08

A Comprehensive Data Processing Plan for Crop Calendar MSS Signature Development from Satellite Imagery

Second Progress Report

April 1976

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1.0 INTRODUCTION

Preliminary analysis of a few of the LACIE test sites shows poor to fair classification accuracy using the NASA supplied ground truth. A detailed accounting of errors indicated that most of the errors occurred on field boundaries. This implies that there is some misregistration of the temporal band congruencing done by NASA. An experiment which flickered one band from one date with the same band from the next date showed as much as a two to three resolution cell error in spatial registration. During our next quarter of work, we will try to re-register those dates having worst registration.

An extensive set of experiments with the Rice County test site yielded about the same results using:

(1) raw LANDSAT data

(2) ratioed LANDSAT data or

(3) LANDSAT data with soil type regressed out.

We did find, however, that if we take combined soil type and crop type for categories, then the resulting probability distributions seem to be more unimodal.

On the more positive side we found that spatial post processing of the classified image can increase identification accuracy and that a spatial clustering of the imagery tends to make much cleaner classified images. During the next quarter of work we will do a detailed study of the clustered images and relate each cluster to the soil type, weather, crop type based on KANSAS crop calendars and manual interpretation of the LANDSAT imagery, and the NASA supplied ground truth. We as other investigators, such as those in the Institute for Space Studies, feel there are errors in the NASA supplied ground truth. By doing a cluster analysis preceeding the spectral-temporal signature identification there will be a better correspondence between the classification results and the crop type and condition really occuring on the ground.

Section 2 describes the preliminary analysis using a 10% sample of the data. Section 3 describes the initial table look-up processing of four of the five test sites and Section 4 describes the initial spatial clustering done on four of the five test sites. The appendices assemble data on the test sites as well as some of the detailed results of the preliminary analysis.

2.0 RESULTS FROM STATISTICAL PROGRAMS

In this section we will give a brief summary of the results obtained using some standard statistical programs on the crop inventory project. There are five LACIE sites, all in Kansas, involved in this study (see Appendix A1 for coordinates). Of the five sites involved we have chosen three, Rice county, Morton county and Saline county, to put through a preliminary analysis. Rice county has been analyzed in some detail and the results will be discussed in the body of this section.

2.1 Preparing Data for Analysis

We received a tape for each study site, from NASA, which contained the ERTS images for that site from a number of dates in the 1973-1974 crop year. These images had already been registered by NASA. The images on these tapes were then converted to the proper format to use by the KANDIDATS system on the PDP-15 by Gary Minden. It was then necessary to find that portion of the image that just covered the study site.

In order to find the study sites on the image it was necessary to use black and white transparencies of the whole ERTS frame containing the study site. First the study site was found on the transparency with the band that gave the best contrast. This was done by locating landmarks on maps of the area and then finding them on the transparency. The area of the study site would then be marked off in grease marker on the transparency. After locating the study site on the transparency, sections of the image stored on discpacks on the PDP-15 would be placed out on the IDECS television display using the KANDIDATS package of image processing routines. Then features on the marked off area on the transparency would be searched for on the TV image. By this method the section of the image containing the study site was found and a subimage containing the study site was created for further manipulation.

After finding the study site on the digital image stored on the disc, it was necessary to overlay the ground truth. Since there were only two bands of ground truth (crop type and soil type), these were manipulated to fit the ERTS image patterns. It was necessary to rotate and slightly distort the ground truth to

overlay the ERTS images.[1] This was done by trial and error, visually on the IDECS, using the KANDIDATS package on the PDP-15 to compute the rotations and distortions. Appendices B, C, and D contain the details of the rotations and distortions of Rice, Morton, and Saline counties respectively.

With the ground truth bands and the ERTS images registered, it was possible to take samples of the images. Initially random samples of about 10% of the observation vectors were taken. These were written out, in their raw form on a tape in a format compatible with the Honeywell 600 series computer (actually in Honeywell system standard format). The sample of observation vectors was then sorted by a program written in FORTRAN 6000 into groups on the basis of crop type. This set of sorted vectors could be written out on a time share file for analysis by time share programs, or punched on cards or written onto tape, for analysis by batch processing (all on the Honeywell 635).

2.2 Types of Analysis Used

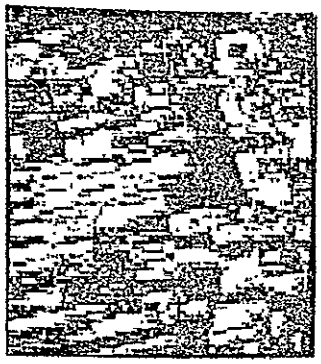
Three different packages have been used to date and the use of a fourth is planned. The BMDP package (Dixon, 1975), the KANDIDATS package (Johnson, 1973), and a package of time sharing programs developed by Peter Neely at the KUCC have been used.

The programs used were BMDP9D, a general data describing program, BMDP7M, a discriminant analysis program (Dixon, 1975); REGRESS, a step wise regression program, CANCORR, a canonical correlation program, PRINCOMP, a principal components analysis, (Neely 1973-1974); and various routines in the KANDIDATS package.

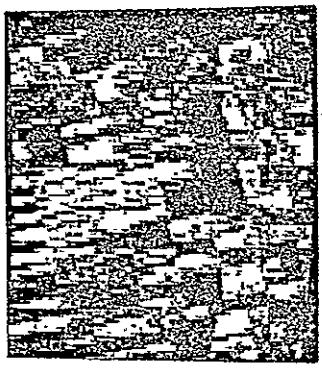
2.3 Results

Intensive analysis has been carried out on the Rice county site. Figures 2.1a - 2.1d show the four original ERTS bands, for the four dates over the Rice county test site. Initially the BMDP7M discriminant analysis program was used on the raw data. The control cards, and selected parts of the results

[1] Ground truth data for the LACIE sites have been congruenced to the MSS CCT by the following procedure. The ground truth image was rotated by 16-18° in a counter-clockwise direction and the upper left corner was "stretched" upward and to the left. The centroid of rotation is irrelevant since the ground truth data was later translated to fit the image data. "Stretching" was required to obtain a better bit between the ground truth and image data. Parameters for each site are given in the appendices.



MSS BAND 4



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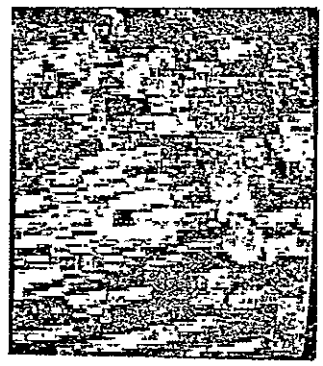

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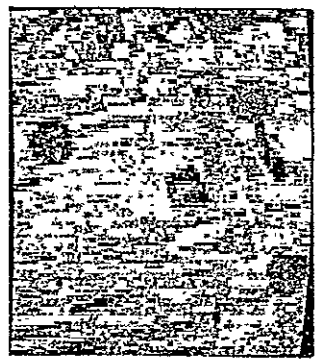

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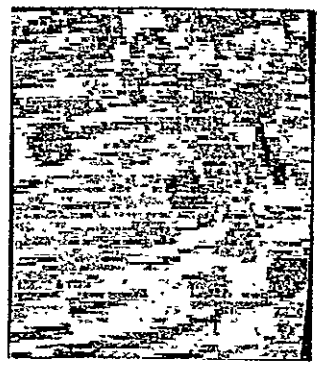
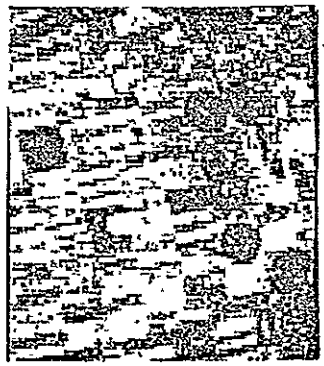


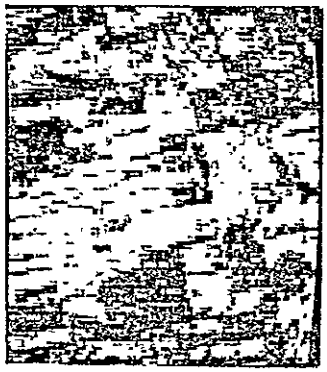
10/21/73
Fig. 2.1a

4/18/74
Fig. 2.1b

RICE COUNTY

MSS BAND 4





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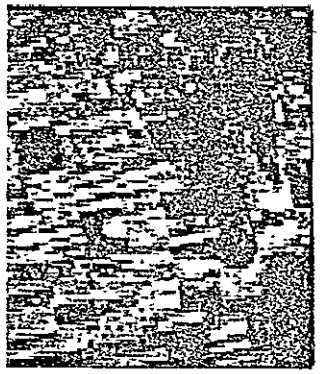

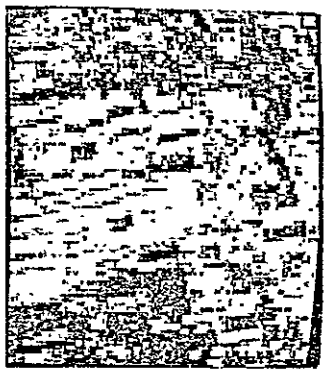

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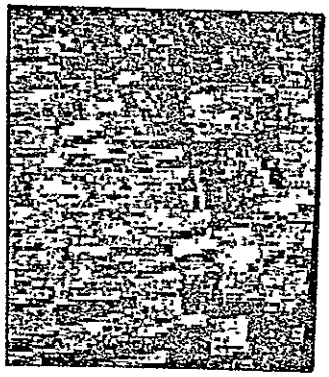
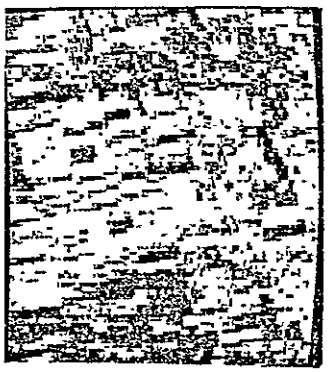
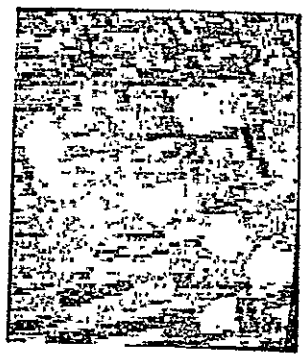




MSS BAND 7



6/12/74
Fig. 2.1c

RICE COUNTY

7/18/74
Fig. 2.1d

are in Appendix BB1. Six variables were entered, the F - matrix and the classification functions are also given in Appendix BB1. The Jackknifed classification gives a total of 46.2% correct classification, with 75.6% of the corn being correctly classified, 39.7% of the wheat being correctly classified, 37.5% of the grass, 28.8% of the summer fallow, 14.3% of the non-agricultural and 43.2% of the grain sorghum being correctly classified. This poor rate of success cried out for an explanation. Three possibilities suggested themselves:

1. the different soil types were contributing to the variation in the ERTS reflectivities which increased within crop type variation in reflectivity;
2. the atmospheric effects were contributing random variation to each ERTS band; or
3. those observations mis-classified were edges, or places where ground truth was incorrect or had changed during the time period understudy.

To test the idea that the soil types were contributing to within group variation of crop types, each ERTS band was regressed onto soil type, using the REGRESS program of the KUCC time sharing system. The equations of all significant regressions were used to calculate the residuals for the various bands and these residuals were used in a rum of BMDP7M. Appendix BB2 contains the selected results of this run. This lead to a 47.1% total correct classification, a non-significant increase in the total percentage of correct classification. There was actually a 6% decrease in the number of grass observations correctly classified! There was a 10% increase in the number of summer fallow correctly classified and non-significant changes for the other categories. Next, straight ratioing of the data was tried (Appendix BB3). This time the program went 7 steps, i.e., included 7 variables, but the total correct classification was 46.4%. The percentage of correct classifications of winter wheat, grass, and corn increased and that of summer fallow and grain sorghum decreased. Thus it seems that if atmospheric interference is causing an increase in variation within crop types it is not corrected by straight ratioing. Figure 2.2 shows the change in percentage of correct classifications for the three different treatments of the data discussed above, as the variables are entered.

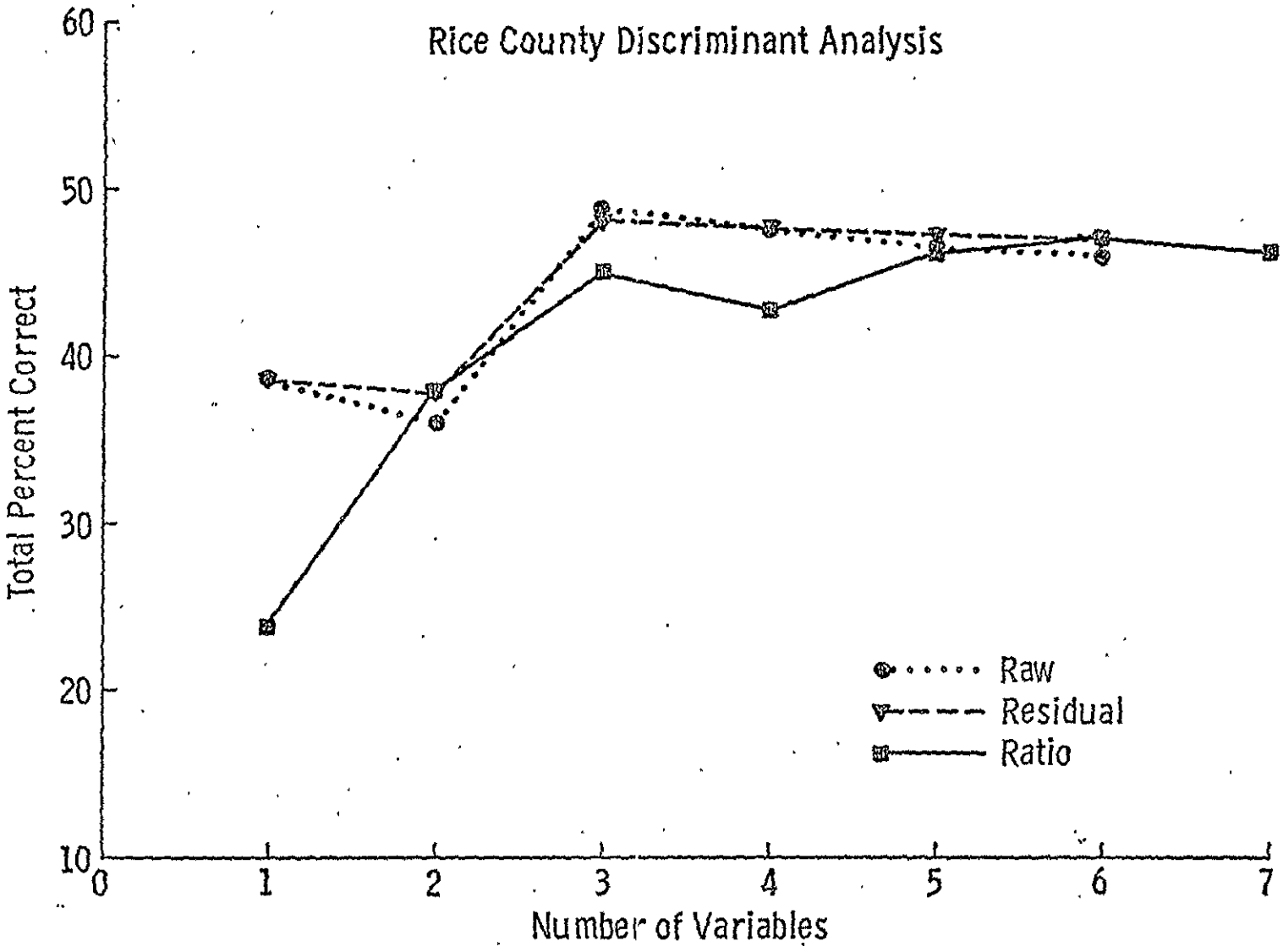

Rice County Discriminant Analysis
Total Percent Correct
60
50
40
30
20
10
0
1
2
3
4
5
6
7
Number of Variables
Raw
Residual
Ratio

Figure 2.2

As a result of the above analysis, it was clear that there was not a reliable method for removing excessive error variance that did not take into account the confusing effects of soil-crop-date interaction. In order to find out the nature of the problem, BMDP9D, a general data description program, was used to look at the effects of classifying the observations on crop type alone, soil type alone, and cross classifying by soil and crop type. When only one criteria was used to classify the observations, most of the distributions were multi-modal. However, when both criteria were used to cross classify, the distributions were unimodal, according to the crude histograms produced by BMDP9D. To illustrate this look at Figure 2.3. This shows the mean and one standard deviation limits for ERTS reflectivity for each soil type within a date for band 4 for winter wheat in Rice county. As can be seen there is considerable variation within a date in the means for different soil types. Not only this, but the relation between the means for different soil types within a date is not the same from one date to the next. Now if you look at Figure 2.4, you see that the effect of soil is not the same within a date for different crop types. Thus there is a time-soil interaction (Figure 2.3) and a crop-soil interaction (Figure 2.4). It is not possible to look for the three way crop-soil-time interaction with a graph, but we must use a statistical test. Figure 2.5a to Figure 2.5v show further the variation in crop signatures for the six crop classes to Rice county.

Forgetting the problems addressed above, there are two other methods of improving the total percentage of correct classification. These are:

1. do not use categories that are rare to calculate the discriminant function;
2. use prior probabilities, which describe the relative frequencies "known" to be present, to weight the decision rule.

Appendix BB4 shows the result of not using the category "non-agricultural" to calculate the discriminant functions. In this case, the percentage correct was 49.9, about a 4% improvement. If one used prior probabilities (Appendix BB5) then the total percentage correct was 61.2, a 15% improvement. When

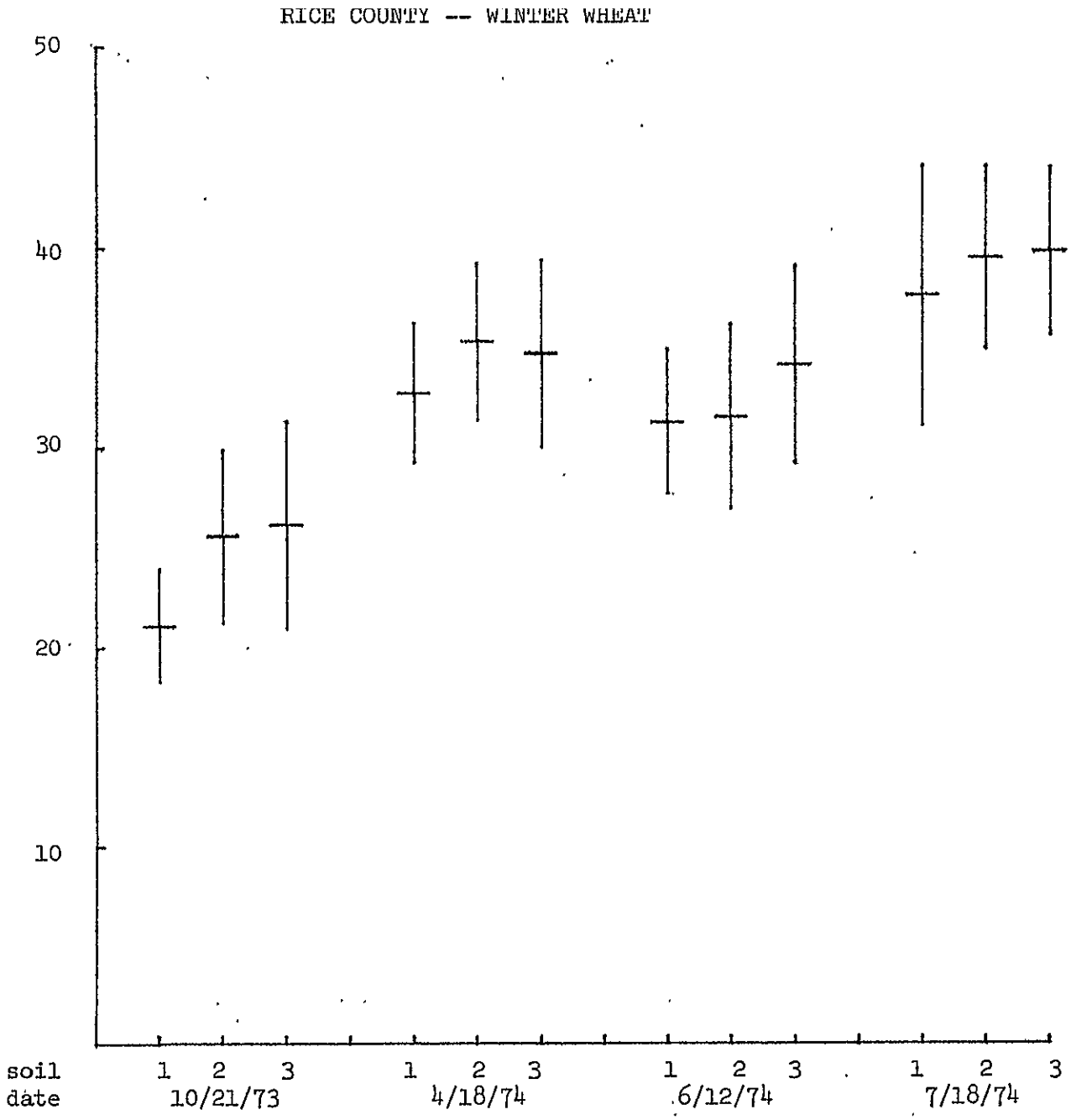
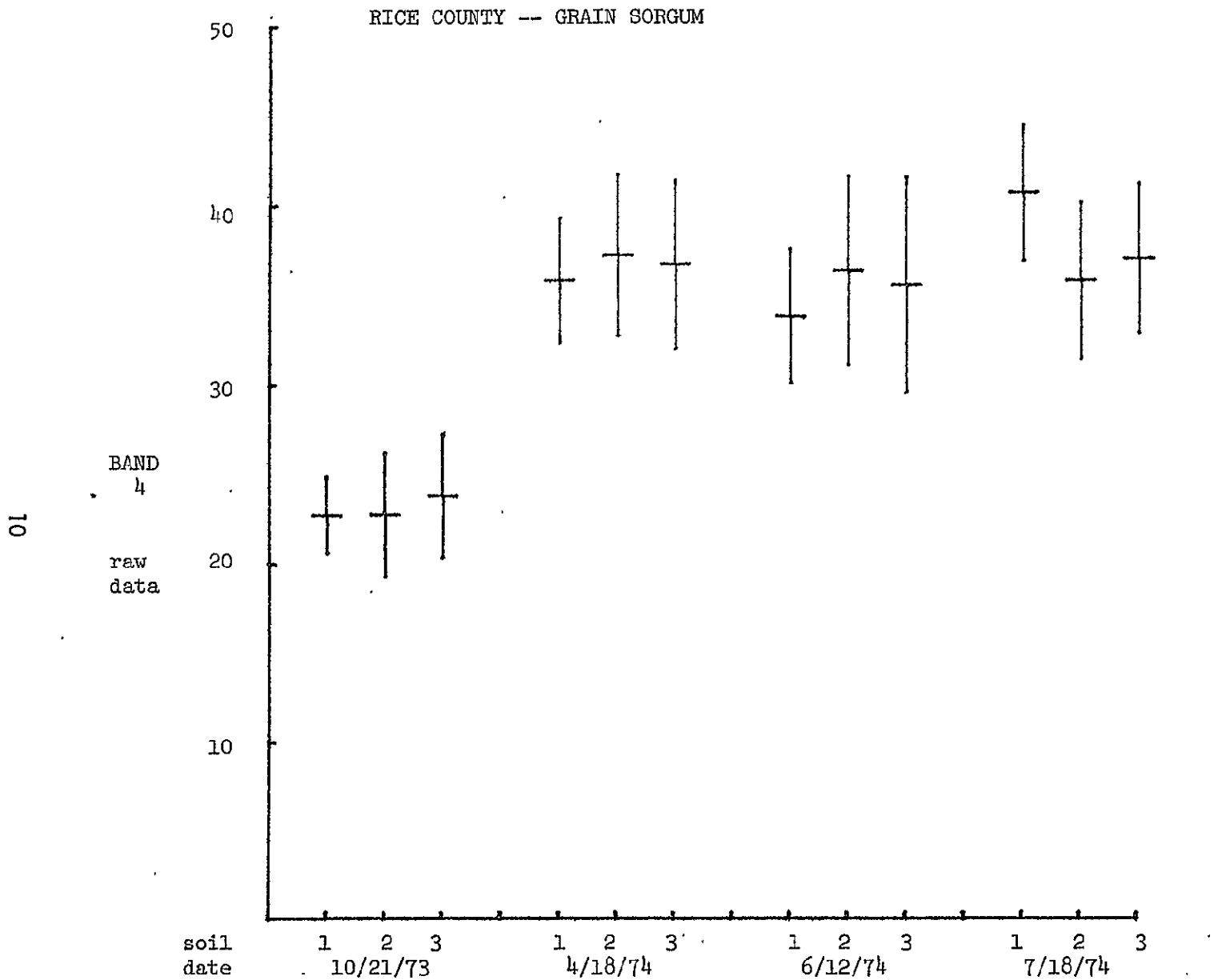

RICE COUNTY -- WINTER WHEAT
50
40
30
BAND
4
raw
data
20
10
soil
date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.3


RICE COUNTY -- GRAIN SORGUM
50
40
30
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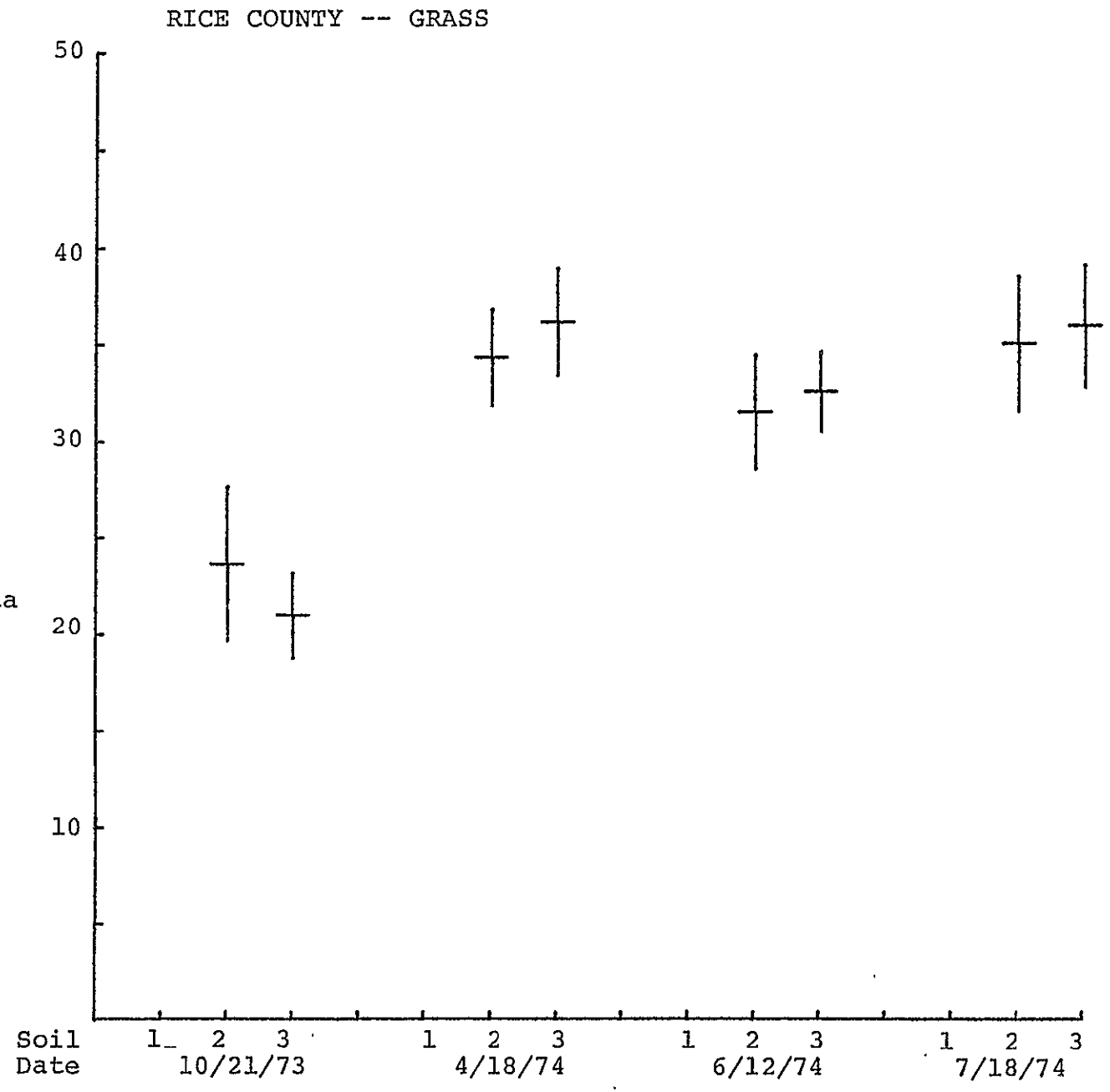
10
BAND
4
raw
data
soil
date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.4


RICE COUNTY -- GRASS
50
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BAND
4
Raw Data
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1 2 3 1 2 3 1 2 3 1 2 3
10/21/73
4/18/74
6/12/74
7/18/74

Figure 2.5 a

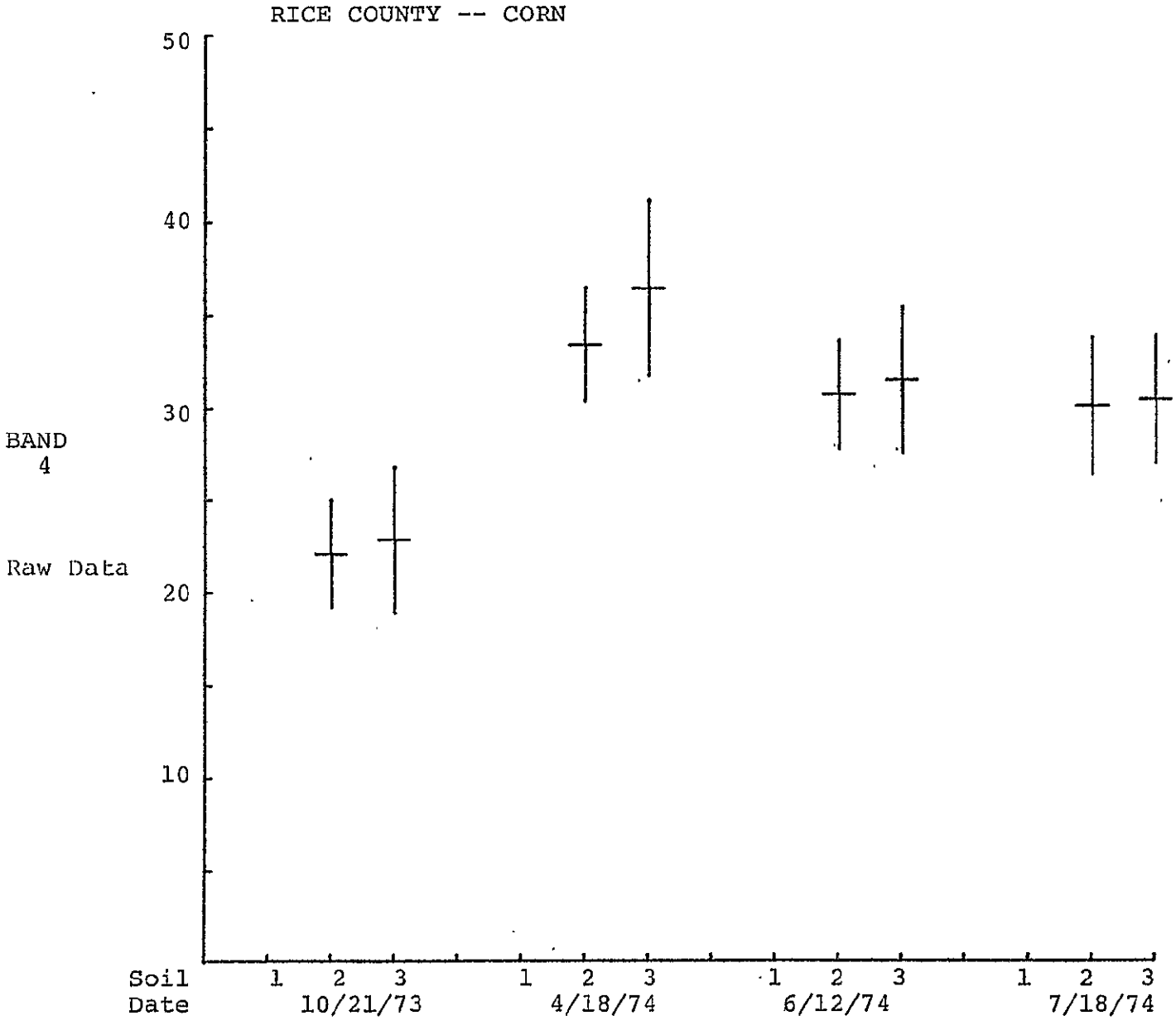
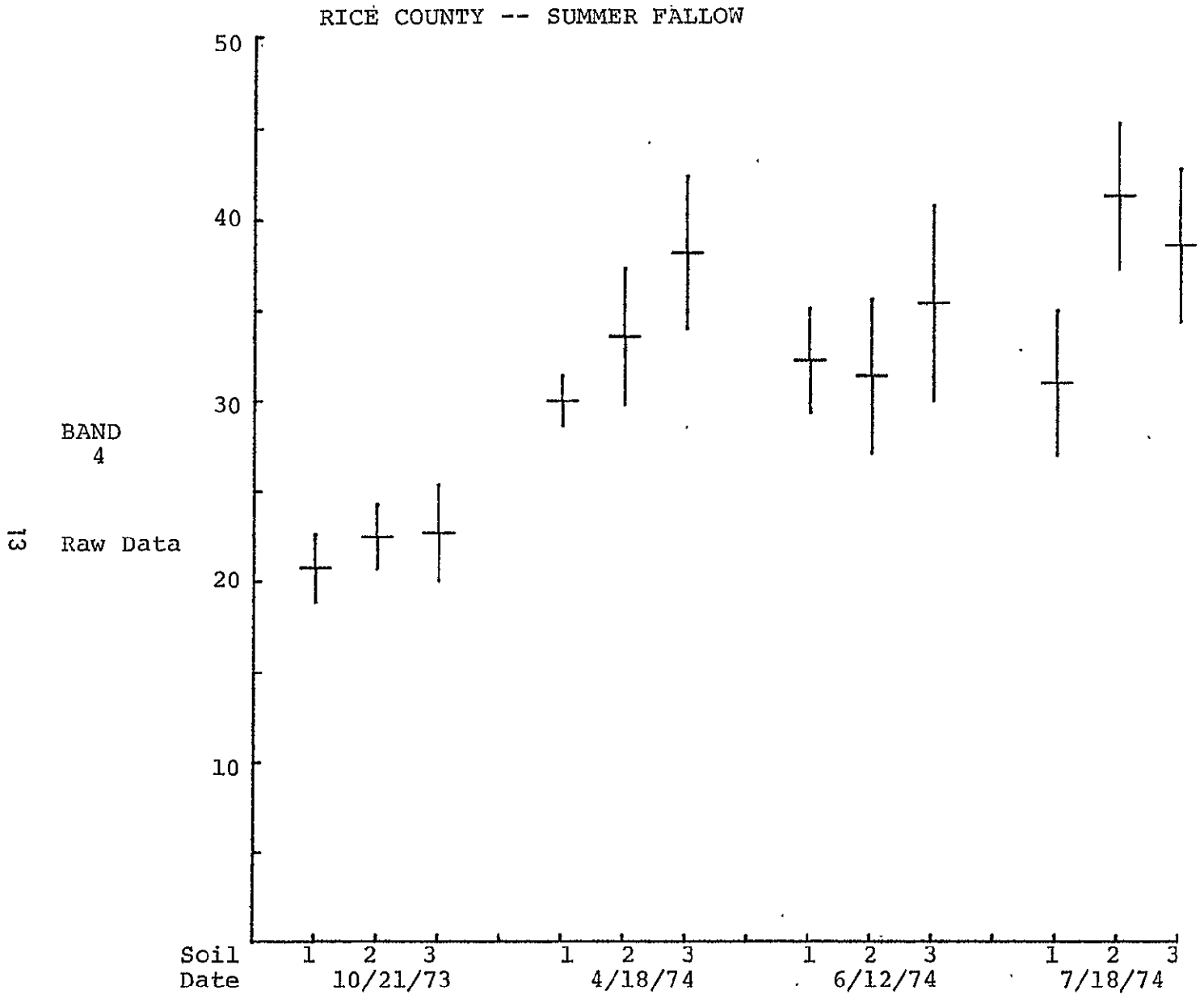


Figure 2.5 b


RICE COUNTY -- SUMMER FALLOW
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BAND
4
Raw Data
Soil
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1 2 3
10/21/73
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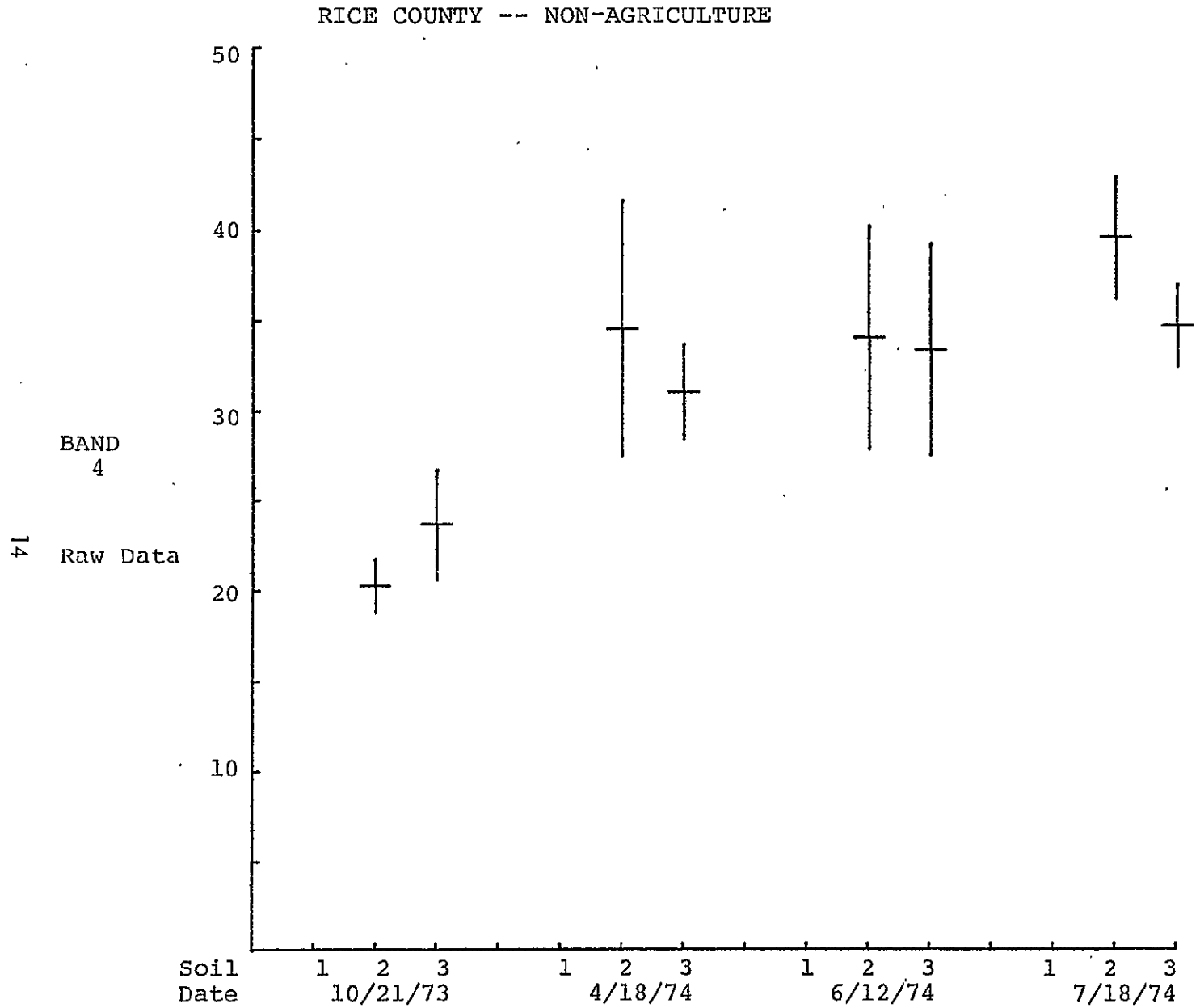
6/12/74
1 2 3
7/18/74

Figure 2.5 c


RICE COUNTY -- NON-AGRICULTURE
50
40
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20
10
BAND
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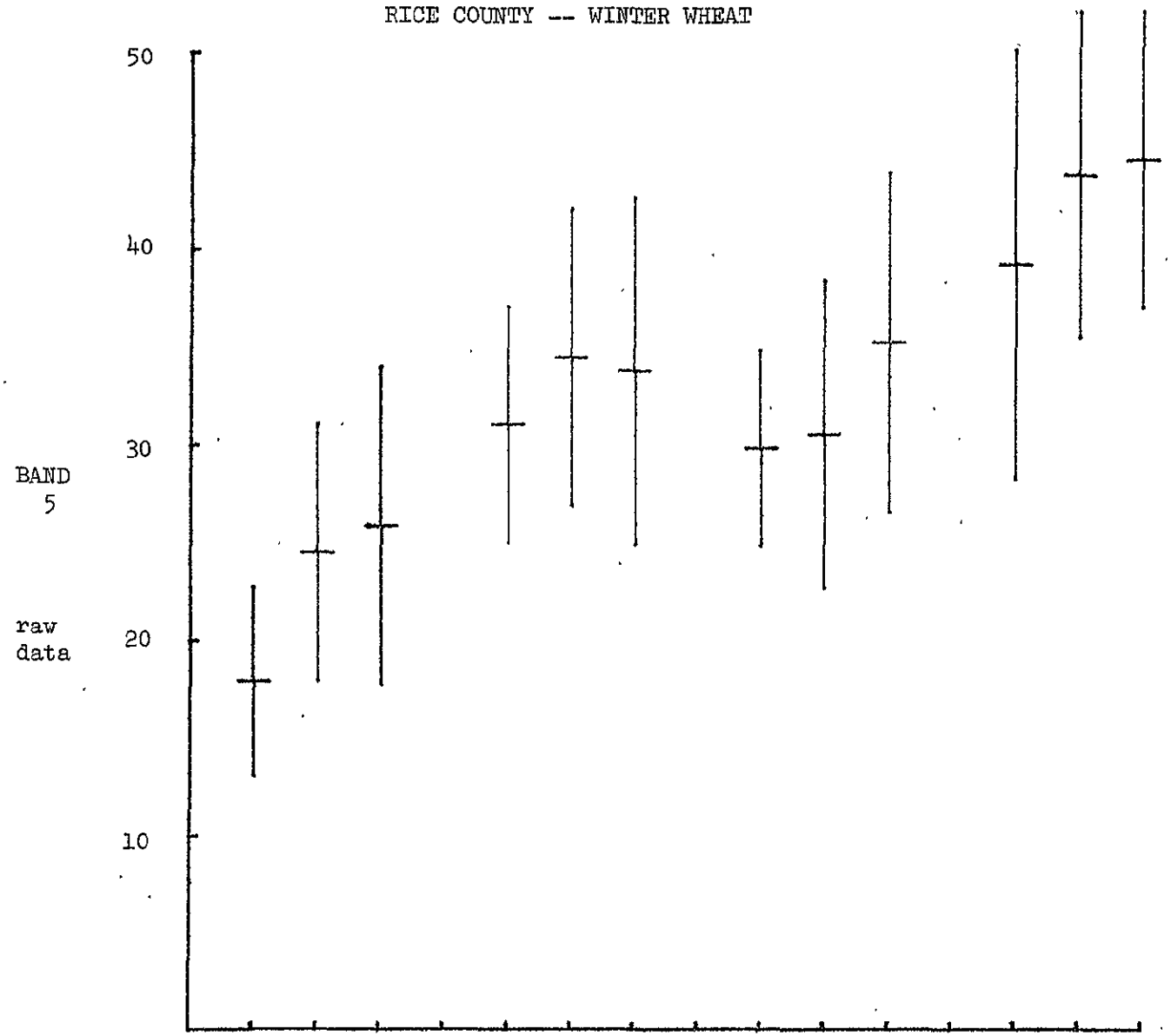
Raw Data
14
Soil
Date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 d


RICE COUNTY -- WINTER WHEAT
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raw
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10/21/73
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4/18/74
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7/18/74

Figure 2.5 d

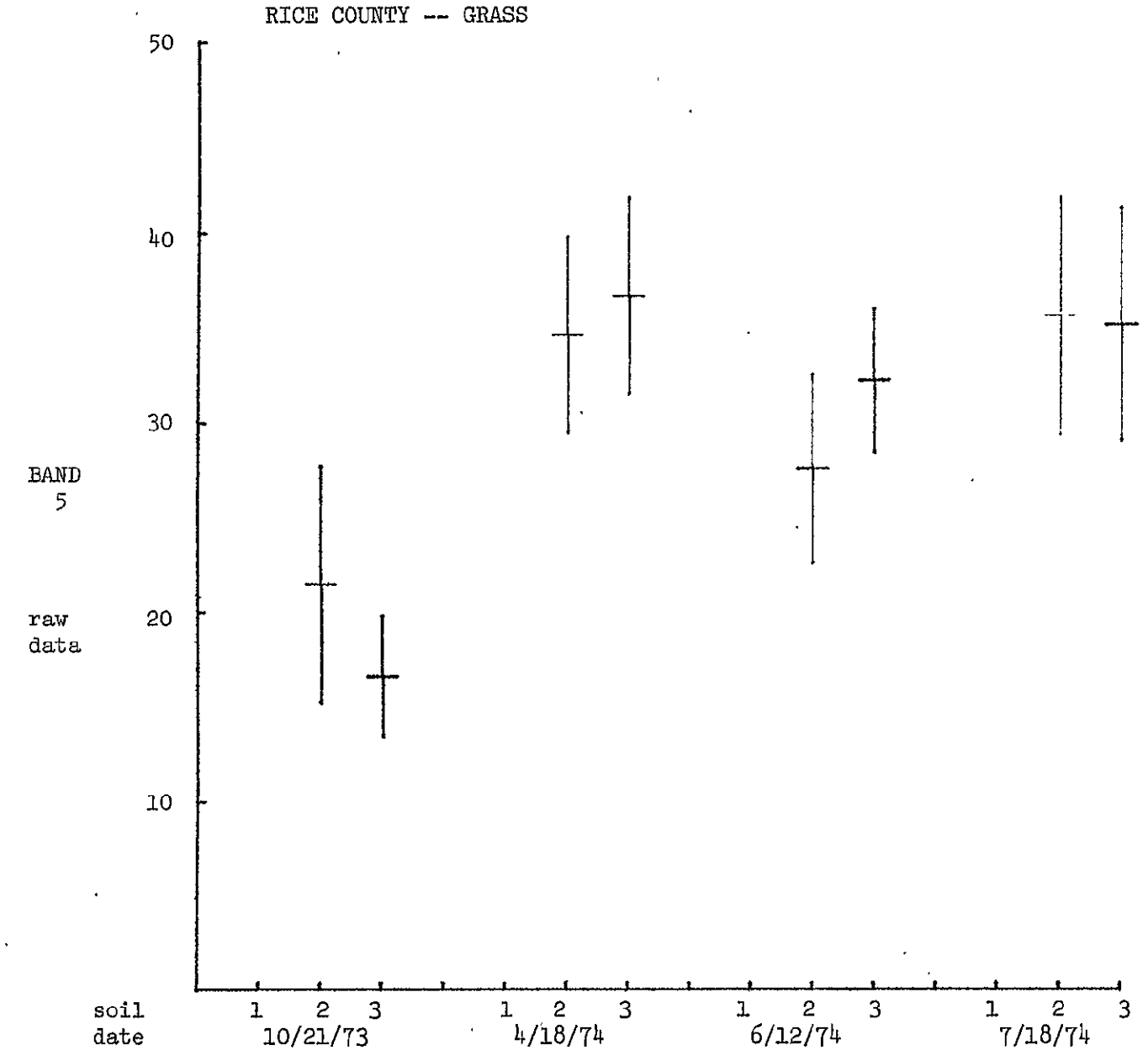
RICE COUNTY -- GRASS
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Figure 2.5 f

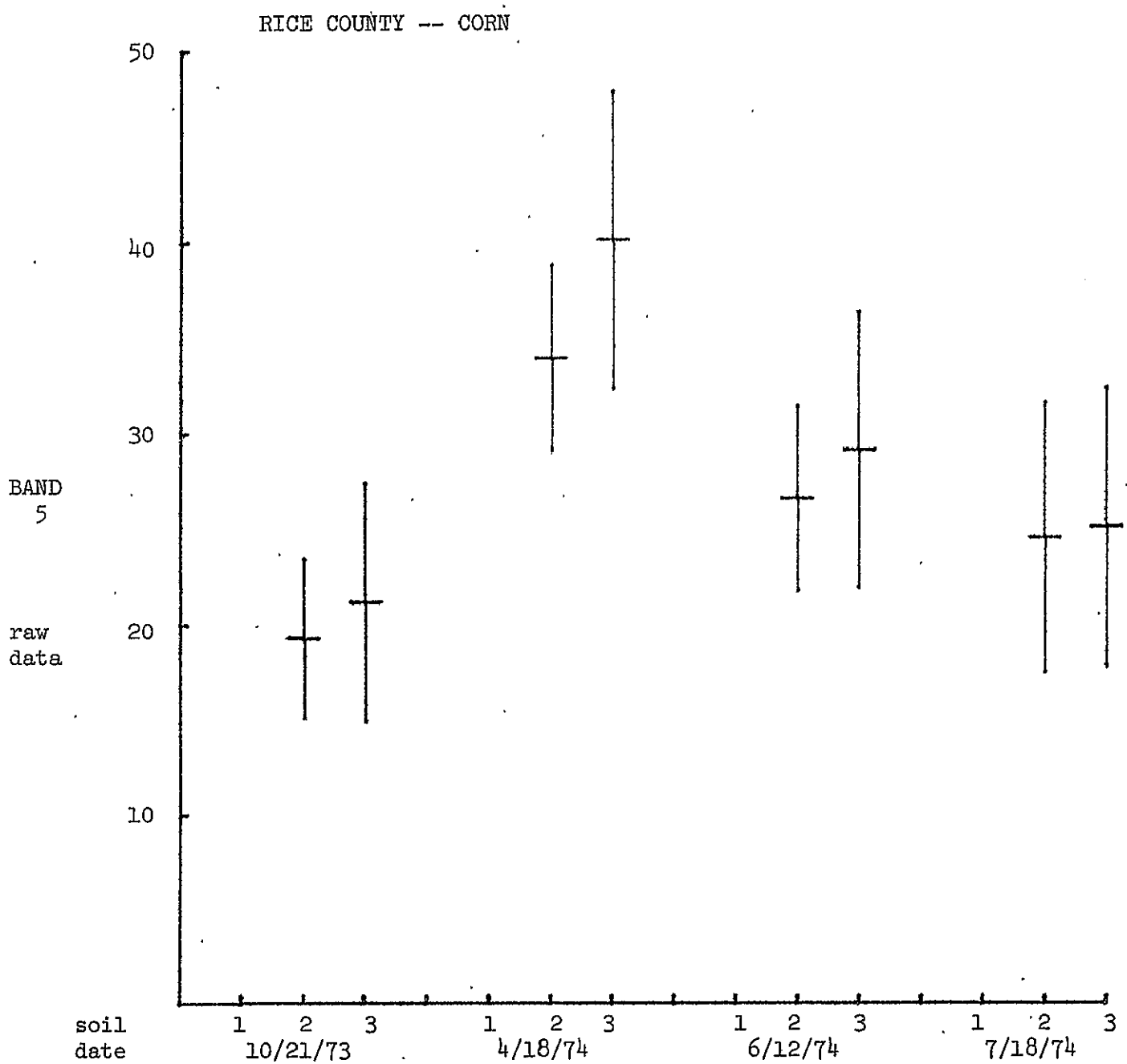
RICE COUNTY -- CORN
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Figure 2.5 g

