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FINAL REPORT

Contract NAS5-21881

"APPLICATIONS OF ERTS-A DATA TO AGRICULTURAL PRACTICES IN THE MISSISSIPPI DELTA REGION"

C. W. Bouchillon

October 1972 - September 1974

Submitted to:

National Aeronautics & Space Administration
Marshall Space Flight Center
Huntsville, Alabama 35812

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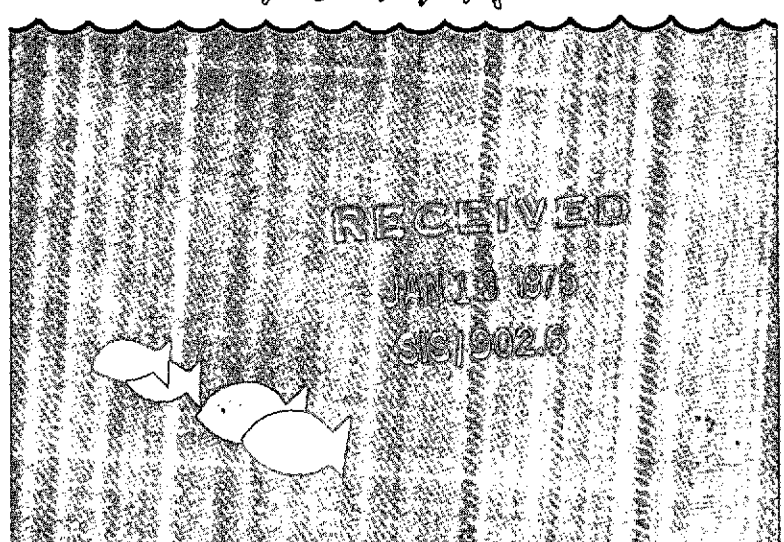

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16. Abstract

Using controlled agricultural test fields located on and around the Mississippi Delta Branch Experiment Station for ground truth, a computer generated color coded map product has been evaluated. Potential users have been interviewed and their opinions of the generated map products have been summarized.

A general conclusion is that these data products could be useful if the system can be made responsive to user needs within a useful time frame.

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APPLICATIONS OF ERTS-A DATA TO AGRICULTURAL PRACTICES IN THE MISSISSIPPI DELTA REGION

FINAL REPORT

Contract NAS5-21881
October 1972 - September 1974

Prepared For

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PREFACE

The main objectives of this work were oriented toward assessing the applicability of the ERTS-A data from a user point of view. To accomplish this, the NASA-MTF-ERL data processing facility was to be used to produce a set of computer generated map and statistical data products for both comparison to ground truth and for use in interviews with potential users. As a secondary objective, a first order crop yield prediction for 1973 was planned.

Ground truth fields were located in the vicinity of the Mississippi Delta Branch Experiment Station and were carefully monitored during the project year of 1973.

Due to a breakdown of the Data Analysis Station (DAS) at NASA-MTF-ERL the computer generated map and statistical table data products were not produced and a computer generated map which was created from 1972 ERTS data was used for the interview sessions (see page 21). This lack of data for the 1973 project year precluded the first order crop yield predictions as originally planned (see page 65).

An analysis of the received data from NASA was made to assess how often one can expect to receive useful satellite data. Based on the first 21 months of ERTS data received by this project some observations were made (see pages 17-20).

A very brief summary of conclusions and recommendations (see pages 64-69 for a detailed discussion) is not easily made without the possibility of being misleading, however, it is evident that the ERT-A system can be made useful for the agricultural industry personnel (that is personnel involved in making a living through production and marketing of agricultural products rather than research) but it will require much attention to overcoming the inertia of the system as presently configured.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPLICATIONS OF ERTS-A DATA TO AGRICULTURAL PRACTICES IN THE MISSISSIPPI DELTA REGION

I. INTRODUCTION

With the launching of the ERTS-A satellite, an opportunity to determine the ability of ground based agricultural industry to utilize the ERTS data products was created. This project's objective was just such a mission. In particular, this program was directed toward a study of the feasibility of the application of ERTS-A data in the area of (1) agronomy-crops, (2) grasslands, and (3) forestry. Ground based data which is pertinent to each of these areas was collected through the spring, summer and fall of 1973 to provide a reference data base for the ERTS data products.

Fields of at least 50 acres containing the "money crops" of the Mississippi Delta were instrumented as control plots to be used as training samples for the digital computer classification program which was operated by NASA-MTF-ERL.[1]

The Mississippi Delta Branch Experiment Station has been the focal point of the ground truth collection activity with some surrounding commercial farms utilized for ground truth collection.

The main objectives of the program were to:

1. Exercise the NASA-MTF-ERL data processing facility and to produce map and statistical data products for comparison to ground truth and to be used for interviewing potential users.

(Superscripts refer to references on page 70).

2. Identify and contact potential users of the data through an interview program in which the interviews were used partially to inform the agencies contacted of the ERTS data products and partially to obtain feedback from them as to the best formats, desired time scale and geographical scale.

3. Using available county ASCS productivity averages make a first order crop yield prediction.

II. DATA MANAGEMENT

There are three types of data involved in this study. The first is photographic copies of specific ERTS-1 frames. These are supplied to the MSU investigators by NASA/Goddard Space Flight Center. The second type of data is further refined items produced by the Earth Resources Laboratory at NASA/Mississippi Test Facility. This includes agriculturally classified maps and some corresponding statistics. Our third data type is ground truth data collected by investigators from the Delta Branch Experiment Station at Stoneville, Mississippi, and from the Cooperative Extension Service located on the campus of MSU.

The use and handling of each of these three types of data will be considered separately in the following sections.

Data From NASA/Goddard

NASA/Goddard Space Flight Center provides photographic copies of some ERTS-1 MSS frames and Standard Catalogs listing all MSS frames available. Photographic data, in the form of 70 mm negatives and 9.5+ in positive transparencies, is received for all ERTS-1 frames which (1) cover any part of the area in the rectangle having corners at 34.15, 91.15; 34.15, 90.15; 32.15, 90.15; 32.15, 91.15 (coordinates in N Latitude and W Longitude respectively) and (2) have a cloud cover of not more than 30%. The data is logged upon receipt and the negatives are filed for possible future reproduction. The catalogs and positive transparencies are used in a manner to be described.

The Data File

Most relevant data from Goddard and some results of visual analysis are kept in a computer card file. The program which operates on this file is capable of:

(1) Printing a listing of every ERTS-1 frame which covers any part of our 6 county test site and calculating the percentage of each county covered by that frame.

(2) Performing an analysis of all received data to determine its suitability for the computerized recognition routines used by NASA/MTF.

(3) Identifying any ERTS-1 frame we have received which covers a certain point when given the coordinates of that point.

The data entered into the data file is:

(1) ERTS-1 frame I.D.

(2) Calendar date of pass

(3) Percent cloud cover over frame

(4) Principal point coordinates

(5) Data quality

(6) Indication if frame was received

(7) Sensor output quality

(8) Percent cloud cover over site only

Items (1) through (5) are taken directly from the U. S. Standard Catalogs and are entered for every frame that approaches the test site area. Items (7) and (8) are the results of visual analysis and are entered only for frames which have been received.

The sensor output quality (Item 7) is rated from 0 to 3 where a 3 indicates that the output was perfect, a 2 indicates good quality with only minor flaws present, a 1 indicates poor quality output, and a 0 indicates that this particular sensor's output was not received although other sensors' outputs were received for the same frame. A 0 is assumed to mean that the sensor was not operating or that the output quality was very poor. The sensor output quality rating concerns only the data quality and not the location or the cloud cover of the area to which the data corresponds.

Percent cloud cover over site only (Item 8) is a visual estimate made by overlaying the frame on a map (drawn to approximate the data scale) and observing the cloud cover over the part of the 6 county area covered by that frame. Obviously the cloud cover over the site only may differ greatly from the cloud cover over the entire frame. The map mentioned here is also used to check the coverage figures generated by the program for the frames which have been received. The figures seem to be quite representative.

<u>Option 1</u>: List of ERTS-1 Data Taken Over the Mississippi Delta

Option 1 produces a listing of all ERTS-1 data appearing in the U. S. Standard Catalogs which covers any part of the 6 county Delta test site. Coverage of a county is determined by an algorithm which (1) inputs the individual counties' boundaries in coordinates taken from a system having its origin at Stoneville, Mississippi, (2) inputs the principal point coordinates for a particular frame and translates them into the other coordinate system, (3) approximates the area covered by that frame based on a model derived from several early ERTS-1 frames, and (4) determines the area common to both county and frame in terms of percentage of the county. After the coverages of each of the 6 counties has been determined the percent coverage of the total site area is calculated from them.

The output for Option 1 is a list, by cycles, giving the frame I.D., date of data take, site coverage, data quality, cloud cover, coverage of each county, and an indication if the data was received. Here the data quality (Good, Fair or Poor) and cloud cover were taken directly from the U.S. Standard Catalog. The output for Option 1, including all data through May of 1974, is given in Table II-1.

Option 2: Analysis of Received Data

This option considers only the frames which have been received. It employs the coverage routine of option 1 to determine total site coverage. If there is any coverage of the site the program determines if the data is suitable for the classification programs used by NASA/MTF. The criterion for usefulness is that there must be at least three good sensor outputs and a cloud cover not greater than 10%. A good sensor output is considered to be one which received a 2 or a 3 from the visual analysis, and the cloud cover used here is the cover over the site only, also determined by visual analysis.

The output lists the the frame I.D., date of pass, site coverage, sensor output quality, cloud cover over both frame and site, and whether the data is usable by MTF. If the data was not usable the reason is given. No data was received for any cycle which does not appear in the output list. A "NA" in the site cloud cover column indicates "Not Applicable" in that there was no site coverage by the frame. Hence, no evaluation of usefulness can be made for the frame. An output for Option 2 is given in Table II-2.

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) POLVR	SUFLR	WSHTN	HMPRY	SHRKY	ISQNA	DATA RCVD
CYCLE 1											
1016-16061	8/ 9/72	29%	100%	GGGG	62%	72%	6%	0%	0%	0%	
1016-16064	8/ 9/72	69%	20%	GGGG	18%	55%	86%	100%	100%	100%	
1017-16120	8/ 9/72	71%	40%	GGGG	100%	100%	93%	53%	22%	0%	
1017-16123	8/ 9/72	32%	80%	GGGG	0%	0%	29%	13%	98%	99%	
CYCLE 2											
1034-16061	8/26/72	12%	30%	GFFG	29%	26%	0%	0%	0%	0%	
1034-16064	8/26/72	86%	50%	GFFG	58%	93%	86%	100%	100%	90%	
1034-16070	8/26/72	1%	50%	GFF	0%	0%	0%	0%	0%	6%	
1035-16121	8/27/72	83%	0%	GGGG	100%	99%	100%	47%	69%	42%	YES
1035-16124	8/27/72	16%	10%	GGGG	0%	0%	0%	0%	55%	85%	YES
CYCLE 3											
1052-16061	9/13/72	11%	10%	GGPG	26%	26%	0%	0%	0%	0%	YES
1052-16064	9/13/72	86%	0%	GGPG	59%	93%	86%	100%	100%	100%	YES
1052-16070	9/13/72	1%	0%	GGPG	0%	0%	0%	0%	0%	6%	YES
CYCLE 4											
1070-16061	10/ 1/72	3%	0%	GGGG	8%	7%	0%	0%	0%	0%	YES
1070-16064	10/ 1/72	83%	0%	GGGG	56%	100%	74%	100%	100%	92%	YES
1070-16070	10/ 1/72	6%	0%	GGGG	0%	0%	0%	0%	5%	43%	YES
1071-16120	10/ 2/72	15%	0%	GGGG	43%	26%	0%	0%	0%	0%	YES
1071-16122	10/ 2/72	95%	0%	GGGG	91%	100%	100%	69%	100%	100%	YES
1071-16125	10/ 2/72	1%	0%	GGGG	0%	0%	0%	0%	0%	6%	YES
CYCLE 5											
1088-16064	10/19/72	12%	90%	GGGG	30%	26%	0%	0%	0%	0%	
1088-16070	10/19/72	68%	100%	GGGG	64%	93%	90%	100%	100%	100%	
1088-16073	10/19/72	1%	100%	GGGG	0%	0%	0%	0%	0%	6%	
1089-16122	10/20/72	22%	10%	GGGG	62%	38%	0%	0%	0%	0%	
1089-16125	10/20/72	76%	50%	GGGG	66%	70%	100%	18%	91%	97%	
CYCLE 6											
1106-16065	11/ 6/72	20%	60%	GGGG	54%	30%	0%	0%	0%	0%	
1106-16072	11/ 6/72	89%	60%	GGGG	67%	87%	96%	100%	100%	100%	
1107-16124	11/ 7/72	29%	60%	GGGG	80%	54%	0%	0%	0%	0%	
1107-16130	11/ 7/72	69%	60%	GGGG	49%	57%	100%	17%	90%	97%	

