EGYPT WATER USE AND MANAGEMENT PROJECT

EWUP MANUAL NO. 2

PROGRAMS FOR THE HEWLETT-PACKARD COMPUTER MODEL 9825 FOR EWUP OPERATIONS

By

M. Helal, D. Sunada, J. Loftis, M. Quenemoen, W. Ree, R. McConnen, R. King, A. Nasr and R. Stalford.

Cairo ARE
Fort Collins, Colorado USA

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Mohamed Helal

Engineer (EWUP) Research

TABLE OF CONTENTS

INTRODUCTION	iii
DISCHARGE COMPUTATIONS FOR CUTTHROAT AT FLUMES	1
DISCHARGE COMPUTATIONS FOR THE BENI MAGDOUL NYRPIC GATE	17
WATER TABLE CONTOUR PROGRAM	25
CHANNEL HYDRAULICS	46
REDUCTION OF AUGER HOLE DATA BY ERNST METHOD	50
WEATHER DATA ENTRY	59
ET_o (POTENTIAL EVAPOTRANSPIRATION), FAO-BLANEY-CRIDDLE TECHNIQUE	73
PROGRAM ET CROP	81
CROP EVAPOTRANSPIRATION PROGRAM	87
PROGRAM ET_o, PAN EVAPORATION TECHNIQUE	100
PROGRAM ET CROP, PART 1	104
PROGRAM ET CROP, PART 2	107
IRRIGATION SIMULATION PROGRAM	110
PLANT-SOIL-WATER SIMULATION PROGRAM	119
LEVEL BORDER SIMULATION PROGRAM	124
PRECIPITATION DATA ENTRY	127
WATER LIFTING PROGRAM	133
MACHINERY COST PROGRAM	155
SUMMARY FARM RECORD PROGRAM	171
ENTERPRISE COST PROGRAM	188
INVENTORY PROGRAM	204

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INTRODUCTION

This manual contains programs for the Hewlett-Packard Model 9825 computer need by the Egypt Water Use and Management Project in the conduct of its operations. It is divided into four sections: engineering, agronomy, economics and administrative.

Background material is presented for each program and includes citations to references where available. A flow chart is provided for some programs. Instructions for the operation of the programs are given in complete detail. Though the instructions are explicit and detailed the user should be familiar with the computer and its operation before attempting to use these programs.

DISCHARGE COMPUTATIONS FOR CUTTHROAT FLUMES

Program Description

This program is used to calculate the daily discharge of a cutthroat flume for a one month period.

The input is taken from two water level charts, one for the upstream water level and the other for the downstream. The charts are read with a digitizer, an integral part of the computer system.

The output of the program is a tabulation of the daily discharge volume, the summation of the discharge volumes, and the daily average values of H_a and H_b.

The program can be used for any type of flume by changing the discharge functions accordingly.

Background

Cutthroat flumes [1] are used by EWUP to measure rates in furrows, farm ditches, meskas and canals. Two water depths are measured in the flume, the upstream depth or head, h_a, and the downstream, h_b. The larger permanently installed flumes are provided with recorders to obtain a continuous record of the two heads, for example, the flumes on the Dekalt, Omsen and Hamad Canals at Kafr El Sheikh. The charts are read to obtain corresponding pairs of values of head and time which are then fed to the computer to calculate the rates and volumes of discharge.

The charts can be read manually or by a digitizer (chart reader). The program given here is designed for use for a digitizer.

---

(1) Skogerboe, Gaylord V., Bennett, Ray S; Walker, Wynn R. Selection and Installation of Cutthroat Flumes for Measuring Irrigation and Drainage Water, Colorado State University Experimental Station, Fort Collins, Technical Bulletin 120, 1973.

The Discharge Functions

Technical Bulletin 120 (1) provides the discharge equations for the flume in English system units. Helal[2] has converted these to metric system units. The equations are; for free flow:

$$Q = K_1 W^{1.025} h_a^{n_1} \qquad \text{(with English system)}$$

$$Q = (3.281)^{n_1 - 1.975} K_1 W^{1.025} h_a^{n_1} \qquad \text{(with metric system)}$$

and for submerged flow

$$Q = \frac{K_2 W^{1.025} (h_a - h_b)^{n_1}}{\left(-\log \frac{h_b}{h_a}\right)^{n_2}} \qquad \text{(with English system)}$$

$$Q = \frac{(3.281)^{n_1 - 1.975} K_2 W^{1.025} (h_a - h_b)^{n_1}}{\left(-\log \frac{h_b}{h_a}\right)^{n_2}} \qquad \text{(with metric system)}$$

Equations for the relationships between n_1, n_2, K_1, K_2, submergence S_t and flume length given in EWUP Staff Paper #6 are:

$$K_1 = 2.962 + \frac{1.448}{L}$$

$$n_1 = 1.418 + \frac{.408}{L}$$

$$K_2 = 2.51 - .801 \ln L$$

---

(2) Helal, M.; Cutthroat Flume Metric Equations, EWUP Staff Paper #6, May 1980.

$$\frac{1}{n_2} = .748 - \frac{.064}{L}$$

$$S_t = .485 + .1887L - .0269L^2 + \frac{.0102}{L^2}$$

These equations are limited in application to flume lengths, $0.46<L<2.74$ meters. Thus they do not apply to the Abueha Canal flume at El Minya which is 3.3 meters long.

A. PROGRAM OPERATION (used U.S.L. & D.S.L. Charts)

* Turn on the calculator, disc drive, digitizer and the printer then insert the disc.

Do the following operations:

1. Execute: get "file name"

   Where the file name is the program name such as "K.E. HA" or KE.OS" or "K.E. HE"

2. Press RUN key

3. When "Date = DDMMYY = DD is the end day" appears in the display

   1. Type the date of the last day of the month

   2. Press CONTINUE key

4. When "new =1, old = 2" appears in the display

   1. Type 1 for new data or 2 for old data

   2. Press CONTINUE

   * for new data go to step #6

5. Old data will be printed by the printer and stop

6. When "L = flume length (mt)" appears in the display

   1. Type the flume length in meters

   2. Press CONTINUE

7. When "W = cutthroat width (mt)" appears in the display

   1. Type the flume width in meters

   2. Press CONTINUE

8. When "H_a U.S.L. = 1, H_b D.S.L. = 2" appears in the display

   1. Type 1 for reading the upstream level chart (H_a)

   or Type 2 for reading the downstream level chart (H_b)

   2. Press CONTINUE

9. When "Day of Reading" appears in the display

   1. Place chart onto digitizer

2. Type last day of chart that will digitized on this section

3. Press CONTINUE

10. When "set lower extreme lt + rt pts" appears in the display

    1. Mark 4 points on the chart near the corners, forming a rectangle

    2. Take the reading of the left and right lower points from the chart by pressing sample (S) key each time

11. When "upper rt & lt" appears in the display, read the upper right and left points with sample key

12. When "X val lower lt" appears in the display

    1. Type the X value of the lower left (time in days)

    2. Press CONTINUE

13. When " X val lower rt" appears in the display

    1. Type the X value of the lower right point (time in days)

    2. Press CONTINUE

14. When "Y val lower lt" appears in the display

    1. Type Y value of the lower left point (w.s. elev. in mt)

    2. Press CONTINUE

15. When "Y val upper lt" appears in the display

    1. Type Y value of the upper left point (w.s. elev. in mt)

    2. Press CONTINUE

16. Read the chart by placing the cursor on each chart trace "break point" and pressing the S key on the cursor. Also take readings immediately before and after midnight. Make certain that the before and after readings fall on the two separate days.

