MULTIPLE ELEMENT SOIL EXTRACTANTS AND A DATA MANAGEMENT SYSTEM

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DATA MANAGEMENT SYSTEM

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INTRODUCTION

There are three parts to this dissertation which involve two separate studies. The first study, Part I, is a comparison of two new multi-element soil extractants, the Mehlich III and the ammonium bicarbonate-DTPA extractants, with the more traditional Bray/Kurtz and 1N ammonium acetate extractants. The latter are both in use at Oklahoma State University Soil Testing Laboratory. The study involves 310 soil samples taken from five University long term soil fertility experiments. All soils were extracted in triplicate for each extractant.

Parts II and III discuss a newly developed computer assisted data management system. Part II is a discussion of the system designed for the researcher. Part III is the user's manual for this system and details daily operations giving examples of the many features of this system. The data management system is designed for flexibility and is very user friendly. This system can be a valuable tool for the researcher, providing a complete system of data flow plus access to advanced statistical services. Using the widely available TSO option and SAS and FORTRAN languages with an IBM 3081D, this data management system can be adapted, in whole or in part, to other research disciplines with only minor modifications.

Part I is presented in a form suitable for publication in Communications in Soil and Plant Analysis. Part II is written for publication as an Oklahoma State University Bulletin, while Part III is presented for publication as a research paper.

PART I

BRAY/KURTZ, MEHLICH, III, AB/D AND AMMONIUM ACETATE EXTRACTIONS OF P, K AND MG IN FOUR OKLAHOMA SOILS

ABSTRACT

Multi-element soil extraction solutions offer increased convenience in soil testing laboratory operations. The recently developed Mehlich III and ammonium bicarbonate-DTPA multi-element extraction solutions were each compared with the more conventional Bray/Kurtz extractant for P determination and 1N ammonium acetate for K and Mg determinations. The latter two solutions are single and tri-element extractants in current use by the Oklahoma State University Soil Testing Laboratory. The Bray/Kurtz extractant was also compared with the 1N ammonium acetate for K and Mg determination. A total of 310 soil samples from four soil types, which included five long-term soil fertility experiments, were used for these comparisons. All sites have been in continuous wheat production and received various N-P-K fertilizer treatments for at least five years prior to soil sampling. All soil samples were extracted in triplicate for each extractant. Results showed that extraction of elements by all solutions were highly correlated to the Bray/Kurtz and 1N ammonium acetate extractants for Oklahoma soils.

INTRODUCTION

Recent advances in computer controlled data collection systems have led to sophisticated laboratory instruments that are capable of analyzing a solution for many elements simultaneously. Use of instruments, such as the inductively coupled plasma spectrograph, in soil testing laboratories is becoming more widespread. The advantages of such instrumentation can be fully realized if a single soil extraction solution can provide information on several soil nutrients. However, to be effective, the soil extracting solution must be capable of removing a portion of the elements under consideration that can be related to plant growth in the field. Thus, adoption of a multi-element extracting solution must be predicated on successful statewide soil test calibrations.

This study was conducted to ascertain which of four selected soil extracting solutions could be successfully used to predict plant nutrient response. The study included soil from five long term soil fertility research sites across Oklahoma. Phosphorus (P), potassium (K) and magnesium (Mg) were extracted using Bray/Kurtz, Mehlich III (M III), and ammonium bicarbonate-DTPA (AB/D) extracting solutions. K and Mg were also determined using 1N ammonium acetate. The degree to which each of these solutions might be used to reliably predict crop response was evaluated by correlation of nutrient levels extracted by each of these procedures with levels using current methods.

LITERATURE REVIEW

The search for an effective soil phosphorus (P) extracting solution has been a continuing one. An effective P extracting solution must extract a portion of P from the labile P pool (Holford, 1980). This pool is a dynamic system consisting of soluble and sorbed P and primary minerals (Bisen and Ramamoorthy, 1971; Mehlich, 1982). The chemical reactions and structures of some primary minerals are reviewed by Lindsay, 1977. The Bray/Kurtz extracting solution, formerly Bray P1, has been shown to reliably estimate the ability of a soil to renew the soil solution with P for plant growth (Bray and Kurtz, 1945). It has been adapted for use by soil testing laboratories throughout the United States and abroad (Southern Cooperative Series, Bull. 190, 1974; Buys and Venter, 1980).

Bray/Kurtz Experiment

The Bray/Kurtz extracting solution consists of 0.025N HCl and 0.03N NH_4F. This mild acid solution has been shown to reliably predict crop response to added fertilizer on both acid and neutral soils (McLean et al., 1979; Vaughn and Jones, 1980). The reaction in basic soils, however, is less effective. The acid is quickly neutralized by the bases present and the F anion is precipitated by the formation of calcium fluoride (Mehlich, 1978). To overcome this handicap, various modifications of Bray/Kurtz extractant have been extensively tested. These include varying shaking times, soil to solution ratios and filtering times (Aaboola and Omeuta, 1980; Randall and Grava, 1971; Breland and Sierra, 1962; Smith et al., 1957). Oklahoma State Soil Testing Laboratory uses a 1:20 soil to solution modified Bray/Kurtz extraction to obtain a soil P index on all soils requesting routine fertility testing (Hanlon and Johnson, 1983).

While originally designed for P, the extractant has also been used for K determination (Peterson et al., 1971). Both the hydrogen and ammonium cations would contribute to the effectiveness of cation extraction in acid and neutral soils, only ammonium may be available in basic soils. The ability to obtain P, K and Mg soil index values from a single extract would greatly enhance laboratory efficiency.

Multi-element Extractants

Two other extractants, M III and AB/D, have also been shown to reliably extract these same elements. Both solutions have been compared to Bray/Kurtz and 1N ammonium acetate for P and cation extraction, respectively (Mehlich, 1982; Soltanpour and Schwab, 1977; Soltanpour et al., 1979). The high correlations found have led to the adoption of these new procedures in several soil testing laboratories (Mehlich, 1982; Soltanpour and Workman, 1981). The M III solution: 0.2N acetic acid, 0.25N ammonium nitrate, 0.015N ammonium fluoride, 0.013N nitric acid and 0.001M EDTA, has been designed for extraction of acid and neutral soils, but because of the increased acidic buffering capacity, it is also quite effective on basic soils. The P is extracted by reaction with the acetic acid and ammonium fluoride compounds while K and Mg are extracted by the action of ammonium nitrate and nitric acid. The EDTA allows for the desorption of micronutrients, Cu, Fe, Zn and Mn (Mehlich, 1982).

Since the solubility of P in basic soils in predominantly controlled by the activity of Ca cation, several extractants have included the bicarbonate anion as a major component (Mitscherlich, 1930; Olsen et al., 1954). The newest technique includes 1M ammonium bicarbonate and 0.005M DTPA (Soltanpour and Schwab, 1977; Soltanpour and Workman, 1979). The advantage of this solution is that one solution may reliably extract P, K, Mg and the micronutrients (Haulin and Soltanpour, 1982).

With respect to laboratory operations all solutions under consideration in this study can be converted to gases when undergoing atomic absoption flame analyses (Mehlich, 1982).

MATERIALS AND METHODS

Soil samples from the 0-15 cm depth at five sites, each located on an Oklahoma State University Agronomy Research Station, were used in this experiment. Pertinent information about each of the soils is given in Table I.

These sites were selected because they are part of the University long term soil fertility research program and each soil represents an agriculturally important soil series. Each site has been in continuous wheat production for at least the last five years. Various N-P-K fertilizer treatments have been applied yearly to all sites. The Altus location included both irrigated and nonirrigated wheat studies. Soil samples were composites of 15-20 cores from each plot. Each sample was dried at 75C for 6-8 hours, ground to pass a 2 mm screen and submitted for routine soil fertility analysis by the Oklahoma State Soil Testing Laboratory. The ground soils were subjected to the various extraction procedures shown in Table II. Each extraction was repeated in triplicate. Each replication was completed before the next replication was started to simulate normal daily laboratory operations. In this way, day to day laboratory variability is included in the replication variance component. Additionally, a control soil sample was analyzed at the end of each replication. The accuracy and precision within and among daily runs were used as

TABLE I

DESCRIPTION AND NUTRIENT STATUS OF FOUR SAMPLED SOILS

Location	Series	Classification	pH	BI[2]	NO_3-N	P	K
					kg ha^{-1}		
Haskell	Taloka silt loam	fine mixed thermic Mollic Albaqualts	5.0	6.7	7	17	112
Stillwater	Kirkland silt loam	fine mixed thermic Udertic Paleustolls	5.9	6.9	0	25	345
Lahoma	Grant silt loam	fine mixed thermic Udic Argiustolls	5.3	6.7	1	82	665
Altus[1]	Hollister clay loam	fine mixed thermic Pachic Paleustolls	7.6	-	3	24	799

1 Two sampling sites including nonirrigated and irrigated wheat.

2 SMP Buffer pH

TABLE II

EXTRACTION PROCEDURES USED

Solution #	Name	P	K	Mg	Soil Scoop(g)	Soil-solution Ratio
1	1<u>N</u> NH_4OAC		x	x	2	1:10
2	Bray/Kurtz	x	x	x	2	1:20
3	Mehlich III	x	x	x	2	1:10
4	AB/D	x	x	x	10	1:2

an estimate of any daily variation.

The 2.0 g (1.8 cm^3) scoop was used to standarize measurement of the soil sample subjected to extraction, while the soil to solution ratios were: 1) that recommended by the literature; or 2) that used at Oklahoma State University (Bray/Kurtz). Due to the narrow soil to solution ratio of the AB/D test, the 10 g of soil specified by Soltanpour and Schwab (1977) was used to obtain sufficient solution for analysis. Fifty ml Erlenmeyer flasks, Whatman #2 filter paper and an Eberbach 6150 rotation shaker (240 rpm) were used for all extractions. Shaker speed was adjusted to 180 rpm for the AB/D extractions. Filtrate was collected in plastic cups (Solo P35A, 3 1/2 oz., Duckwalls). Phosphorus was analyzed by the Watanabe/Olsen modification to the Murphy/Riley phosphomolybdenum blue color complex (1965). Color solutions were read using a Brinkman 801 probe colorimeter. Analytical results were entered into the University's IBM 3081D computer for statistical evaluation using the SAS system (SAS, 1979).

RESULTS AND DISCUSSION

An analysis of variance and linear regression were calculated for each soil nutrient and site combination. The error mean square and F tests of the extracting solutions and laboratory replication effects, are found in Table III.

The error mean square observed for P determination on samples originating from the Lahoma site was an order of magnitude larger than error terms from other sites. The same differential was seen in the analysis of variance for K determination at the Lahoma and Altus non-irrigated sites and for Mg determination only at the Altus non-irrigated site. It was found that the major contributing factor to the larger error terms was the interaction effect of extractant and either field treatments or field replications. While of statistical significance, this heterogeniety of error is not critical to the testing of these laboratory methods. Therefore, it was decided to include all sites in the final regression models. In each case, the soil test index is 2 to 3 times higher than the 100% nutrient sufficiency index. The laboratory precision measured by the laboratory replication effect was also found to be significant when the soil test index was well above 100% sufficiency.

The information in Table IV contains the results of the control soil sample analyses. The statistics confirm that all extractants

TABLE III

TOTAL NUMBER OF EXTRACTIONS, ERRORS MEAN SQUARE AND DEGREES OF FREEDOM AND F TEST VALUES FOR EXTRACTANT AND LABORATORY REPLICATION EFFECTS BY NUTRIENT LOCATION

Location	Number of Extractions	Error Mean Square	df(error)	F Test: Extractants[1]	F Test: Laboratory Replications
		PHOSPHORUS			
Haskell	468	145	213	333	105.00**
Stillwater	468	102	213	103	1.05
Lahoma	504	1587	440	510	0.74
Altus (nonirrig.)	702	170	616	512	7.20**
Altus (irrig.)	648	113	568	637	5.23**
		POTASSIUM			
Haskell	624	68	561	637	7.28**
Stillwater	624	191	561	1277	14.56**
Lahoma	672	1960	604	1190	1.38
Altus (nonirrig.)	936	768	847	5399	5.35**
Altus (irrig.)	864	871	781	6587	5.44**
		MAGNESIUM			
Haskell	624	68	561	5003	31.00**
Stillwater	624	2298	561	2362	35.98**
Lahoma	672	919	604	1359	18.4**
Altus (nonirrig.)	936	1803	847	5842	4.17**
Altus (irrig.)	864	1186	781	10633	6.39**

[1] All extractant F tests were found highly significant (P=0.01)

*Statistically significant at the P = 0.05 level.

**Statistically significant at the P = 0.01 level.

TABLE IV

CONTROL SOIL SAMPLE STATISTICS

Analysis	Extractant	Mean[1]	Standard Error of Mean (±)	Coefficient of variation
		kg ha^{-1}	kg ha^{-1}	%
P	Bray/Kurtz	31	0.8	7.3
	M III	23	0.5	8.8
	AB/D	36	0.1	4.9
K	Bray/Kurtz	332	3.8	4.5
	M III	395	1.3	1.3
	AB/D	361	5.6	6.0
	NH_4OAC	413	3.0	2.9
Mg	Bray/Kurtz	762	13.4	7.1
	M III	1095	15.7	6.2
	AB/D	734	8.7	4.6
	NH_4OAC	1130	9.9	3.4

1 Mean represents 15 extractions for each extracting solution.

can provide low day to day laboratory variability. This finding is true even at very high soil test values, such as that of Mg in the control sample.

Linear regression statistics are shown in Tables V, VI and VII. Each regression used either the Bray/Kurtz or 1N ammonium acetate extractant as the independent variable since these are the standard extractants used in Oklahoma State Soil Testing Laboratory. Each table gives the range of soil test indices observed at each site. Research has shown that 100% sufficiency is reached for soil test indices of 73 kg P ha^{-1}, 280 kg K ha^{-1} and 112 kg Mg ha^{-1}. Individual plots of observed values confirmed that linear regression was appropriate (these plots not shown), this is also evident from the R values near 1.0 .

A definite trend can be seen in the slopes for P regression, Table V. For all but the Lahoma site, the M III vs. Bray/Kurtz slopes approach 1 while slopes of AB/D vs. Bray/Kurtz approach 0.15. This finding indicates that the M III and Bray/Kurtz extractants will have about the same index values and allow the same degree of sensitivity while the AB/D index will be an order of magnitude less sensitive than that of the other two.

Referring to Table VI, the slopes for M III and Bray/Kurtz comparisons with the ammonium acetate extractant approach 1 at all sites. However, as the K index exceeds the 700 kg K ha^{-1}, the slope for AB/D vs. ammonium acetate extractant is much less than 1. Since no dilutions were made and the highest standard for all tests contained an actual K concentration of 70 ug K ml^{-1}, the narrow soil to solution range of the AB/D extracted concentrations far in

TABLE V

PHOSPHORUS LINEAR REGRESSION SLOPES, INTERCEPTS, AND R2 RATIOS AT FIVE LOCATIONS IN OKLAHOMA

Location (n)**	Extractants*	Slope	SEE***	Intercept ($kg\ ha^{-1}$)	R^2	Bray/Kurtz Index P Range ($kg\ P\ ha^{-1}$)
Haskell	1 vs 3	0.637	0.01	-1	0.995	20-65
(13)	2 vs 3	0.150	0.06	0	0.980	
Stillwater	1 vs 3	0.782	0.03	-6	0.988	30-100
(13)	2 vs 3	0.110	0.03	-1	0.947	
Lahoma	1 vs 3	1.517	0.13	-74	0.917	90-190
(14)	2 vs 3	0.338	0.39	-22	0.862	
Altus (nonirrigated)	1 vs 3	0.904	0.02	0	0.995	20-95
(13)	2 vs 3	0.160	0.06	-1	0.986	
Altus (irrigated)	1 vs 3	0.931	0.02	1	0.995	20-120
(12)	2 vs 3	0.175	0.10	-1	0.963	

* 1 = Mehlich III; 2 = AB/D; 3 = Bray/Kurtz

** Each point is the mean of 12 to 18 observations and was obtained by averaging over field and laboratory replications.

*** Standard error of the estimate for the slope of each regression.

TABLE VI

LINEAR REGRESSION SLOPES, INTECEPTS AND R2 VALUES COMPARING DIFFERENT POTASSIUM SOIL EXTRACTANTS AT FIVE LOCATIONS IN OKLAHOMA

Location (n)**	Extractants*	Slope	Intercept (kg ha^{-1})	R^2	Ammonium Acetate K index (kg K ha^{-1})
Haskell	1 vs 4	0.936	-5	0.995	
(13)	2 vs 4	0.895	-14	0.993	120-240
	3 vs 4	0.843	13	0.989	
Stillwater	1 vs 4	0.998	-14	0.984	
(13)	2 vs 4	0.876	-44	0.875	360-450
	3 vs 4	0.760	33	0.886	
Lahoma	1 vs 4	1.297	-248	0.988	
(14)	2 vs 4	0.541	178	0.939	740-1040
	3 vs 4	1.184	-190	0.986	
Altus	1 vs 4	1.135	-79	0.993	
(nonirrigated) (13)	2 vs 4	0.209	428	0.798	910-1110
	3 vs 4	0.937	71	0.977	
Altus	1 vs 4	1.106	-55	0.952	
(irrigated) (12)	2 vs 4	0.471	232	0.818	850-970
	3 vs 4	1.090	-156	0.950	

* 1 = Mehlich III; 2 = AB/D; 3 = Bray/Kurtz; 4 = Ammonium Acetate.

** Each point is the mean of 12 to 18 observations and was obtained by averaging over field and laboratory replications.

excess of the standard. Thus, results from the Lahoma and the two Altus sites are extrapolations and indicate much lower values than that extracted. It should be noted that these sites had soil test indices approximately three-fold that of the 100% sufficiency level. Accuracy at such high levels is not required. Similar comments also apply to Table VII containing Mg regression comparisons.

The data from all sites for each element were combined to produce the information in Table VIII. Over the entire range of soil indices, all extractants are highly correlated to the refernce extractants. This finding supports the cited literature findings.

In addition to accurately estimating the soil level of a nutrient, the extractant must have the additional attributes of speed and ease of handling. The increased shaking time of 15 minutes, the need to neutralize excess bicarbonate anion with concentrated HCl and reshake the mixture, detract from the AB/D procedure for routine use. Since this extractant is relatively unstable with respect to pH, the soil:solution mixture tends to have stronger ammonia odor than any of the other solutions even though all contain various amounts of ammonia. The chemistry of the AB/D and ammonium acetate extractants allow the determination of Ca while the presence of F in both the M III and Bray/Kurtz solutions preclude this analysis.

TABLE VII

LINEAR REGRESSION SLOPES, INTERCEPTS AND R2 VALUES COMPARING DIFFERENT MAGNESIUM SOIL EXTRACTANTS AT FIVE LOCATIONS IN OKLAHOMA

Location (n)**	Extractants*	Slope	Intercept ($kg\ ha^{-1}$)	R^2	Bray/Kurtz Index Mg Range ($kg\ Mg\ ha^{-1}$)
Haskell	1 vs 4	0.929	-30	0.933	
(13)	2 vs 4	0.675	-46	0.960	1010-1280
	3 vs 4	0.541	124	0.940	
Stillwater	1 vs 4	0.918	20	0.982	
(13)	2 vs 4	0.626	-18	0.954	200-260
	3 vs 4	0.748	-8	0.974	
Lahoma	1 vs 4	0.903	12	0.939	
(14)	2 vs 4	0.624	-16	0.990	430-640
	3 vs 4	0.771	-25	0.971	
Altus	1 vs 4	0.839	235	0.682	
(nonirrigated)	2 vs 4	0.7111	-58	0.888	1250-1350
(13)	3 vs 4	0.472	221	0.778	
Altus	1 vs 4	1.013	4	0.592	
(irrigated)	2 vs 4	0.431	214	0.212	1130-1230
(12)	3 vs 4	0.954	-256	0.877	

* 1 = Mehlich III;2 = AB/D; 3 = Bray/Kurtz; 4 = Ammonium Acetate.

** Each point is the mean of 12 to 18 observations and was obtained by averaging over field and laboratory replications.

TABLE VIII

LINEAR REGRESSION SLOPES, INTERCEPTS AND R2 VALUES FOR P, K AND MG

Element	Extractants*	Slope	Intercept	R^2
P	1 vs 3	1.12	-19	0.942
	2 vs 3	2.10	-44	0.881
K	1 vs 4	1.091	-43	0.998
	2 vs 4	0.634	46	0.977
	3 vs 4	0.945	-21	0.983
Mg	1 vs 4	1.000	-21	0.984
	2 vs 4	0.667	-34	0.993
	3 vs 4	0.657	24	0.977

*1 = Mehlich III; 2 = AB/D; 3 = Bray/Kurtz; 4 = Ammonium Acetate

CONCLUSIONS

The four extractants in this study were found to be highly correlated in the amounts of P, K and Mg extracted from four agronomically important soils in Oklahoma. Any of these extractants, would be suitable for use at the Oklahoma State Soil Testing Laboratory. The AB/D extractant, originally developed for basic soils containing amounts of free lime, reliably extracted P, K and Mg on the acidic and neutral soils in this study. When considering speed and ease of analysis, the Bray/Kurtz, M III and ammonium acetate procedures are superior to the AB/D procedure.

LITERATURE CITED

1. Aaboola, A. A. and J. A. I. Omeute. 1980. Effect of some modification of extraction technique on extractable P in soils of South West Nigeria. Comm. in Soil Sci. and Plant Analysis. 11(7):653-675.
2. Bisen, D. C. and B. Ramamoorthy, 1971. Relationship of different forms of soil phosphorus to available phosphorus extracted by Olsen's and Bray's P-1 methods in alluvial soil. Indian J. Agric. Sci. 41(11):967-970.
3. Bray, E. H. and L. T. Kurtz. 1945. Determination of total, organic and available form of phosphorus in soil. Soil Sci. 59:39-45.
4. Breland, H. L. and F. A. Sierra. 1962. A comparison of the amount of phosphorus removed from different soils by various extractants. Soil Sci. Soc. Amer. Proc. 26:348-350.
5. Buys, A. J. and G. C. H. Venter. 1980. Correlations between Bray 1, Bray 2 and ISFEI (Volume) soil-P extractants. Fertilizer Society of South Africa Journal, No. 1, 13-18.
6. Hanlon, Jr., E. A., and G. V. Johnson. 1983. Oklahoma State University Agronomic Services. Procedure of soil, forage, and water testing. Oklahoma State University fact sheet No. 2901.
7. Havlin, J. L. and P. N. Soltanpour. 1982. Greenhouse and field evaluation of NH_4HCO_3-DTPA soil test for Fe. Journ. Plant Nutrition 5(4):769-783.

8. Holford,, I. C. R. 1980. Effects of phosphate buffer capacity on critical levels and relationships between soil tests and labile phosphate in wheat-growing soils. Australian J. of Soil Res. 18(4):405-414.

9. Lindsay, W. L. and P. L. G. Vlek. 1977. Phosphate minerals, p. 639-671. In J. B. Dixon, S. B. Weed, J. a. Kittrick, M. H. Milford and J. L. White (ed.) Minerals in soil environments. Soil Sci. Soc. of Amer. Madison, Wisconsin,

10. McLean, E. O., T. D. Oloya and J. L. Adams. 1979. Soil tests to inventory the intially available levels and to assess the fates of added P and K as bases for improved fertilizer recommendations. Comm. in Soil Sci. and Plant Analysis. 10(3):623-630.

11. Mehlich. A. 1978. Influence of fluoride, sulfate and acidity on extractable phosphorus, calcium, magnesium and potassium. Comm. in Soil Sci. and Plant Analysis 9(6):455-476.

12. Mehlich, A. 1982. Comprehensive methods in soil testing. North Carolina Dept. of Agric. Mimeo 1-82.

13. Mitscherlich, E. A. 1930. Eine bestimmung des dungerbedunfnisse des bodens. 3rd ed. Paul Porey, Berlin.

14. Olsen, S. R., C. V. Cole and F. S. Watanabe. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular 939, Washington, D.C.

15. Peterson, L. A., G. G. Weis and L. M. Walch. 1971. Potato response to varying levels of soil test P and K. Comm. in Soil Sci. and Plant Analysis. 2(3):267-274.

16. Randall, G. W. and J. Grava. 1971. Effect of soil:Bray No. 1 ratios on the amount of phosphorus extracted from calcareous Minnesota soils. Soil Sci. Soc. Amer. Proc. 35:112-114.

17. SAS Institute. 1979. SAS Users Guide. SAS Institute, Raleigh, North Carolina.

18. Smith, F. W., B. G. Ellis and J. Grava. 1957. Use of acid-fluoride solutions for the extraction of available phosphorus in calcarious soils and in soils to which rock phosphate has been added. Soil Sci. Soc. Amer. Proc. 21:400-404.

19. Soltanpour, P. M. and A. P. Schwab. 1977. A new soil test for simultaneous extraction of macro- and micro-nutrients in alkaline soils. Comm. in Soil Sci. and Plant Analysis 8:195-207.

20. Soltanpour, P. N. and S. Workman. 1979. Modification of the NH_4HCO_3-DTPA soil test to omit carbonblack. Comm. in Soil Sci. and Plant Analysis 10(11):1411-1420.

21. Soltanpour, P. N., S. M. Workman and A. P. Schwab. 1979. Use of inductively-coupled plasma spectrometry for the simultaneous determination of macro- and micro-nutrients in NH_4HCO_3-DTPA extracts of soils. Journ. Soil Sci. Soc. of Amer. 43:73-78.

22. Soltanpour, P. N. and S. M. Workman. 1981. Soil testing methods used at Colorado State University soil testing laboratory--for evaluation of fertility, salinity, sodicity and trace element toxicity. CSU Experiment Station Fort Collins Tech. Bull. 142.

23. Southern Cooperative Series. 1974. Procedures used by state soil testing laboratories in the southern region of the United States. Southern Cooperative Series Bull. 190.

24. Vaughn, O. B. and M. B. Jones. 1980. Soil phosphorus tests on California subclover-annual grass pastures. Soil Sci. 130(6):307-313.

25. Watanabe, F. S. and S. R. Olsen. 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. Soil Sci. Soc. Amer. Proc. 29:677-678.

PART II

A COMPUTER ASSISTED SOIL FERTILITY DATA MANGEMENT SYSTEM

A COMPUTER ASSISTED SOIL FERTILITY DATA MANAGEMENT SYSTEM

ABSTRACT

A definite need for developing an efficient data management system existed for the Oklahoma State University Soil Fertility Research program. Because of the the large amount of data that is gathered yearly, the Soil Fertility Research program requires the use of the university's main computer and statistical packages. However, use of this equipment without training in one or more computer languages can prove to be very frustrating. Therefore, the proposed data management system is designed to be user friendly for the benefit of individuals who do not have a strong background in the use of IBM computers. This data management system (DMS), in use for the last nine months, is very user friendly. The DMS allows the inexperienced user to select options or choices from a menu displayed on the terminal screen. The actual programs, written in Statistical Analysis System (SAS) and FORTRAN languages, are modified automatically according to the user's choices without any further action by the user. These modifications use the IBM Time Sharing Option (TSO) employing the Command Language Listing (CLIST) feature.

Data entry is accommodated by 1) terminal input methods, including TSO or WYLBUR editing; 2) keypunch cards; or 3) data transferred from a microcomputer. Computer generated worksheets

provide an organized and efficient link from data recording in the field and laboratory to data entry into the computer. All worksheets are controlled by a CLIST which permits the user to specify the form type, quantity and titles which vary for the type of form.

Data from soil, plant or field input disk files are transformed from raw measurements to SI units via CLIST controlled programs. These results are written to calculated data files. A unique set of experiment and treatment descriptors are added to the calculated data before storage on tape. The experiment descriptors indentify the various experimental parameters, such as location and crop, while the treatment descriptors describe the actual treatments, such as soil fertilizer rates and sources.

Specific data may be retrieved from the tape or disk storage file by defining the descriptor values of interest within the retrieval program. This technique allows the creation of a smaller data subset on disk containing only the descriptors of interest and the observed measurements.

Due to the flexible design of the system, it can readily be adapted to other disciplines within the agricultural community. This bulletin describes the DMS in detail.

INTRODUCTION

Because of the variablility of climatic factors, soils, crops, and cultural practices, most soil fertility experiments, such as those used for soil test calibration, must be conducted over many years and locations. Long term research generates volumes of data that include soil analyses, plant analyses, plot yields, etc. In addition, many such experiments may be similar in design and, if combined, may broaden the data base from which conclusions are drawn. An entire data management system was neeeded to manage such data. This system should provide rapid statistical analyses, electronically store and retrieve data and yet be user friendly. The computer assisted Soil Fertility Data Management system (DMS) was designed to meet these objectives. This DMS has been in active use for the last nine months at Oklahoma State University. The purpose of this bulletin is to explain the operation of the DMS so that it may be used, all or in part, by other researchers. The system has many features which could be adapted for other agricultural disciplines. For example, the storage and retrieval system might be used by plant breeders to trace the various stages of development for a particular cultivar. Many researchers could adapt the worksheet system for use by lab and field technicians and graduate students to speed data recording.

DISCUSSION

Procedural Methods

The data management system is based on the supposition that the user is not versed in computer programming. The user must have access, however, to TSO, which is a text editor, and FORTRAN and SAS languages. The TSO is used in its interactive mode to display a series of options to the user and to allow the user to choose which option should be executed. This interactive mode is called a CLIST (pronounced see-list) which is a command listing. The FORTRAN and SAS languages are used in all other programs to actually manipulate the data according to the user selected options. Checklists, worksheets that contain the various options available in each CLIST, are provided to assist the user in deciding which options are required before program execution. For example, the graduate student and professor can discuss the benefits of combining forage and soil information from several locations. During the discussion, the appropriate checklist is filled out. Later the graduate student can use the DMS to combine his forage and soil data in preparation for eventual statistical analysis. The professor retains the checklist as a file record of the graduate student's activities within the DMS.

The programs to generate worksheets for field, plant and soil analyses are written in FORTRAN. As with all programs within the

DMS, the actual modifications, such as beginning lab number, number of worksheets needed, etc., are entered by the user under CLIST control. Should the user make an invalid response, a response that is outside the programmed limits within the CLIST, the CLIST will prompt for a valid response to the same option.

All other background programs are written in SAS. Data handling is accomplished in such a manner that at least two copies of data will reside within the on-line disk system. Duplication of data is user controlled via CLIST options so that, if this duplication is not desired, the user may keep only the most current data in the disk file. While this action may reduce disk use charges, the charge will seem small should one data set be lost by improper user input or mechanical failure of the disk. A data flow chart for the entire DMS is shown in Figure 1. All programs, regardless of program language, are documented by 1) comments within each program, 2) a user's manual and 3) a straightforward (linear) programming style.

Once the FORTRAN or SAS program has been modified to conform to the user selected options by the CLIST, the computer executes the program which is no longer accessible to the user. Printing of a job log and listings of all data handled by an individual program are provided to verify the success of the operations. The data listing is a hard copy of the data suitable for filing or as an appendix to thesis or dissertation work.

