimburse for value received, the benefit may still be credited against the cost. In either case, additional processing costs must be "charged" against the additional user.

2. Scope

The primary users of ESCS's LANDSAT regression estimates will be the USDA Crop Reporting Board and ESCS State Statistical Offices and their State Cooperators. They would consider the regression estimates along with current survey results to arrive at official estimates. Any benefits in accuracy will be passed on to conventional users of USDA crop-area statistics, such as farmers, economists, agri-business, crop market, and government agencies. ESCS anticipates using LANDSAT estimates to provide increased accuracy of state, substate and county level estimates. ESCS's final classification data may be the "raw data" for other users of LANDSAT.

Coupled with the Current Area Estimation for major crops (two states/ year) Task, an information program will be initiated to contact potential users and to determine users needs that are appropriate to the basic processing of classifying each pixel in the state to a specific land cover. Additional ground data will be collected as needed to support specific user needs. An objective user evaluation is to be a part of this task.

3. Probable Duration of Task

Finding and developing other potential direct users will be a continuing effort (see task schedule).

4.5.2 RESEARCH TO BE CONDUCTED

Identify likely Public interests (National, Regional, State and substate). As the LANDSAT crop area estimate effort begins in each state, other Federal agencies will be notified and the State Statistical Office will contact public agencies and organizations withing the State. ESCS will invite the likely public interests to meetings or orientations where the LANDSAT crop area estimation program will be discussed.

Those interested will be asked to present suggestions and proposals for (1) additional uses of crop area estimates, (2) additional uses of LANDSAT which might complement or be compatible with the crop area estimates, (3) changes in format of estimates and other special products to meet participant needs, and (4) data base or inventory and monitoring efforts which might potentially use crop area estimation outputs as "raw data" or an input data source. Individual consultations will follow to develop specific plans and test products.

ESCS will work with participants to determine format and details of

proposed data needs and provide sample products for the participant to test and evaluate. Special hard copy outputs in map or photograph-like products. Software will need to be developed to expedite special product outputs. Participants will be encouraged to test and propose refinements needed or desired. Cost estimates for new products will be developed and participants will be asked to develop benefit estimates.

As participation continues further refinements will be explained. As new or adopted products are developed additional potential users will be contracted.

As secondary and complementing uses of LANDSAT are developed, the basic "Core" costs of materials and processing can be spread to a wider benefit base. As the LANDSAT crop area estimates move from the research mode into a production effort, the benefits anticipated should justify costs of LANDSAT regression estimates and other uses. Some of the products will be associated with tapes of classified pixels where optimum strategies have been used to identify specific land covers. Digital overlay masks such as soil survey data, watershed boundaries, flood control areas, special zoning etc., are anticipated for use to provide either summary statistics, or classifed LANDSAT data or to create other natural resources management information.

4.5.3 RESPONSIBILTIES

1. The overall task manager will be from USDA.
2. USDA will:
   (a) Inform within-state potential users as to the nature of task 4.1, exploring possibilities for linkage with their programs and responsibilities.

(b) Develop a user test program with identified within-state users.

(c) Participating with users create products oriented to serve their needs.

(d) After usary evaluation, seek refinements and establish means for ongoing participation..

3. NASA will assist USDA in developing user test programs.

(b) Assist in developing user products.

(c) Assist in refinemnts for continuing participant use.

4.5.4 RESOURCES

	FY 80		FY 81	
	$	MYE	$	MYE
USDA	050	1	100	2
NASA	0	0	0	0

The majority of dollars is for specialized product development with an estimated marginal amount for product development. At this point, the ratio of resources and the total amount is obviously only a best guess.

4.5.5 SCHEDULE FOR PRODUCT USE (Each State Entering 4.1)

	FY 80	FY 81	FY 82	FY 83	FY 84
o Invite Public Interests	T B D				
o Develop User Test Program					
o Create User Products					
o User Evaluation					
o Refinements & Ongoing Participation					

4.5.6 INTERFACES

None known at this time, except a potential for special products from NASA/ARC or NASA/ERL.

Land Cover Mapping Task will provide various procedures/technology for input to Product Use Task.