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA

ORIGINAL PAGE IS OF POOR QUALITY

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) POLVR	SNFLR	WSHTN	HMPRY	SHRKY	TSQNA	DATA RCVD
CYCLE 7											
1124-16070	11/24/72	13%	70%	GGGG	33%	26%	0%	0%	0%	0%	
1124-16073	11/24/72	89%	80%	GGGG	67%	93%	92%	100%	100%	100%	
1124-16075	11/24/72	1%	100%	GGGG	0%	0%	0%	0%	0%	6%	
1125-16125	11/25/72	29%	90%	GGGG	80%	54%	0%	0%	0%	0%	
1125-16131	11/25/72	73%	90%	GGGG	57%	65%	100%	20%	92%	97%	
CYCLE 8											
1143-16125	12/13/72	33%	100%	PGPG	89%	63%	0%	0%	0%	0%	
1143-16131	12/13/72	67%	100%	PGPG	38%	52%	100%	20%	92%	97%	
CYCLE 9											
1160-16065	12/30/72	9%	100%	GGGG	23%	19%	0%	0%	0%	0%	
1160-16071	12/30/72	89%	100%	GGGG	67%	100%	85%	100%	100%	99%	
1160-16074	12/30/72	4%	100%	GGGG	0%	0%	0%	0%	0%	30%	
1161-16123	12/31/72	25%	0%	GPGG	70%	45%	0%	0%	0%	0%	YES
1161-16130	12/31/72	76%	0%	GPGG	57%	60%	100%	28%	97%	90%	YES
CYCLE 10											
1178-16064	1/17/73	6%	80%	GGGG	16%	13%	0%	0%	0%	0%	
1178-16065	1/17/73	59%	20%	GGGG	64%	100%	69%	82%	10%	0%	YES
1178-16070	1/17/73	67%	70%	GGGG	65%	100%	81%	100%	100%	95%	
1178-16072	1/17/73	40%	20%	GGGG	0%	0%	39%	60%	100%	99%	YES
1178-16073	1/17/73	6%	60%	GGGG	0%	0%	0%	0%	5%	43%	
1179-16124	1/19/73	71%	100%	GGGG	100%	100%	93%	51%	22%	0%	
1179-16130	1/19/73	35%	100%	GGGG	0%	0%	39%	20%	99%	100%	
CYCLE 11											
1196-16070	2/ 4/73	10%	50%	GGGG	29%	19%	0%	0%	0%	0%	
1196-16073	2/ 4/73	96%	40%	GGGG	86%	100%	95%	100%	100%	100%	
1196-16075	2/ 4/73	2%	30%	GGGG	0%	0%	0%	0%	0%	13%	
1197-16125	2/ 5/73	22%	10%	GGGG	62%	38%	0%	0%	0%	0%	
1197-16131	2/ 5/73	78%	20%	GGGG	75%	74%	100%	16%	89%	96%	
CYCLE 12											
1214-16071	2/22/73	11%	30%	GGGG	33%	19%	0%	0%	0%	0%	YES
1214-16074	2/22/73	99%	60%	GGGG	96%	100%	99%	100%	100%	99%	
1214-16080	2/22/73	4%	40%	GGGG	0%	0%	0%	0%	0%	30%	
1215-16130	2/23/73	21%	0%	GGGG	62%	35%	0%	0%	0%	0%	YES
1215-16132	2/23/73	59%	0%	GGGG	66%	34%	97%	1%	46%	80%	YES

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA (Continued)

Page 2 of 6

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) BOLVR	SNFLR	WSHTN	HMPRY	SHRKY	ISQNA	DATA RCVD
CYCLE 13											
1232-16072	3/12/73	8%	0%	GPGG	25%	13%	0%	0%	0%	0%	YES
1232-16075	3/12/73	99%	0%	GPGG	97%	100%	100%	100%	100%	98%	YES
1232-16081	3/12/73	4%	0%	GPGG	0%	0%	0%	0%	0%	30%	YES
1233-16131	3/13/73	22%	70%	GGGG	70%	32%	0%	0%	0%	0%	
1233-16133	3/13/73	53%	80%	GGGG	57%	23%	96%	0%	36%	76%	
CYCLE 14											
1250-16072	3/30/73	8%	70%	GGGG	25%	13%	0%	0%	0%	0%	
1250-16075	3/30/73	99%	80%	GGGG	97%	100%	100%	100%	100%	98%	
1250-16081	3/31/73	4%	90%	GGGG	0%	0%	0%	0%	0%	30%	
1251-16131	3/31/73	15%	10%	GGGG	51%	17%	0%	0%	0%	0%	YES
1251-16133	3/31/73	50%	0%	GGPG	75%	10%	91%	0%	11%	69%	YES
CYCLE 15											
1268-16072	4/17/73	8%	90%	GGGG	25%	13%	0%	0%	0%	0%	
1268-16075	4/17/73	99%	100%	GGGG	97%	100%	100%	100%	100%	100%	
1268-16081	4/17/73	4%	100%	GGGG	0%	0%	0%	0%	0%	30%	
1269-16131	4/18/73	15%	70%	GGGG	51%	14%	0%	0%	0%	0%	
1269-16133	4/18/73	46%	50%	GGGG	75%	7%	90%	0%	6%	67%	
CYCLE 16											
1286-16071	5/ 5/73	5%	0%	GGGG	16%	7%	0%	0%	0%	0%	YES
1286-16074	5/ 5/73	99%	0%	GGGG	100%	100%	100%	100%	100%	94%	YES
1286-16080	5/ 5/73	9%	0%	GGGG	0%	0%	0%	0%	19%	50%	YES
1287-16130	5/ 6/73	13%	100%	GGGG	43%	16%	0%	0%	0%	0%	
1287-16132	5/ 6/73	53%	100%	GGGG	84%	13%	92%	0%	12%	69%	
CYCLE 17											
1305-16125	5/24/73	14%	10%	GGGG	51%	11%	0%	0%	0%	0%	YES
1305-16131	5/24/73	45%	10%	GGGG	73%	3%	86%	0%	2%	62%	YES
CYCLE 18											
1322-16065	6/10/73	5%	20%	GGGG	16%	7%	0%	0%	0%	0%	YES
1322-16072	6/10/73	99%	20%	GGPG	100%	100%	100%	100%	100%	94%	YES
1322-16074	6/10/73	6%	20%	GGPG	0%	0%	0%	0%	5%	43%	YES
1323-16123	6/11/73	15%	60%	GGGG	51%	15%	0%	0%	0%	0%	
1323-16130	6/11/73	49%	80%	GGGG	83%	6%	88%	0%	3%	64%	

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA (Continued)

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) BOLVR	SNFLR	WSHTN	HMPRY	SHRKY	ISQNA	DATA RCVD
CYCLE 19											
1340-16064	6/28/73	12%	10%	GGGG	34%	19%	0%	0%	0%	0%	YES
1340-16070	6/28/73	98%	20%	GGGG	91%	100%	100%	100%	100%	100%	YES
1340-16073	6/28/73	2%	20%	GGGG	0%	0%	0%	0%	0%	13%	YES
1341-16122	6/29/73	21%	80%	GGGG	70%	24%	0%	0%	0%	0%	
1341-16125	6/29/73	50%	60%	GGGG	66%	14%	93%	0%	19%	71%	
CYCLE 20											
1358-16063	7/16/73	12%	90%	PGPG	34%	19%	0%	0%	0%	0%	
1358-16065	7/16/73	99%	60%	GGPG	97%	100%	100%	100%	100%	100%	
1358-16072	7/16/73	4%	20%	GGGG	0%	0%	0%	0%	0%	30%	YES
1359-16121	7/17/73	18%	90%	GGGG	62%	18%	0%	0%	0%	0%	
1359-16123	7/17/73	45%	80%	GGGG	65%	4%	88%	0%	4%	65%	
CYCLE 21											
1376-16061	8/ 3/73	8%	20%	GGGG	25%	13%	0%	0%	0%	0%	YES
1376-16064	8/ 3/73	99%	20%	GGGG	97%	100%	100%	100%	100%	100%	YES
1376-16070	8/ 3/73	4%	20%	GGGG	0%	0%	0%	0%	0%	30%	YES
1377-16120	8/ 4/73	21%	10%	GGGG	70%	26%	0%	0%	0%	0%	YES
1377-16122	8/ 4/73	48%	10%	GGGG	66%	9%	92%	0%	12%	69%	YES
CYCLE 22											
1394-16060	8/21/73	15%	10%	GGGG	43%	26%	0%	0%	0%	0%	YES
1394-16062	8/21/73	98%	0%	GGGG	91%	100%	100%	100%	100%	100%	YES
1394-16065	8/21/73	2%	10%	GGGG	0%	0%	0%	0%	0%	13%	YES
1395-16114	8/22/73	20%	0%	GGGP	70%	19%	0%	0%	0%	0%	YES
1395-16120	8/22/73	45%	0%	GGGP	57%	7%	91%	0%	11%	69%	YES
CYCLE 23											
1412-16054	9/ 8/73	8%	40%	GGGG	24%	13%	0%	0%	0%	0%	
1412-16060	9/ 8/73	99%	20%	GGGG	96%	100%	99%	100%	100%	90%	YES
1412-16063	9/ 8/73	4%	80%	GGGG	0%	0%	0%	0%	0%	30%	
1413-16112	9/ 9/73	21%	0%	GGGG	62%	37%	0%	0%	0%	0%	YES
1413-16114	9/ 9/73	68%	10%	GGGG	66%	51%	100%	4%	69%	91%	YES
CYCLE 24											
1430-16051	9/26/73	8%	60%	GGGG	24%	13%	0%	0%	0%	0%	
1430-16054	9/26/73	98%	70%	GGGG	95%	100%	99%	100%	100%	98%	
1430-16060	9/26/73	4%	80%	GGGG	0%	0%	0%	0%	0%	30%	
1431-16105	9/27/73	21%	90%	GGGG	62%	37%	0%	0%	0%	0%	
1431-16112	9/27/73	65%	80%	GGGG	66%	45%	99%	3%	61%	97%	

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA (Continued)

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) BOLVR	SNFLR	WSHTN	HMPRY	SHRKY	ISSQNA	DATA RCVD
CYCLE 25											
1448-16044	10/14/73	5%	70%	GGGG	15%	7%	0%	0%	0%	0%	
1448-16050	10/14/73	95%	100%	GGGG	88%	100%	95%	100%	100%	94%	
1448-16053	10/14/73	0%	100%	GGGG	0%	0%	0%	0%	5%	47%	
1449-16102	10/15/73	18%	30%	GGGG	51%	32%	0%	0%	0%	0%	YES
1449-16105	10/15/73	80%	90%	GGGG	75%	77%	100%	20%	92%	97%	
CYCLE 26											
1466-16042	11/ 1/73	7%	0%	P G	18%	13%	0%	0%	0%	0%	YES
1466-16045	11/ 1/73	91%	0%	P G	74%	100%	89%	100%	100%	98%	YES
1466-16051	11/ 1/73	4%	0%	G P	0%	0%	0%	0%	0%	30%	YES
1467-16101	11/ 2/73	25%	90%	GGGG	70%	45%	0%	0%	0%	0%	
1467-16103	11/ 2/73	80%	60%	PGGG	66%	77%	100%	31%	98%	99%	
CYCLE 27											
1484-16042	11/19/73	17%	20%	GGGG	47%	32%	0%	0%	0%	0%	YES
1484-16044	11/19/73	69%	20%	GGPG	67%	87%	96%	100%	100%	100%	YES
1485-16100	11/20/73	29%	100%	PPP	80%	54%	0%	0%	0%	0%	
1485-16103	11/20/73	69%	100%	PPP	49%	56%	100%	15%	89%	96%	
CYCLE 28											
1502-16041	12/ 7/73	20%	10%	GGGG	57%	38%	0%	0%	0%	0%	YES
1502-16043	12/ 7/73	86%	10%	GGGG	60%	81%	96%	100%	100%	100%	YES
1503-16095	12/ 8/73	29%	30%	G G	80%	52%	0%	0%	0%	0%	YES
CYCLE 29											
1520-16035	12/25/73	17%	80%	PGP	47%	32%	0%	0%	0%	0%	
1520-16041	12/25/73	95%	100%	PGP	77%	93%	96%	100%	100%	100%	
1520-16044	12/25/73	1%	100%	PGP	0%	0%	0%	0%	0%	6%	
1521-16093	12/26/73	24%	90%	GGG	70%	43%	0%	0%	0%	0%	
1521-16095	12/26/73	64%	50%	GGG	57%	45%	100%	4%	68%	90%	
CYCLE 30											
1538-16031	1/12/74	13%	70%	PPGP	36%	26%	0%	0%	0%	0%	
1538-16034	1/12/74	89%	80%	PPGP	67%	93%	92%	100%	100%	100%	
1538-16040	1/12/74	1%	90%	PPPP	0%	0%	0%	0%	0%	6%	
1539-16090	1/13/74	25%	90%	GGGP	70%	45%	0%	0%	0%	0%	
1539-16092	1/13/74	73%	90%	GGPP	57%	64%	100%	12%	91%	97%	