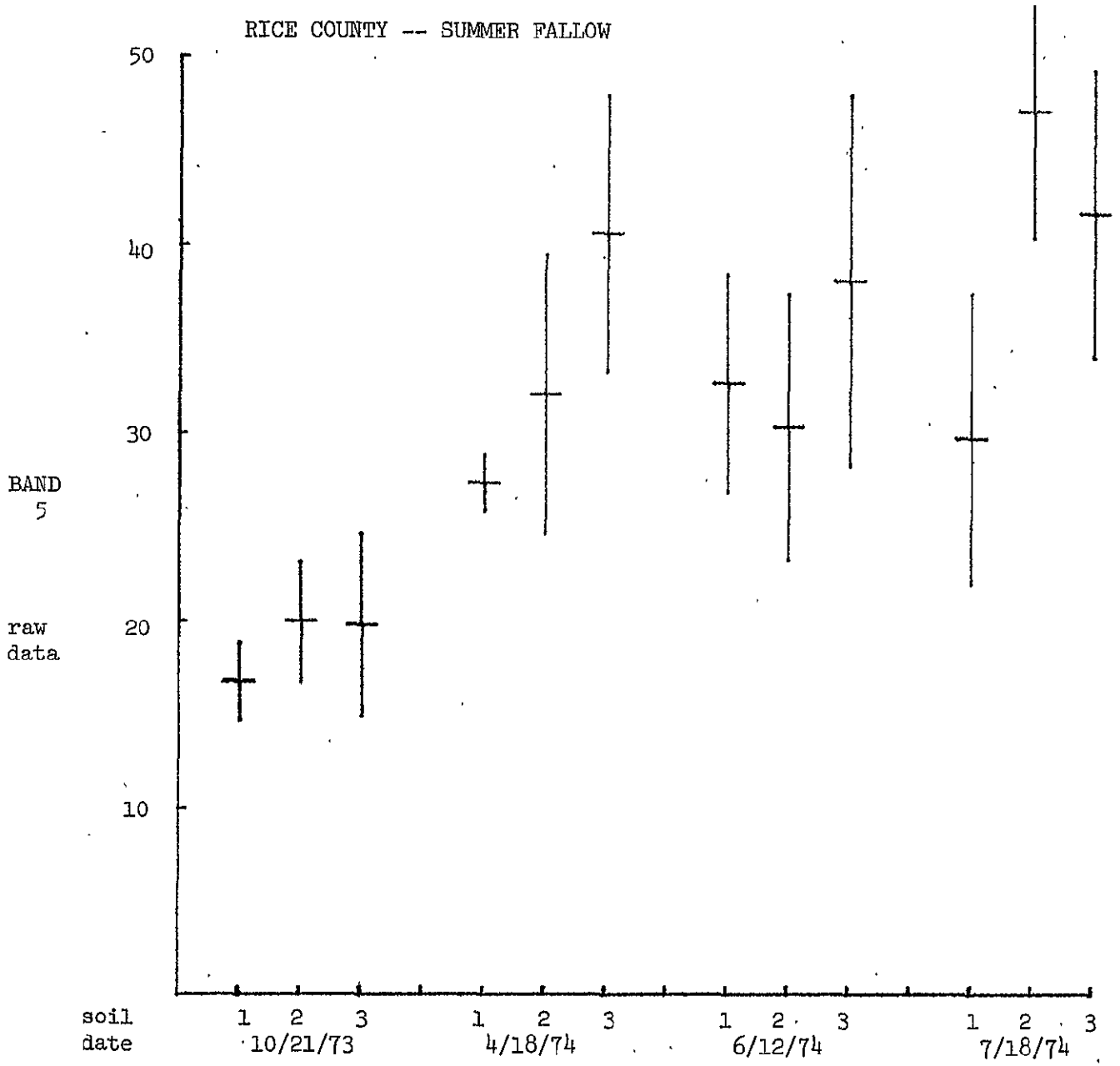
RICE COUNTY -- SUMMER FALLOW
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Figure 2.5 h

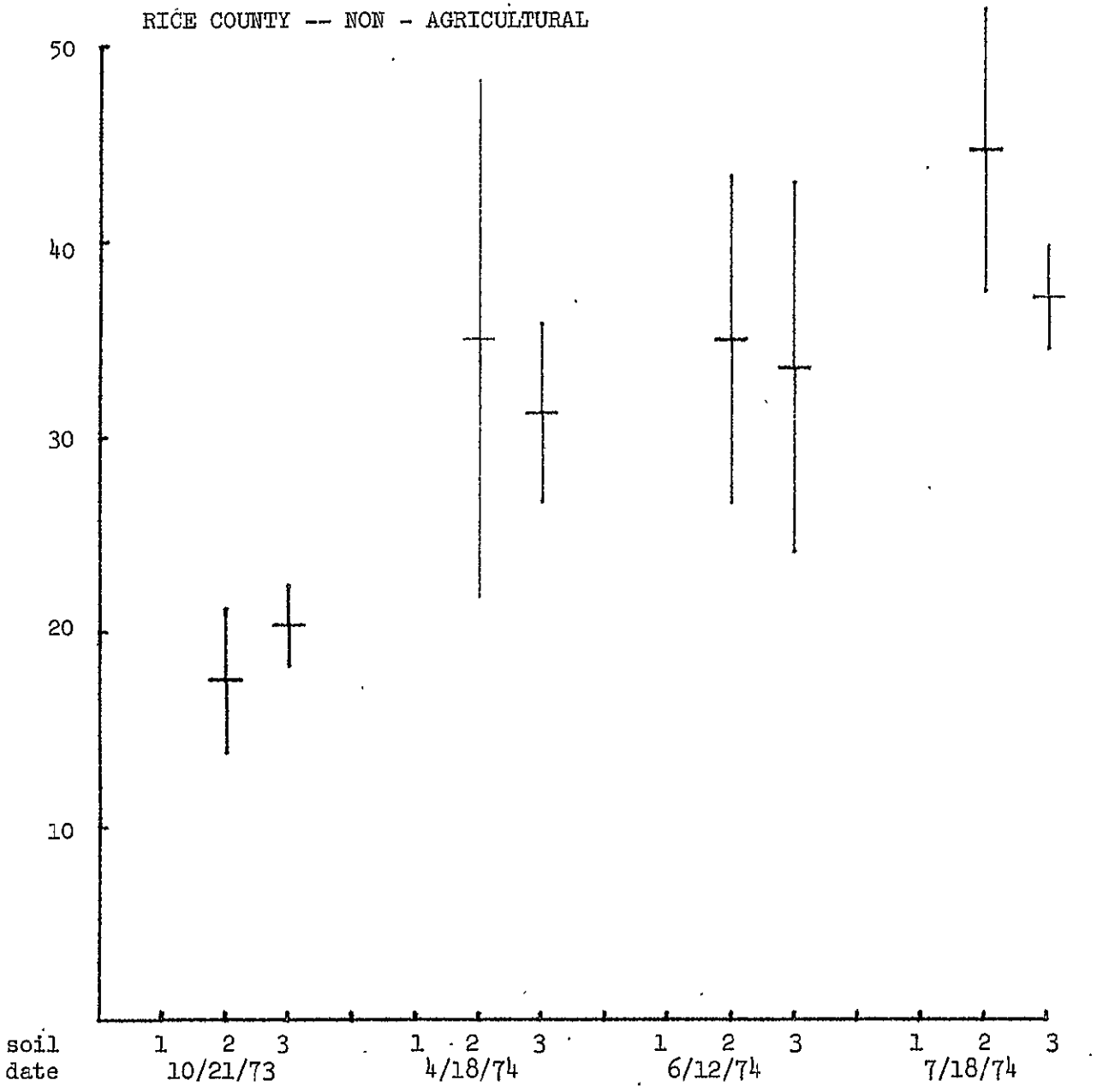
RICE COUNTY -- NON - AGRICULTURAL
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Figure 2.5 i

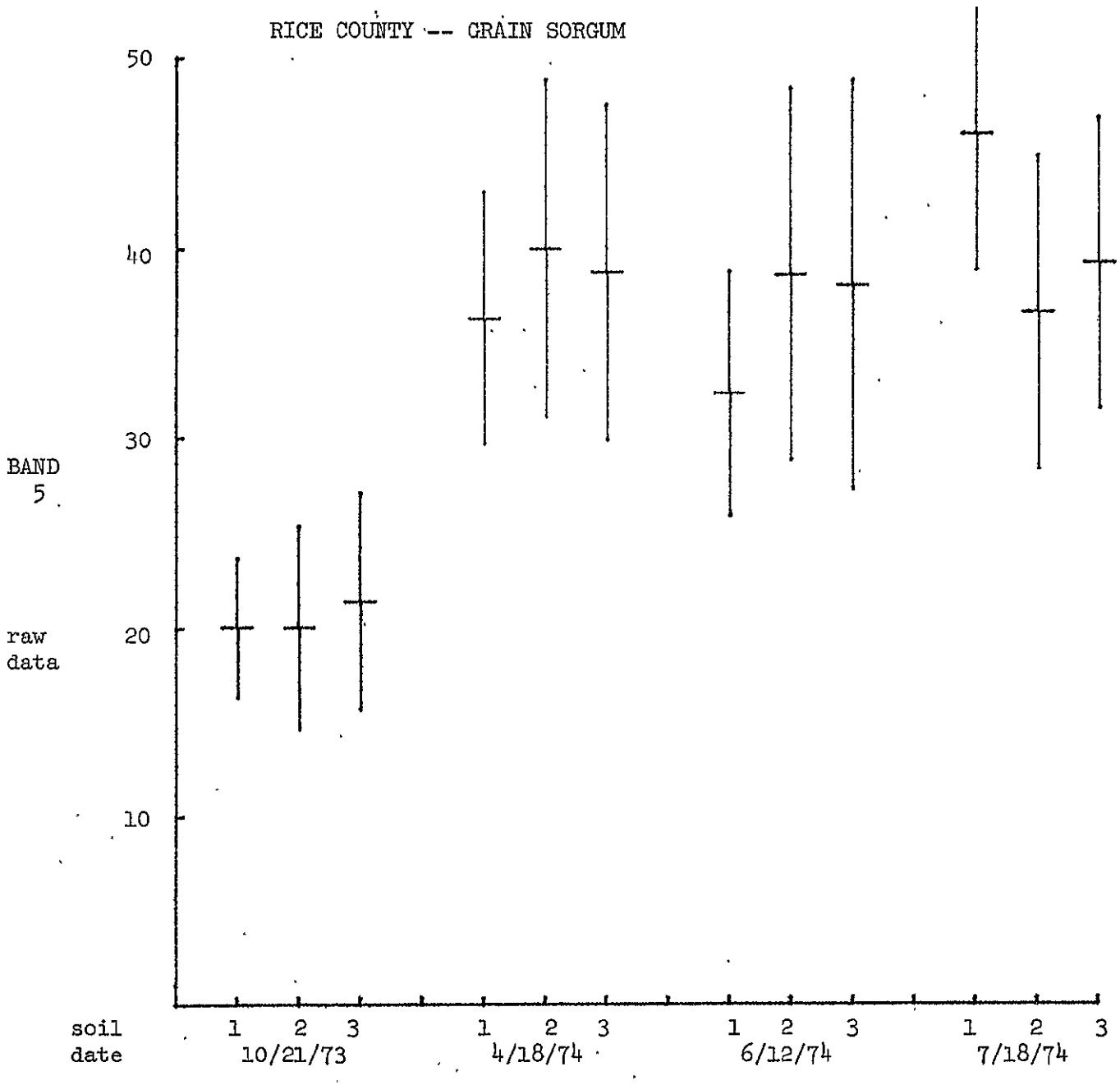
RICE COUNTY -- GRAIN SORGUM
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Figure 2.5 j

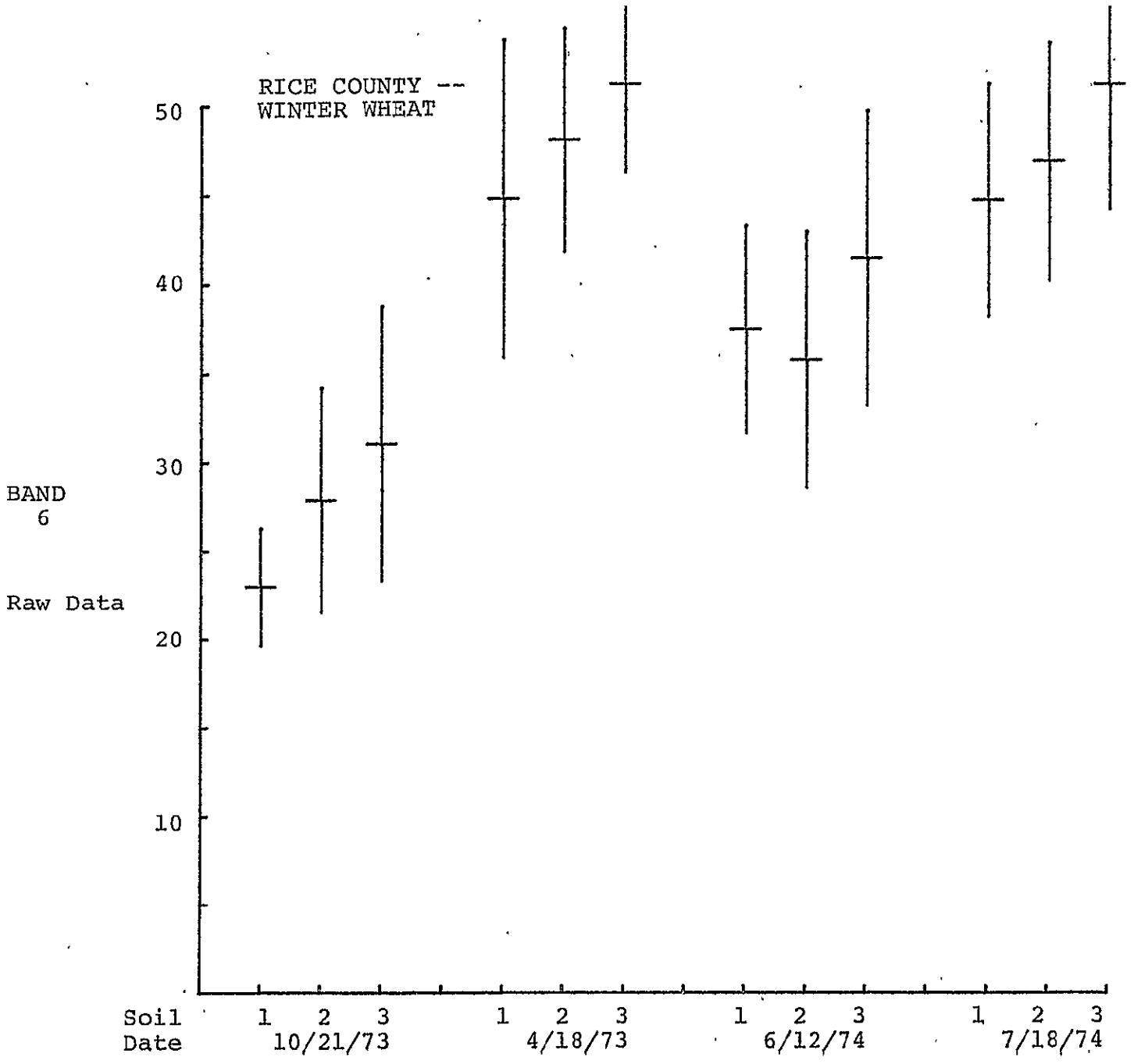
RICE COUNTY --
WINTER WHEAT
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Figure 2.5 k

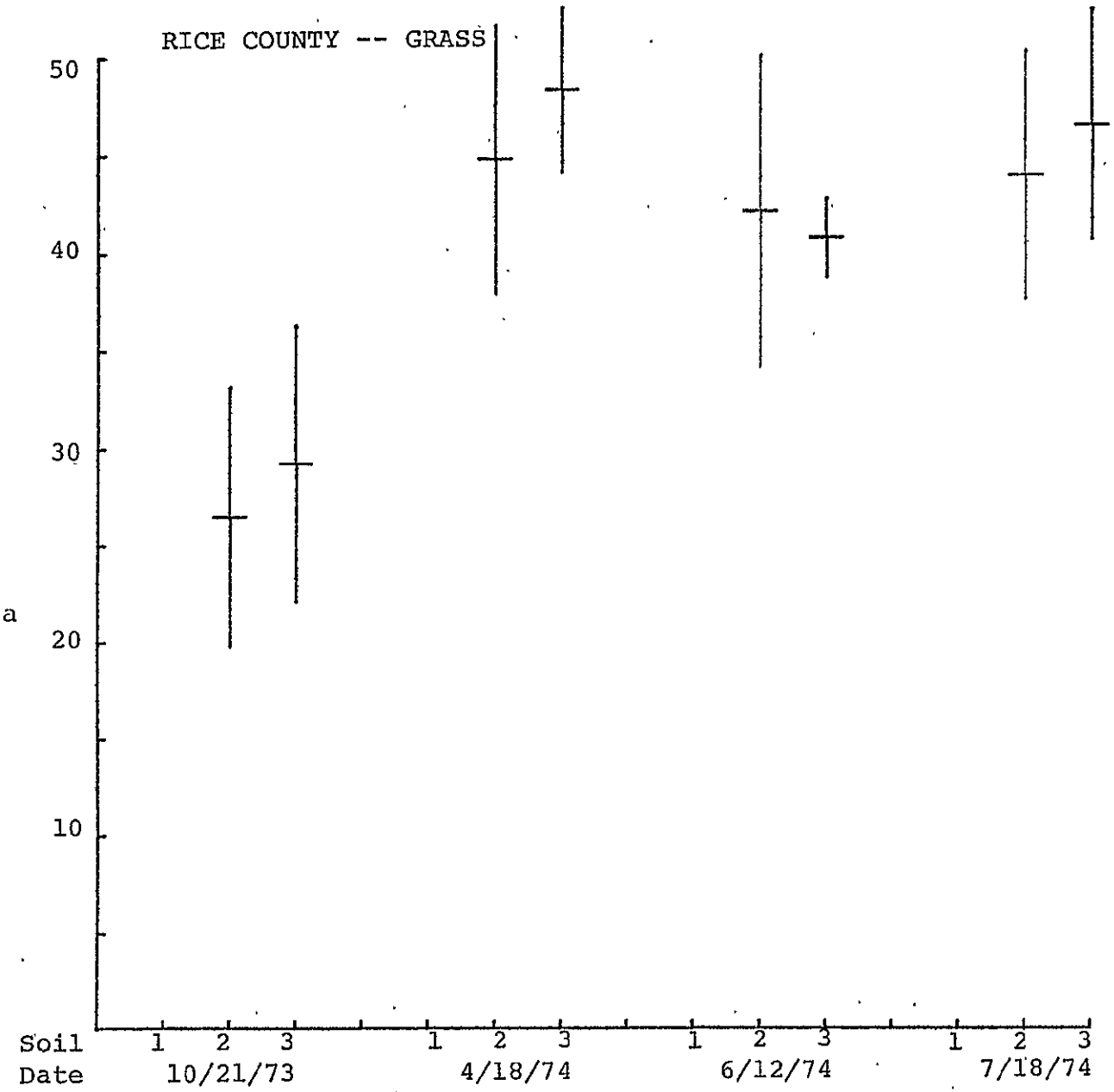
RICE COUNTY -- GRASS
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Figure 2.5 I

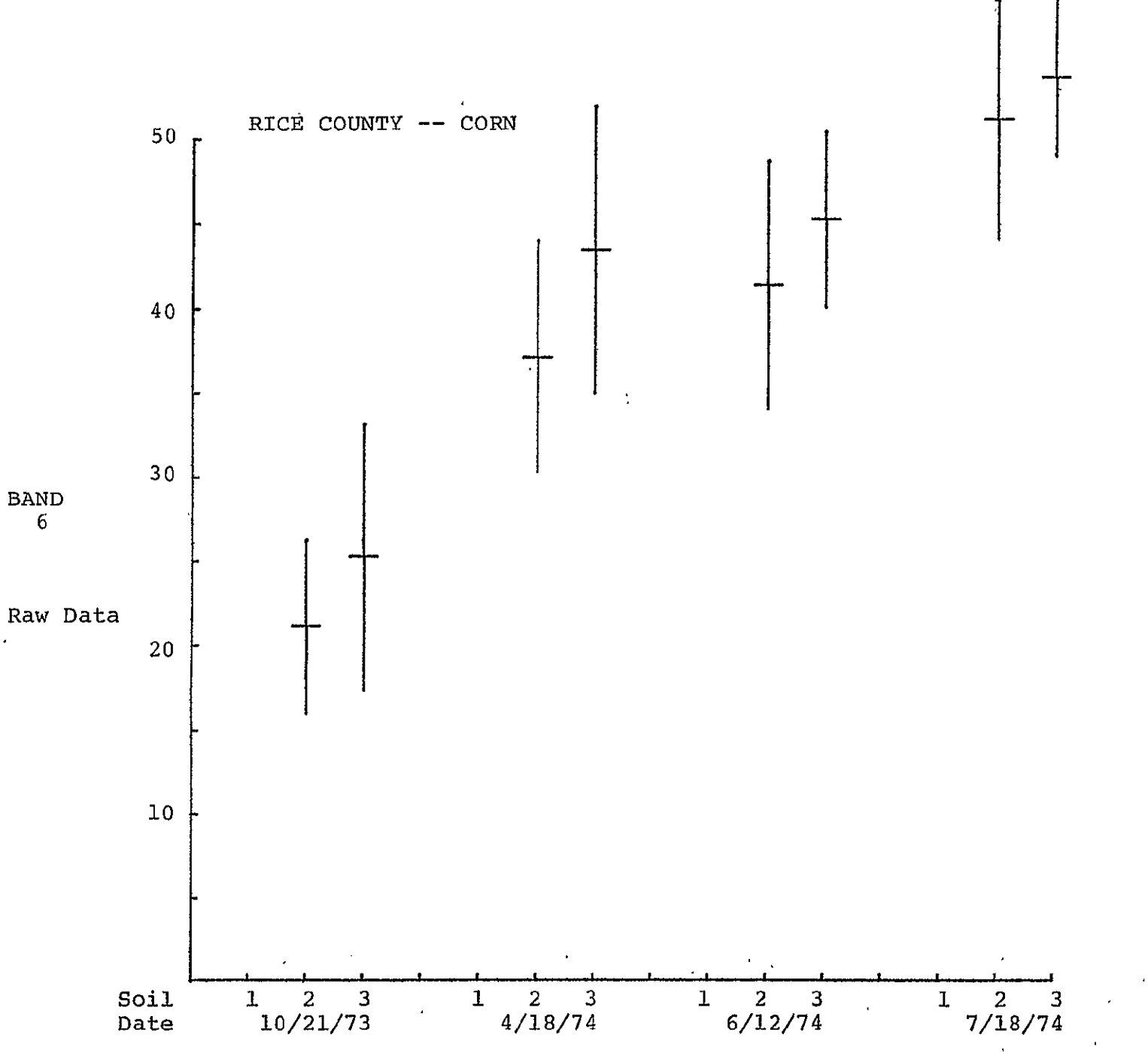
RICE COUNTY -- CORN
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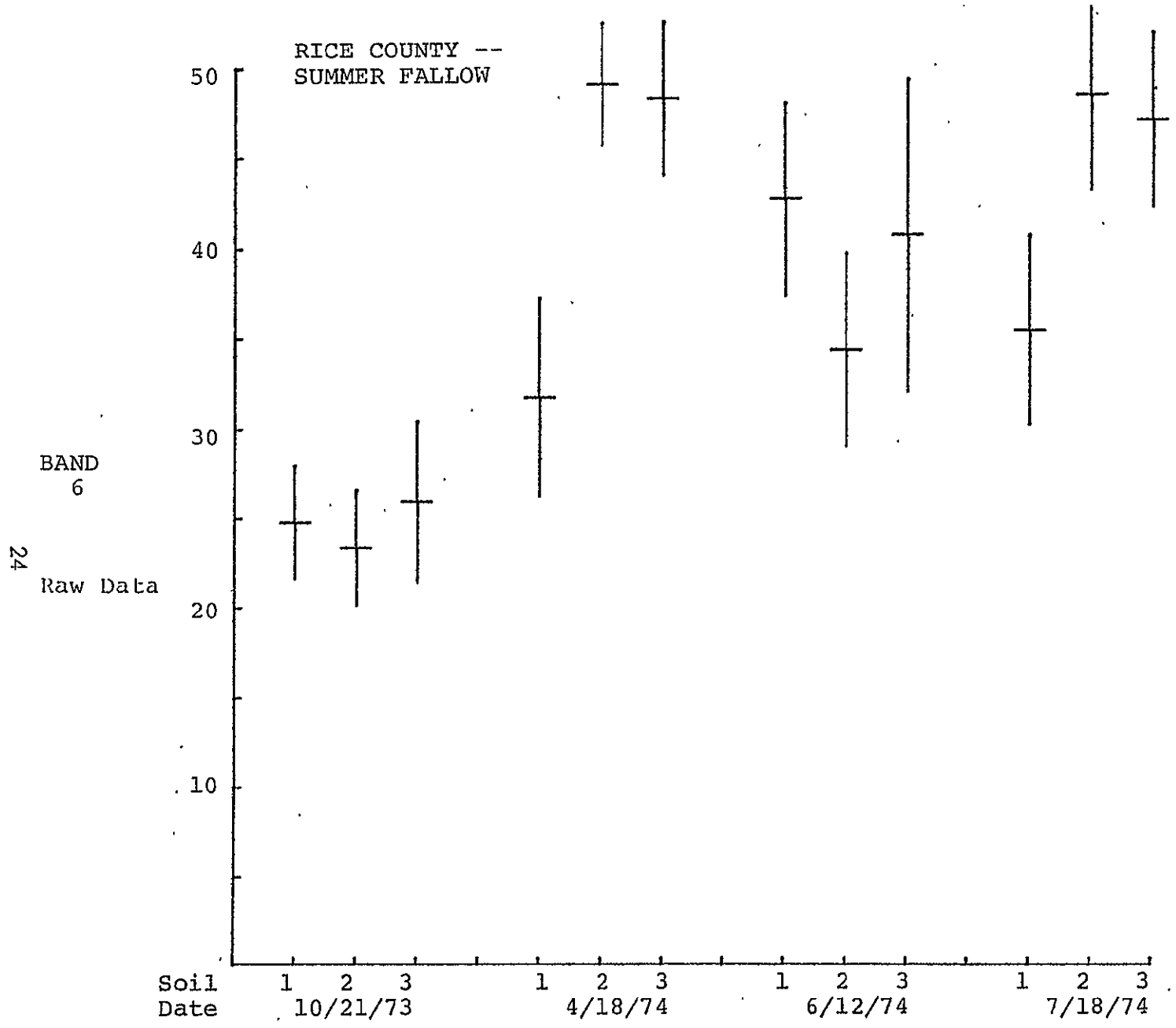
Figure 2.5 m


RICE COUNTY --
SUMMER FALLOW
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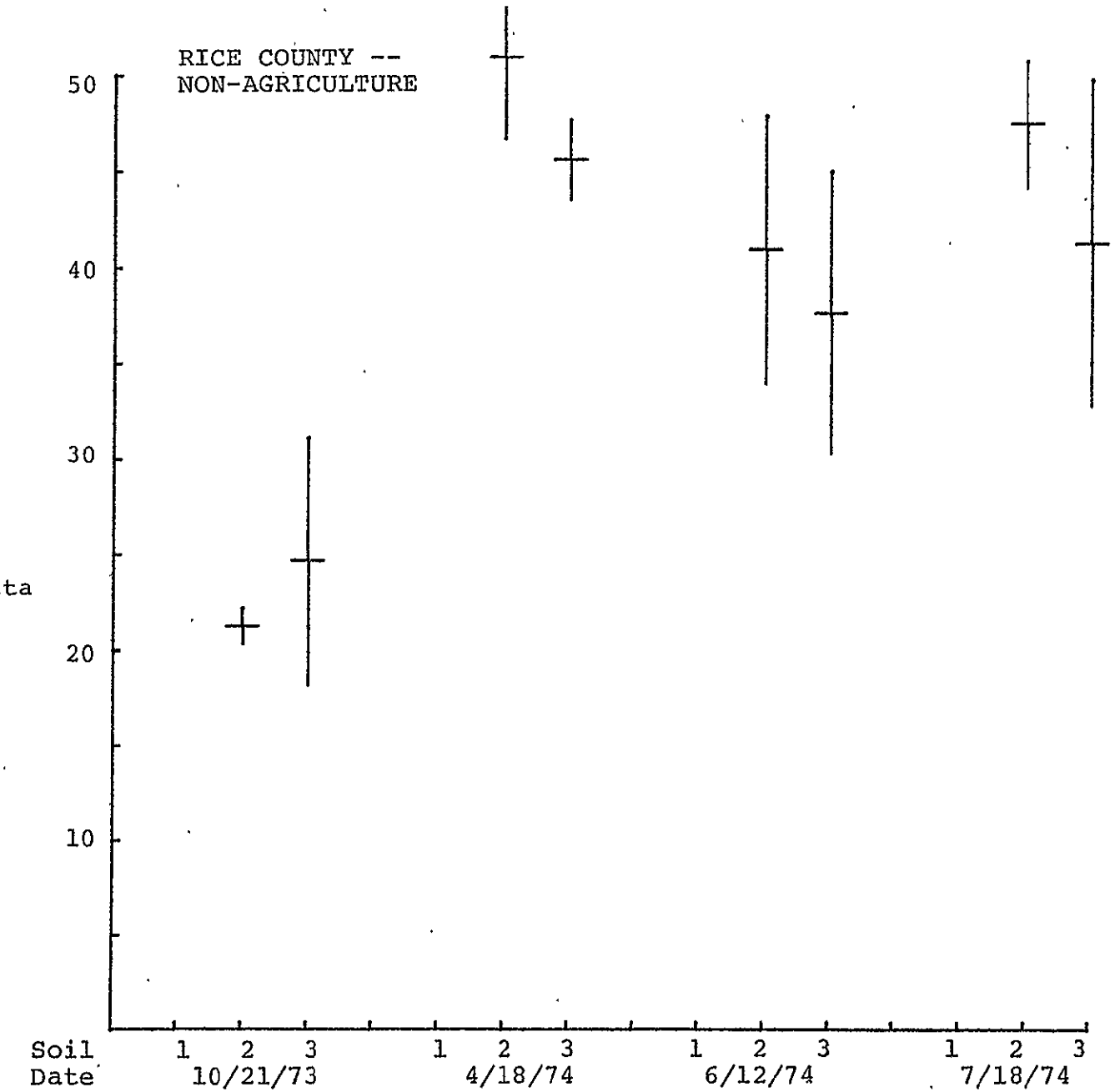
7/18/74

Figure 2.5 n


RICE COUNTY --
NON-AGRICULTURE
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Date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 o

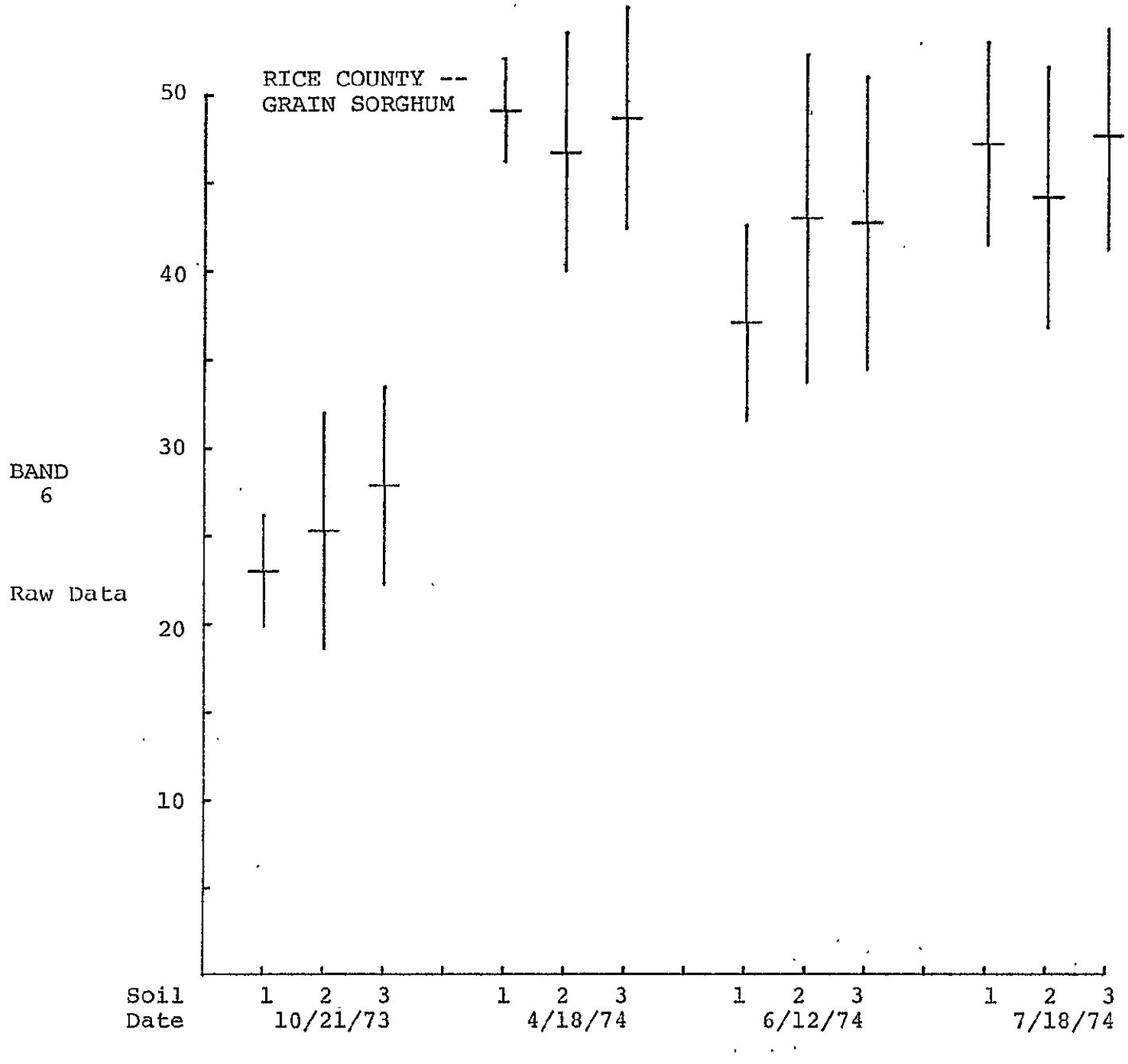


Figure 2.5 p

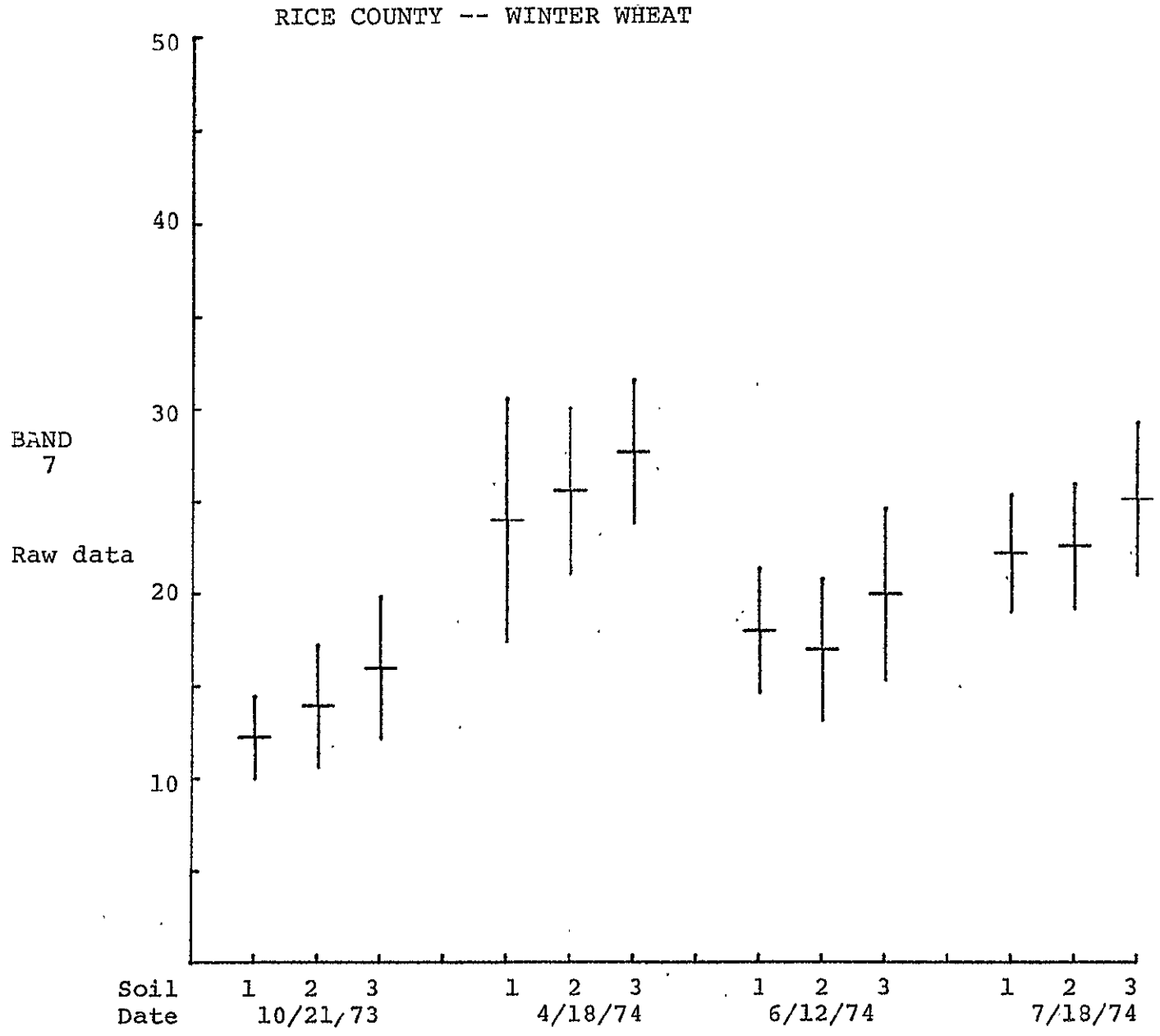

RICE COUNTY -- WINTER WHEAT
50
40
30
20
10
BAND
7
Raw data
Soil
Date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 q

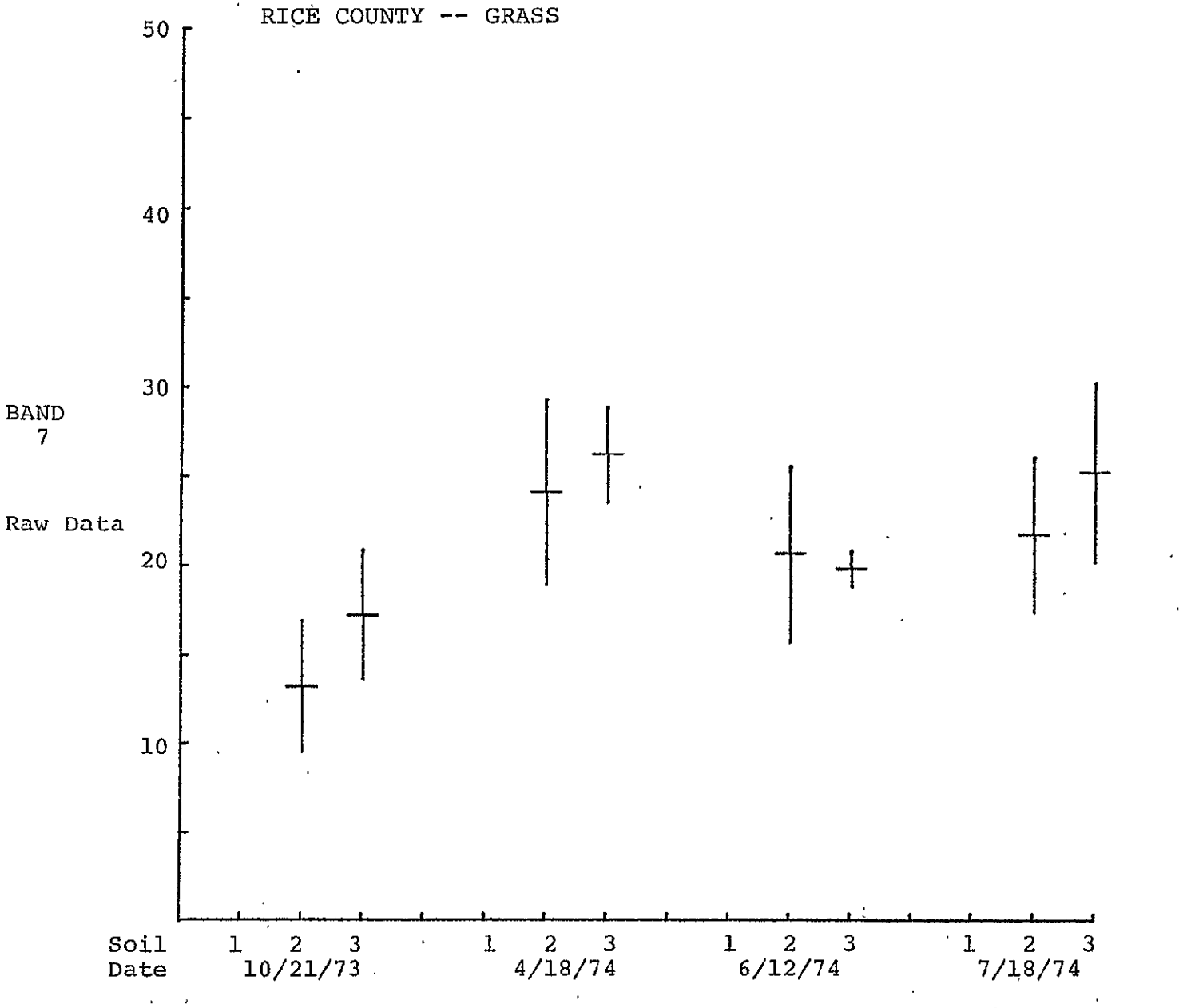

RICE COUNTY -- GRASS
50
40
30
20
10
BAND
7
Raw Data
Soil
Date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 r

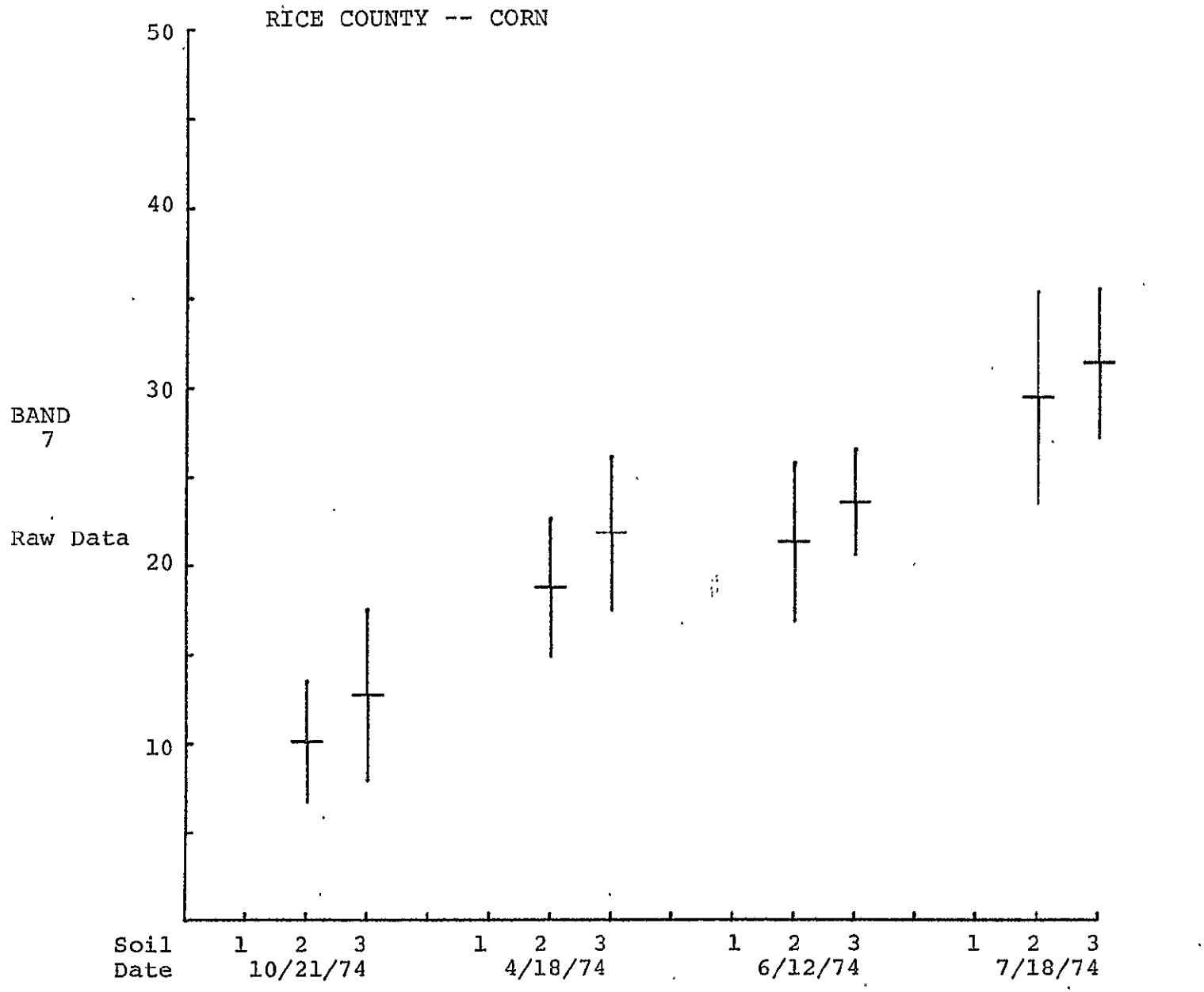

RICE COUNTY -- CORN
50
40
30
20
10
BAND
7
Raw Data
Soil
Date
1 2 3
10/21/74
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 s

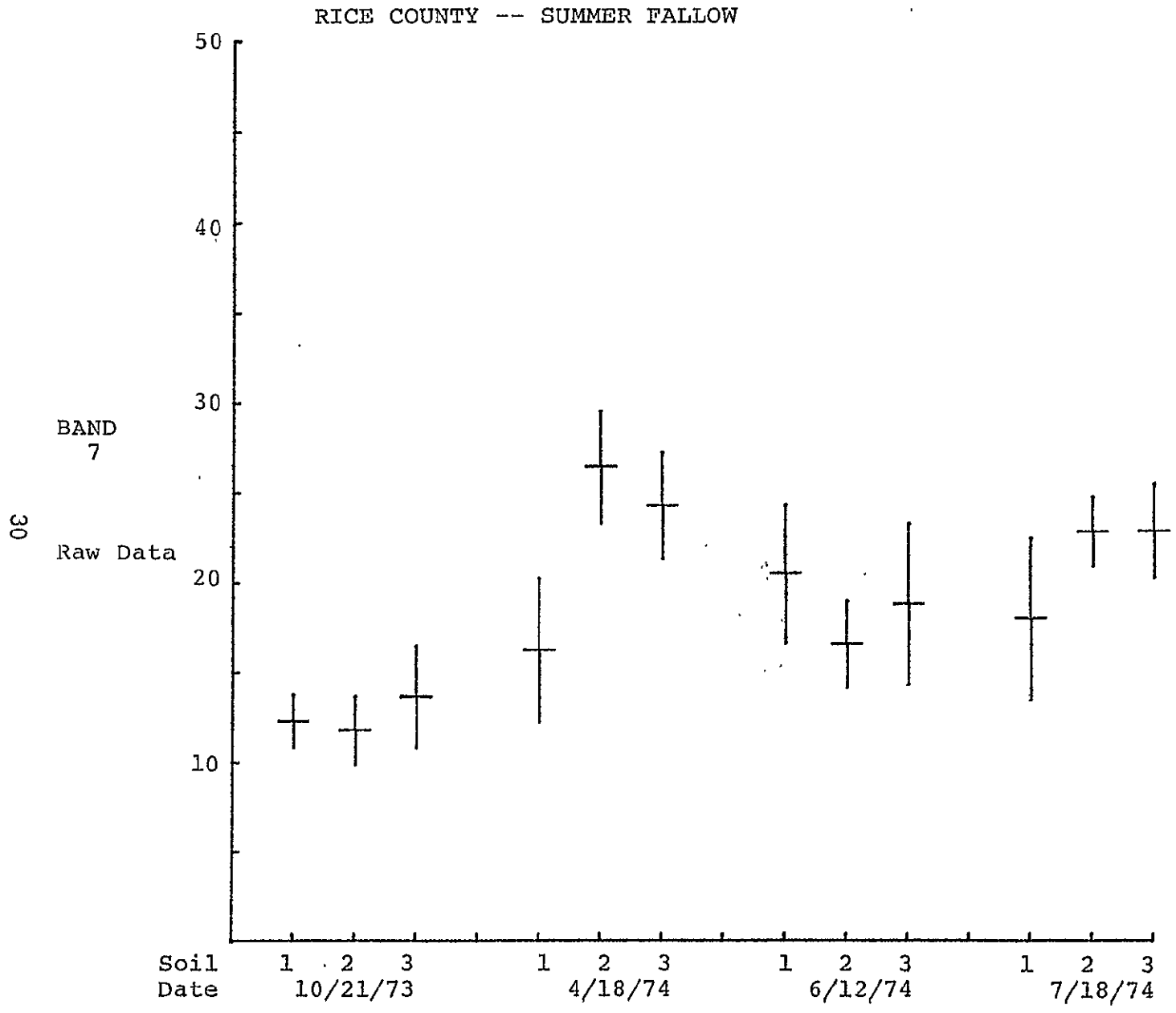

RICE COUNTY -- SUMMER FALLOW
50
40
30
20
10
BAND
7
Raw Data
30
Soil
Date
1 2 3 1 2 3 1 2 3 1 2 3
10/21/73
4/18/74
6/12/74
7/18/74

Figure 2.5 t

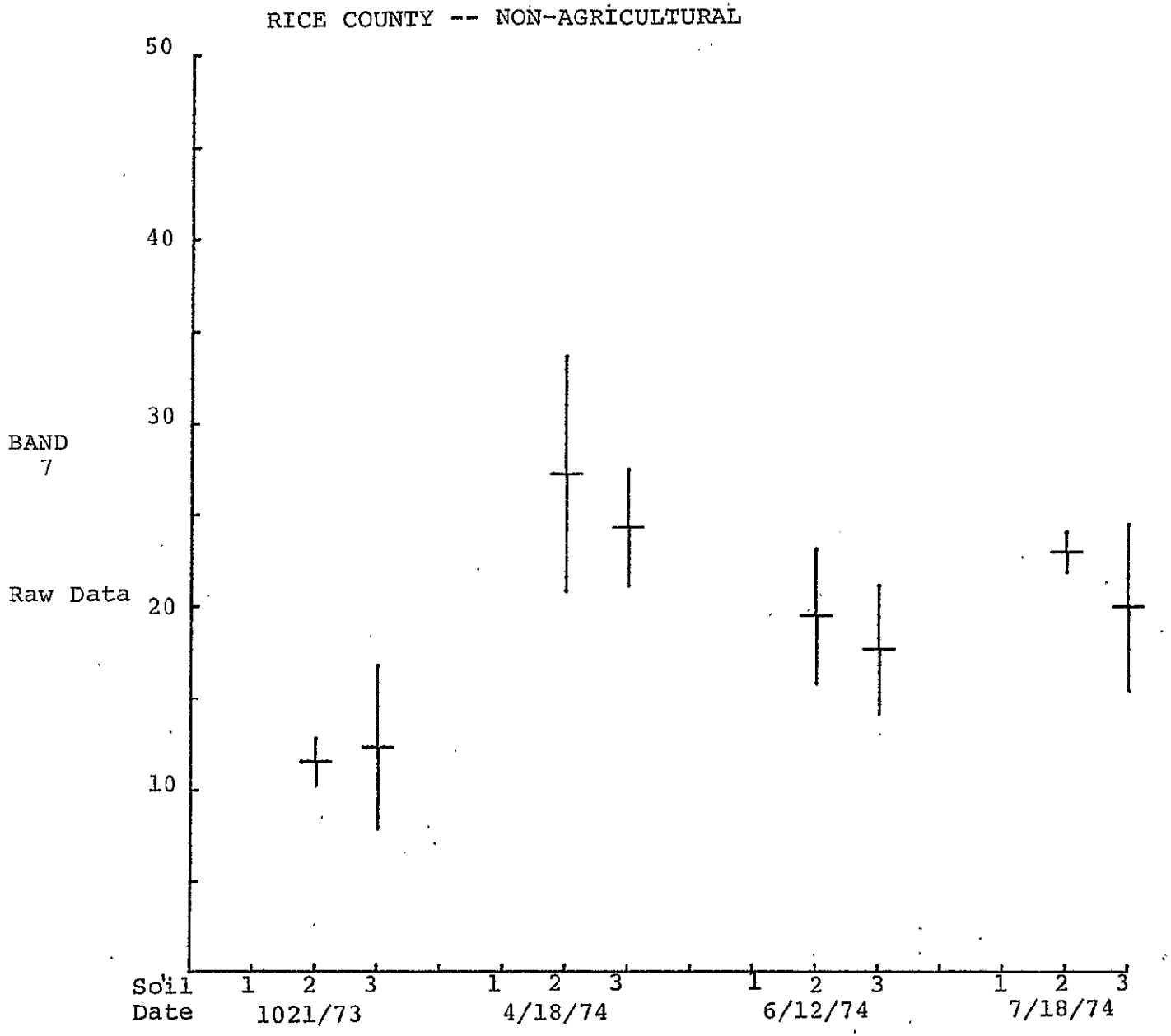

RICE COUNTY -- NON-AGRICULTURAL
50
40
30
BAND
7
Raw Data
20
10
Soil
Date
1
2
3
1021/73
4/18/74
6/12/74
7/18/74

Figure 2.5 u

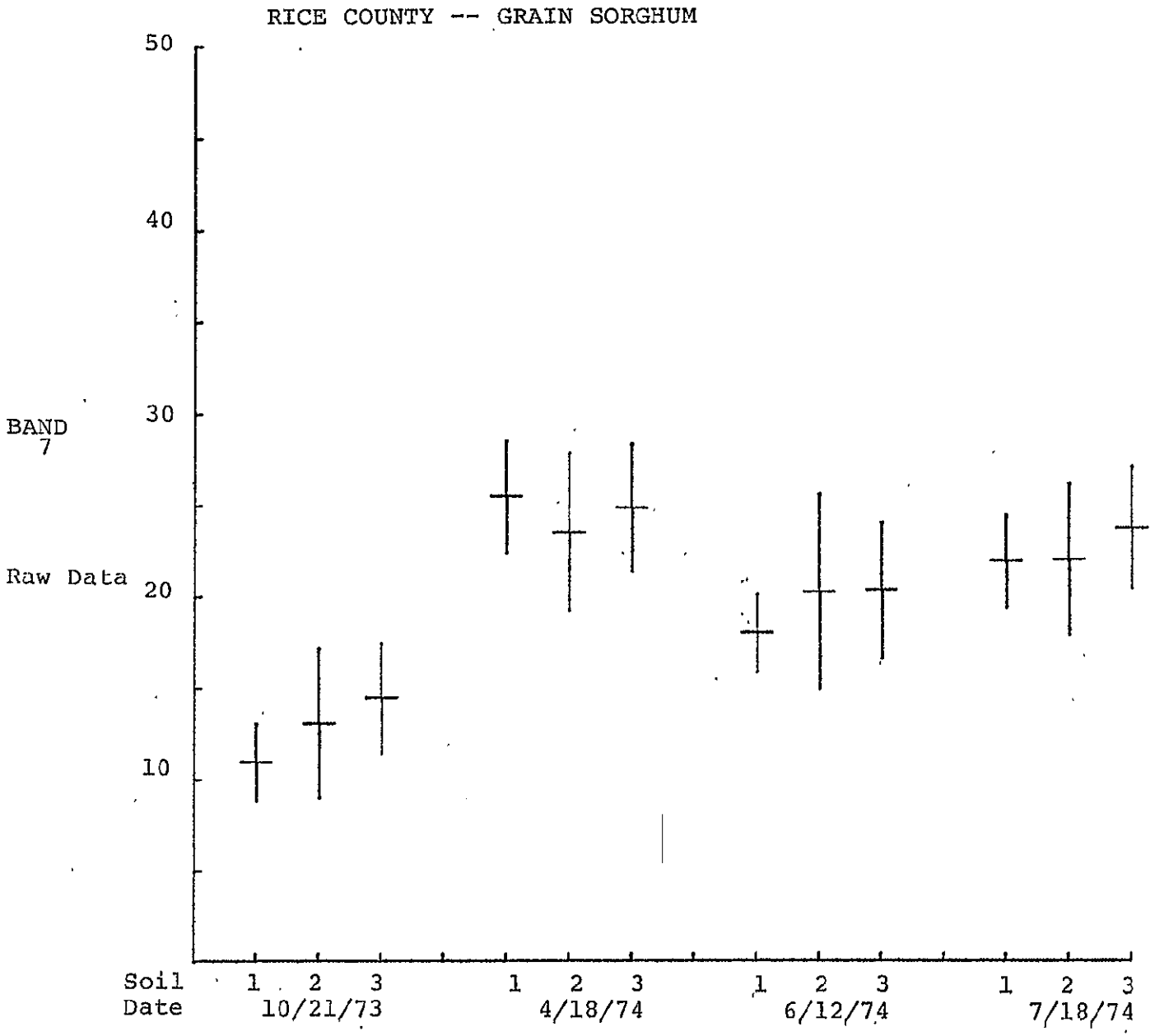

RICE COUNTY -- GRAIN SORGHUM
50
40
30
20
10
BAND
7
Raw Data
Soil
Date
1 2 3
10/21/73
1 2 3
4/18/74
1 2 3
6/12/74
1 2 3
7/18/74

Figure 2.5 v

both prior probabilities and the deletion of the non-agricultural category were combined, the total correct percentage classification was 61.9. Thus, the best improvement was obtained by using prior probabilities of class frequency.