4.5.7 DATA REQUIREMENTS

None beyond those provided under 4.1

4.6 PROJECT ELEMENT - LAND COVER INVENTORY AND MAPPING

4.6.0 SUMMARY

4.6.0.1 TASK DESCRIPTION:

1. Background:

Overall the DCLC program will develop, test, and evaluate the use of satellite data for more precise, cost effective, and timely domestic crop and land cover acreage estimates at the state, CRD, multicounty, and county levels in the United States.

To date the ESCS has experimented with providing crop acreage estimation at the state level using in part LANDSAT data and have an ongoing activity with a current system (hardware, software/ methodology/and procedure) for providing estimates to an increasing number of states. For this element, ESCS would like to extend this current system to address not only improved crop acreage estimations but to include key land cover acreage estimates and develop a capability to provide accurate land cover maps to the county level. Land cover information is an essential component of the resources, conservation, and commodity management baselines for various USDA agencies, e.g., USFS, SCS, ESCS, and ASCS.

2. Objectives:

This element area will have five separate objectives-- (1) identify and evaluate current USDA information requirements and inventory methods; (2) investigate and develop a methodology to improve the current system to provide land cover acreage estimates to the county level, and (3) investigate and develop capability to provide accurate land cover location and mapping information to the county level;

(4) investigate and develop a change detection/monitoring capability for updating land cover inventories; and (5) investigate and develop the capability to interface remote sensing data with existing geographic information systems.

3. Scope:

The development of crops and land cover classification, measurement, and mapping capability will be separated into two different areas: (1) classification and estimation of crops and (2) classification, measurement and mapping of various land cover, e.g., forestlands, rangelands and urban. This will concern itself with the development of a capability for land cover. Crop related classification and acreage estimation will be covered in a previous section (Major Crop Estimations). Although there are many similarities in the development process of crops and land cover; there are, however, distinct differences which dictate this separation: (1) differences in requirements (accuracy, frequency, cell size, etc.); (2) emphasis on statistical estimates for crop versus location and identification of land cover; (3) emphasis in change monitoring for land cover; (4) R&D in land cover lagging behind that of crops; and (5) all cropland must be inventoried, not simply major crops.

In the development of the overall crop and land cover classification and measurement system (crops and land cover), each of the separate efforts for crops and land cover will use the same basic capability (acreage, technology and data base) previously developed for crops where possible. In the development process from R&D, Pilot Test through LSAT, both crop efforts and land cover efforts will attempt to use jointly the same test areas, data sets, etc.

inventory or data system (4) identify areas where refinement of remote sensing data might allow for inclusion into the data system.

2. Anticipated Results of Task:

If task is successful, data systems would serve their broadest potential use within USDA, LANDSAT would be applied as applicable, and duplication of efforts would be reduced, or eliminated.

3. Products to be Developed:

(a) list of inventory and data systems

(b) flow chart - cross walk between data systems

(c) list of potential LANDSAT applications

(d) remote sensing data needs listing

4.6.1.3 RESPONSIBILITIES:

USDA/ESCS

4.6.1.4 RESOURCES:

	Funds	Civil Servants
FY80		
USDA	0	2.5
NASA	0	0

4.6.1.5 INTERFACES:

Intra department relationships will be established in conjunction with support requirements levied or each agency to aquire needed information.

The results from this objective will be prerequisite and/or input to other tasks within the DCLC plan, i.e., classification clustering, with other tasks within the DCLC plan ie. classification clustering, product use, sensor evaluation.

4.6.1.6 DATA REQUIREMENTS:

None

4.6.2 TASK 2 - Area Estimation, Location and Mapping

.06 .06 .02 .01 .00 .120075 .130075 .020075
.200050 .050050 020050

- Investigate and develop procedures to provide land cover area estimates using Editor System.
- Investigate and develop capability for providing accurate land cover maps.

4.6.2.1 TASK DESCRIPTION:

1. Objectives:

(a) determine if Editor System can provide improved land cover area estimates at the county level

(b) develop the methodology and procedures necessary for such estimates

(c) develop and test capability to provide land cover location and mapping information at the county level

2. Scope:

Furnishing land cover acreage estimates is more compatible with the methodology and techniques currently used for crop acreage estimates. Area estimation of land cover using the Editor System is highly probable and is pleased for early consideration within the overall land cover estimation and mapping task. A pilot test for land cover area estimates should be ready by 1982. Providing accurate land cover maps will be more of a problem in which considerable attention will be given to achieving a high percent correct classifcation, minimizing of ommission/commission errors, and considerable revision to ground truth/sampling methodology.