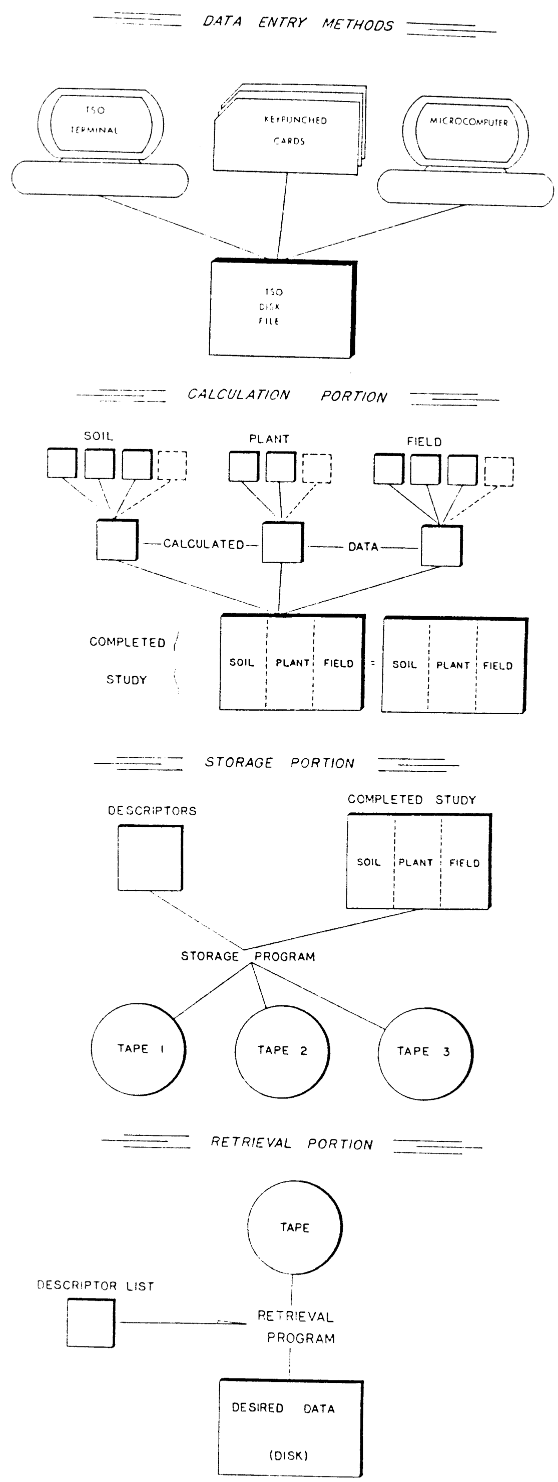

Figure 1. Flow Chart of Data

Data Organization

Data management becomes a concern very quickly for complex experiments conducted over several years. An ongoing alfalfa phosphorus/potassium experiment at five locations throughout the state contains four levels of phosphorus and three levels of potassium. The study is in its third year and will run for at least two more years. The measured parameters include plant analyses, soil analyses, yield (dry matter weights) from each of the 4x3 treatment combinations for three replications with three cuttings per year.

The first step toward a solution is designing a method of recording the measurements in a manner that allows flexibility yet demands consistency to insure that all the needed information is gathered. The information should also be recorded in a manner that permits data encoding directly from the papers upon which the information was originally written.

From these objectives, a series of computer generated laboratory and field worksheets were designed. Worksheet programs are controlled by SHEET.CLIST. The CLIST allows the user to select such parameters as the type of form, beginning laboratory number and the number of each worksheet desired. Reductions of each worksheet can be found in Appendix A. The exact options available are shown on the SHEET.CLIST checklist which is found in Appendix B. Each type of worksheet is designed to minimize the number of entries that need be made and to increase laboratory organization.

An additional feature of the soil and plant worksheets is that the worksheets provide a unique laboratory number for each sample. Space is provided on the worksheet to list the origin of each sample, such as the experiment number, replication, treatment, sampling depth, etc. One line is provided for each sample and each line is given a unique laboratory number. This procedure minimizes the information that has to be written on the actual sample bag or box, identifies the sample quickly and eliminates any lab bias that might result from knowledge of exact sample source.

Soil Worksheets

The current worksheets used for laboratory soils analyses consist of a group of three sheets. The first two worksheets allow for entry of results from the routine or most frequently desired soil tests. The third sheet is used for more specialized tests and has room to add new determinations. These new determinations can be added to the third page by a small change to the worksheet program and changes to the "input" and "put" statements in two programs within the DMS. The addition of new variables is discussed in more detail later.

Space is provided for duplicate analyses for most tests. The duplicates are provided as a laboratory control, not as a subsampling technique. Once in the DMS, duplicates are averaged and no statistics are available on duplicate variablility. If a measure of subsampling variablility is desired, the user should assign a lab number to each subsample when first entering sample information on the worksheet. The user can then include the subsampling effect in the statistical analyses of the data.

Plant Worksheets

The computer generated plant worksheets are very similar to the soil worksheets and all comments about soil worksheets apply equally to plant worksheets. Two variables on the plant worksheet are different, however, and are worthy of comment. These variables are the sample weights for Kjeldahl nitrogen and perchloric digestion analyses. The parameters can be changed on a sample by sample basis. This feature is very useful when total sample weight is small and the standard weight of 0.250 g can not be used. If the standard weight of 0.250 g is used, data entry is simplified by entering a "." in place of an actual weight. The user may enter the "." on the worksheet in the columns marked "N_WT" and/or "P_WT" or may leave these columns blank. In either case the user must enter the "." when entering the data into the computer. The DMS will adjust the "." to the standard weight in all subsequent calculations.

Field Worksheets

Unlike the soil and plant worksheets which are printed on standard 8 1/2" x 15" computer paper, field worksheets are printed on 8 1/2" x 11" portrait white paper. Since these forms are used mainly in the field, they were designed to fit a regular clipboard. Three field forms have been developed: forage, grain and peanut. Each worksheet is dedicated to information pertaining to the type of material being harvested. In our opening example, the hypothetical experiment might use just the forage worksheets. If the crop were wheat, both forage and grain forms might be used to gather information on potential grazing and grain yields.

Field worksheets can be tailored to fit the exact number of treatments by an entry in the controlling CLIST. The CLIST will allow a maximum of 25 treatments per page. Using the exact number of treatments can be of great assistance in the field in that there are no extra lines upon which to make incorrect entries. If a mistake is made, it will be caught earlier due to the structured entry system.

This tailoring can also be extended to the selection of the replication number. The tailoring does require modification to the main program and should therefore be done only by someone with expertise in program editing. This feature could easily be included in the controlling CLIST and checklist, if desired. All field worksheets currently print four replications automatically. Both treatments and replications are printed in sequential order on the worksheets and are not randomized.

REFERENCE Variable

The value of REFERENCE, a variable name, is used to define a particular set or grouping of data. Its current use is to identify data that has come from a specific location, crop, and sampling date within an experiment. This assignment was arbitrary and could be changed to suit the needs of the user so long as a unique group of characters is assigned to a set of data. Use of a descriptive REFERENCE makes the group of identifying characters more user fiendly. In its current use, REFERENCE is a listing of up to 12 alphanumeric characters.

Referring to the research example at the beginning of this discussion. Plant data could be easily grouped by location and harvest date. Soil samples might be grouped by location and sampling date. Cultural practice used might further define both soil and plant samples and therefore be included within the REFERENCE. There is no maximum number of REFERENCE's allowed within an experiment. A typical REFERENCE might be "HBP6", where the letter "H" refers to the location Haskell, "B" refers to the crop bermudagrass, "P" denotes the experiment is a phosphorus study and "6" is the sampling month June.

The variable REFERENCE is used throughout the DMS. Specific REFERENCE's can be called upon by the user to select a specific setof data from within all data from a particular experiment or from within all data contained in the DMS. It is this feature, the ability to select one or more REFERENCE's, that allows concurrent multiple users within the DMS. For more information about the use of REFERENCE, see the data entry section of this publication.

Data Entry

When enough data has been gathered and recorded on the appropriate worksheets, it is time to transfer this information into the DMS. The various forms of data entry are shown in Figure 2. In our example there are many possible entry points, but a logical point might be after the last harvest for a particular year for the field information, after the plant analyses have been completed for each harvest, etc. Remember that any number of REFERENCE's can be used in an experiment. Here the field data will most likely be encoded first, and hence, assigned REFERENCE's first. The researcher should use care such that the same REFERENCE's are used to describe the complimentary plant analyses. Later in the DMS, the plant analyses will be joined to the respective field results (same for soil analyses) by using the unique REFERENCE string.

Entry of data can be done in many different ways. The objective is to create a TSO-type data set on disk. Direct entry of data can be accomplished using either TSO or WYLBUR text editing modes at Oklahoma State University.

Many researchers still use keypunched cards. Batch keypunching services allow data to be handled relatively quickly by professional keypunchers and the cards act as a permanent record of that line of data. If, however, the data must be entered by inexperienced keypunch machine operators, this method becomes much less attractive due to the excessive time spent learning this

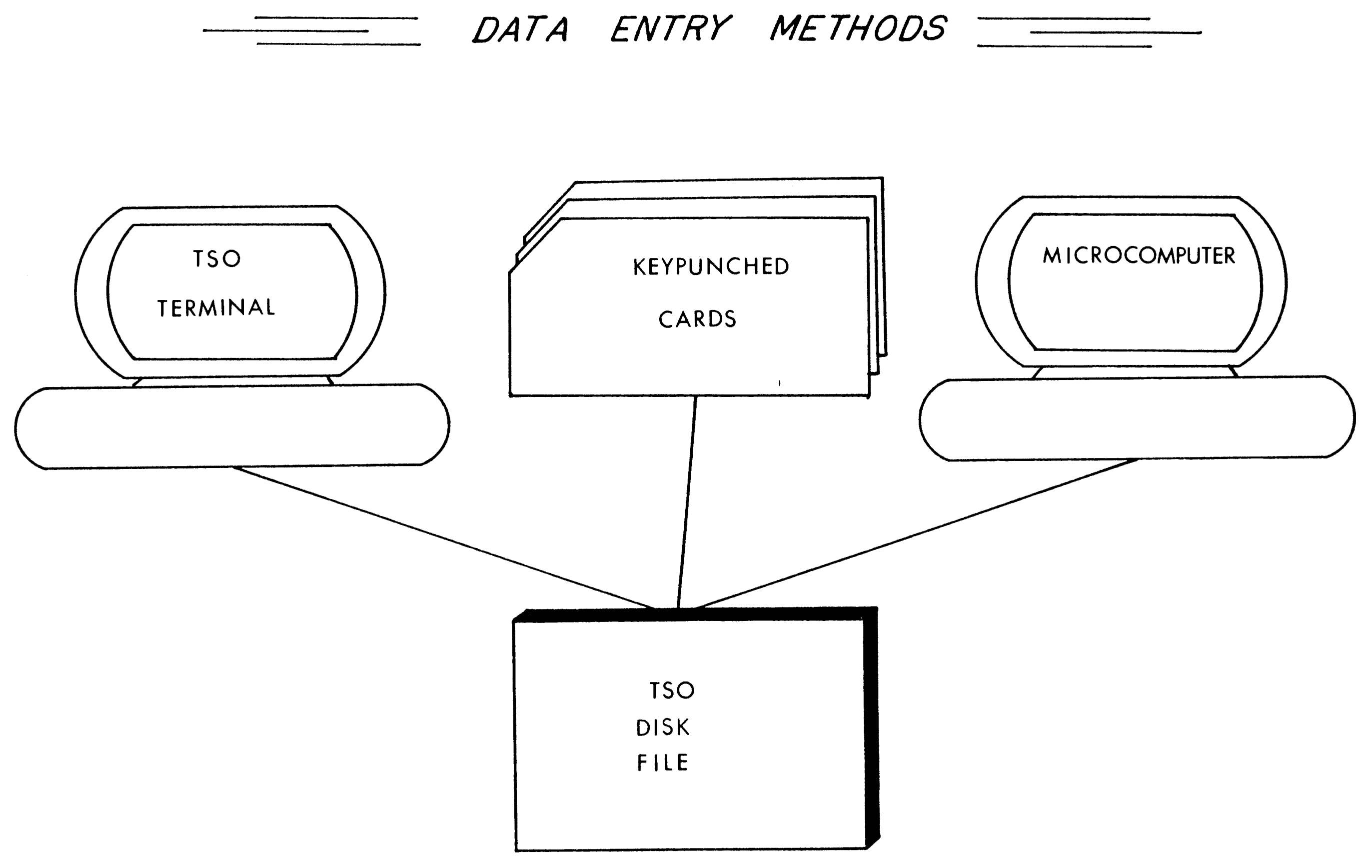

Figure 2. Methods of Data Entry

skill. Additionally, the bulk associated with large numbers of cards creates handling and storage problems. If keypunched cards figure into the research operations, the DMS has been designed to handle this data entry technique. Some applications require the use of a specially designed program (MOVE) that is included within the DMS. The use of this program is not governed by a CLIST and requires an intermediate understanding of computer programming.

An increasing number of researchers have access to microcomputers. If the microcomputer system can communicate (data transmission via modems) with the main frame (the IBM 3081D at OSU), data entry could be via the microcomputer. This method may also require the use of the interfacing program (MOVE). There are several attractive advantages to this mode of data entry. Since the cost of operation is usually much lower than batch keypunching services, TSO or WYLBUR text editing, the operator need be less skilled. A floppy disk file can be produced which (when properly backed up) can act as a semipermanent copy of raw data. Editing of this file can be done on the microcomputer and then transferred to the main computer and the DMS.

At present there are no plans to adopt more of the DMS to microcomputer use. The design of the DMS was tailored to ease the handling of large data sets and/or many small data sets in concert with high speed data storage and retrieval; all strengths of larger computers at this time.

CLIST

As mentioned before, the interface between the data management programs and the user is the CLIST. There are just two CLIST's provided with the DMS: SHEET.CLIST and CALC.CLIST. The first controls all worksheet generation while the second controls all calculation, merge and storage programs. The function of the CLIST is to gather the answers to a preset series of choices. Once all parameters are entered by the user, and all responses are judged to be within the internal logic structure of the CLIST, these parameters are used to modify the selected program such that the user's selections are carried out.

Choices offered by each of the CLIST's are found on the checklists in Appendix B. These choices are generally of two types. The first type causes action at a data set level. For example, the researcher using CALC.CLIST may choose to run the soil calculation program but not store the answers on a disk data set. Alternately, the researcher may wish to run the same soil calculation program, but to store the results in a data set and remove old data from that same data set. Either of the above actions can be done by simply entering a "1" or a "4". There is no need for the researcher to be versed in the job control language which is envoked to accomplish the above tasks.

The second type of choice is the specification of parameters that are used in data calculation. These parameters, which can be modified through the CLIST, are those that change only infrequently and affect large numbers of samples. The normality of a standardized acid is such a parameter. It is important to remember that all data are affected by changing one or more parameters through the CLIST. For this reason, data can be selectively moved through the DMS and results correctly calculated by selecting a REFERENCE and/or using the partial entry technique.

For example, if acid normality changed midway through a particular REFERENCE sample group, enter the first part of data that requires the old nomarlity. Run the program specifying the REFERENCE and old normality. Repeat the same operations for the second part of the data, however, specify the new normality in this instance. The entire problem can be avoided by creating small data groups (REFERENCE) and judicious planning in the lab.

Calculation Programs

A schematic of this program portion is shown in Figure 3. Each box represents a data set. There is a data set for each type of worksheet. Thus, there are three different data sets for soil information since there are three pages for soil. The dashed boxes indicate how new forms might be added to the DMS. This process is relatively simple requiring only four modifications. Addition of variables will be discussed in more detail in the discussion describing how to adapt the DMS to other disciplines.

The vectors connecting the various data set boxes represent the FORTRAN and SAS programs which are CLIST driven. For example, the soil calculation program takes information from the three raw

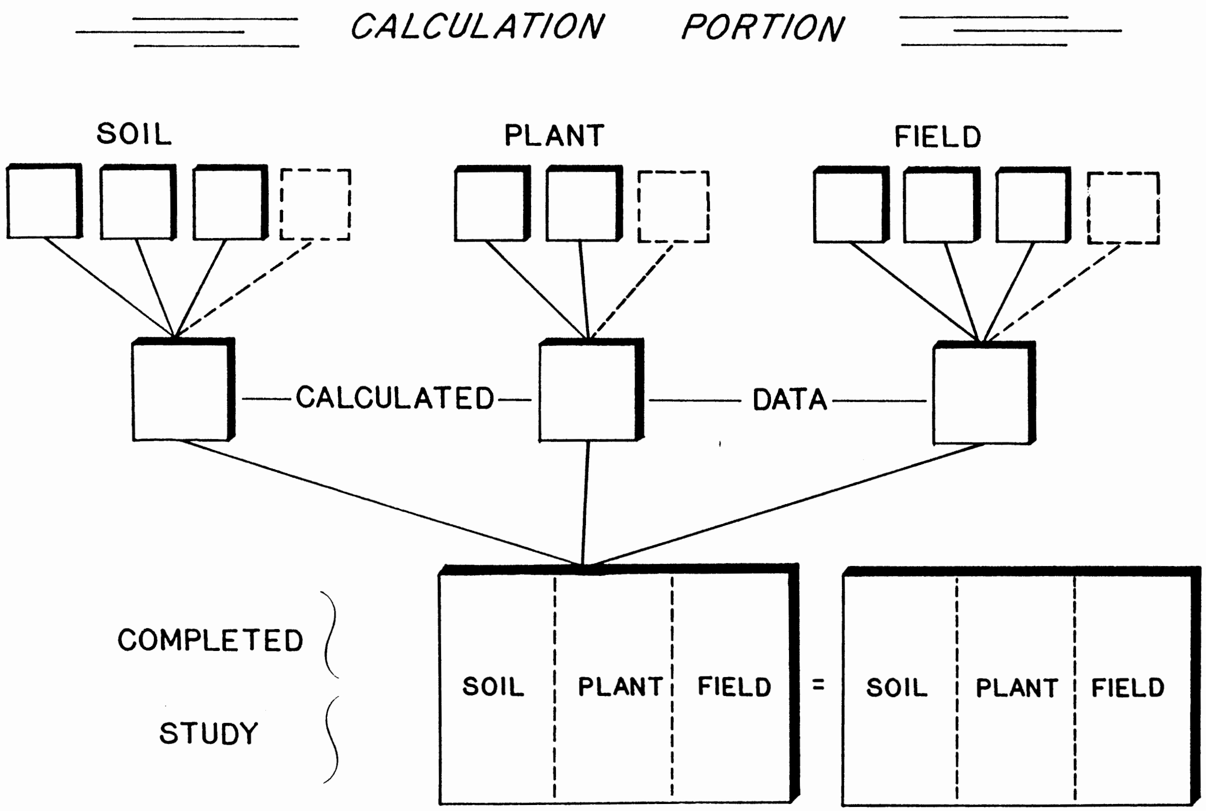

Figure 3. Flow Chart of Calculation Portion of the Data Management System

data files, merges information from all three data sets by laboratory number and performs calculations. These calculations transform the data from raw lab values to SI (1) units. This information, depending upon the disk operation selected, will then be written to another file that is referred to as "Calculated Data" in Figure 3. Both plant and field raw data have similar programs to convert the information to SI units and move this data to the appropriate "Calculated Data" file.

These calculation programs provide several helpful functions. The programs will provide a list of data read into the program, a list of the calculated data and a log to provide a record of all files used within the program. The data is printed to allow quick review and ample room for error checking.

A summary of soil, plant and field calculations are shown in Tables I, II, and III. In each case the raw data are assumed to be either the mg ml in solution or the plot weight without conversions for dilution factors, moisture, etc. This procedure has been adopted to simplify standard and unknown preparation in the laboratory. Field forms for forage provide blanks for moisture calculations. The computer is programmed to do all calculations and unit conversions.

The next major function of the calculation portion is to merge data from the three calculated data files to a composite file termed "Completed Study File". The program responds to the user's CLIST choices by merging information from any combination of the three data files. In normal operations, the information from all three data sets will be merged such that measured soil, plant and

TABLE I

EQUATIONS USED IN THE SOIL CALCULATION PROGRAM

Total Nitrogen = (Average ml * Normality * 14 * 1000)/1

By titration:

Urea = (Average reading * 200 * 0.4662)/20

Ammonium = (Average reading * 200 * 0.7778)/20

Nitrate = (Average reading * 200)/2

Nitrate = (Average reading * 200)/2

Or:

Urea = (Average reading - Blank) * (Normality * 1000 * 100)/(25 * 10)

Ammonium = (Average reading - Blank) * (Normality * 1000 * 100)/(25 * 10)

By electrode:

Nitrate = (Average reading * 25)/10

Or:

Nitrate = (Average reading - Blank) * (Normality * 14 * 1000 * 100)/(25 * 10)

Nitrite = (Average reading - Blank) * (Normality * 14 * 1000 * 10)/(25 * 10)

Organic Nitrogen = Total - Urea + Ammonium + Nitrate + Nitrite

Phosphorus = (Average reading * 20)/1

For Potassium and Sodium:

K = (Average reading * 25)/5

For Calcium and Magnesium:

Ca = (Average reading * 25 * 5)(5 * 4)

For Sulfur, Iron, Zinc, Manganese and Copper:

S = (Average reading * 25)/10

Molybdenum = (Average reading * 250)/25

Carbonate = (Reading * 2 * Normality * 1000)/Aliquot

Bicarbonate = (Aliquot - (2 * Carbonate reading) * Normality * 1000)/Aliquot

Chloride by titration:

Chloride = (25.5 * 1000 * Normality * Reading)/Aliquot

Chloride by electrode:

Chloride - reading

Readings for sulfate, organic matter and aluminum are equal to amounts in soil.

TABLE II

EQUATIONS USED IN THE PLANT CALCULATION PROGRAM

```
% Nitrogen = (NH4 - Blank) * Normality * ((14 * 100)/N_WT * 1000))
                                      @
Phosphorus = P * ( 35 /(5  * P_WT))

Potassium, Iron, Zinc, Manganese use the following format:

    Potassium = K * ( 35 /(P_WT))
```

@ CLIST will allow the user to enter this value.

TABLE III

EQUATIONS USED FOR FIELD CALCULATIONS

Moisture = ((Wet weight - Dry weight) * 100)/(Wet weight - Bag weight)

Dry matter Factor = 1 - (Moisture/100)

Forage, kg ha^{-1} = Dry matter factor * plot weight * ((1.12 * 43560)/A)

where A is the harvest plot area.

field parameters from a particular replication and treatment combination are written to the same data line. This action facilitates the statistical analyses of the combined data. Referring to the beginning research example, the ability of the soil test value to predict alfalfa yield and actual plant nutrient content may be statistically analyzed without data set modifications.

The merge program allows a copy of the merged data to be written to a user defined file. This file, whose actual name is also user defined, is called the "Graduate File". This option is very powerful in that the file created can be used as a subsetting feature - very useful when the main set (contained in the "Completed Study File") is very large and the subset is very small. But, the main purpose for providing the "Graduate File" was to permit data access to the graduate student for use in statistical analyses. This file is a copy of information written to the "Completed Study File". However, under a multiple user environment, the "Completed Study File" may actually contain many experiments and data sets while the "Graduate File" need only contain one experiment or subset. Thus, while there is only one "Completed Study File", there may be any number of user defined "Graduate Files". In this context the "Completed Study File" acts as the disk file backup of the "Graduate File(s)". Therefore, should the graduate student err in such a way that the "Graduate File" is changed (or deleted), the information can still be found, unharmed, in the "Completed Study File".

Data Storage

The storage option of the DMS allows the researcher to move data from on-line disk to tapes. The storage operation is shown in Figure 4. Maintenance of on-line disk files can be costly varying with data set size and disk residence time. Except for a small initial cost and program in/out charges, there is no charge for data storage on tapes. Because of the nature of the tape medium and in the interest of prudence, the DMS uses a series of three tapes in which the third tape is the backup, a copy of the most current information.

Data contained in the "Completed Study File", selected by experiment and REFERENCE, must have additional information added that will describe the various details that makeup the experiment and treatments. These "descriptors" have been divided into experiment and treatment types. A current listing of all descriptors and the worksheet designed for use with the listing are found in Appendix C.

The experiment descriptors provide the DMS with much more information about the what, where and when of the experiment. Until now, the only information about the experiment has been the experiment number and REFERENCE. This description is adequate to separate one experiment and REFERENCE data grouping from all others within the calculation phase but is inadequate if a flexible retrieval system is to be used.

The only parameter dealing with individual treatments is a

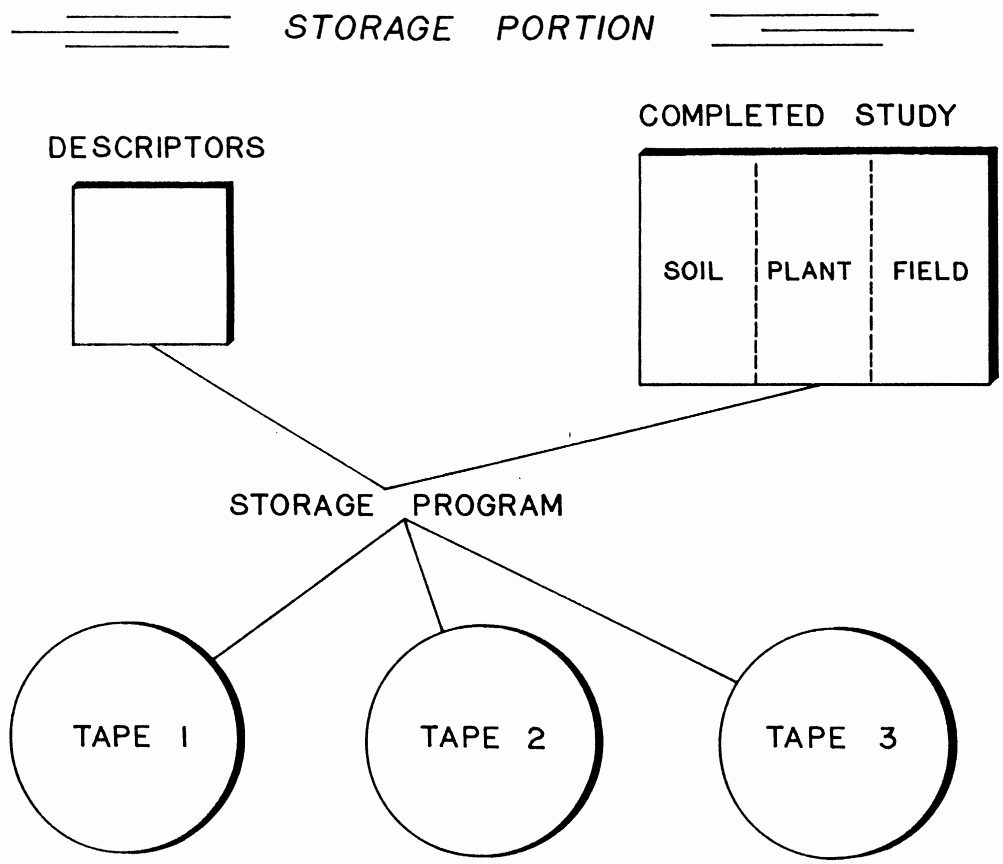

Figure 4. Data Storage Flow Chart

simple counting device - each treatment has been assigned an integer (1,2, ..., n). The treatment descriptors explain in detail each treatment within the experiment.

The selection and entry of experiment and treatment descriptors are very straightforward and detailed in the User's Manual (2). The descriptors need not be entered in any numerical order except that the experiment descriptors must appear on the first line, treatment descriptors on line 2, etc.

The CLIST will not allow access to file tapes without a current user defined storage password. This feature was provided to limit unauthorized access to such important and large data files. This password should be different from either the TSO password or the second password required to run the DMS programs and access to this password should be limited.

An additional feature allows the user to direct the combined data and descriptors to another disk file. This option of writing the combined data and descriptors to another disk file is useful in situations where the data set is large or where the data set will be accessed many times since much computer time is saved during the input phase of the program.

This disk file is a SAS-type data set as are all three tape files. There is only one SAS-type data set per tape to speed searching the tape files when using the retrieval program. The SAS-type data set offers additional benefits in that the eventual need for additional descriptors is a simple change. Once this change has been made, the next time a tape file is accessed, the file is automatically updated with the new variable included. A missing value will be entered for that variable for all previously stored data while the value(s) for current data will be that entered through the DMS.

The user must specify the tape the DMS will read. The second active tape then becomes the tape that is overwritten with input tape and newly added information. Appendix D contains a copy of the Storage Tape Log checklist. Instructions are on the checklist and the Use's Manual explains its use in detail.

The storage program and controlling CLIST have been designed to trap errors. Should an error occur, which causes the program to end abnormally, the backup tape will not be updated. This precaution will leave the backup tape information intact and not include any erroneous data.