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA (Continued) Page 5 of 6

ERTS-1 FRAME ID	PASS DATE	SITE COV	CLOUD COV	QUAL 4567	COVERAGE (PERCENT OF EACH COUNTY) BOLVR	SNFLR	WSHTN	HMPRY	SHRKY	ISQNA	DATA RCVD
CYCLE 31											
1556-16023	1/30/74	7%	10%	PPPG	20%	13%	0%	0%	0%	0%	YES
1556-16030	1/30/74	95%	0%	PGGP	77%	100%	91%	100%	100%	100%	YES
1556-16032	1/30/74	4%	0%	PPGG	0%	0%	0%	0%	0%	30%	YES
1557-16081	1/31/74	18%	10%	GGGG	51%	32%	0%	0%	0%	0%	YES
1557-16084	1/31/74	83%	0%	GGGG	75%	83%	100%	31%	98%	99%	YES
CYCLE 32											
1574-16021	2/17/74	5%	0%	GGGP	15%	7%	0%	0%	0%	0%	YES
1574-16024	2/17/74	94%	0%	GGGG	83%	100%	93%	100%	100%	98%	YES
1574-16030	2/17/74	6%	0%	GGGG	0%	0%	0%	0%	5%	43%	YES
1575-16075	2/18/74	18%	90%	GGPG	51%	32%	0%	0%	0%	0%	
1575-16082	2/18/74	78%	100%	PGPG	75%	74%	100%	16%	89%	96%	
CYCLE 33											
1592-16015	3/ 7/74	6%	90%	GGGG	23%	13%	0%	0%	0%	0%	
1592-16022	3/ 7/74	96%	60%	PGGG	87%	100%	96%	100%	100%	98%	
1592-16024	3/ 7/74	4%	20%	PGGG	0%	0%	0%	0%	0%	30%	YES
1593-16074	3/ 8/74	18%	30%	GGGG	51%	32%	0%	0%	0%	0%	YES
CYCLE 34											
1610-16013	3/25/74	11%	20%	PPPP	32%	10%	0%	0%	0%	0%	YES
1610-16020	3/25/74	96%	60%	PPPP	87%	100%	97%	100%	100%	100%	
1610-16022	3/25/74	2%	90%	PPPP	0%	0%	0%	0%	0%	13%	
1611-16072	3/26/74	24%	20%	PPPP	70%	43%	0%	0%	0%	0%	YES
1611-16074	3/26/74	63%	90%	P P	57%	44%	100%	3%	66%	90%	
CYCLE 35											
1628-16011	4/12/74	15%	100%	PPPG	42%	26%	0%	0%	0%	0%	
1628-16014	4/12/74	94%	100%	GGPG	81%	93%	98%	100%	100%	100%	
1628-16020	4/12/74	1%	100%	GGPG	0%	0%	0%	0%	0%	6%	
1629-16065	4/13/74	28%	80%	PPPP	80%	50%	0%	0%	0%	0%	
1629-16072	4/13/74	58%	60%	PPPP	49%	34%	99%	2%	57%	85%	
CYCLE 36											
1646-16004	4/30/74	12%	40%	GPPP	34%	10%	0%	0%	0%	0%	
1646-16011	4/30/74	98%	50%	PPPP	91%	100%	100%	100%	100%	100%	
1646-16013	4/30/74	2%	50%	PPPP	0%	0%	0%	0%	0%	13%	
1647-16063	5/ 1/74	23%	100%	GGGG	70%	33%	0%	0%	0%	0%	
1647-16065	5/ 1/74	56%	90%	GGGG	57%	29%	97%	1%	45%	70%	

TABLE II-1 ERTS DATA TAKEN OVER THE MISSISSIPPI DELTA (Concluded)

TABLE II-2 ANALYSIS OF RECEIVED DATA

ERTS-1 FRAME ID	PASS DATE	SITE COV	QUAL 4567	CLOUD COV FRAME	CLOUD COV SITE	DATA USABLE	UNUSABLE BECAUSE
CYCLE 2							
1035-16121	8/27/72	83%	3323	0%	0%	YES	
1035-16124	8/27/72	18%	3333	10%	15%	NO	CLOUD COVER
COVERAGE BY GOOD DATA EQUALS 83% OF SITE FOR THIS CYCLE							
BOLVR 100%,SNFLR 99%,WSHTN 100%,HMPRY 47%,SHRKY 69%,ISONA 42%							
CYCLE 3							
1052-16061	9/13/72	11%	3313	10%	0%	YES	
1052-16064	9/13/72	86%	3313	0%	0%	YES	
1052-16070	9/13/72	1%	3313	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 89% OF SITE FOR THIS CYCLE							
BOLVR 67%,SNFLR 100%,WSHTN 86%,HMPRY 100%,SHRKY 100%,ISONA 100%							
CYCLE 4							
1070-16061	10/ 1/72	3%	3333	0%	0%	YES	
1070-16064	10/ 1/72	83%	3333	0%	0%	YES	
1070-16070	10/ 1/72	6%	3333	0%	0%	YES	
1071-16120	10/ 2/72	15%	3333	0%	0%	YES	
1071-16122	10/ 2/72	95%	3333	0%	0%	YES	
1071-16125	10/ 2/72	1%	3333	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 100%,WSHTN 100%,HMPRY 100%,SHRKY 100%,ISONA 100%							
CYCLE 9							
1161-16123	12/31/72	25%	3333	0%	0%	YES	
1161-16130	12/31/72	76%	3333	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 90% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 95%,WSHTN 100%,HMPRY 28%,SHRKY 97%,ISONA 99%							
CYCLE 10							
1178-16065	1/17/73	59%	3333	20%	100%	NO	CLOUD COVER
1178-16072	1/17/73	40%	3333	20%	100%	NO	CLOUD COVER
CYCLE 12							
1214-16071	2/22/73	11%	3333	30%	100%	NO	CLOUD COVER
1215-16130	2/23/73	21%	3333	0%	0%	YES	
1215-16132	2/23/73	59%	3333	0%	5%	YES	
COVERAGE BY GOOD DATA EQUALS 71% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 59%,WSHTN 97%,HMPRY 1%,SHRKY 46%,ISONA 80%							
CYCLE 13							
1232-16072	3/12/73	8%	3333	0%	0%	YES	
1232-16075	3/12/73	90%	3333	0%	5%	YES	
1232-16081	3/12/73	4%	3333	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 100%,WSHTN 100%,HMPRY 100%,SHRKY 100%,ISONA 100%							
CYCLE 14							
1251-16131	3/31/73	15%	3333	10%	0%	YES	
1251-16133	3/31/73	50%	3333	0%	0%	YES	
1251-16140	3/31/73	0%	3303	0%	NA		
COVERAGE BY GOOD DATA EQUALS 58% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 20%,WSHTN 91%,HMPRY 0%,SHRKY 11%,ISONA 69%							

TABLE II-2 ANALYSIS OF RECEIVED DATA (Continued)

ERTS-1 FRAME ID	PASS DATE	SITE COV	QUAL 4567	CLOUD COV FRAME	CLOUD COV SITE	DATA USABLE	UNUSABLE BECAUSE
CYCLE 15							
1269-16140	4/18/73	0%	3333	30%	NA		
CYCLE 16							
1285-16022	5/ 4/73	0%	3333	0%	NA		
1286-16071	5/ 5/73	5%	3333	0%	0%	YES	
1286-16074	5/ 5/73	99%	3333	0%	0%	YES	
1286-16080	5/ 5/73	9%	3333	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%, SNFLR 100%, WSHTN 100%, HMPRY 100%, SHRKY 100%, ISONA 100%							
CYCLE 17							
1305-16125	5/24/73	14%	3333	10%	0%	YES	
1305-16131	5/24/73	45%	3333	10%	1%	YES	
COVERAGE BY GOOD DATA EQUALS 53% OF SITE FOR THIS CYCLE							
BOLVR 97%, SNFLR 14%, WSHTN 86%, HMPRY 0%, SHRKY 2%, ISONA 62%							
CYCLE 18							
1322-16065	6/10/73	5%	3333	20%	40%	NO	CLOUD COVER
1322-16072	6/10/73	99%	3333	20%	30%	NO	CLOUD COVER
1322-16074	6/10/73	6%	3323	20%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 6% OF SITE FOR THIS CYCLE							
BOLVR 0%, SNFLR 0%, WSHTN 0%, HMPRY 0%, SHRKY 5%, ISONA 43%							
CYCLE 19							
1339-16014	6/27/73	0%	3333	30%	NA		
1340-16064	6/28/73	12%	3333	10%	0%	YES	
1340-16070	6/28/73	98%	3333	20%	1%	YES	
1340-16073	6/28/73	2%	3333	20%	5%	YES	
1341-16131	6/29/73	0%	3333	30%	NA		
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%, SNFLR 100%, WSHTN 100%, HMPRY 100%, SHRKY 100%, ISONA 100%							
CYCLE 20							
1358-16072	7/16/73	4%	3333	20%	95%	NO	CLOUD COVER
CYCLE 21							
1375-16012	8/ 2/73	0%	3333	30%	NA		
1376-16061	8/ 3/73	8%	3333	20%	5%	YES	
1376-16064	8/ 3/73	99%	3333	20%	5%	YES	
1376-16070	8/ 3/73	4%	3333	20%	10%	YES	
1377-16120	8/ 4/73	21%	3333	10%	0%	YES	
1377-16122	8/ 4/73	48%	3333	10%	20%	NO	CLOUD COVER
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%, SNFLR 100%, WSHTN 100%, HMPRY 100%, SHRKY 100%, ISONA 100%							
CYCLE 22							
1393-16010	8/20/73	0%	3333	0%	NA		
1394-16060	8/21/73	15%	3333	10%	0%	YES	
1394-16062	8/21/73	98%	3333	0%	0%	YES	
1394-16065	8/21/73	2%	3333	10%	0%	YES	
1395-16114	8/22/73	20%	3333	0%	0%	YES	
1395-16120	8/22/73	45%	3333	0%	0%	YES	
1395-16123	8/22/73	0%	3333	0%	NA		
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%, SNFLR 100%, WSHTN 100%, HMPRY 100%, SHRKY 100%, ISONA 100%							

ERTS-1 FRAME ID	PASS DATE	SITE COV	QUAL 4567	CLOUD FRAME	COV SITE	DATA USABLE	UNUSABLE BECAUSE
CYCLE 23							
1412-16000	9/ 8/73	99%	3333	20%	20%	NO	CLOUD COVER
1413-16112	9/ 9/73	21%	3333	0%	2%	YES	
1413-16114	9/ 9/73	68%	3333	10%	1%	YES	
1413-16121	9/ 9/73	0%	3333	30%	NA		
COVERAGE BY GOOD DATA EQUALS 79% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 74%,WSHTN 100%,HMPRY 4%,SHRKY 69%,ISONA 91%							
CYCLE 24							
1431-16114	9/27/73	0%	3333	30%	NA		
CYCLE 25							
1449-16102	10/15/73	18%	3333	30%	100%	NO	CLOUD COVER
CYCLE 26							
1466-16042	11/ 1/73	7%	0303	0%	0%	NO	DATA QUALITY
1466-16045	11/ 1/73	91%	0303	0%	0%	NO	DATA QUALITY
1466-16051	11/ 1/73	4%	0302	0%	0%	NO	DATA QUALITY
CYCLE 27							
1484-16042	11/19/73	17%	3333	20%	50%	NO	CLOUD COVER
1484-16044	11/19/73	89%	3333	20%	15%	NO	CLOUD COVER
1484-16051	11/19/73	0%	3333	20%	NA		
CYCLE 28							
1502-16041	12/ 7/73	20%	3333	10%	20%	NO	CLOUD COVER
1502-16043	12/ 7/73	86%	3333	10%	2%	YES	
1502-16050	12/ 7/73	0%	3333	0%	NA		
1503-16095	12/ 8/73	29%	0303	30%	2%	NO	DATA QUALITY
COVERAGE BY GOOD DATA EQUALS 86% OF SITE FOR THIS CYCLE							
BOLVR 60%,SNFLR 81%,WSHTN 96%,HMPRY 100%,SHRKY 100%,ISONA 100%							
CYCLE 29							
1521-16102	12/26/73	0%	3333	10%	NA		
CYCLE 31							
1556-16023	1/30/74	7%	3333	10%	0%	YES	
1556-16030	1/30/74	93%	3333	0%	0%	YES	
1556-16032	1/30/74	4%	3333	0%	0%	YES	
1557-16081	1/31/74	18%	3333	10%	0%	YES	
1557-16084	1/31/74	83%	3333	0%	0%	YES	
1557-16090	1/31/74	0%	3333	0%	NA		
COVERAGE BY GOOD DATA EQUALS 99% OF SITE FOR THIS CYCLE							
BOLVR 97%,SNFLR 100%,WSHTN 100%,HMPRY 100%,SHRKY 100%,ISONA 100%							
CYCLE 32							
1574-16021	2/17/74	5%	3333	0%	0%	YES	
1574-16024	2/17/74	94%	3333	0%	0%	YES	
1574-16030	2/17/74	6%	3333	0%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 94% OF SITE FOR THIS CYCLE							
BOLVR 80%,SNFLR 100%,WSHTN 93%,HMPRY 100%,SHRKY 100%,ISONA 100%							