4.6.2.2 DEFINE RESEARCH TO BE CONDUCTED:

1. Assessment:

The assessment is divided into two areas -- First, we want to assess the current USDA system for extending to land cover estimation. Secondly, assess other technology which is applicable to land cover mapping. Remember, these activities are closely tied to other tasks having their respective assessment. Basically this will be a paper exercise to assess current technology for land cover mapping and estimation with regard to level of land cover mapping obtained, accuracy of land cover maps, omission/commission errors, existing processing techniques, classification algorithms' and procedures, sampling methodologies, systems thru-put, sensor platforms and their contributions to the overall classification mapping procedure -- In addition, further testing and evaluation will be recommended in areas where insufficient testing or questionable concerns may exist. The product from the assessment will idenify improvements needed, probable pieces of technology, pieces of technology that need modification and methodology to be tested and evaluated. This effort will have a major input to the overall experiment design and performance criteria.

2. Experiment Design:

This effort is designed to layout a pilot experiment plan for the evaluation of a land cover mapping and estimation capability. It will layout the baseline logic and procedures for evaluation. It will identify the basic components (procedures, techniques, methodologies, systems, etc.) for pilot testing that will lead to the improvements for the eventual LSAT evaluation. The technology assessment task in conjunction with previous tasks (classification, preprocessing, registration,

etc.) are parallel and will have an input to this effort. This task will also identify performance criteria for subsequent pilot test efforts.

3. Technique and Procedure Development:

This effort will take the recommended components from the previous tasks (including the Technology Assessment and Experimental Design) and integrate the pieces for future pilot testing. If needed some of the components will be modified and tested under this task. This task will develop land estimation and mapping procedure (incorporating all components) including those for area estimates using Editor and overall procedures for both area estimates and land cover mapping.

4. Test and Evaluation:

This effort will involve the testing of the procedures and integrated components both off-line and on-line. The off-line test and evaluation will be a proof of concept test prior to a larger on-line test. It will involve testing the procedures over 1-2 scenes within each representative states (approximately four states). Based on predetermined criteria and performance, the USDA will determine whether to pilot test on-line. The pilot test (two years) will consist of several selected scenes from two to four states per year. Prior to pilot testing on-line adaption will be required. The first year of the pilot test will emphasize testing of procedures for land cover area estimation using Editor. The second year a pilot test should be ready for testing and overall capability for both area estimation and land cover mapping.

5. Products to be Developed:

(a) documented procedures for a capability to provide land cover area estimation and mapping

(b) thorough evaluation of a on-line pilot test covering 2-4 states

- accuracy assessment
- performance evaluation
- cost-effectiveness for LSAT

(c) design specification for LSAT

4.6.2.3 RESPONSIBILITIES

USDA
- Task Manager/ESCS
- Go-no-go for experiment design
- support assessment of EDITOR technology
- ground truth acquisition
- support procedure development
- pilot test and performance evaluation
- adaption of technology on-line

NASA
- assessment of land cover technology and experiment design
- recommend design for USDA approval
- development of procedures
- test and evaluation of procedures off-line
- support pilot test accuracy assessment and performance evaluation
- NASA/ERL is responsible for NASA assigned work.

4.6.2.4 RESOURCE REQUIREMENTS:

	FY80		FY81	
	$	CS	$	CS
USDA	75	.3	120	2.0
NASA	50	.6	170	1.5

NASA/ERL will provide the overall technical and contract management of their assigned responsibilities. They will be responsible for the overall technical integrity of their assigned work. NASA resources given here allow for data processing and special data acquisition requirements.

USDA will provide predominately civil service manpower for their assigned responsibilities. A majority of data acquisition and processing costs for pilot testing will be their responsibility. The adaption of developed procedures to on-line facilities will be funded by USDA. Special ground truth acquisition for this task will also be funded by USDA. Funds will be provided to support NASA tasks, i.e., assessment, experiment design, procedure development, test and evaluations (off-line).

4.6.2.5 SCHEDULES (SEE TABLE 2):

4.6.2.6 INTERFACES:

(a) Task 1 (evaluation of USDA inventory methods and requirements) will provide input to the assessment and experiment design.