Data Retrieval

The last main section of the DMS is the retrieval system, shown in Figure 5. This section allows the user to specify parameters of interest from the descriptor listing and create a subset of data stored on a user defined tape. The subset is written as a SAS-type data set to a disk file under a user specified name. The desired parameter(s) must be specified as a completed SAS statement. For instance, the researcher wishes to study the effect of soil applied phosphorus on wheat. A particular phosphorus source, treble superphosphate, is of interest and the information should contain only data from the Stillwater Research Station. A schematic of data flow and results can be found in

RETRIEVAL PORTION

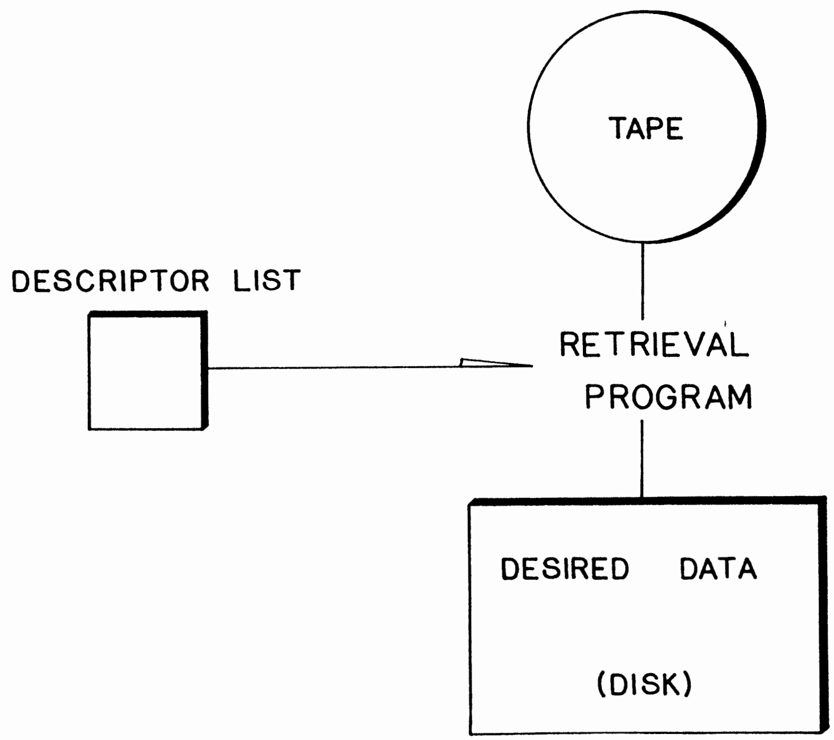

Figure 5. Data Retrieval Flow Chart

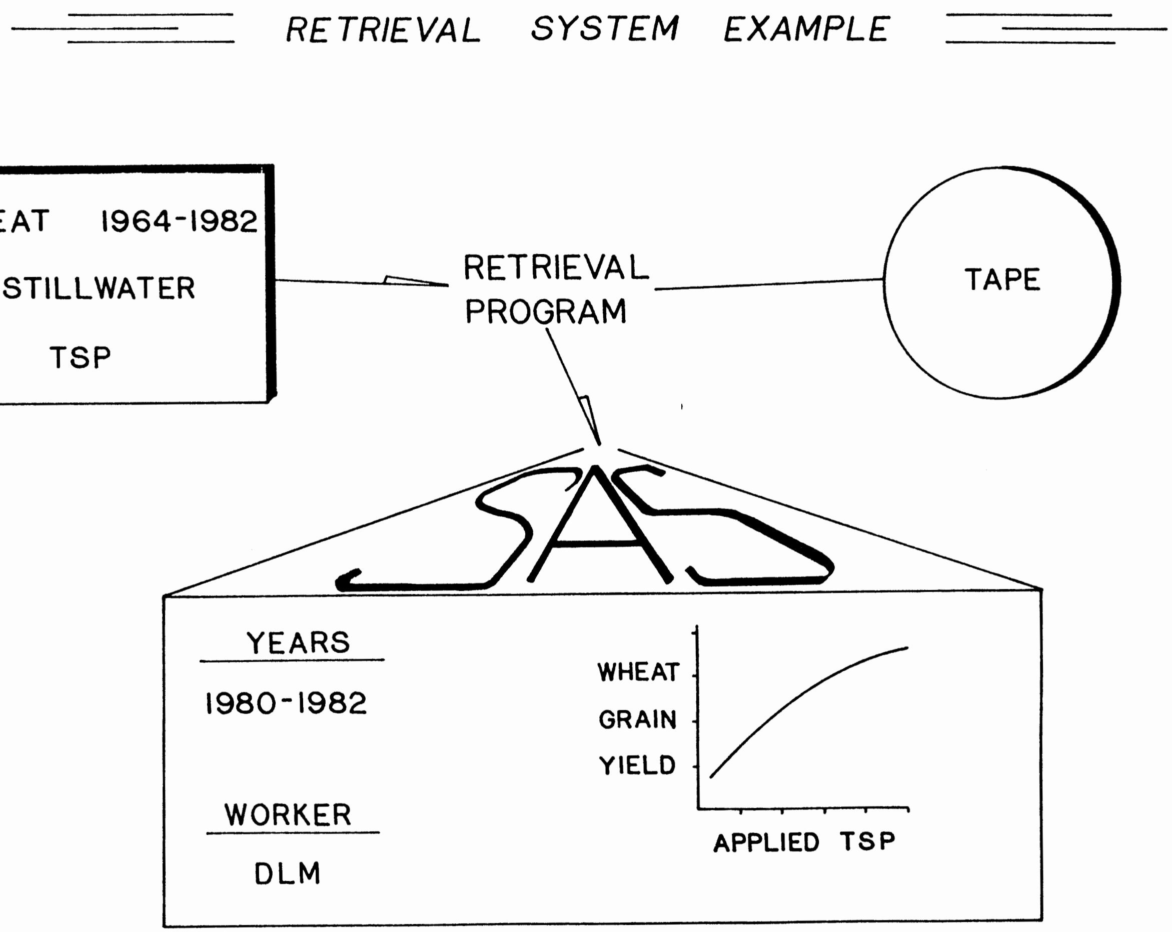

Figure 6. Example of Data Retrieval

Data Errors

The data sets in the calculation portion of the DMS are accessible via either TSO or WYLBUR text editors. As stated previously, each program lists the data as it is read and again after the calculation/merge operations. Therefore, there are several opportunities to detect data errors from data input to "Graduate File". Good data review locations are: 1) during data entry; 2) the listing obtained from the calculation program that transfers the raw data to the "Calculated Data" files; 3) the second calculation program listing reflecting data movement from the "Calculated Data" files to the "Completed Study" and "Graduate Files". The user must judge the magnitude of the error and edit the appropriate file(s). Generally, if there are only small faults present, edit the output data set, annotating all changes on the hard copy maintained in the permanent records. Alternately, major errors might require correcting the input data set(s), deleting the affected portion in the output data set and re-running that operation. Always use the TSO edit feature when deleting data. This feature will allow deletion of a part or all the data within the data set yet will not affect the parameters that are allocated to the actual disk file within the computer. The data set may appear empty, but the computer system still recognizes the disk file space as belonging to that data set name. Deletion of entire data sets is not advised unless all ramifications of such action are thoroughly understood.

Figure 6. The DMS provides the data, subsetted and ready for statistical analyses and interpretation. No statistics or statistical analyses are provided within the DMS. The requirements of each researcher vary and no statistical arrangement could be created that would be flexible enough to satisfy such diverse needs.

Selection of data parameters for retrieval operations is also allowed. Use of parameters such as wheat protein content above a threshold amount may be useful to help define conditions which lead to higher protein levels, for instance. In short, any parameter within the DMS data file can be used to aid the researcher in creating the desired subset. It must be understood that, if the researcher places too many restrictions on the data to be included in the subset, the subset may only include a few lines (in some cases, no lines). Therefore, it is wise to create a subset that will include the desired information plus information that has descriptive values within a small increment of that desired. If a phosphorus rate of 21 kg ha^{-1} is specified, only that rate will be in the subset. However, if a range, say 20 to 25 kg ha^{-1}, were used instead, it is likely that more data may indeed end up in the subset. This procedure may help limit the number of retrievals necessary to meet the demands of a specific task.

Since the program allows the user to specify the name (and device) of the file to be searched, the user can use this portion of the DMS to subset and retrieve information from SAS-type disk or tape files. This feature expands the convenience of the retrieval program to SAS-type files that have been created either through the

DMS or by other user programs not included in the DMS. For example, an initial subset file may be created from data on the DMS tapes. By specifying the subset file as the data source and running the retrieval program a second time, but with more restrictive descriptor limits, a second and smaller subset of the first subset can be created. This technique might be employed where the size of the data sets are large but can be separated into various parts prior to statistical analyses or summarization. In this instance, the first subset is rather large but is much smaller than the original data set on tape. The second and subsequent subsets are smaller than or equal in size to the first since these subsets were created from the first subset. The savings lie in the fact that the very large tape file was read only once and subsequent files were created from the first subset.

Adapting the DMS for Other Disciplines

A listing of the current coding for all programs and CLIST's can be found in Appendix E. The entire series is well documented by the use of comments in both the job control language and the main body of the program. All calculations are written with the expanded equation, i.e., an equation that displays all factors used. This longer approach is used to allow easy understanding and permit easy modification to suit other needs. Any information in a main program that is modified via user CLIST input is labeled. Extra care was taken to choose variable names that reflect the nature of the variable: "P_SOURCE" can be easily understood to mean phosphorus fertilizer source. All of these considerations were given to the program code to enhance the adaptibility of the DMS to other uses and/or disciplines.

All worksheet programs are divided into several main parts (format statements). Major changes should be made only after a complete sketch of the new design has been made. The straightforward coding allows the entry of the new characters over the old, while using the old characters as a guide to the character location on the page. The number of iterations is controlled by "DO" loops so that there are really only 5 to 6 formatted lines to change per page. A new form raely takes more than one-half hour for an operator experienced with the editing feature of TSO.

New variables or the deletion of old variables that are to appear on the worksheets require the addition or deletion of a variable name to programs that must read the variable. These programs are: 1) the applicable calculation program (input and put statements); 2) the merge program (input and put statements); and 3) the input statement of the storage program. These locations are well marked and should present no problem for the user. The more adaptable list directed input was employed instead of a column input format. Decimal location if any, is controlled by statements following the input statements in each of the calculation programs. The addition of a variable name in the applicable program is covered in the User's Manual in more detail.

As new experiments are initiated, new descriptors should be added to increase the power of subsequent retrieval operation. Only the experiment or treatment arrays need by modified in the storage and retrieval programs. New experiment descriptors may be added to the end of the experiment array in these programs and also to the Descriptor Listing. Many dummy variables now occupy the treatment array (eg., "SOR_18"). Change the appropriate dummy variable to the new variable name and add this descriptor and its number to the Descriptor Listing. Since the storage and retrieval programs produce and search SAS-type data sets, respectively, the new variable will be automatically included (once given a value other than ".") upon the next program execution.

SUMMARY

As with any major program, be it a field experiment or the DMS contained herein, mistakes can be made. An attempt has been made to guide the user through most of the difficult portions of data management by providing the following major safeguards.

1. Checklists for all CLIST activities.
2. Worksheets which provide standardization for data collection and entry.
3. CLIST response checking to limit mistakes while entering selections.
4. Hard copies of data before and after program modification.
5. Five TSO-type data sets allow data to be edited throughout the entire DMS.
6. Three separate safeguards on storage tape selection.
    a. Tapelog.
    b. CLIST entry check.
    c. CLIST secondary user password.
7. Backup tape, made only if storage addition is correct.
8. All program languages are widely available as is programming assistance, especially at major universities.

If normal attention to detail is supplied by the user, this Soil Fertility Data Management System provides the researcher with a helpful modern tool.

REFERENCES CITED

1. American Society of Agronomy. 1982. SI Units required in society manuscripts. Agron. News (March-April)., p. 10-13.

2. Hanlon, Jr., E. A., and R. L. Westerman. 1983. User's manual for a computer assisted data management system. Oklahoma State University Research Paper (in press).

3. International Business Machines Corporation. 1978. OS/VS2 TSO command language reference. IBM Corporation Publications Department, Poughkeepsie, N. Y.

4. International Business Machines Corporation. 1978. OS/VS2 TSO terminal user's guide. IBM Corporation Publications Department, Poughkeepsie, N. Y.

5. International Business Machines Corporation. 1978. OS/VS2 MVS JCL. IBM Corporation Publications Department, Poughkeepsie, N. Y.

6. International Business Machines Corporation. 1982. VS FORTRAN application programming: language reference. IBM Corporation Publications Department, Poughkeepsie, N. Y.

7. SAS Institute, Inc. 1979. SAS user's guide. SAS Institute, Raleigh, North Carolina.

8. SAS Institute, Inc. 1982. SAS user's guide: basics. SAS Institute, Raleigh, North Carolina.

APPENDIX A

SOIL, PLANT AND FIELD WORKSHEETS

SOIL ANALYSIS FORM

REFERENCE ___/___/___/___/ LOCATION __________ CROP __________ EXP_NO __________ SAMPLING DATE __________
DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	REP TRT	DEPTH	METH USED	UREA-N ONE	UREA-N TWO	N	NH4-N ONE	NH4-N TWO	NO3-N ONE	NO3-N TWO	NO2-N ONE	NO2-N TWO	TOTAL-N ONE	TOTAL-N TWO		PH	BI	BRAY-P1 ONE	BRAY-P1 TWO	LABNO
1000			TSE	X.XX												X.X	X.X			1000
1001			TSE																	1001
1002			TSE																	1002
1003			TSE																	1003
1004			TSE																	1004
1005			TSE																	1005
1006			TSE																	1006
1007			TSE																	1007
1008			TSE																	1008
1009			TSE																	1009
1010			TSE																	1010
1011			TSE																	1011
1012			TSE																	1012
1013			TSE																	1013
1014			TSE																	1014
1015			TSE																	1015
1016			TSE																	1016
1017			TSE																	1017
1018			TSE																	1018
1019			TSE																	1019

COMMENTS

SOIL ANALYSIS FORM SECOND PAGE

SAMPLING DATE ______________ DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	K		CA		MG		NA		S		FE		MN		ZN		CU				LABNO
	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2			
1020																					1020
1021																					1021
1022																					1022
1023																					1023
1024																					1024
1025																					1025
1026																					1026
1027																					1027
1028																					1028
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1033																					1033
1034																					1034
1035																					1035
1036																					1036
1037																					1037
1038																					1038
1039																					1039

COMMENTS

SOIL ANALYSIS FORM THIRD PAGE

SAMPLING DATE ____________ DATE INTO LAB ____________ DATE COMPLETED ____________ PAGE __ OF __

LABNO	MO PPM1	MO PPM2	CO3S READ	HCO3 READ	MET	CL	B PPM1	B PPM2	EC	FACT	OM ONE	OM TWO	AL	AL							LABNO
1000	XXX		XXX	XXX	E T	XXX	XXX		XXX	XXX	XX.X		X.XX								1000
1001					E T																1001
1002					E T																1002
1003					E T																1003
1004					E T																1004
1005					E T																1005
1006					E T																1006
1007					E T																1007
1008					E T																1008
1009					E T																1009
1010					E T																1010
1011					E T																1011
1012					E T																1012
1013					E T																1013
1014					E T																1014
1015					E T																1015
1016					E T																1016
1017					E T																1017
1018					E T																1018
1019					E T																1019

COMMENTS

PLANT NUTRIENT ANALYSIS FORM

REFERENCE ___/___/___/___/ LOCATION __________ CROP ________ EXP_NO ________ SAMPLING DATE ____________

DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	PLT PART	REP TRT	_N_ WT.	N/P WT.	%N BLK	%N ML1	%N ML2	%N RRUN	P PPM1	P PPM2	K PPM1	K PPM2	FE PPM1	FE PPM2	ZN PPM1	ZN PPM2	MN PPM1	MN PPM2	LABNO
1000			.XX	.XX	.XX	XXX			XXX	XXX	XX.X	XX.X	XXX	XXX	XXX	XXX	XX.X		1000
1001							X.XX											XX.X	1001
1002																			1002
1003																			1003
1004																			1004
1005																			1005
1006																			1006
1007																			1007
1008																			1008
1009																			1009
1010																			1010
1011																			1011
1012																			1012
1013																			1013
1014																			1014
1015																			1015
1016																			1016
1017																			1017
1018																			1018
1019																			1019

COMMENTS

PLANT NUTRIENT ANALYSIS FORM SECOND PAGE

SAMPLING DATE ____________ DATE INTO LAB ____________ DATE COMPLETED ____________ PAGE __ OF __

LABNO	NO3	CL	NA		AL		CA		MG		S		CU		B		MO		CHLOR	LABNO
	PPM	PPM	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	READ	
1020	XX.X	XXX	X.XX		XX.X		X.XX		X.XX		X.XX		X.XX		X.XX		X.XX		XXX	1020
1021																				1021
1022																				1022
1023																				1023
1024																				1024
1025																				1025
1026																				1026
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1036																				1036
1037																				1037
1038																				1038
1039																				1039

COMMENTS

FORAGE FIELD FORM

REFERENCE __/__/__/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION _______ CROP _______ EXP_NO _______ HARVEST DATE _______
TITLE ____________________
DATE INITIATED _______ CROP YEAR _______ VARIETY _______
SEED RATE _______ FERT APP DATE _______
PLANTING DATE _______ HARVEST # ____ UNITS REPORTED________

REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	DRY	REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	DRY	REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	DRY	REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	DRY
101	XX.X	XX.	XXX.		201				XXX.	301					401				
102					202					302					402				
103					203					303					403				
104					204					304					404				
105					205					305					405				
106					206					306					406				
107					207					307					407				
108					208					308					408				
109					209					309					409				
110					210					310					410				
111					211					311					411				
112					212					312					412				
113					213					313					413				
114					214					314					414				
115					215					315					415				

COMMENTS

GRAIN FIELD FORM

REFERENCE __/___/___/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION _______ CROP _______ EXP_NO _______ HARVEST DATE _______
TITLE ______________________
DATE INITIATED _______ CROP YEAR _______ VARIETY _______
SEED RATE _______ FERT APP DATE _______
PLANTING DATE _______ HARVEST # ____ UNITS REPORTED________

REP TRT	SAMPLE	REP TRT	SAMPLE	REP TRT	SAMPLE	REP TRT	SAMPLE
101	XX.X ___ ___ ___	201	____ ___ ___ ___	301	____ ___ ___ ___	401	____ ___ ___ ___
102	____ ___ ___ ___	202	____ ___ ___ ___	302	____ ___ ___ ___	402	____ ___ ___ ___
103	____ ___ ___ ___	203	____ ___ ___ ___	303	____ ___ ___ ___	403	____ ___ ___ ___
104	____ ___ ___ ___	204	____ ___ ___ ___	304	____ ___ ___ ___	404	____ ___ ___ ___
105	____ ___ ___ ___	205	____ ___ ___ ___	305	____ ___ ___ ___	405	____ ___ ___ ___
106	____ ___ ___ ___	206	____ ___ ___ ___	306	____ ___ ___ ___	406	____ ___ ___ ___
107	____ ___ ___ ___	207	____ ___ ___ ___	307	____ ___ ___ ___	407	____ ___ ___ ___
108	____ ___ ___ ___	208	____ ___ ___ ___	308	____ ___ ___ ___	408	____ ___ ___ ___
109	____ ___ ___ ___	209	____ ___ ___ ___	309	____ ___ ___ ___	409	____ ___ ___ ___
110	____ ___ ___ ___	210	____ ___ ___ ___	310	____ ___ ___ ___	410	____ ___ ___ ___
111	____ ___ ___ ___	211	____ ___ ___ ___	311	____ ___ ___ ___	411	____ ___ ___ ___
112	____ ___ ___ ___	212	____ ___ ___ ___	312	____ ___ ___ ___	412	____ ___ ___ ___
113	____ ___ ___ ___	213	____ ___ ___ ___	313	____ ___ ___ ___	413	____ ___ ___ ___
114	____ ___ ___ ___	214	____ ___ ___ ___	314	____ ___ ___ ___	414	____ ___ ___ ___
115	____ ___ ___ ___	215	____ ___ ___ ___	315	____ ___ ___ ___	415	____ ___ ___ ___

COMMENTS

PEANUT FIELD FORM

REFERENCE __/___/___/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION _______ CROP _______ EXP_NO _______ HARVEST DATE _______
TITLE ______________________
DATE INITIATED _______ CROP YEAR _______ VARIETY _______
SEED RATE _______ FERT.APP DATE _______
PLANTING DATE _______ HARVEST # ____ UNITS REPORTED________

REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %
101	XX.	XX.	XX.	XX.	201					301					401				
102					202					302					402				
103					203					303					403				
104					204					304					404				
105					205					305					405				
106					206					306					406				
107					207					307					407				
108					208					308					408				
109					209					309					409				
110					210					310					410				
111					211					311					411				
112					212					312					412				
113					213					313					413				
114					214					314					414				
115					215					315					415				

COMMENTS

APPPENDIX B

SHEET.CLIST AND CALC.CLIST CHECKLISTS

SHEET.CLIST CHECKLIST

	Type of Form		
	Soil	Plant	Field
Number of Pages (1 to 20)			
Beginning Lab Number (four digits only)			
Third page?			
Type of Field Form			Forage Grain Peanut
Number of Treatments (1 to 25)			

CALC.CLIST Checklist

Run program for: ____ Soil ____ Plant ____ Field

Soil, Plant, Field Disk Operatons

	Option #	Choice
Review results only - no data on disk	1	
Append new results to end of disk data set	2	
Purge all other data on disk data set	3	
Create a new disk data set	4	

Data Selection

Calculate all data	1	
Calculate only data with a specific REFERENCE	2	
If 2 above, enter REFERENCE		________

Soil Parameters

Normality of HCL used for %N ________

Normality and aliquots used for carbonates and bicarbonates ________

Normality and aliquots used for chlorides ________

Plant Parameters

Normality of HCL used for %N ________

Aliquot for P test ________

Field Parameters

Select data type: ____ Forage ____ Grain
____ Peanut ____ Cotton

CALC.CLIST Checklist (continued)

	Option #
Merge Disk Operations	
Append merged results to UxxxxxA.COMPLETE.DATA	1
Purge all other data in UxxxxxA.COMPLETE.DATA and write merged results to the same file	2
Create a new file, UxxxxxA.COMPLETE.DATA	3
Options 1 plus create a graduate student file	4
Option 2 plus create a graduate student use file	5
Option 3 plus create a graduate student use file	6
If option 4-6, enter graduate student file name	________
Select files to be merged: ____ Soil ____ Plant ____ Field	
Data Selection	
Merge all data	1
Merge only data with a specific REFERENCE	2
If 2 above, enter REFERENCE	________
Storage of Data	
Storage password	________
Write the completed data plus descriptors to disk?	Y N
If YES, then specify disk file name	________
Specify tape number to be read	1 2

APPENDIX C

DESCRIPTOR LISTING AND WORKSHEET

DESCRIPTOR LISTING

EXPERIMENT DESCRIPTORS

1. Initials ____
2. Crop ____
3. Crop year ____
4. Location ____
5. Experiment number ____
6. Reference number ____
7. Title ____
8. Date initiated ____
9. Variety ____
10. Seed Rate ____
11. Fertilizer Application Date ____
12. Planting date ____
13. Harvest number ____
14. Harvest date ____
15. Units reported ____
16. ____
17. ____
18. ____
19. ____
20. ____

TREATMENT DESCRIPTORS

---------------------------------------SOURCE---------------------------------------

1. N ____	2. P ____	3. K ____	4. S ____
5. Ca ____	6. Mg ____	7. Fe ____	8. Mn ____
9. Zn ____	10. Cu ____	11. B ____	12. Mo ____
13. LIME ____	14. GYPSUM ____	15. HERBICIDE ____	16. FUNGICIDE ____
17. INHIBITOR ____	18. ____	19. ____	20. ____
21. ____	22. ____	23. ____	24. ____

------------------------------------RATE ($KG \cdot HA^{-1}$)------------------------------------

31. N ____	32. P ____	33. K ____	34. S ____
35. Ca ____	36. Mg ____	37. Fe ____	38. Mn ____
39. Zn ____	40. Cu ____	41. B ____	42. Mo ____
43. LIME ____	44. GYPSUM ____	45. HERBICIDE ____	46. FUNGICIDE ____
47. INHIBITOR ____	48. ____	49. ____	50. ____
51. ____	52. ____	53. ____	54. ____

---------------------------------------METHOD---------------------------------------

61. N ____	62. P ____	63. K ____	64. S ____
65. Ca ____	66. Mg ____	67. Fe ____	68. Mn ____
69. Zn ____	70. Cu ____	71. B ____	72. Mo ____
73. LIME ____	74. GYPSUM ____	75. HERBICIDE ____	76. FUNGICIDE ____
77. INHIBITOR ____	78. TILLAGE ____	79. ____	80. ____
81. ____	82. ____	83. ____	84. ____

---------------------------------------15N WORK---------------------------------------

91. ATOM % EXCESS ____ 92. SOURCE 15N ____

------------------------------------GROWTH CHAMBER------------------------------------

111. TEMPERATURE ____ 112. TEMPERATURE DURATION ____

DESCRIPTOR WORKSHEET

EXPERIMENT

___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________

___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________

TREATMENTS

1. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
2. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
3. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
4. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
5. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
6. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
7. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
8. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
9. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
10. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
11. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
12. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
13. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
14. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
15. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
16. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
17. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
18. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
19. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
20. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
21. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
22. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
23. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
24. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________
25. ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________ ___ _________

COMMENTS:

APPENDIX D

STORAGE TAPE LOG

The Storage Tape Log must be consulted before each use of the storage program. Since this step is very important, consider the following example which explains the use of this appendix. Users must understand the actions required to preclude loss of data by entering the correct tape number.

Example: Use of the Storage Tape Log

User Jones has just determined that the data set he has been using should be stored using the storage tape system. No disk file is needed in this case. Upon consulting the Storage Tape Log, he finds the following information.

Date Used	User Init.	Tape Read	Tape Written	Experiment Number REFERENCE Added
24 Fb 83	EAH	2	1	P&K, HBP6

Following the instructions at the bottom of the Storage Tape Log form, he would fill in the next line with the information for his data.

27 Fb 83	UJ	1	2	222, SW28

Note that the tape numbers simply change columns. As above, EAH wrote information to tape 1 on the 24th of February. Therefore, user Jones will read that tape, tape 1. This action insures that information entered by EAH will remain in the data storage system. If user Jones reads tape 2, data pertaining to experiment P&K, entered by EAH, will be lost!

STORAGE TAPE LOG

DATE USED	USER'S INITIALS	TAPE READ	TAPE WRITTEN	EXPERIMENT NUMBER & REFERENCE ADDED	DISK FILE DATA SET NUMBER

INSTRUCTIONS:

1. Enter date storage program was run.
2. Enter your initials
3. Enter the number of tape read. This tape will have the same number as the tape to which data was last WRITTEN.
4. Enter tape written number. This tape will be the number from which data was last READ.
5. Enter experiment number and REFERENCE of data that has been added to tape file.
6. Enter # of the disk file data set used, if any. Numbers should not be reused and cannot exceed 99.