    It is not necessary to read each fluctuation of the chart trace. Instead select the points which define the trend of the line.

Limit the number of readings per day to about 14.

Take readings until the right side of the chart is reached. Then shift the chart to the left and fix to the digitizer table. When weekly charts are involved remove the chart for the first week and replace it with the chart for the next week. Go to Step #9 until end of month is reached.

When 425 points have been read the computer will print "425". This serves as a warning that only 25 more points may be read. For example, if 3 days remain the 25 points must be carefully spaced over this remaining time. If an additional reading is attempted the result will be "error".

17. When the H_a or H_b charts for the month have been read, start the reading of the remaining U.S.L. or D.S.L. chart.
    Follow steps 8 through 15.
    These readings are taken in the continuous mode. Press the "C" key one time only, and then follow the chart trace from left to right until the right limit is reached. Shift the chart or fix the next weekly chart, continue following the chart trace until the end of the month is reached.

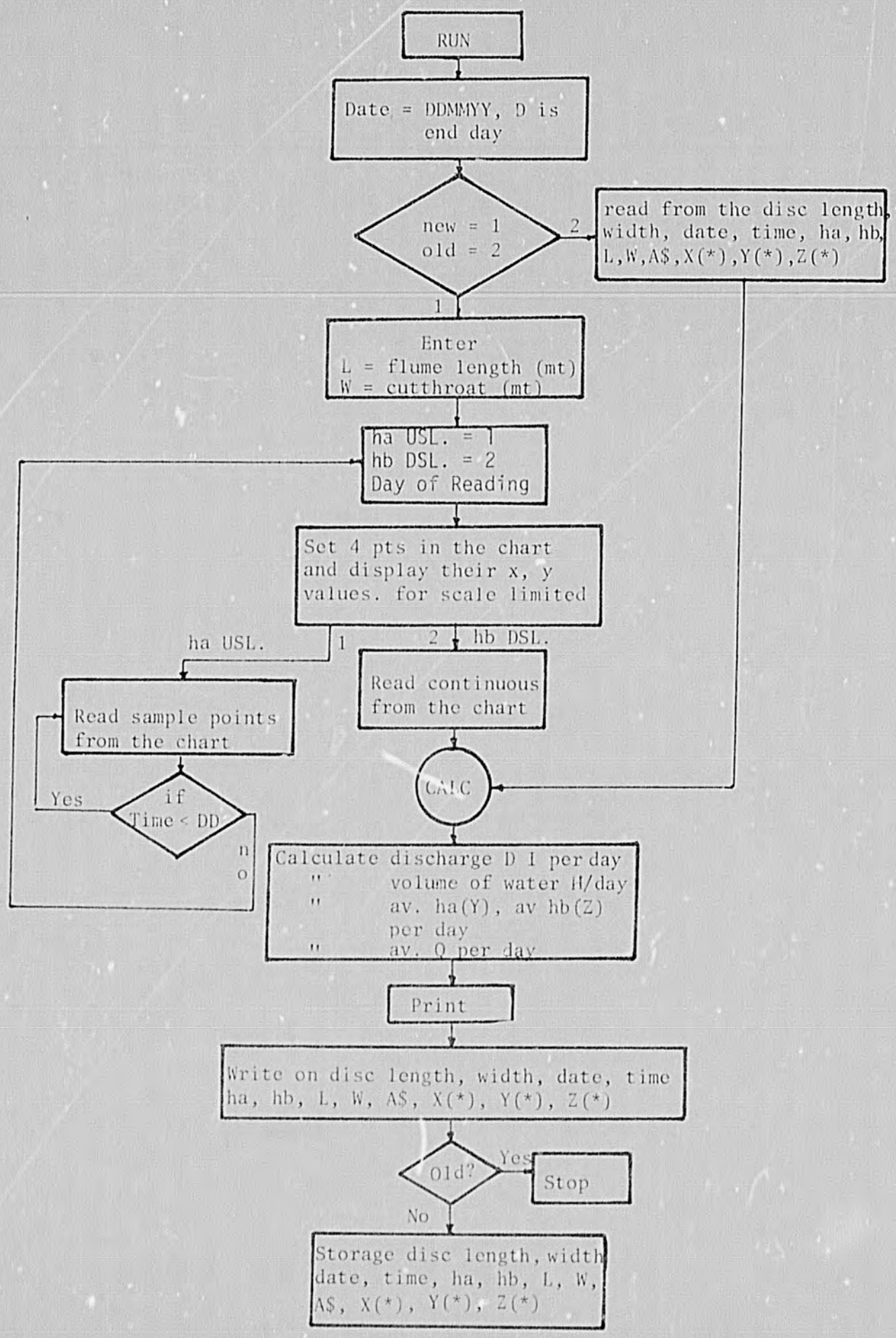
18. When "prepared by" appears in the display
    1. Type in the name of the operation
    2. Press CONTINUE, digitized values will be printed for examination