(b) The classification/clustering and registration tasks are closely related to this task. Algorithms generated from these tasks will be the basic components utilized within this task.

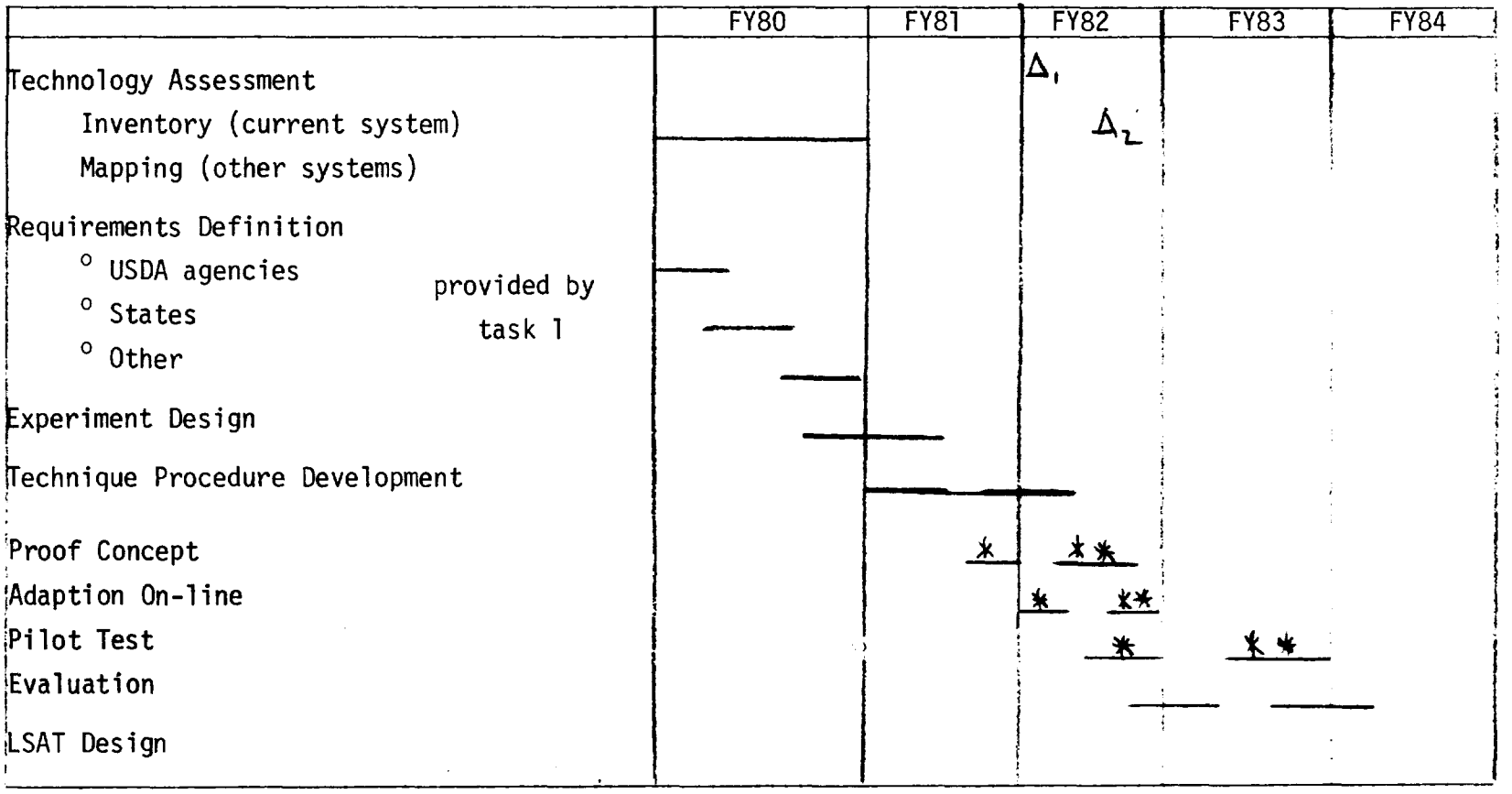
(c) The sensor evaluation task and particularly the TM procedure development will use the same basic components under this task. There components will be modified and extended for TM utility.