APPENDIX E

PROGRAM AND CLIST CODING

SHEET.CLIST AND WORKSHEETS

```
PROC 0
/* +++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++ */
/* +++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* +++++++  USE OF THIS PROGRAM IS PROHIBITED WITHOUT  ++++++++++++ */
/* +++++++++++  WRITTEN PERMISSION  ++++++++++++++++++++++++++++++ */
WRITE
WRITE
WRITE
WRITE
ZZZ: WRITE WHAT TYPE OF FORM DO YOU WANT(SOIL,PLANT OR FIELD)?
WRITENR ===>
  READ &A
IF &A=SOIL THEN GOTO AAA
IF &A=PLANT THEN GOTO BBB
NEWPAGE
WRITE
WRITE
WRITE
WRITE
WRITE YOU HAVE CHOSEN TO PRINT FIELD FORMS.
MMM: WRITENR HOW MANY PAGES DO YOU WANT?(1 TO 20) ===>
  READ &ONE
  IF &ONE>20 THEN DO
    WRITE YOU HAVE ASKED FOR MORE THAN 20 FORMS.  PLEASE REENTER.
    GOTO MMM
  END
NNN: WRITENR WHAT TYPE OF FIELD FORM?(FORAGE,GRAIN,PEANUT)===>
  READ &TWO
  IF &TWO EQ FORAGE OR &TWO EQ GRAIN OR &TWO EQ PEANUT THEN GOTO OK
  WRITE YOU HAVE NOT ENTERED FORAGE, GRAIN OR PEANUT. REENTER.
  GOTO NNN
OK: IF &TWO EQ FORAGE THEN SET &THRE=4
IF &TWO EQ GRAIN THEN SET &THRE=3
IF &TWO EQ PEANUT THEN SET &THRE=2
WRITE
WRITE
WRITENR HOW MANY TREATMENTS ARE THERE?(1 TO 25) ===>
  READ &FOUR
  E 'U11459A.CALCULAT(FIELDPG)' CNTL
    V
    C 2100 /2/&ONE/
    C 2300 /1000/&THRE/
    C 7300 /10/&FOUR/
           SUBMIT
    END NOSAVE
    FREEALL
WRITENR DO YOU WANT TO PRINT ANOTHER FORM?(Y N) ===>
  READ &MORE
```

```
  IF &MORE=Y THEN GOTO ZZZ
  ELSE EXIT
  READ &B
  IF &B=Y THEN GOTO ZZZ
  ELSE EXIT
AAA: NEWPAGE
WRITE
WRITE
WRITE
WRITE
WRITE YOU HAVE CHOSEN TO PRINT SOIL FORMS
CCC: WRITENR HOW MANY PAGES DO YOU WANT?(1 TO 20) ===>
  READ &C
  IF &C>20 THEN DO
    WRITE YOU HAVE ASKED FOR MORE THAN 20 FORMS.  PLEASE REENTER.
    GOTO CCC
  END
DDD: WRITENR WHAT IS THE BEGINNING LABNO? ===>
  READ &D
  SET &E=&D+(20*&C)
  IF &E>9999 THEN DO
   WRITE YOU HAVE ASKED FOR A NUMBER THAT MAY EXCEED 4 DIGITS. REENTER.
   GOTO DDD
  END
WRITE THE THIRD PAGE HAS THE FOLLWING TITLES:
WRITE
WRITE    MO,CO3,HCO3,CL,B,EC,OM,AL
WRITE
WRITENR DO YOU WANT TO PRINT THE THIRD PAGE? (Y  N)===>
  READ &F
  SET &FF=0
  IF &F=Y THEN SET &FF=3
  E 'U11459A.CALCULAT(SOILPG)' CNTL
    V
    C 1900 /2/&C/
    C 2100 /1000/&D/
    C 2300 /0/&FF/
          SUBMIT
    END NOSAVE
    FREEALL
WRITENR DO YOU WANT TO PRINT ANOTHER FORM?(Y N) ===>
  READ &MORE
  IF &MORE=Y THEN GOTO ZZZ
  ELSE EXIT
BBB: NEWPAGE
WRITE
WRITE
WRITE
```

```
WRITE
WRITE YOU HAVE CHOSEN TO PRINT PLANT FORMS.
EEE: WRITENR HOW MANY PAGES DO YOU WANT?(1 TO 20) ===>
  READ &H
/* ++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++ */
/* +++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* +++++++  USE OF THIS PROGRAM IS PROHIBITED WITHOUT  ++++++++++++ */
/* +++++++++++  WRITTEN PERMISSION  ++++++++++++++++++++++++++++++ */
  IF &H>20 THEN DO
    WRITE YOU HAVE ASKED FOR MORE THAN 20 FORMS.  PLEASE REENTER.
    GOTO EEE
  END
FFF: WRITENR WHAT IS THE BEGINNING LABNO? ===>
  READ &I
  SET &J=&I+(20*&H)
  IF &J>9999 THEN DO
  WRITE YOU HAVE ASKED FOR A NUMBER THAT MAY EXCEED 4 DIGITS. REENTER.
    GOTO FFF
  END
  E 'U11459A.CALCULAT(PLANTPG)' CNTL
    V
    C 1900 /2/&H/
    C 2100 /1000/&I/
          SUBMIT
    END NOSAVE
    FREEALL
WRITENR DO YOU WANT TO PRINT ANOTHER FORM?(Y N) ===>
  READ &EXTRA
  IF &EXTRA=Y THEN GOTO ZZZ
/* ++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++ */
/* +++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* +++++++  USE OF THIS PROGRAM IS PROHIBITED WITHOUT  ++++++++++++ */
/* +++++++++++  WRITTEN PERMISSION  ++++++++++++++++++++++++++++++ */
EXIT
```

```
//DIRTPAGE JOB (11459,DIR-TY-PAGE),HANLON,TIME=(0,5),CLASS=F,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT LOCAL
//*
//* ++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
//* ++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++
//* ++++++++       EDWARD A HANLON, JR        +++++++++++++++++++++
//* ++++++++    USE OF THIS PROGRAM REQUIRES  +++++++++++++++++++++
//* ++++++++       WRITTEN PERMISSION         +++++++++++++++++++++
//*
//* ++++++++  PROGRAM STORED IN CALCULAT(SOILPG)  +++++++++++++++++
//*
//  EXEC FORTVCLG
//*
//FORT.SYSIN DD *
C+++++  CLIST ENTERS NUMBER OF DESIRED PAGES INTO ICOPY  ++++++++++
      ICOPY=2
C++++++++  CLIST ENTERS DESIRED FIRST LAB NUMBER  +++++++++++++++++
      INUM=1000
C++++++++  CLIST ENTERS CHOICE FOR THIRD PAGE  ++++++++++++++++++++
      ISKIP=0
      ISEC=INUM
      ITHRE=INUM
      DO 100 I=1,ICOPY
      WRITE(6,1)
C++++++++  WRITE TITLE, DATES AND HEADING AT TOP OF FIRST PAGE  +++
  1   FORMAT('1',52X,'SOIL ANALYSIS FORM',/'0',
     $10X,'REFERENCE ___/___/___/___/ LOCATION __________',
     $' CROP __________ EXP_NO __________ SAMPLING DATE __________'/' ',
     $10X,'DATE INTO LAB ______________',30X,
     $'  DATE COMPLETED ______________  PAGE __ OF __'/'0',
     $'LABNO*REP*DEPTH*METH*  UREA-N   * N *  NH4-N    *',
     $'   NO3-N   *   NO2-N   *  TOTAL-N  * * PH * BI * BRAY-P1  *',
     $'LABNO'/' ',
     $'     *TRT*     *USED* ONE  TWO  *   * ONE  TWO  *',
     $' ONE  TWO  * ONE  TWO  * ONE  TWO  * *    *    * ONE  TWO *',
     $I5)
      DO 200 J=1,20
      WRITE(6,2)INUM,INUM
C++++++++++++  WRITE TWENTY LINES FOR RESULTS  ++++++++++++++++++++
  2   FORMAT(' ',
     $'     *   *     *     *           *   *           *',
     $'           *           *           * *    *    *          *',
     $/' ',
     $I5,'*___*_____*TSE * ____ ____ *___* ____ ____ *',
     $' ____ ____ * ____ ____ * ____ ____ *_*____*____*____ ____ *',
```

```
     $I5)
      INUM=INUM + 1
 200  CONTINUE
      WRITE(6,3)
C+++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
  3   FORMAT(' ','COMMENTS')
 100  CONTINUE
C++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
C+++++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++
C+++++++++++       EDWARD A HANLON, JR       ++++++++++++++++++++
C+++++++++++    USE OF THIS PROGRAM REQUIRES  ++++++++++++++++++++
C+++++++++++       WRITTEN PERMISSION         ++++++++++++++++++++
C++++++++++++  BEGIN SECOND PAGE PRINTING  ++++++++++++++++++++++++
      DO 300 K=1,ICOPY
      WRITE(6,4)
C++++  WRITE TITLE, DATES AND HEADING AT TOP OF SECOND PAGE  ++++++
  4   FORMAT('1',52X,'SOIL ANALYSIS FORM   SECOND PAGE',/'O',
     $11X,'SAMPLING DATE ______________  DATE INTO LAB ______________',
     $'  DATE COMPLETED ______________  PAGE __ OF __'/'O',
     $'LABNO*     K     *     CA     *    MG     *    NA     *',
     $'     S      *    FE     *    MN     *    ZN     *    CU     *',
     $'            *LABNO'/' ',
     $'     * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 *',
     $' PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 *',
     $'            *')
      DO 400 KK=1,20
      WRITE(6,5)ISEC,ISEC
C++++++++++++  WRITE TWENTY LINES FOR RESULTS  ++++++++++++++++++++
  5   FORMAT(' ',
     $'     *           *           *           *           *',
     $'           *           *           *           *           *',
     $'           *'/' ',
     $I5,'* ____ ____ * ____ ____ * ____ ____ * ____ ____ *',
     $' ____ ____ * ____ ____ * ____ ____ * ____ ____ * ____ ____ *',
     $' ____ ____ *',I5)
      ISEC=ISEC + 1
 400  CONTINUE
      WRITE(6,6)
C+++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
  6   FORMAT(' ','COMMENTS')
 300  CONTINUE
C++++++++++++  DECIDE TO PRINT THIRD PAGE  ++++++++++++++++++++++++
      IF(ISKIP)700,700,800
C++++++++++++  BEGIN THIRD PAGE PRINTING  +++++++++++++++++++++++++
 800  DO 500 K=1,ICOPY
      WRITE(6,7)
C++++  WRITE TITLE, DATES AND HEADING AT TOP OF THIRD PAGE  +++++++
  7   FORMAT('1',52X,'SOIL ANALYSIS FORM   THIRD PAGE',/'O',
```

```
     $11X,'SAMPLING DATE _______________ DATE INTO LAB _______________',
     $'  DATE COMPLETED ______________ PAGE __ OF __'/'O',
     $'LABNO*    MO     * CO3S HCO3 *MET* CL *     B     *',
     $' EC  FACT  *    OM     *    AL      *            *            *',
     $'             *LABNO'/' ',
     $'      * PPM1 PPM2 * READ READ *    *    * PPM1 PPM2 *',
     $'             * ONE  TWO  *            *            *            *',
     $'             *')
      DO 600 KK=1,20
      WRITE(6,8)ITHRE,ITHRE
C++++++++++++  WRITE TWENTY LINES FOR RESULTS  ++++++++++++++++++++
   8  FORMAT(' ',
     $'      *            *            *    *    *            *',
     $'             *            *            *            *            *',
     $'             *'/' ',
     $I5,'* ____ ____ * ____ ____ *E T*____* ____ ____ *',
     $' ____ ____ * ____ ____ * ____ ____ * ____ ____ * ____ ____ *',
     $' ____ ____ *',I5)
      ITHRE=ITHRE + 1
 600  CONTINUE
      WRITE(6,9)
C++++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
   9  FORMAT(' ','COMMENTS')
 500  CONTINUE
C++++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
C++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++
C++++++++++++       EDWARD A HANLON, JR        +++++++++++++++++++++
C++++++++++++    USE OF THIS PROGRAM REQUIRES  +++++++++++++++++++++
C++++++++++++       WRITTEN PERMISSION         +++++++++++++++++++++
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 700  STOP
      END
//GO.FT06F001 DD SYSOUT=(E,,9001)
//
/*EOF
```

```
//P11459PG JOB (11459,FOR-GE-PAGE),HANLON,TIME=(0,5),CLASS=F,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT LOCAL
//*
//* ++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++++
//* ++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++
//* ++++++++    EDWARD A HANLON, JR            ++++++++++++++++++++
//* ++++++++    USE OF THIS PROGRAM REQUIRES  ++++++++++++++++++++
//* ++++++++       WRITTEN PERMISSION          ++++++++++++++++++++
//*
//* ++++++++  PROGRAM STORED IN CALCULAT(PLANTPG)  ++++++++++++++++
//*
//  EXEC FORTVCLG
//*
//FORT.SYSIN DD *
C+++++++++++  SET NUMBER OF DESIRED PAGES INTO ICOPY  +++++++++++++
      ICOPY=2
C++++++++++++  SET COUNTER TO DESIRED FIRST LABNO  ++++++++++++++++
      INUM=1000
      ISEC=INUM
      DO 100 I=1,ICOPY
      WRITE(6,1)
C++++++++  WRITE TITLE, DATES AND HEADING AT TOP OF FIRST PAGE  +++++++
  1   FORMAT('1',45X,'PLANT NUTRIENT ANALYSIS FORM',/'0',
     $10X,'REFERENCE ___/___/___/___/ LOCATION __________',
     $'CROP ________ EXP_NO ________ SAMPLING DATE ____________'/' ',
     $10X,'DATE INTO LAB ______________',30X,
     $'  DATE COMPLETED ______________  PAGE __ OF __'/'0',
     $'LABNO* PLT*REP* *_N_*N/P* *      %N           * *',
     $'     P     *     K     *     FE     *     ZN     *     MN     *',
     $'LABNO'/' ',
     $'     *PART*TRT* *WT.*WT.* * BLK ML1 ML2 RRUN * *',
     $' PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 *')
      DO 200 J=1,20
      WRITE(6,2)INUM,INUM
C++++++++++++  WRITE TWENTY LINES FOR RESULTS  +++++++++++++++++++++++
  2   FORMAT(' ',
     $'     *    *   * *   *   * *                  * *',
     $'          *          *          *          *          *',
     $/' ',
     $I5,'*____*___*_*___*___*_* ___ ___ ___ ____ *_*',
     $' ____ ____ * ____ ____ * ____ ____ * ____ ____ * ____ ____ *',
     $I5)
      INUM=INUM + 1
 200  CONTINUE
      WRITE(6,3)
```

```
C+++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
  3   FORMAT(' ','COMMENTS')
 100  CONTINUE
C++++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++++
C++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++
C++++++++++++    EDWARD A HANLON, JR           +++++++++++++++++++++
C++++++++++++    USE OF THIS PROGRAM REQUIRES  +++++++++++++++++++++
C++++++++++++       WRITTEN PERMISSION         +++++++++++++++++++++
C+++++++++++++  BEGIN SECOND PAGE PRINTING  +++++++++++++++++++++++++
      DO 300 K=1,ICOPY
      WRITE(6,4)
C++++  WRITE TITLE, DATES AND HEADING AT TOP OF SECOND PAGE  ++++++
  4   FORMAT('1',45X,'PLANT NUTRIENT ANALYSIS FORM   SECOND PAGE',/'O',
     $11X,'SAMPLING DATE ______________  DATE INTO LAB ______________',
     $'  DATE COMPLETED ______________  PAGE __ OF __'/'O',
     $'LABNO* * NO3 * CL  * *     NA     *     AL     *     CA     *',
     $'     MG     *     S     *     CU     *     B     *     MO     *',
     $'CHLOR*LABNO'/' ',
     $'     * * PPM * PPM * * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 *',
     $' PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 * PPM1 PPM2 *',
     $'READ *')
      DO 400 KK=1,20
      WRITE(6,5)ISEC,ISEC
C+++++++++++++  WRITE TWENTY LINES FOR RESULTS  ++++++++++++++++++++
  5   FORMAT(' ',
     $'     * *     *     * *          *          *          *',
     $'          *          *          *          *          *',
     $'     *'/' ',
     $I5,'*_* ___ * ___ *_* ____ ____ * ____ ____ * ____ ____ *',
     $' ____ ____ * ____ ____ * ____ ____ * ____ ____ * ____ ____ *',
     $'____ *',I5)
      ISEC=ISEC + 1
 400  CONTINUE
      WRITE(6,6)
C+++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
  6   FORMAT(' ','COMMENTS')
 300  CONTINUE
C++++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++++
C++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++
C++++++++++++    EDWARD A HANLON, JR           +++++++++++++++++++++
C++++++++++++    USE OF THIS PROGRAM REQUIRES  +++++++++++++++++++++
C++++++++++++       WRITTEN PERMISSION         +++++++++++++++++++++
      STOP
      END
//GO.FT06F001 DD SYSOUT=(E,,9001)
//
/*EOF
```

```
//F11459PG JOB (11459,FIE-LD-PAGE),HANLON,TIME=(0,5),CLASS=F,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE PRINT LOCAL
//*
//* ++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
//* ++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++++
//* ++++++     EDWARD A HANLON, JR          +++++++++++++++++++++++
//* ++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++++++
//* ++++++       WRITTEN PERMISSION         +++++++++++++++++++++++
//* ++++++++++  PROGRAM STORED IN CALCULAT(FIELDPG)  ++++++++++++++
//*
//  EXEC FORTVCLG
//*
//FORT.SYSIN DD *
C+++++++++++  DECLARE ARRAY FOR LINE PRINTOUT  ++++++++++++++++++++
      INTEGER REPTRT
      DIMENSION REPTRT(4)
C++++++ CLIST SETS NUMBER OF DESIRED PAGES INTO ICOPY  ++++++++++++
      ICOPY=2
C+++  CLIST CHANGES LINE TO PRINT VARIOUS TITLES  +++++++++++++++++
      ITOP=3 - 1000
C++++++++++  LOOP FOR NUMBER OF PAGES REQUESTED  ++++++++++++++++++
      DO 100 II=1,ICOPY
C+++++++  PRINT TYPE OF FIELD FORM  ++++++++++++++++++++++++++++++
      IF(ITOP)10,20,30
 10   WRITE(6,1)
  1   FORMAT('1',//,32X,'FORAGE FIELD FORM')
      GOTO 40
 20   WRITE(6,2)
  2   FORMAT('1',//,32X,'GRAIN FIELD FORM')
      GOTO 40
 30   WRITE(6,3)
  3   FORMAT('1',//,32X,'PEANUT FIELD FORM')
 40   WRITE(6,4)
C++++++++  WRITE STUDY INFORMATION AT TOP OF FIRST PAGE  ++++++++++
  4   FORMAT('0',5X,'REFERENCE __/___/___/__/',11X,
     $' HARVEST PLOTSIZE___FT X ___FT' /' ',
     $5X,'LOCATION _______ CROP _______ EXP_NO _______ ',
     $'HARVEST DATE _______'/' ',
     $'TITLE ______________________'/' ',
     $'DATE INITIATED _______ CROP YEAR _______ VARIETY _______'/' ',
     $'SEED RATE _______',15X,'FERT.APP DATE _______'/' ',
     $'PLANTING DATE _______ HARVEST # ____ UNITS REPORTED_______')
C+++++++  DECIDE ON COLUMN HEADINGS  ++++++++++++++++++++++++++++++
      IF(ITOP)50,60,70
 50   WRITE(6,5)
```

```
    5   FORMAT('O','REP  PLT   SAMPLE   *REP  PLT   SAMPLE   *',
       $'REP  PLT   SAMPLE   *REP  PLT   SAMPLE   *'/' ',
       $'TRT  WET BAG WET DRY*TRT  WET BAG WET DRY',
       $'*TRT  WET BAG WET DRY*TRT  WET BAG WET DRY*')
        GOTO 200
   60   WRITE(6,6)
    6   FORMAT('O','REP      SAMPLE     *REP      SAMPLE     ',
       $'*REP      SAMPLE     *REP      SAMPLE     *'/' ',
       $'TRT                 *TRT                 ',
       $'*TRT                 *TRT                 *')
        GOTO 200
   70   WRITE(6,7)
    7   FORMAT('O','REP   SMK SS OK  TK *REP   SMK SS OK  TK ',
       $'*REP   SMK SS OK  TK *REP   SMK SS OK  TK *'/' ',
       $'TRT   %   %  %   % *TRT   %   %  %   % ',
       $'*TRT   %   %  %   % *TRT   %   %  %   % *')
C+++++++  PRINT DATA BLANKS AND REP/TRT NUMBERS  +++++++++++++++++
C++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++
C+++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++++
C+++++++++     EDWARD A HANLON, JR          ++++++++++++++++++++++
C+++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++++
C+++++++++       WRITTEN PERMISSION         ++++++++++++++++++++++
  200   REPTRT(1)=101
C++++++  CLIST ENTERS NUMBER OF TREATMENTS  ++++++++++++++++++++++
        ITRT=10
        DO 300 J=1,ITRT
        WRITE(6,9)
    9   FORMAT(' ',20X,'*',20X,'*',20X,'*',20X,'*')
        DO 400 JTRT=1,4
        IF(JTRT-1)400,400,399
  399   REPTRT(JTRT)=REPTRT(JTRT-1) + 100
  400   CONTINUE
        WRITE(6,8)REPTRT
    8   FORMAT(' ',4(I3,'_____ ___ ___ ___*'))
        REPTRT(1)=REPTRT(1) + 1
  300   CONTINUE
        WRITE(6,99)
C+++++++++++++++  WRITE CAPTION AT BOTTOM OF PAGE  ++++++++++++++++
   99   FORMAT(' ','COMMENTS')
  100   CONTINUE
//* ++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
//* ++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++++
C+++++++++     EDWARD A HANLON, JR          ++++++++++++++++++++++
C+++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++++
C+++++++++       WRITTEN PERMISSION         ++++++++++++++++++++++
        STOP
        END
//GO.FT06F001  DD  SYSOUT=(I,,9031)
```

//
/*EOF

CALC.CLIST

```
PROC 0
/* +++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++ */
/* ++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* ++++++  USE OF THIS MATERIAL IS PROHIBITED WITHOUT  +++++++++++ */
/* ++++++++++++++++  WRITTEN PERMISSION  ++++++++++++++++++++++++ */
WRITE
AAA: WRITE   DO YOU WANT TO RUN SOIL, PLANT, FIELD, MERGE OR THE
WRITENR              STORAGE PROGRAM  (S  P  F  M  SP)? ===>
READ &A
IF &A=S THEN GOTO BBB
IF &A=P THEN GOTO CCC
IF &A=F THEN GOTO DDD
IF &A=M THEN GOTO EEE
IF &A=SP THEN GOTO ABC
GOTO AAA
BBB: WRITE DO YOU WANT TO:
WRITE  1) REVIEW RESULTS ONLY.  PROGRAM WILL NOT WRITE TO DISK.
WRITE  2) STORE RESULTS ON DISK ADDING NEW RESULTS AT THE END
WRITE     OF THE DISK FILE 'U11459A.SOIL.DATA'.
WRITE  3) STORE RESULTS ON DISK REMOVING ANY PRIOR RESULTS IN
WRITE     THE DISK FILE 'U11459A.SOIL.DATA'.
WRITE  4) CREATE A NEW FILE, NAMED 'U11459A.SOIL.DATA', SINCE
WRITE     THE OLD FILE IS NO LONGER CATALOGED.
FFF: WRITENR    (1  2  3  4)===>
READ &B
IF &B LE 0 OR &B GE 5 THEN GOTO FFF
IF &B=1 THEN +
  SET &DISK=&STR(2600 .//*.//.)
IF &B=2 THEN +
  SET &DISK=&STR(2700 .//*.//.)
IF &B=3 THEN +
  SET &DISK=&STR(2800 .//*.//.)
IF &B=4 THEN +
  SET &DISK=&STR(2900 3100 .//*.//. ALL)
WRITE DO YOU WANT TO:
WRITE     1.  CALCULATE ALL THE DATA IN THE INPUT FILES.
WRITE     2.  LIMIT THE DATA BEING CALCULATED
WRITE           TO DATA HAVING A SPECIFIC REFERENCE(EG.  HPB6).
SSS: WRITENR  ( 1  2 )===>
READ &F
IF &F LE 0 OR &F GE 3 THEN GOTO SSS
IF &F=1 THEN DO
  SET &SELECT=&STR(.*.*.)
  SET &CONFLICT=&STR(.1000.1000.)
    END
IF &F=2 THEN DO
  WRITENR ENTER REFERENCE(EG. HBP6)===>
  READ &REFER
```

```
   SET &SELECT=&STR(.*..)
   SET &CONFLICT=&STR(.1000.&REFER.)
     END
WRITE
WRITE LABORATORY INFORMATION FOR SOILS.
WRITE
WRITE IF PARAMETER IS NOT NEEDED JUST PRESS ENTER.
WRITENR ENTER NORMALITY OF HCL USED IN %N TEST(EG. 0.100)====>
   READ &NORM1
IF &NORM1 LT 0 THEN SET &NORM1=0.100
WRITE ENTER NORMALITY AND ALIQUOTS USED FOR CARBONATE AND BICARBONATE.
WRITENR       (EG. 0.010 10 10)====>
   READ &NORM2 &CARBBAL &BICAL
IF &NORM2 LT 0 THEN SET &NORM2=0.010
IF &CARBBAL LT 0 THEN SET &CARBBAL=10
IF &BICAL LT 0 THEN SET &BICAL=10
WRITENR ENTER NORMALITY AND ALIQUOT USED FOR CL(EG. 0.0297 10)====>
   READ &NORM3 &CLAL
IF &NORM3 LT 0 THEN SET &NORM3=0.005
IF &CLAL LT 0 THEN SET &CLAL=10
  E 'U11459A.CALCULAT(SOIL)' CNTL
 V
 C &DISK
 C 5500 /0.1000/&NORM1/
 C 12000 /0.010/&NORM2/
 C 12100 /10/&CARBBAL/
 C 12200 /10/&BICAL/
 C 12300 /0.005/&NORM3/
 C 14900 /10/&CLAL/
 C 14900 &SELECT
 C 14900 &CONFLICT
       SUBMIT
 END NOSAVE
FREEALL
EXIT
CCC: WRITE DO YOU WANT TO:
WRITE  1) REVIEW RESULTS ONLY.  PROGRAM WILL NOT WRITE TO DISK FILE.
WRITE  2) STORE RESULTS ON DISK ADDING NEW RESULTS AT THE END
WRITE     OF THE DISK FILE 'U11459A.PLANT.DATA'.
WRITE  3) STORE RESULTS ON DISK REMOVING ANY PRIOR RESULTS IN
WRITE     THE DISK FILE 'U11459A.PLANT.DATA'.
WRITE  4) CREATE A NEW FILE, NAMED 'U11459A.PLANT.DATA', SINCE
WRITE     THE OLD FILE IS NO LONGER CATALOGED.
GGG: WRITENR    (1  2  3  4)===>
READ &B
IF &B LE 0 OR &B GE 5 THEN GOTO GGG
IF &B=1 THEN +
  SET &DISK=&STR(2500 .//*.//.)
```

```
IF &B=2 THEN +
  SET &DISK=&STR(2600 .//*.//.)
IF &B=3 THEN +
  SET &DISK=&STR(2700 .//*.//.)
IF &B=4 THEN +
  SET &DISK=&STR(2800 3000 .//*.//. ALL)
WRITE DO YOU WANT TO:
WRITE      1.  CALCULATE ALL THE DATA IN THE INPUT FILES
WRITE      2.  LIMIT THE DATA BEING CALCULATED
WRITE            TO DATA HAVING A SPECIFIC REFERENCE(EG.  HPB6).
QQQ: WRITENR  ( 1  2 )===>
READ &F
/* +++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++ */
/* ++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* ++++++  USE OF THIS MATERIAL IS PROHIBITED WITHOUT  +++++++++++ */
/* +++++++++++++++  WRITTEN PERMISSION  +++++++++++++++++++++++++ */
IF &F LE 0 OR &F GE 3 THEN GOTO QQQ
IF &F=1 THEN DO
  SET &SELECT=&STR(.*.*.)
  SET &CONFLICT=&STR(.1000.1000.)
    END
IF &F=2 THEN DO
  WRITENR ENTER REFERENCE(EG. HBP6)===>
  READ &REFER
  SET &SELECT=&STR(.*..)
  SET &CONFLICT=&STR(.1000.&REFER.)
    END
WRITE
WRITE LABORATORY INFORMATION FOR PLANTS.
WRITE
WRITE IF PARAMETER IS NOT NEEDED JUST PRESS ENTER.
WRITENR ENTER NORMALITY OF HCL USED IN %N TEST(EG. 0.0500)====>
   READ &NORM5
IF &NORM5 LT 0 THEN SET &NORM5=0.0500
WRITENR ENTER ALIQUOT FOR P TEST(EG. 5 )====>
   READ &NORM6
IF &NORM6 LT 0 THEN SET &NORM6=5
  E 'U11459A.CALCULAT(PLANT)' CNTL
 V
 C &DISK
 C 6700 / 0.0500/&NORM5/
 C 7100 /(5 /(&NORM6/
 C 11400 &SELECT
 C 11400 &CONFLICT
      SUBMIT
 END NOSAVE
FREEALL
EXIT
```

```
DDD: WRITE DO YOU WANT TO:
WRITE  1) REVIEW RESULTS ONLY.  PROGRAM WILL NOT WRITE TO DISK FILE.
WRITE  2) STORE RESULTS ON DISK ADDING NEW RESULTS AT THE END
WRITE     OF THE DISK FILE 'U11459A.FIELD.DATA'.
WRITE  3) STORE RESULTS ON DISK REMOVING ANY PRIOR RESULTS IN
WRITE     THE DISK FILE 'U11459A.FIELD.DATA'.
WRITE  4) CREATE A NEW FILE, NAMED 'U11459A.FIELD.DATA', SINCE THE
WRITE     OLD FILE FILE IS NO LONGER CATALOGED.
HHH: WRITENR    (1  2  3 4)===>
READ &B
IF &B LE 0 OR &B GE 5 THEN GOTO HHH
IF &B=1 THEN +
  SET &DISK=&STR(2400 .//*.//.)
IF &B=2 THEN +
  SET &DISK=&STR(2500 .//*.//.)
IF &B=3 THEN +
  SET &DISK=&STR(2600 .//*.//.)
IF &B=4 THEN +
  SET &DISK=&STR(2700 2900 .//*.//. ALL)
WRITE      THIS PROGRAM WILL RUN EITHER FORAGE, GRAIN OR PEANUT
WRITE FIELD CALCULATIONS BUT NOT ALL THREE AT THE SAME TIME.
III: WRITE DO YOU WANT TO RUN FORAGE, GRAIN OR PEANUT FIELD DATA?
WRITENR                               (F  G  P)===>
READ &C
IF &C=F OR &C=G OR &C=P THEN GOTO JJJ
GOTO III
JJJ: IF &C=F THEN DO
  SET &TYPE=&STR(FORAGE)
  SET &LINE=&STR(1800 .//*F.//F.)
    END
IF &C=G THEN DO
  SET &TYPE=&STR(GRAIN)
  SET &LINE=&STR(1900 .//*G.//G.)
    END
IF &C=P THEN DO
  SET &TYPE=&STR(PEANUT)
  SET &LINE=&STR(2000 .//*P.//P.)
    END
WRITE DO YOU WANT TO:
WRITE     1.  CALCULATE ALL THE DATA IN THE INPUT FILES.
WRITE     2.  LIMIT THE DATA BEING CALCULATED
WRITE           TO DATA HAVING A SPECIFIC REFERENCE(EG.  HPB6).
RRR: WRITENR  ( 1  2 )===>
READ &F
IF &F LE 0 OR &F GE 3 THEN GOTO RRR
IF &F=1 THEN DO
  SET &SELECT=&STR(.*.*.)
  SET &CONFLICT=&STR(.1000.1000.)
```

```
    END
IF &F=2 THEN DO
  WRITENR ENTER REFERENCE(EG. HBP6)===>
  READ &REFER
  SET &SELECT=&STR(.*..)
  SET &CONFLICT=&STR(.1000.&REFER.)
    END
 E 'U11459A.CALCULAT(FIELD)' CNTL
   V
   C &DISK
   C &LINE
   C 3600 /FORAGE/&TYPE/
   C 4300 /FORAGE/&TYPE/
   C 8900 &SELECT
   C 8900 &CONFLICT
       SUBMIT
 END NOSAVE
FREEALL
EXIT
EEE: WRITE DO YOU WANT TO:
WRITE   1) PUT MERGED RESULTS INTO 'U11459A.COMPLETE.DATA' ADDING TO
WRITE      ANY PRIOR RESULTS IN THAT FILE.
WRITE   2) PUT MERGED RESULTS INTO 'U11459A.COMPLETE.DATA' REMOVING
WRITE      ANY PRIOR RESULTS IN THAT FILE.
WRITE   3) CREATE A NEW FILE, NAMED 'U11459A.COMPLETE.DATA', SINCE
WRITE      THE OLD FILE IS NO LONGER CATALOGED.
WRITE   4) PUT MERGED RESULTS INTO 'U11459A.COMPLETE.DATA', ADDING TO
WRITE      MERGED RESULTS TO ANY PRIOR DATA IN 'U11459A.COMPLETE.DATA'
WRITE      AND CREATE ANOTHER FILE, CONTAINING ONLY MERGED RESULTS, TO
WRITE      BE USED BY GRADUATE STUDENTS.
WRITE   5) PUT MERGED RESULTS INTO 'U11459A.COMPLETE.DATA', REMOVING
WRITE      ANY PRIOR DATA IN 'U11459A.COMPLETE.DATA'
WRITE      AND CREATE ANOTHER FILE, CONTAINING ONLY MERGED RESULTS, TO
WRITE      BE USED BY GRADUATE STUDENTS.
WRITE   6) CREATE A NEW FILE, NAMED 'U11459A.COMPLETE.DATA',SINCE
WRITE      THE OLD FILE IS NO LONGER CALTALOGED AND CREATE ANOTHER
WRITE      FILE TO BE USED BY GRADUATE STUDENTS.
KKK: WRITENR    (1  2  3  4  5  6)===>
READ &B
WRITE
IF &B LE 0 OR &B GE 7 THEN GOTO KKK
IF &B GE 4 THEN DO
  WRITE ENTER GRADUATE STUDENT DATA SET NAME(MAX---8 CHARACTERS).
  WRITENR                                ===>
  READ &Z
  SET &GRADFILE=&STR(3200 /NAME/&Z/)
    END
IF &B LT 4 THEN DO
```

```
  SET &Z=&STR(NAME)
  SET &GRADFILE=&STR(3200 /NAME/&Z/)
  SET &WRITE=&STR(.*.*. ALL)
    END
IF &B=1 THEN DO
  SET &DISK=&STR(2700 .//*.//.)
  SET &GRAD=&STR(.//*.//*. ALL)
    END
IF &B=2 THEN DO
  SET &DISK=&STR(2800 .//*.//.)
  SET &GRAD=&STR(.//*.//*. ALL)
    END
IF &B=3 THEN DO
  SET &DISK=&STR(2900 3100 .//*.//. ALL)
  SET &GRAD=&STR(.//*.//*. ALL)
    END
IF &B=4 THEN DO
  SET &DISK=&STR(2700 .//*.//.)
  SET &GRAD=&STR(.//*.//. ALL)
  SET &WRITE=&STR(.*.. ALL)
    END
IF &B=5 THEN DO
  SET &DISK=&STR(2800 .//*.//.)
  SET &GRAD=&STR(.//*.//. ALL)
  SET &WRITE=&STR(.*.. ALL)
    END
IF &B=6 THEN DO
  SET &DISK=&STR(2900 3100 .//*.//. ALL)
  SET &GRAD=&STR(.//*.//. ALL)
  SET &WRITE=&STR(.*.. ALL)
    END
WRITE       THIS PROGRAM WILL MERGE 'U11459A.SOIL.DATA',
WRITE 'U11459A.PLANT.DATA' AND 'U11459A.FIELD.DATA' OR ANY COMBINATION.
LLL: WRITE DO YOU WANT TO INCLUDE SOIL DATA IN THE MERGE?
WRITENR                              (Y  N)===>
READ &C
IF &C=Y THEN DO
   SET &MERGE1=&STR( SOIL(IN=IN1))
   SET &BOZO1=&STR(IN1=0 )
     END
IF &C=N THEN DO
  SET &MERGE1=&STR(              )
  SET &BOZO1=&STR(      )
    END
IF &C=Y OR &C=N THEN GOTO MMM
GOTO LLL
MMM: WRITE DO YOU WANT TO INCLUDE PLANT DATA IN THE MERGE?
WRITENR                              (Y  N)===>
```

```
READ &D
IF &D=Y THEN DO
  SET &MERGE2=&STR( PLANT(IN=IN2))
  SET &BOZO2=&STR( IN2=0 )
    END
IF &D=N THEN DO
  SET &MERGE2=&STR(              )
  SET &BOZO2=&STR(       )
    END
IF &D=Y OR &D=N THEN GOTO NNN
GOTO MMM
NNN: WRITE DO YOU WANT TO INCLUDE FIELD DATA IN THE MERGE?
WRITENR                                   (Y  N)===>
READ &E
IF &E=Y THEN DO
  SET &MERGE3=&STR( FIELD(IN=IN3))
  SET &BOZO3=&STR( IN3=0 )
    END
IF &E=N THEN DO
  SET &MERGE3=&STR(              )
  SET &BOZO3=&STR(        )
    END
  IF &C=Y AND &D=Y AND &E=Y THEN DO
    SET &PLUS1=&STR( OR )
    SET &PLUS2=&STR( OR )
      END
  IF &C=Y AND &D=Y AND &E=N THEN DO
    SET &PLUS1=&STR( OR )
    SET &PLUS2=&STR(    )
      END
  IF &C=Y AND &D=N AND &E=N THEN DO
    SET &PLUS1=&STR(    )
    SET &PLUS2=&STR(    )
      END
  IF &C=N AND &D=Y AND &E=N THEN DO
    SET &PLUS1=&STR(    )
    SET &PLUS2=&STR(    )
      END
  IF &C=N AND &D=N AND &E=Y THEN DO
    SET &PLUS1=&STR(    )
    SET &PLUS2=&STR(    )
      END
  IF &C=Y AND &D=N AND &E=Y THEN DO
    SET &PLUS1=&STR( OR )
    SET &PLUS2=&STR(    )
      END
  IF &C=N AND &D=Y AND &E=Y THEN DO
    SET &PLUS1=&STR(    )
```

```
    SET &PLUS2=&STR( OR )
      END
IF &E=Y OR &E=N THEN GOTO OOO
GOTO NNN
OOO: SET &MERGE4=&STR( +
  /SOIL(IN=IN1) PLANT(IN=IN2) FIELD(IN=IN3)+
  /&MERGE1&MERGE2&MERGE3/)
 SET &BOZO4=&STR( +
  /IN1=0 OR IN2=0 OR IN3=0+
  /&BOZO1&PLUS1&BOZO2&PLUS2&BOZO3/)
WRITE DO YOU WANT TO:
WRITE      1.  MERGE ALL DATA.
WRITE      2.  LIMIT THE DATA BEING MERGED TO DATA HAVING A SPECIFIC
WRITE              REFERENCE(EG.  HPB6).
PPP: WRITENR  ( 1  2 )===>
READ &F
IF &F LE 0 OR &F GE 3 THEN GOTO PPP
IF &F=1 THEN DO
  SET &SELECT=&STR(.*.*.)
  SET &CONFLICT=&STR(.1000.1000.)
    END
IF &F=2 THEN DO
  WRITENR ENTER REFERENCE(EG. HBP6)===>
  READ &REFER
  SET &SELECT=&STR(.*..)
  SET &CONFLICT=&STR(.1000.&REFER.)
    END
E 'U11459A.CALCULAT(MERGE)' CNTL
V
C &DISK
C 3200 &GRADFILE
C 3200 3400 &GRAD
C 6700 &MERGE4
C 7600 &SELECT
C 7600 &CONFLICT
C 8100 &BOZO4
C 10100 10200 &WRITE
      SUBMIT
END NOSAVE
FREEALL
EXIT
WRITE
ABC: WRITENR       ENTER STORAGE PASSWORD ===>
READ &PASS
IF &PASS=&STR(BOB) THEN GOTO DEF
EXIT
DEF: WRITE   DO YOU WANT TO WRITE THE COMBINED DATA (COMPLETE
WRITE             PLUS DESCRIPTORS) TO A SAS DATA FILE ON DISK?
```

```
BBBB: WRITENR           ( Y   N ) ===>
READ &AA
IF &AA=Y OR &AA=N THEN GOTO CCCC
GOTO BBBB
CCCC: IF &AA=Y THEN DO
DDDD: WRITENR SPECIFY DISK FILE NUMBER (XX) ===>
  READ &BB
  IF &BB LT 1 OR &BB GT 99 THEN GOTO DDDD
  SET &DISK1=&STR(.//*.//. ALL )
  SET &DISK2=&STR(.XX.&BB.)
  SET &DISK3=&STR(/LINEOUT.STORAGE/LINEOUT.STORAGE/)
  SET &DISK4=&STR(/LINEOUT.STORAGE/LINEOUT.STORAGE/)
    END
IF &AA=N THEN DO
  SET &DISK1=&STR(.//*.//*. ALL )
  SET &DISK2=&STR(.XX.XX.)
  SET &DISK3=&STR(/LINEOUT.STORAGE/LINE/)
  SET &DISK4=&STR(/LINEOUT.STORAGE/LINE/)
    END
EEEE: WRITENR SPECIFY TAPE TO BE READ ( 1   2 ) ===>
READ &CC
IF &CC LT 1 OR &CC GT 2 THEN GOTO EEEE
IF &CC=1 THEN SET &DD=2
IF &CC=2 THEN SET &DD=1
WRITE   THE TAPE FROM WHICH DATA WILL BE READ IS TAPE=&CC .
WRITE        ALL DATA ON TAPE=&DD WILL BE LOST.
WRITE        VERIFY THAT YOU HAVE CHOSEN THE CORRECT TAPE.
FFFF: WRITENR        IS &CC THE CORRECT TAPE NUMBER? ( Y   N ) ===>
READ &EE
IF &EE=Y OR &EE=N THEN GOTO GGGG
GOTO FFFF
GGGG: IF &EE=N THEN GOTO EEEE
IF &CC=1 THEN DO
  SET &TAPE1=&STR(.X.&CC.)
  SET &TAPE2=&STR(.XXXX.2669.)
  SET &TAPE3=&STR(.Y.&DD.)
  SET &TAPE4=&STR(.YYYY.2670.)
  SET &TAPE5=&STR(.Z.&DD.)
  SET &TAPE6=&STR(.ZZZZ.2670.)
    END
IF &CC=2 THEN DO
  SET &TAPE1=&STR(.X.&CC.)
  SET &TAPE2=&STR(.XXXX.2670.)
  SET &TAPE3=&STR(.Y.&DD.)
  SET &TAPE4=&STR(.YYYY.2669.)
  SET &TAPE5=&STR(.Z.&DD.)
  SET &TAPE6=&STR(.ZZZZ.2669.)
    END
```

```
E 'U11459A.CALCULAT(STORAGE)' CNTL
V
C 2900 3000 &DISK1
C 2900  &DISK2
C 11500 &DISK3
C 12700 &DISK4
C 3400  &TAPE1
C 3500  &TAPE2
C 3900  &TAPE3
C 4000  &TAPE4
C 13300 &TAPE5
C 13400 &TAPE6
      SUBMIT
END NOSAVE
FREEALL
/* ++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++ */
/* ++++  THIS PROGRAM IS COPYRIGHTED BY EDWARD A HANLON, JR  +++++ */
/* ++++++  USE OF THIS MATERIAL IS PROHIBITED WITHOUT  +++++++++++ */
/* ++++++++++++++++  WRITTEN PERMISSION  +++++++++++++++++++++++++ */
EXIT
```