Another way of dealing with the problems created when there are more than one criteria for classifying ones groups (in this case soil and crop type) is to combine the two criteria into one and use linear contrasts to pick out the groups one wants to contrast. The results of one set of contrasts is shown in Appendix BB7. Here there was a 35.5% total correct classification. This is not too bad since there are three times as many groups (potentially, that is, actually there are some categories missing such as grass on soil type 1) and thus, more types of error are possible. Since we are interested in crop type only, and the contrast we used only looked at crop type differences we can ignore the type of error where winter wheat on soil type 1 got classified as winter wheat on soil type 2. Ignoring this type of error, the total correct classification was increased to 51.0%. Since non-agricultural was excluded from calculating this equation, there was only a 1% increase in correct classification. Remember that leaving non-agricultural out increased correct classification from 46.2% to 49.9%. It may be that using a different contrast would improve the percentage of correct classification even more.

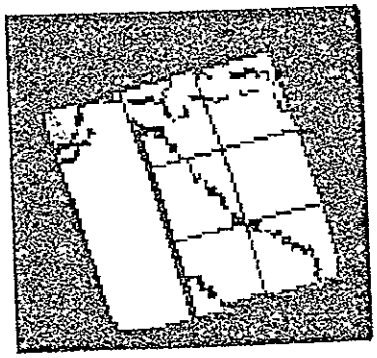
A canonical correlation analysis was carried out to see what percentage of the variation in the two ground truth parameters would be explained by variation in the ERTS bands. With the rank of the ERTS band matrix reduced to 5, from 16, 27.33% of the variation in the ground truth bands was determined by variation in the ERTS bands.

At this point we will return to consider the third source of error mentioned above, i.e., edge effects and ground truth errors. Since BMDP7M gives a listing of all individuals and the group to which they were assigned and the group to which they actually belong it was possible to find the coordinates of those observations which were not classified correctly. Using a routine that can put a marker on the IDECS screen, the bad classifications were located on a symbolic map of the crop types. It was found that most of the bad classifications for observations that were winter wheat, corn, grass or summer fallow were on edges. This was not the case with grain sorghum. Observations that were in the middle

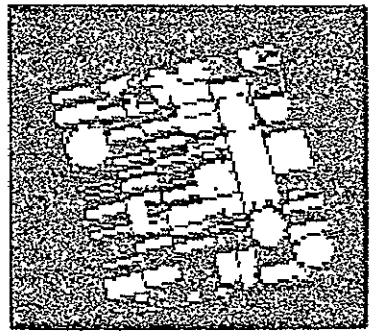
of grain sorghum fields were misclassified. It should be noted that there were a series of bad floods in the crop year '73-'74 and parts of some fields were damaged, some crops were replanted. In one field that was damaged some of the classification errors were from observations in the damaged area.

Based on the above analysis, there are a number of procedures that might help improve the rate of correct classification. First, a more accurate method of overlaying ground truth and ERTS bands should decrease the error due to edge effects, also, using the shrink and fill options on KANDIDATS should help this problem. Secondly, it would help to have a large enough area to sample so that rare categories would have a large sample size. Alternately, rare categories could be eliminated from the function as was done above. Also, in this particular case it seemed that there were basically only three distinguishable categories (winter wheat, corn, grain sorghum), perhaps the use of more images from throughout the growing period would help, or the use of some different spectral bands. In statistical techniques, it may be necessary to use a logistic or quadratic discriminant function. These are much more complicated to compute. It may be that some transformation of the ERTS bands will give better classification, but this would be largely trial and error.

In the analysis of Morton county, the original BMDP7M analysis gave 74.1% total correct classification and 16 variables were included in the discriminant function. Soil type was a variable included in the discriminant function, actually the fifth variable entered. This is in contrast to the Rice county study which did not use soil type as a discriminating variable. In studying the results of the Morton county analysis (Appendix CC1) it is clear that there is a much better discrimination than for Rice county. On the other hand, both Morton and Rice counties are much better classified than Saline county (Appendices DD1 and DD2). In Saline county, soil type was the first variable to be used to discriminate crop types, and only one ERTS band was used. This produced only 43.4% correct classification. The increase in percent correct classification from Saline to Rice to Morton counties is correlated with the number of ERTS scenes available for that county. This supports the hypothesis that more scenes of a site would permit a better success rate. If soil type is not used for



2.6a



2.6b

Figures 2.6a and 2.6b show the ground truth for soil and crop types for Rice County.

discriminating in the Saline county site (Appendix DD2), the percentage of correct classification drops to 22.8%. If one were to use the Rice study as a guide, the addition of a June observation to the Saline county site would have improved the classification.

The Morton and Saline county sites need to be studied in more detail before much more can be said about them. Following are a list of things that have been done but which have not been included in this report, or discussed in it. BMDP9D analysis has been done on both Morton and Saline counties. Black and white and color slides have been made of all of the Rice county bands, ERTS and ground truth.

2.4 Effects of Soils on Crop Classification

The soil ground truth used in the analysis to date has consisted of rankings of agricultural suitability, taken from Figures 2.7a - 2.7c. Unfortunately, a number of different textures of soil (and presumably of different reflectance) may be included under the same ranking for agricultural suitability. For example, in Figures 2.7a and 2.6a you can see that the area marked 19Bx1 is classified the same as area 20Bx2, while in actuality they have different sources, denoted by the codes 19B and 20B and different textures denoted by the horizontal versus diagonal hatching. Figures 2.7b-2.7e show the soil, ground truth for the Morton, Saline, Finney and Ellis sites respectively. In the analysis of Rice county as you recall an interaction between the soil type and crop type was discovered which prevented using the simple regression of band against soil to remove the effect of soil on reflectance. The use of a more relevant soil classification will probably not change this, although, it may make it more susceptible to analysis.

It is reasonable to expect each plant type to react differently to given soil types. This is because not only are the plants physiologically different, but differences in the character of the soil, such as the ability to hold water, the ability to drain excess water, etc., will effect such general properties as the rate and stage of growth at a particular date after planting, and the length of time necessary for the crop to mature. Thus, to accurately include the effect of soil type one would need sufficient variables to indicate the

reflectance of bare soil., and the plant soil interaction. However, it is more complicated than this, because weather interacts with soil type to effect not only the reflectance of the bare soil at a given time, but also to create a weather, soil, crop interaction. It is easy to imagine the complicated types of interaction between soil type, topography, and crop type for various extreme weather types.

2.4 Crop-Soil-Weather Interactions

Above, we have suggested some of the ways our analysis may be complicated by interaction. It would probably be futile to try and use the variation in weather from site to site, within a year to discover the effect of weather. This is because the general soil types vary from county to county (Table 2.1) and there is little concordance in source or texture of soils from site to site (Table 2.2 and Figures 2.7b-2.7e). Thus, within a year, the effect of weather would be confused by the soil-crop type interaction. The only way to resolve the problem is to have data from a number of years from a particular site. Then it would be possible to resolve the effects of crop type, weather, and soil type on reflectance for a particular site. If the ERTS images were collected at the same time for all of the sites thus removing the effects of look angle and sun elevation it might be possible to remove the effects of site by using Longitude and Latitude as covariates in the discriminant analysis. From a report by M. Jay Harnage, HC/75/102 at the Houston NASA Center it can be seen that solar angle can have a significant effect on the image contrast as a function of band wavelength. Thus, the fact that images of different sites were taken not only on different dates, but also at different solar angles would have a confusing effect on trying to develop a site free discriminant method. This would also be a problem in going from year to year for a particular site.

Table 2.1

This table of general soil types was taken from a map of soils for the state of Kansas, compiled by O. W. Bidwell, Kansas Agricultural Experimental Station and C. W. McBee, Soil Conservation Service, Salina, KS., 1973. Published by the Kansas Agricultural Experiment Station, Kansas State University, Manhattan.

Site	Soil Types	Description
Saline Co.	Ustolls, Usterts, and Udolls	Deep, moderately deep, and shallow, dark grayish brown and very dark grayish brown silt loams, silty clay loams, and silty clays; depth to secondary carbonates, more than 36 inches.
Rice Co.	Ustalfs, Ustolls, and Aquolls	Deep dark grayish brown loams and fine sandy loams and pale-brown loamy fine sands; depth to secondary carbonates, more than 36 inches.
Ellis Co.	Ustolls and Usterts	Deep and moderately deep, dark grayish brown silt loams and moderately deep gray clays; depth to secondary carbonates, less than 36 inches.
Morton Co. & Finney Co.	Ustolls, Orthents, and Ustalfs	Deep, grayish brown and dark grayish brown silt loams; depth to secondary carbonates and less than 36 inches.

Table 2.2

This table of soil sources was taken from the maps listed in Appendices B, C, and D.

Site	Source
Saline Co.	Stream terrace deposits
Rice Co.	Stream terrace deposits, old alluvium and wind reworked sands, old alluvium and wind laid sands
Ellis Co.	Loess; Loess, Limy shales, old alluvium
Finney Co.	Outwash loess, lacustrine deposits, terrace deposits
Morton Co.	Loess, old alluvium, old alluvium sands

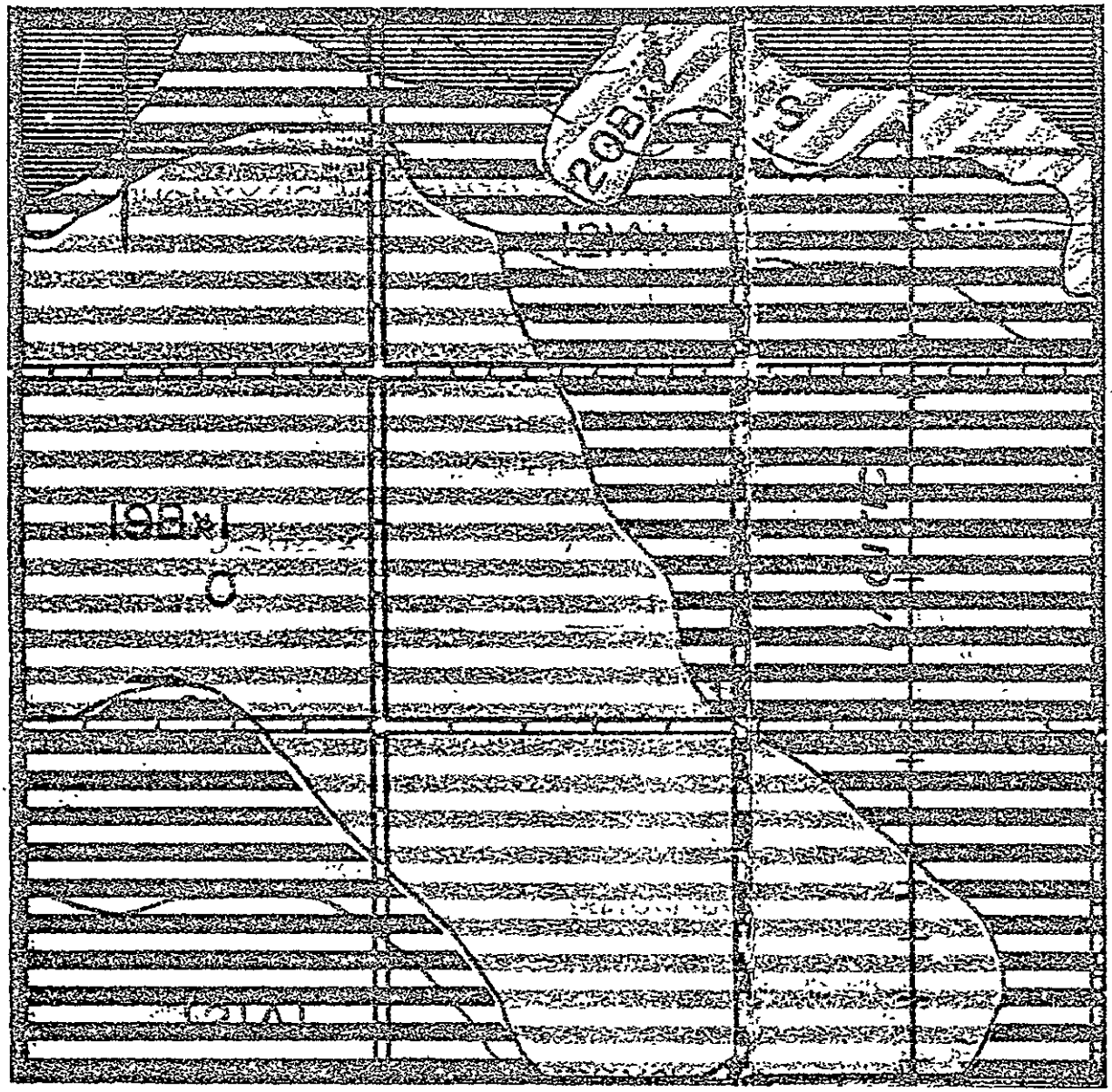


Figure 2.7a Soil Type Rice County

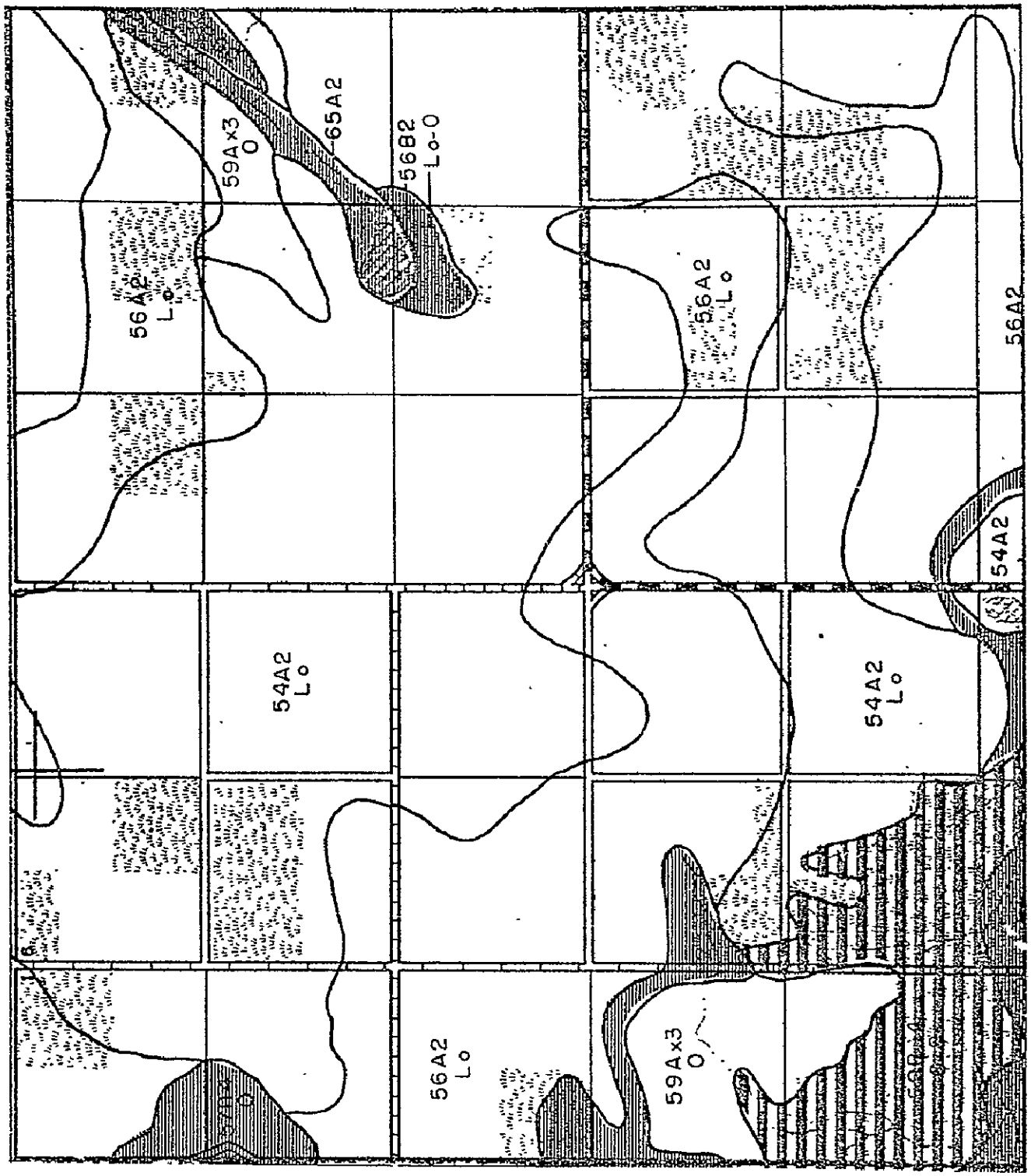


Figure 2.7b Soil Type Morton County

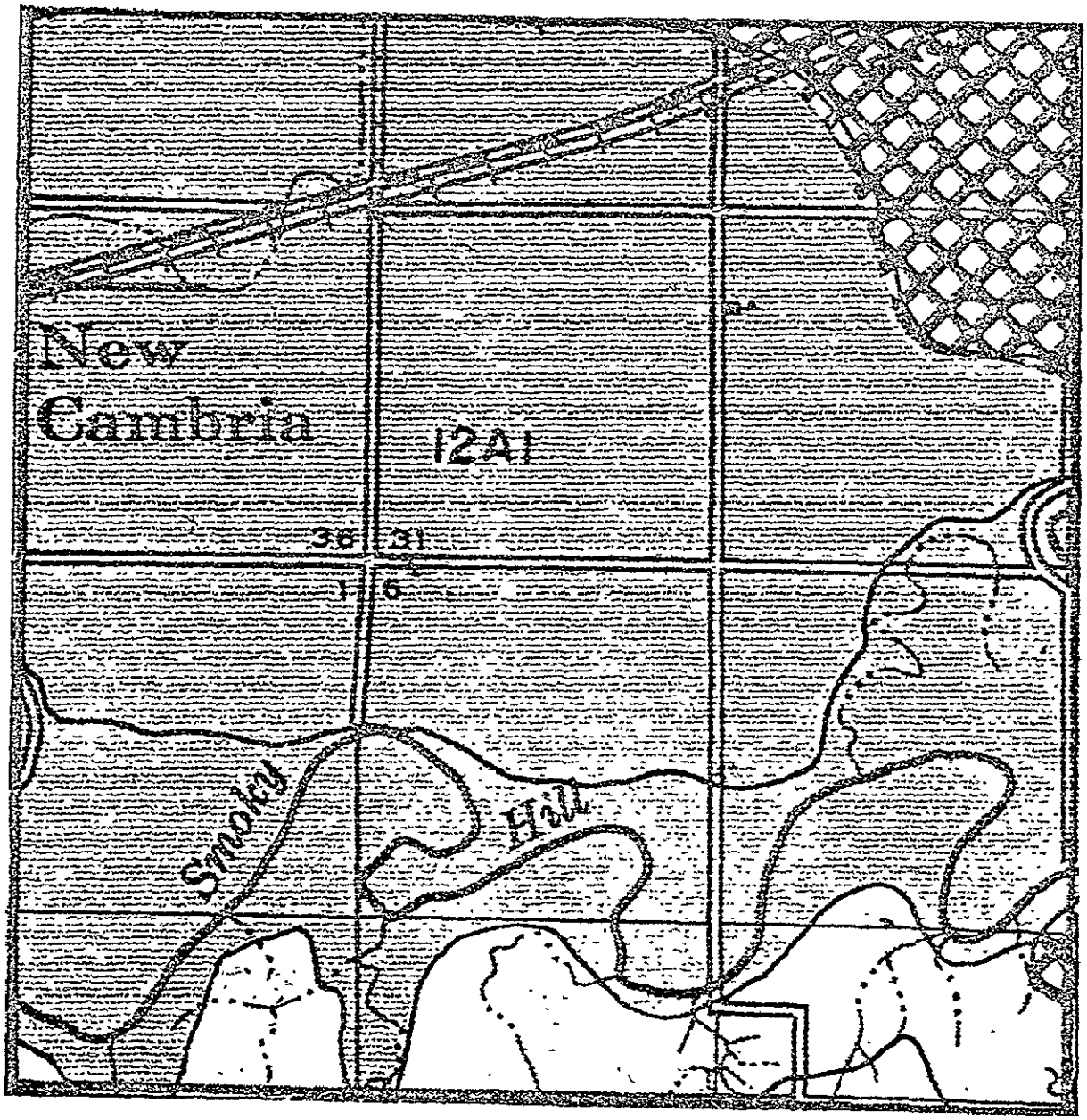


Figure 2.7c Soil Type Saline County

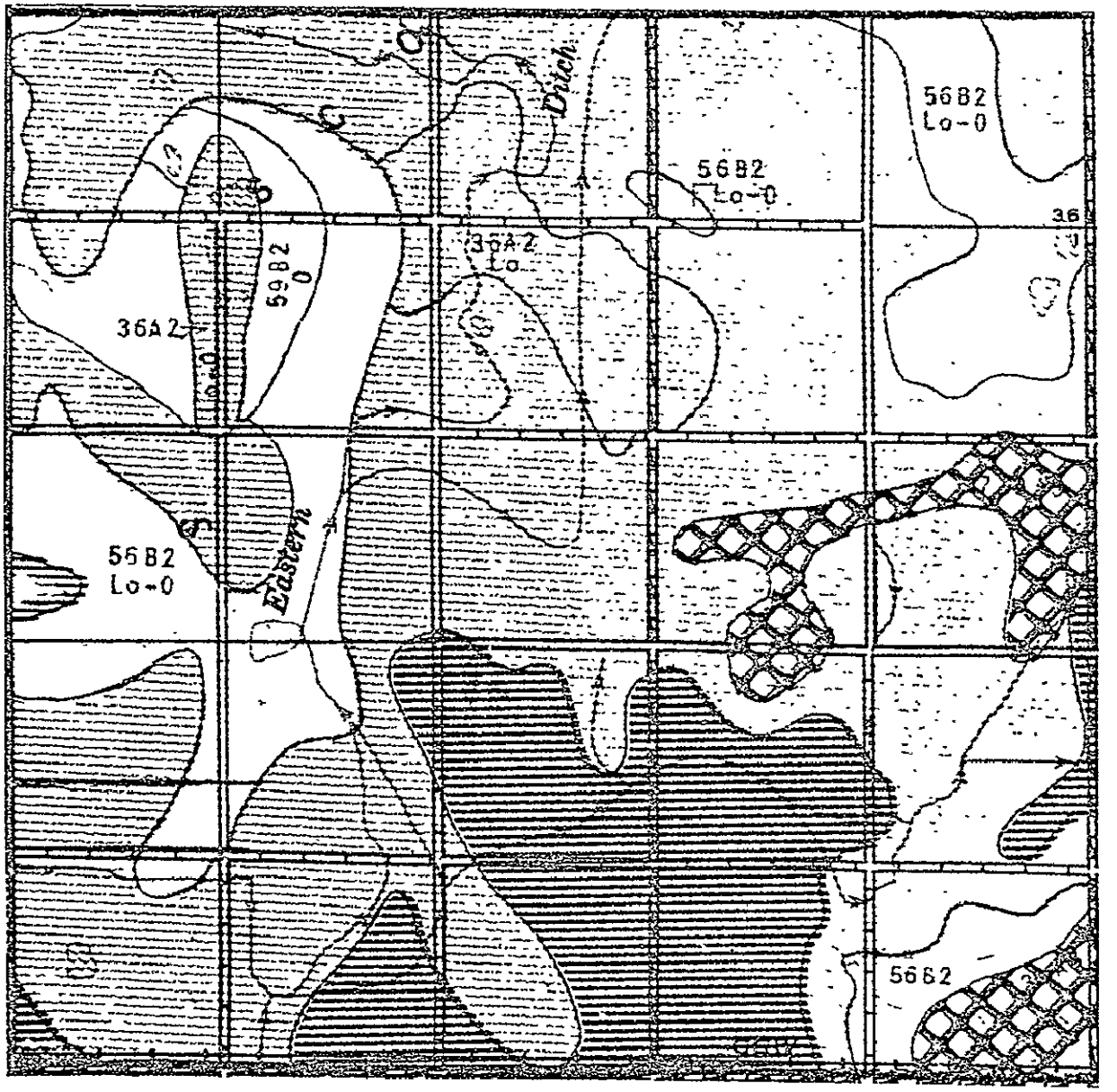


Figure 2.7d Soil Type Finney County

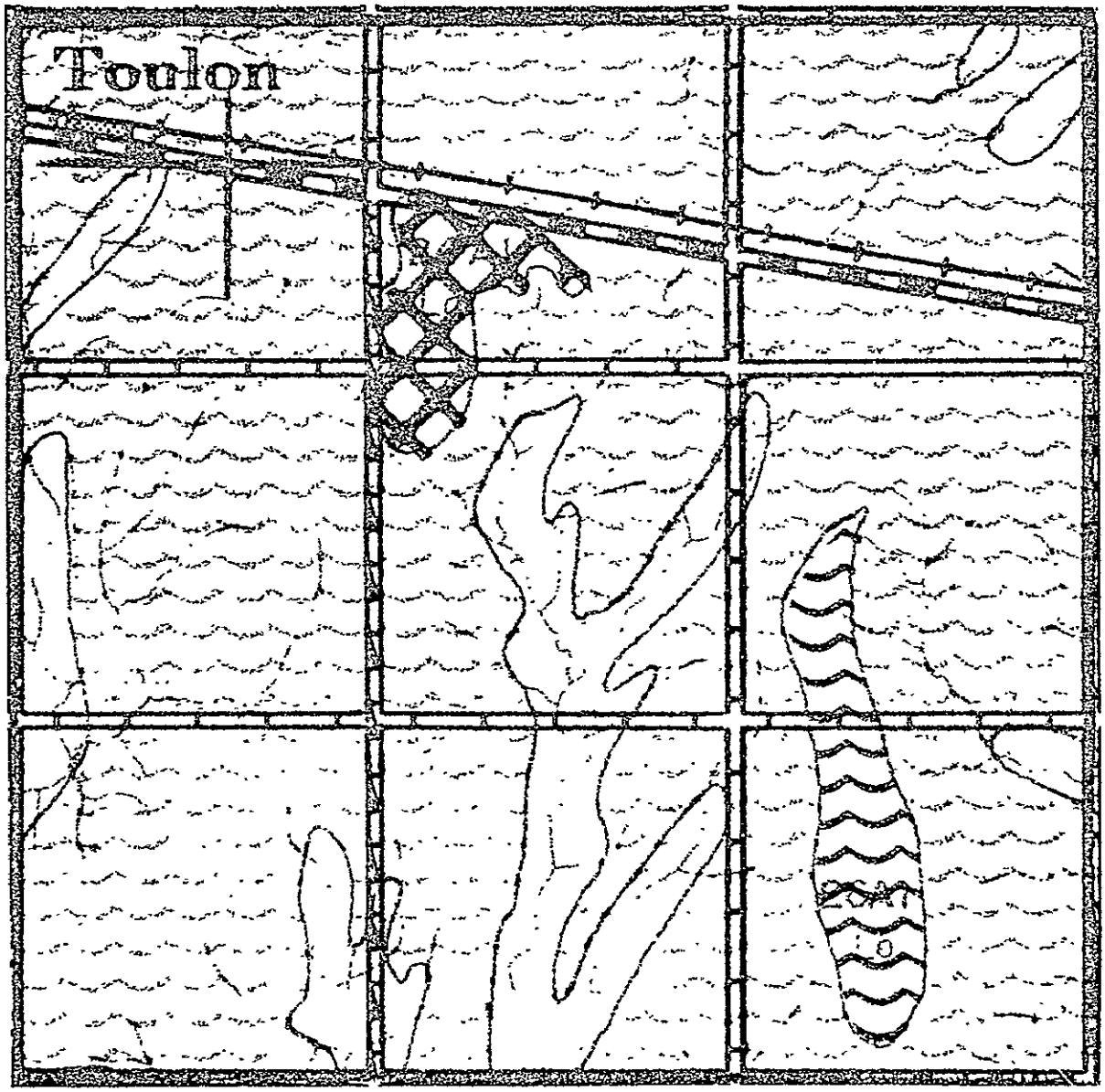


Figure 2.7e Soil Type Ellis County

3.0 PATTERN DISCRIMINATION WITH A BAYES TABLE LOOK-UP RULE

Four test sites were processed using the table look-up rule. These were Rice, Saline, Morton and Finney counties. Sites were typically processed in the following manner:

(1) Ground truth for crop type was separated after registration and edited. Editing consisted of removing categories of rare occurence and shrinking the description of each ground truth region. This has the effect of removing ground truth, and hence statistics gathering, from the edges of fields. Hopefully, the training statistics will be improved.

(2) An error rate measure was run for all band pairs for each site. This gave a measure of which band pairs would produce the best results for discrimination. The best band pairs for each site are given in succeeding sections.

(3) The three best band pairs were used in the table look-up processing. Several levels of error parameters were applied to each image. The results are reported in the following sections.

(4) The best bands were rotated onto the principle axis by a principal component analysis. The resultant image was then used as input to steps (2) and (3) above.

In addition some spatial processing of the resultant category-map was experimented with for Rice County. The spatial processing reduced the error rate.

The following sections outline the specific processing parameters for the four test sites.

3.1 Supervised Discrimination of Rice County Image

The image for Rice county was intensely studied. Several band pair sets were tried along with several different decision rules. The following band pairs were used with a majority vote decision rule:

MSS Band 5/Jul. 74 - MSS Band 7/Jul.74
MSS Band 4/Oct. 73 - MSS Band 6/Oct. 73
MSS Band 4/Apr. 74 - MSS Band 6/Apr. 74

Equal prior probabilities were assumed for each category and a majority vote table look-up rule was used.

Mis/False Parameters			% Mis-identification	% False identification
β	α	# categories	error	error
0.0	0.1	8	48	68
0.0	0.1	6	48	43
.021	.3	6	44	46
.014	.2	6	47	43

A second step involved using the intersection table look-up rule with different band pairs.

Input Parameters			Band Pairs	%Mis-identification error	%False Identification error
β	α	# categories			
.021	.3	8	MSS band 4/Oct. 73-MSS band 4/Apr. 74, MSS band 6/Oct. 73-MSS band 6/Apr. 74	51	76
.021	.3	8	MSS band 5/Oct. 73-MSS band 5/Apr. 74, MSS band 7/Oct. 73-MSS band 7/Apr. 74	49	74
.021	.3	8	MSS band 4/Apr. 73-MSS band 4/Jun. 74, MSS band 7/Apr. 73-MSS band 6/Jun. 74,	50	72
.021	.3	8	MSS band 5/Apr. 74-MSS band 5/Jun. 74, MSS band 7/Apr. 74-MSS band 7/Jun. 74	49	72
.021	.3	8	MSS band 4/Jun. 74-MSS band 4/Jul. 74, MSS band 6/Jun. 74-MSS band 6/Jul. 74	46	69
.021	.3	8	MSS band 5/Jun. 74-MSS band 5/Jul. 74, MSS band 7/Jun. 74-MSS band 7/Jul. 74	45	68
.028	.4	4	MSS band 5/Apr. 74-MSS band 5/Jun. 74, MSS band 6/Jun. 74-MSS band 5/Jul. 74, MSS band 7/Jun. 74-MSS band 7/Jul. 74	41	17
.021	.3	4	MSS band 5/Apr. 74-MSS band 5/Jun. 74, MSS band 6/Jun. 74-MSS band 5/Jul. 74, MSS band 7/Jun. 74-MSS band 7/Jul. 74	43	18

In the last two experiments the categories wheat, grain sorghum, corn and summer fallow were retained. Most of the error occured due to mis-identification of summer fallow and grain sorghum. The principal components of the Rice image were found and the image date projected onto the principal axis. The error rate measure showed axis pairs 1-2, 1-3, and 2-3 would produce the least error. The minimum error from these trials was 26%.

Spatial post-processing was tried with the Rice image. This was a re-assignment of the categories based on geometric considerations. The first spatial operation on a category map was to change to reserve decision category assignments

of resolution cells whose neighbors differed. If a resolution cell has more than n neighboring resolution cells whose assignment is different, then its category assignment becomes reserved. This has the effect of eliminating small regions from the classified image. The shrunken map is then iteratively filled back assigning resolution cells of reserved decision to the categories of its nearest assigned neighbor. The shrink-fill operation typically increases classification accuracy. Note the decrease in error percentage with a shrink with a maximum of 1 dissimilar neighbor and a fill.

Bayes Type	Band Pairs	Bayes error mi:/false	filled	Number of Dissimilar Neighbors for Shrink Followed by 1 Fill 4	3	2	1	0
intersection table look-up rule	MSS band 5/Jul. 74-MSS band 7/Jul. 74 MSS band 4/Oct. 73-MSS band 4/Apr. 74 MSS band 4/Jun. 74-MSS band 4/Jul. 74	31/24	34/27	34/27	34/24	36/25	35/15	43/19
majority vote table look-up rule	MSS band 5/Jul. 74-MSS band 7/Jul. 74 MSS band 4/Oct. 73-MSS band 4/Apr. 74 MSS band 4/Jun. 74-MSS band 4/Jul. 74	35/28	36/29	36/29	35/22	35/18	35/17	39/16

Examples of contingency tables are given in Tables 3.1.1 and 3.1.2 for an image with no spatial processing and spatial processing with shrink and fill, respectively.

3.2 Supervised Discrimination of Saline County Image

The Saline county image was processed using fewer different parameters. There is some problem with the NASA date-to-date registration of this image set. This problem can be corrected at a later time. The error rate step selected the following band pairs as best for the discrimination step:

MSS band 4/Oct. 73-MSS band 6/Oct. 73
MSS band 4/Oct. 73-MSS band 4/Apr. 74
MSS band 4/Jul. 74-MSS band 6/Jul. 74

The errors are listed below.

CONTINGENCY TABLE FOR RICEBGCMB -19 RICEBGB13 - 1 SCALE FACTOR 10** 0

$\beta = .028$ $\alpha = .4$

COL = ASSIGN CAT ROW = TRUE CAT

R DEC	WHEAT	GSORG	CORN	SUFAL	TOTAL	#ERR	% ERR	% SD
UNKWN	3056	2188	795	348	110	6497	0	0	0
WHEAT	211	441	32	19	12	715	63	13	1
GSORG	192	106	211	7	3	519	116	35	1
CORN	136	2	11	259	0	408	13	5	0
SUFAL	60	41	20	0	22	143	61	73	4
TOTAL	3655	2778	1069	633	147	8282	253	31	0
#ERR	0	149	63	26	15	253	*****	*****	*****
% ERR	0	25	23	9	41	24	*****	*****	*****

Table 3.1.1 Contingency table for image with no spatial processing

CONTINGENCY TABLE FOR RICEBGCMB -19 RICEBG113 - 1 SCALE FACTOR 10** 0

$\beta = .028$ $\alpha = .4$

COL = ASSIGN CAT ROW = TRUE CAT

R DEC	WHEAT	GSORG	CORN	SUFAL	TOTAL	#ERR	% ERR	% SD
UNKWN	0	4581	1092	776	48	6497	0	0	0
WHEAT	0	681	21	13	0	715	34	5	0
GSORG	0	188	298	33	0	519	221	43	2
CORN	0	39	8	360	1	408	48	12	1
SUFAL	0	82	31	1	29	143	114	80	3
TOTAL	0	5571	1450	1183	78	8282	417	35	0
#ERR	0	309	60	47	1	417	*****	*****	*****
% ERR	0	31	17	12	3	15	*****	*****	*****

Table 3.1.2 Contingency table for image with spatial processing

Bayes Parameter β	α	% Mis-identification error	% False identification error
.028	.4	74	67
.0315	.45	73	70
.035	.5	71	72

The following categories were retained for processing: wheat, grass, corn, soybeans, non-agriculture and grain sorghum. Further work must be done to register the image correctly and try to improve the results.

3.3 Supervised Discrimination of Morton County Image

The Morton county image was processed along the steps outlined above. The error rate measure selected the following bands for further processing.

MSS band 5/May 9, 74-MSS band 7/May 9, 74
MSS band 5/May 27, 74-MSS band 7/May 27, 74
MSS band 5/Jul. 74-MSS band 7/Jul. 74

The Bayes decision rule used the following parameters with corresponding results.

Bayes Parameter β	α	% Mis-identification error	% False identification error
.0245	.35	25	16
.028	.40	27	18
.0315	.45	28	20
.035	.50	29	22
.0385	.55	28	23
.042	.7	29	26

The categories wheat, grass, corn, summer fallow, grain sorghum and rye were retained for processing. Most of the error occured in discriminating grain sorghum and rye.

The contingency table for the first entry is shown below.

CONTINGENCY TABLE FOR MORTBGCMB -23 MORTSGBYO - 1 SCALE FACTOR 10** 0

$\beta = .0245$ $\alpha = .35$

COL = ASSIGN CAT ROW = TRUE CAT

R DEC	WHEAT	GRASS	CORN	SUFAL	GSORG	RYE	TOTAL	#ERR	% ERR	% SD
UNKWN 8593	2085	505	141	1392	72	17	12805	0	0	0
WHEAT 1931	1962	1	0	89	0	2	3985	92	4	0
GRASS 529	7	490	0	2	0	0	1028	9	2	0
CORN 541	4	0	175	6	14	0	740	24	12	0
SUFAL 1583	9	3	5	1521	2	4	3127	23	1	0
GSORG 194	1	0	2	10	13	0	220	13	50	1
RYE 161	27	0	0	47	0	16	251	74	82	2
TOTAL 13532	4095	999	323	3067	101	39	22156	235	25	0
#ERR 0	48	4	7	154	16	6	235	*****	*****	*****
% ERR 0	2	1	4	9	55	27	16	*****	*****	*****

The nine best bands selected by the error rate program were used for principal components. In addition to those listed above MSS band 4/Jul. 74, MSS band 6/Jul. 74 and MSS band 5/Oct. 73 were used. The first three principal component axes were used for Bayes discrimination. The results are below.

Bayes Parameters		% Mis-identification error	% False identification error
β	α		
.028	.4	40	35
.0315	.45	40	38
.035	.5	40	38

The principal component results do not show any improvement over using the raw data image. Further work will be in the areas of using the shrink-fill operation to improve accuracy and finding the error measure for the principal component image.

3.4 Supervised Discrimination of Finney County Image

The last site processed was that occuring in Finney county. Again the steps outlined above were followed for this site. The error rate measure selected the following band pairs.

MSS band 5/Oct. 73-MSS band 7/Oct. 73

MSS band 5/Apr. 74-MSS band 7/Apr. 74

MSS band 5/Jul. 74-MSS band 7/Jul. 74

Five categories were retained for the Finney image: wheat, grass, corn, summer fallow and grain sorghu. The image was processed with the Bayes discrimination rule with the following results:

Bayes Parameters		% Mis-identification error	% False identification error
β	α		
.0245	.35	25	18
.028	.4	26	18
.0315	.45	24	18
.035	.5	24	18
.0385	.55	21	20

Following is the contingency table for the first entry above.

CONTINGENCY TABLE FOR FINNAGCNT -23 FINNAGBY1 = 1 SCALE FACTOR 10** 0

β = .0245 α = .35

COL = ASSIGN CAT ROW = TRUE CAT

R DEC	WHEAT	GRASS	CORN	SUFAL	GSORG	TOTAL	#ERR	% ERR	% SD
UNKWN 19483	2063	621	2501	158	606	25432	0	0	0
WHEAT 975	706	9	10	3	6	1709	28	4	0
GRASS 605	5	123	16	1	6	756	28	19	0
CORN 1230	25	9	1017	6	16	2303	56	5	0
SUFAL 505	5	12	21	26	3	572	41	61	1
GSORG 637	8	0	42	0	77	764	50	39	0
TOTAL 23435	2812	774	3607	194	714	31536	203	25	0
#ERR 0	43	30	89	10	31	203	*****	*****	*****
% ERR 0	6	20	8	28	29	18	*****	*****	*****

The above six bands were used for principal component analysis and the error rate measure used to select the best principal axis pairs. The selected axes pairs were:

1-3

1-4

2-4

Using these pairs with the Bayes process produced the following:

Bayes Parameters β	α	# categories	% Mis-identification error	% False identification error
.028	.4	5	50	36
.0315	.45	5	48	51
.035	.5	5	48	51

Clearly the principal components has not improved over the raw data.

3.5 Supervised Discrimination Summary

The supervised discrimination process has shown poor results so far. Part of the cause may be poor date-to-date and ground truth to image registration. An attempt was made to reduce the effect of mis-registration by shrinking the ground truth regions.

The processing has shown the temporal data to be important, typically choosing images from October, April-May and July for best results. The red (MSS 5) and second Infrared (MSS 7) bands seem to produce the best results.

The Bayes pattern discrimination process has shown wheat to be fairly well classified in all instances (see contingency tables) and grain sorghum tends to be confused with corn, wheat and summer fallow. Summer fallow is confused with almost every other category.

Initial studies with the geometric category modification, shrink-fill, show a decrease by as much as 9% in the error percentage. Further work will be done in this area.

4.0 UNSUPERVISED CLUSTERING

Because of the high error rate in the misclassification of summer fallow and grain sorghum crop types, some unsupervised clustering was performed on four of the LACIE test sites. As the term implies, unsupervised clustering allows the processing of data without apriori knowledge of the ground truth for the area. After the clustering is done, an analysis can be made to see which group corresponds to which category. As a lot of summer fallow fields were being classified as wheat, the ground truth for some of the test sites was a suspect. A study using unsupervised clustering would allow us to check if the spectral signatures of these fields were similar or not. As yet a quantitative analysis has not been done yet, but Figures 4.1a and 4.1b show us a qualitative result of clustering on the Rice and Saline test sites.

In order to understand the clustering process, a brief description of the program follows. The clustering is really done in two steps. In the first section, spatial clustering is performed to determine spectrally homogenous areas in the image. This part of the process involves generating the gradient image, which emphasizes the boundaries. The gradient image is then thresholded. The resolution cells comprising the interior of a field have similar spectral signatures, and thus form a homogenous area. In the gradient image this shows up as low values. On the other hand, at the boundaries of the fields there is large variation in the signature, which corresponds to high gradient values. Thus by single level thresholding of the gradient image and some noise cleaning it is possible to determine the homogenous regions in the image.

The second stage involves the clustering of the homogenous areas which have similar signature. The similarity of signatures is measured by the Eucledian distance function in the multidimensional space defined by the ERTS bands of the original image. This is an iterative process. In each iteration the clusters from the previous iteration are reduced to a smaller number by further grouping, depending on some control parameters that the user enters.

In addition to the functions described in the previous paragraphs, some preprocessing functions like quantization and contrast enhancing were also performed on the image. These tend to improve the result of the spatial clustering routines.

In the processing of the LACIE test sites two points emerged which bear special mention. The first is directly related to the accuracy of the spatial clustering process. The gradient function is defined to operate on a multi-band image, as each of the test site images are. However, using all the bands on all the dates would give a poor result, unless registration of these bands is exact. This certainly is not the case. The IDECS display facilities allows one to compare different bands and/or dates by flickering from one image to another. On doing so, it was seen that on the average the registration was off by one to two cells, between dates. However, using bands from one date only, though it gives a passable result, does not make use of the additional information that is there. For example, using pre and post wheat harvest dates gives a much better definition of the field boundaries than just one of the dates. Also MSS bands 5 and 7 have a better spatial definition than bands 4 or 6. Thus keeping these points in mind one has to compromise by using as few bands as possible, to minimize registration error, but nevertheless pick enough bands from suitable dates.

The second fact that emerged from this study was that by doubling every resolution cell vertically and horizontally, the result is enhanced considerably. Two sets of clustering were done on the Saline image. One on the original image, while the second on an image which had been expanded by a factor of two both horizontally and vertically. This increased the spatial sampling by a factor of four. It was found that the spatial clustering not only picked up more fields, but the shapes of the fields were better. While this process increases the execution time on the computer, it is of value to work with the expanded image and also to find out if even larger sampling size helps much more or not.

4.1 Unsupervised Clustering of Rice County Image

The spatial clustering for the Rice image was done in quite a different manner than for Morton, Saline and Finney. Instead of using the quantized ERTS bands as data for the process, the first four bands of the spatially expanded principal component image of Rice county were taken. Further a two by two cell rectangular convolution was performed on the image. This was then followed by the clustering steps described above. The spatial clustering generated 155 spectrally homogenous regions which were then clustered down to 17 groups in 8

iterations. Spatial generalization was then performed using the FILL command in KANDIDATS. This involves assigning of labels to unclassified cells based on the category assignments of their neighbors. The final image was compressed by a factor of 2, both horizontally and vertically, to bring it back to its original size. Figure 4.1a shows as this result, as photographed from the IDECS display. Because of lack of contrast on the screen, it is not possible to see all the 17 categories on the photograph. It only serves to give a qualitative idea of the product. For a quantitative analysis either the color display is used, or a line printer map of the region is generated.

4.2 Unsupervised Clustering of Saline County Image

The Saline test site image consists of images registered over three dates as given in Appendix D. For the spatial clustering part only MSS bands 5 and 7 of the July date were chosen. This was because the registration between dates did not seem adequate. For the one date, it was felt that the post harvest picture would be best for showing the fixed boundaries. This process resulted in 506 homogenous regions for the spatially expanded image. This does not mean that there are 506 fields in the image. It is likely that different parts of a field have different signatures, and therefore come up as different regions. This is no problem however, for if the signatures are close enough, the corresponding regions will be put together during the clustering process.

The Euclidean space clustering brought the 506 regions down to 21 classes in 7 iterations. Figure 4.1b shows this image after spatial generalization and compression.

4.3 Unsupervised Clustering of Morton County Image

The Morton county image was also clustered twice. In both cases, spatially expanded images were used. For the first process MSS bands 5 and 7 of the May 9th and July 2nd dates (Appendix C) were chosen, while in the second run MSS bands 5 and 7 of the October and July dates were chosen. In addition a 2x2 convolution was also applied to the data before processing. The spatial results of the two processes were considerably different. The first one yielded 225 regions, while the second gave 607. It is felt this difference

was due to the different dates used. The wheat fields show up quite different on the pre and post harvest images of the second run, than they do in the first. This supports the idea that a judicious choice of dates is important.

For the measurement or Euclidean space clustering for the first run, MSS bands 5 and 7 of May 9th and July 2nd dates were used. However, for the second run bands 5 and 7 for all five dates were used to describe the spectral signature. It should be noted here that any misregistration between dates is not critical for this operation. We are only looking at cells which define the interior or homogenous parts of regions, and not cells at the boundaries, where registration is essential.

For the two runs, 225 and 607 regions were reduced to 35 and 23 classes in 3 and 10 iterations, respectively. Unfortunately, photographs of these two images are not available in time to put in this quarterly report.

4.4 Unsupervised Clustering of Finney County Image

The clustering on the Finney image was performed in a similar manner as the second clustering run for the Morton image. The homogenous region image was obtained using spatially expanded MSS bands 5 and 7 of the October and July dates (Appendix E). This yielded 1148 homogenous regions. For the second stage the signature selection was made from MSS bands 5 and 7 for all five dates. The 1148 regions were grouped into 29 classes in 10 iterations. Photographs of the clustered results were not available in time to put them in this quarterly report.

4.5 Clustering Summary

Spatial clustering has been done for four of the five intensive test sites. A detailed analysis of the clustering results and a comparison of them with the NASA supplied ground truth will be done during the next quarter.