Page 3 of 4

ERTS-1 FRAME ID	PASS DATE	SITE COV	QUAL 4567	CLOUD COV FRAME	CLOUD COV SITE	DATA USABLE	UNUSABLE BECAUSE
CYCLE 33							
1592-16024	3/ 7/74	4%	3333	20%	3%	YES	
1593-16074	3/ 8/74	18%	3333	30%	0%	YES	
COVERAGE BY GOOD DATA EQUALS 21% OF SITE FOR THIS CYCLE							
DOLVR 46%, SNFLR 32%, WSHTN 0%, HMPRY 0%, SHRKY 0%, ISONA 30%							
CYCLE 34							
1610-16013	3/25/74	11%	3333	20%	0%	YES	
1611-16072	3/26/74	24%	3333	20%	5%	YES	
COVERAGE BY GOOD DATA EQUALS 24% OF SITE FOR THIS CYCLE							
DOLVR 70%, SNFLR 43%, WSHTN 0%, HMPRY 0%, SHRKY 0%, ISONA 0%							

Site Coverage = % of 6 county area shown by the frame

Data Quality (Cameras 4, 5, 6, & 7) (Does not consider clouds)

0 - did not receive, assumed to be poor
1 - poor quality, not usable
2 - decent quality, usable
3 - excellent quality, usable

Cloud Cover

Frame - % Coverage listed in U. S. Standard Catalogs
Site - % Coverage over site only determined visually

Data Usable

Yes - 3 or more good sensor outputs, 10% cloud cover
No - Either < 3 good sensors or > 10% cloud cover

Option 3: Received Data Covering a Particular Point

This option uses the procedure from the coverage calculation to determine if a particular point is covered by the received data frames. The latitude and longitude of the point must be inputted to initiate the routine. The output lists all received data which covers the point by its frame I.D. and date. Quality and cloud cover from the U. S. Standard Catalogs is also printed.

Observations and Conclusions from NASA/Goddard Data

One of the more important issues considered in this investigation is how often one can expect to receive useful satellite data. Based on the first 21 months of ERTS-1 data, some observations can be made.

A total of 169 frames appeared in the U. S. Standard Catalogs for this period which covered a part of the six county test site. No listings appeared for September 14, 1972,(1053) or December 12, 1972,(1142) when there should have been two and three frames respectively taken over the site. The five frames were assumed to be lost due to system failure. Any frame with not more than 30% cloud cover was to be sent to MSU as photographic data. Six frames, 1016-16064 (20%), 1034-16061 (30%), 1089-16122 (10%), 1196-16075 (30%), 1197-16125 (10%), and 1197-16131 (20%) should have been sent but no data was received (cloud cover from U. S. Standard Catalogs is given in parentheses). These frames are listed as being lost to data handling although they should actually be included in some other group. The data taken was divided into three groups; those with unacceptable cloud cover, those with acceptable cloud cover but insufficient data quality, and those that are usable. Table II-3 gives the breakdown for the first 21 months of data.

Another breakdown that is possibly more significant is to see how the good data corresponds to the growing seasons. It is known that certain classifications are more accurate when the data is taken at the proper time of the year. For example, pine can be distinguished from hardwood much more accurately if the data was taken during the winter.

To accomplish this breakdown it is necessary to identify time periods which correspond to the different crop stages. Summer can be defined as that time between when the crops are up and when they are harvested, roughly June 15 through October 1. Winter can be considered to be the period from when winter crops come up until preparation for summer crops begins, around December 15 until March 1. Spring is the planting period from April 1 until May 30. Fall is the harvest time or from October 15 to December 1. Notice that the seasons as defined here are separated by transition periods.

Table II-4 shows how the good data takes correspond to these seasons. The coverage figure is total percent of the six county area covered by any usable data, that is, the percentage of the site for which useful data was taken anytime during the cycle. The notion of frames has been dropped here as a frame is a superficial division with respect to the digital tapes used for the classification.

In this study it appears that one could reasonably expect to receive good data for every season except fall. Neither fall of 1972 or fall of 1973 produced acceptable data. This result agrees with a similar study concerning the Mississippi Gulf Coast.

TABLE II-3

USEFUL SATELLITE DATA

174	ERTS-1 frames possible
5	Not taken (system failure)
169	ERTS-1 frames taken
94	Frames with cloud cover > 30%
6	Frames not received with clouds ≤ 30%
69	Frames received by MSU investigators
13	Frames with site cloud cover > 10%
4	Frames with insufficient data quality
52	Usable frames

By Percentage

2.9%	Suffered system failure
3.5%	Were lost in the data handling
61.5%	Had too great a cloud cover
2.3%	Had acceptable clouds but insufficient quality
29.8%	Were usable for classification

Table II-4

SEASONAL CORRELATION OF USEFUL SATELLITE DATA

Cycle No.	% Site Coverage	Date	Season
2	83%	8/27/72	Summer
3	89%	9/13/72	Summer
4	100%	10/ 1/72	Summer
9	90%	12/31/72	Winter
12	71%	2/23/73	Winter
13	100%	3/12/73	Transition period
14	58%	3/31/73	Spring
16	100%	5/ 5/73	Spring
17	53%	5/24/73	Spring
18	6%	6/10/73	Transition period
19	100%	6/28/73	Summer
21	100%	8/ 3/73	Summer
22	100%	8/21/73	Summer
23	79%	9/ 9/73	Summer
28	86%	12/ 7/73	Winter
31	100%	1/30/74	Winter
32	94%	2/17/74	Winter
33	21%	3/ 7/74	Transition period
34	24%	3/25/74	Transition period

Data Products From NASA/MTF

The Earth Resources Lab at NASA/Mississippi Test Facility receives digital tapes of selected MSS data and uses a computerized classification routine to identify crop types and land usage from it. Based on previous experience it was decided that the most useful format for the output of the classification program would be a color coded map and some corresponding statistics (i.e. what percentage of a county is involved with each classification).

A classification of some August 1972 ERTS-1 data was performed in order to test the procedure, resulting in a color coded map of part of the Delta (about one county) printed at a 1:200,000 scale. No statistics were derived from this classification. Classification of August 1973 data was to be performed and delivered in January 1974. Primarily due to the inoperative status of the Data Analysis Station at MTF, this data has not yet been classified even though the August 21 and 22 data was excellent. Possibly it will be ready before the final report due date.

The evaluation performed in this study was conducted using the classification of the 1972 data. Since all the ground truth was taken in 1973, it has been impossible to correlate the two data types. Maps and statistics generated by MTF for a similar study concerning the Mississippi Gulf Coast were also considered, in lieu of the desired data.

Ground Truth Data

Ground truth data must be used in order to train the computerized recognition routine. The classification program must have the data characteristics of each desired classification group available for comparison. This is accomplished by locating plots from each classification in the ERTS-1 MSS data (visually displayed on the Data Analysis Station) and then having the computer examine the data from these known plots in order to determine the data statistics for each desired classification.

Delta Branch Experiment Station Fields

The plots or "training samples" were identified in cooperation with the Delta Branch Experiment Station at Stoneville, Mississippi. Nine fields of at least 30 acres each were identified as training fields. The fields were selected to give a wide variety of species and planting styles within each crop type of major concern. Eight of these fields were instrumented and monitored at the time of each ERTS-1 pass between June and December, 1973. In order to be able to monitor these fields near the same time for each pass, all fields were located near Stoneville.

A list identifying these fields is given in Table II-5 and a map locating them in Figure II-1. Any parameter which was considered to be likely to effect the field's reflectance was evaluated every 18 days. The field was then photographed and all data was recorded on data sheets, Figure II-2 and II-3. The data from these nine fields is currently being maintained at MSU in the form of a computer card file.

A sample print out for one field is given in Figure II-4. Shown in Figure II-5, are pictures of the test fields during three stages of the crop season. The first stage is just after

TABLE II-5 DELTA BRANCH EXPERIMENT STATION

Instrumented Fields

Field #	Crop	Size
1	Corn	73 acres
2	Pasture	150 acres
3	Cotton (2 x 2)	240 acres
4	Cotton (2 x 1)	247 acres
5	Forrest	30 acres
6	Rice	145 acres
7	Soybeans (clean)	110 acres
8	Soybeans (and weeds)	100 acres
9*	Cotton (solid)	acres

* Field not monitored with each pass.

Figure II-1

LOCATION OF DELTA BRANCH EXPERIMENT STATION

INSTRUMENTED FIELDS

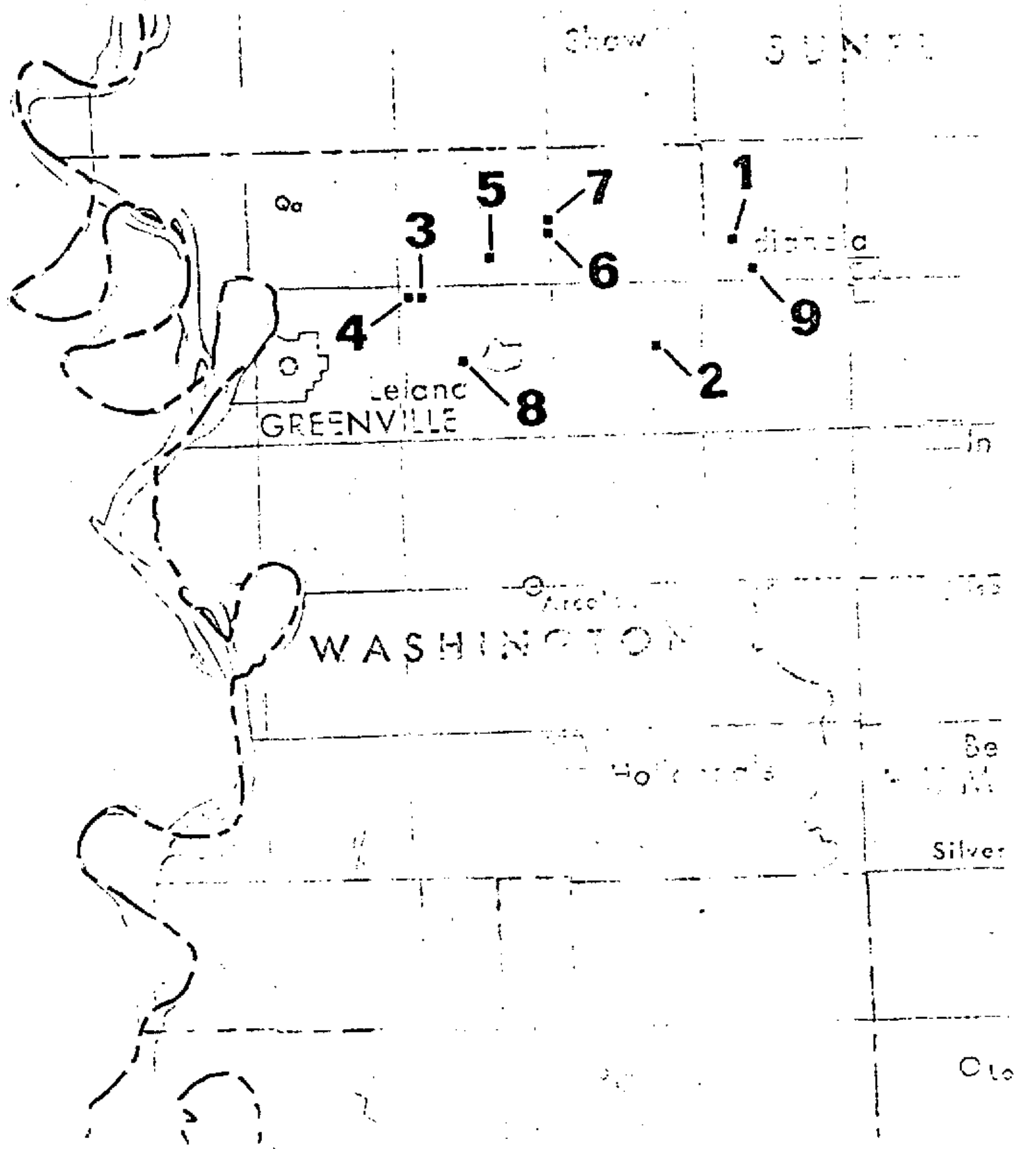

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Figure II-2

NASA ERTS-1 GROUND TRUTH
Test Site Identification

I.D.
Card 1

Field Number ______________

Size ______________ Crop ______________
Acres

Location
Card 2

County ______________

Range ______________ Township ______________

Section and Location ______________

Map
Coordinates
Card 3

______________ to ______________ N. Latitude
Deg Min Sec Deg Min Sec
______________ to ______________ W. Longitude
Deg Min Sec Deg Min Sec

Owner
Card 4

Name and Address of Owner ______________

____

Tenant
Card 5

Name and Address of Tenant ______________

____

Crop
Information
Card 6

Size ______________
Acres
Crop ______________ Variety ______________

Planting Date ______________

Soil
Information
Card 7

Soil Type ______________
Series, Texture, Color, Slope, etc.