19. When "data is correct yes - 1" appears in the display
    1. Type 1 to store the results
    2. Press CONTINUE

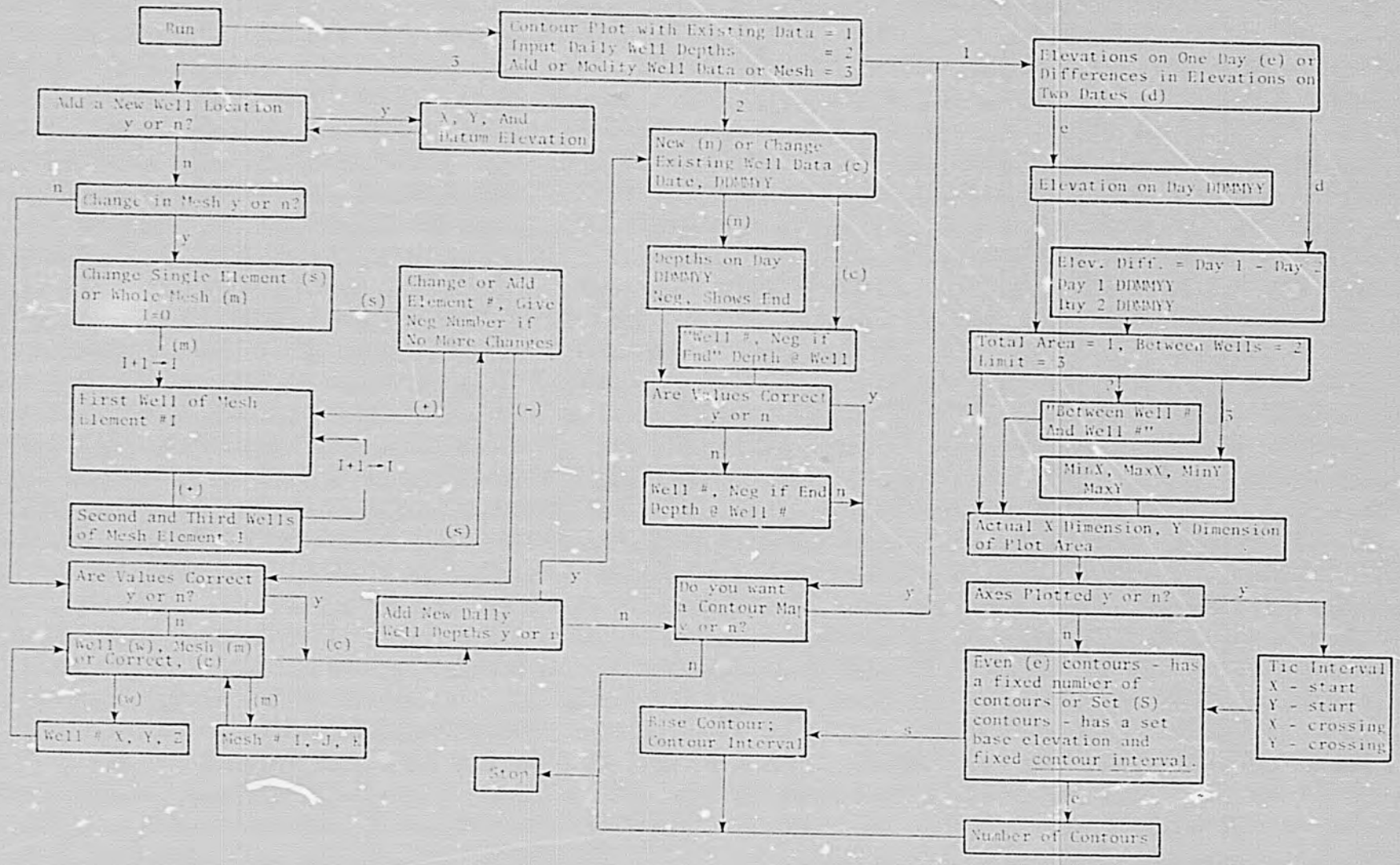
    or

1. if data is not correct type any number except 1 and repeat program.
2. Press CONTINUE

Flow Chart


RUN
Date = DDMMYY, D is end day
new = 1
old = 2
2
read from the disc length, width, date, time, ha, hb, L,W,A$,X(*),Y(*),Z(*)
1
Enter
L = flume length (mt)
W = cutthroat (mt)
ha USL. = 1
hb DSL. = 2
Day of Reading
Set 4 pts in the chart and display their x, y values. for scale limited
ha USL.
1
2
hb DSL.
Read continuous from the chart
Read sample points from the chart
Yes
if Time < DD
no
CALC
Calculate discharge D I per day
" volume of water H/day
" av. ha(Y), av hb(Z) per day
" av. Q per day
Print
Write on disc length, width, date, time ha, hb, L, W, A$, X(*), Y(*), Z(*)
Old?
Yes
Stop
No
Storage disc length, width date, time, ha, hb, L, W, A$, X(*), Y(*), Z(*)

DECISION MAP FOR WELL DATA INPUT AND CONTOUR PLOT



```
0: dim A[3,3],B[4,3],C[3,4],L[4,1],F[3,1],G[3,1],H[3,1]
1: dim L$[25],A$[16],S,K,E,F,P,A,B,C,D,S,W,X[445],Y[445],Z[445],X$[20]
2: dim D[44],S[445]
3: deg
4: "KAFER CO. SHAFER OR SEN"D$*dsp L$,wait 1000
5: enp "Date DDMMYY DD ... END DAY",A$
6: ent "NEW DATA=1  OLD DATA=2",J;if J=2;gto "OLD"
7: enp "PREPARED BY",X$
8: enp "FLUME SIZE(inches)",E,"CONTROL(meters)",W
9: 2.962+1.448/E-1A.1.51-.40/E-B;2.51-.3011n(E)C;.748-.064/E)D;1/D)D
10: .4/E+1001-  0.29/E+.01/E^2/5,001+A5)K;1.0fre(K/100)F
11: 100fre(K/100)-100000/E;int((K-100E/10000)K;F+1900)F
12: if J=2;gto "CALC."
13: 0)r14
14: "H":ent "DAY OF READING",r15
15: "Hb":enp "Hb U.S.L.=1 , Hb D.S.L.=2",G
16: dsp "Set lower extreme  ft & rt pts";wait 1500
17: red 4,r1,r2;red 4,r3,r4
18: dsp "upper rt,lt";red 4,r5,r6;red 4,r7,r8
19: enp " X val lower lt",E[1,1];enp " X val lower rt",E[2,1]
20: E+1,1)r14,1;E[2,1]DE[3,1]
21: 1)B[1,1]B[2,1]B[3,1]B[4,1];r1)B[1,2];r2)B[1,3];r3)B[2,2];r4)B[2,3]
22: r5)B[3,2];r6)B[3,3];r7)B[4,2];r8)B[4,3]
23: trn B[ ,*]B;mat B*B;mat C*B;mat C)B
24: enp "Y val lower lt",E[1,1];enp "Y val upper lt",E[3,1]
25: E[1,1]DE[2,1]DE[3,1]DE[4,1]
26: mat E)F;mat A*F)H
27: r14)I
28: if G=1;I+1)I;if I=425;prt I
29: if G=2;I+1)I
30: red 4,X,Y,G[1,1]+G[2,1]X+G[3,1]Y)I;H[1,1]+H[2,1]X+H[3,1]Y)Z
31: if G=2;if Y=X[I];if Y(X[I]+.5-2)Z[I];if I<P;gto 28
32: if G=2;if Y>=X[I];if X[I]<E;Z)Z[P];I)r14;gto "H"
33: if G=2;if Y>=P;Z)Z[P];gto "CALC."
34: if G=2;gto 30
35: I)X[I];Z)Y[I];if X[I]<r15;gto 28
36: gto "Hb"
37: "CALC.":
38: 0)I
39: I+1)I;if X[I]=0;if Y[I]=0;if Z[I]=0;gto "LIST"
40: if Y[I]=Z[I]=0;0)S[I];gto 43
41: if Z[I]/Y[I]<S;3.281^(B-1.975)AW^1.025Y[I]^B)D[I];jmp 2
42: 3.281^(B-1.975)AW^1.025(Y[I]-Z[I])^B/(-log(Z[I]/Y[I]))^D)D[I]
43: if I=1;D[1])M;gto 39
44: 43200(D[I]+M)(X[I]-X[I-1]))Q;D[I])M
45: Q+H)D[I])H
46: if int(X[I])>int(X[I-1]);0)H
47: Q+S[I-1])S[I]
48: gto 39
49: "LIST":
50: conv 124,27
51: wrt 701,"[&k1S"
52: fmt 2,25x,wrt 701,L$
53: wrt 701," [&k0S"
54: fmt 2,/,/;wrt 701.2
55: fmt 3,10x,f2.0,2x,f4.0;wrt 701.3,"DURING",E,F
56: wrt 701.2
57: fmt 4,3x,"Date",12x,"USL",12x,"DSL",12x,"av.Q",12x,"DAY V.",14x,"TOT V."
58: wrt 701.4
59: wrt 701,"[&0B"
60: fmt 5,20x,"Mt",13x,"Mt",11x,"Mt3/s",14x,"Mt3",17x,"Mt3",3x;wrt 701.5
61: wrt 701,"[&0A"
62: 0)I
63: I+1)I
64: I+R)R
65: Y[I]+Y)Y;Z[I]+Z)Z;if I=1;gto -2
66: if int(Y[I])=int(X[I-1]);gto -3
67: Y/R)Y;Z/R)Z
68: if Y=Z(0;0)Q,jmp 3
69: if Z/Y<5,3.281^(B-1.975)AW^1.025Y^B)Q,jmp 2
70: 3.281^(B-1.975)AW^1.025(Y-Z)^B/(-log(Z/Y))^D)Q
71: fmt 6,4x,f2.0,10x,f7.2,8x,f7.2,5x,f8.3,6x,f12.3,3x,f12.3
72: wrt 701.6,int(X[I]),Y,Z,Q,D[I],S[I]
```

```
74: if X[I+1]>0;gto 63
75: fmt 7,25x,"(design & analysis by M.HELAL & AZZA)";wrt 701.7
76: fmt 8,10x,"PREPARD BY:  ",c20;wrt 701.8,X$
77: if J=2;stp
78: if J=1;ent "DATA is CORRECT yes=1",H
79: if J=1;if H=1;open A$,46
80: if J=1;if H=1;asgn A$,1,0
81: if J=1;if H=1;sprt 1,L,W,A$,X[*],Y[*],Z[*]
82: "OLD":
83: if J=2;asgn A$,1,0
84: if J=2;rec 1,L,W,A$,X[*],Y[*],Z[*]
85: if J=2;disp L$,"   ",A$;stp
86: if J=2;gto 9
87: stp
*19022
```