SOIL CALCULATIONS

```
//C11459LC JOB (11459,CAL-CU-LATE),HANLON,TIME=(0,05),CLASS=F,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT RMT4
//*
//* ++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++
//* +++++++++  THIS PROGRAM IS COPYRIGTHED BY  +++++++++++++++++++++
//* +++++++++       EDWARD A HANLON, JR        +++++++++++++++++++++
//* +++++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++++
//* +++++++++     WRITTEN PERMISSION           +++++++++++++++++++++
//* ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
//*
//*
//* +++++++++  BATCH JOB STORED IN CALCULAT(SOIL)  +++++++++++++++++
//   EXEC SAS
//*
//* +++++++++  READ LAB DATA FROM SOIL FILES  +++++++++++++++++++++
//*
//SOIL1  DD DSN=U11459A.INPUT(SOIL1),DISP=(OLD,KEEP)
//SOIL2  DD DSN=U11459A.INPUT(SOIL2),DISP=(OLD,KEEP)
//SOIL3 DD DSN=U11459A.INPUT(SOIL3),DISP=(OLD,KEEP)
//*
//* ++++++++  WRITE CALCULATED DATA INTO DISK FILE  ++++++++++++++++
//*
//*SOILOUT DD DUMMY
//*SOILOUT DD DSN=U11459A.SOIL.DATA,DISP=(MOD,KEEP)
//*SOILOUT DD DSN=U11459A.SOIL.DATA,DISP=(SHR,KEEP)
//*SOILOUT DD DSN=U11459A.SOIL.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD40, SPACE=(TRK,(5,1)),DCB=(LRECL=140,BLKSIZE=6160,
//* RECFM=FB)
//*
//* ++++++++  RUN SAS PROGRAM  ++++++++++++++++++++++++++++++++++++
//*
//SYSIN DD *
OPTIONS       NODATE NONUMBER;
DATA PAGEONES; TITLE;
  INFILE SOIL1 MISSOVER;
**********  READ DATA FROM INPUT(SOIL1)  +++++++++++++++++++++++++;
    INPUT   EXP_NO $  REF_NO $     SLABNO     REPTRT    DEPTH $
      N_METH $      UREA1      UREA2      N_BLK      NH4_1      NH4_2
      NO3_1         NO3_2      NO2_1      NO2_2      TOT_N1     TOT_N2
      PH            BI         BRAY1      BRAY2      ;
   IF DEPTH='.' THEN DEPTH='    0';
******  CHECK FOR MISSING VALUES BEFORE AVERAGING DUPS  +++++++++++;
  ARRAY TRY1 UREA1 NH4_1 NO3_1 NO2_1 TOT_N1 BRAY1;
  ARRAY TRY2 UREA2 NH4_2 NO3_2 NO2_2 TOT_N2 BRAY2;
  ARRAY AVG  UREAA NH4_A NO3_A NO2_A TOT_NA BRAYA;
```

```
  DO OVER TRY1;
    IF TRY1=. AND TRY2>0 THEN TRY1=TRY2;
    IF TRY2=. AND TRY1>0 THEN TRY2=TRY1;
    AVG=(TRY1 + TRY2)/2;
      END;
******  CLIST INSERTS NORMALITY OF KJELDAHL ACID HERE  ++++++++++++;
  NORM1= 0.1000;
******  ALL SOIL NITROGEN CALCULATIONS  ++++++++++++++++++++++++++;
  S_TOTN= (TOT_NA *  NORM1 * 14 * 1000)/1;
  IF N_METH='T' THEN DO;
    S_UREA=(UREAA * 200 * 0.4662)/20;
    S_NH4 =(NH4_A * 200 * 0.7778)/20;
    S_NO3 =(NO3_A * 200)/2;
    S_NO2 =(NO2_A * 200)/2;
    GO TO AAA;
      END;
  S_UREA=((UREAA-N_BLK) * (NORM1 * 14 * 1000 * 100))/(25 * 10);
  S_NH4 =((NH4_A-N_BLK) * (NORM1 * 14 * 1000 * 100))/(25 * 10);
  AAA: IF N_METH='E' THEN DO;
    S_NO3 =(NO3_A * 25)/10;
    GO TO BBB;
      END;
  S_NO3 = ((NO3_A - N_BLK) * NORM1 * 14 * 1000 * 100)/(25 * 10);
  BBB: ;
  S_NO2 = ((NO2_A - N_BLK) * NORM1 * 14 * 1000 * 100)/(25 * 10);
  S_ORG_N = S_TOTN - (S_UREA + S_NH4 + S_NO3 + S_NO2);
******  SOIL PHOSPHORUS CALCULATION  ++++++++++++++++++++++++++++;
  S_P =  (BRAYA * 20)/1;
******  KEEP ONLY LISTED VARIABLES  ++++++++++++++++++++++++++++++;
  KEEP EXP_NO REF_NO SLABNO REPTRT DEPTH S_UREA S_NH4 S_NO3 S_NO2
    S_TOTN S_ORG_N S_P;
PROC SORT; BY SLABNO;
**********************  ATTENTION  ++++++++++++++++++++++++++++++++;
*************  THIS PROGRAM IS COPYRIGTHED BY  ++++++++++++++++++++;
*************        EDWARD A HANLON, JR         ++++++++++++++++++++;
*************   USE OF THIS PROGRAM REQUIRES     ++++++++++++++++++++;
*************     WRITTEN PERMISSION             ++++++++++++++++++++;
*******************************************************************;
DATA PAGETWOS;
  INFILE SOIL2;
**********  READ DATA FROM INPUT(SOIL2)  +++++++++++++++++++++++++;
    INPUT SLABNO  K1  K2   CA1   CA2   MG1   MG2   NA1  NA2   S1   S2
      FE1   FE2  MN1 MN2  ZN1   ZN2   CU1   CU2   ;
*******  CHECK FOR MISSING VALUES BEFORE AVERAGING DUPS  +++++++++;
  ARRAY TRY1 K1 CA1 MG1 NA1 S1 FE1 MN1 ZN1 CU1;
  ARRAY TRY2 K2 CA2 MG2 NA2 S2 FE2 MN2 ZN2 CU2;
  ARRAY AVG  KA CAA MGA NAA SA FEA MNA ZNA CUA;
  DO OVER TRY1;
```

```
    IF TRY1=. AND TRY2>0 THEN TRY1=TRY2;
    IF TRY2=. AND TRY1>0 THEN TRY2=TRY1;
    AVG=(TRY1 + TRY2)/2;
      END;
**************  CALCULATIONS  +++++++++++++++++++++++++++++++++++;
  S_K=(KA * 25)/5;
  S_NA=(NAA * 25)/5;
  S_CA=(CAA * 25 * 5)/(5 * 4);
  S_MG=(MGA * 25 * 5)/(5 * 4);
  ARRAY CALIN  SA  FEA  MNA  ZNA  CUA;
  ARRAY CALOUT S_S   S_FE   S_MN   S_ZN   S_CU;
  DO OVER CALIN;
    CALOUT =(CALIN * 25)/10;
      END;
*********  KEEP ONLY LISTED VARIABLES  ++++++++++++++++++++++++++;
  KEEP SLABNO S_K S_CA S_MG S_NA S_S S_FE S_MN S_ZN S_CU;
PROC SORT; BY SLABNO;
DATA PAGETRES;
**********  READ DATA FROM INPUT(SOIL3)  +++++++++++++++++++++++++;
  INFILE SOIL3;
    INPUT SLABNO    MO1       MO2      CARB  BICARB   CL_METH $  CL1
      SO41   SO42   ECREAD    ECFACT   OM1   OM2      AL1        AL2;
*********  CLIST CHANGES ALIQUOTS AND NORMALITIES  +++++++++++++++;
  NORM2 = 0.010;
  CARBAL= 10;  BICAL= 10;
  NORM3 = 0.005;
  CL_AL = 10;
*******  CHECK FOR MISSING VALUES BEFORE AVERAGING DUPS  +++++++++;
  ARRAY TRY1  MO1   SO41  OM1  AL1;
  ARRAY TRY2  MO2   SO42  OM2  AL2;
  ARRAY AVG   MOA   SO4A  OMA  ALA;
  DO OVER TRY1;
    IF TRY1=. AND TRY2>0 THEN TRY1= TRY2;
    IF TRY2=. AND TRY1>0 THEN TRY2= TRY1;
    AVG=(TRY1 + TRY2)/2;
      END;
**************  CALCULATIONS  +++++++++++++++++++++++++++++++++++;
  S_MO=(MOA * 250)/25;
  S_CO3 =(CARB * 2 * NORM2 * 1000)/CARBAL;
  S_HCO3=((BICAL - (2 * CARB)) * NORM2 * 1000)/BICAL;
  IF CL_METH='T' THEN DO;
    S_CL =(35.5 * 1000 * NORM3 * CL1)/CL_AL;
      END;
  IF CL_METH='E' THEN S_CL = CL1;
  S_EC = ECREAD * ECFACT;
  S_SO4=SO4A;
  S_OM =OMA;
  S_AL=ALA;
```

```
  KEEP SLABNO S_MO S_CO3 S_HCO3 S_CL S_SO4 S_EC S_OM S_AL;
PROC SORT; BY SLABNO;
DATA TOGETHER; MERGE PAGEONES PAGETWOS PAGETRES; BY SLABNO;
*++++  CLIST MODIFIES NEXT LINE TO SELECT DATA BY REF_NO  ++++++++++;
*IF REF_NO='1000';
*++++++++  WRITE DATA TO SOIL.DATA  ++++++++++++++++++++++++++++++;
  FILE SOILOUT;
    PUT EXP_NO $    SLABNO   REF_NO $       REPTRT      DEPTH
      S_UREA      S_NH4    S_NO2    S_NO3     S_ORG_N     S_TOTN      S_P
      S_K         S_CA     S_MG     S_S       S_FE        S_ZN        S_MN
      S_CU        S_B      S_MO     S_CL      S_NA        S_AL        S_EC
      S_OM        S_PH     S_BI     S_HCO3    S_CO3       ;
PROC PRINT; ID SLABNO;
  TITLE '++++  INFORMATION WRITTEN TO SOIL.DATA  ++++';
*++++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++;
*+++++++++++++  THIS PROGRAM IS COPYRIGTHED BY  ++++++++++++++++++++;
*+++++++++++++        EDWARD A HANLON, JR        ++++++++++++++++++++;
*+++++++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++;
*+++++++++++++      WRITTEN PERMISSION           ++++++++++++++++++++;
*+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//
/*EOF
```

PLANT CALCULATIONS

```
//C11459LC JOB (11459,CAL-CU-LATE),HANLON,TIME=(0,25),CLASS=A,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT RMT4
//*
//* +++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++
//* +++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++
//* +++++++++++       EDWARD A HANLON, JR        +++++++++++++++++++
//* +++++++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++
//* +++++++++++      WRITTEN PERMISSION          +++++++++++++++++++
//* ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
//*
//* ++++  BATCH JOB STORED IN CALCULAT(PLANT)  ++++++++++++++++++++
//*
//   EXEC SAS
//*
//* +++++++++  READ LAB DATA FROM PLANT FILES  ++++++++++++++++++++
//*
//PLNT1  DD DSN=U11459A.INPUT(PLNT1),DISP=(OLD,KEEP)
//PLNT2  DD DSN=U11459A.INPUT(PLNT2),DISP=(OLD,KEEP)
//*
//* +++  WRITE CALCULATED DATA INTO DISK FILE, CLIST CONTROLLED  +++
//*
//*PLNTOUT DD DUMMY
//*PLNTOUT DD DSN=U11459A.PLANT.DATA,DISP=(MOD,KEEP)
//*PLNTOUT DD DSN=U11459A.PLANT.DATA,DISP=(SHR,KEEP)
//*PLNTOUT DD DSN=U11459A.PLANT.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(5,1)),DCB=(LRECL=140,BLKSIZE=6160,
//* RECFM=FB)
//*
//* ++++++++  PRINT RESULTS TO REGULAR COMPUTER PAPER  +++++++++++++
//*
//PLNTPRNT DD SYSOUT=A
//PLNTREVW DD SYSOUT=A
//*
//* ++++++++  RUN SAS PROGRAM  +++++++++++++++++++++++++++++++++++++
//SYSIN DD *
OPTIONS        NODATE NONUMBER;
DATA PAGEONES; TITLE;
  INFILE PLNT1 MISSOVER;
**********  READ DATA FROM INPUT(PLANT1)  +++++++++++++++++++++++;
  INPUT        EXP_NO $ REF_NO $  LABNO     PART $
    REPTRT     N_WT      P_WT      N_BLK     NH4_1     NH4_2
    P_1        P_2       K_1       K_2       FE_1      FE_2
    ZN_1       ZN_2      MN_1      MN_2      @1 LINE $ 104.;
  IF PART=' ' THEN PART='.';
*++++++  ADJUST DECIMAL POINTS FOR ALL VARIABLES  +++++++++++++++++;
```

```
  ARRAY POINT N_WT P_WT N_BLK NH4_1 NH4_2 MN_1 MN_2;
  DO OVER POINT;
    IF POINT GT O THEN POINT=POINT*O.01;
      END;
  K_1=K_1 * O.1; K_2=K_2 * O.1;
******  CHECK FOR MISSING VALUES BEFORE AVERAGING DUPS  +++++++++++;
  ARRAY TRY1 NH4_1 P_1 K_1 FE_1 ZN_1 MN_1;
  ARRAY TRY2 NH4_2 P_2 K_2 FE_2 ZN_2 MN_2;
  ARRAY AVG NH4_A P_A K_A FE_A ZN_A MN_A;
  DO OVER TRY1;
    IF TRY1=. AND TRY2>O THEN TRY1=TRY2;
    IF TRY2=. AND TRY1>O THEN TRY2=TRY1;
    AVG=(TRY1 + TRY2)/2;
      END;
******  SET NITROGEN AND PERCHLORIC SAMPLE WEIGHTS  +++++++++++++++;
  IF N_WT LE O THEN N_WT=O.250;
  IF P_WT LE O THEN P_WT=O.250;
******  CLIST INSERTS NORMALITY OF KJELDAHL ACID HERE  ++++++++++++;
  NORM1= O.0500;
***************  NITROGEN CALCULATION  +++++++++++++++++++++++++++;
  PCT_N=((NH4_A - N_BLK)*NORM1*((14*100)/1000))/N_WT;
***  PHOSPHORUS CALCULATION.  ALIQUOT SUPPLIED BY CLIST.  +++++++++;
  P=P_A * (35/(5 * P_WT));
*******  POTASSIUM, IRON, ZINC AND MANGANESE CALCULATIONS  ++++++++;
  ARRAY TRY3 K_A FE_A ZN_A MN_A;
  ARRAY TRY4 K FE ZN MN;
  DO OVER TRY3;
    TRY4=TRY3 * (35/P_WT);
      END;
******  KEEP ONLY LISTED VARIABLES  ++++++++++++++++++++++++++++++;
  KEEP EXP_NO REF_NO LABNO PART REPTRT P_WT PCT_N P K FE ZN MN LINE;
PROC SORT; BY LABNO;
***********************  ATTENTION  ++++++++++++++++++++++++++++++++;
***************  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++;
***************        EDWARD A HANLON, JR        ++++++++++++++++++;
***************   USE OF THIS PROGRAM REQUIRES    ++++++++++++++++++;
***************       WRITTEN PERMISSION          ++++++++++++++++++;
*******************************************************************;
DATA PAGETWOS;
  INFILE PLNT2 MISSOVER;
**********  READ DATA FROM INPUT(PLANT2)  +++++++++++++++++++++++;
    INPUT LABNO    NO3     CL      NA1     NA2     AL1     AL2
      CA1 CA2      MG1     MG2     S1      S2      CU1     CU2
      B1  B2       MO1     MO2     CHLOR   @1 ALLLINE $ 104.;
******  ADJUST DECIMAL POINTS FOR ALL VARIABLES  ++++++++++++++++++;
  ARRAY POINT2 CL NA1 NA2 CA1 CA2 MG1 MG2 S1 S2 B1 B2 MO1 MO2 CU1 CU2;
  DO OVER POINT2;
    IF POINT2 GT O THEN POINT2=POINT2*O.01;
```

```
      END;
  NO3=NO3 * 0.1; AL1=AL1 * 0.1; AL2=AL2 * 0.1;
*++++++  CHECK FOR MISSING VALUES BEFORE AVERAGING DUPS  +++++++++;
  ARRAY TRY1 NA1 AL1 CA1 MG1 S1 CU1 B1 MO1;
  ARRAY TRY2 NA2 AL2 CA2 MG2 S2 CU2 B2 MO2;
  ARRAY AVG  NAA ALA CAA MGA SA CUA BA MOA;
  DO OVER TRY1;
    IF TRY1=. AND TRY2>0 THEN TRY1=TRY2;
    IF TRY2=. AND TRY1>0 THEN TRY2=TRY1;
    AVG=(TRY1 + TRY2)/2;
      END;
*++++++++  KEEP ONLY LISTED VARIABLES  +++++++++++++++++++++++++;
  KEEP LABNO NO3 CL NAA ALA CAA MGA SA CUA BA MOA CHLOR ALLLINE;
PROC SORT; BY LABNO;
DATA TOGETHER; MERGE PAGEONES(IN=IN1) PAGETWOS(IN=IN2); BY LABNO;
  RETAIN COUNT COUNTER;
*++++  CLIST MODIFIES NEXT LINE TO SELECT DATA BY REF_NO  ++++++++;
*IF REF_NO='1000';
*+++++++++  SET COUNTERS THAT CONTROL DATA PRINTING  +++++++++++++;
  IF _N_=1 THEN DO;
    COUNT=1;  COUNTER=1;
      END;
  FILE PRINT;
*++  PRINT PAGE ONE LINE IF NOT MATCHED WITH PAGE TWO  +++++++++++;
  IF IN1=1 AND IN2=0 THEN DO;
    IF COUNT=1 THEN PUT _PAGE_ @25 'FOLLOWING DATA DID NOT MATCH' //;
      PUT @1 'PAGE ONE = ' LINE $104.;
    COUNT=COUNT+1;
      END;
*+++  PRINT AND DELETE PAGE TWO LINE IF NOT MATCHED WITH PAGE ONE  ++;
  IF IN1=0 AND IN2=1 THEN DO;
    IF COUNT=1 THEN PUT _PAGE_ @25 'FOLLOWING DATA DID NOT MATCH' //;
      PUT @1 'PAGE TWO = ' ALLLINE $104.;
    COUNT=COUNT+1;
    DELETE;
      END;
*+++++++++++++  CALCULATIONS  +++++++++++++++++++++++++++++++++++;
  ARRAY TRY3 NAA ALA CUA MOA SA;
  ARRAY TRY4 NA AL CU MO S;
  DO OVER TRY3;                      *+++  NITRATES, CHLORIDES    ;
    TRY4=TRY3 * (35/P_WT);           *+++  AND CHLOROPHYLL ARE    ;
       END;                          *+++  DIRECT READINGS  ++++++;
  CA=CAA * (35/P_WT) * (5/4);
  MG=MGA * (35/P_WT) * (5/4);
  B=BA;
*+++++++++++  WRITE DATA TO PLANT.DATA  ++++++++++++++++++++++++;
  FILE PLNTOUT;
    PUT EXP_NO $ LABNO REF_NO $     PART $        REPTRT
```

```
      PCT_N 5.2 +1      P      K       CA      MG      S      FE      ZN
      MN  CU      B      MO     CL      NA      AL      CHLOR          NO3;
  FILE PLNTREVW;
    IF COUNTER=1 THEN DO;
      PUT _PAGE_ @20 'CALCULATED DATA WRITTEN TO'
        ' PLANT.DATA' //
        @1 'EXP_NO LABNO REF PART REPTRT PCT_N P K CA MG S FE ZN MN'
        ' CU B MO CL NA AL CHLOR NO3' //;
          END;
    PUT EXP_NO $ LABNO   REF_NO $ PART $   REPTRT
        PCT_N 5.2  +1  P   K     CA 6.1 +1 MG 6.1 +1 S  FE  ZN    MN
        CU              B   MO    CL         NA         AL     CHLOR
        NO3;
  FILE PLNTPRNT;
    IF COUNTER=1 THEN DO;
      COUNTER=2;
      PUT _PAGE_ @20 'KEYPUNCH REVIEW SHEET' //;
        END;
    PUT @1 LINE $104. / @15 ALLLINE $104.;
*+++++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++;
*+++++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++;
*+++++++++++++++       EDWARD A HANLON, JR        ++++++++++++++++++;
*+++++++++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++;
*+++++++++++++++      WRITTEN PERMISSION          ++++++++++++++++++;
*+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//
/*EOF
```

FIELD CALCULATIONS

```
//C11459LC JOB (11459,CAL-CU-LATE),HANLON,TIME=(0,05),CLASS=F,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT RMT4
//*
//* ++++++++++++++++  ATTENTION  +++++++++++++++++++++++++
//* ++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++
//* ++++       EDWARD A HANLON, JR        +++++++++++++++++
//* ++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++
//* ++++     WRITTEN PERMISSION           +++++++++++++++++
//* +++++++++  BATCH JOB STORED IN CALCULAT(FIELD)  ++++++++
//*
//   EXEC SAS
//*
//* +++++++++  CLIST SELECTS FILE TO BE READ  +++++++++++++++
//*
//*FORAGE  DD DSN=U11459A.INPUT(FORAGE),DISP=(OLD,KEEP)
//*GRAIN   DD DSN=U11459A.INPUT(GRAIN),DISP=(OLD,KEEP)
//*PEANUT  DD DSN=U11459A.INPUT(PEANUT),DISP=(OLD,KEEP)
//*
//* ++++++  CLIST SELECTS OUTPUT FILE STATUS  ++++++++++++++
//*
//*FIELDOUT DD DUMMY
//*FIELDOUT DD DSN=U11459A.FIELD.DATA,DISP=(MOD,KEEP)
//*FIELDOUT DD DSN=U11459A.FIELD.DATA,DISP=(SHR,KEEP)
//*FIELDOUT DD DSN=U11459A.FIELD.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(5,1)),DCB=(LRECL=140,BLKSIZE=6160,
//* RECFM=FB)
//*
//* ++++++++  RUN SAS PROGRAM  +++++++++++++++++++++++++++++
//*
//SYSIN DD *
OPTIONS       NODATE NONUMBER;
DATA ONE; TITLE;
  INFILE FORAGE MISSOVER;
**********  RETAIN ALL HEADING INFORMATION  +++++++++++++++++++++;
  RETAIN  REF_NO EXP_NO PLOT_D1 PLOT_D2;
**********  READ DATA FROM INPUT FILE  ++++++++++++++++++++++++++;
  INPUT X@;
    IF X LT 101 THEN INPUT @1 REF_NO $ EXP_NO $ PLOT_D1 PLOT_D2;
**********  CLIST SETS TYPE OF FIELD FORM  +++++++++++++++++++++;
  TYPE='FORAGE';
**********  CHECK TREATMENT AND FORM TYPE, INPUT FORAGE DATA  ++++;
  IF X GE 101 AND TYPE='FORAGE' THEN DO;
    INPUT @1 REPTRT PLOT_WT BAG WET DRY;
******  CONVERSION FROM PLOT SIZE TO KG/HA (WET WEIGHT BASIS)  ++++;
    PLOT_WT=PLOT_WT*0.1;
```

```
    KG_HA=(PLOT_WT*1.12 *43560)/(PLOT_D1*PLOT_D2);
************  PERCENT MOISTURE CALCULATION  +++++++++++++++++++++++;
    IF BAG LE 0 THEN BAG=0;
    MOISTURE=(WET-DRY)*100/(WET-BAG);
******  CONVERSION FROM KG/HA WET WEIGHT TO DRY WEIGHT  +++++++++++;
    DRY_MAT=1-(MOISTURE/100);
    KG_HA=KG_HA*DRY_MAT;
    SMK=.;
    ETC=.;
    OUTPUT;
      END;
*****  CHECK TREATMENT AND FORM TYPE, INPUT GRAIN DATA  +++++++++++;
  IF X GE 101 AND TYPE='GRAIN' THEN DO;
    INPUT @1 REPTRT PLOT_WT;
*********************  ATTENTION  +++++++++++++++++++++++++++++++++;
********  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++++++;
********       EDWARD A HANLON, JR        ++++++++++++++++++++++++;
********   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++++++;
********     WRITTEN PERMISSION           ++++++++++++++++++++++++;
******  CONVERSION FROM PLOT SIZE TO KG/HA (WET WEIGHT BASIS) +++++;
    PLOT_WT=PLOT_WT*0.1;
    KG_HA=(PLOT_WT*1.12 *43560)/(PLOT_D1*PLOT_D2);
    MOISTURE=.;
    SMK=.;
    ETC=.;
    OUTPUT;
      END;
*****  CHECK TREATMENT AND FORM TYPE, INPUT PEANUT DATA  ++++++++++;
  IF X GE 101 AND TYPE='PEANUT' THEN DO;
    INPUT @1 REPTRT PLOT_WT SMK ETC;
******  CONVERSION FROM PLOT SIZE TO KG/HA (WET WEIGHT BASIS)  ++++;
    PLOT_WT=PLOT_WT*0.1;
    KG_HA=(PLOT_WT*1.12 *43560)/(PLOT_D1*PLOT_D2);
    MOISTURE=.;
    OUTPUT;
      END;
  DROP X;
PROC SORT; BY REF_NO REPTRT;
DATA TO_FILE; SET ONE;
*****  CLIST SELECTS DATA LINES TO BE WRITTEN BY REF_NO  ++++++++++;
  *IF REF_NO='1000';
********  WRITE CALCULATED DATA TO FIELD.DATA  +++++++++++++++++++;
  FILE FIELDOUT;
    PUT REF_NO $  REPTRT EXP_NO $  PLOT_D1  PLOT_D2  MOISTURE 5.1
      KG_HA 6. +1 SMK  ETC;
PROC PRINT; ID REPTRT; TITLE '++++  DATA WRITTEN TO FIELD.DATA  ++++';
*********************  ATTENTION  +++++++++++++++++++++++++++++++++;
********  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++++++;
```

```
*++++++++      EDWARD A HANLON, JR       ++++++++++++++++++++++++;
*++++++++  USE OF THIS PROGRAM REQUIRES  ++++++++++++++++++++++++;
*++++++++    WRITTEN PERMISSION          ++++++++++++++++++++++++;
*++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//
/*EOF
```