Planting
Information
Card 8

Row Orientation ______________
i.e. North to South
Row Spacing ______________ Drill Spacing ______________
Inches Inches
Pattern ______________
i.e. Solid, Skiprow, 2-1, 2-2, etc.

Figure II-3

NASA ERTS-1 GROUND TRUTH
Field Observations
Delta Branch Experiment Station

Card 1

General Information

Field Number	1 [ ][ ]	
Pass Number	4 [ ][ ]	
Date	8 [ ][ ]/[ ][ ]	,1973

Experiment Station Readings

Wind, Velocity	15 [ ][ ]	MPH
Direction	19 [ ][ ]	
Solar Radiation	24 [ ][ ][ ]	Langleys/Day

Field Readings

Time (Local)	29 [ ][ ]:[ ][ ]	
Temperature	36 [ ][ ][ ]	°F
Cloud Cover	41 [ ][ ][ ]	%
Ground Cover	46 [ ][ ][ ]	%
Plant Height	51 [ ][ ][ ]	Inches
Infestation, Weed	55 [ ][ ][ ]	(Non, Lgt, Med, Hvy)
Type ______		
Disease	59 [ ][ ][ ]	(Non, Lgt, Med, Hvy)
Type ______		
Insect	63 [ ][ ][ ]	(Non, Lgt, Med, Hvy)
Type ______		
Soil, Moisture at 6"	68 [ ][ ][ ]	%
Moisture at 12"	73 [ ][ ][ ]	%
Moisture at 18"	78 [ ][ ][ ]	%
Condition ______		

FIGURE II-3 NASA ERTS-1 GROUND TRUTH (Continued)

Field Observations

Delta Branch Experiment Station
(Page 2)

	1	4	
Card 2	☐☐	☐☐[1]	Data Taken By: ______
			Pictures: 66 ☐☐ 68 ☐☐☐☐☐☐ 76 ☐☐☐☐☐
Card 3	☐☐	☐☐[2]	Soil Condition: ______
Card 4	☐☐	☐☐[3]	Crop Physiological Condition: ______
Card 5	☐☐	☐☐[4]	Crop Visual Condition: ______
Card 6	☐☐	☐☐[5]	Comments: ______
	Field No.	Pass No.	

Infestation Code:

Non - None
Lgt - Light Infestation
Med - Moderate Infestation
Hvy - Heavy Infestation

FIGURE II-9

DELTA GROUND TRUTH
COMPUTER CARD FILE

```
**************************************************************************************

FIELD 1              73 ACRES             CORN

                   * * *  GENERAL  INFORMATION  * * *

SUNFLOWER COUNTY. R5W. T19N. SECTION 23. NORTH WEST CORNER
33 28 10 N LAT.. 90 44 35 W LONG.
JAMES ROBINSON. HOLLY RIDGE. MS.       (OWNER)
73 ACRES. CORN.12 TONS/ACRE
DUNDEE SILT LOAM.
EAST/WEST 40 IN ROWS. SOLID

                 * * *  10 DAY GROUND TRUTH DATA  * * *

              WIND     SOL  LOCAL         CLD  GRD  PLT INFESTATION  SOIL MOISTURE
I.D.   DATE  VEL DIR   RAD  TIME  TEMP    CVR  CVR  HGT  WD DIS INS   6C    12C  18C

01 01  05/23  10  SW   373  10:45   80    00    5   16 NON NON NON 16.4 20.3 23.7
       DATA TAKEN BY:  GORDON A TUPPER                  PICTURES:  AL 01.FRS 01-05
       SOIL CONDITION:  SMOOTH
       CROP PHYSIOLOGICAL CONDITION: SOME REDDISH COLORING ON LEAF EDGES
       CROP VISUAL CONDITION:  FAIRLY UNIFORM
       COMMENTS:  LEAF COLORING - POSSIBLY PHOSPHORUS DEFICIENCY

01 02  06/11   3  SW   320  10:20   82    90   35   40 LGT NON NON  7.9 14.5 19.5
       DATA TAKEN BY:  GORDON A TUPPER                  PICTURES:  AL 03.FRS 01-05
       SOIL CONDITION:  UNCULTIVATED
       CROP PHYSIOLOGICAL CONDITION:  GOOD GROWTH
       CROP VISUAL CONDITION:  GOOD

01 03  06/28  13 WNW   615   1:40   91    20   70   72 LGT NON NON   IRRIGATING
       DATA TAKEN BY: GORDON A TUPPER
       SOIL CONDITION:  WET
       CROP PHYSIOLOGICAL CONDITION:  GOOD TASSELING. BEGINNING EAR FORMATION
       CROP VISUAL CONDITION:  GOOD
       COMMENTS:  IRRIGATING ON THAT DAY. NO SOIL MOISTURES TAKEN

01 04  07/24   3  SE   626  10:15   90     0   90   78 LGT LGT LGT      DRY
       DATA TAKEN BY:  GORDON A TUPPER                  PICTURES:  AL 09.FRS 03-06
       SOIL CONDITION:  SMOOTH
       CROP PHYSIOLOGICAL CONDITION:  DENT STAGE
       CROP VISUAL CONDITION:  JUST STARTING TO DRY UP IN MATURE CORN

01 05  08/03   5  WE   601   1:40   80    35   80   80 LGT NON LGT 11.1 14.6 14.7
       DATA TAKEN BY:  GORDON A TUPPER                  PICTURES:  AL 11.FRS 01-05
       SOIL CONDITION:  DRYING OUT - AREAS TURNING WHITE
       CROP PHYSIOLOGICAL CONDITION:  MATURE - HARVESTING FROM SOUTH TO NORTH
       CROP VISUAL CONDITION:  YELLOWING

01 06  08/06   4   S   516   9:35   75    90   20   10 MED NON NON 10.7 13.0 16.7
       DATA TAKEN BY:  GORDON A TUPPER                  PICTURES:  AL 13.FRS 01-05
       SOIL CONDITION:  DRY AND SMOOTH
       CROP PHYSIOLOGICAL CONDITION:  SOUTH HALF OF FIELD HAS BEEN HARVESTED
       CROP VISUAL CONDITION:  NORTH HALF MATURE
       COMMENTS:  CLEAR ON SUNDAY
```

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FIGURE II-5 TEST FIELDS ILLUSTRATED FOR THREE STAGES DURING CROP GROWTH

-30-

FIGURE II-5 TEST FIELDS ILLUSTRATED FOR THREE STAGES DURING CROP GROWTH

FIGURE II-5 TEST FIELDS ILLUSTRATED FOR THREE STAGES DURING CROP GROWTH

FIGURE II-5 TEST FIELDS ILLUSTRATED FOR THREE STAGES DURING CROP GROWTH

Page 4 of 4

planting, around May 1973, and illustrates the beginning of the crop. The second stage is pictured during the August 21, 1973 ERTS pass and is the data for which the computer derived classification map should be produced. The third stage is shown during the December/January season and reflects the test field situation at that time.

Cooperative Extension Service Fields

Through the efforts of the Agronomy section of the Cooperative Extension Service here at MSU in conjunction with the various county agents, we have identified another 52 fields of various crop types located throughout the six county area. Some of these fields may be identified to MTF for use as training sites. Others will not be used to train the computer but will be used to check the accuracy of the classification program results. As these fields will not be included in the score card figures, they will be able to demonstrate how closely the score card accuracy figures correlate to the ability of the routine to properly classify existing crops. These 52 fields have been identified as to crop type, size, and location with other items noted when appropriate. No attempt was made to monitor these fields during the growing season. Table II-6 gives a list of these fields.

Forest Stands

Since foresty is one of the biggest industries in Mississippi, it is important to include the identification of forested lands in this study. Forests in the Delta are almost entirely restricted to the Mississippi River area as most other land has been cleared for crops. Through the Forestry section of the Cooperative Extension

TABLE II-6 COOPERATIVE EXTENSION SERVICE

Identified Fields

BOLIVAR COUNTY

1	Cotton (2 x 1: D & PL 16)	240 acres
2	Cotton (Solid: Stoneville 213)	190 acres
3	Cotton (2 x 1: Stoneville 213)	400 acres
4	Soybeans (Lee 68)	240 acres
5	Soybeans (Dare & Bragg)	720 acres
6	Rice (Starbonnet)	400 acres
7	Cucumber	80 acres

SUNFLOWER COUNTY

8	Cotton (2 x 2)	80 acres
9	Cotton (Solid: D & PL 16)	245 acres
10	Cotton (Solid: D & PL 16)	200 acres
11	Cotton (2 x 2: D & PL 16)	350 acres
12	Cotton (2 x 2)	600 acres
13	Soybeans (Lee 68)	94 acres
14	Soybeans (Lee 68)	
15	Soybeans (Lee 68)	120 acres
16	Soybeans (Lee 68)	180 acres
17	Soybeans (Lee 68)	73 acres
18	Rice (Starbonnet)	150 acres

WASHINGTON COUNTY

19	Cotton (2 x 1:D & PL 16 & Stoneville 213)	320 acres
20	Cotton (2 x 1 x 2 x 2: Stoneville 213)	300 acres
21	Cotton (2 x 1 x 2 x 2: Stoneville 213)	300 acres
22	Cotton (2 x 1: Stoneville 213)	500 acres
23	Soybeans (Lee 68)	320 acres
24	Soybeans (Lee 68)	150 acres
25	Soybeans (Lee 68)	300 acres
26	Soybeans (Dare)	80 acres
27	Rice (Starbonnet)	400 acres

Page 1 of 2

TABLE II-6 COOPERATIVE EXTENSION SERVICE (Concluded)

HUMPHREYS COUNTY

28	Cotton (Stoneville 213)	100 acres
29	Cotton	90 acres
30	Cotton (2 x 1: Stoneville 213)	300 acres
31	Cotton	100 acres
32	Soybeans (Bragg)	400 acres
33	Soybeans (Simmes)	80 acres
34	Soybeans (Bragg)	230 acres
35	Soybeans (Simmes)	150 acres
36	Rice (Starbonnet)	212 acres
37	Rice (Bluebell)	300 acres
38	Rice (Starbonnet)	40 acres

SHARKEY COUNTY

39	Cotton (D & PL 16)	200 acres
40	Cotton (D & PL 16)	180 acres
41	Cotton (D & PL 16)	300 acres
42	Cotton (D & PL 16)	300 acres
43	Cotton (D & PL 16)	300 acres
44	Soybeans	2,000 acres

ISSAQUENA COUNTY

45	Cotton (D & PL 16)	188 acres
46	Cotton	120 acres
47	Cotton (2 x 2:D & PL 16)	
48	Cotton (D & PL 16)	58 acres
49	Soybeans (Lee 68)	200 acres
50	Soybeans (Bragg)	200 acres
51	Soybeans (Lee 68, Bragg & Simmes)	200 acres
52	Soybeans (Bragg)	300 acres

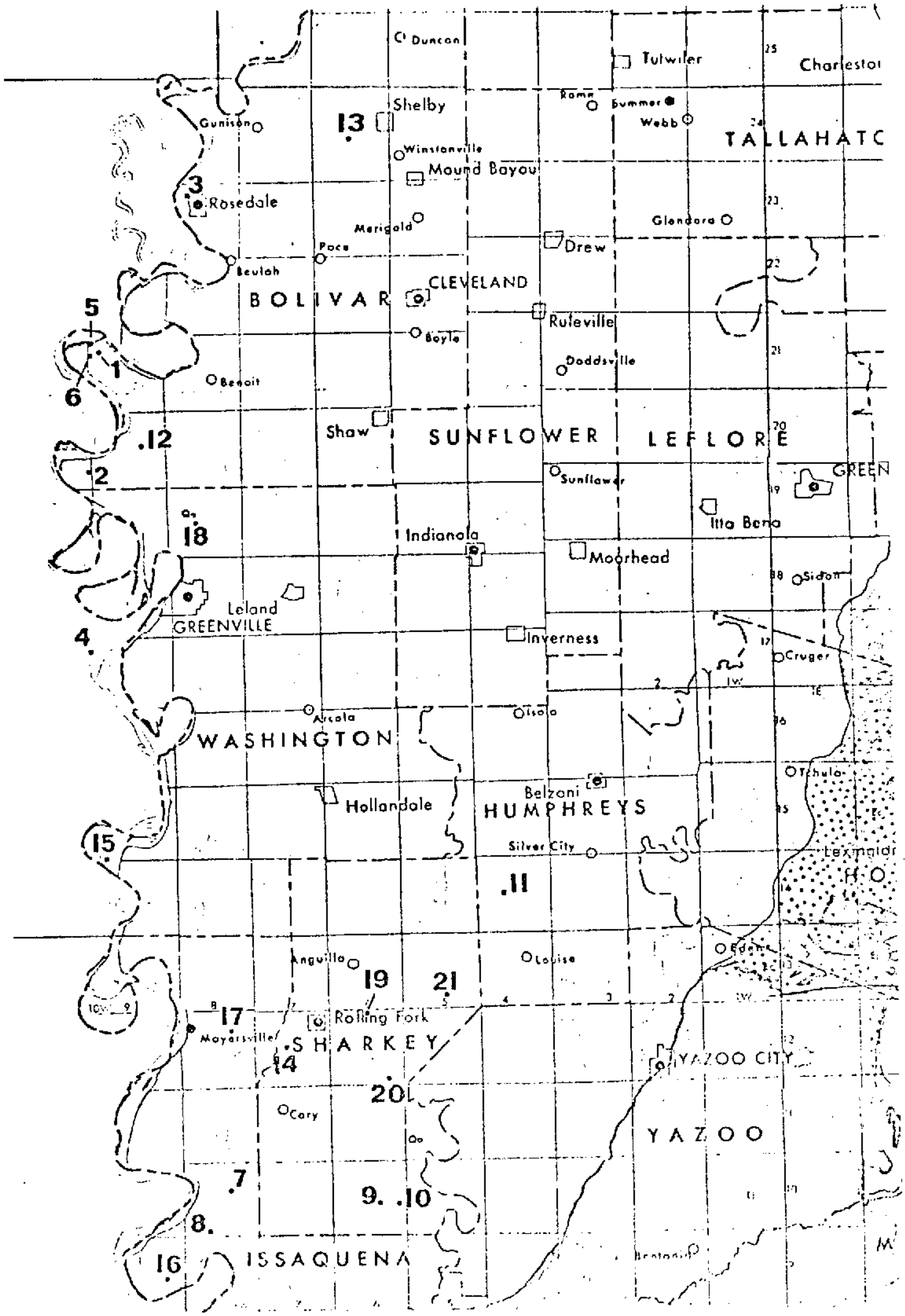
Page 2 of 2

Service, we have located 21 forestry stands in the Delta area. Data on these stands is quite accurate and complete as most belong to commercial lumber companies who keep exact records. The stands were chosen to give variations in age, canopy, density, specie, and purity in order to determine how these factors effect classification accuracy. Again, these stands will be used both for training and for varifying results. A list of the stands is given in Table II-7 and a map locating them in Figure II-6.