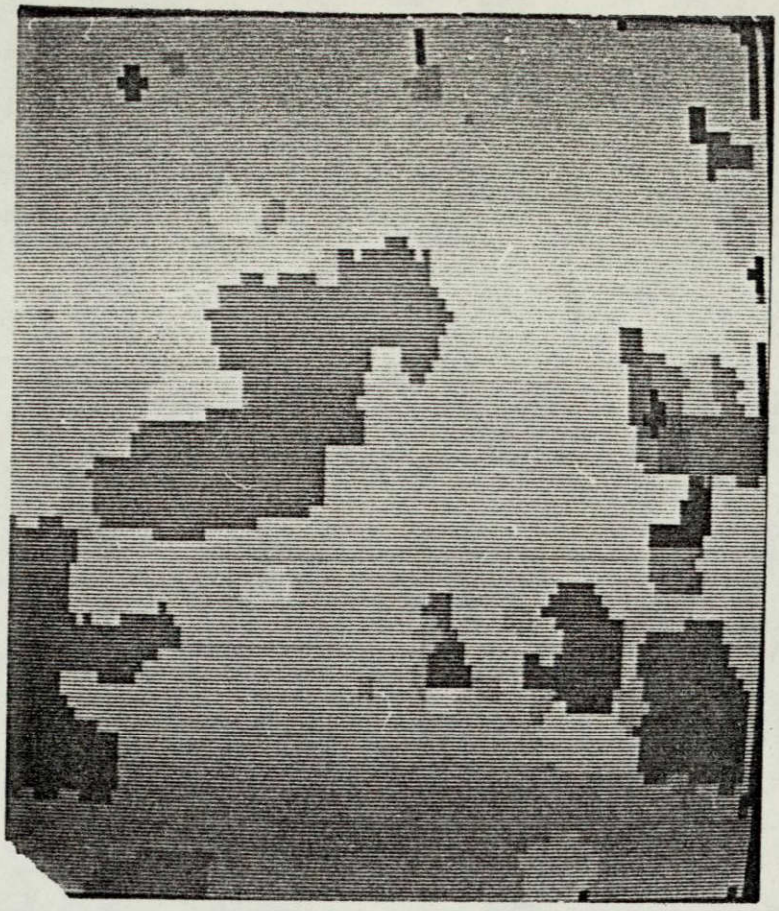


Figure 4.1a

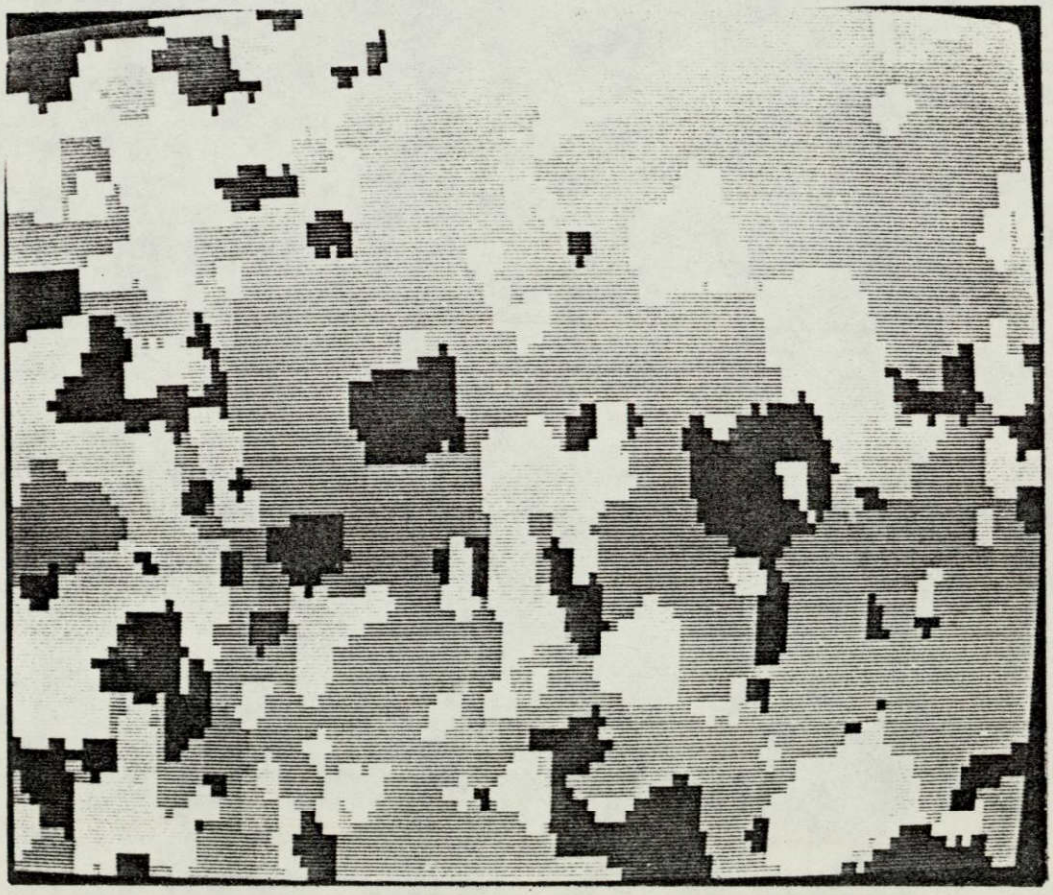


Figure 4.1b

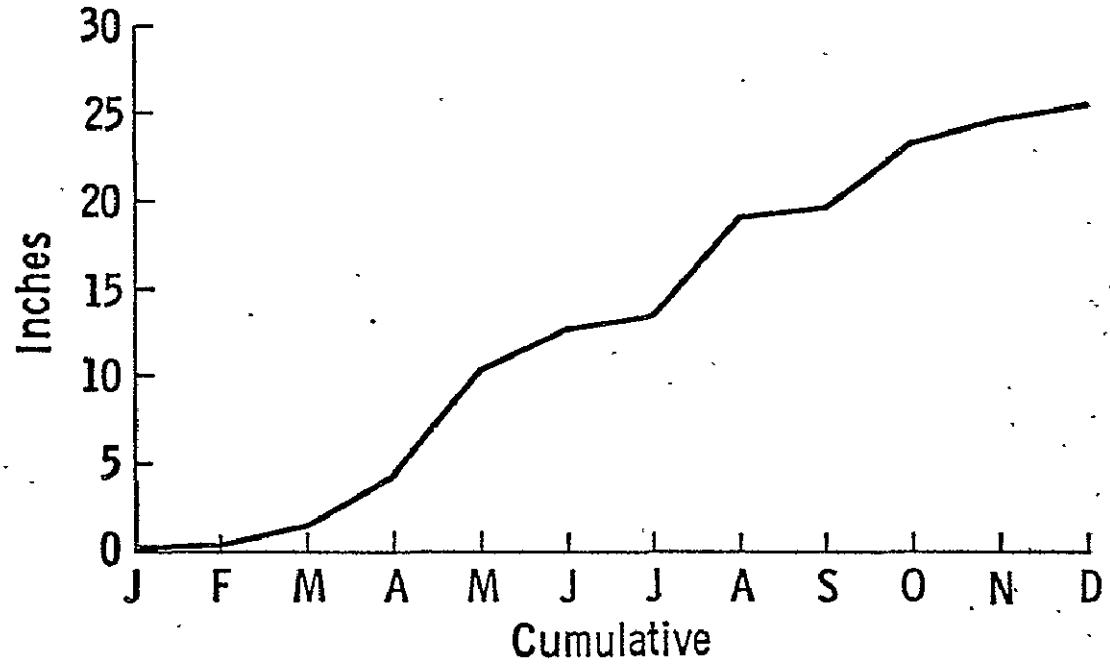
APPENDIX A1

TEST SITES' COORDINATES

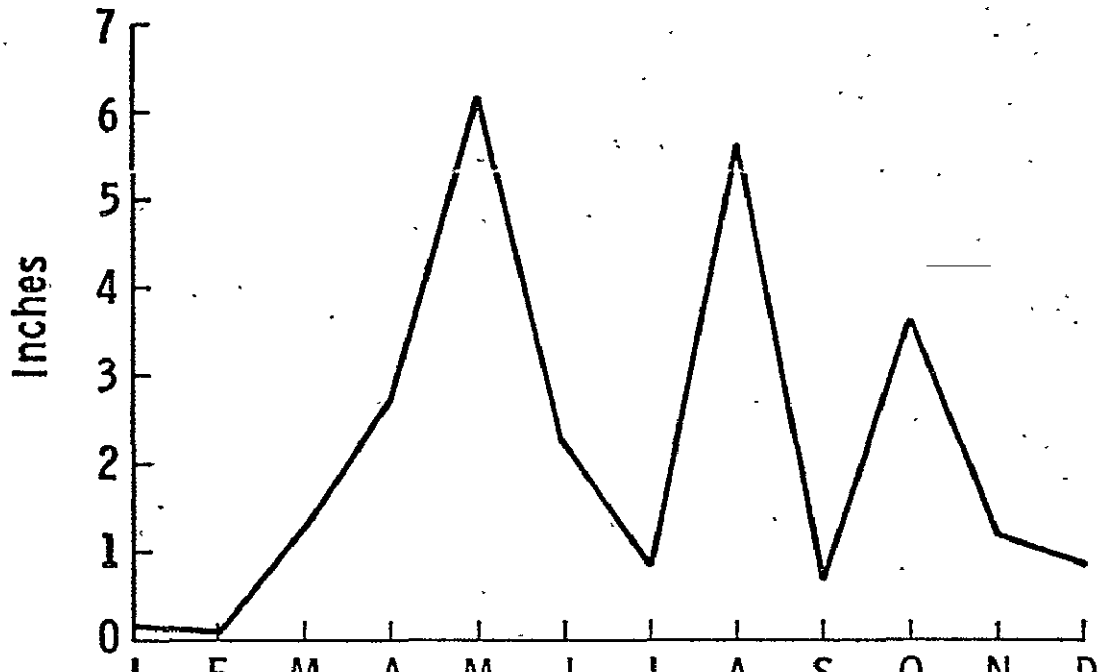
Counties		Corners of Sites NW	NE	SW	SE
Rice	Lat.	38°18'	38°18'	38°15'	38°15'
	Long.	98°14'	98°11'	98°14'	98°11'
Morton	Lat.	37°18'	37°18'	37°13'	37°13'
	Long.	101°55'	101°49'	101°55''	101°49'
Saline	Lat.	38°531	38°53'	38°51'	38°51'
	Long.	97°30'	97°27'	97°30'	97°27'
Finney	Lat.	38°06'	38°06'	38°02'	38°02'
	Long.	101°05'	100°58'	101°05'	100°58'
Ellis	Lat.	38°51'	38°51'	38°48'	38°48'
	Long.	99°14'	99°11'	99°14'	98°11'

APPENDIX A2

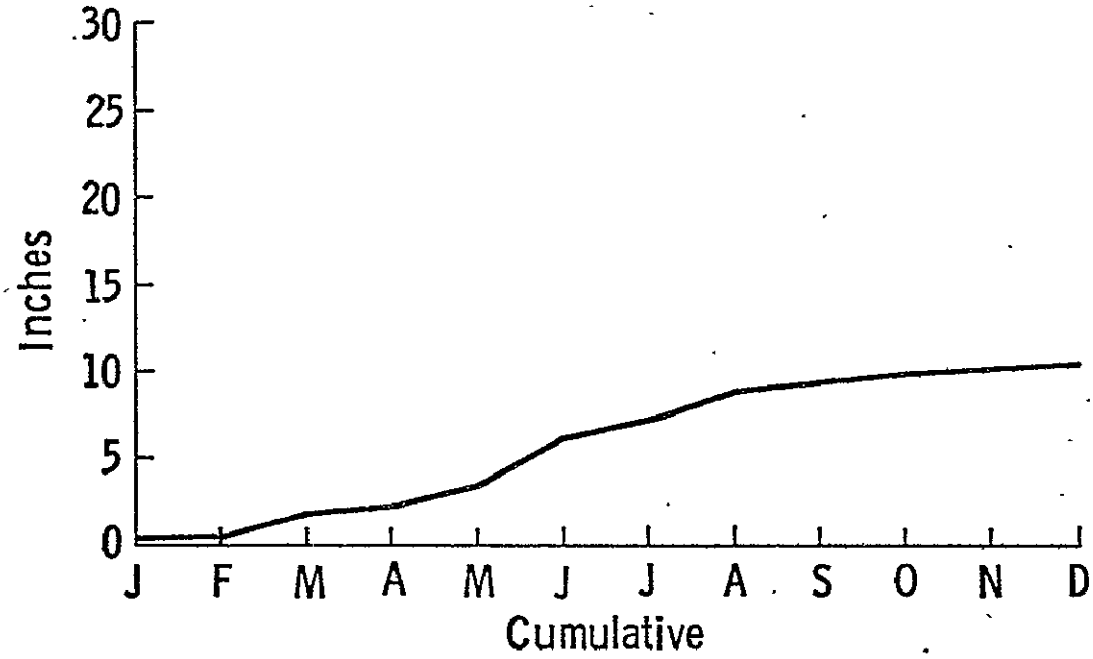
l temperature graphs for 1974 for the five test sites.



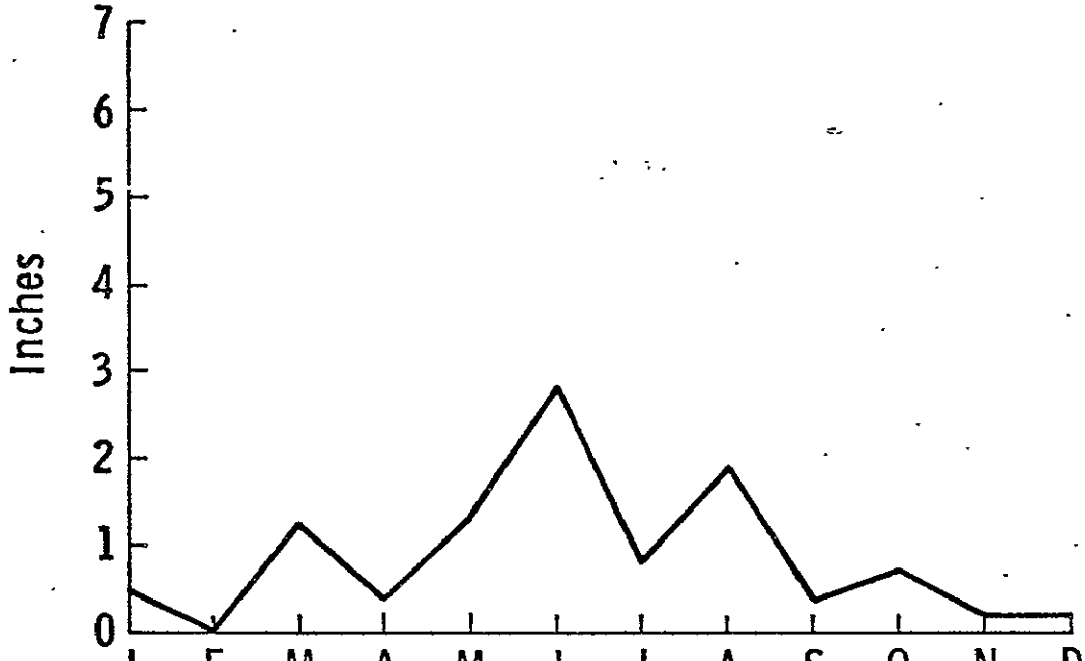
Cumulative



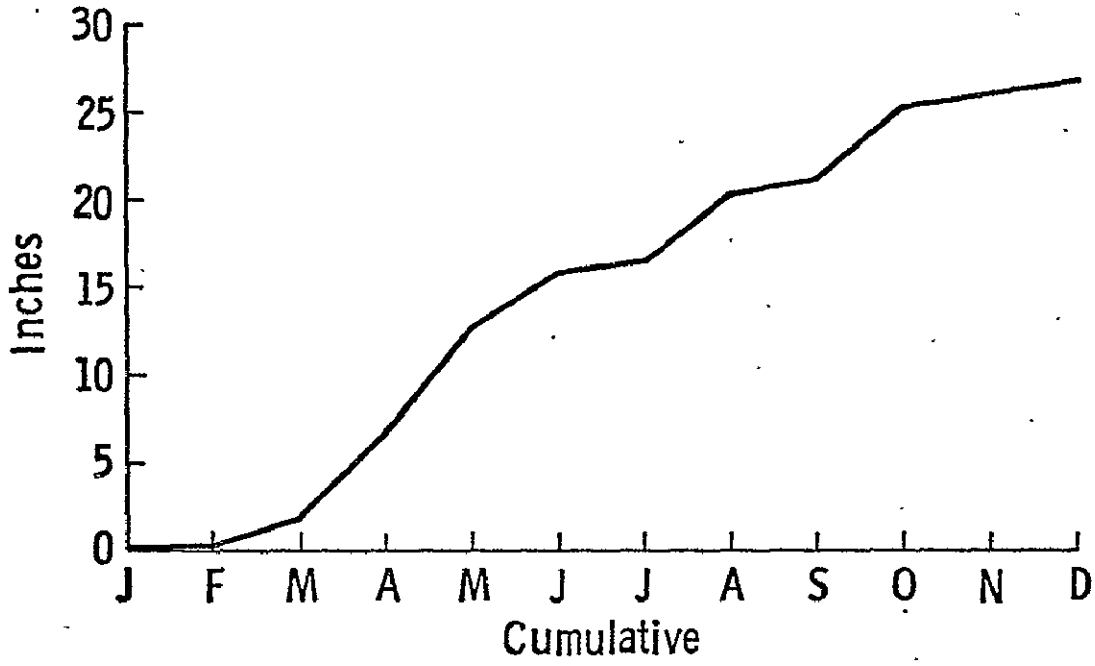
Precipitation, 1974, Rice County



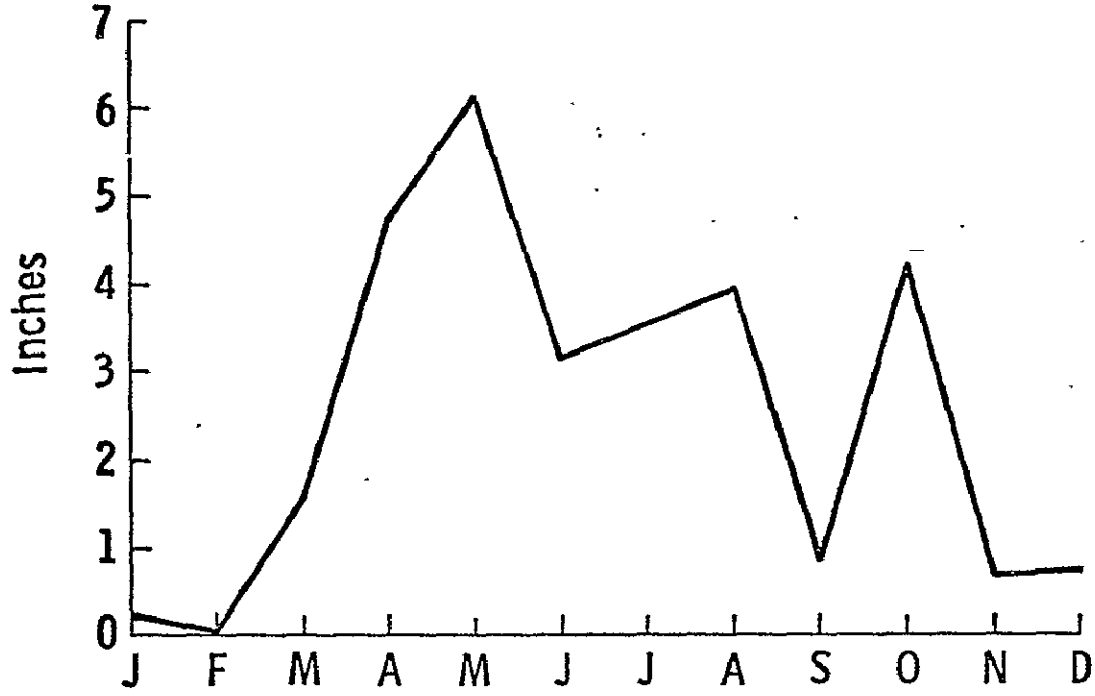
Cumulative



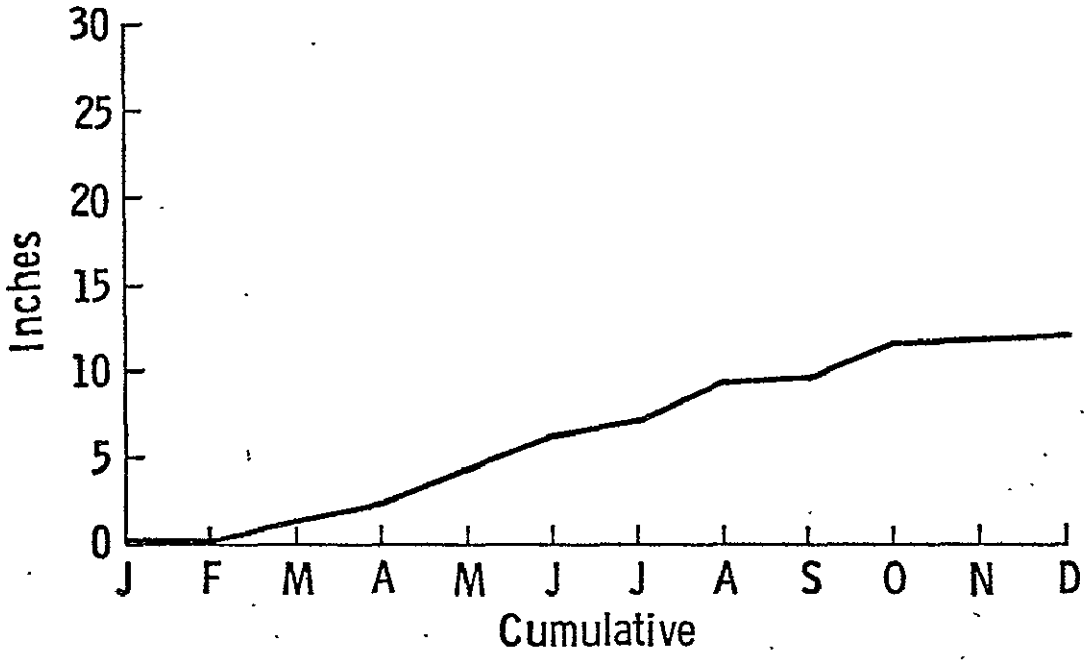
Precipitation, 1974, Morton County

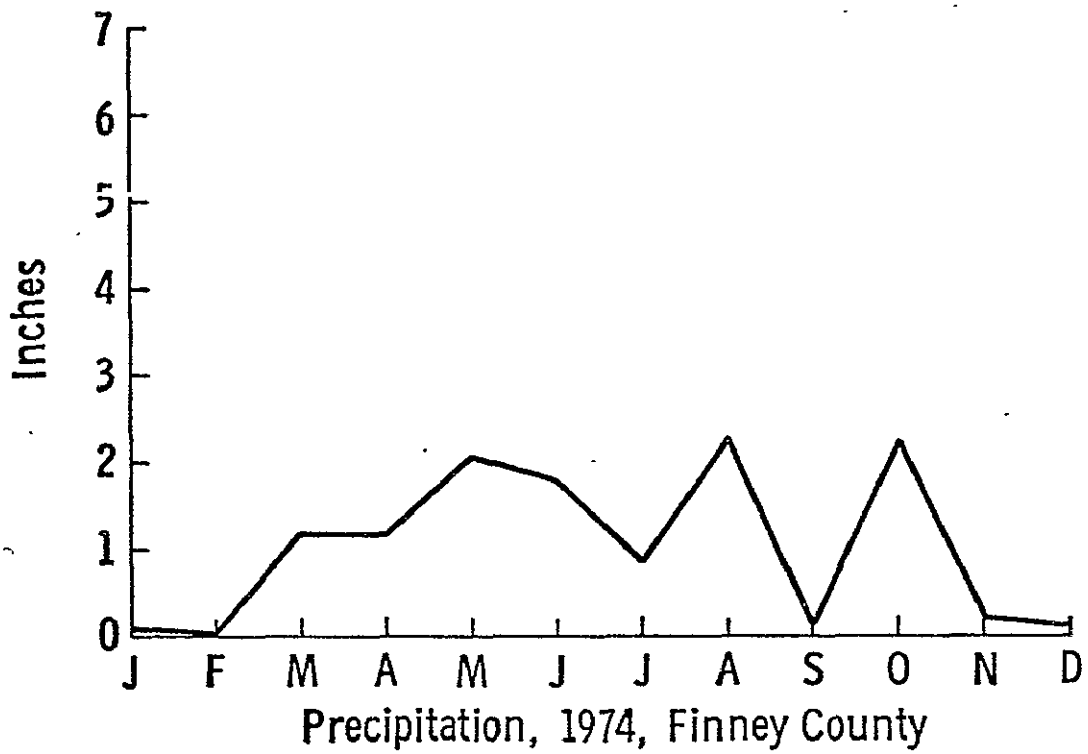


Cumulative

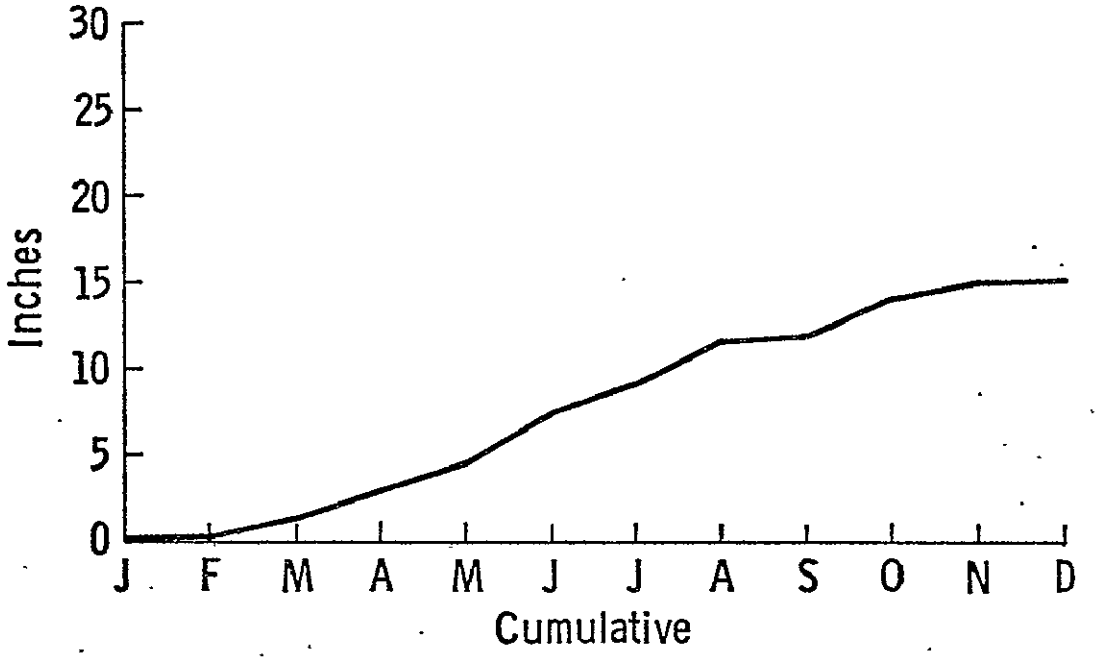


Precipitation, 1974, Saline County

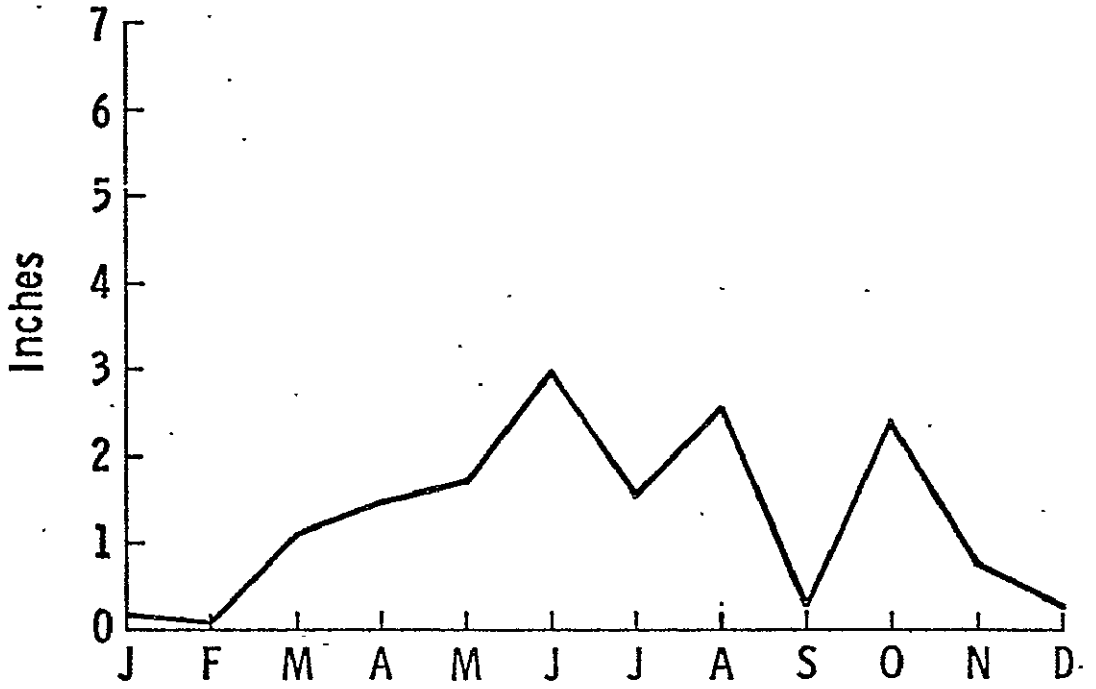




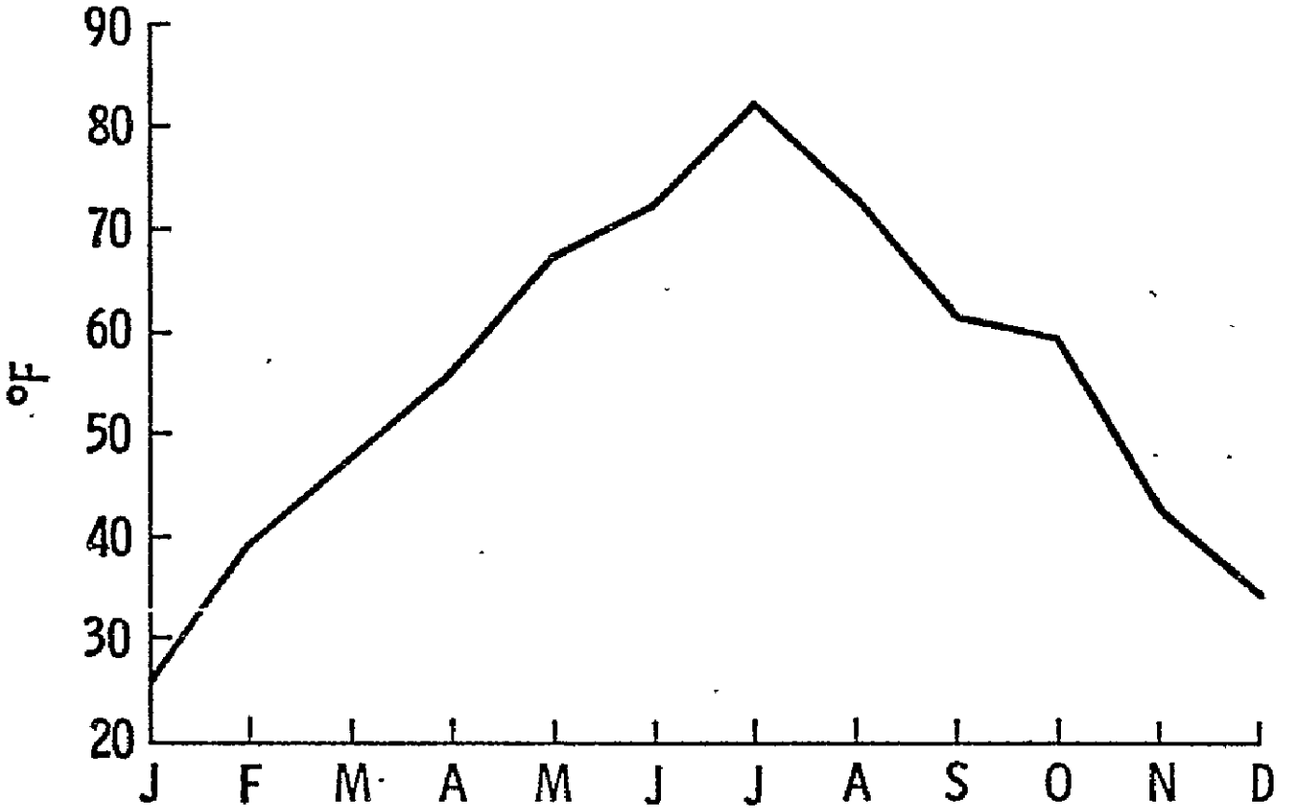
Precipitation, 1974, Finney County



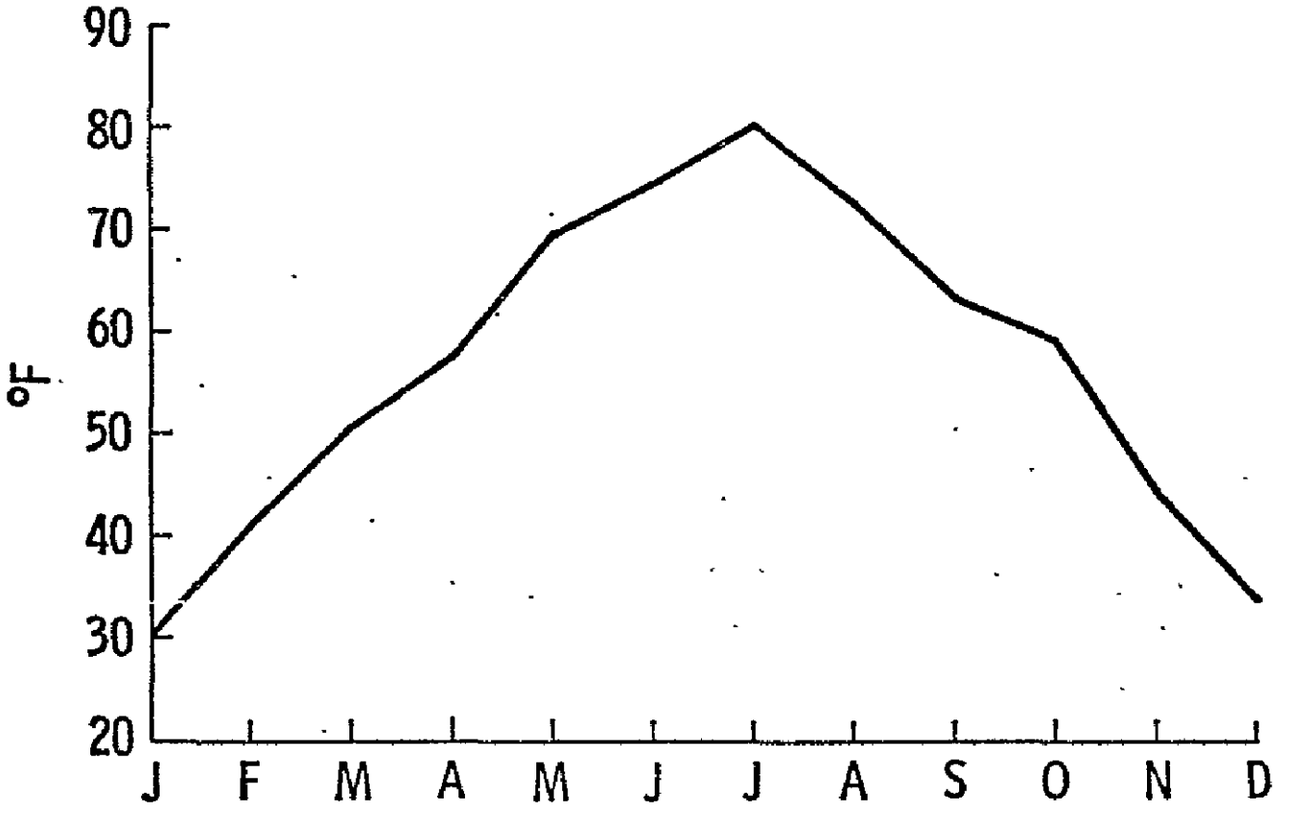
Cumulative



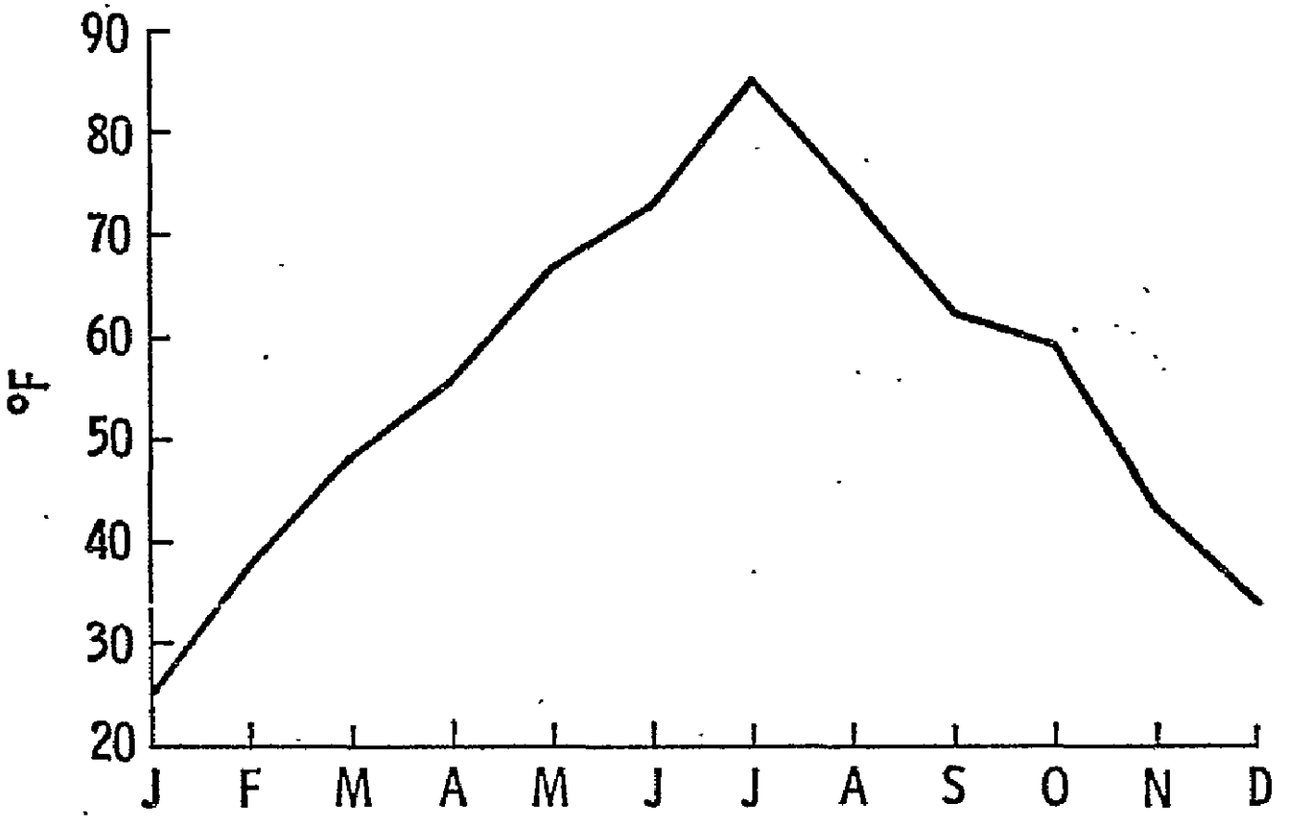
Precipitation, 1974, Ellis County



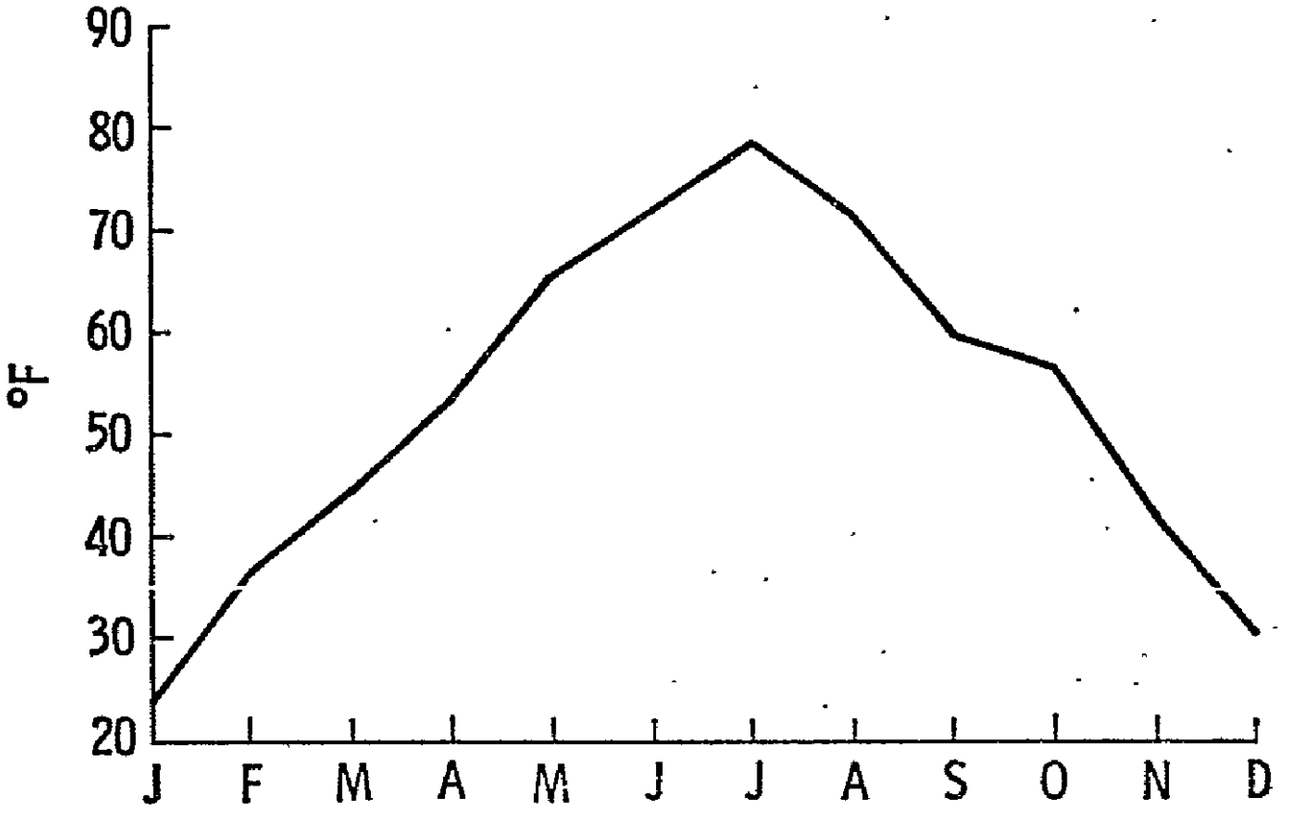
Average Temperatures, 1974, Rice County



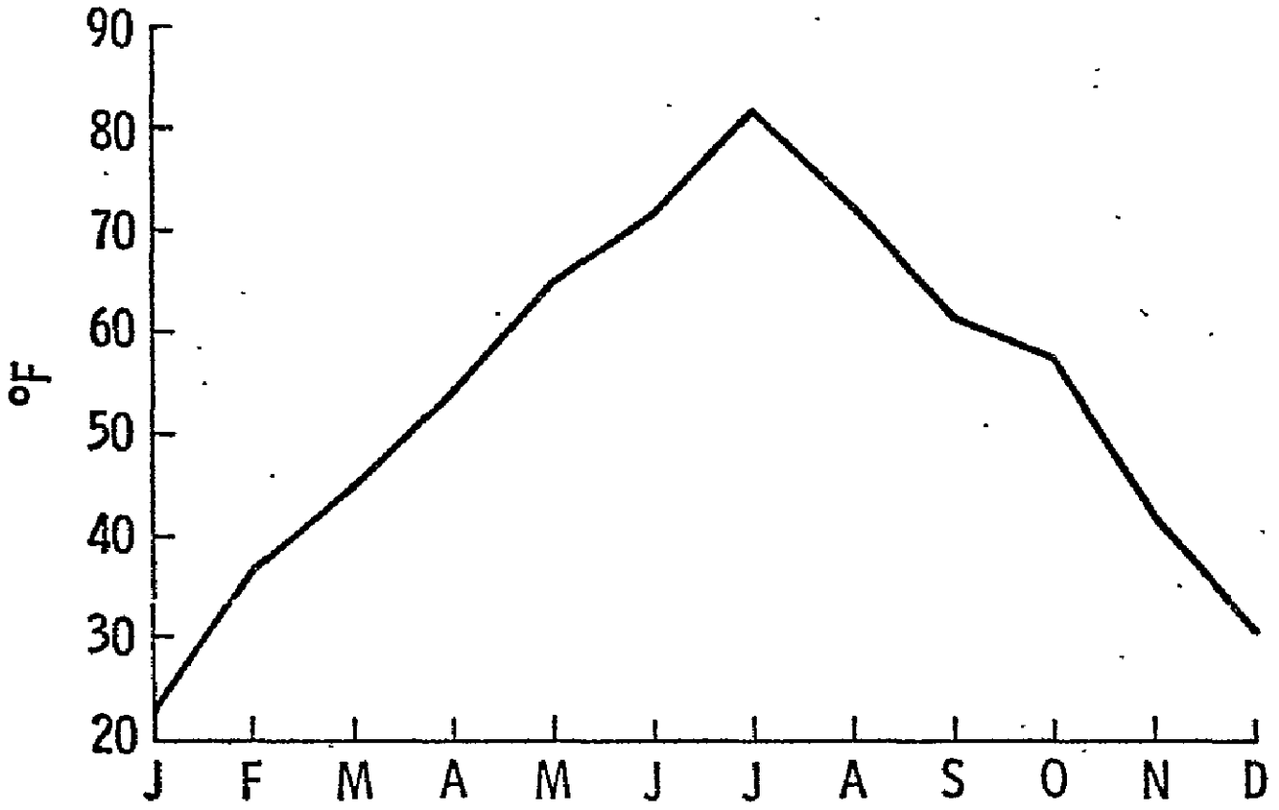
Average Temperatures, 1974, Morton County



Average Temperatures, 1974, Saline County



Average Temperatures, 1974, Finney County



Average Temperatures, 1974, Ellis County

APPENDIX B

Rice County LACIE Intensive Study Site

Computer compatible tape coordinates

FR 230 LR 429

FC 230 LC 429

16 Bands of ERTS data from 4 dates:

October 21, 1973

April 18, 1974

June 12, 1974

July 18, 1974

ERTS observation ID's:

1455-16432 [reference scene]

1634-16344

1689-16382

1725-16374

Rotation and distortion parameters for ground truth bands to overly ERTS bands.[1]

+ 16.5° Rotation

Vertical Stretch .0875 pel/pel at upper left.

Horizontal Stretch .05714 pel/pel at upper left.

Soil types taken from map of Rice County reconnaissance soil conservation survey from Soil Conservation Service, Washington, D. C., 1946.

Crop types were identified from land use data collected by ASCS, June, 1974, prepared by FSO, Cartographic Laboratory Earth Observation Division, S&AD JSC/NASA, Houston, Texas, September 1974.

APPENDIX BB1

Discriminant Analysis of RICE County Using Original Raw Data

```
BMDP7M  =  STEPWISE DISCRIMINANT ANALYSIS;
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED;


   PROGRAM CONTROL INFORMATION
PROBLEM TITLE = 'RICE CO SAMP, 1;',/
INPUT
    VARIABLE = 20,
    FORMAT = '(2A5,12F5.0/6F5.0)',
    CASE = 660,
    UNIT = 12,/
VARIAB ADD = 1,
     NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
      'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4',
      'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL',
   USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,
   LABEL = 1,2,
   GROUP = 'CROP TYP',/
GROUP CODE = 1,2,3,4,5,8,
    NAME = 'WINTWHET','GRASS','CORN','SUMFALO',
           'NON AGR','GRASORG',/
TRANSFORMATION
   X(21) = X(19)*X(20),/
SAVE
  UNIT = 10,
  CODE = 'RICE CO',
  LABEL = 'RICE CO SAMPLE 1 RAW DATA',/
PRINT STEP,
    CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,/
PLOT CANON,
   GROUP = 1,2,3,4,5,8,
  GROUP = 1,2,3,4,8,/
DISCRIMINANT METHOD = 2,
    FORCE = 0,
    STEP = 40,
    JACK,/
END/


   PROBLEM TITLE . . . . . RICE CO SAMP, 1.

   NUMBER OF VARIABLES TO READ IN. . . . . 20
   NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. . 1
   TOTAL NUMBER OF VARIABLES . . . . . 21
   NUMBER OF CASES TO READ IN. . . . . 660
   CASE LABELING VARIABLES . . . . . ROW  COLUMN
   LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
   INPUT UNIT NUMBER . . . . . 12
   REWIND INPUT UNIT PRIOR TO READING. . DATA. . . YES

   INPUT FORMAT
         (2A5,12F5.0/6F5.0)
```

```
INTERPRETIVE TRANSFORMATIONS ARE

     CROP*SOL = CROP TYP * SOIL TYP.

  VARIABLES TO BE USED
                3  B4D1        4  B5D1        5  B6D1        6  B7D1        7  B4D2
                8  B5D2        9  B6D2       10  B7D2       11  B4D3       12  B5D3
               13  B6D3       14  B7D3       15  B4D4       16  B5D4       17  B6D4
               18  B7D4       20  SOIL TYP

  TOLERANCE. . . . . .  0.010
  F-TO-ENTER . . . . .  4.000
  F-TO-REMOVE. . . . .  3.996
  METHOD . . . . . .  2
  MAXIMUM FORCED LEVEL . .  0
  MAXIMUM NUMBER OF STEPS.  40
  PRIOR PROBABILITIES. . .  0.16667  0.16667  0.16667  0.16667  0.16667  0.16667

                    BEFORE TRANSFORMATION                          INTERVAL RANGE
  VARIABLE          MINIMUM    MAXIMUM    MISSING    CATEGORY  CATEGORY    GREATER    LESS THAN
  NO.  NAME         LIMIT      LIMIT      CODE       CODE      NAME        THAN       OR EQUAL TO

  19   CROP TYP                                                1.00000   SPRNGWHT
                                                               2.00000   GRASS
                                                               3.00000   CORN
                                                               4.00000   SUMFALO
                                                               5.00000   NON AGR
                                                               6.00000   GRASORG

  FILE TO WRITE SAVE FILE ONTO IS NOT A SAVE FILE.

  NUMBER OF CASES READ. . . . . .  660
```

Note: In this appendix and others that follow, the following notation is used --
B4D1 stands for MSS Band 4 on Date 1, B5D2 stands for MSS Band 5 on Date 2, etc.