(d) ICD will be developed for both b and c.

(e) The results from this task will be integrated with the "Product Use" task. The technology developed here will be the bases for data products for the user.

TASK 2

LAND COVER AREA ESTIMATION, LOCATION, AND MAPPING



* Area Estimation

** Mapping

Δ_1 Go-no-go (Adaption on-line) area estimates

Δ_2 Go-no-go (Adaption on-line) mapping

4.6.2.7 DATA REQUIREMENTS

1. Data Acquisition:

This task will draw upon data provided under the Area Estimation for Major Crops (2 states/yr.) task.

Additional scenes may be required and not more than 10 scenes per year.

This task will require both LANDSAT B/W images and CCT. Selected seasonal observations will be required.

Aircraft requirements may be required and will be defined during the experiment design phase in FY81.

2. Data Preprocessing Requirements:

None

3. Data Distribution:

TBD

4.6.3 TASK 3 - CHANGE DETECTION/MONITORING CAPABILITY

.06 .06 .03 .01 .00 .120000 .130000 .300000
.200000 .050000 .300000

4.6.3.1 TASK DESCRIPTION

Development of a change detection and monitoring system requires the assessment of changes in land cover as well as the location-specific identification of natural and man-induced changes in land cover features. Over a period of time a change monitoring system will result in the capability to provide accurate inventory updates based on USDA requirements, trend and pattern assessments, and land utilization prediction.

1. The objectives of this task are:

   - to improve current capabilities and methods and develop procedures for detecting and monitoring changes in land cover through temporal, multistage remotely sensed data in diverse environments.
   - Develop and determine cost effective methods for storing and retrieving inventory information in a geo-based reference system for updating purposes.

2. Scope

   At present, there are some R&D efforts underway that, at a minimum, seek to detect land cover change. For instance, the radiance shift in going from vegetation cover to bare soil in a short non-seasonal time frame is being studied as an indication of active clear-cutting. These types of methodologies should be reviewed for applicability to the USDA Secretary's Initiative. Initially, canidate methods should be investigated; at least 2 should be selected for more intense research, beginning in FY81. Procedure development includes modifying (or designing) the software and operation on a representation computer

system to establish a credible "proof-of-concept" level. Once each change monitoring method reaches this level, it should be documented and released for a pilot test. Accurate frame-to-frame (scene-to-scene) registration of data (0.5 pixel relative displacement) is essential to change monitoring procedure success, and all procedure research must early-on assess this fact. Ultimately, change will have to be stored and retrieved in terms of a geo-based reference system.

A comprehensive land cover data base, containing both remotely- and non-remotely-sensed variables will contribute greatly to effective change monitoring techniques. The addition of variables, such as soils or census, increases the dimensionality (and inherent accuracy) of the decision-making process, and, in a computer-oriented system, does not necessarily make it more time consuming or costly. This task should investigate only the practical utilization of data bases for change monitoring purposes. It is not the intention to develop an all-encompassing national data base for USDA use, but only to develop and test data bases of limited area and number of variables to support specific change monitoring procedure research.

4.6.3.2 DEFINE RESEARCH TO BE CONDUCTED

1. Technical Assessment and Experimental Design

   a. Survey and evaluate existing change detection/monitoring techniques

- Accuracy assessment
- USDA and other user requirements
- Computer capability - software available
- Costs
- Utilization of data base (storage/retrieval of information)
- Updating capability
- Registration procedures

b. Select one or two techniques which indicate potential for use in the domestic crops and land cover program.

c. Establish performance criteria.

d. Evaluate procedures and methodologies for pilot testing (Pilot test design).

2. Technique/Procedure Development

a. Develop comprehensive land cover data base.

- Define universal land cover units
- Design method for storage/retrieval of inventory information by geographic location (both remotely sensed and non-remotely sensed)
- Determine optimum size units of change for various land cover types
- Determine compatibility to various computer systems

b. Develop regional change detection calendars.

c. Develop/modify change detection/monitoring techniques for higher accuracy.

- Variety of environments
- Updating

d. Revise/update performance criteria and methodology.

e. Complete pilot test design.