TABLE II-7 DELTA FORESTRY PLOTS

			Map #
BOLIVAR COUNTY			
1	Red Oak, Sweetgum	90 acres	(13)
2	Sycamore	40 acres	(3)
3	Hackberry, Elm, Sweet Pecan	150 acres	(5)
4	Sweet Pecan, Sycamore, Gum	500 acres	(6)
5	Cottonwood, Sycamore	100 acres	(1)
6	Cottonwood (Mature)	75 acres	(12)
7	Cottonwood	800 acres	(2)
WASHINGTON COUNTY			
8	Oak, Elm, Hackberry, Cypress	50 acres	(18)
9	Cottonwood	175 acres	(15)
CHICOT COUNTY (Arkansas)			
10	Willow	500 acres	(4)
HUMPHREYS COUNTY			
11	Red Oak, Elm, Gum, Ash, Overcup	210 acres	(11)
SHARKEY COUNTY			
12	Willow, Oak (& water)	40 acres	(21)
13	Green Ash, Hackberry	40 acres	(19)
14	Red Oak, Overcup Oak, Soft Elm, Pecan, Hackberry	550 acres	(14)
15	Nutall Oak, Hackberry	40 acres	(20)
16	Green Ash, Hackberry	40 acres	(9)
17	Overcup Oak	40 acres	(10)
ISSAQUENA COUNTY			
18	Sweet Gum, Red Oak, Elm	82 acres	(17)
19	Pecan, Sweet Gum, Red Oak, Hackberry, Overcup, Green Ash	537 acres	(7)
20	Cottonwood	800 acres	(8)
21	Cottonwood	260 acres	(16)

FIGURE II-6 LOCATION OF DELTA FORESTRY PLOTS



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III. INTERVIEW PROGRAM

A. Introduction

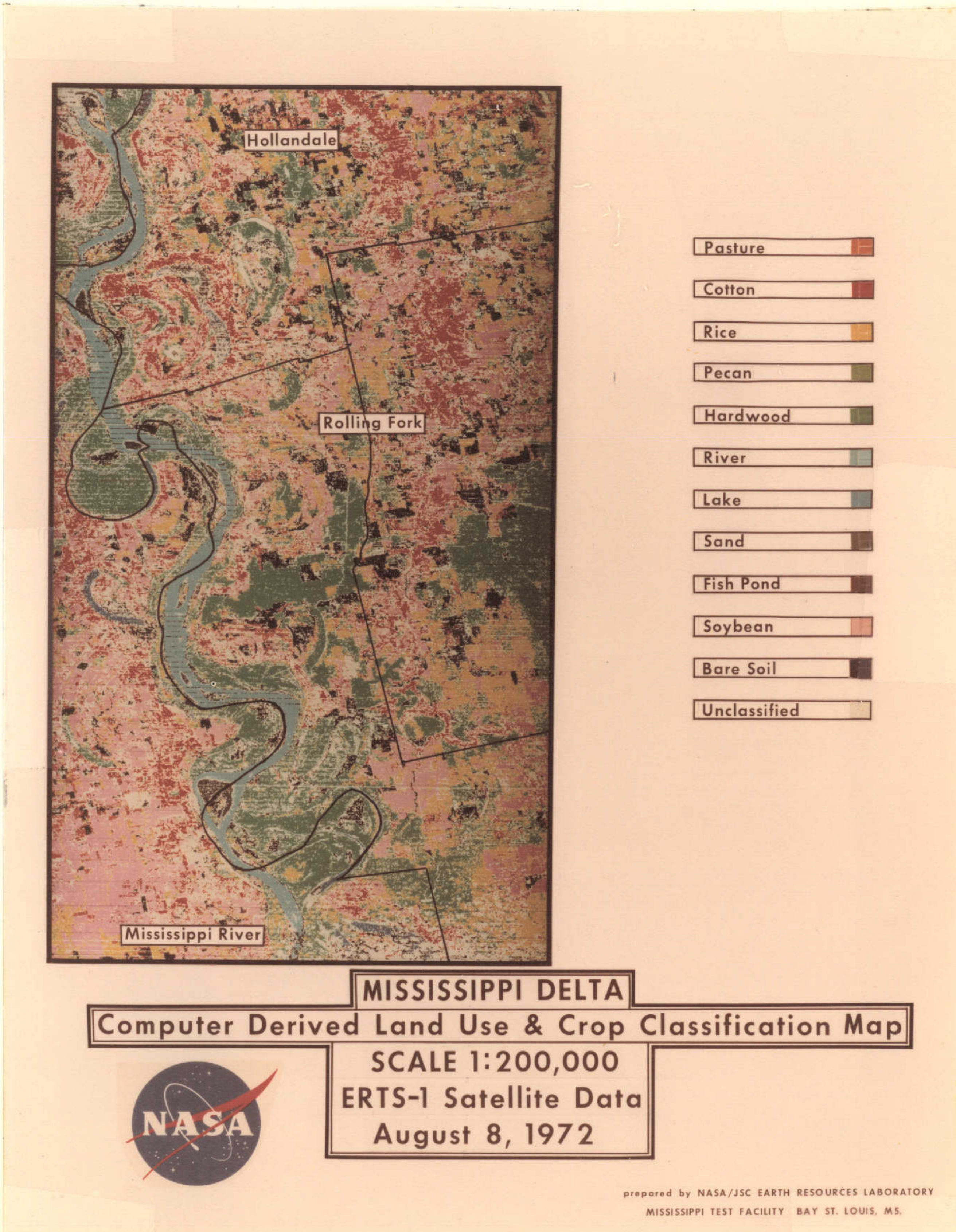
Data from the ERTS satellite is processed by the NASA-MTF-ERL facility. The data used is the multispectral scanner (MSS) data which is sent to earch in digitized data streams and recorded on magnetic tapes. These tapes are the data items which are received by the NASA-MTF-ERL facility.

Using statistical classification schemes that have been developed and refined at NASA-MTF-ERL the MSS data is classified according to the crop and a color coded map is printed which identifies a section of land with its type of crop. A set of statistical tables is also produced and these indicate what percentage of the total land area classified is corn, soybeans, rice, etc.

The data that Mississippi State University (MSU) receives from NASA-MTF-ERL are these color coded maps and the statistical tables. A copy of the 1972 color coded map is shown in Figure III-1.

FIGURE III-1 COMPUTER CLASSIFIED MAP USING ERTS DATA

August 21, 1974



For the interviews of this project, a set of data made by NASA-MTF-ERL in 1972 was used by the interviewers.[2] The data from the summer 1973 ERTS pass for which the ground truth data was collected was scheduled to be used; however, it was not possible for NASA-MTF-ERL to produce those data products in time due to technical problems with the Data Analysis System (DAS). The original schedule called for delivery of these data products during January 1974. This was slipped to June 1974 and a contract extension was requested. Extension until August 1974 was granted but the 1973 data was not available in June 1974 and, in fact, will barely be delivered in time to be included in this final report.

As a consequence, there were no statistical tables to compare with the ground truth nor was there a map product of the last years data available for comparison with the ground truth data.

This did not seem to be too serious a lacking for the interviewing however, which was carried out by the researchers using the 1972 data, see Figure III-1. The 1972 data used for the interviews was printed at a scale of 1:200,000. In addition a set of 1:62,500 scale data from a previous contract was taken along to serve as an indicator of different scales that could be provided.[3] Statistical tables accompanied the 1:62,500 data and were used for interviewing.[3]

Most of the interviewing was conducted in the Mississippi Delta region although some institutions in other regions of

Mississippi were interviewed due to their relevance to the agriculture industry.

B. Interview Program with Various Delta Agriculture Workers

The main objective of the work performed in this contract is to carry forth to potential users of the ERTS data system a product of the system for evaluation and for critique. A two-fold effect is expected during this phase--first is to find out how useful the data product is in today's context and secondly, to expose to the people we felt would be potential users, the data products and the capabilities of the system.

Both objectives have been achieved to a large extent. The data products, as they are in the second generation form, are useful to a wide variety of agricultural workers, from the county agent to the individual farmer and supplier. On the other hand, we received many good suggestions for changes in the format and we were able to bring to some agents a form of data they had not seen before and to show to many others a system capability they had not been aware of before.

Interviews were conducted with many different representations of the agricultural industry in Mississippi including:

1. Mississippi Agricultural and Industrial Board
2. Mississippi Planning and Development Districts
3. Local Development Associations
4. Rural Development Programs
5. Privately Owned Mill and Lumber Companies
6. State Forestry Agents

7. Federal Forestry Agents
8. Federal Land Banks
9. County Agricultural Agents
10. Large Farmers (over 2,000 acres)
11. Saml1 Farmers (up to 2,000 acres)
12. Farm Implement Dealers
13. Agricultural Buyers
14. Bankers
15. Farm Supply and Marketing Coops
16. Crop Storage Agents

1. COUNTY AGENTS

Apparent Uses

A. Crop estimation appears to be a very useful application of the ERTS data. Even though some crops such as cotton or rice are reported to the county agents, the agents admit that they cannot enforce the reporting requirements. As a result the crop estimates are often in error by 15% or 20% for reported crops and for non-reported crops such as soybeans, catfish, pecans, etc., there are possibilities of much larger errors in estimates. Use of the ERTS data could help to increase the accuracy of crop estimation by giving a more accurate estimate of the crop acreage in process.

A second use is to catalog the apparent acreage of grass/pastures for Mississippi. One agent told us he had recently received over 150 serious inquiries as to how much grass/pasture land was in existence behind the Mississippi River levees. Unfortunately there was no method available at that time by which the agent could respond. However, it was apparent that a fairly good estimate can be obtained from the ERTS data in false color photo form by inspecting the print and the statistical tables. Furthermore, if photos exist for all seasons of the year, a good estimate can be made of how the grass/pasture availability fluctuates during wet and dry seasons.

Marketing personnel are, of course, very interested in the estimated acreage of crops. In fact, one item that could be of tremendous value for the buyer would be the knowledge of how many acres of unharvested crops are left standing after approximately two-thirds of the harvesting season has past. This could have a large effect on pricing during the critical harvesting periods.

B. Drainage control is a second area that ERTS data promises to contribute. Drainage problems are very noticeable on false color photos especially if taken just after a wet period. Every change in surface features, such as changes from one crop to another or from agricultural to commercial uses, create large accumulative effects on the overall drainage patterns. Thus, continual monitoring of drainage patterns is necessary. This is one effect that is more easily picked up by large scale presentation, such as photos from aircraft or satellites using IR, than by foot work. The ERTS data gives one an excellent view of whole counties and major protions of rivers, lakes, etc., at a glance and by using the seasonal variations, the drainage pattern changes will be apparent.

C. Monitoring acreage of controlled crops

It is easy to visualize the use of ERTS data for monitoring the acreage of controlled crops such as cotton. It is no secret that many farmers report only the acreage allowable to be planted for controlled or alloted crops while during the same season they may also have more acreage of the crop planted in out of the way fields that are not easily found nor ownership easily identified. This, of course, leads to poor estimates and harsh market/price reactions.

ERTS data may be used in a two-fold manner to help control this problem. First, the acreage of a controlled crop in a county may be estimated by using the ERTS data with a statistical table being printed and a map showing the areas classified in this crop being plotted.