MEANS

VARIABLE	GROUP #	WINTWHET	GRASS	CORN	SUMFALC	NON AGR	GRASORG	ALL GP
3	B4D1	25,50633	22,81250	22,47059	22,48077	21,71429	23,09170	23,77727
4	B5D1	24,66245	19,93750	20,23529	19,59615	18,71429	20,48035	21,83636
5	B6D1	29,10127	27,31250	23,22689	24,84615	22,71429	26,03493	26,53182
6	B7D1	14,78059	11,43750	11,42017	12,80769	11,85714	13,39738	13,50000
7	B4D2	34,67089	34,93750	34,95798	35,76923	33,00000	36,91266	35,57576
8	B5D2	33,84388	35,00000	36,85714	36,09615	33,14286	39,02620	36,38333
9	B6D2	49,47257	45,93750	40,39496	47,38461	48,71429	47,51965	46,91000
10	B7D2	26,54008	24,75000	20,35294	24,50000	26,00000	24,10044	24,36818
11	B4D3	32,85654	31,87500	31,12605	33,63461	33,71429	35,72726	33,59788
12	B5D3	32,75949	28,81250	27,69748	34,55769	34,14286	37,77729	33,64848
13	B6D3	38,79747	41,75000	43,38655	38,48077	39,57143	42,53712	40,97727
14	B7D3	18,59916	20,37500	22,48739	18,11538	18,71429	20,17031	19,85152
15	B4D4	39,45992	35,37500	30,27731	39,05769	37,42857	36,37555	36,59182
16	B5D4	43,65401	35,31250	24,63025	42,55769	41,28571	37,80349	37,88030
17	B6D4	48,91561	44,81250	52,45378	46,80769	44,85714	45,52402	48,04848
18	B7D4	23,86920	22,81250	30,42857	22,50000	21,71429	22,61135	24,45909
20	SOIL TYP	2,43038	2,31250	2,51261	2,46154	2,42857	2,29258	2,39697
19	CROP TYP	1,00000	2,00000	3,00000	4,00000	5,00000	8,00000	4,09242
COUNTS		237,	16,	119,	52,	7,	229,	660,

STANDARD DEVIATIONS

VARIABLE	GROUP #	WINTWHET	GRASS	CORN	SUMFALC	NON AGR	GRASORG	ALL GP
3	B4D1	4,88392	3,69177	3,58985	2,33885	2,75162	3,44701	3,97254
4	B5D1	7,55741	5,84772	5,43483	4,16926	3,25137	5,42378	6,13935
5	B6D1	7,30671	6,70044	6,96777	4,10349	4,23140	6,33970	6,67413
6	B7D1	3,74652	4,04918	4,39857	2,58228	2,79455	3,79106	3,81276
7	B4D2	4,32294	2,64496	4,26733	4,75937	5,53775	4,53942	4,46696
8	B5D2	8,17013	5,05964	7,22318	8,49010	9,92352	8,77093	8,21174
9	B6D2	6,22021	6,28722	6,32926	6,04283	4,30946	6,47097	6,70836
10	B7D2	4,57002	4,58258	4,37556	4,01712	5,16398	4,05591	4,32558
11	B4D3	4,88647	2,70493	3,50195	5,15649	5,52914	5,47210	4,87750
12	B5D3	8,44104	5,02266	6,28363	9,26150	8,09174	10,02489	8,70289
13	B6D3	8,12046	6,65833	6,60009	7,94217	6,75419	8,82404	8,07194
14	B7D3	4,47025	4,09675	3,93779	3,93403	3,45033	4,75282	4,42841
15	B4D4	4,56630	3,32415	3,56519	4,84884	3,73529	4,43160	4,34497
16	B5D4	8,23480	6,03013	7,18150	8,48161	6,65117	8,26803	8,02854
17	B6D4	7,22704	6,15596	6,07125	5,98764	6,36209	7,13931	6,87773
18	B7D4	3,98989	4,69352	5,16601	2,83169	3,25137	3,89509	4,13336
20	SOIL TYP	0,63145	0,47871	0,50195	0,64051	0,53452	0,56738	0,58433
19	CROP TYP	0,	0,	0,	0,	0,	0,	0,

STEP NUMBER 0

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 5 655		*		DF= 5 654		
			*	3 S4D1	14,593	1	1,000000
			*	4 S5D1	15,643	1	1,000000
			*	5 S6D1	14,280	1	1,000000
			*	6 S7D1	13,261	1	1,000000
			*	7 S4D2	7,246	1	1,000000
			*	8 S5D2	9,678	1	1,000000
			*	9 S6D2	29,963	1	1,000000
			*	10 S7D2	32,867	1	1,000000
			*	11 S4D3	16,353	1	1,000000
			*	12 S5D3	23,037	1	1,000000
			*	13 S6D3	9,354	1	1,000000
			*	14 S7D3	14,196	1	1,000000
			*	15 S4D4	74,686	1	1,000000
			*	16 S5D4	93,452	1	1,000000
			*	17 S6D4	18,035	1	1,000000
			*	18 S7D4	63,221	1	1,000000
			*	20 SOIL TYP	2,747	1	1,000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1 BAND 7 October 21, 1973

VARIABLE	DF	F TO REMOVE 5 649	LEVEL	*	VARIABLE	DF	F TO ENTER 5 648	LEVEL	TOLERANCE
4 B5D1		7,956	1	*	3 B4D1		0,602	L	0,091205
6 B7D1		4,899	1	*	5 B6D1		0,374	L	0,061799
10 B7D2		7,143	1	*	7 B4D2		2,343	L	0,756391
12 B5D3		17,955	1	*	8 B5D2		2,936	L	0,712985
16 B5D4		34,177	1	*	9 B6D2		2,290	L	0,158665
18 B7D4		53,201	1	*	11 B4D3		2,018	L	0,078758
				*	13 B6D3		2,189	L	0,461416
				*	14 B7D3		2,041	L	0,600939
				*	15 B4D4		0,847	L	0,091606
				*	17 B6D4		1,186	L	0,035686
				*	20 SOIL TYP		2,187	L	0,855998

U-STATISTIC OR WILKS' LAMBDA 0,3060451 DEGREES OF FREEDOM 6 5 654
APPROXIMATE F-STATISTIC 29,832 DEGREES OF FREEDOM 30,00 2598,00

F - MATRIX DEGREES OF FREEDOM = 6 649

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4,04				
CORN	141,99	19,83			
SUMFAL	6,82	4,41	72,81		
NON AG	1,52	1,73	14,41	0,41	
GRASOR	22,90	4,48	127,45	5,02	0,97

CLASSIFICATION FUNCTIONS

GROUP = VARIABLE	WINTWHET	GRASS	CORN	SUMFALL	NON AGR	GRASORG
4 B5D1	0,05471	-0,05205	0,17085	-0,06963	-0,07325	0,01566
6 B7D1	0,26827	0,42131	0,05637	0,21681	0,14272	0,18968
10 B7D2	0,71167	0,74985	0,45993	0,63081	0,78107	0,66649
12 B5D3	0,32629	0,25816	0,26652	0,36275	0,36743	0,40761
16 B5D4	0,40827	0,29537	0,12883	0,46064	0,41394	0,35039
18 B7D4	0,96487	0,94965	1,51275	0,94774	0,87461	0,93711
CONSTANT	-39,90266	-33,35975	-36,81572	-36,91873	-36,44772	-36,17089

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP =					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	40,5	96	31	11	38	26	35
GRASS	50,0	1	8	2	3	1	1
CORN	76,5	4	15	91	3	1	5
SUMFALO	32,7	7	3	1	17	10	14
NON AGR	42,9	0	1	0	2	3	1
GRASORG	43,7	25	39	2	35	28	100
TOTAL	47,7	133	97	107	98	69	156

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP =					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	39,7	94	31	12	38	27	35
GRASS	37,5	1	6	2	4	2	1
CORN	75,6	4	16	90	3	1	5
SUMFALO	28,8	7	3	1	15	11	15
NON AGR	14,3	1	1	0	3	1	1
GRASORG	43,2	25	39	2	35	29	99
TOTAL	46,2	132	96	107	98	71	156

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 R5D4		93,4517	1	0,5933	93,452
2	18 B7D4		52,6907	2	0,4156	71,994
3	12 B5D3		20,9253	3	0,3581	54,080
4	4 B5D1		8,4599	4	0,3363	42,014
5	10 R7D2		7,6480	5	0,3176	34,960
6	6 B7D1		4,8988	6	0,3060	29,832

Percent of Variation Between Groups Explained

Eigenvalues	1.53071	0.21092	0.03385	0.02832	0.00293
Percentage	84.72	11.67	1.87	1.57	0.16

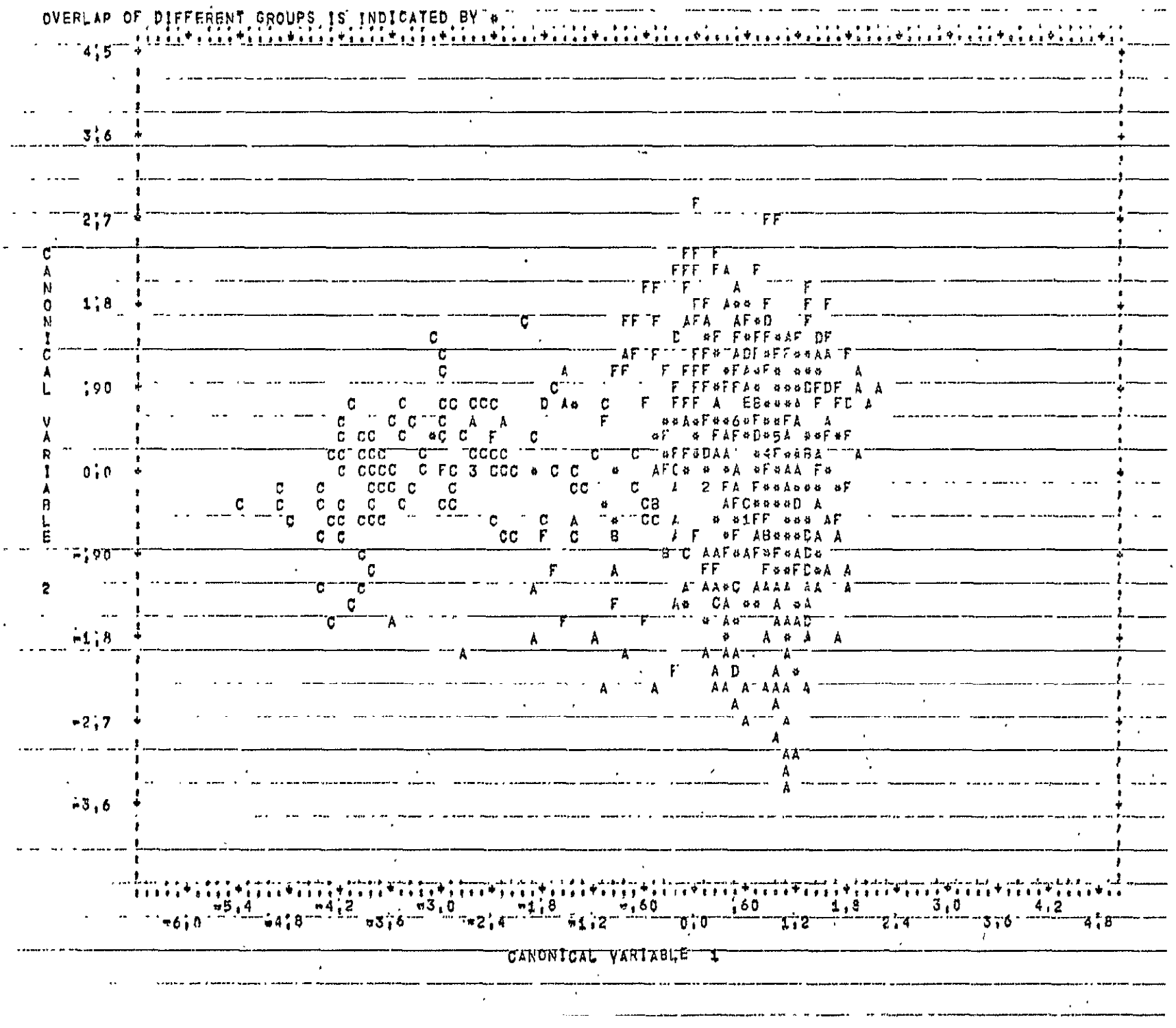
Canonical Correlations

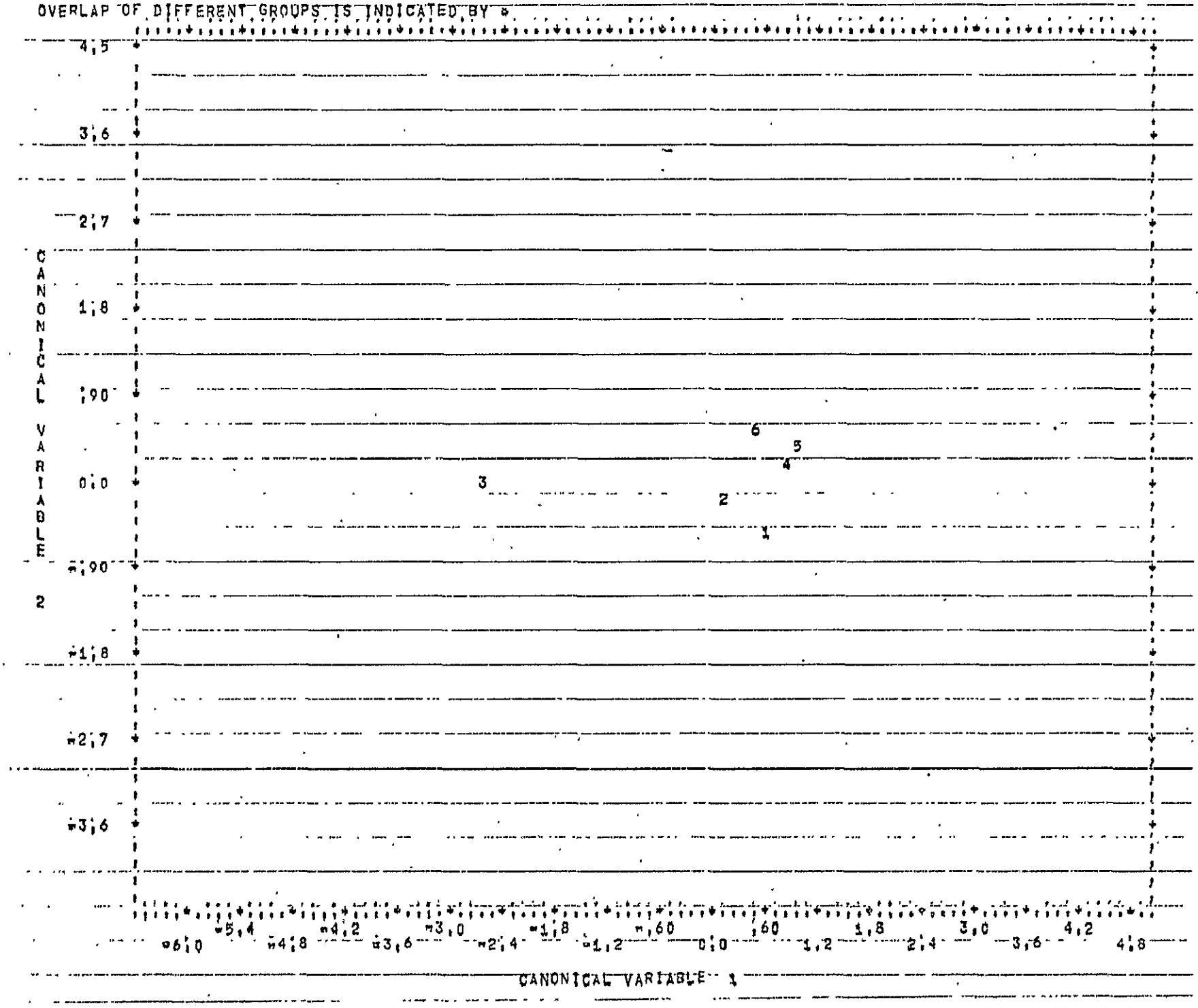
	0.7772	0.41735	0.18094	0.16595	0.05406

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES				
4 B5D1	-0,04654	-0,04834	0,13858	-0,07601	-0,02882
6 B7D1	0,05429	-0,07122	0,01412	0,18839	0,20957
10 B7D2	0,07034	-0,03613	0,07351	0,10894	-0,20231
12 B5D3	0,02899	0,07962	0,05201	-0,06415	-0,00539
16 B5D4	0,08263	-0,03455	-0,08581	-0,07210	0,04491
18 B7D4	-0,17131	-0,06695	-0,05022	-0,10976	0,02306
CONSTANT	-1,34590	3,16445	-2,30597	4,03609	0,64621

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS				
WINTWHET	0,64311	-0,53704	0,05662	-0,03145	-0,00198
GRASS	0,09584	-0,17488	-0,17418	1,03864	0,04672
CORN	-2,61081	-0,04512	-0,02348	-0,02567	-0,00277
SUMFALO	0,82440	0,19477	-0,56549	-0,12632	0,05280
NON AGR	0,93682	0,31443	-0,46417	0,12960	-0,49745
GRASORG	0,46866	0,53783	0,10837	-0,00195	0,00344

GROUP	Mean Coordinates		Symbol for Classes	Symbol for Mean
Winter wheat	0.64	-0.54	A	1
Grass	0.10	-0.17	B	2
Corn	-2.61	-0.05	C	3
Summer Fallow	0.82	0.19	D	4
Non-agriculture	0.94	0.31	E	5
Grain sorghum	0.47	0.54	F	6




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4,5
3,6
2,7
1,8
,90
0,0
-,90
-1,8
-2,7
-3,6
CANONICAL VARIABLE 2
-6,0
-5,4
-4,8
-4,2
-3,6
-3,0
-2,4
-1,8
-1,2
-,60
0,0
,60
1,2
1,8
2,4
3,0
3,6
4,2
4,8
CANONICAL VARIABLE 1
1
2
3
4
5
6

APPENDIX BB2

Discriminant Analysis of RICE County Using Residuals From ERTS Bands Regressed on Soil Type

Transformations of Original Variables

```
      1              SUBROUTINE TRANSF(X,KASE,NPROG,USE)
      2              COMMON/GETCME/PA(17),XMIS
      3              DIMENSION X(1)
      4             X(3) = X(3) - (1.133163*X(20) + 21.061115)
      5             X(4) = X(4) - (1.885455*X(20) + 17.316985)
      6             X(5) = X(5) - (2.076673*X(20) + 19.396823)
      7             X(6) = X(6) - (1.714957*X(20) + 9.399300)
      8             X(7) = X(7) - (0.676121*X(20) + 33.955117)
      9             X(8) = X(8) - (1.287607*X(20) + 33.296979)
     10             X(9) = X(9) - (2.496556*X(20) + 40.915830)
     11             X(10) = X(10) - (1.363968*X(20) + 21.050853)
     12             X(11) = X(11) - (0.776229*X(20) + 31.727281)
     13             X(12) = X(12) - (1.903983*X(20) + 29.084695)
     14             X(13) = X(13) - (2.403371*X(20) + 35.216465)
     15             X(14) = X(14) - (1.337328*X(20) + 16.645980)
     16             X(17) = X(17) - (3.294544*X(20) + 40.171258)
     17             X(18) = X(18) - (2.165488*X(20) + 19.268482)
     18              RETURN
     19              END
```

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.                    PROGRAM REVISED FEBRUARY 7, 1975
HEALTH SCIENCES COMPUTING FACILITY                          MANUAL DATE -- 1975
UNIVERSITY OF CALIFORNIA, LOS ANGELES


IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED.


   PROGRAM CONTROL INFORMATION
 PROBLEM TITLE = 'RICE CO ERTS BANDS & GROUND TRUTH USING RESIDUALS    00001170
   FROM ERTS BANDS REGRESSED ON SOIL TYPE',/                           00001180
 INPUT                                                                 00001190
     VARIABLE = 20.                                                    00001200
     FORMAT = '(2A5,12F5.0/6F5.0)'.                                    00001210
     CASE = 660.                                                       00001220
     UNIT = 12./                                                       00001230
 VARIAB ADD = 1.                                                       00001240
       NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',       00001250
       'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4', 00001260
       'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL'.                 00001270
     USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18.                   00001280
     LABEL = 1,2.                                                      00001290
     GROUP = 'CROP TYP',/                                              00001300
 TRANSFORMATION                                                        00001310
     X(21) = X(19)*X(20),/                                             00001320
 GROUP CODE = 1,2,3,4,5,8.                                             00001330
     NAME = 'WINTWHET','GRASS','CORN','SUMFALO',                       00001340
            'NON AGR','GRASORG',/                                      00001350
 PRINT STEP.                                                           00001360
      CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15./                    00001370
 PLOT CANON.                                                           00001380
    GROUP = 1,2,3,4,5,8.                                               00001390
    GROUP = 1,2,3,4,8./                                                00001400
 DISCRIMINANT METHOD = 2.                                              00001410
      FORCE = 0.                                                       00001420
      STEP = .40.                                                      00001430
     JACK./                                                            00001440
 END/                                                                  00001450


   PROBLEM TITLE . . . . . .RICE CO ERTS BANDS & GROUND TRUTH USING RESIDUALS FROM ERTS BANDS REGRESSED ON SOIL
                                TYPE
   NUMBER OF VARIABLES TO READ IN. . . . . .      20
   NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS.   1
   TOTAL NUMBER OF VARIABLES . . . . . .          21
   NUMBER OF CASES TO READ IN. . . . . .         660
   CASE LABELING VARIABLES . . . . . .    ROW          COLUMN
   LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
   INPUT UNIT NUMBER . . . . . .                 12
   REWIND INPUT UNIT PRIOR TO READING. . DATA. . .    YES

   INPUT FORMAT
         (2A5,12F5.0/6F5.0)


   INTERPRETIVE TRANSFORMATIONS ARE
         CROP*SOL = CROP TYP *    SOIL TYP.
```

VARIABLES TO BE USED

3	B401	4	B501	5	B601	6	B701	7	B402		
8	B502	9	B602	10	B702	11	B403	12	B503		
13	B603	14	B703	15	B404	16	B504	17	B604		
18	B704										

TOLERANCE	0.010
F-TO-ENTER	4.000
F-TO-REMOVE	3.996
METHOD	2
MAXIMUM FORCED LEVEL	0
MAXIMUM NUMBER OF STEPS	40

PRIOR PROBABILITIES	0.16667	0.16667	0.16667	0.16667	0.16667	0.16667

		BEFORE TRANSFORMATION					INTERVAL RANGE	
VARIABLE NO.	NAME	MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	GREATER THAN	LESS THAN OR EQUAL TO
19	CROP TYP				1.00000	WINTWHET		
					2.00000	GRASS		
					3.00000	CORN		
					4.00000	SUMFALO		
					5.00000	NON AGR		
					8.00000	GRASORG		

NUMBER OF CASES READ 668

MEANS

VARIABLE	GROUP =	WINTWHT	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3 B4D1		1.69120	-0.86905	-1.43772	-1.36967	-2.09880	-0.56727	0.00000
4 B5D1		2.76309	-1.73960	-1.81909	-2.36195	-3.18166	-1.15919	0.00000
5 B6D1		2.47000	1.03212	-3.64914	-1.87785	-3.91160	-0.18514	0.00000
6 B7D1		1.72329	1.38236	-2.27814	-0.80304	-1.59705	0.87541	0.00000
7 B4D2		-0.92746	-0.58115	-0.69596	0.14982	-2.59713	1.40749	-0.00000
8 B5D2		-2.58247	-1.27457	0.32492	-0.37032	-3.25117	2.77728	-0.00000
9 B6D2		2.49916	-0.75162	-6.79373	0.32342	1.73539	0.88028	0.00000
10 B7D2		2.12566	0.49972	-4.17528	0.04245	1.58868	-0.12327	-0.00000
11 B4D3		-0.75727	-1.64731	-2.55159	-0.00330	0.10188	2.22241	0.00000
12 B5D3		-0.95268	-4.67516	-6.17117	0.78627	0.43420	4.32757	0.00000
13 B6D3		-2.26019	0.97574	2.13137	-2.65163	-1.48179	1.61374	0.00000
14 B7D3		-1.29724	0.63645	2.48124	-1.82243	-1.17949	0.45840	0.00000
15 B4D4		39.45992	35.37500	30.27731	39.05759	37.42857	36.37565	36.58182
16 B5D4		43.65401	35.31250	24.63025	42.55763	41.28571	37.80349	37.08030
17 B6D4		0.73736	-2.97739	4.00464	-1.47321	-3.31515	-2.20023	0.00000
18 B7D4		-0.66224	-1.46367	5.71907	-2.09891	-2.81324	-1.62168	-0.00000
19 CROP TYP		1.00000	2.00000	3.00000	4.00000	5.00000	8.00000	4.09242
COUNTS		237.	16.	119.	52.	7.	229.	660.

STANDARD DEVIATIONS

VARIABLE	GROUP =	WINTWHT	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3 B4D1		4.78255	3.91058	3.49216	2.32355	2.39269	3.41912	3.91842
4 B5D1		7.37039	6.26144	5.35003	4.26485	2.92138	5.40909	6.10929
5 B6D1		6.94452	6.57121	6.67597	4.10985	3.82423	6.18032	6.41889
6 B7D1		3.54994	3.72981	4.22024	2.48033	2.79878	3.69166	3.65826
7 B4D2		4.32642	2.55569	4.15919	4.52090	5.67005	4.55961	4.37746
8 B5D2		8.15324	4.97777	6.36856	8.06277	10.08509	6.80736	8.15729
9 B6D2		5.90198	6.07116	7.93699	5.50310	5.28780	6.50883	6.49376
10 B7D2		4.41362	4.48343	4.18401	3.93162	5.43328	4.06664	4.23041
11 B4D3		4.78437	2.66175	3.47976	5.01387	5.57129	5.49157	4.83383
12 B5D3		9.19375	4.69190	6.15974	8.91805	8.24944	10.02152	8.96823
13 B6D3		7.82585	6.86871	6.34940	7.80852	7.20050	8.63024	7.92911
14 B7D3		4.33034	4.20783	3.80194	3.95239	3.71709	4.75959	4.36158
15 B4D4		4.56630	3.32415	3.56519	4.84834	3.73529	4.43160	4.34497
16 B5D4		8.23480	6.03013	7.18150	8.48161	6.65117	8.26803	8.02854
17 B6D4		6.83079	6.03798	5.95825	5.75432	7.42877	7.08856	6.68763
18 B7D4		3.79554	4.43363	5.07763	2.73539	3.95266	3.84761	4.02355
19 CROP TYP		0.	0.	0.	0.	0.	0.	0.

STEP NUMBER 0

VARIABLE	F TO REMOVE DF= 5 655	FORCE LEVEL	*	VARIABLE	F TO ENTER DF= 5 654	FORCE LEVEL	TOLERANCE
			*	3 8401	14.823	1	1.000000
			*	4 8501	15.649	1	1.000000
			*	5 8601	16.242	1	1.000000
			*	6 8701	15.632	1	1.000000
			*	7 8402	8.026	1	1.000000
			*	8 8502	10.424	1	1.000000
			*	9 8602	34.024	1	1.000000
			*	10 8702	35.433	1	1.000000
			*	11 8403	17.848	1	1.000000
			*	12 8503	25.659	1	1.000000
			*	13 8603	9.220	1	1.000000
			*	14 8703	14.396	1	1.000000
			*	15 8404	74.686	1	1.000000
			*	16 8504	93.452	1	1.000000
			*	17 8604	15.551	1	1.000000
			*	18 8704	60.747	1	1.000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 5 649		*		DF= 5 648		
4 B5D1	7.769	1	*	3 B4D1	0.568	1	0.095747
6 B7D1	5.104	1	*	5 B6D1	0.392	1	0.066701
10 B7D2	7.558	1	*	7 B4D2	2.346	1	0.760538
12 B5D3	18.096	1	*	8 B5D2	2.953	1	0.722201
16 B5D4	33.399	1	*	9 B6D2	2.358	1	0.168666
18 B7D4	47.355	1	*	11 B4D3	1.991	1	0.079496
			*	13 B6D3	2.201	1	0.478138
			*	14 B7D3	2.869	1	0.619224
			*	15 B4D4	0.918	1	0.091152
			*	17 B6D4	1.298	1	0.090525

U-STATISTIC OR WILKS' LAMBDA 0.3115796 DEGREES OF FREEDOM 6 5 654
APPROXIMATE F-STATISTIC 29.311 DEGREES OF FREEDOM 30.00 2598.00

F - MATRIX DEGREES OF FREEDOM = 6 649

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4.82				
CORN	139.32	19.39			
SUMFAL	7.44	4.67	71.44		
NON AG	1.59	1.83	14.08	0.41	
GRASCR	22.04	4.45	121.72	5.85	1.11

CLASSIFICATION FUNCTIONS

GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASCRS
VARIABLE						
4 B5D1	-0.40691	-0.51205	-0.29557	-0.53299	-0.53287	-0.44333
6 B7D1	0.14806	0.20585	-0.37244	0.07411	0.00762	0.07573
10 B7D2	-0.52997	-0.48882	-0.78675	-0.62178	-0.47058	-0.57132
12 B5D3	-0.03520	-0.10304	-0.39419	-0.09242	0.00227	0.04616
16 B5D4	0.92884	0.81364	0.65597	0.98428	0.93562	0.86729
18 B7D4	0.01561	-0.01277	0.52553	-0.03366	-0.10496	-0.02165
CONSTANT	-21.04237	-16.89573	-13.65732	-23.35702	-21.74069	-18.59751

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	39.7	94	29	11	40	31	32
GRASS	43.8	2	7	2	3	1	1
CORN	77.3	2	14	92	4	3	4
SUMFALO	40.4	5	3	1	21	8	14
NON AGR	57.1	0	0	0	2	4	1
GRASORG	44.5	27	36	2	32	30	102
TOTAL	48.5	130	89	108	102	77	154

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	39.2	93	29	11	40	31	33
GRASS	31.3	2	5	2	4	2	1
CORN	76.3	2	15	91	4	3	4
SUMFALO	34.5	6	3	1	20	8	14
NON AGR	14.3	1	1	0	3	1	1
GRASORG	44.1	27	36	2	32	31	101
TOTAL	47.1	131	89	107	103	76	154

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 B504		93.4517	1	0.5833	93.452
2	18 B704		48.5812	2	0.4251	69.790
3	12 B503		21.3347	3	0.3654	52.825
4	4 B501		8.3584	4	0.3433	41.381
5	10 B702		7.8222	5	0.3238	34.273
6	6 B701		5.1035	6	0.3116	29.311

Percent of Variation Between Groups Explained

Eigenvalues	1.48721	0.20053	0.04240	0.02807	0.00297
Percentage	84.44	11.39	2.41	1.59	0.17

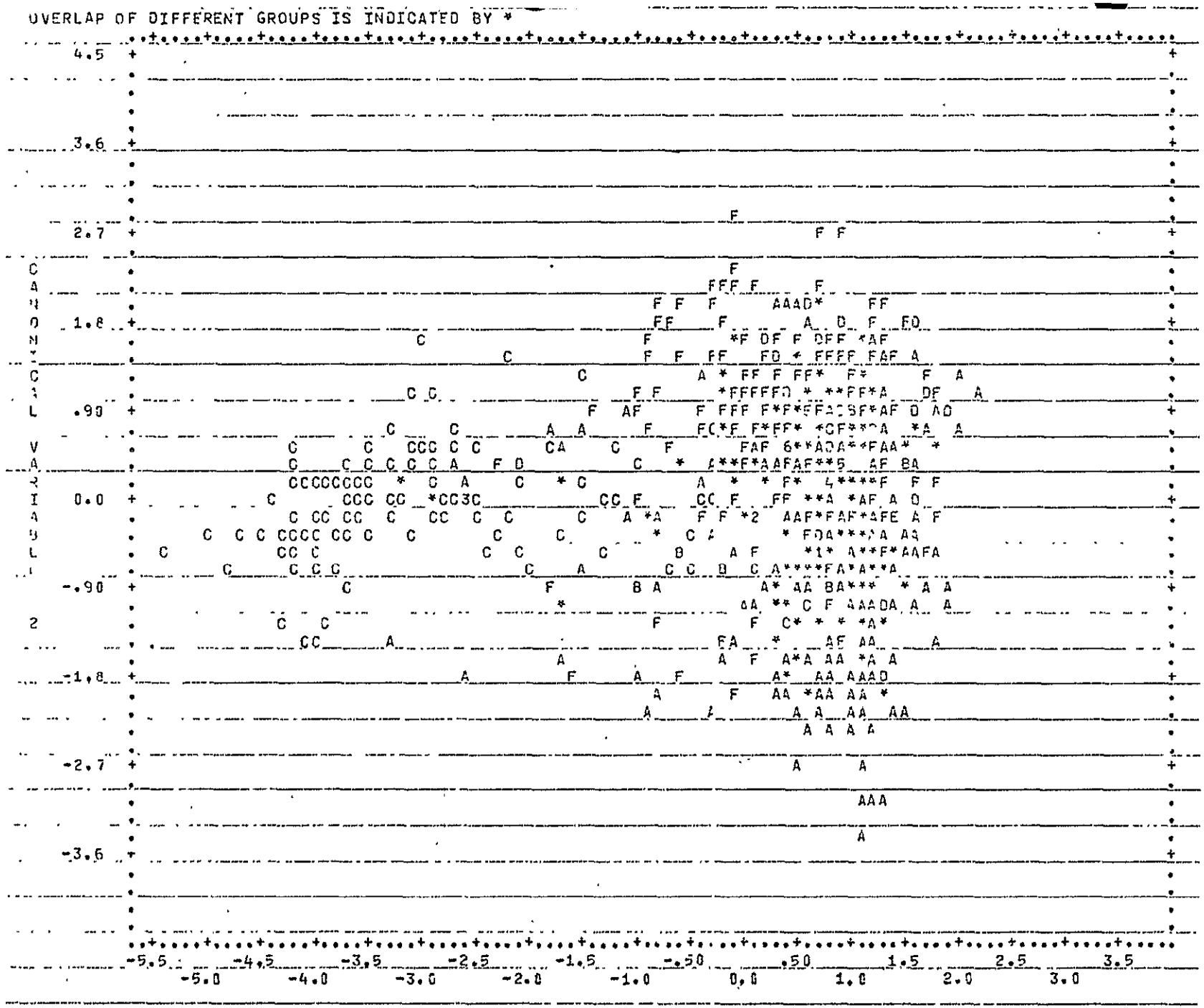
Canonical Correlations

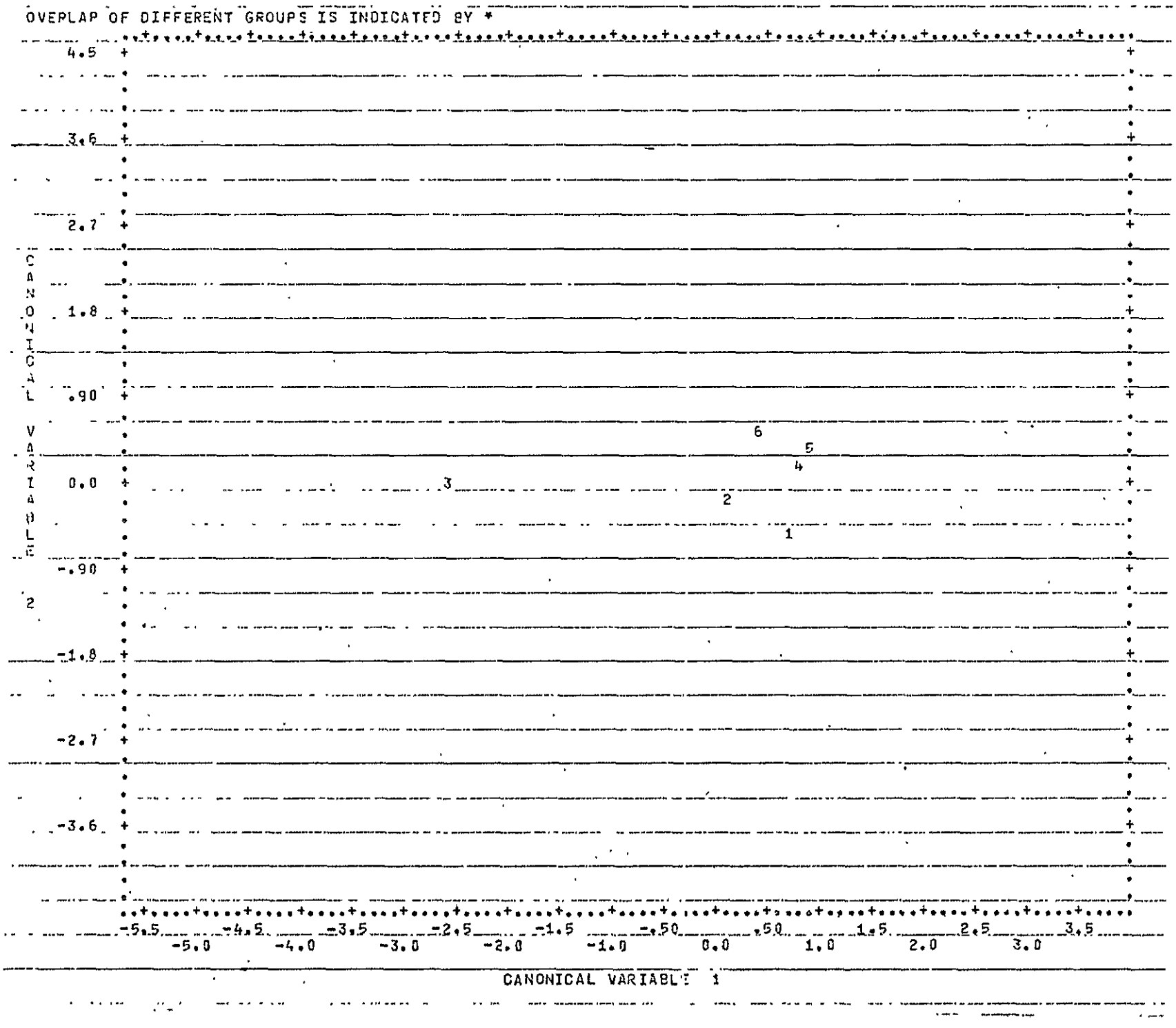
0.77327	0.40870	0.20169	0.16524	0.05438

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES				
4 B501	-0.04524	-0.04949	0.11836	-0.09478	-0.03511
6 B701	0.05794	-0.06724	0.05051	0.19157	0.21326
10 B702	0.07292	-0.03212	0.09480	0.10353	-0.20090
12 B503	0.02850	0.08266	0.04819	-0.08704	-0.00535
16 B504	0.08181	-0.03433	-0.09049	-0.06272	0.04793
19 B704	-0.16714	-0.06639	-0.03225	-0.10012	0.03198
CONSTANT	-3.09894	1.30028	3.42790	2.37585	-1.81545

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS				
WINTWHET	0.65676	-0.51938	0.05567	-0.03942	-0.00232
GRASS	0.07913	-0.20397	-0.03871	1.04488	0.04693
CORN	-2.56989	-0.05783	-0.03201	-0.02416	-0.00271
SUMFALO	0.81931	0.21310	-0.64188	-0.06151	0.05599
NON_AGR	0.92261	0.32635	-0.52538	0.17983	-0.49816
GRASORG	0.43597	0.52409	0.12354	-0.01119	0.00304

GROUP	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat	0.66	-0.52	A	1
Grass	0.08	-0.20	B	2
Corn	-2.57	-0.06	C	3
Summer Fallow	0.82	0.21	D	4
Non-agriculture	0.92	0.33	E	5
Grain sorghum	0.44	0.52	F	6


OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
CANONICAL VARIABLE 2
-5.5
-4.5
-3.5
-2.5
-1.5
-.50
.50
1.5
2.5
3.5
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
CANONICAL VARIABLE 1


OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
CANONICAL VARIABLE 2
-5.5
-4.5
-3.5
-2.5
-1.5
-.50
.50
1.5
2.5
3.5
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
CANONICAL VARIABLE 1
1
2
3
4
5
6

APPENDIX BB3

Discriminant Analysis of RICE County with ERTS Bands Ratioed Within a Date --

$$R_i = \frac{x_i}{\sum_{j=1}^{4} x_j}$$

Transformation of Original Variables

```
      1          SUBROUTINE TRANSF(X,KASE,NFROG,USE)
      2          COMMON/GETCOM/PAD(17),XMIS
      3          DIMENSION X(1)
      4          B1 = X(3) + X(4) + X(5) + X(6)
      5          B2 = X(7) + X(8) + X(9) + X(10)
      6          B3 = X(11) + X(12) + X(13) + X(14)
      7          B4 = X(15) + X(16) + X(17) + X(18)
      8          X(3) = X(3)/B1
      9          X(4) = X(4)/B1
     10          X(5) = X(5)/B1
     11          X(6) = X(6)/B1
     12          X(7) = X(7)/B2
     13          X(8) = X(8)/B2
     14          X(9) = X(9)/B2
     15          X(10) = X(10)/B2
     16          X(11) = X(11)/B3
     17          X(12) = X(12)/B3
     18          X(13) = X(13)/B3
     19          X(14) = X(14)/B3
     20          X(15) = X(15)/B4
     21          X(16) = X(16)/B4
     22          X(17) = X(16)/B4
     23          X(18) = X(16)/B4
     24          RETURN
     25          END
```

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS,
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES


IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED,


  PROGRAM CONTROL INFORMATION
PROBLEM TITLE = 'RICE CO SAMP, 1, RATIO DATA',/
INPUT
    VARIABLE = 20,
    FORMAT = '(2A5,12F5.0/6F5.0)',
    CASE = 660,
    UNIT = 12,/
VARIAB ADD = 1,
     NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
      'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4',
      'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL',
    USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,
    LABEL = 1,2,
    GROUP = 'CROP TYP',/
TRANSFORMATION
    X(21) = X(19)*X(20),/
GROUP CODE = 1,2,3,4,5,8,
    NAME = 'WINTWHET','GRASS','CORN','SUMFALO',
           'NON AGR','GRASORG',/
PRINT STEP,
     CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,/
PLOT CANON,
     GROUP = 1,2,3,4,5,8,
    GROUP = 1,2,3,4,8,/
DISCRIMINANT METHOD = 2,
     FORCE = 0,
     STEP = 40,
     JACK,/
END/


   PROBLEM TITLE . . . . . .RICE CO SAMP, 1, RATIO DATA

   NUMBER OF VARIABLES TO READ IN. . . . . 20
   NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS, . 1
   TOTAL NUMBER OF VARIABLES . . . . . 21
   NUMBER OF CASES TO READ IN. . . . . 660
   CASE LABELING VARIABLES . . . . . ROW        COLUMN
   LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
   INPUT UNIT NUMBER . . . . . 12
   REWIND INPUT UNIT PRIOR TO READING, . DATA, . . YES

   INPUT FORMAT
         (2A5,12F5.0/6F5.0)


   INTERPRETIVE TRANSFORMATIONS ARE
         CROP*SOL = CROP TYP *   SOIL TYP,
```

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	15	B4D4	16	B5D4	17	B6D4		
18	B7D4	20	SOIL TYP								

TOLERANCE, ...	0.010
F-TO-ENTER	4.000
F-TO-REMOVE, ...	3.996
METHOD	2
MAXIMUM FORCED LEVEL . . .	0
MAXIMUM NUMBER OF STEPS, .	40
PRIOR PROBABILITIES, . . .	0.16667 0.16667 0.16667 0.16667 0.16667 0.16667

VARIABLE NO, NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
19 CROP TYP				1.00000	WINTWHET		
				2.00000	GRASS		
				3.00000	CORN		
				4.00000	SUMFALO		
				5.00000	NON AGR		
				8.00000	GRASORG		

NUMBER OF CASES READ, ... 660

MEANS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3	R4N1	0,27441	0,27279	0,29630	0,28365	0,29054	0,28221	0,28193
4	R5N1	0,25933	0,23533	0,26277	0,24496	0,25025	0,24647	0,25368
5	R6N1	0,30878	0,32201	0,29681	0,31105	0,30188	0,31146	0,30798
6	R7N1	0,15747	0,16987	0,14412	0,16034	0,15733	0,15986	0,15642
7	R4N2	0,24027	0,24936	0,26615	0,24976	0,23342	0,25123	0,24959
8	R5N2	0,23286	0,24965	0,27787	0,24949	0,23287	0,26285	0,25310
9	R6N2	0,34275	0,32575	0,30310	0,33028	0,34734	0,32241	0,32720
10	R7N2	0,18412	0,17525	0,15288	0,17106	0,18637	0,16351	0,17012
11	R4N3	0,26968	0,26066	0,25098	0,27237	0,26934	0,26548	0,26483
12	R5N3	0,26479	0,23530	0,27122	0,27306	0,26880	0,27513	0,26057
13	R6N3	0,31494	0,33884	0,34755	0,30808	0,31440	0,31182	0,31982
14	R7N3	0,15060	0,16519	0,18012	0,14559	0,14846	0,14758	0,15478
15	R4N4	0,25413	0,25624	0,22003	0,25926	0,25862	0,25745	0,24964
16	R5N4	0,27873	0,25568	0,17840	0,27994	0,28364	0,26378	0,25564
17	R6N4	0,00181	0,00186	0,00130	0,00187	0,00198	0,00189	0,00175
18	R7N4	0,00181	0,00186	0,00130	0,00187	0,00198	0,00189	0,00175
20	SOIL TYP	2,43638	2,31250	2,51261	2,46154	2,42857	2,29258	2,39697
19	CROP TYP	1,00000	2,00000	3,00000	4,00000	5,00000	6,00000	4,09242
COUNTS		237,	16,	119,	52,	7,	229,	660,

STANDARD DEVIATIONS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3	R4N1	0,02409	0,02695	0,03413	0,02453	0,01879	0,03022	0,02835
4	R5N1	0,03150	0,04237	0,03460	0,03396	0,03479	0,03583	0,03405
5	R6N1	0,02416	0,03623	0,03201	0,02790	0,02090	0,03125	0,02883
6	R7N1	0,02266	0,03234	0,03082	0,02391	0,02392	0,02956	0,02712
7	R4N2	0,02123	0,02091	0,01894	0,02028	0,02353	0,02146	0,02051
8	R5N2	0,04402	0,03520	0,02220	0,04189	0,05324	0,02762	0,03868
9	R6N2	0,03309	0,02837	0,02048	0,03272	0,03467	0,02789	0,02924
10	R7N2	0,03063	0,02540	0,01594	0,02784	0,04221	0,02567	0,02653
11	R4N3	0,01985	0,02524	0,01991	0,01873	0,01122	0,02607	0,02222
12	R5N3	0,02917	0,03980	0,03300	0,02375	0,01730	0,03378	0,03138
13	R6N3	0,02370	0,03705	0,02741	0,01663	0,01277	0,02795	0,02579
14	R7N3	0,01513	0,02584	0,02129	0,01326	0,01048	0,02319	0,02044
15	R4N4	0,01701	0,02334	0,02214	0,01382	0,01246	0,02215	0,01982
16	R5N4	0,02950	0,04199	0,04651	0,02952	0,01962	0,02967	0,03351
17	R6N4	0,00026	0,00035	0,00034	0,00024	0,00029	0,00034	0,00031
18	R7N4	0,00026	0,00035	0,00034	0,00024	0,00029	0,00034	0,00031
20	SOIL TYP	0,63145	0,47871	0,50195	0,64051	0,53452	0,56738	0,58433
19	CROP TYP	0,	0,	0,	0,	0,	0,	0,

STEP NUMBER 0

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 5 655		*		DF= 5 654		
			*	3 B4D1	9,947	1	1,000000
			*	4 B5D1	6,682	1	1,000000
			*	5 B6D1	5,216	1	1,000000
			*	6 B7D1	6,708	1	1,000000
			*	7 B4D2	26,490	1	1,000000
			*	8 B5D2	26,553	1	1,000000
			*	9 B6D2	31,596	1	1,000000
			*	10 B7D2	26,750	1	1,000000
			*	11 B4D3	12,881	1	1,000000
			*	12 B5D3	52,217	1	1,000000
			*	13 B6D3	37,691	1	1,000000
			*	14 B7D3	47,493	1	1,000000
			*	15 B4D4	65,769	1	1,000000
			*	16 B5D4	158,054	1	1,000000
			*	17 B6D4	64,457	1	1,000000
			*	18 B7D4	64,457	1	1,000000
			*	20 SOIL TYP	2,747	1	1,000000

STEP NUMBER 7
VARIABLE ENTERED 18 B7D4

VARIABLE	F TO REMOVE DF= 5 648	LEVEL	*	VARIABLE	F TO ENTER DF= 5 647	LEVEL	TOLERANCE
3 B4D1	6,617	1	*	5 B6D1	0,718	1	0,050408
4 B5D1	10,302	1	*	6 B7D1	0,718	1	0,090901
9 B6D2	9,486	1	*	7 B4D2	1,957	1	0,235544
12 B5D3	17,413	1	*	8 B5D2	2,958	1	0,094129
13 B6D3	7,780	1	*	10 B7D2	2,417	1	0,167474
16 B5D4	32,469	1	*	11 B4D3	1,007	1	0,208685
18 B7D4	6,859	1	*	14 B7D3	1,007	1	0,237141
			*	15 B4D4	1,142	1	0,191533
			*	17 B6D4	0,	1	0,
			*	20 SOIL TYP	2,185	1	0,874156

U-STATISTIC OR WILKS' LAMBDA 0,3000841 DEGREES OF FREEDOM 7 5 654
APPROXIMATE F-STATISTIC 25,824 DEGREES OF FREEDOM 35,00 2728,32

F - MATRIX DEGREES OF FREEDOM = 7 648

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4,50				
CORN	126,46	16,56			
SUMFAL	4,77	4,60	64,53		
NON AG	1,29	2,10	14,07	0,73	
GRASOR	19,42	4,34	112,49	3,94	1,12

CLASSIFICATION FUNCTIONS

GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
VARIABLE						
3 B4D1	757,84616	753,43532	757,30466	786,56788	793,82223	775,98604
4 B5D1	30,42546	19,30686	55,86445	7,34435	8,34834	20,99501
9 B6D2	631,15462	616,59192	588,86598	621,62938	647,55247	619,27984
12 B5D3	3345,35184	3326,91360	3290,82294	3360,26840	3385,75034	3383,93283
13 B6D3	4220,32990	4241,10834	4182,72552	4227,01862	4265,80273	4257,32336
16 B5D4	53,36277	34,46017	-24,24225	63,60582	52,74608	38,42541
18 B7D4	72108,89355	74602,96191	70945,27246	71588,50586	74188,55469	73896,40918
CONSTANT	-1398,06621	-1390,94946	-1345,63972	-1405,06662	-1437,11513	-1417,49911

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP →					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	43,9	104	33	7	31	33	29
GRASS	56,3	1	9	2	4	0	0
CORN	80,7	3	12	96	3	1	4
SUMFALO	28,8	11	1	1	15	8	16
NON AGR	42,9	1	0	0	3	3	0
GRASORG	39,7	26	28	3	43	38	91
TOTAL	48,2	146	83	109	99	83	140

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP →					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	43,5	103	33	7	32	33	29
GRASS	43,8	1	7	2	4	1	1
CORN	79,8	3	12	95	3	1	5
SUMFALO	23,1	12	2	1	12	9	16
NON AGR	14,3	1	1	0	4	1	0
GRASORG	38,4	27	29	3	43	39	88
TOTAL	46,4	147	84	108	98	84	139

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 R5D4		158,0540	1	0,4528	158,054
2	12 R5D3		16,0506	2	0,4033	75,060
3	4 R5D1		10,2282	3	0,3739	51,378
4	9 R6D2		10,4756	4	0,3461	40,720
5	3 R4D1		7,2921	5	0,3277	33,854
6	13 R6D3		4,8231	6	0,3160	28,907
7	18 R7D4		6,8585	7	0,3001	25,824

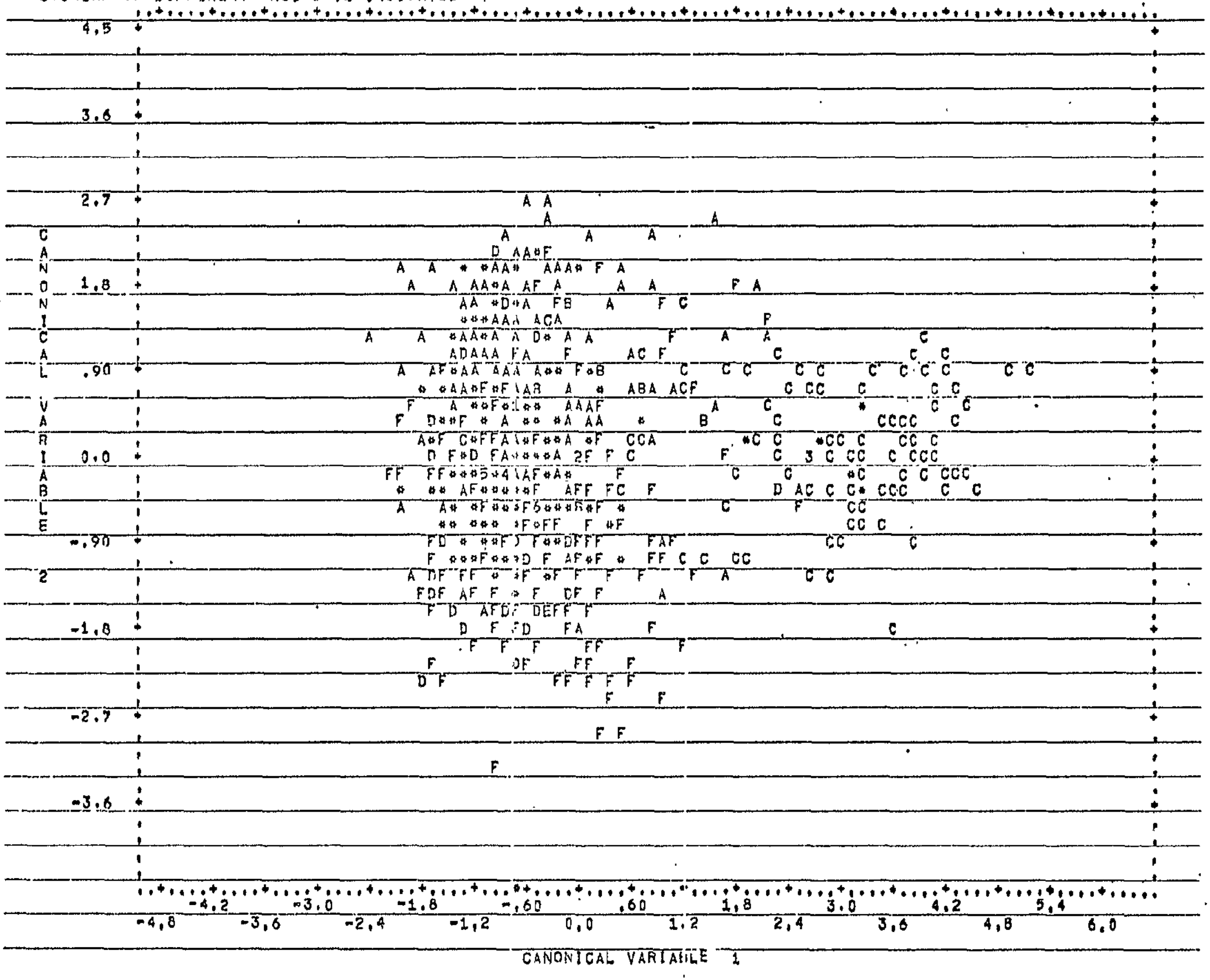
Percent of Variation Between Groups Explained

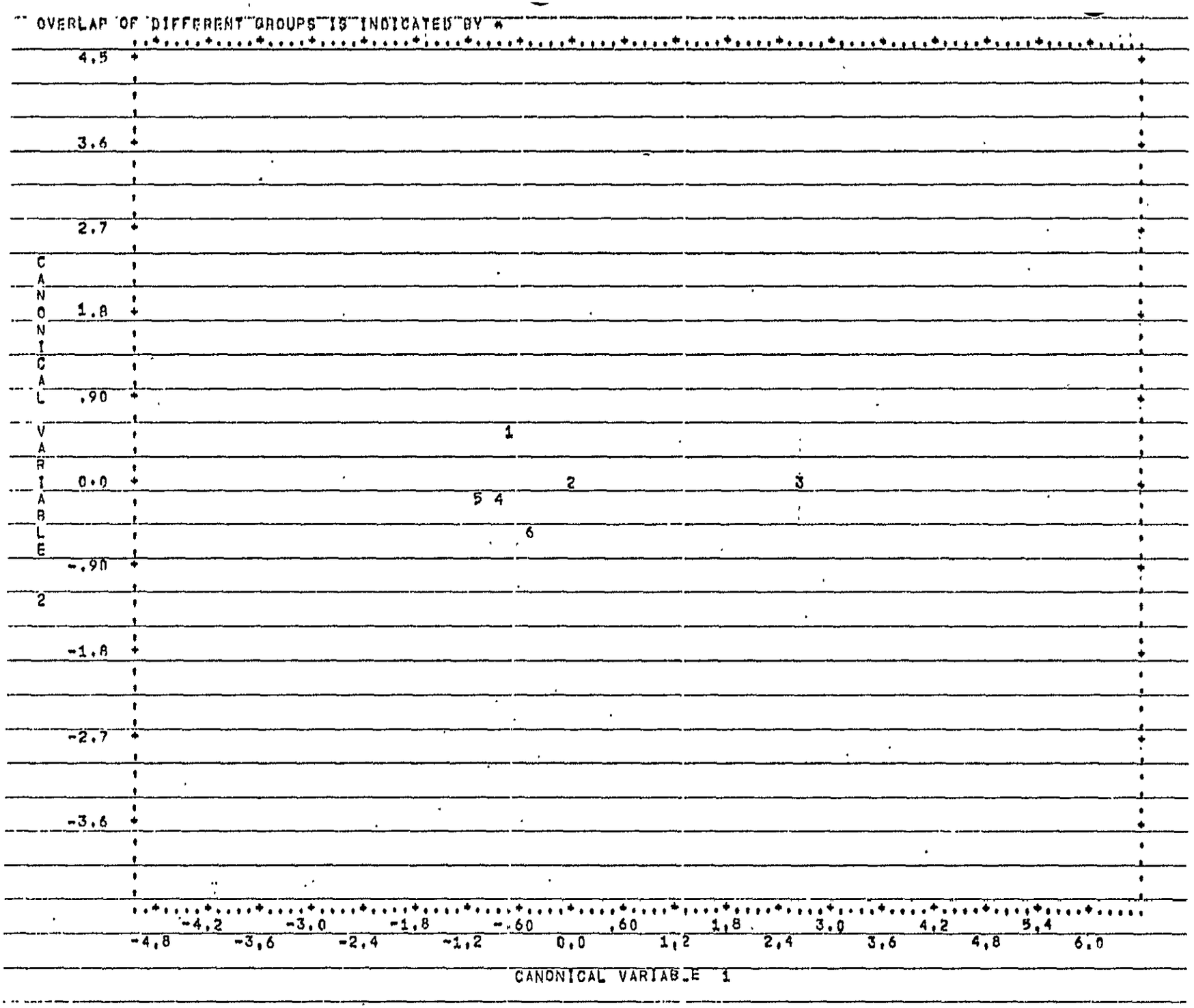
Eigenvalues	1.59526	0.20544	0.03502	0.02345	0.00558
Percentage	85.55	11.02	1.88	1.26	0.30
Canonical Correlations					
	0.78402	0.41283	0.18395	0.15137	0.07447

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES				
3 B401	-3,52706	-18.71295	-14,03328	-26,53526	23,51809
4 B501	9,82732	11,26195	-4,42781	27,30899	-2,77166
9 B602	-11,33526	9,12132	1,05674	8,35455	27,43562
12 B503	-21,46126	-39,58158	-9,81235	30,72887	14,54998
13 B603	-15,83063	-36,52100	21,93465	30,47695	21,22486
16 B504	-22,93767	11,17902	-4,63672	-23,18750	-10,94870
18 B704	-529,16712	-1671,79786	2467,53939	2426,80112	1105,19941
CONSTANT	19,46450	21,50766	-2,76593	-18,27491	-24,63348
GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS				
WINTWHET	-0,66465	0,52615	-0,02167	0,05491	-0,00344
GRASS	0,03911	0,08610	1,14026	-0,22403	-0,05699
CORN	2,65928	0,05333	-0,03547	-0,01623	0,00771
SUMFALO	-0,85101	-0,13852	-0,16062	-0,46069	-0,03742
NON AGR	-1,13859	-0,20112	0,14124	-0,18219	0,70621
GRASORG	-0,46871	-0,54091	-0,00206	0,08197	-0,00955

GROUP				
Winter wheat	-0.66	0.53	A	1
Grass	0.04	0.09	B	2
Corn	2.66	0.05	C	3
Summer Fallow	-0.85	-0.14	D	4
Non-agriculture	-1.14	-0.20	E	5
Grain sorghum	-0.47	-0.54	F	6

OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *




** OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
CANONICAL VARIABLE 2
1
2
3
5 4
6
-4.8 -4.2 -3.6 -3.0 -2.4 -1.8 -1.2 -.60 0.0 .60 1.2 1.8 2.4 3.0 3.6 4.2 4.8 5.4 6.0
CANONICAL VARIABLE 1

APPENDIX BB4

Discriminant Analysis of RICE County with 'NON-AGRICULTURAL' Category Not Used to Calculate the Discriminant Function

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED.