B. PROGRAM OPERATION (Entry Points Reading)

Turn on the calculator, disc drive and printer then insert the disc (or insert tape in tape drive). Do the following operators:

1. Type Get "file name," press EXECUTE (for disc)

   or trk (number), ldf (number), press EXECUTE (for tape)

2. Press RUN

3. When "CUTTHROAT FLUME NUMBER," appears in the display

   1. Type # of Cutthroat

   2. Press CONTINUE

4. When "Farm No." appears in the display

   1. Type Farm #

   2. Press CONTINUE

5. When "Date DDMMYY" appears in the display

   1. Type the date where DD = day, MM = month and YY = years

   2. Press CONTINUE

6. When "flume length in meters" appears in the display

   1. Type the flume length (meters) (0.46 m<L< 2.74 m)

   2. Press CONTINUE

7. When "flume throat width in meters" appears in the display

   1. Type the flume throat width (meters)

   2. Press CONTINUE

8. When "area served in square meters" appears in the display

   1. Type the area in square meters

   2. Press CONTINUE

9. When "number of data points" appears in the display

   1. Type # of data points

   2. Press CONTINUE

10. When "time" appears in the display

    1. Type time with a period between hours and minutes after the hour with respect to midnight for example the time 2:25 p.m. type 14.25

    2. Press CONTINUE

11. When "h_a" appears in the display

    1. Type up stream level reading

    2. Press CONTINUE

12. When "h_b" appears in the display

    1. Type downstream level reading

    2. Press CONTINUE

13. Go to Step 10 for remainder of data points

14. When "changes?, 1 = yes, 0 = No" appears in display

    1. If yes type 1, press CONTINUE

        a. When "data set no I" appears in display type the number of set for change, Press CONTINUE

        b. When "time" appears in display type the time correct; Press CONTINUE

        c. When "h_a" appears in display type the U.S.L.; Press CONTINUE

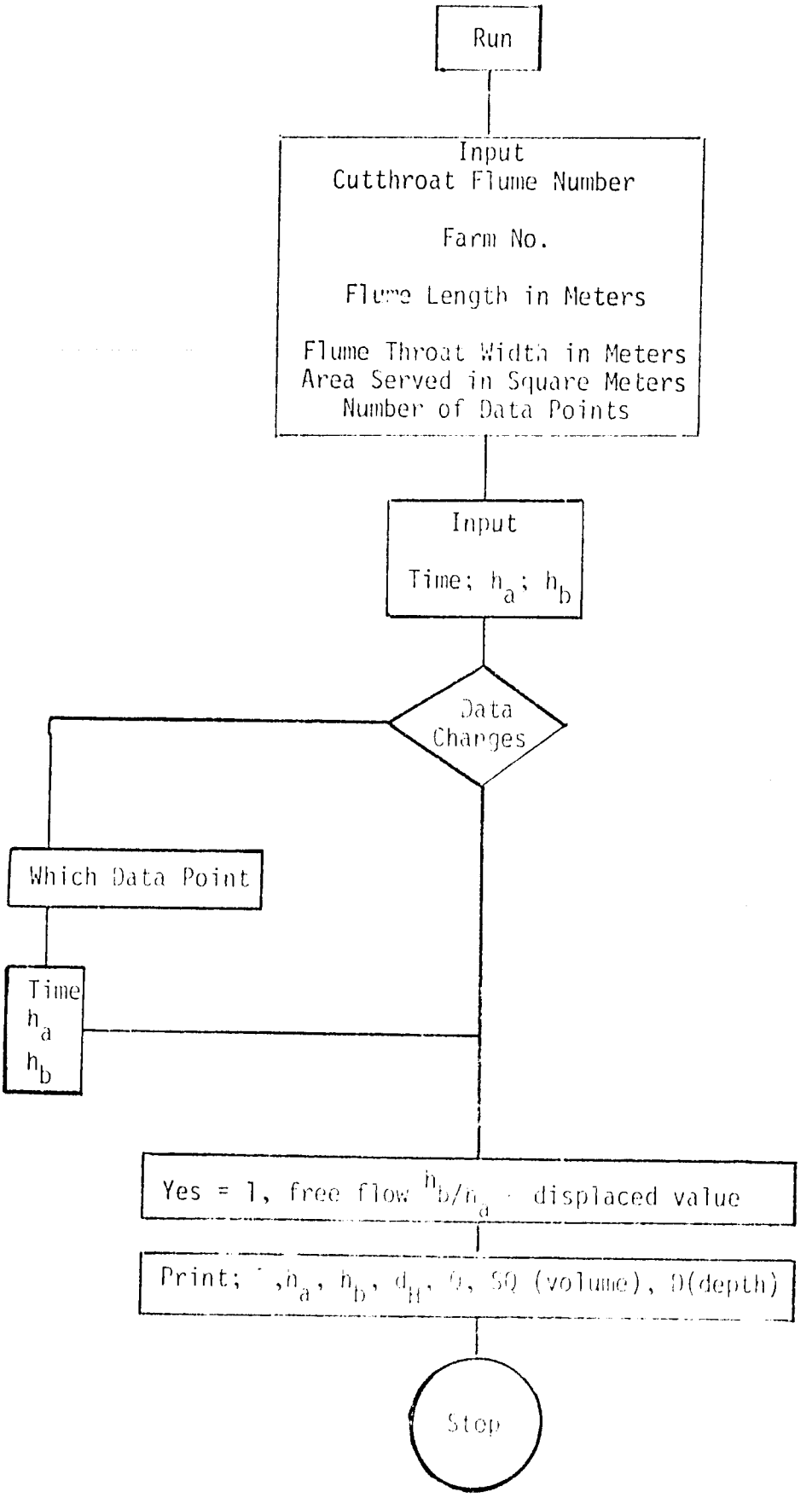
        d. When "h_b" appears in display type the D.S.L.; Press CONTINUE