The county agent then may talley his reported acreage and compare it to the ERTS estimate. If a significant difference is noted, he may then compare the reported locations and acreage to the ERTS map and statistical tables and unreported areas may then be discernable.

In this manner a tighter control may be enforced by the agent and a more accurate estimate would be available.

D. Winter crop estimates are needed for Mississippi.

Some examples are winter small grains and winter pasture. If these two items could be differentiated and classified separately, it would be a big bonus to the county agents and to the agricultural industry.

Desired Formats and Time Scale for Usage

A. Format suggestions have generally followed the same pattern. Rather than presenting one map product with all the crop classifications presented at the same time a set of three or four maps with only two or three crops should be presented; this would be much less confusing than the present method.

A map product with two or three crops depicted should also have some distinguishing land marks, a county boundary and some of the major roads plotted as well. This would aid the agent in the location of depicted crops.

Map scale should be 1:62,500 rather than 1:200,000 for easier use by county agents.

B. Data products would be used mainly on a monthly scale with pecans being needed only every three years. It was pointed out that due to weather problems it is not likely that the present satellite system could provide a monthly data product. However, if a series of satellites or a stationary satellite were to be used it might be feasible to provide monthly data products and during harvest time perhaps bi-monthly data products.

2. SMALL FARMER (Up to 2,000 acres)

Apparent Uses

A. Underfertilization is a matter of concern to the farmer. Too much fertilizer is expensive and too little fertilizer means a reduction in yield. A second problem with too much fertilizer is the chance of a bumper crop developing in a region where there is risk of wind damage to the crop. (A bumper crop is very heavy for the plant's stalk strength and hence more susceptible to wind, heavy rain or hail damage.) In short, the farmer needs to know if the amount of fertilizer he has spread is correct. The question to be resolved is can ERTS data spot the case of underfertilization before it becomes apparent to the ground observer? (At this time it seems unlikely that ERTS can be of use in this situation.) This problem is of concern to the rice farmer in particular. Generally speaking, the period from May 15 to June 15 is used for applying fertilizer and the period from June 15 to July 15 is used for correction of underfertilization.

B. A more serious problem perhaps, is the damage incurred by underground pests such as root maggots. If ERTS can be used to detect and combat insect and/or disease problems, the data maps would have to be available in a 5 to 6 day period to be useful. Scales of 1:62,500 or larger would be highly desirable for this usage.

C. Market information is of particular interest to the farmer. He needs to know the actual crop acreage that has developed and that is likely to mature. For early crops this knowledge might make the difference between a mediocre to bust year on one crop or a plowing under of a poorly developing crop and replanting with a late crop. Knowledge of his immediately surrounding county areas is important in this respect. The farmers basis for pricing his crop can be made partly on up-to-date knowledge of what percentage of the crops planted have matured and what percentage of these are still in the field versus what has gone to market.

D. Drainage patterns of not only his farm lands but of the surrounding areas would be a useful item. Need for ERTS data in this area would be on a semi-annual basis since changes in crops and use of the land each year would effect the drainage patterns from year to year. The farmers we talked to felt that this would be a very important tool since overall drainage patterns that are up-to-date are not readily available.

E. If crop condition information could be developed, maps could show problem areas. This information could be used in intensifying soil testing, planning crop rotations, etc. Annual maps would be sufficient for this purpose.

Desired Formats and Time Scale for Usage

A. Format suggestions were generally the same as those obtained from the county agents--that is, only two or three crops per map and prominent land marks, roads, and county boundaries placed on the map to help locate the fields of interest. Statistical percentages of acreage in the field etc. in tabular form are desired.

B. Time scale of foreseen need varies for the time of the season, of course, but a frequent up-dating during fertilization periods and during harvesting periods.

3. BUYERS

Apparent Uses

A. Again crop estimates are priority information. The interest lies in three geographical breakdowns, local county and the whole delta area, national and world-wide.

The local area is of interest in determining how far the buyer will have to extend his purchasing boundary to fill his sales contracts.

The national and world-wide estimates are important in determining the price of the crop for future markets. The knowledge of how much has been harvested versus how much is still in the fields is of great interest also.

B. Crop condition information would be useful and should be available within 15 days or less after data was collected. The buyer would use such information to plan storage and estimate volumes to be handled thus inforcing the transportation needs.

Desired Formats and Time Scales for Usage

A. Format suggestions were the same as before.

B. Time scale for usage the same as before.

4. FINANCIAL INSTITUTIONS (Land Banks, etc.)

Apparent Uses

A. Aerial maps are in use in these institutions already. However, it seems that even in this age of constant flight by everybody, these institutions are still working with old maps, some being out-of-date by over five years. Many times we recieved comments about trips made to appraise timber land only to find out that it has been crops for the last few years. Needless to say, ERTS-MSS false color maps can be of real service in land classification for these types of applications.

B. Another need by local offices is for soil drainage characteristics for appraisal purposes. They would like map products three or four times per year to assess the wet lands and how long the areas are inundated after heavy wet periods.

C. The height of dry land surrounding marshy land is of interest. It is not immediately apparent that ERTS could provide any information for this particular application but if possible there is potential application of that type of data in many areas.

D. In general for the financial institution users, the land use question is more important than strict crop delineations. Thus, one map presenting classifications such as marsh, forest, urban, etc., and a second map showing drainage patterns seems to be most appropriate. Again, the tie points for locating specific property by use of prominent land marks etc. is important.

Desired Formats and Time Scale for Usage

A. Format suggestions have followed the same trend as before--only two or three classifications illustrated per map and a scale of 1:62,500 preferred. For these types of users the land use classification rather than crop delineation is desirable.

B. Data products would be desired for at least the four seasons of the year and perhaps an extra set around the wet seasons to assess the drainage problems.

5. FARM SUPPLY, CO-OP'S, IMPLEMENT DEALERS

Apparent Uses

For this category of uses, the statistical (or tabular) form of the data is preferred. Data expressed in acres rather than in percentages of scene is also preferred.

The service groups would use the information to know where to concentrate on sales of different types of equipment based on crop distribution and to judge demand for various items such as fertilizers, etc.

Desired Formats and Time Scale for Usage

Tabular data available in 10 to 15 days is desired.

6. FORESTRY

Apparent Uses

A. The long range trends of land use--land drainage, land clearing for agricultural and industrial uses which affect acreage for timber production and soil-moisture relationship are the great concern of the hardwood forest industry. This concern arises from the greatest unknown in the forest resource data--the rate of change in the quantity of forest land in the hands of more than 100,000 small, private owners and the rate and direction of change in forest inventory in these lands. At present, official surveys are made at ten-year intervals by on-the-ground sampling at three-mile grid sample plots.

It is estimated that the small private owners hold some 12 million acres of forestland or some 75% of the total forestland in Mississippi.

ERTS data maps and statistical tables would be very helpful in providing insight into this problem.

B. Hardwood species naturally group themselves into rather specific associations because of the soil conditions in which they grow. If these groups or types are identifiable by ERTS maps as to location, extent, stand density, etc., this information would be of great help. This would provide information of timber inventory as well as soil inventory.

C. The State Forestry Commission is responsible for fire and insect control on private lands as well as state lands. ERTS flight data can be useful in this effort, especially if made available immediately after the pass.

Desired Formats and Time Scales for Usage

A. Again the request for 1:62,500 scale rather than 1:200,000 scale maps and for only two or three classifications per map stands out.

The types of information needed on the maps and tables are:

1. Forest acreage trends-increasing, decreasing, rate
2. Species composition as to pine, hardwood, mixtures
3. Stand density
4. Management practices-reforestation vs. removal for agricultural or other purposes.

B. Annual maps would be sufficient for monitoring trends in the amount of timber lands. Even less frequent classification is required to map the areas of different tree types as they associate themselves closely with the soil type and this will not change. However, if useful information about insect damage or susceptability to fire damage caused by drought is to be obtained, the total time lag between data takes and finished products to the user must be cut to about 15 days.

C. Summary

A series of interviews were held about the Mississippi Delta area concerning the various segments of the agriculture industry. The county agent, farmer, buyers and financial institutions were interviewed and samples of the ERTS data products were demonstrated. In addition, limitations and potentials of the ERTS data system were explained to these potential users.

The majority of the interviews were favorable toward the potential usage of ERTS data. If the data were available today with no further refinements, it is safe to say there would be many uses. However, many suggestions have been made and the more obvious ones are listed below:

1. Map products are too confusing at present with the myrid of colors that are present. Print maps with only two or three classifications to show more clearly what is there.

2. Map scales desired will vary widely. The 1:62,500 is a popular choice as well as the 1:200,000 for overall conceptual ideas.

3. Locations of specific parcels of land is important. Hence inclusion of major terrain features, land marks and major highway networks as well as political boundaries such as township or county boundaries will be important to these users.

The major applications of the ERTS data as it seems for the present would concern itself with the money making aspects of the agricultural industry. In particular:

1. Crop estimates rank high in the application list. Virtually everyone uses this vital statistic.

2. Drainage patterns are of interest to many segments of the industry. In particular, ERTS can give excellent overall synopsis of an area's drainage patterns.

3. Indications of what is harvested versus what is still in the field is an application particularly suitable to ERTS if the proper timescale can be achieved.

4. Use of the indicated field of certain crops and the estimated acreage of certain crops for providing a control mechanism on crop reporting seems very promising. This type of information could be very useful to the county agent.

In all, it certainly is evident that ERTS data is useful, some applications of it are listed above and these applications could make use of it in its present format if necessary, ways to improve data format are apparent and the great flexibility of the data processing methods allows changes in formats without a great deal of effort.

IV. COMPARISON OF SELECTED LAND USE INFORMATION EXTRACTION PROCEDURES

At the present time, much land use information is presented in the form of statistical tabulations derived from ground surveys. However, ground survey procedures are not easily judged or compared with procedures based on remote sensing because the statistics generated by ground surveys are usually not referenced to geographic units smaller than a county. In addition, most ground surveys are based on sampling procedures and some are not implemented to produce information each year. Consequently, the comparisons in this section will be limited to procedures based on remote sensing.

Table IV-1 shows a comparison of three different procedures that have been utilized to produce land use maps and statistics for various Mississippi counties. The three procedures were:

1. The use of large-scale black and white aircraft acquired aerial photography and conventional image interpretation techniques

2. The use of small-scale color infrared aircraft acquired aerial photography and conventional image interpretation techniques.

3. The use of digital data acquired by ERTS-1 and computer implemented techniques.

FIGURE IV-1

COMPARISON OF THREE SELECTED INFORMATION

EXTRACTION PROCEDURES

	Photo Interp. Black and White 1:24,000	Photo Interp. Color Infrared 1:120,000	Computer Implemented ERTS Digital
Cost of Basic Data Per Square Mile	\$11.97[1]	\$0.36[2]	\$0.06[3] \$0.012[4]
Cost of Information Extraction Per Square Mile	\$28.34	\$8.35	\$2.04[5] \$0.41[6] \$0.14[7] \$0.10[8]
Manhour Effort	6200	3300	500
Timeframe	12 months	6 months	1 month
Accuracy	92 - 96%	92 - 96%	89 - 95%

1 --Commercial contract.
2 --\$8 per frame purchased at EROS Data Center.
3 --\$160 per set of 4 tapes purchased at EROS Data Center and prorated over 2650 square miles (see text).
4 --Same as above, but prorated over 13260 square miles.
5 --Prorated over 2650 square miles (see text).
6 --Prorated over 13260 square miles (see text).
7 --Prorated over 66,300 square miles (see text).
8 --Same as (7) but with reduction in computer time for classification incorporated.

The first procedure in which black and white aerial photography was the source of the basic data was applied by the Gulf Regional Planning Commission to produce maps of four coastal counties which together encompass a land area of approximately 2,650 square miles. These maps were finished just prior to the time that Hurricane Camille hit the Mississippi Gulf Coast, the result of which was that there was a need to update the maps even before they had been utilized to any significant degree. This procedure has also been used to produce maps in the Mississippi Delta area.

The second procedure utilized utilized small-scale (1:20,000) color infrared aerial photography to produce 1:24,000 scaled land use maps for the same four counties covered prior to Hurricane Camille as well as some maps for the Mississippi Delta Region.

The principle difference between the two procedures based on the use of aerial photography was that the use of small-scale color infrared photography permitted a considerable cost savings in land use mapping mainly because of the reduced number of frames necessary to cover the area. These cost savings are illustrated by comparing cost figures in columns one and two of Table IV-1 which were derived from cost figures contained in an existing report (see reference No. 4).

The third procedure was implemented by the NASA Earth Resources Laboratory utilizing ERTS digital data and computer implemented techniques to generate a land use map (see Figure III-1) and statistical data to be used as material for an investigation on the Mississippi Gulf Coast as well as for this investigation. As illustrated by cost figures in column three of Table IV-1, the use of ERTS digital data and a computer implemented technique offers the greatest potential for cost shaving in land use classification.