   PROGRAM CONTROL INFORMATION
 PROBLEM TITLE = 'RICE CO SAMP. 1.'./
  INPUT
      VARIABLE = 20,
       FORMAT = '(2A5,12F5.0/6F5.0)',
      CASE = 660,
       UNIT = 12./
 VARIAB ADD = 1,
        NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
       'B5D2','B6D2','P7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4',
        'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL',
     USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,
      LABEL = 1,2,
      GROUP = 'CROP TYP'./
  GROUP CODE = 1,2,3,4,5,8,
       NAME = 'WINTWHET','GRASS','CORN','SUMFALO',
            'NON AGR','GRASORG',
     USE = 'WINTWHET','GRASS','CORN','SUMFALO','GRASORG'./
  TRANSFORMATION
      X(21) = X(19)*X(20)./
  SAVE
    UNIT = 10,
     CODE = 'RICE CO',
     LABEL = 'RICE CO SAMPLE 1 RAW DATA'./
  PRINT STEP,
       CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15./
  PLOT CANON,
     GROUP = 1,2,3,4,5,8,
     GROUP = 1,2,3,4,8./
  DISCRIMINANT METHOD = 2,
        FORCE = 0,
        STEP = 40,
       JACK./
 END/

     PROBLEM TITLE . . . . . .RICE CO SAMP. 1.

     NUMBER OF VARIABLES TO READ IN. . . . . .      20
     NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS.      1
     TOTAL NUMBER OF VARIABLES . . . . . .      21
     NUMBER OF CASES TO READ IN. . . . . .     660
     CASE LABELING VARIABLES . . . . . .  ROW        COLUMN
     LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
     INPUT UNIT NUMBER . . . . . .      12
     REWIND INPUT UNIT PRIOR TO READING, DATA. . .     YES

     INPUT FORMAT
           (2A5,12F5.0/6F5.0)
```

INTERPRETIVE TRANSFORMATIONS ARE
CROP*SOL = CROP TYP * SOIL TYP.

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	15	B4D4	16	B5D4	17	B6D4		
18	B7D4	20	SOIL TYP								

TOLERANCE.	0.010
F-TO-ENTER	4.000
F-TO-REMOVE.	3.996
METHOD	2
MAXIMUM FORCED LEVEL . . .	0
MAXIMUM NUMBER OF STEPS. .	40

PRIOR PROBABILITIES. . . . 0.20000 0.20000 0.20000 0.20000 0.20000 0.20000

	BEFORE TRANSFORMATION					INTERVAL RANGE	
VARIABLE NO. NAME	MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	GREATER THAN	LESS THAN OR EQUAL TO
19 CROP TYP				1.00000	WINTWHET		
				2.00000	GRASS		
				3.00000	CORN		
				4.00000	SUMFALO		
				5.00000	NON AGR		
				6.00000	GRASORG		

FILE TO WRITE SAVE FILE ONTO IS NOT A SAVE FILE.

NUMBER OF CASES READ. 660

MEANS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	GPS, US
3	B4D1	25.50633	22.81250	22.47059	22.48077	21.71429	23.09170	23.79939
4	B5D1	24.66245	19.93750	20.23529	19.59615	18.71429	20.48035	21.86903
5	B6D1	29.10127	27.31250	23.22689	24.84615	22.71429	26.03493	26.57274
6	B7D1	14.78059	14.43750	11.42017	12.80769	11.85714	13.39738	13.51771
7	B4D2	34.67089	34.93750	34.95798	35.76923	33.00000	36.91266	35.60337
8	B5D2	33.84388	35.00000	36.85714	36.09615	33.14286	39.02620	36.41807
9	B6D2	49.47257	45.93750	40.39496	47.38462	48.71429	47.51965	46.80055
10	B7D2	26.54008	24.75000	20.35294	24.50000	26.00000	24.10044	24.35069
11	B4D3	32.85654	31.87500	31.92605	33.63462	33.71429	35.72926	33.50652
12	B5D3	32.75949	28.81250	27.69748	34.55769	34.14286	37.77729	33.64319
13	B6D3	38.79747	41.75000	43.38655	38.48077	39.57143	42.53712	40.99214
14	B7D3	18.59916	20.37500	22.48739	16.11538	18.71429	20.17031	19.86371
15	B4D4	39.45992	35.37500	30.27731	39.05769	37.42857	36.37555	36.57274
16	B5D4	43.65401	35.31250	24.63025	42.55769	41.28571	37.80349	37.84380
17	B6D4	48.91561	44.81250	52.45378	46.80769	44.85714	45.52402	48.10260
18	B7D4	23.86920	22.81250	30.42857	22.50000	21.71429	22.61135	24.48851
20	SOIL TYP	2.43038	2.31250	2.51261	2.46154	2.42857	2.29258	2.39663
19	CROP TYP	1.00000	2.00000	3.00000	4.00000	5.00000	6.00000	4.00270
COUNTS		237.	16.	119.	52.	7.	229.	653.

STANDARD DEVIATIONS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	GPS, US
3	B4D1	4.88392	3.69177	3.50985	2.33883	2.75162	3.44731	3.98269
4	B5D1	7.55741	5.84772	5.43483	4.16923	3.25137	5.42378	6.22012
5	B6D1	7.30671	6.70044	6.96777	4.10349	4.23140	6.33970	6.69259
6	B7D1	3.74652	4.04918	4.32857	2.58223	2.79455	3.79106	3.82052
7	B4D2	4.32294	2.64496	4.26733	4.75937	5.53775	4.53942	4.39513
8	B5D2	8.17013	5.05964	7.82318	8.49051	9.92352	8.77093	8.19422
9	B6D2	6.22021	6.28722	8.32926	6.04283	4.33946	6.47097	6.72657
10	B7D2	4.57002	4.58258	4.37556	4.01712	5.16398	4.05591	4.31765
11	B4D3	4.86647	2.70493	3.50195	5.15649	5.52914	5.47210	4.87106
12	B5D3	8.44104	5.02286	6.28363	9.26180	8.09174	10.02489	8.70835
13	B6D3	8.12046	6.65833	6.60009	7.94217	6.75419	8.82404	8.08364
14	B7D3	4.47825	4.09675	3.93779	3.93403	3.45033	4.75282	4.43646
15	B4D4	4.56630	3.32415	3.56519	4.84634	3.73529	4.43160	4.35022
16	B5D4	8.23480	6.03013	7.38150	8.48161	6.65117	8.26603	8.04019
17	B6D4	7.22704	6.15596	6.07125	5.96704	6.36209	7.13931	6.80233
18	B7D4	3.98989	4.69352	5.16601	2.83189	3.25137	3.89605	4.14065
20	SOIL TYP	0.63145	0.47871	0.50195	0.64051	0.53452	0.56738	0.58477
19	CROP TYP	0.	0.	0.	0.	0.	0.	0.

STEP NUMBER 0

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 4 649		*		DF= 4 648		
			*	3 B4D1	17,679	1	1,000000
			*	4 B5D1	18,977	1	1,000000
			*	5 B6D1	17,177	1	1,000000
			*	6 B7D1	16,179	1	1,000000
			*	7 B4D2	8,499	1	1,000000
			*	8 B5D2	11,872	1	1,000000
			*	9 B6D2	37,123	1	1,000000
			*	10 B7D2	46,993	1	1,000000
			*	11 B4D3	20,494	1	1,000000
			*	12 B5D3	28,755	1	1,000000
			*	13 B6D3	10,360	1	1,000000
			*	14 B7D3	17,564	1	1,000000
			*	15 B4D4	93,065	1	1,000000
			*	16 B5D4	116,159	1	1,000000
			*	17 B6D4	22,129	1	1,000000
			*	18 B7D4	77,971	1	1,000000
			*	20 SOIL TYP	3,423	1	1,000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1

VARIABLE	F TO FORCE REMOVE LEVEL DF= 4 643		*	VARIABLE	F TO FORCE ENTER LEVEL DF= 4 642		TOLERANCE
4 B5D1	9,520	1	*	3 B4D1	0,744	1	0,089750
6 B7D1	5,831	1	*	5 B6D1	0,316	1	0,061929
10 B7D2	8,757	1	*	7 B4D2	2,385	1	0,750833
12 B5D3	22,267	1	*	8 B5D2	3,568	1	0,714839
16 B5D4	42,059	1	*	9 B6D2	2,996	1	0,156438
18 B7D4	64,975	1	*	11 B4D3	2,474	1	0,079214
			*	13 B6D3	2,719	1	0,463426
			*	14 B7D3	2,531	1	0,602599
			*	15 B4D4	0,596	1	0,091737
			*	17 B6D4	1,438	1	0,085086
			*	20 SOIL TYP	2,591	1	0,853113

U-STATISTIC OR WILKS' LAMBDA 0.3081917 DEGREES OF FREEDOM 6 4 648
APPROXIMATE F-STATISTIC 37,527 DEGREES OF FREEDOM 24.00 2244.37

F - MATRIX DEGREES OF FREEDOM = 6 643

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4.03				
CORN	141.11	19.70			
SUMFAL	6.80	4.40	72.31		
NON AG	1.51	1.73	14.32	0.42	
GRASOR	22,82	4,47	126.50	5.00	0.97

CLASSIFICATION FUNCTIONS

GROUP = VARIABLE	WINTWHET	GRASS	CORN	SUMFALO	GRASORG
4 B5D1	0.04977	-0.05559	0.16498	-0,07413	0,01079
6 B7D1	0.26622	0.41846	0.05795	0,20951	0,18918
10 B7D2	0,70886	0,74674	0.45517	0,62080	0,66173
12 B5D3	0.32635	0.25838	0.26741	0,36294	0,40734
16 B5D4	0,41178	0.29889	0.13434	0,46432	0,35453
18 B7D4	0,98679	0,95061	1.51043	0,95078	0,93979
CONSTANT	-39,70769	-33,15950	-36,57932	-36,75076	-35,98165

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -				
		WINTWHET	GRASS	CORN	SUMFALO	GRASORG
WINTWHET	43.0	102	33	11	52	39
GRASS	50.0	1	8	2	3	2
CORN	76.5	4	16	91	3	5
SUMFALO	40.4	10	3	1	21	17
NON AGR	0.	1	1	0	4	1
GRASORG	47.6	26	42	2	50	109
TOTAL	50.7	144	103	107	133	173

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -				
		WINTWHET	GRASS	CORN	SUMFALO	GRASORG
WINTWHET	42.6	101	33	11	53	39
GRASS	37.5	2	6	2	4	2
CORN	75.6	4	17	90	3	5
SUMFALO	38.5	10	3	1	20	18
NON AGR	0.	1	1	0	4	1
GRASORG	47.6	26	42	2	50	109
TOTAL	49.9	144	102	106	134	174

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 B5D4		116.1591	1	0.5824	116,159
2	18 B7D4		64.5442	2	0.4163	88,946
3	12 B5D3		25.8983	3	0.3583	67,413
4	4 B5D1		9.8387	4	0.3381	52,492
5	10 B7D2		9.4544	5	0.3194	43,869
6	6 B7D1		5.8310	6	0.3082	37,527

Percent of Variation Between Groups Explained

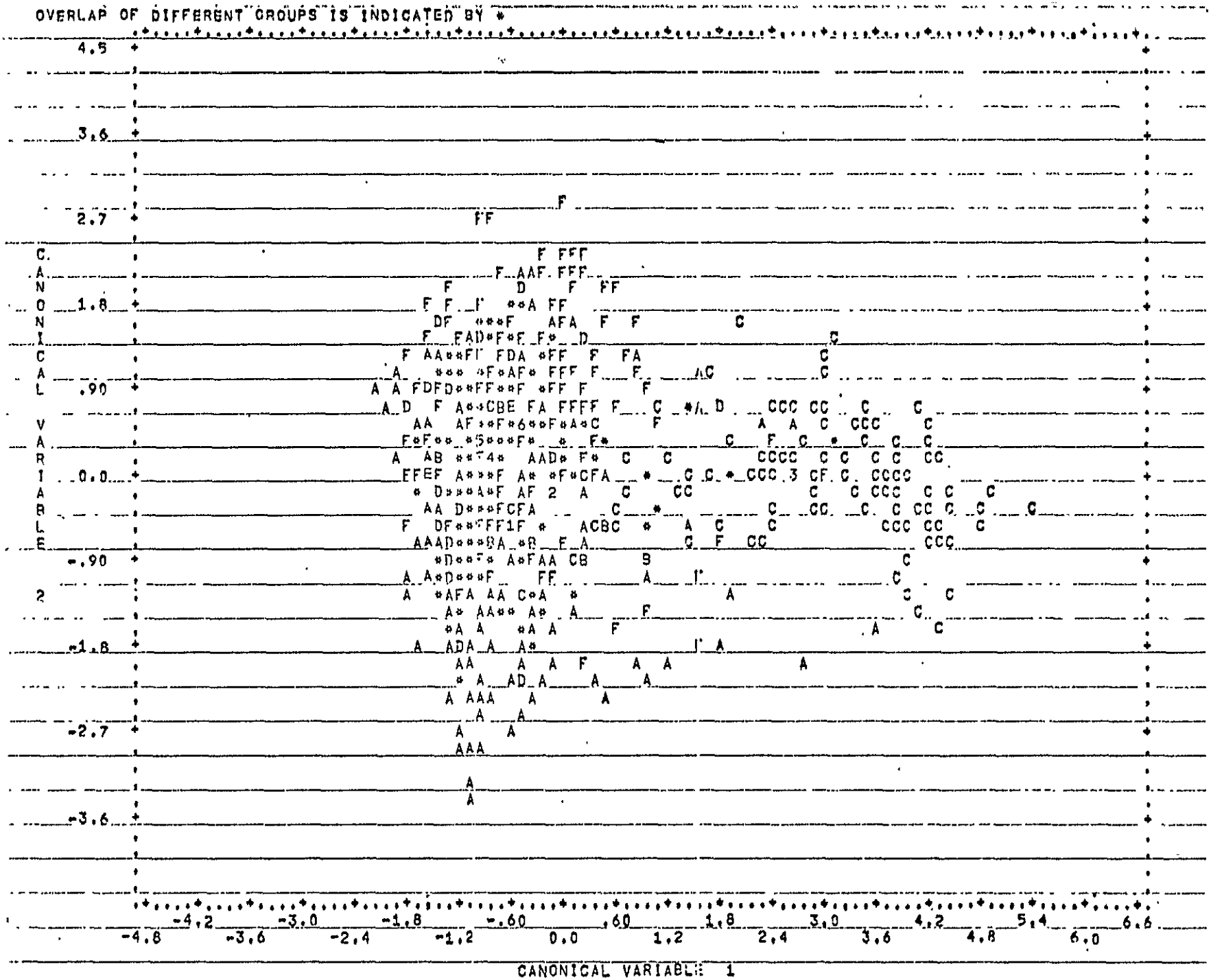
Eigenvalues	1.52504	0.21103	0.03195	0.02824
Percentage	84.90	11.75	1.78	1.57
Canonical Correlations				
	0.77715	0.41744	0.17596	0.16573

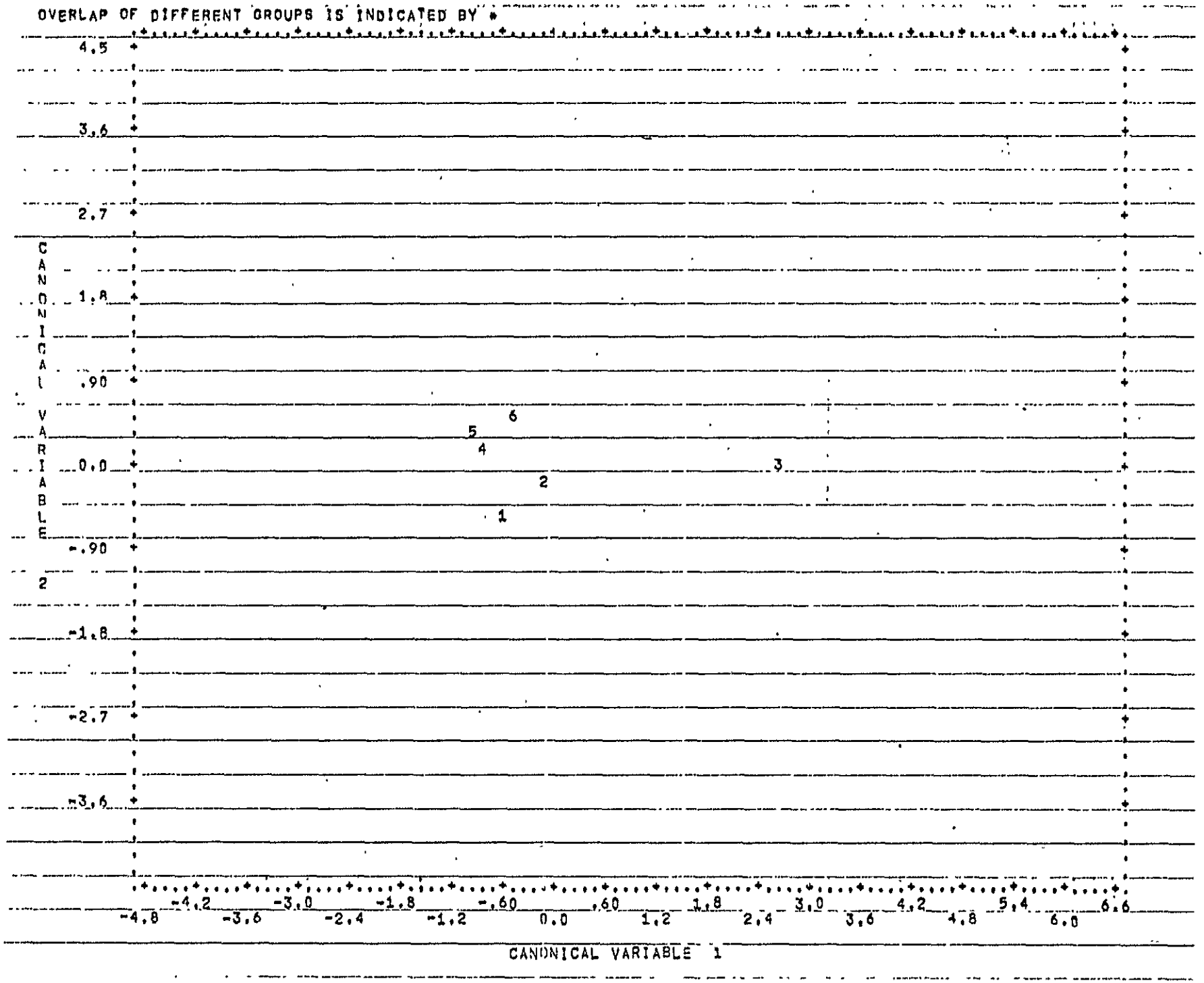
VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES			
4 R5D1	0.04604	-0.04759	-0.12397	-0.10189
6 R7D1	-0.05456	-0.06878	-0.03482	0.19005
10 R7D2	-0.07080	-0.03910	-0.10850	0.08512
12 R5D3	-0.02892	0.08052	-0.03893	-0.07313
16 R5D4	-0.08278	-0.03407	0.10160	-0.05309
18 R7D4	0.12102	-0.06715	0.07180	-0.09874
CONSTANT	1.37220	3.14749	1.53011	4.47417

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS			
WINTWHET	-0.65664	-0.53291	-0.04744	-0.04085
GRASS	-0.10481	-0.17709	-0.02529	1.05887
CORN	2.60383	-0.04903	0.02476	-0.02252
SUMFALO	-0.83325	0.19772	0.59098	-0.01134
NON AGR	-0.94528	0.30912	0.40115	0.20100
GRASORG	-0.47697	0.54448	-0.09620	-0.01743

GROUP	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat	-0.66	-0.53	A	1
Grass	-0.10	-0.18	B	2
Corn	2.60	-0.05	C	3
Summer Fallow	-0.83	0.20	D	4
Non-agriculture	-0.95	0.31	E	5
Grain sorghum	-0.48	0.54	F	6

OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
CANONICAL VARIABLE 2
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
1
2
3
4
5
6
-4.8 -4.2 -3.6 -3.0 -2.4 -1.8 -1.2 -.60 0.0 .60 1.2 1.8 2.4 3.0 3.6 4.2 4.8 5.4 6.0 6.6
CANONICAL VARIABLE 1

APPENDIX BB5

Discrimination Analysis of RICE County Using Prior Probabilities Proportional to Frequency

```
 BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.
 HEALTH SCIENCES COMPUTING FACILITY
 UNIVERSITY OF CALIFORNIA, LOS ANGELES

 IN THIS VERSION OF BMDP7M
 -- GROUP CODES OR CUTPOINTS MUST BE STATED.

    PROGRAM CONTROL INFORMATION
 PROBLEM TITLE = 'RICE CO SAMP. 1.',/
 INPUT
      VARIABLE = 20,
       FORMAT = '(2A5,12F5.0/6F5.0)',
      CASE = 660,
       UNIT = 12,/
 VARIAB ADD = 1,
        NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
        'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4',
        'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL',
      USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,
      LABEL = 1,2,
      GROUP = 'CROP TYP',/
 GROUP CODE = 1,2,3,4,5,6,
      NAME = 'WINTWHET','GRASS','CORN','SUMFALO',
             'NON AGR','GRASORG',
      PRIOR = 0.359, 0.024, 0.180, 0.079, 0.011, 0.347,/
 TRANSFORMATION
      X(21) = X(19)*X(20),/
 SAVE
      UNIT = 10,
      CODE = 'RICE CO',
      LABEL = 'RICE CO SAMPLE 1 RAW DATA',/
 PRINT STEP,
      CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,/
 PLOT CANON,
      GROUP = 1,2,3,4,5,6,
      GROUP = 1,2,3,4,6,/
 DISCRIMINANT METHOD = 2,
        FORCE = 0,
        STEP = 40,
      JACK./
 END/

      PROBLEM TITLE . . . . . .RICE CO SAMP. 1.

      NUMBER OF VARIABLES TO READ IN. . . . . .      20
      NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS.      1
      TOTAL NUMBER OF VARIABLES . . . . . .      21
      NUMBER OF CASES TO READ IN. . . . . .     660
      CASE LABELING VARIABLES . . . . . .  ROW        COLUMN
      LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
      INPUT UNIT NUMBER . . . . . .      12
      REWIND INPUT UNIT PRIOR TO READING. . DATA. . .  YES

      INPUT FORMAT
           (2A5,12F5.0/6F5.0)
```

INTERPRETIVE TRANSFORMATIONS ARE
CROP*SOL = CROP TYP * SOIL TYP.

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	15	B4D4	16	B5D4	17	B6D4		
18	B7D4	20	SOIL TYP								

TOLERANCE	0.010
F-TO-ENTER	4.000
F-TO-REMOVE	3.996
METHOD	2
MAXIMUM FORCED LEVEL	0
MAXIMUM NUMBER OF STEPS	40

PRIOR PROBABILITIES 0.35900 0.02400 0.18000 0.07900 0.01100 0.34700

VARIABLE NO.	NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
19	CROP TYP				1.00000	WINTWHET		
					2.00000	GRASS		
					3.00000	CORN		
					4.00000	SUMFALO		
					5.00000	NON.AGR		
					6.00000	GRASORG		

FILE TO WRITE SAVE FILE ONTO IS NOT A SAVE FILE.

NUMBER OF CASES READ 660

MEANS

VARIABLE	GROUP	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3	B4D1	25,50633	22,81250	22,47059	22,48077	21,71429	23,09170	23,77727
4	B5D1	24,66245	19,93750	20,23529	19,59615	18,71429	20,48035	21,83636
5	B6D1	29,10127	27,31250	23,22689	24,84615	22,71429	26,03493	26,53182
6	B7D1	14,78059	14,43750	11,42017	12,80769	11,85714	13,39738	13,50000
7	B4D2	34,67089	34,93750	34,95798	35,76923	33,00000	36,91266	35,57576
8	B5D2	33,84388	35,00000	36,85714	36,09615	33,14286	39,02620	36,36333
9	B6D2	49,47257	45,93750	40,39496	47,38461	48,71429	47,51965	46,90000
10	B7D2	26,54008	24,75000	20,35294	24,50000	26,00000	24,10044	24,36818
11	B4D3	32,85654	31,87500	31,12605	33,63461	33,71429	35,72926	33,58788
12	B5D3	32,75949	28,81250	27,69748	34,55769	34,14286	37,77729	33,64848
13	B6D3	38,79747	41,75000	43,38655	38,48077	39,57143	42,53712	40,97727
14	B7D3	18,59916	20,37500	22,48739	18,11538	18,71429	20,17031	19,85152
15	B4D4	39,45992	35,37500	30,27731	39,03769	37,42857	36,37555	36,58182
16	B5D4	43,65401	35,31250	24,63025	42,55769	41,28571	37,80349	37,88030
17	B6D4	48,91561	44,81250	52,45378	46,80769	44,85714	45,52402	48,06818
18	B7D4	23,86920	22,81250	30,42857	22,50000	21,71429	22,61135	24,45909
20	SOIL TYP	2,43038	2,31250	2,51261	2,46154	2,42857	2,29258	2,39697
19	CROP TYP	1,00000	2,00000	3,00000	4,00000	5,00000	6,00000	4,09242
COUNTS		237,	16,	119,	52,	7,	229,	660,

STANDARD DEVIATIONS

VARIABLE	GROUP	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	ALL GP
3	B4D1	4,88392	3,69177	3,50985	2,33805	2,75162	3,44701	3,97254
4	B5D1	7,55741	5,84772	5,43483	4,16926	3,25137	5,42378	6,19935
5	B6D1	7,30671	6,70044	6,96777	4,10349	4,23140	6,33970	6,67413
6	B7D1	3,74652	4,04918	4,39857	2,58226	2,79455	3,79106	3,81236
7	B4D2	4,32294	2,64496	4,26733	4,75917	5,53775	4,53942	4,40696
8	B5D2	8,17013	5,05964	7,22318	8,49050	9,92352	8,77093	8,21174
9	B6D2	6,22021	6,28722	8,32926	6,04283	4,30946	6,47097	6,70836
10	B7D2	4,57002	4,58258	4,37556	4,01752	5,16398	4,05591	4,32558
11	B4D3	4,88647	2,70493	3,50195	5,15609	5,52914	5,47210	4,07750
12	B5D3	8,44104	5,02286	6,28363	9,26100	8,09174	10,02489	8,70289
13	B6D3	8,12046	6,65833	6,60009	7,94217	6,75419	8,82404	8,07184
14	B7D3	4,47825	4,09675	3,93779	3,93403	3,45033	4,75282	4,42841
15	B4D4	4,56630	3,32415	3,56519	4,84834	3,73529	4,43160	4,34497
16	B5D4	8,23480	6,03013	7,18150	8,48161	6,65117	8,26803	8,02854
17	B6D4	7,22704	6,15596	6,07125	5,98704	6,36209	7,13931	6,87773
18	B7D4	3,98989	4,69352	5,16601	2,83189	3,25137	3,89805	4,13336
20	SOIL TYP	0,63145	0,47871	0,50195	0,64091	0,53452	0,56738	0,58433
19	CROP TYP	0,	0,	0,	0,	0,	0,	0,

STEP NUMBER 0

VARIABLE	F TO REMOVE	LEVEL	*	VARIABLE	F TO ENTER	LEVEL	TOLERANCE
	DF= 5 655		*		DF= 5 654		
			*	3 B4D1	14,593	1	1,000000
			*	4 B5D1	15,643	1	1,000000
			*	5 B6D1	14,280	1	1,000000
			*	6 B7D1	13,261	1	1,000000
			*	7 B4D2	7,246	1	1,000000
			*	8 B5D2	9,678	1	1,000000
			*	9 B6D2	29,963	1	1,000000
			*	10 B7D2	32,867	1	1,000000
			*	11 B4D3	16,353	1	1,000000
			*	12 B5D3	23,037	1	1,000000
			*	13 B6D3	8,354	1	1,000000
			*	14 B7D3	14,196	1	1,000000
			*	15 B4D4	74,686	1	1,000000
			*	16 B5D4	93,452	1	1,000000
			*	17 B6D4	16,035	1	1,000000
			*	18 B7D4	63,221	1	1,000000
			*	20 SOIL TYP	2,747	1	1,000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1

VARIABLE	F TO REMOVE DF= 5 649	LEVEL	*	VARIABLE	F TO ENTER DF= 5 648	LEVEL	TOLERANCE
4 B5D1	7,956	1	*	3 B4D1	0,602	1	0,091205
6 B7D1	4,899	1	*	5 B6D1	0,374	1	0,061799
10 B7D2	7,143	1	*	7 B4D2	2,343	1	0,750391
12 B5D3	17,955	1	*	8 B5D2	2,936	1	0,712985
16 B5D4	34,177	1	*	9 B6D2	2,290	1	0,158865
18 B7D4	53,201	1	*	11 B4D3	2,018	1	0,078758
			*	13 B6D3	2,169	1	0,461416
			*	14 B7D3	2,041	1	0,600939
			*	15 B4D4	0,847	1	0,091606
			*	17 B6D4	1,186	1	0,085686
			*	20 SOIL TYP	2,187	1	0,855998

U-STATISTIC OR WILKS' LAMBDA 0,3060451 DEGREES OF FREEDOM 6 5 654
APPROXIMATE F-STATISTIC 29,832 DEGREES OF FREEDOM 30,00 2598,00

E = MATRIX ... DEGREES OF FREEDOM = 6 649

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4,04				
CORN	141,99	19,83			
SUMFAL	6,82	4,41	72,81		
NON AG	1,52	1,73	14,41	0,41	
GRASOR	22,90	4,48	127,45	5,02	0,97

CLASSIFICATION FUNCTIONS

GROUP = VARIABLE	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
4 B5D1	0,05471	-0,05205	0,17085	-0,06968	-0,07025	0,01566
6 B7D1	0,26827	0,42131	0,05637	0,21081	0,14272	0,18968
10 B7D2	0,71167	0,74985	0,45993	0,63083	0,78107	0,66649
12 B5D3	0,32629	0,25816	0,26652	0,36275	0,36743	0,40761
16 B5D4	0,40827	0,29537	0,12883	0,46064	0,41394	0,35039
18 B7D4	0,98487	0,94965	1,51275	0,94774	0,87461	0,93711
CONSTANT	-39,13533	-35,29769	-36,73676	-37,66527	-39,16582	-35,43756

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP →					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	63,7	151	1	11	0	0	74
GRASS	0,	8	0	2	0	0	6
CORN	79,8	12	0	95	0	0	12
SUMFALO	0,	21	0	1	0	0	30
NON AGR	0,	2	0	0	0	0	5
GRASORG	70,7	61	0	6	0	0	162
TOTAL	61,8	255	1	115	0	0	269

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP →					
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG
WINTWHET	62,9	149	1	11	1	0	75
GRASS	0,	8	0	2	0	0	6
CORN	79,8	12	0	95	0	0	12
SUMFALO	0,	21	0	1	0	0	30
NON AGR	0,	2	0	0	0	0	5
GRASORG	69,9	63	0	6	0	0	160
TOTAL	61,2	255	1	115	1	0	288

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 B5D4		93,4517	1	0,5833	93,452
2	18 B7D4		52,6907	2	0,4156	71,984
3	12 B5D3		20,9253	3	0,3581	54,080
4	4 B5D1		8,4599	4	0,3363	42,014
5	10 B7D2		7,6480	5	0,3176	34,960
6	6 B7D1		4,8988	6	0,3060	29,832

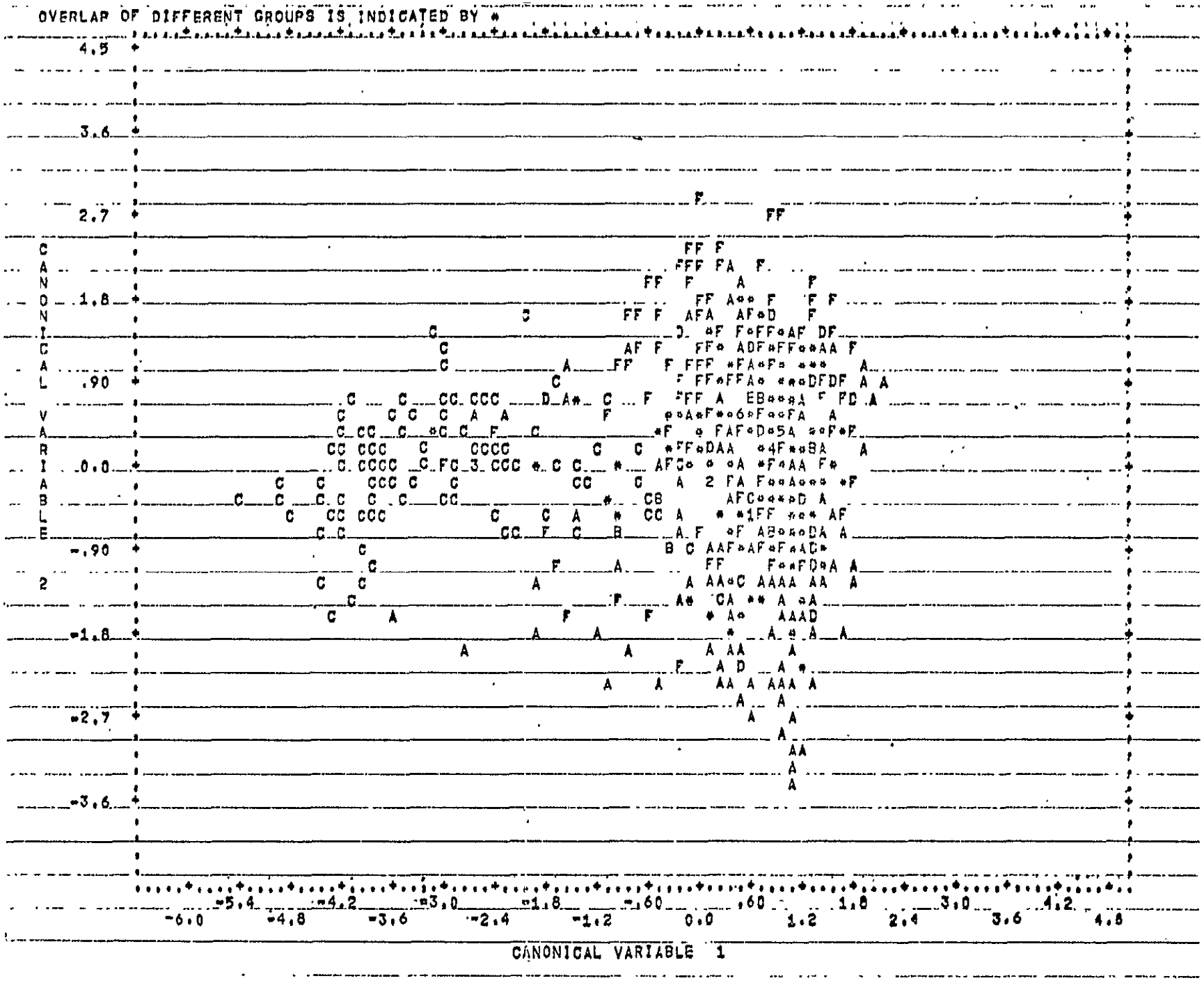
Percentage of Variation Between Groups Explained

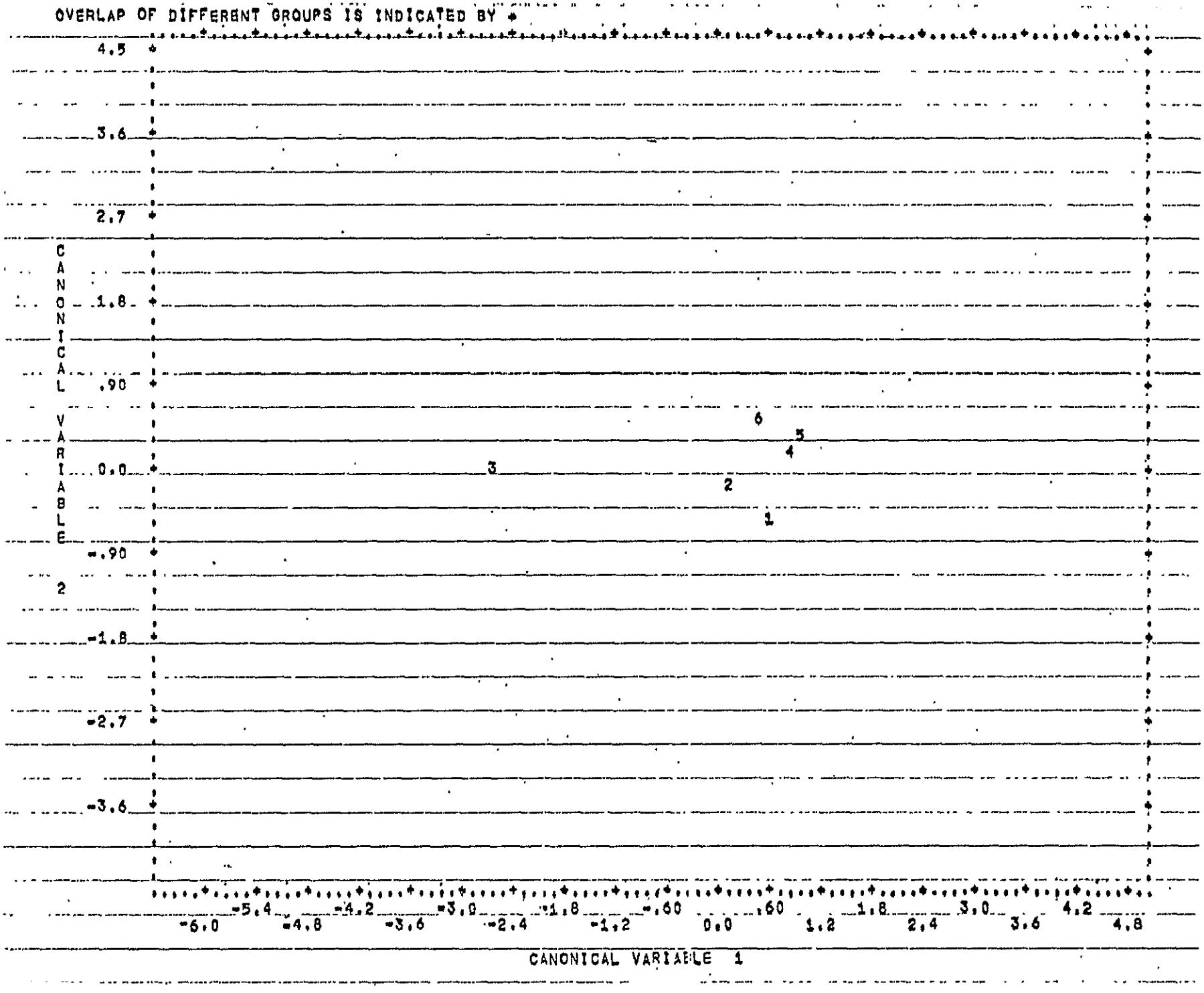
Eigenvalues	1.53071	0.21092	0.03385	0.02832	0.00293
Percentage	84.72	11.67	1.87	1.57	0.16
Canonical Correlation	0.77772	0.41735	0.18094	0.16595	0.05406

VARIABLE		COEFFICIENTS FOR CANONICAL VARIABLES				
4	B5D1	-0.04654	-0.04834	0.13858	-0.07601	-0.02882
6	B7D1	0.05429	-0.07122	0.01412	0.18839	0.20957
10	B7D2	0.07034	-0.03613	0.07351	0.10694	-0.20231
12	B5D3	0.02899	0.07962	0.05281	-0.06415	-0.00539
16	B5D4	0.08263	-0.03455	-0.08581	-0.07210	0.04491
18	B7D4	-0.17131	-0.06695	-0.05022	-0.10976	0.02305
CONSTANT		-1.34590	3.16445	-2.30597	4.03609	0.64621

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS				
WINTWHET	0.64311	-0.53704	0.05662	-0.03145	-0.00198
GRASS	0.09584	-0.17488	-0.17418	1.03864	0.04672
CORN	-2.61061	-0.04512	-0.02546	-0.02567	-0.00277
SUMFALO	0.82440	0.19477	-0.56549	-0.12632	0.05260
NON_AGR	0.93682	0.31443	-0.46417	0.12960	-0.49745
GRASORG	0.46860	0.53763	0.10837	-0.00195	0.00344

GROUP	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat	0.65	-0.54	A	1
Grass	0.10	-0.17	B	2
Corn	-2.61	-0.05	C	3
Summer Fallow	0.82	0.19	D	4
Non-agriculture	0.94	0.31	E	5
Grain sorghum	0.47	0.54	F	6




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
CANONICAL VARIABLE 2
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
6
5
4
3
2
1
-5.4
-4.2
-3.0
-1.8
-.60
.60
1.8
3.0
4.2
-6.0
-4.8
-3.6
-2.4
-1.2
0.0
1.2
2.4
3.6
4.8
CANONICAL VARIABLE 1

APPENDIX BB6

Discrimination Analysis of RICE County With Prior Probabilities and 'NON-AGRICULTURAL' Category Not Used to Calculate the Discrimination Function

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BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED.

  PROGRAM CONTROL INFORMATION
PROBLEM TITLE = 'RICE CO SAMP. 1.'./
INPUT
    VARIABLE = 20.
    FORMAT = '(2A5,12F5.0/6F5.0)'.
    CASE = 660.
    UNIT = 12./
VARIAB ADD = 1.
     NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
     'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3','B4D4','B5D4',
     'B6D4','B7D4','CROP TYP','SOIL TYP','CROP*SOL'.
   USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20.
    LABEL = 1,2.
    GROUP = 'CROP TYP'./
GROUP CODE = 1,2,3,4,5,8.
     NAME = 'WINTWHET','GRASS','CORN','SUMFALO',
          'NON AGR','GRASORG'.
    USE = 'WINTWHET','GRASS','CORN','SUMFALO','GRASORG'.
    PRIOR = 0.359, 0.024, 0.180, 0.079, 0.011, 0.347./
TRANSFORMATION
    X(21) = X(19)*X(20)./
SAVE
   UNIT = 10.
   CODE = 'RICE CO'.
   LABEL = 'RICE CO SAMPLE 1 RAW DATA'./
PRINT STEP.
     CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15./
PLOT CANON.
    GROUP = 1,2,3,4,5,8.
   GROUP = 1,2,3,4,8./
DISCRIMINANT METHOD = 2.
    FORCE = 0.
    STEP = 40.
    JACK./
END/

  PROBLEM TITLE . . . . . .RICE CO SAMP. 1.

 NUMBER OF VARIABLES TO READ IN. . . . . .      20
  NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. .     1
  TOTAL NUMBER OF VARIABLES . . . . . .      21
  NUMBER OF CASES TO READ IN. . . . . .     660
  CASE LABELING VARIABLES . . . . . .  ROW        COLUMN
  LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
  INPUT UNIT NUMBER . . . . . .      12
  REWIND INPUT UNIT PRIOR TO READING. . DATA. . .  YES

  INPUT FORMAT
       (2A5,12F5.0/6F5.0)
```

INTERPRETIVE TRANSFORMATIONS ARE
CROP*SOL = CROP TYP * SOIL TYP.

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	15	B4D4	16	B5D4	17	B6D4		
18	B7D4	20	SOIL TYP								

TOLERANCE.	0.010
F-TO-ENTER	4.000
F-TO-REMOVE.	3.996
METHOD	2
MAXIMUM FORCED LEVEL . . .	0
MAXIMUM NUMBER OF STEPS. .	40
PRIOR PROBABILITIES. . . .	0.35900 0.02400 0.18000 0.07900 0.01100 0.34700

VARIABLE NO.	NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
19	CROP TYP				1.00000	WINTWHET		
					2.00000	GRASS		
					3.00000	CORN		
					4.00000	SUMFALO		
					5.00000	NON AGR		
					8.00000	GRASORG		

FILE TO WRITE SAVE FILE ONTO IS NOT A SAVE FILE.

NUMBER OF CASES READ. 660

MEANS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	GPS. US
3	B4C1	25.50633	22.81250	22.47059	22.48077	21.71429	23.09170	23.79939
4	B5D1	24.66245	19.93750	20.23529	19.59615	18.71429	20.44035	21.86983
5	B6D1	29.10127	27.31250	23.22689	24.84615	22.71429	26.03493	26.57274
6	B7D1	14.78059	14.43750	11.42017	12.80769	11.85714	13.39738	13.51761
7	B4C2	34.67089	34.93750	34.95798	35.76923	33.00000	36.91266	35.60337
8	B5C2	33.84388	35.00000	36.85714	36.09615	33.14286	39.02620	36.41807
9	B6D2	49.47257	45.93750	40.39496	47.38401	48.71429	47.51965	46.88455
10	B7C2	26.54008	24.75000	20.35294	24.50000	26.00000	24.10044	24.35069
11	B4D3	32.85654	31.87500	31.12605	33.63461	33.71429	35.72926	33.20052
12	B5D3	32.75949	28.81250	27.69748	34.55769	34.14286	37.77729	33.64319
13	B6D3	38.79747	41.75000	43.38655	38.48077	39.57143	42.53712	40.99234
14	B7D3	18.59916	20.37500	22.48739	18.11538	18.71429	20.17031	19.86371
15	B4D4	39.45992	35.37500	30.27731	39.05769	37.42857	36.37555	36.57274
16	B5D4	43.69401	35.31250	24.63025	42.55769	41.28571	37.80349	37.84380
17	B6D4	48.91561	44.81250	52.45378	46.80769	44.85714	45.52402	48.10260
18	B7D4	23.86920	22.81250	30.42857	22.50000	21.71429	22.61135	24.48651
20	SOIL TYP	2.43038	2.31250	2.51261	2.46154	2.42857	2.29258	2.39663
19	CROP TYP	1.00000	2.00000	3.00000	4.00000	5.00000	6.00000	4.08270
COUNTS		237.	16.	119.	52.	7.	229.	653.

STANDARD DEVIATIONS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	GRASORG	GPS. US
3	B4C1	4.88392	3.69177	3.50985	2.33685	2.75162	3.44701	3.98209
4	B5D1	7.55741	5.84772	5.43483	4.16926	3.25137	5.42378	6.22012
5	B6C1	7.30671	6.70044	6.96777	4.10349	4.23140	6.33970	6.69259
6	B7D1	3.74652	4.04918	4.39357	2.58225	2.79455	3.79106	3.82652
7	B4D2	4.32294	2.64496	4.26733	4.75937	5.53775	4.53942	4.39513
8	B5D2	8.17613	5.05964	7.22318	8.49050	9.92352	8.77093	6.19422
9	B6D2	6.22021	6.28722	8.32926	6.04283	4.30946	6.47097	6.72657
10	B7D2	4.57002	4.56258	4.37556	4.01712	5.16398	4.09591	4.31705
11	B4D3	4.88647	2.78493	3.50195	5.15649	5.52914	5.47213	4.87136
12	B5D3	8.44104	5.02286	6.28363	9.26150	8.99174	10.02489	8.70835
13	B6D3	8.12046	6.65833	6.60009	7.94217	6.75419	8.82404	8.08304
14	B7D3	4.47825	4.09675	3.93779	3.93403	3.45033	4.75282	4.43646
15	B4D4	4.56630	3.32415	3.56519	4.84834	3.73529	4.43160	4.35022
16	B5D4	8.23480	6.03013	7.18150	6.48161	6.65117	8.26803	8.04019
17	B6D4	7.22704	6.15596	6.07125	5.98734	6.36209	7.13931	6.88233
18	B7D4	3.98989	4.69352	5.16601	2.83189	3.25137	3.89805	4.14065
20	SOIL TYP	0.63145	0.47871	0.50195	0.64051	0.53452	0.56738	0.58477
19	CROP TYP	0.	0.	0.	0.	0.	0.	0.