MERGE PROGRAM

```
//C11459LC JOB (11459,CAL-CU-LATE),HANLON,TIME=(0,25),CLASS=A,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
//*
/*ROUTE  PRINT RMT4
//*
//* ++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++++
//* +++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++++
//* +++++++       EDWARD A HANLON, JR        +++++++++++++++++++++++
//* +++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++++++
//* +++++++     WRITTEN PERMISSION           +++++++++++++++++++++++
//* ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
//*
//* +++++++  PROGRAM IS STORED IN CALCULAT(MERGE)  +++++++++++++++++
//*
//*
//   EXEC SAS
//*
//* +++++++++  READ LAB DATA FROM FILES  ++++++++++++++++++++++++++
//*
//DATA1  DD DSN=U11459A.SOIL.DATA,DISP=(OLD,KEEP)
//DATA2  DD DSN=U11459A.PLANT.DATA,DISP=(OLD,KEEP)
//DATA3  DD DSN=U11459A.FIELD.DATA,DISP=(OLD,KEEP)
//*
//* ++++  WRITE MERGED DATA INTO DISK FILE, CLIST CONTROLED  +++++++
//*
//*COMPLETE DD DSN=U11459A.COMPLETE.DATA,DISP=(MOD,KEEP)
//*COMPLETE DD DSN=U11459A.COMPLETE.DATA,DISP=(SHR,KEEP)
//*COMPLETE DD DSN=U11459A.COMPLETE.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD20,SPACE=(TRK,(5,1)),DCB=(LRECL=250,BLKSIZE=6000,
//* RECFM=FB)
//*GRADFILE DD DSN=U11459A.NAME.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD20,SPACE=(TRK,(5,1)),
//* DCB=(LRECL=250,BLKSIZE=6000,RECFM=FB)
//*
//* ++++++++  RUN SAS PROGRAM  ++++++++++++++++++++++++++++++++++++
//*
//SYSIN DD *
OPTIONS       NODATE NONUMBER;
DATA SOIL; TITLE;
  INFILE DATA1 MISSOVER;
**********  READ DATA FROM SOIL.DATA  ++++++++++++++++++++++++++++;
  INPUT       EXP_NO $ SLABNO  REF_NO $     REPTRT   DEPTH $
    S_UREA    S_NH4   S_NO2   S_NO3   S_ORG_N  S_TOTN      S_P
    S_K       S_CA    S_MG    S_S     S_FE     S_ZN        S_MN
    S_CU      S_B     S_MO    S_CL    S_NA     S_AL        S_EC
    S_OM      S_PH    S_BI    S_HCO3  S_CO3;
PROC SORT; BY REF_NO REPTRT;
```

```
PROC PRINT; ID REPTRT; TITLE '++++  DATA READ FROM SOIL.DATA  ++++';
DATA PLANT; TITLE;
  INFILE DATA2 MISSOVER;
**********  READ DATA FROM PLANT.DATA  ++++++++++++++++++++++++++;
  INPUT     EXP_NO $ LABNO REF_NO $ PART $    REPTRT
    PCT_N   P       K        CA        MG
    S       FE      ZN       MN        CU        B         MO
    CL      NA      AL       CHLOR     NO3;
PROC SORT; BY REF_NO REPTRT;
PROC PRINT; ID REPTRT; TITLE '++++  DATA READ FROM PLANT.DATA  ++++';
DATA FIELD; TITLE;
  INFILE DATA3 MISSOVER;
*+++++++++  READ DATA FROM FIELD.DATA  ++++++++++++++++++++++++++;
  INPUT REF_NO $  REPTRT  EXP_NO $  PLOT_D1  PLOT_D2
        MOISTURE 5.1     KG_HA 6. +1  SMK   ETC;
PROC SORT; BY REF_NO REPTRT;
PROC PRINT; ID REPTRT;  TITLE '++++  DATA READ FROM FIELD.DATA  ++++';
*+++++++  CLIST MODIFIES NEXT LINE FOR PROPER MERGING  ++++++++++;
DATA TOGETHER; MERGE SOIL(IN=IN1) PLANT(IN=IN2) FIELD(IN=IN3); '
  BY REF_NO REPTRT;
*+++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++;
*++++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++;
*++++++++++       EDWARD A HANLON, JR        ++++++++++++++++++++;
*++++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++;
*++++++++++     WRITTEN PERMISSION           ++++++++++++++++++++;
*++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
*+++  CLIST MODIFIES NEXT LINE TO SELECT DATA BY REF_NO  ++++++++;
  *IF REF_NO='1000';
  RETAIN COUNT;
  IF _N_=1 THEN COUNT=1;
    FILE PRINT;
*+++++++  CLIST MODIFIES NEXT LINE TO DETECT MISSING DATA  ++++++;
  IF IN1=0 OR IN2=0 OR IN3=0 THEN DO;
*+++++++  PRINT NOTICE IF ONE OR MORE DATA PARTS MISSING  +++++++;
    IF COUNT=1 THEN PUT _PAGE_ @25 'FOLLOWING DATA DID NOT MATCH' //;
      PUT @1 'ONE OR MORE DATA PARTS MISSING FOR ' REF_NO REPTRT ;
      COUNT=COUNT+1;
      DELETE;
        END;
*+++++++++++  WRITE DATA TO COMPLETE.DATA  ++++++++++++++++++++++;
  FILE COMPLETE;
    PUT        SLABNO   REPTRT   DEPTH $
      S_UREA   S_NH4    S_NO2    S_NO3    S_ORG_N  S_TOTN      S_P
      S_K      S_CA     S_MG     S_S      S_FE     S_ZN        S_MN
      S_CU     S_B      S_MO     S_CL     S_NA     S_AL        S_EC
      S_OM     S_PH     S_BI     S_HCO3   S_CO3
      LABNO    PART $   PCT_N    P        K        CA        MG
      S        FE       ZN       MN       CU       B         MO
```

```
          CL        NA       AL       CHLOR    NO3
          EXP_NO $           REF_NO $          PLOT_D1  PLOT_D2
          MOISTURE 5.1       KG_HA 6. +1       SMK      ETC;
          IF DEPTH=' ' THEN DEPTH='O';
  *FILE GRADFILE;
  *  PUT            SLABNO   REPTRT    DEPTH $
          S_UREA    S_NH4    S_NO2    S_NO3    S_ORG_N  S_TOTN       S_P
          S_K       S_CA     S_MG     S_S      S_FE     S_ZN         S_MN
          S_CU      S_B      S_MO     S_CL     S_NA     S_AL         S_EC
          S_OM      S_PH     S_BI     S_HCO3   S_CO3
          LABNO     PART $   PCT_N    P        K        CA         MG
          S         FE       ZN       MN       CU       B          MO
          CL        NA       AL       CHLOR    NO3
          EXP_NO $           REF_NO $          PLOT_D1  PLOT_D2
          MOISTURE 5.1       KG_HA 6. +1       SMK      ETC;
          IF DEPTH=' ' THEN DEPTH='O';
PROC PRINT; ID SLABNO;
  TITLE '++++  DATA WRITTEN TO COMPLETE.DATA  ++++';
*++++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++++;
*+++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++++;
*+++++++++++       EDWARD A HANLON, JR        +++++++++++++++++++++;
*+++++++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++++;
*+++++++++++     WRITTEN PERMISSION           +++++++++++++++++++++;
*++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//
/*EOF
```

-

STORAGE PROGRAM

```
//D11459LC JOB (11459,DES-CR-IPT1),HANLON,TIME=(0,25),CLASS=B,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
/*MESSAGE MOUNT TAPE T2669 NFP  T2670 NFP T4981 NFP
//*
/*ROUTE  PRINT RMT4
//*
//* +++++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++
//* ++++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++++
//* ++++++++++       EDWARD A HANLON, JR        ++++++++++++++++++++++
//* ++++++++++    USE OF THIS PROGRAM REQUIRES  ++++++++++++++++++++++
//* ++++++++++      WRITTEN PERMISSION          ++++++++++++++++++++++
//* +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
//*
//* ++++++++++  BATCH JOB STORED IN CALCULAT(STORAGE)  +++++++++++++++
//*
//   EXEC SAS
//*
//* ++++++++++  READ NEW DATA FROM COMPLETE.DATA  ++++++++++++++++++++
//*
//DATAIN DD DSN=U11459A.COMPLETE.DATA,DISP=(SHR,KEEP)
//*
//* +++  READ DESCRIPTORS FROM INPUT(DESCRIPT)  +++++++++++++++++++++
//*
//DESCRIPT DD DSN=U11459A.INPUT(DESCRIPT),DISP=(OLD,KEEP)
//*
//* ++  WRITE NEW DATA WITH DESCRIPTORS TO STOREXX.DATA  ++++++++++++
//*
//*LINEOUT DD DSN=U11459A.STOREXX.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(50,10))
//*
//* ++  READ OLD DATA FROM CLIST SPECIFIED TAPE  ++++++++++++++++++++
//*
//OLDDATA DD DSN=STORAGEX.DATA,DISP=(OLD,PASS),UNIT=TAPE,
// VOL=SER=TXXXX
//*
//* ++  WRITE CONCATENATED DATA TO CLIST SPECIFIED TAPE  ++++++++++++
//*
//STORE DD DSN=STORAGEY.DATA,DISP=(NEW,PASS),UNIT=TAPE,
// VOL=SER=TYYYY
//*
//* +++++++++  RUN SAS PROGRAM  ++++++++++++++++++++++++++++++++++++++
//*
//SYSIN DD *
OPTIONS       NODATE NONUMBER;
DATA ONE; TITLE;
  INFILE DATAIN MISSOVER;
*++++++++++  READ DATA FROM COMPLETE.DATA  +++++++++++++++++++++++++;
```

```
    INPUT       SLABNO   REP 1.   TRT 2.   DEPTH $
      S_UREA    S_NH4    S_NO2    S_NO3    S_ORG_N  S_TOTN       S_P
      S_K       S_CA     S_MG     S_S      S_FE     S_ZN         S_MN
      S_CU      S_B      S_MO     S_CL     S_NA     S_AL         S_EC
      S_OM      S_PH     S_BI     S_HCO3   S_CO3
      LABNO     PART $   PCT_N    P        K        CA           MG
      S         FE       ZN       MN       CU       B            MO
      CL        NA       AL       CHLOR    NO3
      EXP_NO $           CREF_NO $         PLOT_D1  PLOT_D2
      MOISTURE 5.1       KG_HA 6.  +1      SMK      ETC;
PROC SORT; BY EXP_NO TRT;
PROC PRINT; ID EXP_NO; TITLE '++++  DATA FROM COMPLETE.DATA  ++++';
DATA TWO; TITLE;
  INFILE DESCRIPT MISSOVER;
*++++++++ DECLARE EXPERIMENT AND TREATMENT DESCRIPTORS  ++++++++++;
  ARRAY EXP (I) $12 INITIALS CROP CROPYEAR LOCATION EXP_NO
    REF_NO TITLE DATEINIT VARIETY SEEDRATE FERTDATE
    PLNTDATE HARV_NO HARVDATE COMMENT;
  ARRAY TREAT (J) $12 N_SORS P_SORS K_SORS S_SORS
    CA_SORS MG_SORS FE_SORS MN_SORS ZN_SORS CU_SORS
    B_SORS MO_SORS LIMESORS GYP_SORS HERBSORS
    FUNGSORS INHISORS
    SORS_18 SORS_19 SORS_20 SORS_21 SORS_22 SORS_23 SORS_24
    SORS_25 SORS_26 SORS_27 SORS_28 SORS_29 SORS_30
    N_RATE P_RATE K_RATE S_RATE CA_RATE MG_RATE
    FE_RATE MN_RATE ZN_RATE CU_RATE B_RATE MO_RATE
    LIMERATE GYP_RATE HERBRATE FUNGRATE INHIRATE
    RATE_48 RATE_49 RATE_50 RATE_51 RATE_52 RATE_53 RATE_54
    RATE_55 RATE_56 RATE_57 RATE_58 RATE_59 RATE_60
    N_METH P_METH K_METH S_METH CA_METH MG_METH
    FE_METH MN_METH ZN_METH CU_METH B_METH MO_METH
    LIMEMETH GYP_METH HERBMETH FUNGMETH
    INHIMETH TIL_METH
    METH_79 METH_80 METH_81 METH_82 METH_83 METH_84 METH_85
    METH_86 METH_87 METH_88 METH_89 METH_90
    ATM_EXS SORS_15N
    N15_101 N15_102 N15_103 N15_104 N15_105 N15_107 N15_108
    N15_109 N15_110
    GRC_TEMP TEMPDUR;
  RETAIN INITIALS CROP CROPYEAR LOCATION EXP_NO
    REF_NO TITLE DATEINIT VARIETY SEEDRATE FERTDATE
    PLNTDATE HARV_NO HARVDATE COMMENT;
  DROP I J;
*++++++++++  READ DATA FROM INPUT(DESCRIPT)  ++++++++++++++++++++++;
  IF _N_ NE 1 THEN GO TO TRT_READ;
  DO OVER EXP;
    INPUT I @;
    IF I=. THEN GO TO OUT;
```

```
    INPUT EXP @;
      END;
  OUT: RETURN;
  TRT_READ: INPUT TRT @;
  DO OVER TREAT;
    INPUT J @;
    IF J=. THEN GO TO DONE;
    INPUT TREAT @;
      END;
  DONE: OUTPUT;
***********************  ATTENTION  *****************************;
*************  THIS PROGRAM IS COPYRIGHTED BY  ********************;
*************       EDWARD A HANLON, JR        ********************;
*************    USE OF THIS PROGRAM REQUIRES  ********************;
*************      WRITTEN PERMISSION          ********************;
******************************************************************;
PROC SORT; BY EXP_NO TRT;
PROC PRINT; ID EXP_NO; TITLE '++++  INPUT(DESCRIPT) DATA  ++++';
DATA LINEOUT.STORAGE;  MERGE ONE(IN=IN1) TWO(IN=IN2);
*+++++  COMBINE DESCRIPTIVE VARIABLES WITH COMPLETED DATA  ++++++++;
  BY EXP_NO TRT;
  IF CREF_NO=REF_NO;
  DROP CREF_NO;
PROC PRINT; ID EXP_NO;
  TITLE '++++  NEW INFORMATION WRITTEN TO TAPE  ++++';
DATA THREE;
*+++++  READ DATA FROM MOST CURRENT TAPE  ++++++++++++++++++++++++;
  SET OLDDATA.STORAGE;
DATA STORE.STORAGE;
*+++++  ADD NEW LINES TO THE MAIN BODY OF DATA  +++++++++++++++++++;
  SET LINEOUT.STORAGE THREE;
*+++++  END OF FIRST SAS PROGRAM.  NEXT PART WILL COPY TAPES  +++++;
//  EXEC SAS,COND=(1,LT)
//*
//* ++  READ DATA FROM NEWLY CREATED TAPE FILE  ++++++++++++++++++++
//*
//NEWLINE DD DSN=STORAGEZ.DATA,DISP=(OLD,KEEP),UNIT=TAPE,
// VOL=SER=TZZZZ
//*
//* ++  COPY NEW TAPE FILE TO BACKUP TAPE  ++++++++++++++++++++++++
//*
//COPYOUT DD DSN=BACKUP.DATA,DISP=(NEW,KEEP),UNIT=TAPE,
// VOL=SER=T4981
//*
//* +++++++++  RUN SAS COPY PROCEDURE  ++++++++++++++++++++++++++++
PROC COPY IN=NEWLINE OUT=COPYOUT;
***********************  ATTENTION  *****************************;
*************  THIS PROGRAM IS COPYRIGHTED BY  ********************;
```

```
*+++++++++++++        EDWARD A HANLON, JR         +++++++++++++++++++++;
*+++++++++++++     USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++++;
*+++++++++++++       WRITTEN PERMISSION           +++++++++++++++++++++;
*+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//*
/*EOF
```

RETRIEVAL PROGRAM

```
//R11459TV JOB (11459,RET-RI-EVE1),HANLON,TIME=(0,25),CLASS=B,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
/*MESSAGE MOUNT TAPE   T4981  FP
//*
/*ROUTE  PRINT RMT4
//*
//* +++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++
//* +++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++
//* +++++++++       EDWARD A HANLON, JR        ++++++++++++++++++++
//* +++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++
//* +++++++++      WRITTEN PERMISSION          ++++++++++++++++++++
//* +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
//*
//* +++++++++  BATCH JOB STORED IN RETRIEVE.CNTL  +++++++++++++++++
//*
//   EXEC SAS
//*
//* ++++++++++++  READ DISK FILES  +++++++++++++++++++++++++++++++++
//*
//*       NORMALLY THE RETRIEVE PROGRAM WILL BE USED WITH TAPES.
//*       USE THIS OPTION ONLY IF DATA TO BE SEARCHED IS ON DISK.
//*       SPECIFY THE DISK FILE TO BE USED BY REMOVING THE "*" FROM
//*       FROM THE FOLLOWING TWO LINES AND CHANGE THE 'XX'
//*       CHARACTERS TO THE DIGITS THAT DESCRIBE THE CORRECT DISK
//*       DATA SET NAME.
//*
//*INFOIN DD DSN=U11459A.STOREXX.DATA,DISP=(OLD,KEEP),UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(50,10))
//*
//* ++++++++++++  READ TAPE FILES  +++++++++++++++++++++++++++++++++
//*
//*     SPECIFY THAT A TAPE IS TO BE READ BY REMOVING THE "*"
//*       FROM THE TWO LINES BELOW.
//*
//*INFOIN DD DSN=BACKUP.DATA,DISP=(OLD,KEEP),UNIT=TAPE,
//* VOL=SER=T4981
//*
//* ++++++  SELECT NAME OF OUTPUT FILE  +++++++++++++++++++++++++++
//*
//*    1). CHANGE YYYYXXXX TO DESIRED FILE NAME.  A NEW DISK
//*        FILE MUST BE BUILT EVERY TIME YOU RUN THE RETRIEVAL
//*        PROGRAM.  IF YOU WANT TO MERGE TWO DATA SETS THAT
//*        WERE GENERATED BY THIS PROGRAM, YOU MUST USE A
//*        SAS PROGRAM TO DO THE MERGING OPERATION.  IF YOU
//*        FAIL TO SPECIFY A NAME THEN THE DATA WILL BE STORED
//*        IN A FILE NAMED "YYYYXXXX.DATA".
//*    2). IF THE PROGRAM CANNOT ALLOCATE SPACE ON THE SPECIFIED
```

```
//*        DISK, CHANGE THE PHRASE "DASD40" TO "SYSTSO" OR OTHER
//*        DISK DRIVE NAME.  A LISTING CAN BE FOUND IN THE
//*        UCC OPERATIONS MANUAL OR BY CALLING X6301.
//*
//*RETRIEVE DD DSN=U11459A.YYYYXXXX.DATA,DISP=(NEW,CATLG),UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(50,10))
//*
//* ++++++++  RUN SAS PROGRAM  ++++++++++++++++++++++++++++++++++++
//SYSIN DD *
OPTIONS       NODATE NONUMBER;
*+++++++++++++++++++  ATTENTION  ++++++++++++++++++++++++++++++++;
*++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  +++++++++++++++++++;
*++++++++++++       EDWARD A HANLON, JR        +++++++++++++++++++;
*++++++++++++   USE OF THIS PROGRAM REQUIRES   +++++++++++++++++++;
*++++++++++++      WRITTEN PERMISSION          +++++++++++++++++++;
*+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
*+++++++++  READ DATA FROM DISK OR TAPE  ++++++++++++++++++++++++;
DATA ONE; SET INFOIN.STORAGE; TITLE;
*+++++++++  SELECT DESIRED DATA FROM TAPE OR DISK  +++++++++++++++++;
*                                                                ;
*  USE THE SPECIFIED IF STATEMENTS AS A FORMAT.                  ;
*     1).  REMOVE THE "*" FROM THE FRONT OF THE LINE.            ;
*     2).  SELECT THE VARIABLE NAME FROM THE FOLLOWING LIST.     ;
*   VARIABLE   DESCRIPTION         VARIABLE   DESCRIPTION        ;
*   INITIALS   LAB WORKER          CROP       CROP GROWN         ;
*   CROPYEAR   CROP YEAR           LOCATION   LOCATION           ;
*   EXP_NO     EXPERIMENT #        REF_NO     REFERENCE #        ;
*   TITLE      TITLE               DATEINIT   DATE STUDY INITIATED ;
*   VARIETY    VARIETY             SEEDRATE   SEED RATE          ;
*   FERTDATE   DATE FERTILIZED     PLNTDATE   PLANTING DATE      ;
*   HARV_NO    HARVEST #           HARVDATE   HARVEST DATE       ;
*   UNITS      UNITS REPORTED                                    ;
*   N_SORS     N SOURCE            P_SORS     P SOURCE           ;
*   K_SORS     K SOURCE            S_SORS     S SOURCE           ;
*   CA_SORS    CA SOURCE           MG_SORS    MG SOURCE          ;
*   FE_SORS    FE SOURCE           MN_SORS    MN SOURCE          ;
*   ZN_SORS    ZN SOURCE           CU_SORS    CU SOURCE          ;
*   B_SORS     B SOURCE            MO_SORS    MO SOURCE          ;
*   LIMESORS   LIME SOURCE         GYP_SORS   GYPSUM SOURCE      ;
*   HERBSORS   HERBICIDE SOURCE    FUNGSORS   FUNGICIDE SOURCE   ;
*   INHISORS   INHIBITOR SOURCE                                  ;
*   N_RATE     N RATE              P_RATE     P RATE             ;
*   K_RATE     K RATE              S_RATE     S RATE             ;
*   CA_RATE    CA RATE             MG_RATE    MG RATE            ;
*   FE_RATE    FE RATE             MN_RATE    MN RATE            ;
*   ZN_RATE    ZN RATE             CU_RATE    CU RATE            ;
*   B_RATE     B RATE              MO_RATE    MO RATE            ;
*   LIMERATE   LIME RATE           GYP_RATE   GYPSUM RATE        ;
```

```
*   HERBRATE   HERBICIDE RATE     FUNGRATE   FUNGICIDE RATE       ;
*   INHIRATE   INHIBITOR RATE                                     ;
*   N_METH     N METHOD           P_METH     P METHOD             ;
*   K_METH     K METHOD           S_METH     S METHOD             ;
*   CA_METH    CA METHOD          MG_METH    MG METHOD            ;
*   FE_METH    FE METHOD          MN_METH    MN METHOD            ;
*   ZN_METH    ZN METHOD          CU_METH    CU METHOD            ;
*   B_METH     B METHOD           MO_METH    MO METHOD            ;
*   LIMEMETH   LIME METHOD        GYP_METH   GYPSUM METHOD        ;
*   HERBMETH   HERBICIDE METHOD   FUNGMETH   FUNGICIDE METHOD     ;
*   INHIMETH   INHIBITOR METHOD   TIL_METH   TILLAGE METHOD       ;
*   ATM_EXS    ATOM % EXCESS      SORS_15N   SOURCE OF 15N        ;
*   GRC_TEMP   GROW CHAMB. TEMP.  TEMPDUR    TEMPERATURE DURATION ;
*      3).  SELECT THE VALUE OF THE VARIABLE BY CONSULTING THE    ;
*             OPERATIONS MANUAL LOG. FOR EXAMPLE:                 ;
*                   CROP='BERMUDAGRASS'.                          ;
*             WHERE CROP IS THE VARIABLE NAME AND THE             ;
*             CHARACTER STRING 'BERMUDAGRASS' IS THE VALUE.       ;
*             IF THE CHARACTER STRING WAS ENTERED AS:        '    ;
*             'BERMUDA' THEN NO DATA WITH THAT VALUE WOULD        ;
*             BE FOUND.                                           ;
*             ALL VARIABLES ARE CHARACTER VARIABLES, NOT          ;
*             NUMERIC, SO "IF" STATEMENTS, SUCH AS IN THE         ;
*             FOLLOWING LINES NOT ALLOWED, THE PROGRAM WILL       ;
*             FAIL.                                               ;
*               EG. 1)    N_RATE=20.                              ;
*               EG. 2)    0 LE P_RATE LE 100.                     ;
*                                                                 ;
*+++++++++  SELECT DESIRED DATA FROM DISK OR TAPE  +++++++++++++++;
*                                                                 ;
*IF CROP='WHEAT' OR CROP='BERMUDAGRASS';
*IF N_SORS='APP';
*IF EXP_NO='EXP222';
*IF REF_NO='HBP6';
*                                                                 ;
PROC PRINT;  TITLE '++++  INFORMATION RETRIEVED  ++++';
DATA RETRIEVE.RETRIEVE; SET ONE;
PROC PRINT; ID EXP_NO;
  TITLE '++++  INFORMATION WRITTEN TO DISK  ++++';
++++++++++++++++++++++  ATTENTION  +++++++++++++++++++++++++++++++++;
+++++++++++++  THIS PROGRAM IS COPYRIGHTED BY  ++++++++++++++++++++;
+++++++++++++       EDWARD A HANLON, JR        ++++++++++++++++++++;
+++++++++++++   USE OF THIS PROGRAM REQUIRES   ++++++++++++++++++++;
+++++++++++++      WRITTEN PERMISSION          ++++++++++++++++++++;
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++;
//
/*EOF
```