3. Test and Evaluation

a. Test selected technique(s) off-line in 3-5 small study areas for proof-of-concept.

b. Compare results with other studies or currently available land cover/use information and maps and evaluate results.

c. Modify technique(s) based on evaluation.

d. Determine whether to adapt procedures to on-line.

e. Adapt on-line.

f. Conduct Pilot test on-line covering 1-2 scenes in each of 4-5 states.

g. Evaluate results in terms of accuracy and performance criteria.

4. Products of Research

a. Documented procedures for a change detection and monitoring capability.

b. Complete evaluation as to performance and utility.

c. Complete accuracy assessment.

d. Design specifications for large scale application (LSAT).

4.6.3.3 RESPONSIBILITIES

1. The overall task manager will be NASA/ERL

2. NASA will provide:

a. Technical & contract management of their assigned work within the task.

b. Technical integrity for task.

c. Assessment of change detection/monitoring technology.

d. Experiment design.

e. Development of procedures.

f. Proof-of-concept test & evaluation.

g. Support pilot test accuracy assessment and performance evaluation.

h. Support design specification development for LSAT.

i. Support technology adaption.

3. USDA will:

a. Conduct Pilot test.

b. Perform Pilot test accuracy assessment and performance evaluation.

c. Develop design specifications for LSAT.

d. Support the assessment, experiment design, procedure development, and proof-of-concept testing.

e. Establish performance criteria.

f. Decide go-no-go for technology adaption to on-line.

g. Perform technology adaption.

4.6.3.4 RESOURCES

	FY80		FY81	
	$	CS	$	CS
USDA	0	.1	50	.5
NASA	0	.2	170	1.5

NASA civil service manpower will be predominately for technical and contract management for their assigned work. Most of the NASA dollars will be for contracts (both in-house and outside). These dollars allow for NASA data processing costs from procedure development through

proof-of-concept testing.

USDA civil service manpower will support directly their assigned work and provisions for technical management. Their dollars allow for USDA data processing costs involved for Pilot testing and the adaption of procedures to on-line. USDA will provide supporting funds to NASA assigned work, i.e. assessment/experiment design, procedure development, and proof-of-concept testing.

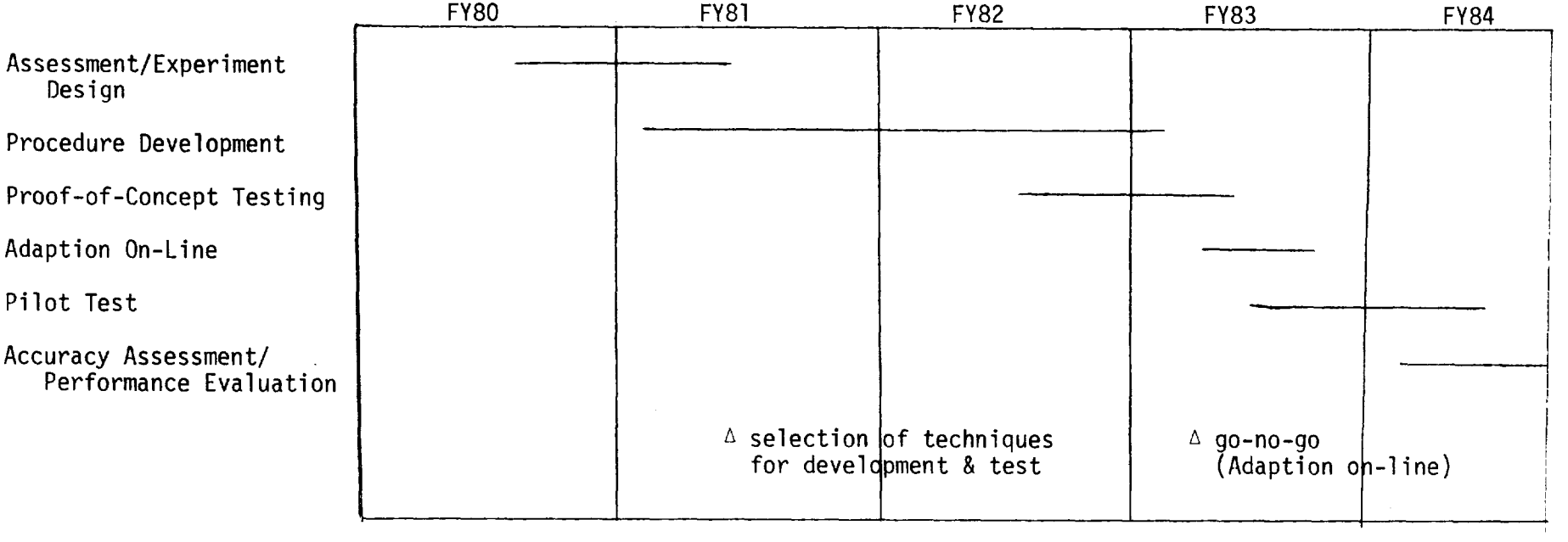
4.6.3.5 SCHEDULE (See Table 4)