STEP NUMBER 0

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 4 649		*		DF= 4 648		
			*	3 B4D1	17.679	1	1.000000
			*	4 B5D1	18.977	1	1.000000
			*	5 B6D1	17.177	1	1.000000
			*	6 B7D1	16.179	1	1.000000
			*	7 B4D2	8.499	1	1.000000
			*	8 B5D2	11.872	1	1.000000
			*	9 B6D2	37.123	1	1.000000
			*	10 B7D2	40.993	1	1.000000
			*	11 B4D3	20.494	1	1.000000
			*	12 B5D3	28.755	1	1.000000
			*	13 B6D3	10.360	1	1.000000
			*	14 B7D3	17.564	1	1.000000
			*	15 B4D4	93.065	1	1.000000
			*	16 B5D4	116.159	1	1.000000
			*	17 B6D4	22.129	1	1.000000
			*	18 B7D4	77.971	1	1.000000
			*	20 SOIL TYP	3.423	1	1.000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1

VARIABLE	F TO REMOVE	DF= 4 643	LEVEL	*	VARIABLE	F TO ENTER	DF= 4 642	LEVEL	TOLERANCE
4 B5D1	9.520		1	*	3 B4D1	0.744		1	0.389750
6 B7D1	5.831		1	*	5 B6D1	0.316		1	0.061829
10 B7D2	8.757		1	*	7 B4D2	2.385		1	0.750633
12 B5D3	22.267		1	*	8 B5D2	3.568		1	0.714539
16 B5D4	42.059		1	*	9 B6D2	2.996		1	0.156438
18 B7D4	64.975		1	*	11 B4D3	2.474		1	0.979214
				*	13 B6D3	2.719		1	0.463426
				*	14 B7D3	2.531		1	0.682599
				*	15 B4D4	0.596		1	0.891737
				*	17 B6D4	1.436		1	0.085066
				*	20 SOIL TYP	2.591		1	0.853113

U-STATISTIC OR WILKS' LAMBDA 0.3081917 DEGREES OF FREEDOM 6 4 648
APPROXIMATE F-STATISTIC 37.527 DEGREES OF FREEDOM 24.00 2244.37

F - MATRIX DEGREES OF FREEDOM = 6 643

	WINTWH	GRASS	CORN	SUMFAL	NON AG
GRASS	4.03				
CORN	141.11	19.70			
SUMFAL	6.80	4.40	72.31		
NON AG	1.51	1.73	14.32	0.42	
GRASOR	22.82	4.47	126.50	5.00	0.97

CLASSIFICATION FUNCTIONS

GROUP = VARIABLE	WINTWHET	GRASS	CORN	SUMFALO	GRASORG
4 B5D1	0.84977	-0.05558	0.16498	-0.17413	0.01379
6 B7D1	0.26622	0.41846	0.05795	0.20951	0.18918
10 B7D2	0.70886	0.74674	0.45517	0.62680	0.66173
12 B5D3	0.32635	0.25838	0.26741	0.36294	0.40734
16 B5D4	0.41178	0.29889	0.13434	0.46432	0.35453
18 B7D4	0.98679	0.95061	1.51043	0.95078	0.93979
CONSTANT	-39.12269	-35.27977	-36.68468	-37.87961	-35.43064

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -				
		WINTWHET	GRASS	CORN	SUMFALO	GRASORG
WINTWHET	63.7	151	1	11	0	74
GRASS	0.	8	0	2	0	6
CORN	79.6	12	0	95	0	12
SUMFALO	0.	21	0	1	0	30
NON AGR	0.	2	0	0	0	5
GRASORG	70.7	61	0	6	0	162
TOTAL	62.5	255	1	115	0	289

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -				
		WINTWHET	GRASS	CORN	SUMFALO	GRASORG
WINTWHET	62.9	149	1	11	1	75
GRASS	0.	8	0	2	0	6
CORN	79.8	12	0	95	0	12
SUMFALO	0.	21	0	1	0	30
NON AGR	0.	2	0	0	0	5
GRASORG	69.9	63	0	6	0	160
TOTAL	61.9	255	1	115	1	288

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 B5D4		116.1591	1	0.5824	116.159
2	18 B7D4		64.5442	2	0.4163	88.946
3	12 B5D3		25.8983	3	0.3588	67.413
4	4 B5D1		9.8387	4	0.3381	52.492
5	10 B7D2		9.4544	5	0.3194	43.889
6	6 B7D1		5.8310	6	0.3082	37.527

Percentage of Variation Between Groups Explained

Eigenvalues	1.52504	0.21103	0.03195	0.02824
Percentage	84.90	11.75	1.78	1.57

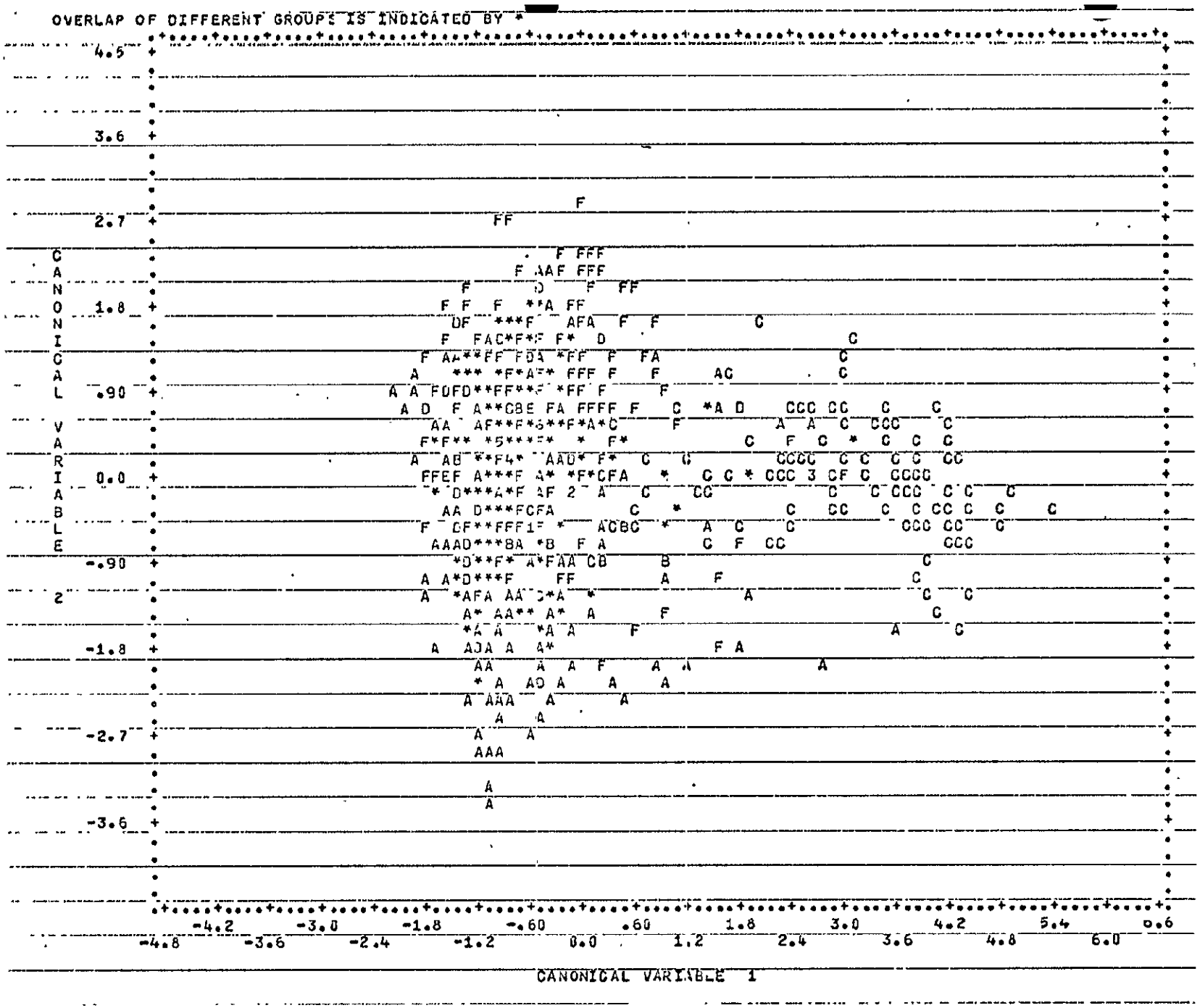
Canonical Correlations

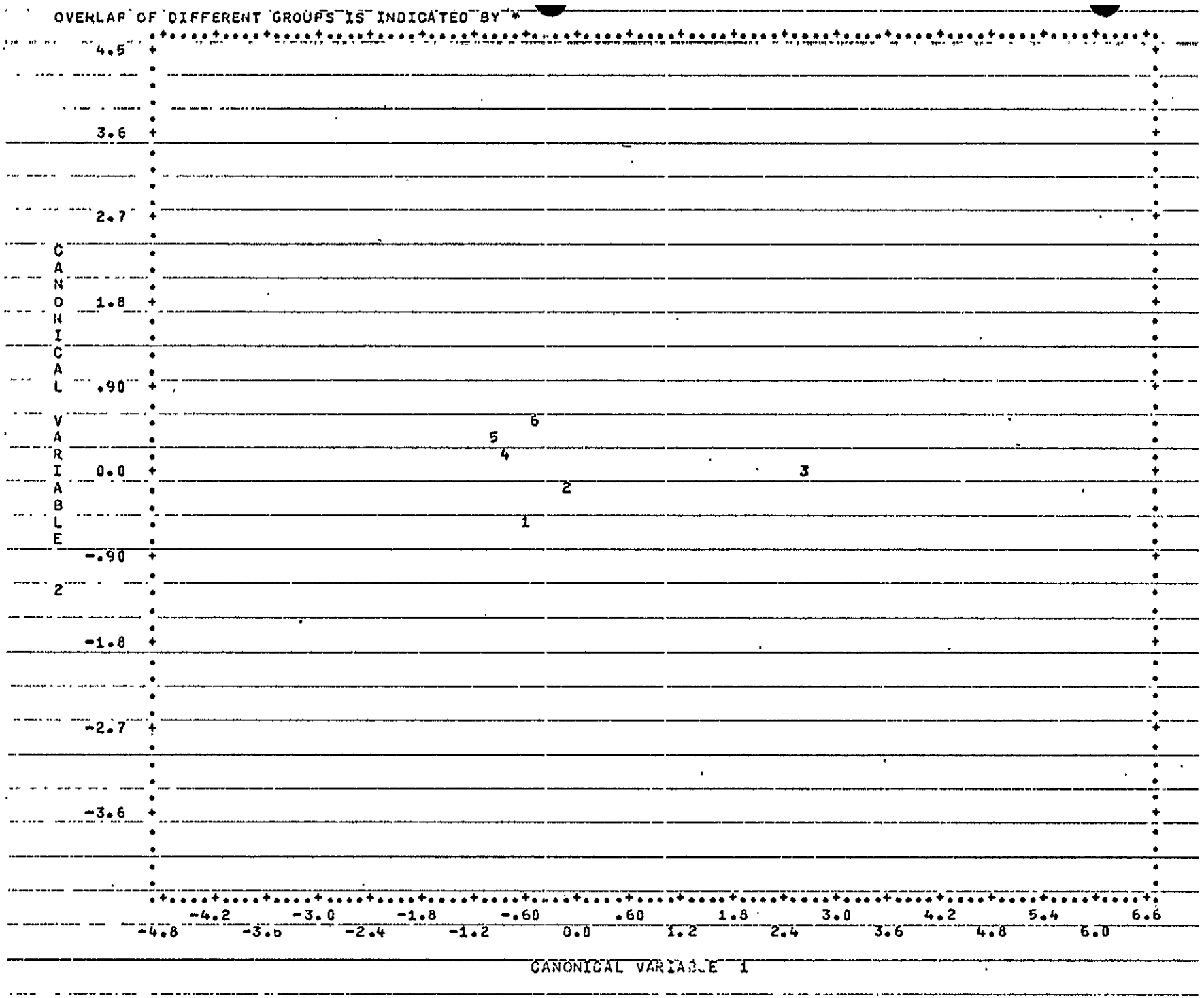
	0.77715	0.41744	0.17596	0.16573

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES			
4 B5D1	0.04604	-0.04759	-0.12397	-0.10189
6 B7D1	-0.05456	-0.06878	-0.03482	0.19035
10 B7D2	-0.07080	-0.03910	-0.10850	0.08512
12 B5D3	-0.02892	0.08052	-0.03893	-0.07313
16 B5D4	-0.08278	-0.03407	0.10160	-0.05309
18 B7D4	0.17102	-0.06715	0.07180	-0.09874
CONSTANT	1.37220	3.14749	1.53011	4.47417

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS			
WINTWHET	-0.65664	-0.53291	-0.04744	-0.04085
GRASS	-0.10481	-0.17709	-0.02529	1.05667
CORN	2.60383	-0.04903	0.02476	-0.02252
SUMFALO	-0.83325	0.19772	0.59098	-0.01134
NON AGR	-0.94526	0.30912	0.40115	0.20100
GRASORG	-0.47697	0.54448	-0.09620	-0.01743

GROUP	Mean Coordinates		Symbol for Cases	Symbol For Mean
Winter wheat	-0.66	-0.53	A	1
Grass	-0.10	-0.18	B	2
Corn	2.60	-0.05	C	3
Summer Fallow	-0.83	0.20	D	4
Non-agriculture	-0.95	0.31	E	5
Grain sorghum	-0.48	0.54	F	6




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
CANONICAL VARIABLE 2
1
2
3
4
5
6
-4.8
-4.2
-3.6
-3.0
-2.4
-1.8
-1.2
-.60
0.0
.60
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
6.0
6.6
CANONICAL VARIABLE 1

APPENDIX BB7

Discriminant Analysis of RICE County Using Combined Classification Variable Incorporationg Both Soil and Crop Types

(Linear contrasts separated crop categories only)

Transformation of Original Variables

```
      SUBROUTINE TRANSF(X,KASE,NPROB,USE)
      COMMON/GETCMB/PAD(17),XMIS
      DIMENSION X(1)
      IF((X(20).LT.1.1).AND.(X(20).GT.0.9)) X(21) = X(19)
      IF((X(20).LT.2.1).AND.(X(20).GT.1.9)) X(21) = X(19)+8.
      IF((X(20).LT.3.1).AND.(X(20).GT.2.9)) X(21) = X(19)+16.
      RETURN
      END
```

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED.

   PROGRAM CONTROL INFORMATION
PROBLEM
     TITLE = 'RICE CO SAMPLE 1 RAW DATA WITH SOIL CONTRAST',/
INPUT
     VARIABLE = 21.
     FORMAT = '(2A5,12F5.0/6F5.0)'.
     CASE = 600.
     UNIT = 12.
      GROUP = 15./
VARIABLE ADD = 1.
      NAME = 'ROW','COLUMN','B401','B501','B601','B701','B402',
      'B502','B602','B702','B403','B503','B603','B703','B404','B504',
      'B604','B704','CROP TYP','SOIL TYP','CRCP&SOL'.
     USE = 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18.
     LABEL = 1,2.
     GROUP = 'CRCP&SOL'./
GROUP
     CODE = 1,4,5,9,10,11,12,13,16,17,18,19,20,21,24.
     NAME = WINTWHT1,SUMFALO1,GRANSOR1,WINTWHT2,GRASS2,CORN2,
          SUMFALO2,NONAG2,GRANSOR2,WINTWHT3,GRASS3,CORN3,
          SUMFALO3,NONAG3,GRANSOR3.
     USE = 1,2,3,4,5,6,7,8,10,11,12,13,15./
SAVE
     UNIT = 10.
     CODE = 'RICE CO'
     LABEL = 'RICE CO SAMP 1 WITH CONTRAST VARIABLE'./
PRINT STEP.
      CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15./
PLOT CANONICAL./
DISCRIMINANT METHOD = 2.
      FORCE = 0.
      STOP = 40.
     CONTRAST = 12,-1,-1,0,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1   } ww
     CONTRAST = 0,-1,-1,12,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1   }
     CONTRAST = 0,-1,-1,0,-1,-1,-1,-1,-1,12,-1,-1,-1,-1,-1
     CONTRAST = -1,12,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,0,-1,-1
     CONTRAST = -1,0,-1,-1,-1,-1,12,-1,-1,-1,-1,-1,0,-1,-1
     CONTRAST = -1,0,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,12,-1,-1
     CONTRAST = -1,-1,12,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,0
     CONTRAST = -1,-1,0,-1,-1,-1,-1,-1,12,-1,-1,-1,-1,-1,0
     CONTRAST = -1,-1,0,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,12
     CONTRAST = -1,-1,-1,-1,13,-1,-1,-1,-1,-1,0,-1,-1,-1,-1
     CONTRAST = -1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,13,-1,-1,-1,-1
     CONTRAST = -1,-1,-1,-1,-1,13,-1,-1,-1,-1,-1,0,-1,-1,-1
     CONTRAST = -1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,13,-1,-1,-1
     CONTRAST = -1,-1,-1,-1,-1,-1,-1,13,-1,-1,-1,-1,-1,0,-1
     CONTRAST = -1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,13,-1.
      JACK./
END/
```

PROBLEM TITLE . . . . . PICE CO SAMPLE RAW DATA WITH SOIL CONTRAST

NUMBER OF VARIABLES TO READ IN.	20
NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. .	1
TOTAL NUMBER OF VARIABLES	21
NUMBER OF CASES TO READ IN.	660
CASE LABELING VARIABLES	ROW COLUMN
LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS	
INPUT UNIT NUMBER	12
REWIND INPUT UNIT PRIOR TO READING. . DATA. . .	YES

INPUT FORMAT
(2A5,12F5.0/6F5.0)

VARIABLES TO BE USED

3	B4G1	4	B5G1	5	B6G1	6	B7G1	7	B4G2		
8	B5G2	9	B6G2	10	B7G2	11	B4G3	12	B5G3		
13	B6G3	14	B7G3	15	B4G4	16	B5G4	17	B6G4		
18	B7G4										

TOO MANY CONTRASTS SPECIFIED.
THE FIRST 12 ARE USED.

TOLERANCE.	0.010							
F-TO-ENTER	4.000							
F-TO-REMOVE.	3.996							
METHOD	2							
MAXIMUM FORCED LEVEL . . .	0							
MAXIMUM NUMBER OF STEPS. .	40							
PRIOR PROBABILITIES. . . .	0.07692	0.07692	0.07692	0.07692	0.07692	0.07692	0.07692	0.07692
	0.07692	0.07692	0.07692	0.07692	0.07692	0.07692	0.07692	

VARIABLE NO.	NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
21	CROPSOL				1.00000	WINTWHT1		
					4.00000	SUMFALO1		
					8.00000	GRANSOP1		
					9.00000	WINTWHT2		
					10.00000	GRASS2		
					11.00000	CORN2		
					12.00000	SUMFALO2		
					13.00000	NONAG2		
					16.00000	GRANSOR2		
					17.00000	WINTWHT3		
					18.00000	GRASS3		
					19.00000	CORN3		
					20.00000	SUMFALO3		
					21.00000	NONAG3		
					24.00000	GRANSOR3		

FILE TO WRITE SAVE FILE ONTO IS NOT A SAVE FILE.

NUMBER OF CASES READ. 660

MEANS

GROUP = VARIABLE	WINTWHT1	SUMFALO1	GRANSOR1	WINTWHT2	GRASS2	CORN2	SUMFALO2	NONAG2	GRANSOR
3 B4C1	21.85556	20.75000	22.69231	20.55556	23.53636	22.06897	22.50000	20.25000	22.7205
4 B5C1	17.88889	16.75000	20.00000	24.46465	21.45455	19.25862	19.95000	17.50000	19.9920
5 B6C1	22.94444	24.75000	23.00000	27.85859	26.45455	21.10345	23.35000	21.25000	25.2500
6 B7C1	12.22222	12.25000	10.92308	13.49899	13.18182	10.68897	11.75000	11.50000	13.0441
7 B4C2	32.61111	32.00000	35.76923	35.15152	34.36364	32.41379	33.55000	34.50000	37.1764
8 B5C2	31.00000	27.25000	30.00000	34.46465	34.36364	33.67241	31.95000	34.75000	39.6764
9 B6C2	44.83333	31.75000	49.07692	48.13131	44.81818	37.15517	49.15000	51.00000	46.7132
10 B7C2	24.00000	16.25000	25.46154	25.59596	24.09091	18.79310	26.45000	27.25000	23.5294
11 B4C3	31.27778	32.25000	33.61538	31.54545	31.54545	30.72414	31.40000	34.00000	36.1544
12 B5C3	29.66667	32.50000	32.07692	30.40404	27.36364	25.37931	30.20000	34.75000	38.3235
13 B6C3	37.50000	42.75000	37.07692	35.79798	42.18182	41.39655	34.40000	41.00000	42.9705
14 B7C3	18.00000	20.50000	18.00000	17.02020	21.63636	21.34483	16.60000	19.50000	20.2647
15 B4C4	37.55556	31.00000	40.53846	39.43434	35.00000	30.10345	41.30000	39.50000	35.6764
16 B5C4	39.05556	29.50000	45.69231	43.59596	35.45455	24.34483	46.80000	44.50000	36.3676
17 B6C4	42.72222	36.50000	47.15385	46.89899	44.00000	51.18965	48.55000	47.50000	44.139
18 B7C4	22.22222	18.00000	21.92308	22.66667	21.72727	29.44828	22.85000	23.00000	22.007
21 CROPSOL	1.00000	4.00000	6.00000	9.00000	10.00000	11.00000	12.00000	13.00000	16.000
COUNTS	18.	4.	13.	99.	11.	58.	20.	4.	136

GROUP = VARIABLE	WINTWHT3	GRASS3	CORN3	SUMFALO3	NONAG3	GRANSOR3	GPS. US
3 B4C1	24.13333	21.00000	22.65246	22.71429	23.66667	23.78750	23.79939
4 B5C1	20.84167	16.60000	21.16393	19.75000	20.33333	21.38750	21.86983
5 B6C1	31.15000	29.20000	25.24590	25.92857	24.66667	27.88750	26.57274
6 B7C1	15.89167	17.29000	12.70492	13.64286	12.33333	14.40000	13.51761
7 B4C2	34.99333	36.20000	36.42623	38.17857	31.00000	36.85000	35.60337
8 B5C2	33.75833	36.40000	39.88525	40.32143	31.00000	36.41250	36.41867
9 B6C2	51.27500	48.40000	43.47541	48.35714	45.66667	48.63750	46.88059
10 B7C2	27.70000	26.20000	21.93607	24.28571	24.33333	24.85000	24.35069
11 B4C3	34.17500	32.60000	31.50820	35.42857	33.33333	34.35000	37.58652
12 B5C3	35.16667	32.00000	28.95082	37.96429	33.33333	37.77500	33.64319
13 B6C3	41.46667	40.80000	45.27869	41.78571	37.66667	42.68750	40.99234
14 B7C3	19.99167	19.80000	23.57377	18.85714	17.66667	20.36250	19.86371
15 B4C4	39.76667	36.00000	30.44262	38.69714	34.66667	36.69750	36.57274
16 B5C4	44.39167	35.00000	24.90164	41.39286	37.00000	38.96250	37.84380
17 B6C4	51.20833	45.60000	53.65574	47.17857	41.33333	47.61250	48.10260
18 B7C4	25.15833	25.20000	31.36066	22.89286	20.00000	23.75000	24.48651
21 CROPSOL	17.00000	18.00000	19.00000	20.00000	21.00000	24.00000	15.25974
COUNTS	120.	5.	61.	28.	3.	80.	653.

STANDARD DEVIATIONS

GROUP =	WINTWPT1	SUMFALO1	GRANSOR1	WINTWPT2	GRASS2	CORN2	SUMFALO2	NONAG2	GRANSOR2
VARIABLE									
3 B4C1	2.83823	1.89297	2.17503	4.35231	4.00681	2.91916	1.79179	1.53000	3.48266
4 B5C1	4.63722	2.86155	3.67423	6.57191	6.25082	4.19089	3.20321	3.69685	5.34377
5 B6C1	3.33282	3.23156	3.16228	6.35675	6.68277	5.11613	3.24889	0.95743	6.70737
6 B7C1	2.26367	1.50000	2.13937	3.33655	3.70994	3.42776	1.91630	1.29999	4.13455
7 B4C2	3.48339	1.41421	3.46750	3.92107	2.50991	3.07243	3.79022	7.04746	4.52791
8 B5C2	6.07793	1.53000	6.65833	7.57455	5.12392	4.86804	7.44435	13.22561	8.68851
9 B6C2	8.91298	5.51100	2.92564	0.29974	6.91112	6.84618	3.37610	4.24264	6.71373
10 B7C2	6.58176	4.03113	3.87179	4.53089	5.29489	3.88320	3.11997	6.44951	4.34777
11 B4C3	3.62679	2.87228	3.75363	4.62755	2.97871	2.93074	4.27231	6.16441	5.24863
12 B5C3	4.98232	5.89230	6.43508	7.84794	4.96633	4.83346	7.07553	8.38153	9.74783
13 B6C3	5.81327	5.37742	5.49942	7.19124	8.01722	7.35315	5.59395	6.97615	9.25677
14 B7C3	3.37213	3.87298	3.41565	3.84384	4.92469	4.48605	2.43656	3.69685	5.31222
15 B4C4	6.50784	4.09000	3.79948	4.56732	3.50984	3.70249	4.00132	3.31662	4.39666
16 B5C4	10.94387	7.72442	7.09912	8.28685	6.28273	7.08978	6.67754	7.16795	8.23888
17 B6C4	6.53222	5.25991	5.71323	6.67082	6.37161	7.87468	5.30615	3.31662	7.36677
18 B7C4	3.19148	4.54616	2.56469	3.37705	4.33799	5.92104	1.92696	1.41421	4.16606
21 CRCRASOL	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP =	WINTWPT3	GRASS3	CORN3	SUMFALO3	NONAG3	GRANSOR3	GPS. US
VARIABLE							
3 B4C1	3.21139	2.23697	3.37843	2.67854	3.05505	3.47757	3.99436
4 B5C1	4.12300	3.20936	6.29333	4.88393	2.38167	5.72468	6.09158
5 B6C1	7.75665	7.08520	7.88174	4.51277	6.50641	5.62486	6.45284
6 B7C1	3.88013	3.61318	4.84198	2.85723	4.50925	3.65477	3.67282
7 B4C2	4.87172	2.77489	5.72743	4.22561	2.64575	4.71222	4.27745
8 B5C2	8.84987	5.17667	7.83933	7.35373	4.58253	8.81641	7.98439
9 B6C2	4.56706	4.21990	8.49236	4.25323	2.28167	6.26067	6.35491
10 B7C2	3.90346	2.68326	4.32890	2.97965	3.21455	3.50804	4.13774
11 B4C3	4.62748	2.17364	3.96653	5.39941	5.45947	5.03443	4.78240
12 B5C3	9.66745	7.89739	7.22363	9.81483	9.45163	10.74795	8.50270
13 B6C3	9.27260	2.54939	5.18051	8.65537	7.37111	8.27317	7.81996
14 B7C3	4.67875	1.30384	2.98585	4.50279	3.51188	3.74248	4.32444
15 B4C4	4.16226	3.16228	3.45217	4.21935	2.30940	4.20164	4.23922
16 B5C4	7.55517	6.12372	7.31598	7.60769	2.64575	7.64902	7.82192
17 B6C4	7.13520	5.89915	4.68290	4.84613	8.53490	6.42265	6.60485
18 B7C4	4.16063	5.01996	4.16746	2.64353	4.58258	3.35457	4.01292
21 CRCRASOL	0.	0.	0.	0.	0.	0.	0.

STEP NUMBER 0

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 13 641		*		DF= 13 640		
			*	3 B401	8.229	1	1.000000
			*	4 B501	8.936	1	1.000000
			*	5 B601	10.174	1	1.000000
			*	6 B701	10.157	1	1.000000
			*	7 B402	6.037	1	1.000000
			*	8 B502	6.068	1	1.000000
			*	9 B602	16.467	1	1.000000
			*	10 B702	17.435	1	1.000000
			*	11 B403	8.258	1	1.000000
			*	12 B503	11.129	1	1.000000
			*	13 B603	5.931	1	1.000000
			*	14 B703	5.401	1	1.000000
			*	15 B404	24.493	1	1.000000
			*	16 B504	29.343	1	1.000000
			*	17 B604	8.963	1	1.000000
			*	18 B704	15.934	1	1.000000

STEP NUMBER 6
VARIABLE ENTERED 6 B7D1

VARIABLE	F TO REMOVE	FORCE LEVEL	*	VARIABLE	F TO ENTER	FORCE LEVEL	TOLERANCE
	DF= 13 635		*		DF= 13 634		
4 B5D1	4.542	1	*	3 B4D1	0.819	1	0.093008
6 B7D1	4.028	1	*	5 B6D1	0.858	1	0.066367
9 B6D2	5.224	1	*	7 B4D2	3.848	1	0.661953
12 B5D3	7.157	1	*	8 B5D2	3.400	1	0.686327
16 B5D4	12.880	1	*	10 B7D2	2.447	1	0.162938
18 B7D4	14.808	1	*	11 B4D3	2.843	1	0.080291
			*	13 B6D3	2.329	1	0.467794
			*	14 B7D3	1.636	1	0.627760
			*	15 B4D4	1.333	1	0.095881
			*	17 B6D4	0.852	1	0.091500

U-STATISTIC OR WILKS' LAMBDA 0.2961369 DEGREES OF FREEDOM 6 13 640
APPROXIMATE F-STATISTIC 11.108 DEGREES OF FREEDOM 78.00 3507.26

F - MATRIX DEGREES OF FREEDOM = 6 635

	WINTWH	SUMFAL	GRANSO	WINTWH	GRASS2	CORN2	SUMFAL	NONAG2	GRANSO	WINTWH	GRASS3	CORN3	SUMFAL
SUMFAL	4.23												
GRANSO	1.42	5.39											
WINTWH	3.16	5.45	2.64										
GRASS2	1.25	2.72	3.35	2.02									
CORN2	22.65	6.96	26.36	70.68	12.32								
SUMFAL	1.97	6.18	0.34	3.65	4.04	36.80							
NONAG2	0.91	4.02	0.29	1.52	2.09	9.78	0.33						
GRANSO	4.33	3.90	5.05	18.26	3.13	63.96	9.55	1.66					
WINTWH	7.41	7.58	5.42	7.86	4.68	73.76	7.09	1.86	24.34				
GRASS3	2.53	4.39	4.83	4.60	2.64	9.94	4.45	2.25	4.33	3.93			
CORN3	24.57	9.72	27.72	71.47	12.76	7.27	37.98	9.51	70.13	68.81	7.77		
SUMFAL	2.08	4.07	2.02	5.11	3.42	39.53	3.02	0.59	2.55	5.40	3.12	38.43	
NONAG3	0.49	1.46	0.83	0.65	0.38	5.29	1.20	0.80	0.28	1.44	1.97	5.62	0.60
GRANSO	3.74	5.97	4.48	9.72	3.11	57.80	6.94	1.33	3.47	7.36	3.01	52.72	1.21

	NONAG3
GRANSO	0.62

CLASSIFICATION FUNCTIONS

GROUP =	WINTWHT1	SUMFALO1	GRANSOR1	WINTWHT2	GRASS2	CORN2	SUMFALO2	GRANSOR2	WINTWH
VARIABLE									
4 B5D1	-0.12873	-0.01298	-0.06119	0.05618	0.03924	0.15599	-0.11456	0.00978	0.046
6 B7D1	0.32537	0.38136	0.08760	0.28018	0.32651	0.05204	0.28143	0.22838	0.383
9 B6D2	0.73623	0.43028	0.81171	0.77945	0.76574	0.57635	0.80281	0.78010	0.826
12 B5D3	0.22632	0.31536	0.27777	0.23859	0.19597	0.22564	0.23789	0.35652	0.262
16 B5D4	0.79343	0.28775	0.48156	0.39810	0.27293	0.11239	0.50930	0.29062	0.386
18 B7D4	1.06690	0.87700	1.01988	1.04916	1.01990	1.57336	1.06222	1.02355	1.131
CONSTANT	-42.95298	-28.79964	-48.98675	-43.12312	-40.89930	-42.59714	-50.20882	-45.87187	-55.7774

GROUP *	GRASS2	CORN2	SUMFALO2	GRANSOR2
VARIABLE				
4 B5C1	-0.39083	0.11756	-0.08716	-0.01599
6 B7C1	0.84492	0.23279	0.31397	0.33368
9 B6C2	0.83597	0.73125	0.78592	0.80133
12 B5C3	0.13662	0.21955	0.33902	0.33030
16 B5C4	0.30422	0.66461	0.40379	0.33155
18 B7C4	1.22753	1.63994	1.07425	1.11741
CONSTANT	-51.41388	-51.09167	-49.83745	-50.26194

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -											
		WINTWHT1	SUMFALO1	GRANSOR1	WINTWHT2	GRASS2	CORN2	SUMFALO2	GRANSOR2	WINTWHT3	GRASS3	CORN3	SUMFAL
WINTWHT1	11.1	2	3	0	2	1	0	5	2	0	2	1	0
SUMFALO1	75.0	0	3	0	0	0	1	0	0	0	0	0	0
GRANSOR1	23.1	0	0	3	1	0	0	4	2	0	0	0	3
WINTWHT2	23.2	19	2	8	23	12	3	8	5	13	2	1	5
GRASS2	45.5	1	2	0	1	5	2	0	1	0	0	1	0
CORN2	62.1	2	1	1	0	6	36	0	1	0	1	8	0
SUMFALO2	60.0	3	0	1	0	0	0	12	3	0	1	0	0
NONAG2	0.	1	0	1	0	0	0	1	0	0	0	0	1
GRANSOR2	34.2	0	9	5	4	11	0	11	52	9	10	2	17
WINTWHT3	47.1	3	1	5	5	6	0	12	9	48	6	5	13
GRASS3	10.2	0	0	0	0	0	0	0	0	0	4	1	0
CORN3	39.3	1	1	1	0	0	22	1	0	3	5	24	0
SUMFALO3	14.3	2	0	4	3	0	0	3	6	2	1	0	4
NONAG3	0.	0	0	1	0	1	0	0	0	0	0	0	0
GRANSOR3	20.0	5	4	3	1	7	1	9	10	6	6	1	9
TOTAL	35.5	39	26	33	40	51	63	66	91	81	40	44	53

		GRANSOR3
WINTWHT1	11.1	0
SUMFALO1	75.0	0
GRANSOR1	23.1	0
WINTWHT2	23.2	1
GRASS2	45.5	1
CORN2	62.1	0
SUMFALO2	60.0	0
NONAG2	0.	0
GRANSOR2	34.2	6
WINTWHT3	47.1	7
GRASS3	10.2	0
CORN3	39.3	3
SUMFALO3	14.3	3
NONAG3	0.	1
GRANSOR3	20.0	16
TOTAL	35.5	37

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -											
		WINTWHT1	SUMFALO1	GRANSOR1	WINTWHT2	GRASS2	CORN2	SUMFALO2	GRANSOR2	WINTWHT3	GRASS3	CORN3	SUMFALO
WINTWHT1	0.	0	4	0	2	1	0	6	2	0	2	1	0
SUMFALO1	75.0	0	3	0	0	0	1	0	0	0	0	0	0
GRANSOR1	23.1	0	0	3	1	0	0	4	2	0	0	0	3
WINTWHT2	21.2	15	3	8	21	12	3	8	5	14	2	1	6
GRASS2	14.2	2	2	0	3	2	0	0	1	0	0	1	0
CORN2	58.6	2	1	1	0	8	34	0	1	0	1	10	0
SUMFALO2	45.0	3	0	4	0	0	0	9	3	0	1	0	0
NONAG2	0.	1	0	1	0	0	0	1	0	0	0	0	1
GRANSOR2	36.8	0	10	5	4	12	0	11	50	9	10	2	17
WINTWHT3	39.2	3	1	6	4	6	0	12	9	47	6	5	14
GRASS3	40.0	1	0	0	0	1	0	0	0	0	2	1	0
CORN3	33.3	1	1	1	0	0	22	1	0	3	5	24	0
SUMFALO3	14.3	2	0	4	3	0	0	3	6	2	1	0	4
NONAG3	0.	0	0	1	0	1	0	0	0	0	0	0	0
GRANSOR3	20.0	5	4	3	1	7	1	9	10	6	8	1	9
TOTAL	32.9	35	29	37	39	50	61	64	89	81	38	46	54

		GRANSOR3
WINTWHT1	0.	0
SUMFALO1	75.0	0
GRANSOR1	23.1	0
WINTWHT2	21.2	1
GRASS2	14.2	0
CORN2	58.6	0
SUMFALO2	45.0	0
NONAG2	0.	0
GRANSOR2	36.8	6
WINTWHT3	39.2	7
GRASS3	40.0	0
CORN3	33.3	3
SUMFALO3	14.3	3
NONAG3	0.	1
GRANSOR3	20.0	16
TOTAL	32.9	37

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	16 B504		29.3433	1	0.6266	29.343
2	18 B704		15.2340	2	0.4783	21.919
3	17 B503		13.6962	3	0.3927	17.986
4	9 B402		5.4735	4	0.3533	14.636
5	4 B501		5.0086	5	0.3205	12.607
6	6 B701		4.0284	6	0.2960	11.108

Percent of Variation Between Groups Explained

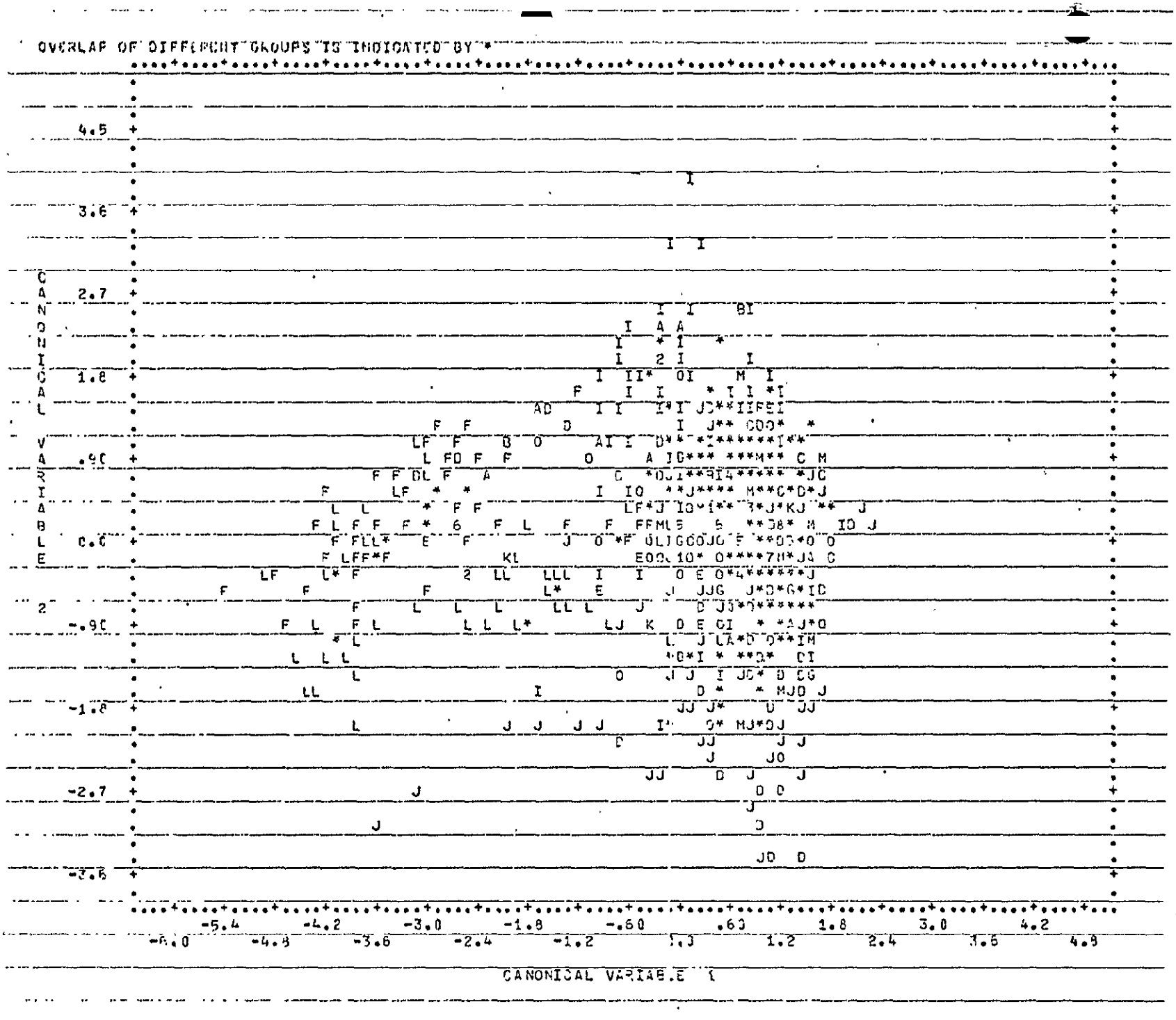
Eigenvalues	1.55352	0.29939	0.19371	0.06496	0.04932	0.02404
Percentage	71.101	13.702	8.866	2.973	2.257	1.100
Canonical Correlations						
	0.77999	0.48001	0.40283	0.24698	0.21681	0.15321

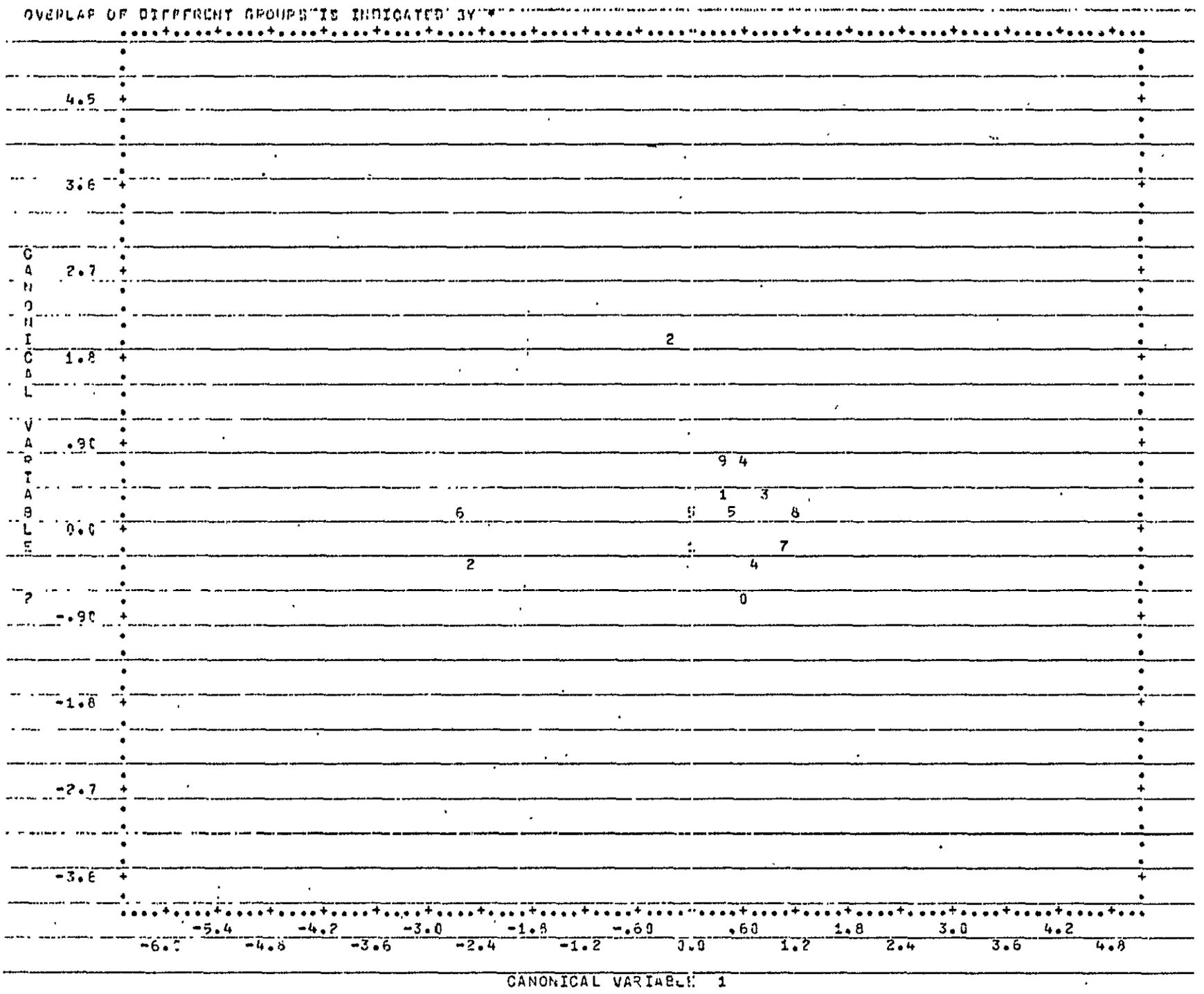
VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES					
4 B5C1	-0.04438	-0.03932	0.09389	0.18353	0.12332	-0.14523
6 B7C1	0.04449	-0.08039	-0.09839	-0.03445	-0.18677	-0.08143
9 B6C2	0.34442	-0.34430	-0.06750	-0.04174	-0.07353	0.06734
12 B8C3	0.02121	0.08655	-0.07139	0.01967	0.02614	0.00146
16 B5C4	0.09784	-0.03323	0.06048	-0.04941	-0.00093	0.04674
19 B7C4	-0.16833	-0.12219	-0.03565	-0.10295	-0.12331	0.10999
CONSTANT	-1.97868	6.39693	5.39523	2.17039	5.49229	-3.86436

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS					
WINTWHT1	0.41719	0.35429	0.68810	-0.43451	0.07988	0.36154
SUMFALO1	-0.24329	1.98730	0.93441	0.79810	1.53236	-1.17175
GRANSOF1	1.15529	0.14736	0.77772	-0.49278	0.36733	0.69768
WINTWHT2	0.71313	-0.33331	0.53479	0.24037	0.29922	-0.27526
GRASS2	0.00436	0.10739	0.57294	0.30054	0.34474	-0.46134
CORN2	-2.64512	0.24886	0.51089	0.06000	0.25230	-0.02287
SUMFALO2	1.11987	-0.17655	0.85916	-0.72038	0.03471	0.79351
NONAG2	1.15397	0.17221	0.28008	-1.04228	-0.25375	1.19636
GRANSOF2	1.41777	0.73624	-0.25435	0.10469	0.38136	-0.03435
WINTWHT3	1.64433	-0.75758	-0.25136	0.09242	-0.33078	-0.12291
GRASS3	0.05706	-0.24234	-0.56548	-1.13554	-1.56517	0.49994
CORN3	-2.53312	-0.42837	-0.38575	-0.12001	-0.64533	0.10734
SUMFALO3	0.83513	0.32922	-0.15717	-0.37371	-0.08627	0.36336
NONAG3	0.59798	0.76869	0.32360	0.31090	0.67219	-0.28731
GRANSOF3	0.44637	0.15577	-0.40825	-0.05756	-0.15677	0.08127

Points to be plotted

GROUP	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat 1	0.42	0.36	A	1
Summer fallow	-0.24	1.99	B	2
Grain sorghum 1	1.16	0.15	C	3
Winter wheat 2	0.71	-0.33	D	4
Grass 2	0.00	0.20	E	5
Corn 2	-2.65	0.25	F	6
Summer fallow 2	1.11	-0.18	G	7
Non-agriculture 2	1.15	0.17	H	8
Grain sorghum 2	0.42	0.74	I	9
Winter wheat 3	0.84	-0.76	J	0
Grass 3	0.06	-0.24	K	1
Corn 3	-2.53	-0.43	L	2
Summer fallow	0.84	0.33	M	3
Non-agriculture 3	0.60	0.77	M	4
Grain sorghum 3	0.45	0.16	O	5




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY "*"
CANONICAL VARIABLE 2
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
-6.0
-5.4
-4.8
-4.2
-3.6
-3.0
-2.4
-1.8
-1.2
-.60
0.0
.60
1.2
1.8
2.4
3.0
3.6
4.2
4.8
CANONICAL VARIABLE 1

APPENDIX C

Morton County LACIE Intensive Study Site

Computer compatible tape coordinates

FR 160	LR 359
FC 270	LC 469

20 Bands of ERTS data from 5 dates:

October 23, 1973

May 9, 1974

May 27, 1974

June 14, 1974

July 2, 1974

ERTS observations ID's:

1457-16551 [reference scene]

1655-16512

1673-16505

1691-16501

1709-16494

Rotation and distortion parameters for ground truth bands to overlay ERTS bands.

+ 15.7° Rotation

Vertical Stretch .116 pel/pel at upper left

Horizontal Stretch .05714 pel/pel at upper left

Soil types taken from map of Morton County reconnaissance soil conservation survey from Soil Conservation Service, Washington, D. C. 1947.

Crop types were identified from landuse data collected by ASCS, June, 1974, prepared by FSO, Cartographic Laboratory Earth Observation Division, S & AD JSC/NASA, Houston, Texas, September, 1974.

APPENDIX CC1

Discrimination Analysis for MORTON

Using Raw Data

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS.
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   -- GROUP CODES OR CUTPOINTS MUST BE STATED.

   PROGRAM CONTROL INFORMATION
 PROBLEM TITLE IS
      'MORTON CO.  SAMPLE 1 DISCRIMINANT ANALYSIS.',
 /
 INPUT VARIABLES ARE 24.
      FORMAT IS '(2A5,12F5.0/10F5.0)'
      CASES ARE 2103.
      UNIT IS 12.
 /
 VARIABLE NAMES ARE ROWS,COLUMNS,B4D1,B5D1,B6D1,B7D1,B4D2,
      B5D2,B6D2,B7D2,B4D3,B5D3,B6D3,B7D3,B4D4,B5D4,B6D4,
      B7D4,B4D5,B5D5,B6D5,B7D5,'CROP TYP','SOIL TYP',
      USE = 3 TO 24.
      LABEL=1,2.
      GROUP='CROP TYP'.
 /
 GROUP CODE IS 1 TO 6,8,9.
    NAME= WINTWHET,GRASS,CORN,SUMFALO,'NON AGR',WATER,GRASORG,
      RYE.
 /
 PRINT STEP,  CLASS=1 TO 15.
 /
 PLOT CANON,  GROUPS ARE 1 TO 6,8,9.
      GROUP=1,2,3,4,8,9.
 /
 DISCRIMINANT METHOD IS 2.  FORCE =0,  STEP=40.
      JACKKNIFE.
 /
 END/

   PROBLEM TITLE . . . . . .MORTON CO. SAMPLE 1 DISCRIMINANT ANALYSIS.

   NUMBER OF VARIABLES TO READ IN. . . . . .      24
   NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS.       0
   TOTAL NUMBER OF VARIABLES . . . . . .      24
   NUMBER OF CASES TO READ IN. . . . . .    2103
   CASE LABELING VARIABLES . . . . . .    ROWS      COLUMNS
   LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
   INPUT UNIT NUMBER . . . . . .      12
   REWIND INPUT UNIT PRIOR TO READING. . DATA. . .     YES

   INPUT FORMAT
        (2A5,12F5.0/10F5.0)
```

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	15	B4D4	16	B5D4	17	B6D4		
18	B7D4	19	B4D5	20	B5D5	21	B6D5	22	B7D5		
23	CROP TYP	24	SOIL TYP								

TOLERANCE	0.010							
F-TO-ENTER	4.000							
F-TO-REMOVE	3.996							
METHOD	2							
MAXIMUM FORCED LEVEL	0							
MAXIMUM NUMBER OF STEPS	40							
PRIOR PROBABILITIES	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500

VARIABLE NO.	NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
23	CROP TYP				1.00000	WINTWHET		
					2.00000	GRASS		
					3.00000	CORN		
					4.00000	SUMFALO		
					5.00000	NON AGR		
					6.00000	WATER		
					8.00000	GRASORG		
					9.00000	RYE		

NUMBER OF CASES READ 2103

CC1-2

STEP NUMBER 16
VARIABLE ENTERED 6 B5D2

VARIABLE	F TO REMOVE DF= 7 2080	FORCE LEVEL	*	VARIABLE	F TO ENTER DF= 7 2079	FORCE LEVEL	TOLERANCE
3 B4D1	11,112	1	*	5 B6D1	0,425	1	0,497941
4 B5D1	8,296	1	*	10 B7D2	2,695	1	0,807300
6 B7D1	31,037	1	*	13 B6D3	3,859	1	0,122104
7 B4D2	7,103	1	*	18 B7D4	2,483	1	0,163184
8 B5D2	4,092	1	*	19 B4D5	3,967	1	0,109117
9 B4D2	20,438	1	*				
11 B4D3	13,697	1	*				
12 B5D3	16,990	1	*				
14 B7D3	11,196	1	*				
15 B4D4	5,906	1	*				
16 B5D4	10,804	1	*				
17 B4D4	6,517	1	*				
20 B5D5	82,114	1	*				
21 B4D5	10,881	1	*				
22 B7D5	6,142	1	*				
24 SOIL TYP	60,205	1	*				

U-STATISTIC OR WILKS' LAMBDA 0,0802244 DEGREES OF FREEDOM 16 7 2095
APPROXIMATE F-STATISTIC 57,352 DEGREES OF FREEDOM 112,00 13457,46

F - MATRIX DEGREES OF FREEDOM = 16 2080

	WINTWH	GRASS	CORN	SUNFAL	NON AG	WATER	GRASOR
GRASS	143,62						
CORN	172,21	81,08					
SUNFAL	228,77	95,73	94,07				
NON AG	3,75	1,25	3,05	1,75			
WATER	2,43	2,80	2,10	1,70	1,71		
GRASOR	67,71	50,48	11,46	34,55	2,51	1,31	
RYE	35,31	33,65	45,93	29,33	6,11	3,43	30,23