MOVE PROGRAM

```
//M11459VE JOB (11459,MOV-EI-TNOW),HANLON,TIME=(0,25),CLASS=A,
// MSGCLASS=A,NOTIFY=U11459A
/*PASSWORD ?
/*ROUTE  PRINT RMT4
//* ++++  BATCH JOB STORED IN CALCULAT(MOVE)  +++++++++++++++++++++
//*
//   EXEC SAS
//*
//* +++++++++  READ DATA FROM USER SPECIFIED FILES  +++++++++++++++
//*
//*READONE   DD DSN=UXXXXXA.XXXXXXXX.DATA,DISP=(OLD,KEEP)
//*READTWO   DD DSN=UXXXXXA.XXXXXXXX.DATA,DISP=(OLD,KEEP)
//*READTHRE  DD DSN=UXXXXXA.XXXXXXXX.DATA,DISP=(OLD,KEEP)
//*READFOUR  DD DSN=UXXXXXA.XXXXXXXX.DATA,DISP=(OLD,KEEP)
//*
//* ++++++++  WRITE DATA TO INPUT PLANT FILES  ++++++++++++++++++++
//*
//*PLNT1  DD DSN=U11459A.INPUT(PLNT1),DISP=(MOD,KEEP)
//*PLNT2  DD DSN=U11459A.INPUT(PLNT2),DISP=(MOD,KEEP)
//*
//* +++++++  WRITE DATA TO INPUT SOIL FILES  ++++++++++++++++++++++
//*
//*SOIL1  DD DSN=U11459A.INPUT(SOIL1),DISP=(MOD,KEEP)
//*SOIL2  DD DSN=U11459A.INPUT(SOIL2),DISP=(MOD,KEEP)
//*SOIL3  DD DSN=U11459A.INPUT(SOIL3),DISP=(MOD,KEEP)
//*
//* ++++++++  WRITE DATA TO PLANT.DATA  +++++++++++++++++++++++++++
//*
//*PLNTOUT DD DSN=U11459A.PLANT.DATA,DISP=(MOD,KEEP)
//*
//* ++++++++  WRITE DATA TO FIELD.DATA  +++++++++++++++++++++++++++
//*
//*FLDOUT DD DSN=U11459A.FIELD.DATA,DISP=(MOD,KEEP)
//*
//* ++++++++  WRITE DATA TO SOIL.DATA  ++++++++++++++++++++++++++++
//*
//*SOILOUT DD DSN=U11459A.SOIL.DATA,DISP=(MOD,KEEP)
//*
//* ++++++  WRITE DATA TO COMPLETE.DATA  ++++++++++++++++++++++++++
//*
//*COMPOUT DD DSN=U11459A.COMPLETE.DATA,DISP=(MOD,KEEP)
//*
//* ++++++++  RUN SAS PROGRAM  ++++++++++++++++++++++++++++++++++++
//SYSIN DD *
OPTIONS             NODATE NONUMBER;
*DATA ONE; TITLE;
*                                                                ;
*+++++  READ DATA FROM FIRST USER DATA SET  +++++++++++++++++++++;
```

```
*                                                                      ;
* INFILE READONE MISSOVER;
******  ENTER INPUT VARIABLE LISTING BEFORE RUNNING PROGRAM  ******;
*    INPUT                                                    ;
*************  SET OTHER VARIABLES  ******************************;
*        MOISTURE=.;
*        EXP_NO=Z;
*        SMK=.;
*        ETC=.;
*        PLOT_D1=X;
*        PLOT_D2=XX;
*        BAG=0;
******  CONVERSION FROM PLOT SIZE TO KG/HA (WET WEIGHT BASIS)  ****;
*    PLOT_WT=PLOT_WT*0.1;
*    KG_HA=(PLOT_WT*1.12 *43560)/(PLOT_D1*PLOT_D2);
***********  PERCENT MOISTURE CALCULATION  **********************;
*    IF BAG LE 0 THEN BAG=0;
*    MOISTURE=(WET-DRY)*100/(WET-BAG);
******  CONVERSION FROM KG/HA WET WEIGHT TO DRY WEIGHT  **********;
*    DRY_MAT=1-(MOISTURE/100);
*    KG_HA=KG_HA*DRY_MAT;
******  SORT DATA BY SPECIFIED VARIABLES  ************************;
*PROC SORT; *BY REF_NO EXP_NO REPTRT;
*DATA TWO; TITLE;
*                                                                      ;
******  READ DATA FROM SECOND USER DATA SET  *********************;
*                                                                      ;
* INFILE READTWO MISSOVER;
******  ENTER INPUT VARIABLE LISTING BEFORE RUNNING PROGRAM  ******;
*   INPUT                                                  ;
*****************  ADJUST DECIMAL, PPM  **************************;
*  PCT_N=PCT_N*.01;
*  P=PCT_P*10;
*  K=PCT_K*100;
**********  SET ALL UNNEEDED VARIABLES TO "."  *******************;
*  ARRAY MISSING LABNO PCT_N P K CA MG S FE ZN MN CU B MO CL
*    NA AL CHLOR NO3;
*  DO OVER MISSING;
*    IF MISSING LT 0 THEN MISSING=.;
*      END;
*    PART ='    ';
******  SORT DATA BY SPECIFIED VARIABLES  ***********************;
*PROC SORT; *BY REF_NO EXP_NO REPTRT;
*DATA THRE; TITLE;
*        ;
********  READ DATA FROM THIRD USER DATA SET  ********************;
*                                                                     ;
*  INFILE READTHRE MISSOVER;
```

```
*++++++  ENTER INPUT VARIABLE LISTING BEFORE RUNNING PROGRAM  ++++;
*    INPUT                                                         ;
*++++++++++  SET OTHER VARIABLES  ++++++++++++++++++++++++++++++++;
*    DEPTH='   ';
*    S_P=LB_P/2.0;
*    S_K=LB_K/2.0;
*    S_NO3=LB_NO3_N/2.0;
*    S_PH=PH*0.1;
*    S_BI=BI*0.1;
*++++++++++  SET ALL UNNEEDED VARIABLES TO "."  ++++++++++++++++++;
*  ARRAY MISSING SLABNO REPTRT          S_UREA  SNH4
*                S_NO2  S_NO3  S_ORG_N  S_TOTN  S_P S_K
*                S_CA   S_MG   S_S      S_FE S_ZN    S_MN
*                S_CU   S_B    S_MO     S_CL    S_NA    S_AL
*                S_EC   S_OM   S_PH     S_BI   S_HCO3   S_CO3;
*  DO OVER MISSING;
*    IF MISSING LT 0 THEN MISSING=.;
*      END;
*    REF_NO='1000';
*+++++  SORT DATA BY SPECIFIED VARIABLES  +++++++++++++++++++++++;
*PROC SORT; *BY REF_NO REPTRT;
*+++++++++  MERGE DATA INTO ONE DATA SET  +++++++++++++++++++++++;
*                                                                 ;
*++++  SELECT DATA LINES TO BE WRITTEN BY REF_NO  +++++++++++++++;
*   IF REF_NO='1000';
*                                                                 ;
*DATA TEN; *MERGE ONE(IN=IN1) TWO(IN=IN2);
*  BY REF_NO EXP_NO REPTRT;
*+++++++++++++++++++  ADJUST DECIMAL, PPM  +++++++++++++++++++++;
*  P=PCT_P*10 ;
*  K=PCT_K*100 ;
*+++++++++  SET ALL UNNEEDED VARIABLES TO "."  +++++++++++++++++++;
*  ARRAY MISSING LABNO PCT_N P K CA MG S FE ZN MN CU B MO CL
*    NA AL CHLOR NO3;
*  DO OVER MISSING;
*    IF MISSING LT 0 THEN MISSING=.;
*      END;
*   PART='ZZZZ';
*                                                                 ;
*+++++++++  WRITE DATA TO USER SPECIFED DISK FILE  +++++++++++++++;
*                                                                 ;
*+++++++++  WRITE DATA TO  INPUT(PLANT1)  +++++++++++++++++++++++;
*  FILE PLNT1;
*    PUT       EXP_NO $  REF_NO $ LABNO    PART $
*    REPTRT    N_WT      P_WT     N_BLK    NH4_1     NH4_2
*    P_1       P_2       K_1      K_2      FE_1      FE_2
*    ZN_1      ZN_2      MN_1     MN_2     @1 LINE $ 104.;
*+++++++++  WRITE DATA TO  INPUT(PLANT2)  +++++++++++++++++++++++;
```

```
*  FILE PLNT2;
*    PUT   LABNO     NO3      CL       NA1      NA2      AL1      AL2
*      CA1 CA2       MG1      MG2      S1       S2       CU1      CU2
*      B1  B2        MO1      MO2      CHLOR    @1 ALLLINE $ 104.;
************  WRITE DATA TO PLANT.DATA  ++++++++++++++++++++++++++;
*  FILE PLNTOUT;
*    PUT EXP_NO $ LABNO REF_NO $     PART $        REPTRT
*      PCT_N 5.2 +1     P     K      CA      MG      S      FE     ZN
*      MN   CU     B     MO    CL     NA      AL      CHLOR        NO3;
++++++++++++  WRITE DATA TO SOIL.DATA  ++++++++++++++++++++++++++;
*  DATA SIX; *SET THRE;
*   FILE SOILOUT;
*     PUT EXP_NO $ SLABNO  REF_NO $ REPTRT   DEPTH $    S_UREA
*         SNH4     S_NO2    S_NO3    S_ORG_N    S_TOTN    S_P
*                  S_K      S_CA     S_MG       S_S       S_FE
*                  S_ZN     S_MN     S_CU       S_B       S_MO
*                  S_CL     S_NA     S_AL       S_EC      S_OM
*                  S_PH     S_BI     S_HCO3     S_CO3;
*DATA TO_FILE; *SET THRE;
*+++++++  WRITE CALCULATED DATA TO FIELD.DATA  ++++++++++++++++++;
*  FILE FLDOUT;
*    PUT REF_NO $  REPTRT EXP_NO $  PLOT_D1  PLOT_D2  MOISTURE 5.1
*      KG_HA 6. +1 SMK  ETC;
PROC PRINT; ID REPTRT; TITLE '++++  COMPOSITE DATA  ++++';
*++++++++  PROGRAM BY ED HANLON  ++++++++++++++++++++++++++++++++;
//
/*EOF
```

PART III

USER'S MANUAL FOR A COMPUTER ASSISTED DATA MANAGEMENT SYSTEM

ABSTRACT

Efficient management of data collected in laboratory, greenhouse and field experiments is essential in any research program. This manual provides detailed instruction for use of a data management system which provides a user friendly method for worksheet generation, data entry, data calculations, data storage and data retrieval. The data management system, using an IBM computer, presents the user with a series of menu options to simplify all data handling. This data management system has been designed for soil fertility research programs but can be adapted to other agronomic disciplines.

INTRODUCTION

The primary objective for development of this manual was to provide a guide for organized flow of laboratory, greenhouse and field data through the entire data collection system in a soil fertility research program. Data transmitted through the system can be used efficiently and effectively within current studies and be available to augment future experiments. All data will be in the proper format for storage and retrieval from tape files. The system is designed to be user friendly, i.e., the user need not be a computer expert nor a programmer to implement the various components of this data management system (DMS). All data entered can be retrieved and reused at any time, thus providing greater flexibility for selection of particular data sets when analyzing experimental results.

The entire DMS consists of many programs which are not directly accessible to the user when within the DMS. These programs are controlled by user prompting "CLISTS" (pronounced See-List), a type of program written in TSO command language that guides the user through the selection of programs and parameters the user chooses via computer terminal inputs. Various worksheets can be generated by using SHEET.CLIST. The CLIST will generate: soil worksheets 1 through 3, plant worksheets 1 and 2, or field worksheets for forage, grain or peanut results.

The use of CALC.CLIST allows data that has been stored in its raw form to be converted to IS units and formatted for future storage operations. The CLIST will calculate information supplied either from soil, plant, or field worksheets. There is also a merge portion that allows the data from any two or three information types to be written to one data set by matching replication and treatment numbers.

Lastly, by using the storage portion, the user can add descriptive parameters to the data and either store the data on tapes or retrieve previously stored data.

CLIST Function and Operation

The CLIST is an interactive command program that will prompt the user with specific questions on the user's terminal display. The use of a CLIST requires that the user be able to log on to TSO, the text editor of the IBM system. Since the requirements for log on and use of TSO are different for each terminal, this manual will not cover the log on procedures. Please consult the manuals provided with the terminal you will be using.

Once in the READY mode, the command EXEC, a blank space and then the name of the CLIST to be run, should be entered. Inspect the encoded line before using the enter or return key to start the CLIST. If there is a mistake, use the back space key to move the cursor to the mistake and retype the remainder of the line.

Examples of a properly executed CLIST:

READY

exec sheet.clist__ Enter key.

+++ OR +++

READY

exec sheet__ Enter key.

Note the omission of the character string ".CLIST" in the second example above. Using this form is acceptable because the computer expects to execute only CLIST command programs and automatically appends the ".CLIST" ending to the given name "SHEET".

If the user gives an incorrect response during CLIST operation, the CLIST will return to the same spot in the display to allow the user to enter the correct choice. For example:

```
WHAT TYPE OF FORM DO YOU WANT(SOIL, PLANT OR FIELD)?  ===> __
```

The above line is the first display from SHEET.CLIST. It gives the user a choice of SOIL, PLANT or FIELD to be entered after the arrow. The cursor (the two underscore lines at the right side of the arrow) is positioned so that one of the three choices can be entered. After entering the correct choice, the user must depress the enter or return key.

```
     Eg.:
 ===> SOIL__                              press  Enter key
```

Later in this manual all required responses for each CLIST will be given. To assist the user a checklist for each CLIST has been prepared. The checklist is a worksheet that contains all the choices or options contained within the CLIST. The user should enter the desired responses on the checklist before running the CLIST. Refer to the appropriate checklist before using the CLIST programs so that correct responses can be made rapidly. Use of the break or interrupt key will allow the user to exit the CLIST at any time. In some cases, such as when the CLIST is editing another program, it will be necessary to use the break or interrupt key twice in succession to return to the READY mode. Examples of this procedure will be given later. If for any reason the CLIST fails to work properly, an explanation will appear on the screen. Record this information, just as it appears on the screen, to help with diagnosing the problem. Use the break or interrupt key to return to the READY mode.

After entering all required responses,the user will experience a short delay. During this time, the CLIST is modifying the appropriate program with the new information. While these modifications are being made, each change to the program will be listed on the screen. After all changes have been made, the CLIST will automatically submit the modified program. Each program is protected by a password, called a batch password, that is different from the password that allowed access to TSO. If the user fails to enter the correct password, the computer system will not process this program.

The computer system will verify the password and assign a job number to the program. Additionally, the computer system will list the job name that has been specified in the programming. Record both the job name and job number. This information can be used to locate the job within the computer system or after printing.

Infrequently, the CLIST may not be able to change certain data within the selected program. Instead of listing the correct changed response, the screen will contain a computer generated message. Record this message as it appears and use the break or interrupt key to return to the READY mode.

Examples of CLIST modification to program:

```
.
.
.
C 1200 ICOPY=20
C 1400 INUM=8560
C 5800 ITRT=25
ENTER FOUR DIGIT PASSWORD CODE xxxx__                  Enter key.
DIRTPAGE JOB(1203) SUBMITTED
READY
```

In the preceding example, xxxx, is the four digit batch password. At some terminals, visual display of this number is suppressed and the cursor moves to indicate the location of the next digit to be typed. Some terminals may display the number on the screen. If you are using the latter type, make sure that the password cannot be read by unauthorized persons. Such a mistake can be very costly. Changes to the program are displayed in the lines starting with four digit numbers. For example, the value of ICOPY was changed by the CLIST to a value of 20 in line 1200 of the program, the user having selected that value.

Example of a CLIST failure:

.

.

.

1200 ICOPY=20

1400 INUM=8560

TEXT NOT FOUND.__

In this example the CLIST could not find line 5800 (see previous example) and wrote the message, "TEXT NOT FOUND". The user should record all of the above display and press the break or interrupt key as in the example below.

Example of using the brak key:

.

.

.

1400 INUM=8560

TEXT NOT FOUND. Break key.

! Break key.

!I

READY

SHEET.CLIST

The following discussion describes all commands found in SHEET.CLIST. This CLIST guides the user through the generation of soil, plant and/or field worksheets. A checklist for use with this portion of the DMS is found in Appendix A. The checklist is actually a worksheet for the CLIST upon which the user may enter all appropriate options or selections. Doing so will greatly speed the entry of these choices during CLIST execution and also will provide a permanent record of the selections made.

Suppose a researcher wanted to print 20 soil worksheets with a beginning laboratory number of 9500. Referring to the checklist, the word "Soil" in the first column would be circled, the number 20 would be entered in the box directly below the circled word and the beginning laboratory number 9500 would be entered in the second box down. The user notes that the third box down, marked with "Third page?" at the left, is blank. The user should enter a yes or no depending upon whether or not printing the third page is desired.

In the following examples of SHEET.CLIST, computer displays are in capital letters and user entries are in lower case.

Examples of using SHEET.CLIST:

.

.

.

```
READY
exec sheet                                              Enter key.
WHAT TYPE OF FORM DO YOU WANT(SOIL, PLANT OR FIELD)?
===> soil                                               Enter key.
YOU HAVE CHOSEN TO PRINT SOIL FORMS.
HOW MANY PAGES DO YOU WANT?(1 TO 20) ===>  30  Enter key.
```

Here the user has ignored the information in parentheses. The computer will disregard the user's entry and asks the question again.

```
YOU HAVE ASKED FOR MORE THAN 20 FORMS.  PLEASE REENTER.
HOW MANY PAGES DO YOU WANT?(1 TO 20) ===>  20
                                                        Enter key.
```

If the user had again reentered a number outside the range indicated, the entire message cycle would reoccur. The number of forms have been limited so that the forms are asked for only when needed, not just once a year, for instance. In addition, 20 pages would print lines for 400 samples.

```
WHAT IS THE BEGINNING LABNO ===> 9500          Enter key.
```

The user has chosen to start the numbering of each line at 9500. By starting here, and knowing that 20 pages are needed, the program checks to see if the final lab number will exceed 9999. In this case the final lab number will be 9899, therefore the condition of having only four digits in the lab number is satisfied. If the user had chosen to start the numbering at 9800, the system would have printed a warning and returned to the question of how many pages the user wanted. Since 10,000 - 9800 = 200 and 200/20 = 10, the maximum number of pages would be 10 pages.

Returning to the original program, where the user has asked for 20 pages and starting the lab number at 9500:

THE THIRD PAGE HAS THE FOLLOWING TITLES:
MO, CO3, HCO3, CL, B, EC, OM, AL
DO YOU WANT TO PRINT THE THIRD PAGE? (Y N) ===> y Enter key.

Usually it is best to print the third page since the information may be part of the group of analyses that are required for the experiment. However, if it is known that this information is not needed, save paper and printing costs by not asking for the third page.

At this point, the computer will modify the worksheet program with the user's responses and display the changes on the screen in coded form. If a mistake has been made, the user can stop the processing and printing of the form by entering a false password when prompted by the computer. The user may also use the break key to return to the READY mode. In the following example, the user has entered all the correct responses and has entered the correct password. The terminal will display the following lines.

Example of the final processing by SHEET.CLIST:

```
E 'U11459A.PAGE2(SOIL)' CNTL
900 ICOPY=20
1100 INUM=9500
1200 IPAGE=3
ENTER FOUR DIGIT PASSWORD: xxxx                    Enter key.
S11459PG(JOB1223) SUBMITTED
```

The display shows that the CLIST has edited the program whose name appears on single quotes, the changes are listed on the next three lines. Note that the user's selections are shown as the last numbers on each line. For example, the character string "ICOPY=20" reflects the user's choice of 20 pages of forms. A review of these parameters is normally not necessary. However, should an error occur, all these lines should be recorded to help determine the exact problem. The system has submitted job number 1233, which is called S11459PG, for printing. All forms will be printed at the OSU computer center because of the high quality printers located therein. Once the CLIST has submitted the program for printing, the CLIST will ask the user if another form is to be printed. Should another form be required, the user should respond with a yes. A no response will return the terminal to the READY mode. The display and responses for plant forms follow without comments.

```
DO YOU WANT TO PRINT ANOTHER FORM? (Y  N) ===> y
                                                   Enter key.
WHAT TYPE OF FORM DO YOU WANT(SOIL, PLANT, OR FIELD)?
===> plant                                         Enter key.
YOU HAVE CHOSEN TO PRINT PLANT FORMS.
HOW MANY PAGES DO YOU WANT?(1 TO 20) ===> 10       Enter key.
WHAT IS THE BEGINNING LABNO? ===> 1000             Enter key.
E 'U11459PGA.PAGE2(PLANT)' CNTL
900 ICOPY=10
1100 INUM=1000
ENTER FOUR DIGIT PASSWORD: xxxx                    Enter key.
P11459PG(JOB1456) SUBMITTED
DO YOU WANT TO PRINT ANOTHER FORM? (Y  N) ===> y   Enter key,
```

Job 1456, under the name of P1459PG, will now be printed at the OSU computer center.

The following is a listing of displays and sample responses for generating a forage field form. No examples for other field forms will be shown since the generation of grain and peanut field forms is similar to the plant and soil forms.

```
YOU HAVE CHOSEN TO PRINT FIELD FORMS.
HOW MANY PAGES DO YOU WANT?(1 TO 20) ===> 5        Enter key.
WHAT TYPE OF FIELD FORM?(FORAGE, GRAIN, PEANUT) ===> forage
```

```
                                                      Enter key.
HOW MANY TREATMENTS ARE THERE? (1 TO 25) ===> 15     Enter key.
E 'U11459A.PAGE2(FIELD)' CNTL
1200 ICOPY=5
1400 ITYPE=4
6900 ITRT=15
ENTER FOUR DIGIT PASSWORD: xxxx                       Enter key.
F11459PG(JOB2344) SUBMITTED
DO YOU WANT TO PRINT ANOTHER FORM? (Y  N) ===> n     Enter key.
READY
```

A SHEET.CLIST checklist for form generation is illustrated in Appendix A and the soil, plant and field worksheets are shown in Appendix B.

DATA ENTRY

All input data files are directly accessible via TSO or WYLBUR systems. Data can also be written to a floppy disk file on a microcomputer, such as the North Star, transmitted to an on line disk file, and copied into any of the input disk files. Any method selected will require that the information be entered in a specific order and format. All programs will automatically enter the decimal point so that the user needs to enter only the numbers (digits) that comprise the variable. No column format is required in any of the data sets; only a blank space need be placed between consecutive values. Each worksheet page also has a corresponding individual data set. For example, suppose a certain experiment required the use of all three types of soil forms; page one, page two and page three; and there were 50 lines of information to be entered. Since there are only 20 lines on each page, there would be three "page one" worksheets, three "page two" worksheets, etc. All "page one" worksheet data would be entered into a designated data set: UxxxxA.INPUT(SOIL1). All "page two" worksheet data would be entered into another data set: UxxxxA.INPUT(SOIL2). Likewise, "page three" data would be entered into UxxxxA.INPUT(SOIL3). This method is used for all soil, plant and field data entries. Consult the following table to determine the correct name(s) of the data sets required for your data.

TABLE I

LIST OF INPUT DATA SETS

Type of Data	Page Number	Data Set Name
Soil	1	UxxxxxA.INPUT(SOIL1)
	2	UxxxxxA.INPUT(SOIL2)
	3	UxxxxxA.INPUT(SOIL3)
Plant	1	UxxxxxA.INPUT(PLANT1)
	2	UxxxxxA.INPUT(PLANT2)
Field	Forage	UxxxxxA.INPUT(FORAGE)
	Grain	UxxxxxA.INPUT(GRAIN)
	Peanut	UxxxxxA.INPUT(PEANUT)

This manual does not cover actual entry procedures since there are numerous entry methods and techniques. In Appendix C, the correct formats for all variables and worksheets have been listed on actual worksheets. Use this appendix as an example BEFORE you record any of your information on worksheets.

As an example, assume that the plant worksheet lists the value of potassium as XXX.X. This format would allow the numbers: 25.4 or 234.6 or 999.9 or 6.2 or 0.4. This format would dictate that the above numbers be entered into the disk file as: 254 or 2346 or 9999 or 62 or 4. Formats have been selected based upon the sensitivity of the machine and the normal range of standards currently in use. If you have special requirements, adjustments can be made in the program(s).

All worksheets have two general sections. The information listed at the top of the page, the title section, provides room to record data that describes the actual measurements found in the lower portion of the worksheet.

Whenever a variable is listed in the title section of a worksheet, it must be entered, regardless of the value. Here are a few examples of data line entries.

Example 1. Plant worksheet, page one.

Suppose that the following is to be entered.

```
PLANT NUTRIENT ANALYSIS FORM

 __________CROP ________ EXP_NO ________ SAMPLING DATE ____________
                        DATE COMPLETED ______________ PAGE __ OF __

* *     P      *     K      *     FE     *     ZN     *     MN     *LABNO
* * PPM1 PPM2  * PPM1 PPM2  * PPM1 PPM2  * PPM1 PPM2  * PPM1 PPM2  *
* *            *            *            *            *            *
* *  _28_ __29 * 35.2 36.0  * ____ ____  * 0.23 0.23  * ____ ____  * 1000
* *            *            *            *            *            *
* * ____ ____  * ____ ____  * ____ ____  * ____ ____  * ____ ____  * 1001
```

Notice that the tests for P, K and Zn have been completed, while Fe and Mn are not required. This portion of the line could be entered correctly as 28 29 352 360 . . 023 023 . .

The values for P, K and Zn have been entered without decimal points with each value being separated by a blank space. The two values for Fe have been entered as "missing values": a blank space, a decimal point (period) and another blank space. The two values of Zn follow, then the two "missing values" of Mn.

When entering data such as this, time can be saved by using the TSO entry system to your advantage. First, since Zn is the last variable with an actual value, it is not necessary to enter the rest of the line as "missing values".

In addition, an alphanumeric character could be entered instead of the two missing values for Fe. This character string could then be changed using the CHANGE subcommand in the TSO EDIT mode. Here is an example of this use: 28 29 352 360 A 023 023.

In the line above, the character "A" has been entered where the two missing values of Fe should appear. After the entire data set has been entered, the following command will change all "A" characters to the two missing values.

TOP	Enter key.
C * 60000 / A / . . / ALL	Enter key.

Using this technique will prove helpful when there are many missing values separating actual values. Additionally, the actual line length is reduced allowing use of the micro computer/TSO data transfer interface.

The DMS allows data within the system from more than one user. The system causes action on your data making all other data within the system transparent, i.e., not acted upon by the use of a REFERENCE. This is a descriptive variable whose value is assigned by the user. In its current context, the REFERENCE is composed of the first one or two letters or numbers from the experiment location, crop grown, study number and date harvested. Thus, such a string might be "HBP6". This REFERENCE translates to "Haskell, Oklahoma, Bermudagrass, P and K study, harvest in June (6). Such coding helps to define the origins of the data for the user but need not be used for success in the DMS. All that is required by the DMS is a unique string that can be used to separate this data from the other data sources within the DMS. The REFERENCE variable may contain up to 12 alphanumericc characters.

Plant data should be formatted according to the example listed in Appendix F. Appropriate reference identification letters and/or numbers should be assigned to your data. Enter those values on Appendix G along with the other required information. Failure to enter this information may result in your data being deleted from the system.

The value assigned to PLT PART (plant part) is limited to a maximum of eight characters. Consult the following table for examples of frequently used values.

The two variables on the plant worksheet are treated differently than all other variables. These variables are listed as N_WT, the dry weight for N analysis, and P_WT, the dry weight for all perchloric digestion analyses, on the worksheet. The DMS will assume that both N_WT and P_WT are equal to a value of 0.250g. When entering either variable, enter the weight only if the actual weight is different from the value 0.250g. Otherwise, enter a "missing value". This method allows rapid data entry, yet provides an easy method for weight adjustment if needed.

Many tests are listed in duplicate. This duplication is provided, not for a measure of sampling or laboratory error, but as a guide to laboratory precision. The program will average the two readings. Statistics are not available on the averaged reading.

If either value is entered as a "missing value", the variable will be set to the reading of the other value. For example, if P PPM1 was entered as a "missing value", and if P PPM2 was entered as 256, the value of P will be set to 256. If the order of the values of P PPM1 and P PPM2 in the above example were reversed, the value

TABLE II

EXAMPLES OF PLANT PART NAMES

Leaves	Grain	Roots
Petioles	Crowns	Tillers
Stems	Seed	Heads

of P would still be set to 256.

Table 3 contains a list of the equations used in the plant calculation program.

Soil data like plant data is entered using the formats specified in Appendix C. Appropriate data set names may be found in Table 1.

The method of entering field data is slightly different from that used in either soil or plant data. The top line on the field form contains the values for: experiment number, REFERENCE, and the dimensions of the harvest plot size (must be in feet only). These variables are entered only once on the first line of the appropriate data set.

The remaining information, starting with a new REP TRT combination, makes up the rest of the data lines. Study the following example for the entry of forage field data.

Example of Forage Field Form-Data entry:

FORAGE FIELD FORM

REFERENCE H / B / P / 6 / HARVEST PLOTSIZE 7 FT X 10 FT

LOCATION _______ CROP _______ EXP NO P&K___ HARVEST DATE _______

TITLE ______________________

DATE INITIATED _______ CROP YEAR _______ VARIETY _______

SEED RATE _______ FERT.APP DATE _______

PLANTING DATE _______ HARVEST # ____ UNITS REPORTED _______

REP TRT	PLT WET	SAMPLE BAG	WET	DRY	*REP TRT	PLT WET	SAMPLE BAG	WET	DRY	*REP TRT	PLT WET	SAMPLE BAG	WET	DRY	*REP TRT	PLT WET	SAMPLE BAG	WET	DRY
101	24.6	-	40	20	*201	22.6	-	43	32	*301	27.0	0	65	46	*401	18.4	-	62	50
				*					*					*					

TABLE III

EQUATIONS USED IN THE PLANT CALCULATION PROGRAM

```
% Nitrogen = (NH4 - Blank) * Normality * ((14 * 100)/N_WT * 1000))

Phosphorus = P * ( 35 /(5@ * P_WT))

Potassium, Iron, Zinc, Manganese use the following format:

    Potassium = K * ( 35 /(P_WT))
```

@ CLIST will allow the user to enter this value.

The data shown in the preceding example creates the following data set:

HBP6 P&K 7 10	Enter key.
101 246 . 40 20	Enter key.
201 226 . 43 32	Enter key.
301 270 . 65 46	Enter key.
401 184 . 62 50	Enter key.

Note that the value for plot weight has been entered without a decimal point. Press the enter key after the information for each REP TRT combination has been typed. Do not type more than one REP TRT combination on a line. Since a BAG weight was not recorded, a "missing value" is entered.

TABLE IV

EQUATIONS USED IN THE SOIL CALCULATION PROGRAM

Total Nitrogen = (Average ml * Normality * 14 * 1000)/1

By titration:

Urea = (Average reading * 200 * 0.4662)/20

Ammonium = (Average reading * 200 * 0.7778)/20

Nitrate = (Average reading * 200)/2

Nitrate = (Average reading * 200)/2

Or:

Urea = (Average reading - Blank) * (Normality * 1000 * 100)/(25 * 10)

Ammonium = (Average reading - Blank) * (Normality * 1000 * 100)/(25 * 10)

By electrode:

Nitrate = (Average reading * 25)/10

Or:

Nitrate = (Average reading - Blank) * (Normality * 14 * 1000 * 100)/(25 * 10)

Nitrite = (Average reading - Blank) * (Normality * 14 * 1000 * 10)/(25 * 10)

Organic Nitrogen = Total - Urea + Ammonium + Nitrate + Nitrite

Phosphorus = (Average reading * 20)/1

For Potassium and Sodium:

K = (Average reading * 25)/5

For Calcium and Magnesium:

Ca = (Average reading * 25 * 5)(5 * 4)

For Sulfur, Iron, Zinc, Manganese and Copper:

S = (Average reading * 25)/10

Molybdenum = (Average reading * 250)/25

Carbonate = (Reading * 2 * Normality * 1000)/Aliquot

Bicarbonate = (Aliquot - (2 * Carbonate reading) * Normality * 1000)/Aliquot

Chloride by titration:

Chloride = (25.5 * 1000 * Normality * Reading)/Aliquot

Chloride by electrode:

Chloride - reading

Readings for sulfate, organic matter and aluminum are equal to amounts in soil.

TABLE V

EQUATIONS USED FOR FIELD CALCULATIONS

Moisture = ((Wet weight - Dry weight) * 100)/(Wet weight - Bag weight)

Dry matter Factor = 1 - (Moisture/100)

Forage, kg ha^{-1} = Dry matter factor * plot weight * ((1.12 * 43560)/A)

where A is the harvest plot area.

CALC.CLIST

CALC.CLIST is a much more powerful CLIST than SHEET.CLIST. CALC.CLIST allows the user to calculate data from soil, plant or field input data sets; create new files to store this information; add this data to existing files while preserving all data contained therein; and write over old data with newly calculated data. Because of this versatility, it is imperative that the user know beforehand that inputs via CALC.CLIST will not adversely affect either his data or the data of others who are also using the DMS. The use of a REFERENCE is advisable to restrict the CLISTto data with the specified REFERENCE. All data with other REFERENCE's will be ignored. See DATA ENTRY for the discussion of REFERENCE.

In the following example, a graduate student has completed work on both field and plant analyses, however, he did not collect soil data in his research. The graduate student followed the guidelines under the DATA ENTRY section in this manual and is now ready to put his data into a reportable form along with statistical evaluation to assist him in summarizing the results of his research.

Example of CALC.CLIST: Selection and File Management Section.

```
READY
exec calc.clist                                      Enter key.
DO YOU WANT TO RUN SOIL, PLANT, FIELD DATA OR THE MERGE PROGRAM
    (S P F M) ===> plant                             Enter key.
DO YOU WANT TO:
1)  REVIEW RESULTS ONLY.  PROGRAM WILL NOT WRITE TO DISK FILE.
2)  STORE RESULTS ON DISK ADDING NEW RESULTS AT THE END OF
    THE DISK FILE 'UxxxxxA.PLANT.DATA'.
3)  STORE RESULTS ON DISK REMOVING ANY PRIOR RESULTS IN THE
    DISK FILE 'UxxxxxA.PLANT.DATA'.
4)  CREATE A NEW FILE, NAMED 'UxxxxxA.PLANT.DATA', SINCE THE
    OLD FILE IS NO LONGER CATALOGED.
    (1 2 3 4) ===> 2                                  Enter key.
```

If he chooses option 1, the program will run all merging and calculating routines but will not store the finished product on a disk file. The only output will be a printed copy of the data. The program does not delete input or output data. Use this option to preview the results or when there is a suspected problem with the input data, format problems, wrong units, etc.

Option 2, (the option used in the example) will perform all calculations on the data as in option 1 but will write these results in printed form and add them to the end of a disk file, PLANT.DATA. This option will be the one most frequently selected since this option considers that other people may be using the

PLANT.DATA file and will leave their data intact by writing new data at the bottom of the file. Data from two or more users in a file is a common situation. As stated before, data will be separated by the computer using the REFERENCE variable, which is covered in the section on data.