        e. Go to Step 14

    2. If all data are correct, type 0, press CONTINUE

15. When "yes = 1, free flow hb/ha < (the submergence ratios)" appears in the display. This step is for the title only; if the submergence ratios on paper display are greater than the submergence ratio in display type 1; if not type 0, press CONTINUE

Flow Chart


Run
Input
Cutthroat Flume Number
Farm No.
Flume Length in Meters
Flume Throat Width in Meters
Area Served in Square Meters
Number of Data Points
Input
Time; h_a; h_b
Data Changes
Which Data Point
Time
h_a
h_b
Yes = 1, free flow h_b/h_a · displaced value
Print; h_a, h_b, d_H, Q, SQ (volume), D(depth)
Stop

```
0: dim L W,V,T[200],H[200],G[200],Q[200],D[200],E[200],P,S,J[5]
1: dim X[200],Y[200]
2: enp "CUTTHROAT FLUME NUMBER",V
3: enp "Form No.",N
4: enp "Date DDMMYY",K
5: 0)P
6: enp "flume length in meters",L;if flg13+(L(.45)+(L)2.75);cfg 13;jmp 0
7: enp "flume throat width in meters",W
8: enp "area served in square meters",S
9: enp "number of data points",Q
10: 2.762+1.448/L)B;1.418+.405/L)C;.748-.064/L)D;1/D)D
11: 2.51-.801ln(L))E;.485+.1807L-.0269L^2+.0102/L^2)F
12: 1)H
13: for I=H to Q;prt I;enp "Time",Y[I];enp "ha",H[I];enp "hb",G[I];next I
14: ent "changes ?,1=Yes,0=NO",J[2];if J[2]=0;gto 17
15: enp "data set no I",I;enp "TIME",Y[I],"Ha",H[I],"Hb",G[I]
16: gto 14
17: for I=H to Q
18: I-1)J
19: if I=1;0)A)T[1];next I
20: if frc(Y[I])-frc(Y[J])(0;100(Y[I]-Y[J]-.4)+A)A)T[I];gto +2
21: 100(Y[I]-Y[J])+A)A)T[I]
22: next I
23: for I=H to Q;G[I]/H[I])X[I];prt X[I];next I
24: spc ;prt F;dsp " yes=1 , FREE FLOW hb/ha(",F;enp "",G
25: for I=H to Q
26: if H[I]=G[I];0)Q[I];gto 29
27: if G[I]/H[I](F;1000B3.281^(C-1.975)W^1.025(H[I]/100)^C)Q[I];gto 29
28: 1000E3.281^(C-1.975)W^1.025((H[I]-G[I])/100)^C/(-log(G[I]/H[I]))^D)Q[I]
29: if I=1;jmp 3
30: 0)E[1]
31: E[I-1]+(6/100)((Q[I]+Q[I-1])/2)(T[I]-T[I-1]))E[I];100E[I]/S)D[I]
32: next I
33: 0)P
34: fmt 8,/,/;wrt 701.8
35: wrt 701.8;wrt 701.8
36: conv 124,27
37: wrt 701,"!n!&k1S"
38: if G=1;fmt 9,2x,"FREE FLOW CUTTHROAT FLUME DATA",/;wrt 701.9;gto 40
39: fmt 2,3x,"SUBMERGED CUTTHROAT FLUME DATA",/;wrt 701.2
40: wrt 701,"!&k0S"
41: fmt 1,30x,f6.0;wrt 701.1,"Date",K
42: fmt 9,22x,"Form No.",f3.1,4x,"Area",2x,f9.3,"mt2";wrt 701.9,N,S
43: fmt 8,/,/;wrt 701.8
44: fmt 3,30x,"for flume number";wrt 701.3
45: fmt 7,35x,f2.0
46: wrt 701.7,V
47: fmt 8,/,/;wrt 701.8
48: fmt 4,5x,"I",9x,"ha",9x,"hb",9x,"dh",9x,"Q",9x,"SQ",9x,"D";wrt 701.4
49: wrt 701,"!&JD"
50: fmt 6,4x,"min",9x,"cm",9x,"cm",9x,"cm",8x,"lps",8x,"m3",9x,"cm";wrt 701.6
51: wrt 701,"!&dA"
52: fmt 5,2x,f5.1,f10.1,f12.2,f10.2,f13.2,f10.2,f11.2
53: 1)H
54: for I=H to Q
55: wrt 701.5,T[I],H[I],G[I],H[I]-G[I],Q[I],E[I],D[I]
56: next I
57: fmt 2,40x,"(design & analysis by M.Helal)";wrt 701.2
58: stp
*24015
```

DISCHARGE COMPUTIONS FOR THE BENI MAGDOUL NYRPIC GATE

Program Description

This program calculates and rates and amounts of discharge through the Nyrpic Gate at the head of the Beni Magdoul Canal.

The input consists of date, water surface elevation in the approach forebay as taken from a recorder chart, and the width of gate opening.

The output is a tabulation of daily discharge volumes and summations for a calendar month.

Program Background

The Nyrpic Gate controls the rate of flow into the Beni Magdoul Canal. Its raised sill provides an excellent control free from submergence effects. Six parallel sluice gates for openings ranging from 10 to 45 centimeters control the flow. A seventh opening, 5 centimeters wide, has no closure gate. Flow through the gate can be either in the weir mode or in sluice gate mode.