CLASSIFICATION FUNCTIONS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	SUMFALO	NON AGR	WATER	GRASORG	RYE
3	B401	4.96922	4.56598	4.41576	4.98555	5.04743	4.53324	4.52607	5.01327
4	B501	-2.90496	-2.77858	-2.81515	-3.09631	-2.99201	-3.07162	-2.96715	-2.97827
6	B701	0.64618	0.40936	0.81313	0.39760	0.41777	1.08870	0.95695	0.49024
7	B402	4.12007	4.54854	4.26815	4.25313	4.75739	4.98595	4.30315	3.74099
8	B502	-2.79869	-2.67668	-2.69814	-2.68456	-2.73254	-3.59240	-2.80290	-2.47855
9	B602	1.32179	0.99334	0.89564	1.12057	0.86275	1.42666	0.93985	1.37840
11	B403	2.91791	3.45419	3.32207	3.22371	3.77421	3.63296	3.50908	3.14322
12	B503	-2.22748	-2.56001	-2.07161	-2.14004	-2.59979	-1.72144	-2.15865	-2.11831
14	B703	3.67774	3.19731	3.12809	3.25725	3.28098	2.06519	3.13209	3.59373
15	B404	2.38104	2.66201	2.34799	2.32699	2.23181	2.27076	2.23599	2.14071
16	B504	-1.51871	-1.76891	-1.43679	-1.47337	-1.56143	-1.72578	-1.45796	-1.42449
17	B604	0.57124	0.49158	0.46958	0.58838	0.71700	0.71175	0.69184	0.45033
20	B505	0.30464	0.15753	-0.20602	0.37236	0.17851	0.39634	0.10737	0.34797
21	B605	0.51435	0.57158	0.54498	0.27256	0.45081	0.28271	0.41968	0.35121
22	B705	-0.43367	-0.48397	0.04028	-0.25512	-0.37783	0.18637	-0.10642	-0.38941
24	SOIL TYP	16.77801	19.10794	17.08736	17.20280	16.66911	16.21811	17.74537	24.64211
CONSTANT		-237.14067	-224.69061	-215.27601	-232.09742	-232.01220	-249.55299	-231.36909	-269.83862

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -							
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	WATER	GRASORG	RYE
WINTWHET	84.4	707	12	3	55	23	9	9	20
GRASS	70.7	6	147	3	6	37	0	2	7
CORN	60.4	7	5	116	9	4	4	46	1
SUMFALO	72.5	30	6	13	534	39	16	73	26
NON AGR	80.0	0	0	1	0	4	0	0	0
WATER	100.0	0	0	0	0	0	2	0	0
GRASORG	51.1	2	0	17	9	3	5	45	7
RYE	75.6	1	0	0	5	0	0	2	25
TOTAL	75.1	753	170	153	618	110	36	177	86

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -							
		WINTWHET	GRASS	CORN	SUMFALO	NON AGR	WATER	GRASORG	RYE
WINTWHET	84.1	706	13	3	55	23	9	10	20
GRASS	70.2	6	146	3	6	38	0	2	7
CORN	59.4	8	5	114	9	4	4	47	1
SUMFALO	71.9	30	7	14	529	40	16	75	26
NON AGR	40.0	0	2	1	0	2	0	0	0
WATER	0.	0	0	0	1	0	0	1	0
GRASORG	43.2	2	0	20	12	3	6	38	7
RYE	72.7	1	0	0	5	0	0	3	24
TOTAL	74.1	752	173	155	617	110	35	176	85

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	11 B403		241.1845	1	0.5538	241.185
2	20 B505		220.4463	2	0.3168	230.658
3	6 B701		102.8893	3	0.2372	188.193
4	21 B605		81.1829	4	0.1965	159.822
5	24 SOIL TYP		73.1057	5	0.1698	143.348
6	14 B703		41.0887	6	0.1317	126.222
7	3 B401		32.4557	7	0.1188	112.692
8	9 B602		27.3344	8	0.1088	102.387
9	12 B503		23.5086	9	0.1009	93.854
10	7 B402		22.2866	10	0.0938	87.015
11	16 B504		16.7535	11	0.0888	80.823
12	4 B501		7.7665	12	0.0866	74.660
13	22 B705		6.4846	13	0.0847	69.362
14	17 B604		6.4223	14	0.0829	64.855
15	15 B404		5.9166	15	0.0813	60.930
16	8 B502		4.0917	16	0.0802	57.352

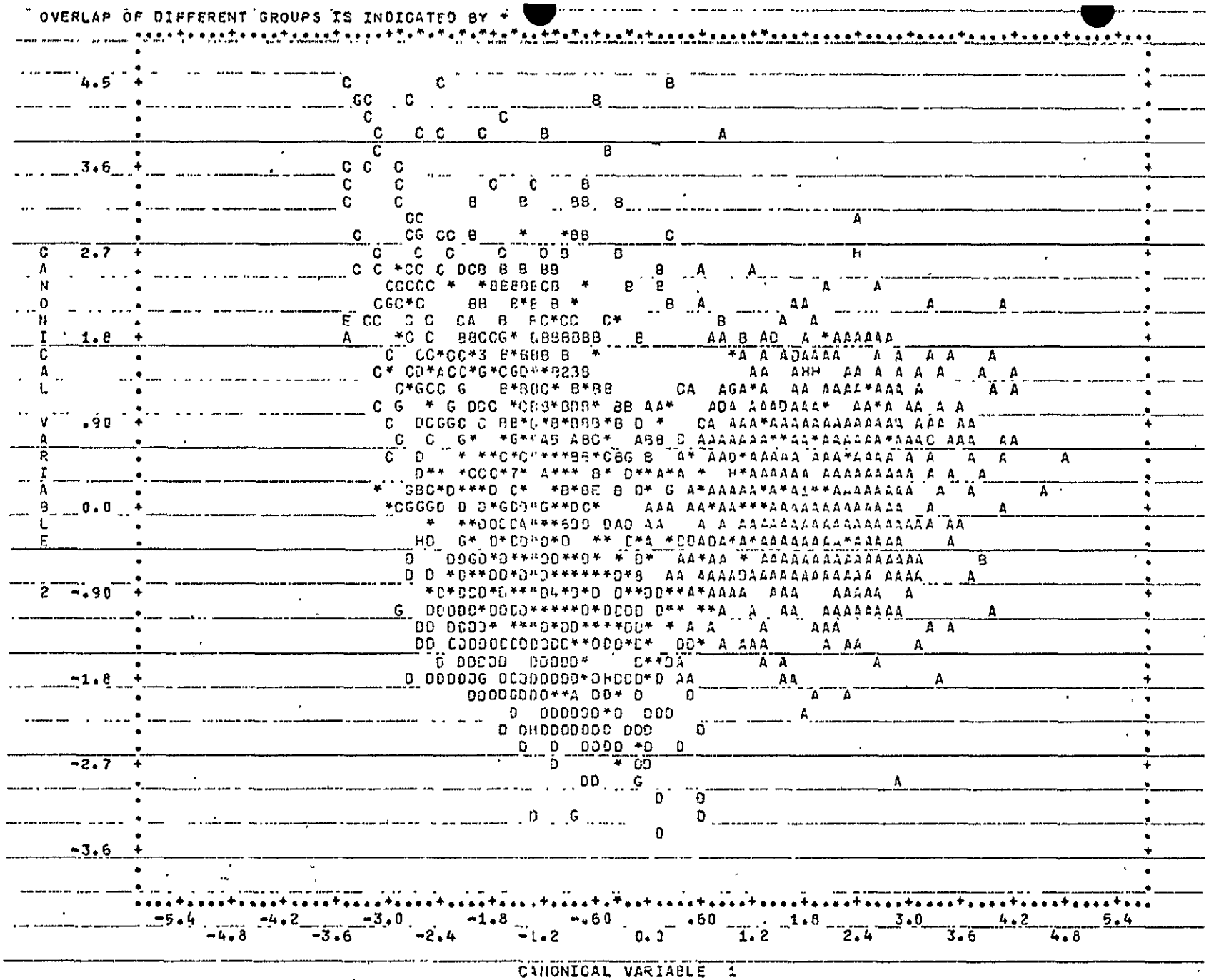
Percentage of Variation Among Groups Explained

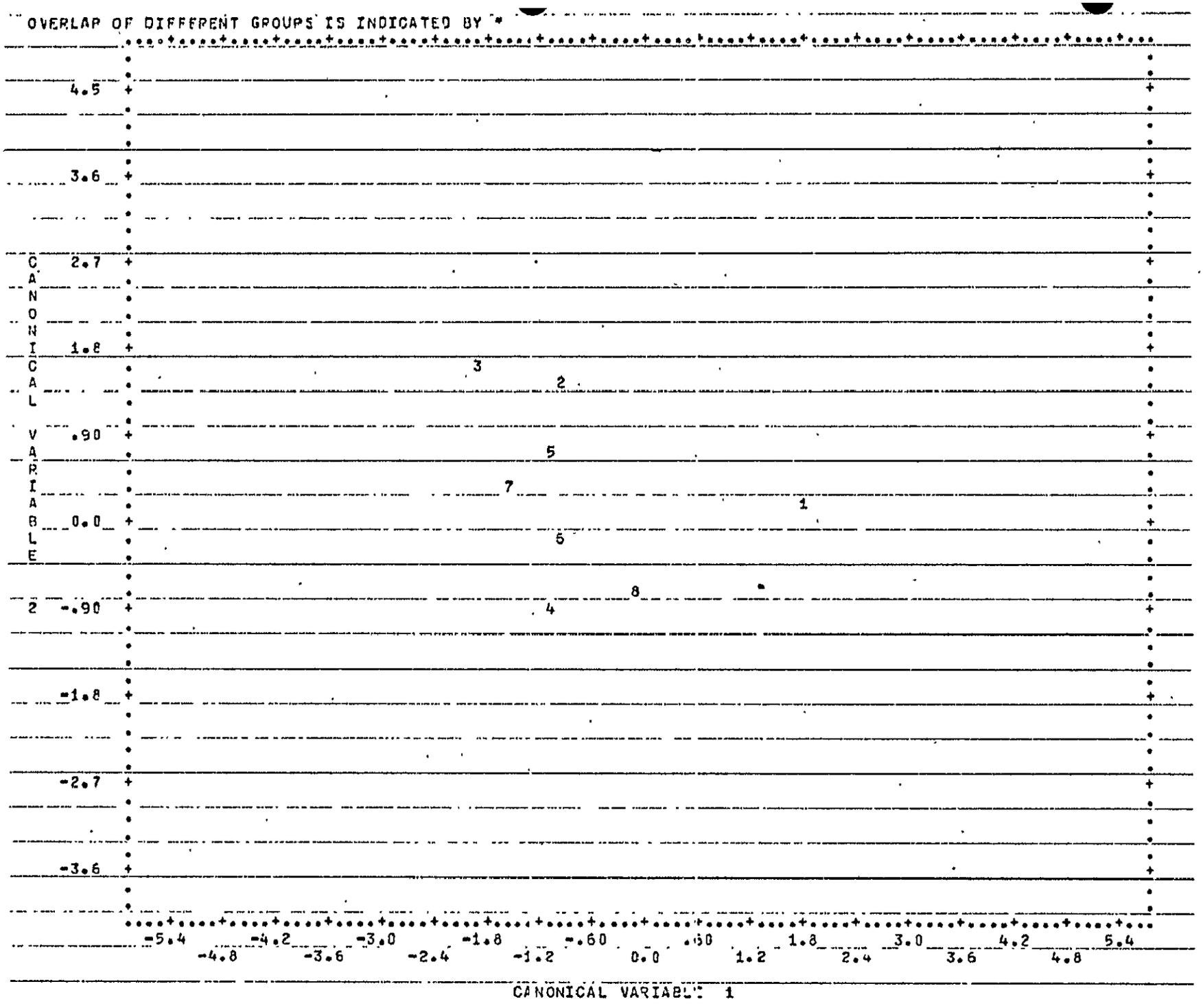
Eigenvalues	2.21455	0.80105	0.69378	0.20089	0.04501	0.00880	0.00407
Percentage	55.81	20.19	17.48	5.06	1.13	0.22	0.10
Canonical Correlations							
	0.83001	0.66691	0.64000	0.40900	0.20754	0.09339	0.06367

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES						
3 B401	0.07157	-0.19067	0.02969	0.00948	0.12384	-0.06067	-0.27496
4 B501	0.02201	0.12076	0.01118	-0.01330	0.01406	-0.00103	0.07194
6 B701	0.03279	0.09904	-0.13391	-0.04929	-0.15434	0.03191	0.01551
7 B4C2	-0.06629	0.05330	0.07812	0.15548	-0.13482	0.14737	-0.22552
8 B502	-0.03228	-0.01220	0.03092	-0.05659	0.13239	-0.20427	0.07173
9 B602	0.09382	-0.06136	0.00686	-0.04959	0.04254	0.15604	0.02982
11 B403	-0.12570	0.05275	0.05218	0.00500	-0.24239	-0.05541	-0.26738
12 B503	-0.01502	-0.07023	-0.12477	-0.04964	0.11061	0.22070	0.13731
14 B703	0.15263	-0.01815	-0.01175	-0.05594	0.10480	-0.35423	0.04298
15 B404	0.00477	0.06756	0.08933	0.07054	0.03084	0.05955	0.23303
16 B5C4	-0.00547	-0.04985	-0.08677	-0.04108	0.06813	-0.07316	-0.05554
17 B6C4	0.00469	-0.03643	-0.01390	0.02750	-0.15116	-0.06830	-0.08448
20 B505	0.04122	-0.15429	0.07657	0.02334	-0.08735	0.02479	0.02100
21 B605	0.03923	0.11963	0.00070	-0.00119	-0.00423	-0.03096	0.02663
22 B705	-0.07600	0.00726	-0.12133	-0.01362	0.06205	0.14586	-0.04828
24 SOIL TYP	-0.22877	0.21414	0.74557	-1.93160	-0.42806	-0.40442	0.39417
CONSTANT	-3.49076	5.68173	-1.60270	8.12547	7.15987	0.41383	8.14782

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS						
WINTWHET	1.78894	0.10933	-0.16257	0.03294	0.00146	-0.00106	0.00059
GPASS	-0.93447	1.46395	1.98647	0.14610	-0.07169	0.00348	0.01946
CORN	-1.91707	1.60505	-1.46496	-0.09491	0.28686	0.02417	-0.00529
SUMFALO	-1.06501	-0.97400	0.10656	0.12335	0.04913	0.00294	0.00319
NON AGR	-1.08672	0.66188	0.91388	0.79990	-0.18378	-0.51120	-1.24711
WATER	-0.90238	-0.16215	-0.98194	0.02165	-1.86425	2.81991	-0.50952
GRASORG	-1.60455	0.36809	-1.28270	-0.24520	-0.87861	-0.11181	0.03103
RYE	-0.10102	-0.66145	1.09143	-3.45465	0.13358	0.00347	-0.04102

Group	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat	1.79	0.11	A	1
Grass	-0.93	1.45	B	2
Corn	-1.92	1.61	C	3
Summer fallow	-1.07	-0.97	D	4
Non-agriculture	-1.09	0.66	E	5
Water	-0.90	-0.16	F	6
Grain sorghum	-1.60	0.37	G	7
Rye	-0.10	-0.66	H	8




OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
4.5
3.6
2.7
1.8
.90
0.0
-.90
-1.8
-2.7
-3.6
CANONICAL VARIABLE 2
3
2
5
7
1
6
8
4
-5.4
-4.8
-4.2
-3.6
-3.0
-2.4
-1.8
-1.2
-.60
0.0
.60
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
CANONICAL VARIABLE 1

APPENDIX D

Saline County LACIE Intensive Study Site

Computer compatible tape coordinates

FR 300 LR 419

FC 160 LC 289

12 Bands of ERTS data from 3 dates:

October 20, 1973

April 18, 1974

July 17, 1974

ERTS observation ID's:

1454-16374 [reference scene]

1634-16341

1724-16313

Rotation and distortion parameters for ground truth bands to overly ERTS bands.

+ 16.0° Rotation

Vertical Stretch 0.1 pel/pel at upper left.

Horizontal Stretch 0.05714 pel/pel at upper left.

Soil types taken from map of Saline County reconnaissance soil conservation survey from Soil Conservation Service, Washington, D. C. 1946.

Crop types were identified from land use data collected by ASCS, June, 1974, prepared by FSO, Cartographic Laboratory Earth Observation Division, S&AD JSC/NASA, Houston, Texas, September 1974

APPENDIX DD1

Discrimination Analysis for SALINE County

Using Soil Type

```
BMDP7M - STEPWISE DISCRIMINANT ANALYSIS,
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

IN THIS VERSION OF BMDP7M
   ** GROUP CODES OR CUTPOINTS MUST BE STATED;

   PROGRAM CONTROL INFORMATION
PROBLEM TITLE = 'SALINE CO; SMP 1; ERTS + GT';/
INPUT
   UNIT = 12,
   CODE = 'SALINE C',
   CONTENT = 'DATA',
   LABEL = 'SALINE CO SAMPLE 1';/
VARIAB ADD = 0,
   NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
   'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3',
   'CROP TYP','SOIL TYP','CROP*SOL',
   USE = 3,4,5,6,7,8,9,10,11,12,13,14,16,
   LABEL = 1,2,
   GROUPING = 'CROP TYP';/
GROUP
   CODE = 1,2,3,5,8,11,
   NAME = 'WINTWHET','GRASS','CORN','NON AG',
          'GRANSORG','SOY BEAN',/
PRINT
   STEP,
   CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,/
PLOT
   CANONICAL,
   GROUP = 1,2,3,5,8,11;/
DISCRIMINANT
   METHOD = 2,
   JACKKNIFE,/
END/

   PROBLEM TITLE . . . . . ;SALINE CO, SMP 1, ERTS + GT

   NUMBER OF VARIABLES TO READ IN. . . . . 17
   NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. . 0
   TOTAL NUMBER OF VARIABLES . . . . . 17
   NUMBER OF CASES TO READ IN. . . . . 1000000
   CASE LABELING VARIABLES . . . . . ROW          COLUMN
   LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
   INPUT UNIT NUMBER . . . . . 12
   REWIND INPUT UNIT PRIOR TO READING DATA. . . YES
```

VARIABLES TO BE USED

3	B4D1	4	B5D1	5	B6D1	6	B7D1	7	B4D2		
8	B5D2	9	B6D2	10	B7D2	11	B4D3	12	B5D3		
13	B6D3	14	B7D3	16	SOIL TYP						

TOLERANCE	0,010						
F-TO-ENTER	4,000						
F-TO-REMOVE	3,996						
METHOD	2						
MAXIMUM FORCED LEVEL	0						
MAXIMUM NUMBER OF STEPS	34						
PRIOR PROBABILITIES	0,16667	0,16667	0,16667	0,16667	0,16667	0,16667	

VARIABLE NO. NAME	BEFORE TRANSFORMATION MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	INTERVAL RANGE GREATER THAN	LESS THAN OR EQUAL TO
15 CROP TYP				1,00000	WINTWHET		
				2,00000	GRASS		
				3,00000	CORN		
				5,00000	NON AG		
				8,00000	GRANSORG		
				11,00000	SOY BEAN		

NUMBER OF CASES READ 574

MEANS

VARIABLE	GROUP #	WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN	ALL GP
3	R4D1	23,89231	23,66667	22,33333	22,50000	22,93578	21,80952	23,56949
4	R5D1	21,15385	22,46667	19,00000	20,90000	19,26605	17,38095	20,64634
5	R6D1	24,10000	26,30000	25,16667	21,50000	22,69725	22,47619	23,89547
6	R7D1	11,84872	12,96667	12,33333	10,83333	11,13761	10,85714	11,74042
7	R4D2	31,38462	32,66667	32,00000	31,00000	32,70642	32,19048	31,55749
8	R5D2	27,64615	29,53333	30,11111	28,16667	27,80734	30,23810	27,95296
9	R6D2	42,24359	47,33333	37,66667	39,50000	39,94495	34,00000	41,59930
10	R7D2	22,72051	25,53333	19,50000	21,00000	21,00000	17,00000	22,21254
11	R4D3	34,43333	35,56667	32,38889	33,83333	34,36697	32,42857	34,47213
12	R5D3	33,93846	36,20000	30,33333	32,00000	33,48624	28,66667	33,64460
13	R6D3	37,19744	44,96667	36,50000	39,16667	37,25688	36,38095	37,55362
14	R7D3	17,57179	22,00000	17,38889	19,66667	17,53211	17,28571	17,80139
16	SOIL TYP	1,20769	2,80000	1,11111	1,00000	1,11927	1,00000	1,26132
15	CROP TYP	1,00000	2,00000	3,00000	5,00000	8,00000	11,00000	2,85192
COUNTS		390,	30;	18;	6,	109,	21;	574;

STANDARD DEVIATIONS

VARIABLE	GROUP #	WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN	ALL GP
3	R4D1	5,12362	2,81794	2,80755	1,37841	2,63268	1,80407	2,96168
4	R5D1	4,80059	4,52376	4,91097	3,52136	4,02916	2,69214	4,58267
5	R6D1	5,54790	5,48445	3,54665	2,58844	4,73268	6,35810	5,36053
6	R7D1	3,20939	3,38845	2,91043	1,72240	2,73004	3,79050	3,20029
7	R4D2	3,69127	3,31489	3,67823	2,00000	3,29225	3,90288	3,59205
8	R5D2	6,19574	5,95230	6,62339	4,30692	6,46998	6,09020	7,65198
9	R6D2	6,82169	4,46099	9,26022	8,80341	6,26908	7,72810	6,70515
10	R7D2	5,14068	3,49120	5,72148	5,72713	4,67856	4,97996	5,03063
11	R4D3	3,54282	3,19379	4,43434	4,02078	3,52152	1,77684	3,50541
12	R5D3	6,26381	5,99089	7,43600	8,12404	6,62852	4,06612	6,31470
13	R6D3	7,14884	8,58420	7,51665	6,67583	9,19444	8,52699	8,95429
14	R7D3	5,15006	4,84234	3,72810	4,45720	5,32563	2,79540	5,06168
16	SOIL TYP	0,52734	0,61020	0,47140	0,	0,32560	0,	0,48608
15	CROP TYP	0,	0,	0,	0,	0,	0,	0,

STEP NUMBER 2
VARIABLE ENTERED 9 B6D2

VARIABLE	F TO FORCE REMOVE LEVEL DF= 5 567		*	VARIABLE	F TO FORCE ENTER LEVEL DF= 5 566		TOLERANCE
9 B6D2	10,836	1	*	3 B4D1	1,380	1	0,796529
16 SOIL TYP	61,876	1	*	4 B5D1	1,461	1	0,745217
			*	5 B6D1	1,529	1	0,931492
			*	6 B7D1	1,003	1	0,966642
			*	7 B4D2	0,313	1	0,952570
			*	8 B5D2	0,519	1	0,922315
			*	10 B7D2	0,186	1	0,126949
			*	11 B4D3	2,110	1	0,978914
			*	12 B5D3	2,303	1	0,946325
			*	13 B6D3	2,332	1	0,956874
			*	14 B7D3	2,664	1	0,963575

U-STATISTIC OR WILKS' LAMBDA 0,5611077 DEGREES OF FREEDOM 2 5 568
APPROXIMATE F-STATISTIC 35,360 DEGREES OF FREEDOM 10,00 1134,00

F = MATRIX DEGREES OF FREEDOM = 2 567

	WINTWH	GRASS	CORN	NON AG	GRANSO
GRASS	157,71				
CORN	4,27	79,74			
NON AG	1,73	37,76	0,28		
GRANSO	6,34	155,19	0,87	0,10	
SOY BE	16,60	109,25	1,68	1,53	7,31

CLASSIFICATION FUNCTIONS

GROUP =	WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
VARIABLE						
9 B6D2	0,92175	1,03655	0,82154	0,86104	0,87106	0,74156
16 SOIL TYP	5,23734	11,99231	4,81494	4,35008	4,85622	4,33374
CONSTANT	-24,41280	-43,11260	-19,93906	-20,97225	-21,90660	-16,56512

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP =					
		WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
WINTWHET	52.6	206	22	22	66	0	72
GRASS	90.0	3	27	0	0	0	0
CORN	11.1	6	1	2	0	0	9
NON AG	16.7	2	0	0	1	0	3
GRANSORG	0.	46	1	5	24	0	33
SOY BEAN	71.4	5	0	0	1	0	15
TOTAL	43.7	266	51	29	94	0	132

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP =					
		WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
WINTWHET	52.6	205	23	22	66	0	72
GRASS	90.0	3	27	0	0	0	0
CORN	11.1	6	1	2	0	0	9
NON AG	0.	2	0	0	0	1	3
GRANSORG	0.	46	1	5	24	0	33
SOY BEAN	71.4	5	0	0	1	0	15
TOTAL	43.4	267	52	29	93	1	132

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	W-STATISTIC	APPROXIMATE F-STATISTIC
1	16 SOIL TYP		64.8373	1	0.6366	64.837
2	9 B6D2		10.8365	2	0.5811	35.360

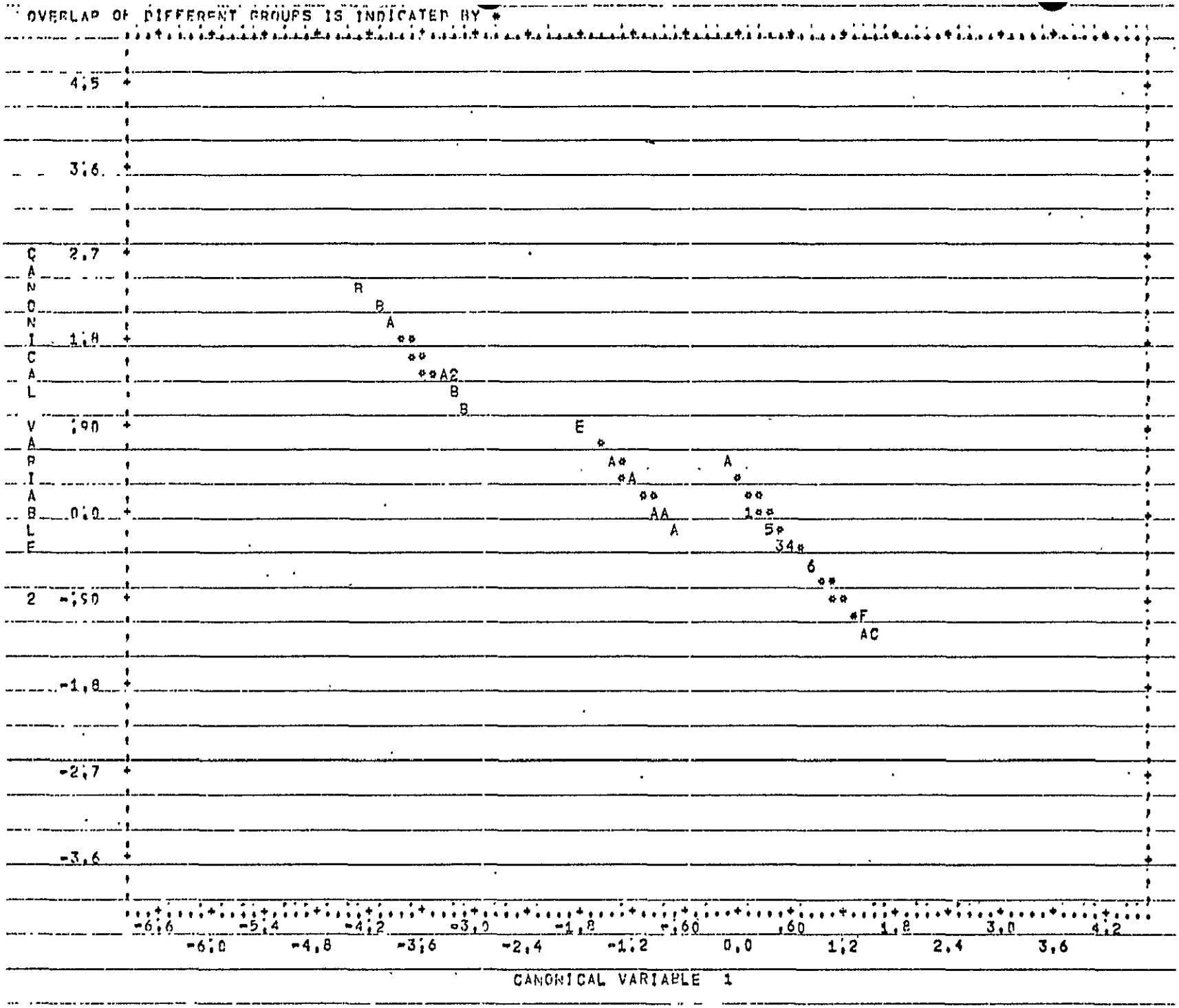
Percent of Variation Between Groups Explained

Eigenvalues	0.63539	0.05226
Percentage	92.40	7.60
Canonical Correlations		
	0.62332	0.22286

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES	
9 R602	-0,04907	0,05051
16 SOIL TYP	-1,94661	0,78042
CONSTANT	4,49658	-3,08538

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS	
WINTWHET	0,07279	-0,20931
GRASS	-3,27658	1,49041
CORN	0,48538	-0,31582
NON AG	0,41171	-0,30997
GRANSORG	0,35771	-0,19442
SOY BEAN	0,68159	-0,58775

GROUP	Mean Coordinates		Symbol for Cases	Symbol for Mean
Winter wheat	0.07	-0.01	A	1
Grass	-3.28	1.49	B	2
Corn	0.49	-0.32	C	3
Non-agriculture	0.61	-0.31	D	4
Grain sorghum	0.36	-0.19	E	5
Soybeam	0.86	-0.59	F	6


OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
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3,6
2,7
1,8
,90
0,0
-,90
-1,8
-2,7
-3,6
CANONICAL VARIABLE 1
-6,6 -5,4 -4,2 -3,0 -1,8 -,60 ,60 1,8 3,0 4,2
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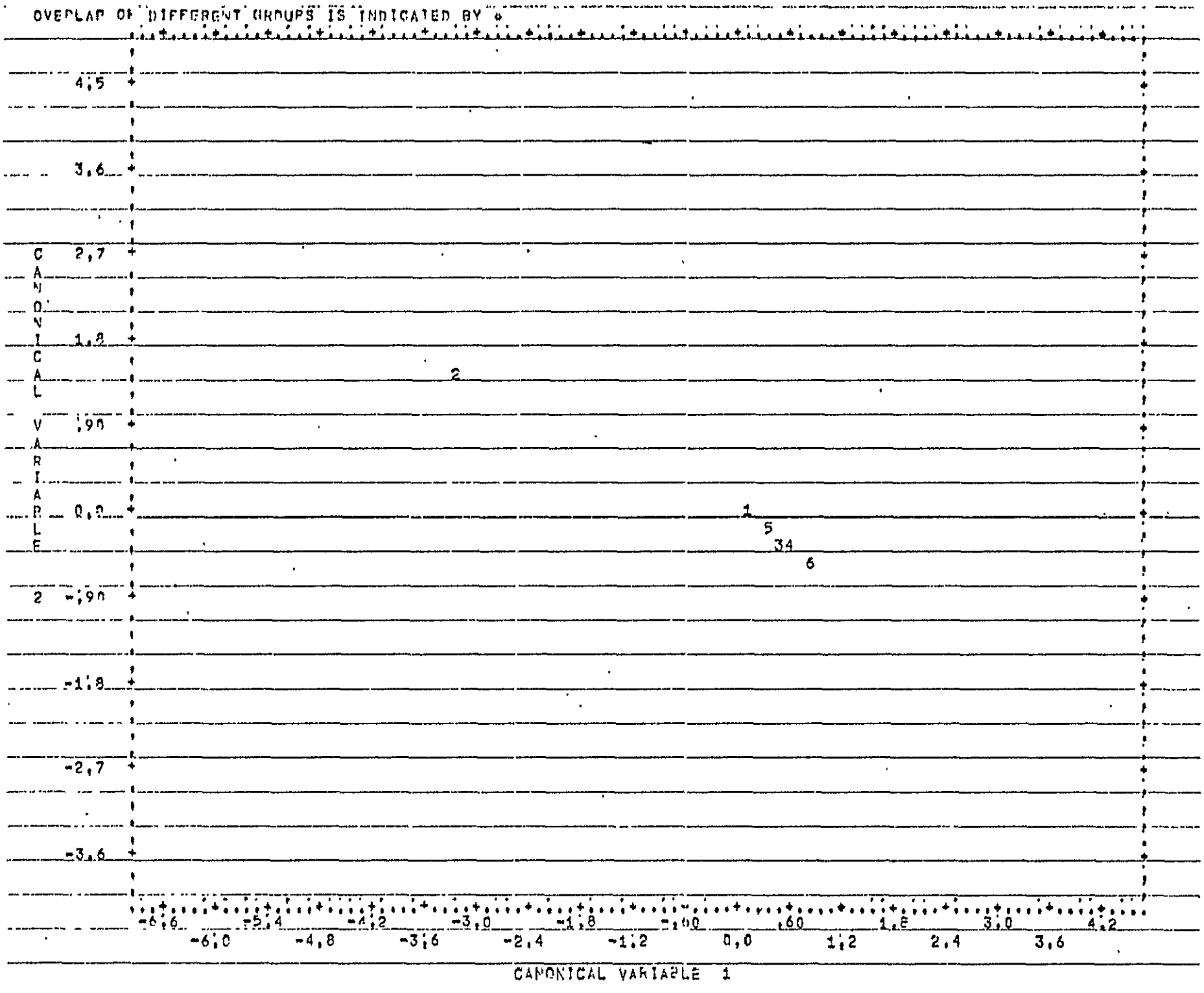
OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
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2,7
1,8
,90
0,0
-,90
-1,8
-2,7
-3,6
CANONICAL VARIABLE 2
2
1
5
34
6
-6,6 -5,4 -4,2 -3,0 -1,8 -,60 ,60 1,8 3,0 4,2
-6,0 -4,8 -3,6 -2,4 -1,2 0,0 1,2 2,4 3,6
CANONICAL VARIABLE 1

APPENDIX DD2

Discriminant Analysis of SALINE County Without Using Soil Type

```
   BMDP7M  -  STEPWISE DISCRIMINANT ANALYSIS.
   HEALTH SCIENCES COMPUTING FACILITY
   UNIVERSITY OF CALIFORNIA, LOS ANGELES

   IN THIS VERSION OF BMDP7M
      -- GROUP CODES OR OUTPOINTS MUST BE STATED.

    PROGRAM CONTROL INFORMATION
   PROBLEM TITLE = 'SALINE CO. SMP 1, ERTS + GT'./
   INPUT
      UNIT = 12.
      CODE = 'SALINE C'.
      CONTENT = 'DATA'.
      LABEL = 'SALINE CO SAMPLE 1'./
   VARIAB ADD = 0.
      NAME = 'ROW','COLUMN','B4D1','B5D1','B6D1','B7D1','B4D2',
     'B5D2','B6D2','B7D2','B4D3','B5D3','B6D3','B7D3',
     'CROP TYP','SOIL TYP','CROP*SOL'.
     USE = 3,4,5,6,7,8,9,10,11,12,13,14.
      LABEL = 1,2.
      GROUPING = 'CROP TYP'./
   GROUP
    CODE = 1,2,3,5,8,11.
      NAME = 'WINTWHET','GRASS','CORN','NON AG',
         'GRANSORG','SOY BEAN'./
   PRINT
      STEP.
      CLASS = 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15./
   PLOT
      CANONICAL.
      GROUP = 1,2,3,5,8,11./
   DISCRIMINANT
      METHOD = 2.
      JACKKNIFE./
   END/

    PROBLEM TITLE . . . . . .SALINE CO. SMP 1. ERTS + GT

    NUMBER OF VARIABLES TO READ IN. . . . . 17
    NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. . 0
    TOTAL NUMBER OF VARIABLES . . . . . 17
    NUMBER OF CASES TO READ IN. . . . . 1000000
    CASE LABELING VARIABLES . . . . . ROW  COLUMN
    LIMITS AND MISSING VALUE CHECKED BEFORE TRANSFORMATIONS
    INPUT UNIT NUMBER . . . . . 12
    REWIND INPUT UNIT PRIOR TO READING. . DATA. . . YES
```

VARIABLES TO BE USED

3	B401	4	B501	5	B601	6	B701	7	B402		
8	B502	9	B602	10	B702	11	B403	12	B503		
13	B603	14	B703								

TOLERANCE.	0.010
F-TO-ENTER	4.000
F-TO-REMOVE.	3.996
METHOD	2
MAXIMUM FORCED LEVEL . . .	0
MAXIMUM NUMBER OF STEPS. .	34

PRIOR PROBABILITIES. . . .	0.16667	0.16667	0.16667	0.16667	0.16667	0.16667			

VARIABLE		BEFORE TRANSFORMATION					INTERVAL RANGE	
NO.	NAME	MINIMUM LIMIT	MAXIMUM LIMIT	MISSING CODE	CATEGORY CODE	CATEGORY NAME	GREATER THAN	LESS THAN OR EQUAL TO
15	CROP TYP				1.00000	WINTWHET		
					2.00000	GRASS		
					3.00000	CORN		
					5.00000	NON AG		
					8.00000	GRAINSORG		
					11.00000	SOY BEAN		

NUMBER OF CASES READ. 574

MEANS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	NON AG	GRAINSORG	SOY BEAN	ALL GP
3	B4C1	23.89231	23.86667	22.33333	22.50000	22.93578	21.80952	23.56969
4	B5C1	21.15385	22.46667	19.00000	20.00000	19.26605	17.38095	20.64634
5	B6C1	24.10000	26.30000	25.16667	21.50000	22.69725	22.47619	23.89547
6	B7C1	11.84872	12.96667	12.33333	10.83333	11.13761	10.85714	11.74042
7	B4C2	31.38462	32.66667	32.00000	31.00000	31.70642	32.19048	31.55749
8	B5C2	27.64615	29.53333	30.11111	28.16667	27.80734	30.23810	27.95296
9	B6C2	42.24359	47.33333	37.66667	39.50000	39.94495	34.00000	41.59930
10	B7C2	22.72051	25.53333	19.50000	21.00000	21.00000	17.00000	22.21254
11	B4C3	34.63333	35.56667	32.38889	33.83333	34.36697	32.42857	34.47213
12	B5C3	33.93846	36.20000	30.33333	32.00000	33.48624	28.66667	33.64460
13	B6C3	37.19744	44.96667	36.50000	39.16667	37.25688	36.38095	37.58362
14	B7C3	17.57179	22.00000	17.38889	19.66667	17.53211	17.28571	17.80139
15	CROP TYP	1.00000	2.00000	3.00000	5.00000	8.00000	11.00000	2.85192
COUNTS		390.	30.	18.	6.	109.	21.	574.

STANDARD DEVIATIONS

VARIABLE	GROUP =	WINTWHET	GRASS	CORN	NON AG	GRAINSORG	SOY BEAN	ALL GP
3	B4C1	3.12362	2.81294	2.80755	1.37840	2.63268	1.80607	2.96168
4	B5C1	4.80059	4.52376	4.91097	3.52136	4.02916	2.69214	4.58267
5	B6C1	5.54790	5.49446	3.56865	2.58844	4.73268	6.39310	5.36053
6	B7C1	3.29839	3.38845	2.91043	1.72240	2.73004	3.79850	3.20029
7	B4C2	3.69127	3.31489	3.67823	2.00000	3.29225	3.80288	3.59205
8	B5C2	8.19574	5.95230	6.62339	4.30891	6.46998	6.09020	7.65198
9	B6C2	6.85169	4.46699	9.26092	8.80341	6.28908	7.72010	6.78515
10	B7C2	5.18068	3.49120	5.72148	5.72713	4.67856	4.97996	5.03063
11	B4C3	3.54282	3.10376	4.43434	4.02078	3.92152	1.77684	3.50541
12	B5C3	6.26351	5.99080	7.43600	8.12404	6.62852	4.06612	6.31470
13	B6C3	9.14884	8.58420	7.51665	6.67583	9.15444	5.52699	8.95429
14	B7C3	5.15006	4.84234	3.72810	4.45720	5.32563	2.79540	5.06168
15	CROP TYP	0.	0.	0.	0.	0.	0.	0.

STEP NUMBER 1
VARIABLE ENTERED 9 B6D2

VARIABLE	F TO REMOVE DF= 5 568	FORCE LEVEL	*	VARIABLE	F TO ENTER DF= 5 567	FORCE LEVEL	TOLERANCE
9 B6D2	12.877	1	*	3 B4D1	1.540	1	0.796530
			*	4 B5D1	1.445	1	0.745644
			*	5 B6D1	1.689	1	0.931699
			*	6 B7D1	1.185	1	0.966690
			*	7 B4D2	1.534	1	0.958241
			*	8 B5D2	1.450	1	0.924713
			*	10 B7D2	0.999	1	0.127640
			*	11 B4D3	1.931	1	0.980465
			*	12 B5D3	2.076	1	0.948222
			*	13 B6D3	3.052	1	0.958965
			*	14 B7D3	3.348	1	0.963748

U-STATISTIC OF WILKS' LAMBDA 0.8981878 DEGREES OF FREEDOM 1 5 568
APPROXIMATE F-STATISTIC 12.877 DEGREES OF FREEDOM 5.00 568.00

F - MATRIX DEGREES OF FREEDOM = 1 568

	WINTWH	GRASS	CORN	NON AG	GRANSO
GRASS	15.68				
CORN	7.83	22.83			
NON AG	0.97	6.66	0.33		
GRANSO	9.78	27.89	1.74	0.02	
SOY BE	29.41	47.70	2.83	3.07	13.52

CLASSIFICATION FUNCTIONS

GROUP = VARIABLE	WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
9 B6D2	0.91758	1.02813	0.81816	0.85798	0.86765	0.73852
CONSTANT	-21.17263	-26.12421	-17.20046	-18.73693	-19.12084	-14.34655

CLASSIFICATION MATRIX

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -					
		WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
WINTWHET	20.0	78	165	34	12	27	74
GRASS	76.7	5	23	2	0	0	0
CORN	11.1	2	5	2	0	0	9
NON AG	0.	1	2	0	0	0	3
GRANSORG	11.9	25	26	12	2	13	31
SOY BEAN	71.4	3	3	0	0	0	15
TOTAL	22.8	114	224	50	14	40	132

JACKKNIFED CLASSIFICATION

GROUP	PERCENT CORRECT	NUMBER OF CASES CLASSIFIED INTO GROUP -					
		WINTWHET	GRASS	CORN	NON AG	GRANSORG	SOY BEAN
WINTWHET	20.0	78	165	34	12	27	74
GRASS	76.7	5	23	2	0	0	0
CORN	11.1	2	5	2	0	0	9
NON AG	0.	1	2	0	0	0	3
GRANSORG	11.9	25	26	12	2	13	31
SOY BEAN	71.4	3	3	0	0	0	15
TOTAL	22.8	114	224	50	14	40	132

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC	APPROXIMATE F-STATISTIC
1	9 BED2		12.8769	1	0.8982	12.877

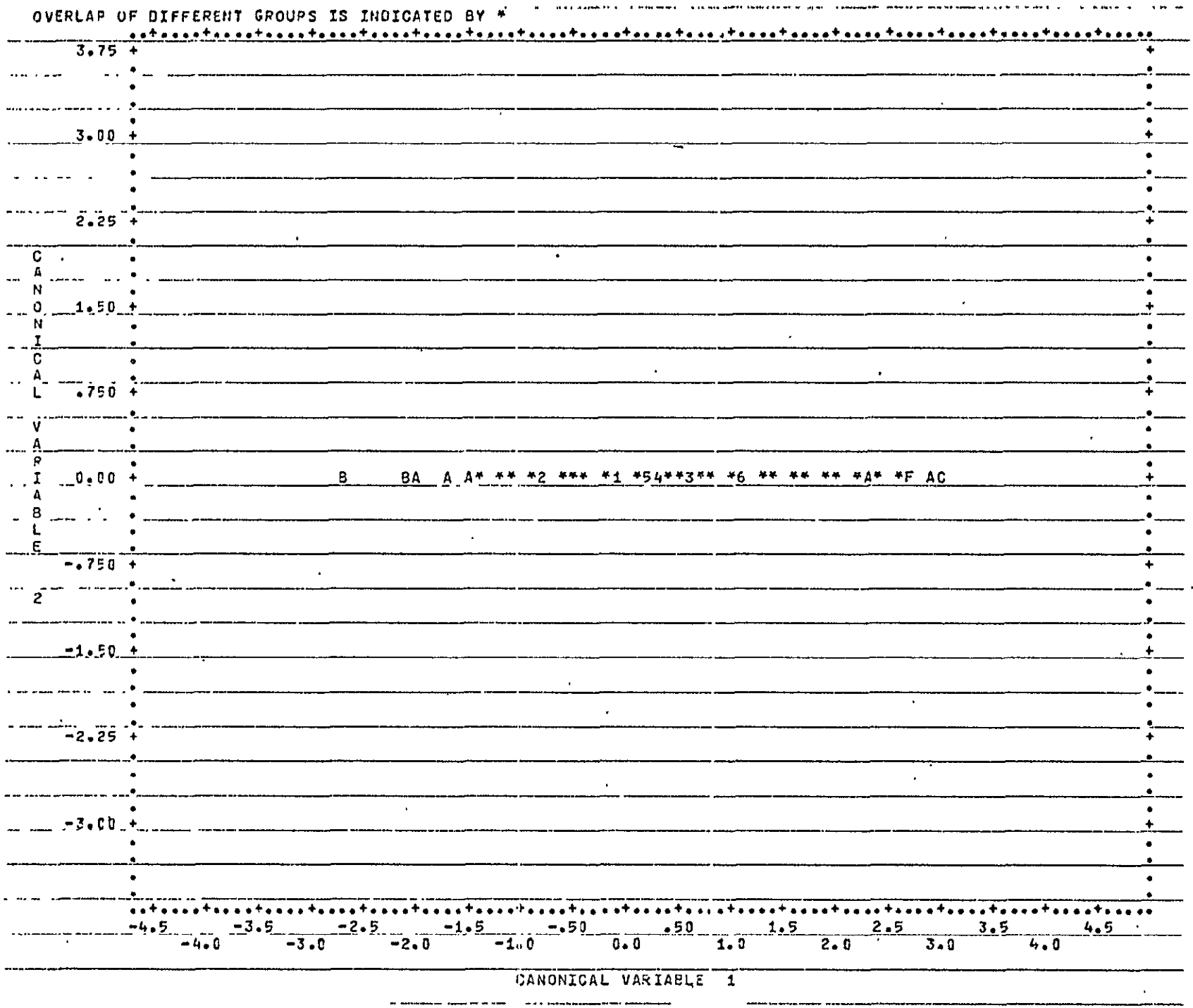
Percentage of Variation Between Groups Explained

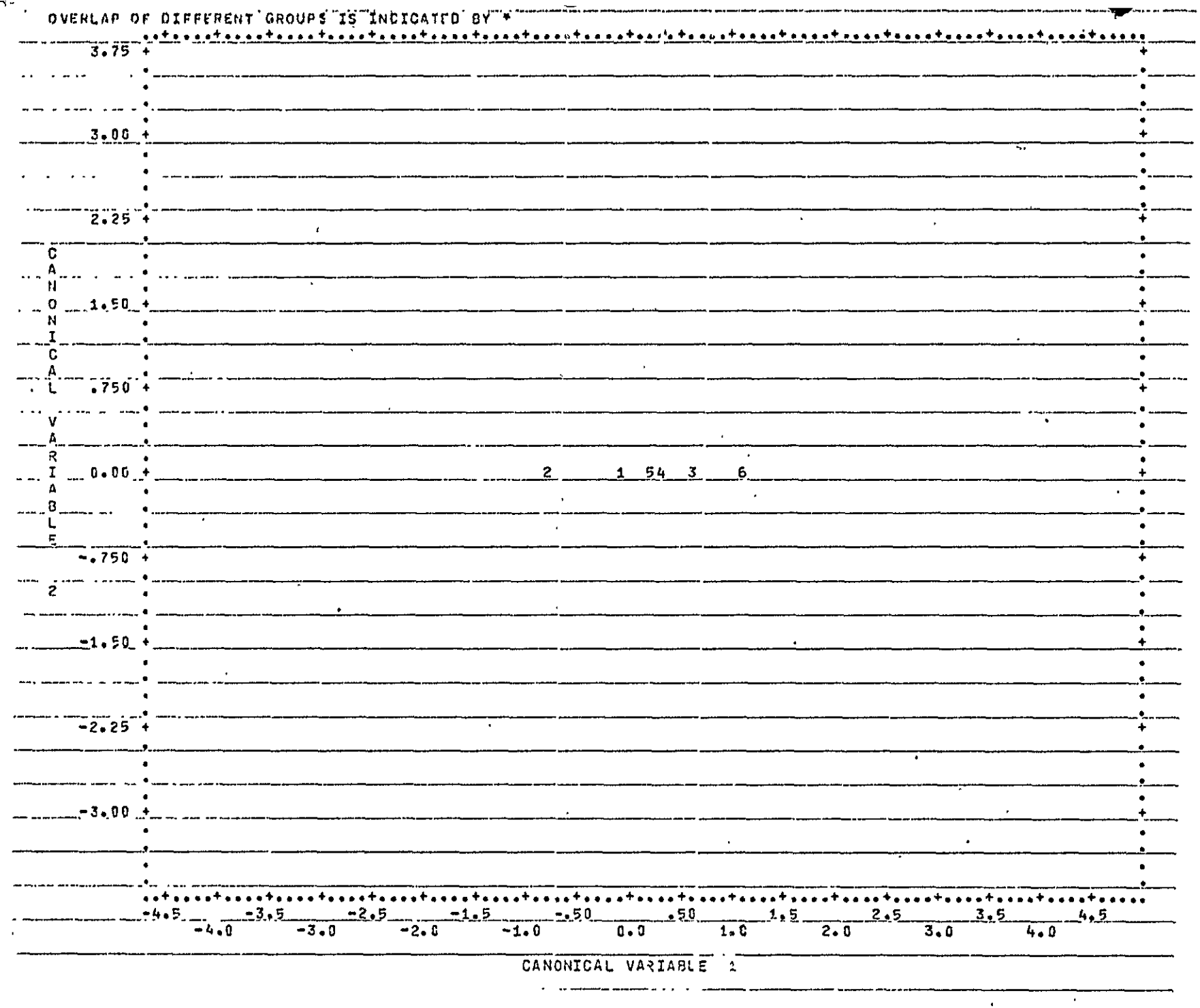
Eigenvalues	0.11335	0.0
Percentage	100.0	0.0
Canonical Correlations		
	-0.31908	0.0

VARIABLE	COEFFICIENTS FOR CANONICAL VARIABLES	
9_86C2	-0.14738	0.00000
CONSTANT	5.13094	-0.00000

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS	
WINTWHET	-0.09496	0.00000
GRASS	-0.64509	0.00000
CORN	0.57960	-0.00000
NON_AG	0.30946	-0.00000
GRAINSORG	0.24382	-0.00000
SOY BEAN	1.11999	-0.00000

GROUP	Mean Coordinates		Symbols for Cases	Symbols for Means
Winter wheat	-0.09	0.0	A	1
Grass	-0.85	0.0	B	2
Corn	0.58	0.0	C	3
Non-agriculture	0.31	0.0	D	4
Grain sorghum	0.24	0.0	E	5
Soybeam	1.12	0.0	F	6


OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
3.75
3.00
2.25
1.50
.750
0.00
-.750
-1.50
-2.25
-3.00
CANONICAL VARIABLE 2
B BA A A* ** *2 *** *1 *54***3** *6 ** ** ** *A* *F AC
-4.5 -3.5 -2.5 -1.5 -.50 .50 1.5 2.5 3.5 4.5
-4.0 -3.0 -2.0 -1.0 0.0 1.0 2.0 3.0 4.0
CANONICAL VARIABLE 1


OVERLAP OF DIFFERENT GROUPS IS INDICATED BY *
3.75
3.00
2.25
1.50
.750
0.00
-.750
-1.50
-2.25
-3.00
CANONICAL VARIABLE 2
2 1 54 3 6
-4.5 -3.5 -2.5 -1.5 -.50 .50 1.5 2.5 3.5 4.5
-4.0 -3.0 -2.0 -1.0 0.0 1.0 2.0 3.0 4.0
CANONICAL VARIABLE 1

APPENDIX E

Finney County LACIE Intensive Study Site

Computer compatible tape coordinates

FR 255	LR 400
FC 180	LC 395

20 Bands of ERTS data from 5 dates:

ERTS Observation ID's	Date
1456-16551	Oct. 23, 1973
1636-16460	Apr. 20, 1974
1654-16453	May 8, 1974
1672-16450	May 26, 1974
1708-16435	July 1, 1974

Rotation and distortion parameters for ground truth bands to overlay ERTS bands.

+ 16.2° Rotation

.116 pel/pel vertical stretch at upper left

.05714 pel/pel horizontal stretch at upper left

Soil types taken from map of Finney County reconnaissance soil conservation survey from Soil Conservation Service, Washington, D. C. 1947.

Crop types were identified from landuse data collected by ASCS, June, 1974, prepared by FSO, Cartographic Laboratory Earth Observation Division, S & AD JSC/NASA, Houston, Texas, September, 1974.

APPENDIX F

Ellis County LACIE Intensive Study Site

Computer compatible tape coordinates

20 Bands of ERTS data from 4 dates:

ERTS Observation ID's	Dates
1455-16432	Oct. 21, 1973
1689-16382	Mar. 24, 1974
1672-16444	May 26, 1974
1726-16425	July 19, 1974

Rotation and distortion parameters for ground truth bands to overlay ERTS bands.

Soil types taken from map of Ellis County reconnaissance soil conservation survey from Soil Conservation Service, Washington, D. C. 1947.
Crop types were identified from landuse data collected by ASCS, June, 1974, prepared by FSO, Cartographic Laboratory Earth Observation Division, S & AD JSC/NASA, Houston, Texas, September, 1974.