4.6.3.6 INTERFACES

1. One factor of utmost importance to change detection is the ability to register LANDSAT data (2 or more dates). This activity is covered by the registration task that is carried as a separate task in this plan to be given high priority in FY80. Therefore, although the assessment of the various requirements will begin in FY80, the selection of specific change detection techniques and their subsequent evaluation and procedure development will be delayed until FY81 in order to take into account the registration technique evaluations.
2. It is anticipated that the same change detection techniques that are evaluated and tested with LANDSAT MSS data will also apply to LANDSAT TM data. Therefore, the TM task of this plan will contribute to the assessment and procedure development of the change detection task.

TASK 3

SCHEDULE FOR CHANGE DETECTION



3. The classification/clustering task will provide inputs to this task for change interpretation and classification.
4. The evaluation of current USDA inventories and requirements task will provide an input to the change detection assessment effort.
5. The results from the task will be integrated with the Product use task. The technology developed here will be the bases for data products for the user.

4.6.3.7 DATA REQUIREMENTS

1. Data Acquisition

Most of the data will be provided through the Estimation of Major Crops (2 states/year) Task. Additional scenes may be required, not more than 10 per year. TM scenes will be required late in the project (83 and 84). The format for both MSS and TM data will be CCT's and B/W images (high contrast from 1 band).

Aircraft requirements may be defined during the technology assessment of this task and will be submitted in FY81.

2. Data Preprocessing

None

3. Data Distribution

TBD

4.6.4 Task 4 - Geographic Information System Interface

.06 .06 .04 .04 .00 .120000 .130000 .300000
.200000 .050000 .300000

4.6.4.1 Task Discription

1. Objectives

The objective of this task is to evaluate and/or develop software and procedures for the efficient input of remotely sensed data to existing geographic information systems and to interface remotely sensed data with other digital data files, e.g., terrain, soils. The task also includes the evaluation of the utility of land cover information derived from remotely sensed data after it has been manipulated in geographic information systems and/or used in models requiring geographically referenced data. These evaluations will be performed by inputting both sources of land cover information (space and conventional) and determining the degree to which output may differ and the significance of any difference to land resource management decisions.

2. Scope

The utility of land cover information derived from remotely sensed data is greatly enhanced when input to a geographically referenced, computerized information system so that it can be geographically correlated with other data, e.g., soil, slope, aspect, elevation, population density, etc. Various types of information in an information system can be fed to model that provide output needed for the land resource management decision process including land capability/suitability, carrying capacity, environmental impact assessments, etc.

The first step in the implementation of this task will be the identification of all existing geographic information systems/models that

(b) Determine problems in inputing Landsat/TM data and the merging of such data with other types of data.

(c) Develop solutions to these problems.

(d) Develop common procedures for inputing Landsat/TM data automatically into information systems.

(e) Update the test plan for evaluating utility.

3. Test and Evaluation

(a) Perform proof of concept test for input procedures using 2-3 common information systems.

(b) Evaluate procedure performance.

(c) Perform Pilot Test which will include an overall utility evaluation in 2-3 management models will be used e.g., Land suitability, carring capacity...

4.6.4.3 Responsibility

1. NASA/ERL will be the Task Manager

- Perform assessment of input/merge procedures.
- Provide development of input/merge procedures.
- Provide proof of concept testing.
- Provide overall Technical and contract management for these work elements.

2. USDA will

- Perform Assessment of existing USDA systems and define requirements.
- Develop test plan for evaluating overall utility of information systems using Landsat/TM data.
- Perform Pilot test and utility evaluation.