Current meter measurements calibrated the gate and yielded the following discharge functions:

Weir Flow

$$Q = 1.443\ W(WL - 16.77)^{1.487}$$

Submerged Flow

$$Q = 0.4856\ W^{0.8429}(WL - 16.77)^{.6453}$$

The head at the change from weir to sluice flow is

$$H_i = 0.2765\ W^{-0.1869}.$$

These equations are incorporated into the program. Any physical changes to the gate would affects its rating. This would necessitate rerating the gate and deriving new discharge functions.

PROGRAM OPERATION

1. A. Turn on the calculator, disc drive, digitizer and the printer.

   B. Fixed the chart on the digitizer

2. A. Type get"file name"where the file name may be B.M.D. or any other name according to the site operation.

   B. Press EXECUTE

3. Press RUN

4. When "NEW DATA = 1 OLD DATA = 2" appears

   either

   A. Type 2 for old data

   B. Press CONTINUE

   Or

   A. Type 1 for new data

   B. Press CONTINUE; go to Step #6

5. When "Date = DDMMYY = DD is end Day of Month" appears

   A. Type the date of the last day of the month

   B. Press CONTINUE; go to Step #20

6. When "set lower extreme lft & rt pts.' appears

   A. Mark 4 points in the chart to read it (rectangle)

   B. Take the reading of the left and right lower points from the chart by pressing sample (S) key each time.

7. When "Upper rt. & lt." appears

   Read the upper right and left points with the sample (s) key.

8. When "X val. lower lt" appears

   A. Type the X value of the lower left (time in days)

   B. Press CONTINUE

9. When "X val lower rt." appears

   A. Type the X value of the lower right point (time in days)

   B. Press CONTINUE

10. When "Y val. lower lt." appears

   A. Type Y value of the lower left point (head in mt)

   B. Press CONTINUE

11. When "Y val. upper lt." appears

   A. Type Y value of the upper left point (head in mt)

   B. Press CONTINUE

12. When "Date = DDMMYY = DD is END day of Month" appears

   A. Type the date of the last day

   B. Press CONTINUE

13. When "No. of W max. (18)" appears

   A. Type the # of time periods during the month which have constant gate openings widths; which must not be more than 18

   B. Press CONTINUE

14. When "W(1)" appears

   A. Type the 1st time period gate opening width in meters

   B. Press CONTINUE

15. When "FROM" appears

   A. Type the starting date of the gate opening period;

      Example: 2 days 6 hours = 2.25

   B. Press CONTINUE

16. When "To" appears

   A. Type the end data of this gate opening period (same form as Step #15)

   B. Press CONTINUE

17. When "W(I)" appears where I changes from 2 to No W

    A. Type the Ith time period gate opening width in meters

    B. Press CONTINUE

18. When "To" appears

    A. Type the last day of this gate opening period

    B. Press CONTINUE

    C. Go to Step #17 until I = No of W

19. Take the reading of the chart with sample (s) Key, take around 14 readings per day.

    Press S key for each data point.

    Take readings within rectangle formed by 4 corner points.

    Press halt (H) to change the chart, and halt (H) at same point next page of chart to continue.

    After taking 400 readings this no. is printed to show you that you can take 50 more readings only.

20. When "TABL = 1, PLOT = 0" appears

    either

    A. Type 1 for taking the results by the printer

    B. Press CONTINUE

    or

    A. Type 0 for taking the results graphically

    B. Press CONTINUE; go to 23

21. When "No. of Copy" appears

    A. Type the # of copies needed

    B. Press CONTINUE

22. A. List consists of Date, USL, DAY V, TOTV. is printed

    B. All the data and results are stored in disc on a file named by date for new data and go to 31

23. When "X AXIS" is printed and when "From" appears

    A. Type the starting day for the graph; Example: 2 days 12 hours = 2.50

    B. Press CONTINUE

24. When "To" appears

    A. Type the end day of the graph (same form as Step #23)

    B. Press CONTINUE

25. When "Tic" appears

    A. Type the incremental units of the X axis

    B. Press CONTINUE

26. When "Step" appears

    A. Type the no. of TIC for which the number of the X value is written (1 is for every TIC mark X value is written; 2 is for value written every other TIC mark.

    B. Press CONTINUE

27. When "Y intercept" appears

    A. Type where the Y axis intercept the x axis

    B. Press CONTINUE

28. When "Y AXIS", "From", "To", "Tic", "Step" and "X intercept" appear do the same as from Step #23 to #27 for the X axis