It should be emphasized that the cost figures in column three for the land use classification produced with ERTS digital data for this investigation are preliminary in nature. Inasmuch as computer implemented techniques were developmental at the time that the land use classification was produced for this investigation, many cost elements were difficult to calculate accurately.

The computer compatible tapes containing the ERTS digital data can only be purchased (EROS Data Center, Sioux Falls, S. Dakota) as a set of four tapes which encompass an area of 13,260 square miles (100 by 100 nautical miles). However, the four county area referred to earlier encompasses only 2,650 square miles of the 13,260 square miles covered by the set of four tapes which cost $160.00. Consequently, the unit area cost of the basic data contained on the set of four tapes would be $0.06 per square mile if prorated over 2,650 square miles, but only $0.012 per square mile if prorated over the 13,260 square miles encompassed by the tapes.

A similar situation arises when data processing costs are calculated. The total cost of $5,400, including 3.3 hours of computer CPU time, would calculate to be $2.04 per square mile if prorated over the 2,650 square miles that were the focus of this comparison, whereas the calculation would result to $0.41 per square mile if prorated over the 13,260 square miles for which a classification was performed for this investigation. It should also be noted that with the computer inplemented technique used for this investigation it is more practical to perform the classification for all 13,260 square miles covered by the set of four tapes than it is to perform a classification for a portion of each tape.

A greater reduction in cost would be shown if a larger area was to be classified. Although more research is needed to determine the degree that geographic extension of signatures is possible, it is not unrealistic to think that two additional scenes (each with a set of four tapes) up a given ERTS track and two additional scenes down at ERTS track, which together with the center scene would encompass twenty tapes or 66,300 square miles, could be processed in one classification run on the computer. In this case, all ground truthing could be carried out within the center scene, all signature development would be performed with the four tapes corresponding to the center scene (as was done for this investigation), but the costs would be prorated over the 66,300 square miles covered by the twenty tapes. The main cost that is directly related to the area covered is the run on the computer during which the actual classification is performed. In the case of twenty tapes, the computer time (using the same program as used for the classification performed by this investigation) would increase from 3.3 hours of CPU used for four tapes in this study to 13.7 hours of CPU for twenty tapes. Costs would, then, be prorated over 66,300 square miles, the result of which would be $0.14 per square mile. Furthermore, new software developments that have occurred since the land use classification for this investigation was performed, have reduced the CPU time for classification from 2.6 hours of CPU per scene (4 tapes) to 1.3 hours of CPU (see reference 5). Consequently, by use of the more recent software, 7.2 hours of CPU would be required to process twenty tapes. With the incorporation of this possibility, the unit cost of the land use classification could possibly be reduced to $0.10 per square mile when extensive areas are to be classified.

The above mentioned costs and those shown in Table IV-1 include only the costs of producing a land use classification and presenting it in a map format. However, it should be noted that the compilation of acreage statistics from a map present a significant cost item. In the case of the computer implemented technique as used to produce the land use classification for this investigation, acreage statistics can be abstracted by the computer from the computer compatible tapes that are utilized to produce the land use map. Furthermore, these same tapes can be utilized in a computerized system designed to combine land use information with other information; whereas, to accomplish this for land use information contained on the maps produced by the two procedures based on the interpretation of photography, the map information must first be digitized.

Other important elements to consider in the production of land use maps is the timeframe within which work can be carried out, and flexibility in utilizing the information. Table IV-1 shows the man-hour effort and the timeframe utilized for each of the three procedures used for comparison in this study. As can be seen, the use of ERTS digital data and the computer implemented technique resulted in significant reduction in both effort and time over the other two procedures. Of course, shortening the timeframe would be possible in the case of the procedures based on photo interpretation by placing more personnel on the job; however, this is usually not feasible from a practical viewpoint. Most organizations cannot carry a large staff of photo interpreters if they are not fully utilized throughout the year, and a large temporary work force creates many administrative problems. In addition, the computer implemented technique is highly flexible. As noted previously, the computer implemented technique utilizing ERTS digital data is more compatible with computerized information systems. Also, the computer implemented technique is more flexible than photo interpretation techniques in which extracted information is recorded on a map format because information digitized from a map is always restricted by the size and shape of the geographic unit for which digitization is performed.

Furthermore, the computer implemented technique offers more flexibility for presenting the extracted information in map formats.

The computer compatible tapes that contain the classification can be used to produce a generalized map presentation (see Figure 1 in this report), or they can be used to produce thematic map presentations (see reference 6). In addition, such map products can be produced for a variety of scales.

Finally, Table IV-1 indicates the general classification accuracy attained by the three procedures compared in this section expressed as a percentage of the study area classified correctly. As shown, the accuracy of the computer implemented technique based on ERTS digital data is somewhat lower than the two techniques based on aerial photo interpretation, but all are well within the realm of use by resource planners and managers. It should also be noted that there is considerable potential for improving the accuracy of computer implemented classification by utilizing data acquired during two or more seasons (see reference 6 and reference 7 for a full detailed description of the accuracy capabilities). This technique could also be utilized with aerial photography from two or more seasons, but with more difficulty than when using digital data on computer compatible tapes.

In summary, the results of the interviews conducted during this investigation indicate that many users want information more frequently than possible with photo interpretation techniques, and that they would welcome any procedures resulting in cost reduction. The comparison made in this study indicates the use of ERTS digital data offers both a reduction in cost and a shortening of the information extraction timeframe. In addition, it offers more flexibility in information handling and presentations on map formats.

V. CONCLUSIONS AND RECOMMENDATIONS

The original objectives of this project were by necessity modified due to a lack of availability of computer generated land use classification maps and statistical tables for the areas under consideration.

Ground truth was collected in good detail consistently through the active period of the contract which coincided with the crop seasons and a data bank which exist in a MSU computer card file with this ground truth data (see the section on Data Management for more explicit details concerning the ground truth data).

The use of the ERTS data in the form of computer generated statistical tables for crop yield estimates was not accomplished due to the lack of availability of those tables for the test areas for the 1973 crop year. The statistical data may be available after this contract report is submitted. In this event, we will undertake to make the estimates for crop yields and compare these to the actual yield figures available, see Table V-1. These results would then be forwarded in letter form as an addendum to the final report.

The main thrust of the program then, was the interview series using the existing August 1972 classification map which was available. The results of the interviews show a great deal of genuine interest and need in the use of ERTS data by the Mississippi Agricultural Industry. A general summary of the conclusions is presented below. While many different requests for variations in scale and availability are to be expected, we feel these conclusions are fairly general in application.

Table V-1

Average Crop Yield Information for Test Fields Located on the Delta Branch Experiment Station

Crop Year 1973

Field Crop	Acres (Ground)	Acres (Crop)	Average Yield Reported*
Corn	73	73	12 tons/acre
Cotton (2 x 2)	240	120	1225 # Lint per crop acre
Cotton (2 x 1)	247	165	1075 # Lint per crop acre
Rice	145	145	107 bushels per acre
Soybean (clean)	110	110	30 bushels per acre
Soybean (weedy)	100	100	30 bushels per acre

* Due to lack of computer generated statistics for the test area for 1973, it was not possible for an estimate of crop yields to be made.

1. ERTS data can be used in its present form with respect to resolution and classification accuracy.
2. Users need for up-dating ERTS data varied from a matter of days to once every two weeks, to monthly, semi-annually and annually.
3. Seasonal mappings were deemed necessary by most users for delineation of wet lands and drainage patterns.
4. Winter mappings were seen to be especially valuable for cataloging winter small grains and winter pastures.
5. The use of ERTS data for mapping and monitoring of Federally controlled crops was seen as a very practical application--one in which no other means currently provides a suitable data source.
6. The use of ERTS data for mapping and monitoring the Levee grass lands was seen to be a practical application which again has no suitable data source available today.
7. Forest inventory, a Mississippi crop which is widely changing in its boundaries, is one which use of ERTS data seems to be particularly applicable.
8. ERTS data could provide very important market information on crops harvested versus unharvested during the harvesting season if the data can be acquired and distributed in weekly time frames. Figure V-1 depicts the normal planting and harvesting dates for Mississippi. (As of this writing, this does not seem feasible.)

9. Crop estimation should be accurate to 5% (or possibly 10%) but any increase in accuracy above the current methods which can be 15% to 20% in error would be very useful.

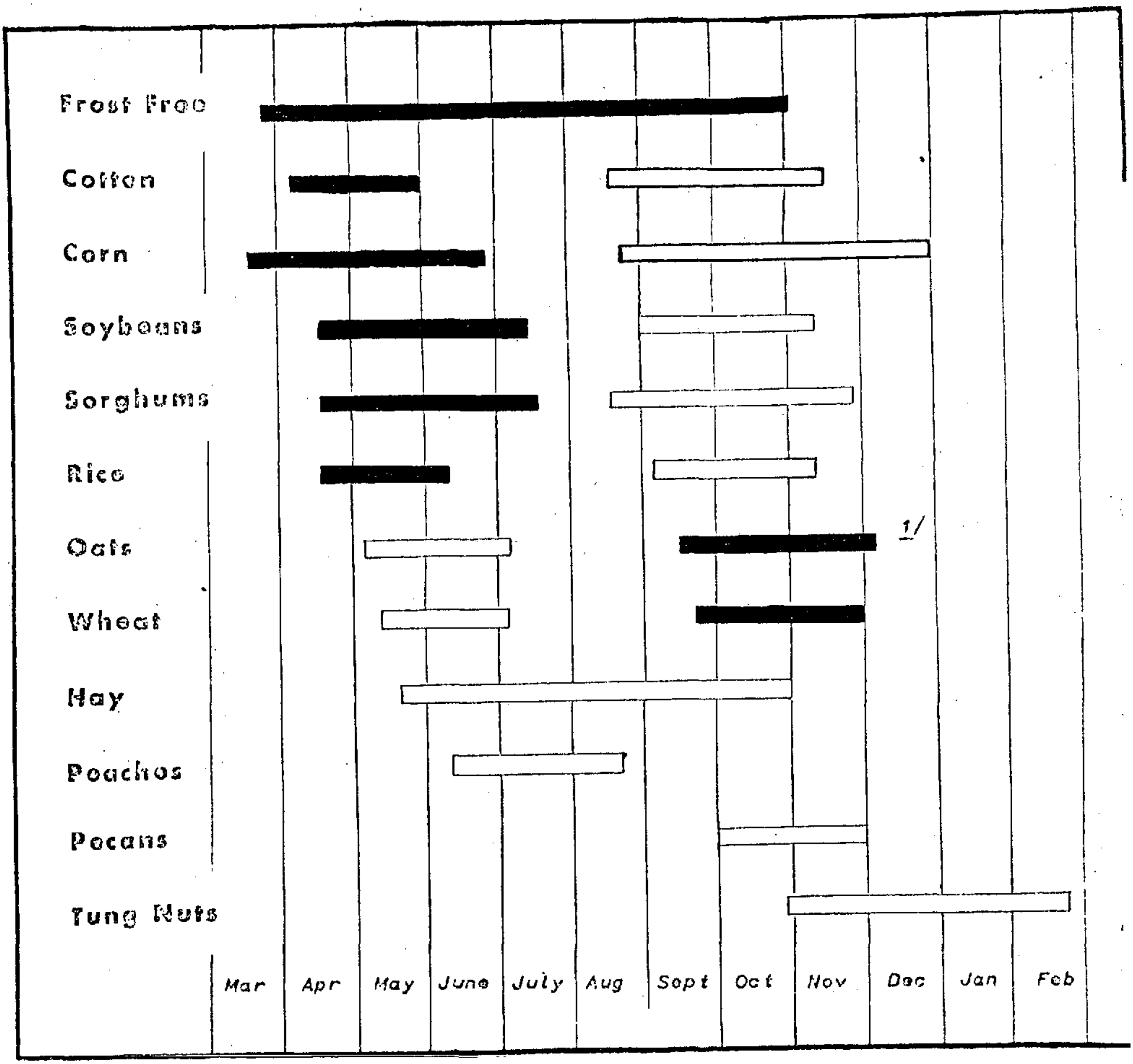
It is recommended that:

1. The classification maps be printed with only two or three items depicted per map. The present system with eight to ten classifications are too confusing and hard to read (see reference 6 for example and discussion of capability).
2. The scale of 1:62,500 seems to be the scale desired by most and hence future maps should be of this scale.
3. Inclusion of some land marks on the map products so that specific areas may be located is highly desirable.
4. A map showing drainage patterns and changes in drainage patterns be generated.
5. A map showing the change in Forest boundaries and the change in forest types be generated.
6. A catalog of map products which could be provided from the computer classification scheme be made by NASA and distributed to potential users and to state agencies. This catalog should have illustrations of the product and should explain to the user how to order what he wants. Pricing, time frames of availability of data and delivery schedule should be included.

FIGURE V-1

Normal Planting and Harvesting Dates

Mississippi



1/ Fall planted only

PLANTING ▬ HARVEST ▭

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At this time we can state that, yes, ERTS data is very useful in some aspects, it shows promise of providing several types of data not now available in any form and it could make feasible some monitoring functions that are not practical today. However, the system must be refined and organized so that a smooth flow of data on a known time scale would be available.

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