Option 3 should be used with caution. If other users have data stored on PLANT.DATA, and will need this data in the future, this option should NOT be selected. It will erase all current entries in PLANT.DATA as it adds the new information to the file. This option should be used to delete old information no longer needed while adding new information to the file.

Option 4 can be used in rare circumstances arising from system disuse. If the system is not used within a 45 day period from its last use, the computer will remove PLANT.DATA from the active disk files and store the information on tapes. Retrieval of information that has been archived will not be covered in this manual. Option 4 will allocate a new data set on disk with the same name, PLANT.DATA. Usually one of the other options will have been selected and that program will fail to run due to a JCL error that will list the cause as PLANT.DATA not being cataloged. Simply execute CALC.CLIST for the data to be calculated but select option 4.

Example of CALC.CLIST, Calculation Section:

DO YOU WANT TO:

1) CALCULATE ALL THE DATA CONTAINED IN THE INPUT FILES.

2) LIMIT THE DATA CALCULATED TO DATA WITH A SPECIFIC REFERENCE (EG,HBP6) ===> 2 Enter key.

The user in the example has selected option 2, so the display asks the user for the value of REFERENCE for use in sorting the input data files.

The user can determine if other users have data within the files by listing the appropriate files on the terminal. If there are other REFERENCE's found in the file, there are other researchers using the DMS. If a user should select option 1 or 2, not knowing that there are data from other users in the files, no data will be lost by any user. The DMS will calculate all data in the files and write the results to the appropriate files. Editing of the results will delete any erroneously calculated data. It is wise, however, to use option 2 to insure that the correct data are advanced through the DMS.

Example of CALC.CLIST, REFERENCE and laboratory parameters entry.

```
ENTER REFERENCE (EG. HBP6) ===> LAHW89            Enter key.
LABORATORY INFORMATION FOR PLANTS.
IF PARAMETER IS NOT NEEDED JUST PRESS ENTER.
ENTER NORMALITY OF HCL USED IN %N TEST
     (EG 0.1000) ===> 0.0050                      Enter key.
ENTER ALIQUOT FOR P TEST(EG. 10) ===>             Enter key.
E
1200 NORM1=0.0050;
5200 ALIQUOT=10;
5600 REF=1000;
5600 REF=LAHW89;
ENTER FOUR DIGIT PASSWORD:xxxx                     Enter key.
C11459LC(JOB 1344) SUBMITTED
READY
```

After reading the new REFERENCE value, LAHW89, certain values that pertain to the laboratory operations are needed. Values entered through CLIST will affect all the calculations that require those values. If a value is correct as shown in the example on the computer display, simply press the enter key and that value will be used. If the value is incorrect, enter the correct response and then press the enter key. In the example above, a new normality was entered for the Kjeldahl %N determination, but the aliquot of 10 was correct for the P analyses, so the user did not reenter a

10, he just pressed the Enter key. If there were no P analyses in the data, use the Enter key to set the calculation to the default value of 10. A CALC.CLIST ckecklist is shown in Appendix E.

EXPERIMENT AND TREATMENT DESCRIPTORS

Until now a particular set of data has been defined by experiment numbers, REFERENCE's, or REP TRT and PLT PART. While these descriptive variables are enough to separate different data sets within the calculation potion of the data management system, more definition must be given to each line before the set is stored with a large amount of data on tape. For instance, your data set has a REP TRT combination of "101". While this combination of replication and treatment means something to you, it is not definitive enough since other experiments may have that same combination. The actual treatment varies with experiments and locations.

Two worksheets have been prepared to help complete the list of descriptive variables that will be needed. The first worksheet, entitled Descriptor Listing, Appendix F, contains a complete list of the descriptors currently in use. No one experiment will use all of these descriptors. Descriptors can be added to the list and there is no limit to the number you may have.

The Descriptor Listing is divided into two categories - Experiment Descriptors and Treatment Descriptors. The former are variables that pertain to the entire experiment, such as location or planting date. Treatment descriptors help define which treatments were used within the experiment.

In some instances an experiment will include testing at more than one experiment descriptor level. For example, an experiment may be conducted at more than one location. In this case the experiment number will be the same for each of the locations but several REFERENCE's will be assigned, one or more for each location, sampling date, etc. A separate worksheet must be filled out for each REFERENCE to avoid conflicts within the DMS.

The Descriptor Worksheet, Appendix F, is simply an encoding sheet that has been organized to speed data entry. This worksheet may also be used as a cover sheet for all field and laboratory worksheets when they are filed.

Both the Descriptor Listing and the Descriptor Worksheet were designed to be used together. The Listing has underscored areas that can be used as a checklist. Place a check next to all descriptors that pertain to your study. Be sure to mark all pertinent descriptors. After completing the checklist, start entering the information on the Descriptor Worksheet. The small underscore is provided for entry of the number that precedes the descriptor. The larger underscore is the location where the value of the descriptor would be entered. Consider the following example of a partially completed Worksheet. Due to space limitation, the full width of the Worksheet is not shown.

DESCRIPTOR WORKSHEET

EXPERIMENT

1	DLM	2	Bermuda	3	1982	4	Haskell	5	P & K	6	HBP6

TREATMENTS

1.	1	Ammonia	31	0	61	knife						
2.	1	Ammonia	31	200	61	knife						
3.	1	Ammonia	31	400	61	knife						

The experiment descriptors are recorded first. As the line is filled out, the number of the experiment descriptor is written followed by the value of that descriptor. For example, the researcher's initials are entered by recording a "1" followed by the intitials, "DLM". The entry "6 HBP6" refers to the sixth experiment descriptor as described on the Descriptor Listing. The six descriptor is the REFERENCE whose value is "HBP6".

All treatments are defined in a similar manner. Special consideration should be given to a control or check treatment. In our example, let us suppose that this study only involved various rates of anhydrous ammonia using a knife aplication in bermudagrass. Treatment one is the control. Thus, the user has entered the nitrogen source as anhydrous ammonia, and the application method as knife, but has entered the nitrogen rate as zero. This method is used to define just what source and/or method with which the control is to be compared. If there had been various rates of phosphorus used in the study, and if treatment one was also the check plot for phosphorus, then the following information would need to be added to the line for treatment one.

1. 1 ammonia 2 APP 31 0 32 0 61 knife 62 broadcast

While it is not necessary to keep the list in numeric order, it is advisable. Some experiments involve multiple fertilizer sources or application methods. Due to the programming structure it is not feasible to list all source or method descriptors on the control treatment line. Therefore, list only one source or method. If more than one source or method descriptor is listed, the program will set the value of either source or method to the LAST value listed. The important point to remember is that the rate for the check or control plot has been set to zero.

After completing the Descriptor Listing and Worksheet, inspect both worksheets and make sure that the list is complete and correct. The information that has been listed on the worksheet can now be entered into UxxxxxA.INPUT(DESCRIPT). Entry of this data is similar to entry of field data. The first line will contain all of the experiment descriptors. Do not enter experiment descriptors on subsequent lines. Enter all treatment descriptors such that the data set contains one line for each treatment in the study.

The storage program, described in the next section, will work with one, and only one REFERENCE. If your study involves more than one REFERENCE, you will be required to enter the descriptors and run the storage program for each REFERENCE. Since the descriptors for each new REFERENCE will remain the same, usually all that is required is updating of the REFERENCE in the descriptor listing file and rerunning the storage program.

DATA STORAGE

The storage portion of the CLIST data mangement system allows the user to direct the new information located in UxxxxxA.COMPLETE.DATA to be appended with experiment and treatment descriptors. This combined information can then be stored in a SAS disk file under a user specified name and/or stored on tape containing all other data with the DMS.

Use of the disk file is appropriate when the user wishes to use SAS statistical programs to analyze the data. The SAS data set in which the data is stored is not directly available to the user through TSO. The data is in a form that only a SAS program, either interactive or background, can interpret. The value of the SAS data set is that no input lines need be specified since all variable names and types are stored in a SAS record at the beginning of the SAS data set. Also the speed of reading the data is greatly increased because the data has been arranged in a SAS form and need not be rearranged as is the case for TSO type data sets.

The use of tapes to store the data is structured such that the most current tape (of two) is read into a temporary data set. The new information is added to this tape and the resulting file is written to the second tape. Once all data has been transferred to the second tape, the program checks that all steps have been executed correctly and then copies the second tape to a third backup tape. The identity of the third tape is fixed. However, it is the user's responsibility to determine and use the correct tape names for the read/write sequence. A discussion of the Storage Tape Log to assist the user in choosing the correct tape, occurs later in this section.

By selecting the storage program (SP) option in the first question from the CLIST, it is possible to enter data into the storage tapes. The part of the CLIST that allows use of the storage program is protected by a password that should be different from either the batch password or the TSO access password.

Other important points and options of this portion of CALC.CLIST have been covered in the discussion of descriptors and disk and tape storage. Consult these topics and Appendix G, Storage Tape Log, before using the CLIST.

The following is an example of the use of the storage CLIST and program. This example is a continuation of the example in the preceding section.

```
READY
exec calc.clist                                     Enter key.
DO YOU WANT TO RUN SOIL, PLANT, FIELD, MERGE OR THE
   STORAGE PROGRAM (S  P  F  M  SP)? ===> sp        Enter key.
ENTER STORAGE PASSWORD ===> xxx                     Enter key.
DO YOU WANT TO WRITE THE COMBINED DATA (COMPLETE PLUS
   DESCRIPTORS) TO A SAS DATA FILE ON DISK?
   (Y  N) ===>  n                                   Enter key.
SPECIFY TAPE TO BE READ (1  2) ===> 1               Enter key.
THE TAPE FROM WHICH DATA WILL BE READ IS TAPE=1.
   ALL DATA ON TAPE=2 WILL BE LOST.
   VERIFY THAT YOU HAVE CHOSEN THE CORRECT TAPE.
   IS 1 THE CORRECT TAPE NUMBER?
   (Y  N) ===> y                                    Enter key.
ENTER FOUR DIGIT PASSWORD xxxx                      Enter key.
DxxxxLC(JOB00324) SUBMITTED
READY
```

If the user in the above example had wanted a new SAS data set written to a disk file, the CLIST would have prompted the user for the number of the disk file to be created. The user would have found the last disk file number that was used in the far right column in Appendix G. The user should then add one to this number to get the next disk file number to be used. The disk file that will be created is UxxxxxA.STORExx.DATA, where the character string "xxxxx" is the user ID number and "xx" is the number of the disk file specified by the user.

Since SAS data sets are set up in a library fashion, the second level name assigned to the file is also needed. This name, assigned by the storage program - not the user, is STORAGE. This name is constant and is independent of the data set file name and number in which the data resides.

DATA RETRIEVAL

The retrieval program is not CLIST driven and must be set up by the user each time access to the taped information is required. This program was designed in this manner to allow the greatest flexibility. This program will be used less than other programs within the system, and therefore, a CLIST is not required. The retrieval program is stored on disk under the name UxxxxA.CALCULAT(RETRIEVE).

Many lines of comments are provided through the entire program to guide the user through each step. The program has the ability to search either a user specified disk file or information on tape.

Searching of information contained in a disk file need not be limited to the STORExx.DATA files as specified within the program. However, before the user attempts to seach other files, an understanding of JCL, SAS and disk file management should be acquired. This manual will not discuss use of the program except for use with the STORExx.DATA sets generated in the storage operations. Additionally, the program can be used to search other tapes with the same cautions as above.

The first part of the program guides the user in the selection of a disk file search. The following lines are a copy of this program.

```
800  //* ++++++++++++++++++++++++  READ DISK FILES  ++++++++++++++++++
900  //*
1000 //*       NORMALLY THIS RETRIEVE PROGRAM WILL BE USED WITH TAPES.
1100 //*       USE THIS OPTION ONLY IF DATA TO BE SEARCHED IS ON DISK.
1200 //*       SPECIFY THE DISK FILE TO BE USED BY REMOVING THE "*"
1300 //*       FROM THE FOLLOWING TWO LINES AND CHANGE THE 'XX'
1400 //*       CHARACTERS TO THE DIGITS THAT DESCRIBE THE CORRECT DISK
1500 //*       DATA SET NAME.
1600 //*
1700 //*INFOIN DD DSN-U13413C.STOREXX.DATA,DISP=(OLD,KEEP),UNIT=3350,
1800 //* VOL=SER=DASD40,SPACE=(TRK,(50,10))
1900 //*
```

The "*" are found at the beginning of lines 1700 and 1800. The 'XX' string is located after the word "STORE". Use the change command below to delete the "*" characters.

```
list 1700 1800                                   Enter key.
//*INFOIN DD DSN=UxxxxxA.STORExx.DATA,DISP=(OLD,KEEP),
//* UNIT=3350,
//* VOL=SER=DASD40,SPACE=(TRK,(50,10))
1700 1800 .//*.//. ALL                           Enter key.
```

The following command will change the 'XX' string to the user specified disk file number 23.

```
c  1700 .storexx.store23.                        Enter key.
```

If searching of disk files is not required, do not enter any of above commands. This program will allow searching of either one disk file or one tape, but not both.

The following lines are from the portion of the program that allows access to information on tape. Since it is the backup tape that will be used for all search requests, the user should not change the name of the tape specified on these lines. Remove the "*" from the beginning of lines 2500 and 2600 for access to the taped information. Here is the command.

c 2500 2600 /*./. all   Enter key.

In the last step of the data set management portion of the program, the user must specify the data set name to which the data subset will be written. The data set name is entered in place of the character string, "YYYYXXXX", found on line 4200. In this example, suppose the user wished to call the data set stored on disk "JOHN2".

c 4200 .yyyyxxxx.john2.   Enter key.

The retrieval program will build a SAS data set on disk for each execution of the program. If the first execution of the program is done incorrectly, the user must enter a new name before submitting the second run. This name change is needed due to the structure of the JCL, job control language, on lines 4200 and 4300. Remember, that each run of the program will build one data set on disk. Any incorrect data sets (or empty ones) should be deleted as soon as possible.

The second level name used for the retrieval program SAS data set is always RETRIEVE.

Once either disk or tape have been chosen, the variable(s) used in the search must be selected. There is a complete list of variable names and brief description of each variable in the section of the program entitled, "SELECT DESIRED DATA FROM TAPE OR DISK". At the bottom of the list, there are some examples of inappropriate entries. Study this part carefully to minimize problems with your search. Use the listings for common plant parts and the full names of species and other abbreviations found in this manual and in the Appendix F, Descriptor Listing and Worksheet.

Note that the entire list of descriptors is specified as character variables. Thus, even though a rate may be given in numerics, SAS has stored this information as if it were a character string or word. The program shows two examples of incorrect statements.

Lastly, several example lines are given which would be correct statements and result in successful searches. For example, the first line shows the following:

```
*IF CROP='WHEAT' OR CROP='BERMUDAGRASS'
```

Once the "*" is removed, this line would produce a subset of the main data set being searched that would include all information that pertained to either wheat or bermudagrass. When composing the "IF" statement, try to be specific. When in doubt, ask for a data subset that will definitely include the information that you seek. For instance, suppose that you are trying to obtain information about various rates of phosphorus fertilizer. However, you do not have a list of the various rates that have been applied and have no easy way to get such a list. One option is to go through all experiments by hand and find the rates used. Of course, this is a very time consuming task. A much better option might be to subset the data subset of all phosphorus studies that used either of the above sources with the statement:

```
IF P_SORS='APP' or P_SORS='TSP'
```

The retrieval program will give a listing of each line written to the new data subset (and to a user specified disk file). One of the variables will be the phosphorus rate(s), exactly the subset that you required.

REFERENCES CITED

1. American Society of Agronomy. 1982. SI Units required in society manuscripts. Agron. News (March-April)., p. 10-13.

2. International Business Machines Corporation. 1978. OS/VS2 TSO command language reference. IBM Corporation Publications Department, Poughkeepsie, N. Y.

3. International Business Machines Corporation. 1978. OS/VS2 TSO terminal user's guide. IBM Corporation Publications Department, Poughkeepsie, N. Y.

4. International Business Machines Corporation. 1978. OS/VS2 MVS JCL. IBM Corporation Publications Department, Poughkeepsie, N. Y.

5. International Business Machines Corporation. 1982. VS FORTRAN application programming: language reference. IBM Corporation Publications Department, Poughkeepsie, N. Y.

6. SAS Institute, Inc. 1979. SAS user's guide. SAS Institute, Raleigh, North Carolina.

7. SAS Institute, Inc. 1982. SAS user's guide: basics. SAS Institute, Raleigh, North Carolina.

APPENDIX A

SHEET.CLIST CHECKLIST

SHEET.CLIST CHECKLIST

	Type of Form		
	Soil	Plant	Field
Number of Pages (1 to 20)			
Beginning Lab Number (four digits only)			
Third page?			
Type of Field Form			Forage Grain Peanut
Number of Treatments (1 to 25)			

APPENDIX B

SOIL, PLANT AND FIELD FORMS

SOIL ANALYSIS FORM

REFERENCE ___/___/___/___/ LOCATION __________ CROP __________ EXP_NO __________ SAMPLING DATE __________
DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	REP	TRT	DEPTH	METH USED	UREA-N ONE	UREA-N TWO	N	NH4-N ONE	NH4-N TWO	NO3-N ONE	NO3-N TWO	NO2-N ONE	NO2-N TWO	TOTAL-N ONE	TOTAL-N TWO		PH	BI	BRAY-P1 ONE	BRAY-P1 TWO	LABNO
1000				TSE	X.XX												X.X	X.X			1000
1001				TSE																	1001
1002				TSE																	1002
1003				TSE																	1003
1004				TSE																	1004
1005				TSE																	1005
1006				TSE																	1006
1007				TSE																	1007
1008				TSE																	1008
1009				TSE																	1009
1010				TSE																	1010
1011				TSE																	1011
1012				TSE																	1012
1013				TSE																	1013
1014				TSE																	1014
1015				TSE																	1015
1016				TSE																	1016
1017				TSE																	1017
1018				TSE																	1018
1019				TSE																	1019

COMMENTS

SOIL ANALYSIS FORM SECOND PAGE

SAMPLING DATE ______________ DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	K		CA		MG		NA		S		FE		MN		ZN		CU				LABNO
	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2	PPM1	PPM2			
1020																					1020
1021																					1021
1022																					1022
1023																					1023
1024																					1024
1025																					1025
1026																					1026
1027																					1027
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1033																					1033
1034																					1034
1035																					1035
1036																					1036
1037																					1037
1038																					1038
1039																					1039

COMMENTS

SOIL ANALYSIS FORM THIRD PAGE

SAMPLING DATE ______________ DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	MO PPM1	MO PPM2	CO3S READ	HCO3 READ	MET	CL	B PPM1	B PPM2	EC	FACT	OM ONE	OM TWO	AL	AL							LABNO
1000	XXX		XXX	XXX	E T	XXX	XXX		XXX	XXX	XX.X		X.XX								1000
1001					E T																1001
1002					E T																1002
1003					E T																1003
1004					E T																1004
1005					E T																1005
1006					E T																1006
1007					E T																1007
1008					E T																1008
1009					E T																1009
1010					E T																1010
1011					E T																1011
1012					E T																1012
1013					E T																1013
1014					E T																1014
1015					E T																1015
1016					E T																1016
1017					E T																1017
1018					E T																1018
1019					E T																1019

COMMENTS

PLANT NUTRIENT ANALYSIS FORM

REFERENCE ___/___/___/___/ LOCATION __________ CROP ________ EXP_NO ________ SAMPLING DATE ____________

DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO	PLT PART	REP TRT	N WT.	N/P WT.	%N BLK	%N ML1	%N ML2	%N RRUN	P PPM1	P PPM2	K PPM1	K PPM2	FE PPM1	FE PPM2	ZN PPM1	ZN PPM2	MN PPM1	MN PPM2	LABNO
1000			.XX	.XX	.XX	XXX			XXX	XXX	XX.X	XX.X	XXX	XXX	XXX	XXX	XX.X		1000
1001							X.XX											XX.X	1001
1002																			1002
1003																			1003
1004																			1004
1005																			1005
1006																			1006
1007																			1007
1008																			1008
1009																			1009
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1014																			1014
1015																			1015
1016																			1016
1017																			1017
1018																			1018
1019																			1019

COMMENTS

PLANT NUTRIENT ANALYSIS FORM SECOND PAGE

SAMPLING DATE ______________ DATE INTO LAB ______________ DATE COMPLETED ______________ PAGE __ OF __

LABNO		NO3 PPM	CL PPM		NA PPM1	NA PPM2	AL PPM1	AL PPM2	CA PPM1	CA PPM2	MG PPM1	MG PPM2	S PPM1	S PPM2	CU PPM1	CU PPM2	B PPM1	B PPM2	MO PPM1	MO PPM2	CHLOR READ	LABNO
1020		XX.X	XXX		X.XX		XX.X		X.XX		X.XX		X.XX		X.XX		X.XX		X.XX		XXX	1020
1021																						1021
1022																						1022
1023																						1023
1024																						1024
1025																						1025
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1037																						1037
1038																						1038
1039																						1039

COMMENTS

GRAIN FIELD FORM

REFERENCE __/___/___/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION ________ CROP ________ EXP_NO ________ HARVEST DATE ________
TITLE _________________________
DATE INITIATED ________ CROP YEAR ________ VARIETY ________
SEED RATE ________ FERT.APP DATE ________
PLANTING DATE ________ HARVEST # ____ UNITS REPORTED_________

REP TRT	SAMPLE	REP TRT	SAMPLE	REP TRT	SAMPLE	REP TRT	SAMPLE
101	XX.X	201		301		401	
102		202		302		402	
103		203		303		403	
104		204		304		404	
105		205		305		405	
106		206		306		406	
107		207		307		407	
108		208		308		408	
109		209		309		409	
110		210		310		410	
111		211		311		411	
112		212		312		412	
113		213		313		413	
114		214		314		414	
115		215		315		415	

COMMENTS

PEANUT FIELD FORM

REFERENCE __/___/___/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION _______ CROP _______ EXP_NO _______ HARVEST DATE _______
TITLE ______________________
DATE INITIATED _______ CROP YEAR _______ VARIETY _______
SEED RATE _______ FERT.APP DATE _______
PLANTING DATE _______ HARVEST # ____ UNITS REPORTED________

REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %	REP TRT	SMK %	SS %	OK %	TK %
101	XX.	XX.	XX.	XX.	201					301					401				
102					202					302					402				
103					203					303					403				
104					204					304					404				
105					205					305					405				
106					206					306					406				
107					207					307					407				
108					208					308					408				
109					209					309					409				
110					210					310					410				
111					211					311					411				
112					212					312					412				
113					213					313					413				
114					214					314					414				
115					215					315					415				

COMMENTS

FORAGE FIELD FORM

REFERENCE __/___/___/__/ HARVEST PLOTSIZE___FT X ___FT
LOCATION ________ CROP ________ EXP_NO ________ HARVEST DATE ________
TITLE ________________________
DATE INITIATED ________ CROP YEAR ________ VARIETY ________
SEED RATE ________ FERT.APP DATE ________
PLANTING DATE ________ HARVEST # ____ UNITS REPORTED_________

REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	SAMPLE DRY	*REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	SAMPLE DRY	*REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	SAMPLE DRY	*REP TRT	PLT WET	SAMPLE BAG	SAMPLE WET	SAMPLE DRY*
101	XX.X	XX.	XXX.		*201				XXX	*301					*401				*
102					*202					*302					*402				*
103					*203					*303					*403				*
104					*204					*304					*404				*
105					*205					*305					*405				*
106					*206					*306					*406				*
107					*207					*307					*407				*
108					*208					*308					*408				*
109					*209					*309					*409				*
110					*210					*310					*410				*
111					*211					*311					*411				*
112					*212					*312					*412				*
113					*213					*313					*413				*
114					*214					*314					*414				*
115					*215					*315					*415				*

COMMENTS

APPENDIX C

DATA FORMAT

DATA FORMAT

Examples of data entry are shown on actual worksheets in Appendix B with formats listed by capital "X"'s. The "X"'s to the left of the decimal are listed to show the maximum size of the integer portion. The "X"'s to the right of the decimal point show the required decimal portion.

Examples of format errors. Consider the format: XXX.X. The maximum value allowed would be 999.9. The value of 1000.0 is not allowed, since 1000.0 > 999.9. Alternately, a value such as 2.34 would be changed by the program to 23.4, resulting in a tenfold error, since only one position to the right of the decimal is specified in the format.

If you do not include the value to the right of the decimal point, an error will result. For instance, if the number 100 were entered, the program will assume that the value should be 10. Thus, you should have entered 1000 to allow one digit to the right of the decimal point. The above entry will produce 100.0.

Follow the given formats carefully. Next to keypunch errors, formatting will account for most of the common mistakes you will make.

APPENDIX D

CURRENT REFERENCE LISTING

Current REFERENCE Listing

DATE DATA ENTERED	REFERENCE	DATA SETS USED											DATES FINISHED WITH DATA
		Soil1	Soil2	Soil3	Plant1	Plant2	Forage	Grain	Peanut	Cotton			

Instructions: Enter date that data started. Enter REFERENCE. Mark only sets you will use for your data. After data has been processed, enter date that your data can be deleted from those file you have marked. Data will be deleted within a month unless prior arrangements have been made.

APPENDIX E

CALC.CLIST CHECKLIST

CALC.CLIST Checklist

Run program for: ____ Soil ____ Plant ____ Field

Soil, Plant, Field Disk Operatons

	Option #	Choice
Review results only - no data on disk	1	
Append new results to end of disk data set	2	
Purge all other data on disk data set	3	
Create a new disk data set	4	

Data Selection

	Option #	Choice
Calculate all data	1	
Calculate only data with a specific REFERENCE	2	
If 2 above, enter REFERENCE		________

Soil Parameters

Normality of HCL used for %N ________

Normality and aliquots used for carbonates and bicarbonates ________

Normality and aliquots used for chlorides ________

Plant Parameters

Normality of HCL used for %N ________

Aliquot for P test ________

Field Parameters

Select data type: ____ Forage ____ Grain
____ Peanut ____ Cotton

CALC.CLIST Checklist (continued)

	Option #
Merge Disk Operations	
Append merged results to UxxxxxA.COMPLETE.DATA	1
Purge all other data in UxxxxxA.COMPLETE.DATA and write merged results to the same file	2
Create a new file, UxxxxxA.COMPLETE.DATA	3
Options 1 plus create a graduate student file	4
Option 2 plus create a graduate student use file	5
Option 3 plus create a graduate student use file	6
If option 4-6, enter graduate student file name	________
Select files to be merged: ____ Soil ____ Plant ____ Field	
Data Selection	
Merge all data	1
Merge only data with a specific REFERENCE	2
If 2 above, enter REFERENCE	________
Storage of Data	
Storage password	________
Write the completed data plus descriptors to disk?	Y N
If YES, then specify disk file name	________
Specify tape number to be read	1 2

APPENDIX F

DESCRIPTOR LISTING AND WORKSHEET

DESCRIPTOR WORKSHEET

EXPERIMENT

TREATMENTS

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.

COMMENTS:

DESCRIPTOR LISTING

EXPERIMENT DESCRIPTORS

1. Initials ____
2. Crop ____
3. Crop year ____
4. Location ____
5. Experiment number ____
6. Reference number ____
7. Title ____
8. Date initiated ____
9. Variety ____
10. Seed Rate ____
11. Fertilizer Application Date ____
12. Planting date ____
13. Harvest number ____
14. Harvest date ____
15. Units reported ____
16. ____
17. ____
18. ____
19. ____
20. ____

TREATMENT DESCRIPTORS

---SOURCE---

1. N ____	2. P ____	3. K ____	4. S ____
5. Ca ____	6. Mg ____	7. Fe ____	8. Mn ____
9. Zn ____	10. Cu ____	11. B ____	12. Mo ____
13. LIME ____	14. GYPSUM ____	15. HERBICIDE ____	16. FUNGICIDE ____
17. INHIBITOR ____	18. ____	19. ____	20. ____
21. ____	22. ____	23. ____	24. ____

---RATE ($KG \cdot HA^{-1}$)---

31. N ____	32. P ____	33. K ____	34. S ____
35. Ca ____	36. Mg ____	37. Fe ____	38. Mn ____
39. Zn ____	40. Cu ____	41. B ____	42. Mo ____
43. LIME ____	44. GYPSUM ____	45. HERBICIDE ____	46. FUNGICIDE ____
47. INHIBITOR ____	48. ____	49. ____	50. ____
51. ____	52. ____	53. ____	54. ____

---METHOD---

61. N ____	62. P ____	63. K ____	64. S ____
65. Ca ____	66. Mg ____	67. Fe ____	68. Mn ____
69. Zn ____	70. Cu ____	71. B ____	72. Mo ____
73. LIME ____	74. GYPSUM ____	75. HERBICIDE ____	76. FUNGICIDE ____
77. INHIBITOR ____	78. TILLAGE ____	79. ____	80. ____
81. ____	82. ____	83. ____	84. ____

---15N WORK---

91. ATOM % EXCESS ____ 92. SOURCE 15N ____

---GROWTH CHAMBER---

111. TEMPERATURE ____ 112. TEMPERATURE DURATION ____

APPENDIX G

STORAGE TAPE LOG

The Storage Tape Log must be consulted before each use of the storage program. Since this step is very important, consider the following example which explains the use of this appendix. Users must understand the actions required to preclude loss of data by entering the correct tape number.

Example: Use of the Storage Tape Log

User Jones has just determined that the data set he has been using should be stored using the storage tape system. No disk file is needed in this case. Upon consulting the Storage Tape Log, he finds the following information.

Date Used	User Init.	Tape Read	Tape Written	Experiment Number REFERENCE Added
24 Fb 83	EAH	2	1	P&K, HBP6

Following the instructions at the bottom of the Storage Tape Log form, he would fill in the next line with the information for his data.

27 Fb 83	UJ	1	2	222, SW28

Note that the tape numbers simply change columns. As above, EAH wrote information to tape 1 on the 24th of February. Therefore, user Jones will read that tape, tape 1. This action insures that information entered by EAH will remain in the data storage system. If user Jones reads tape 2, data pertaining to experiment P&K, entered by EAH, will be lost!

STORAGE TAPE LOG

DATE USED	USER'S INITIALS	TAPE READ	TAPE WRITTEN	EXPERIMENT NUMBER & REFERENCE ADDED	DISK FILE DATA SET NUMBER

INSTRUCTIONS:

1. Enter date storage program was run.

2. Enter your initials

3. Enter the number of tape read. This tape will have the same number as the tape to which data was last WRITTEN.

4. Enter tape written number. This tape will be the number from which data was last READ.

5. Enter experiment number and REFERENCE of data that has been added to tape file.

6. Enter # of the disk file data set used, if any. Numbers should not be reused and cannot exceed 99.

VITA

Edward A. Hanlon, Jr.

Candidate for the Degree of

Doctor of Philosophy

Thesis: MULTIPLE ELEMENT SOIL EXTRACTANTS AND A DATA MANAGEMENT SYSTEM

Major Field: Soil Science

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