29. For old data go to Step #32.

30. When "DATA IS CORRECT yes = 1" appears

    either

    A. Type 1 to store the data

    B. Press CONTINUE

    or

    A. Type Ø if date incorrect;

    B. Press CONTINUE, and repeat run

31. When "want another plot (yes = 1; no = 0)" appears

    A. Type 1 press CONTINUE for plotting, go to Step #23

    B. Type Ø press CONTINUE, go to #32

32. STOP

```
 0: dim D[430],A[3,3],B[4,3],C[3,4],E[4,1],F[3,1],G[3,1],H[3,1]
 1: dim T[430],S[430],I,J
 2: dim A$[6],X[430],Y[430],W[20],L[20],M[20],L$[20],K,E,F
 3: dsp
 4: dsp "B.MAG. DIS.PROG.";wait 500
 5: ent "NEW DATA=1  OLD DATA=2",J;if J=1;gto 10
 6: ent "Date =DDMMYY=DDis end DAY of Month",A$
 7: asgn A$,1,0
 8: sread 1,A$,X[*],Y[*],W[*],L[*],M[*],L$,K,E,F
 9: gto 29
10: dsp "set lower extreme lft & rt pts";wait 1500
11: red 4,r1,r2;red 4,r3,r4
12: dsp "upper rt,lt";red 4,r5,r6;red 4,r7,r8
13: enp " X val lower lt",E[1,1];enp "X val lower rt",E[2,1]
14: E[1,1]>E[4,1];E[2,1]>E[3,1]
15: 1>B[1,1]>B[2,1]>B[3,1]>B[4,1];r1>B[1,2];r2>B[1,3];r3>B[2,2];r4>B[2,3]
16: r5>B[3,2];r6>B[3,3];r7>B[4,2];r8>B[4,3]
17: trn B>C;mat C*>A;inv A>A;mat CE>F;mat AF>G
18: enp "Y val lower lt",E[1,1];enp "Y val upper lt",E[3,1]
19: E[1,1]>E[2,1];E[3,1]>E[4,1]
20: mat CE>F;mat AF>H
21: "RANI MAGDGUL">L$
22: enp "Date=DDMMYY=DDis END day of Month",A$;val(A$)>K;100frc(K/100)>F
23: 100frc((K-F)/10000)>E;int((K-F-100E)/10000)>K;F+1900>F
24: enp "No. of W max.(18)",A
25: 0>B
26: 1+B>B;if B=1;enp W[1],"FROM",L[1],"TO",M[1];jmp 0
27: enp W[B];M[B-1]>L[B];enp "TO",M[B]
28: if B<A;gto -2
29: 0>I>R;1>B
30: 1+R>R
31: if J=2;1+I>I>P;gto 37
32: I+1>I>P;if P=400;prt P
33: red 4,X,Y;G[1,1]+G[2,1]X+G[3,1]Y>X[I];H[1,1]+H[2,1]X+H[3,1]Y>Y[I]
34: jmp 2
35: 1+B>B
36: if X[I]>K;gto +3
37: if X[I]<M[B];W[B]>W;gto +2
38: gto -3
39: if Y[I]-16.77<=.2765W^(-.1869);1.443W(Y[I]-16.77)^1.487>L[20];gto +2
40: .4856W^.8427(Y[I]-16.77)^.6453>L[20]
41: if I=1;0>M[19];L[20]>L[19];if X[I]<K;gto 31
42: abs(X[I]-X[I-1])>W[20]
43: 43200W[20](L[20]+L[19])>W[19]
44: 0>T[I]
45: W[19]+M[19]>M[20]>S[I]
46: if X[I]>=R;R>T[I];1+R>R;0>M[20]
47: 0>D[I]
48: W[19]+D[I-1]>D[I]
49: if int(X[I])<K;L[20]>L[19];M[20]>M[19];if J=2;gto 31
50: if J=1;if X[I]<K;gto 32
51: enp "TABL=1 , PLOT=0",O;if O=0;gto 75
52: enp "NO. OF COPY",V
53: 0>H
54: 1+H>H
55: conv 124,27
56: wrt 701,"in:%k1S"
57: fmt 2,2%;wrt 701,I
58: wrt 701,"%.0f"
59: fmt 2,/,/;wrt 701,2
60: fmt 3,10x,"B.MAG.",2x,F4.0;wrt 701,3,"DURING",E,F
61: wrt 701,2
62: fmt 4,3x,"Date",12x,"USL",12x,"DAY V.",14x,"TOT V.";wrt 701,4
63: wrt 701,"%dD"
```

```
64: fmt 5,20x,"Mt",13x,"Mt3",17x,"Mt3",3x;wrt 701.5
65: wrt 701,":&dA"
66: 0)I
67: 1+I)I
68: if T[I]=0;gto -1
69: fmt 6,4x,f2.0,10x,f7.2,6x,f10.0,5x,f17.0
70: wrt 701.6,T[I],Y[I],S[I],D[I]
71: if I<P;gto -4
72: fmt 7,25x,"(design & analysis by M.Helal)";wrt 701.7
73: if H<V;wrt 701.2;gto 95
74: gto 95
75: prt "XAXIS";enp "From",r1,"To",r2,"Tic",r3,"Step",r4,"Yintercept",r5
76: prt "YAXIS";enp "From",r6,"To",r7,"Tic",r8,"Step",r9,"Xintercept",r0
77: pen# 4
78: fxd 0
79: scl r1,r2,r6,r7
80: xax r5,r3,r1,r2,r4
81: yax r0,r8,r6,r7,r9
82: csiz 1.65,2,1,0
83: plt r1+(r2-r1)/2,r6-1.3r8,0;lbl "TIME [days]      des&ana byHELAL"
84: plt (r1+r2)/2,r7;lbl L$
85: plt (r1+r2)/2,r7-r8;lbl E,"    ",F
86: csiz 1.65,2,1,90
87: plt r1-r3,r7+r8,0;lbl "T.DIS.Q[mt3]"
88: pen# 3
89: 1)I
90: plt X[I] D[I]
91: if I<P;1+I)I;gto -1
92: pen
93: if J=1;ent "DATA is CORRECT yes=1",H
94: if J=1;if H=1;0)W[19])W[20])M[19])M[20])L[19])L[20]
95: if J=1;if H=1;open A$,30
96: if J=1;if H=1;asgn A$,1,0
97: if J=1;if H=1;sprt 1,A$,X[*],Y[*],W[*],L[*],M[*],L$,K,E,F
98: enp "Want Another Plot (yes=1;no=0)",W;if W=1;gto 79
99: stp
*15867
```

WATER TABLE CONTOUR PROGRAM

Program Description

This program is used to analyze and portray observation well water level data from the study areas.

The input consists of fixed data and of variable data.

The fixed data include:

a. The X and Y coordinates of the canals and drainage ditches

b. The X and Y coordinates of each observation well

c. The elevation (Z coordinate) of the top of casing for each well.

d. The triangular mesh into which the well net work is divided.

d. Specific yield.

The variable data include:

a. Dates of observation

b. Distance from top of well casing to water level in the well.

The output consists of:

a. Contour map of ground water elevations.

b. Change in ground water elevation between two dates

c. Contour map of depth to ground water

d. Print out of:

1. X, Y, Z coordinates of wells

2. Division of well network into triangular mesh

3. Ground water elevations for a given day

4. Area bounded by wells

5. Average water table elevation change

6. Specific yield

7. Change in water volume under well field

8. Equivalent average water depth change.

9. Area of stydy region

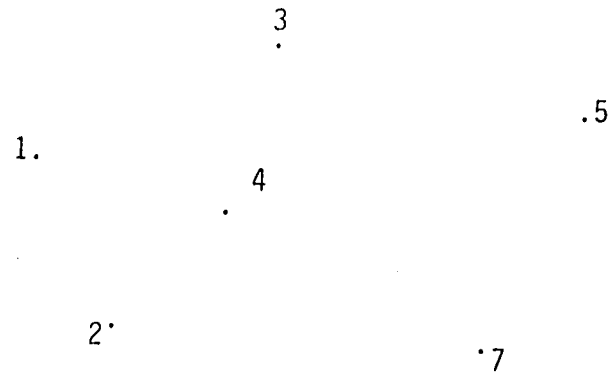
10. Total change in volume

11. Change in ground water elevation between two selected dates

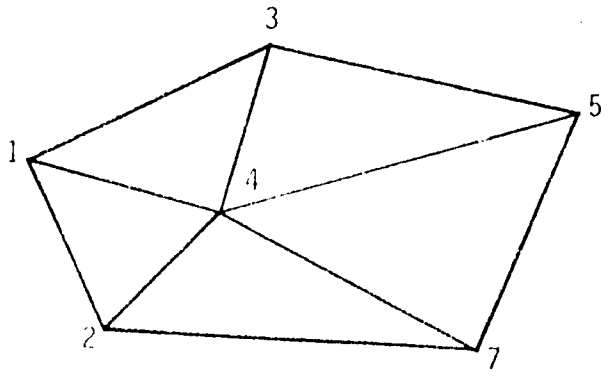
Program Background*

1. Establishing the Mesh

The procedure is best illustrated by example. Imagine that the network consists of seven wells as illustrated below:



The network must be divided into convenient triangles. A possible arrangement is shown below

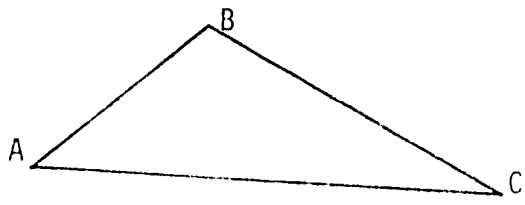


* Water Table Contour Program (WTCP), J. C. Loftis

Each mesh element is simply a triangle which is specified by indicating the three wells (I, J, K) which make up its corners. For this example, the mesh is:

Mesh #	I	J	K
1	1	3	4
2	1	4	2
3	2	4	7
4	3	6	4
5	4	6	7
6	3	5	6

2. <u>Area bounded by wells</u>



Area ABC = $P(P-\overline{AB})\ (P-\overline{BC})\ (P-\overline{AC})$

Where

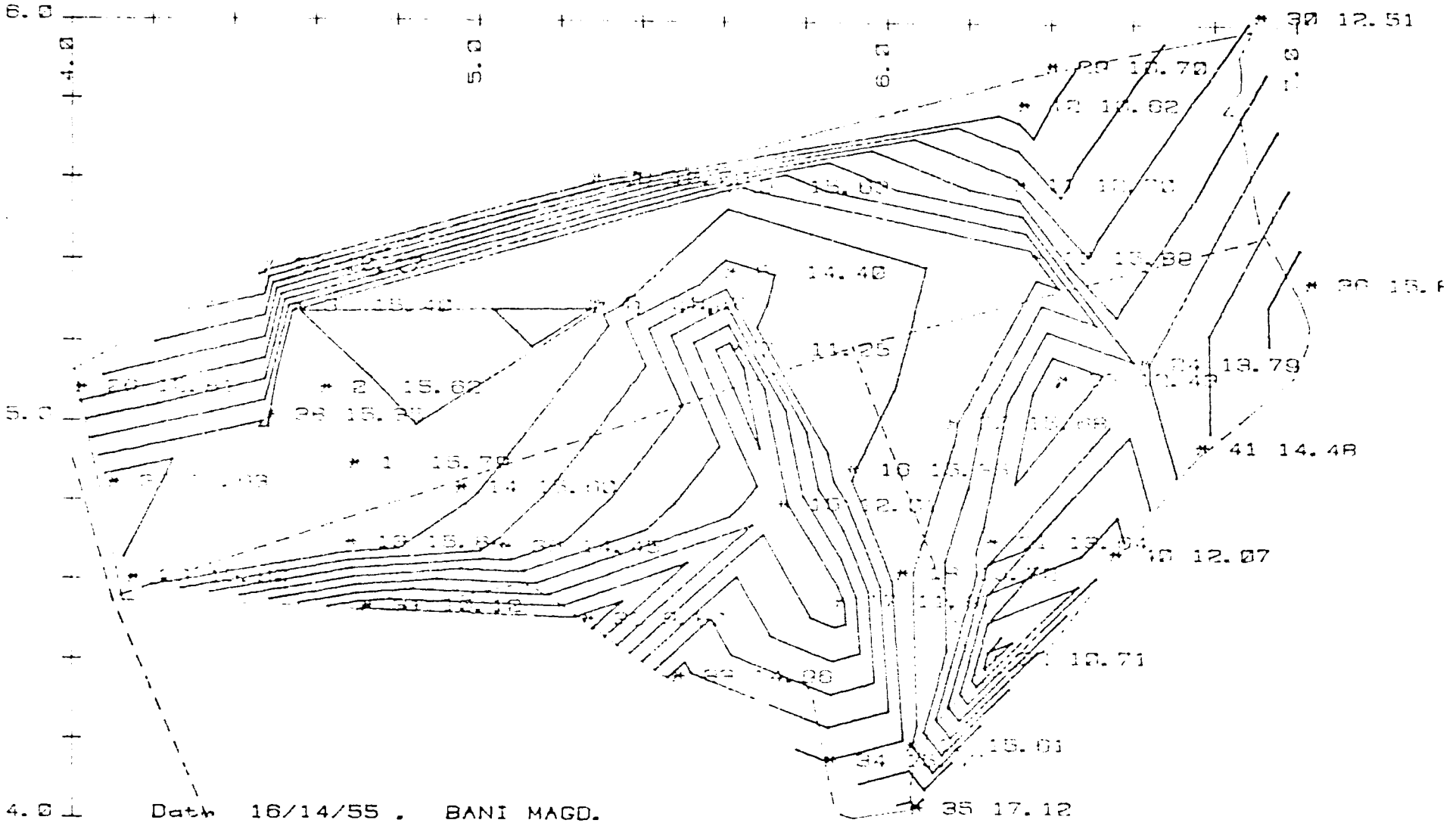
$P = .5(\overline{AB}+\overline{BC}+\overline{AC})$

WELL

#	X	Y	Z
1	4.68	4.[illegible]	17.04
2	4.61	5.07	16.98
3	4.54	5.07	16.98
4	5.26	5.28	16.87
5	5.28	5.29	16.97
6	5.28	5.37	16.97
7	5.61	5.17	16.94
8	5.66	5.36	16.98
9	5.61	5.57	16.79
10	6.35	5.49	17.14
11	6.31	5.53	16.95
12	6.32	5.[illegible]	16.93
13	4.67	4.68	[illegible]
14	4.94	4.82	16.85
15	5.73	4.79	[illegible]
16	5.90	4.87	16.93
17	5.87	4.54	[illegible]
18	6.02	4.61	16.95
19	6.24	4.18	[illegible]
20	6.14	[illegible]	[illegible]
21	6.24	[illegible]	17.09
22	6.24	4.40	17.01
23	6.41	5.10	[illegible]
24	6.61	5.14	16.91
25	4.14	4.59	17.45
26	4.11	5.07	[illegible]
27	4.47	5.32	[illegible]
28	[illegible]	5.57	[illegible]
29	5.39	5.09	[illegible]
30	[illegible]	5.21	[illegible]
31	4.21	[illegible]	[illegible]
32	5.25	4.47	[illegible]
33	5.47	4.35	[illegible]
34	5.84	4.14	16.03
35	6.15	4.62	17.57
36	5.02	5.34	16.50
37	4.09	4.93	16.95
38	4.47	5.60	17.09
39	5.05	4.67	[illegible]
40	6.54	4.66	16.72
41	6.75	4.53	16.78

MESH

#	I	J	K
1	22	21	24
2	22	19	21
3	19	18	21
4	19	17	18
5	38	26	27
6	21	23	24
7	21	20	23
8	18	20	21
9	18	16	20
10	17	16	18
11	17	15	16
12	30	37	26
13	36	25	37
14	23	10	24
15	20	10	23
16	20	8	10
17	16	8	20
18	16	7	8
19	15	7	16
20	15	6	7
21	15	14	6
22	13	1	14
23	14	1	6
24	24	11	12
25	24	10	11
26	7	6	8
27	1	4	6
28	1	2	4
29	10	9	11
30	10	8	9
31	6	9	8
32	6	5	9
33	6	4	5
34	38	13	25
35	2	4	3
36	4	3	5
37	9	12	11
38	5	3	9
39	36	1	13
40	30	2	1
41	38	3	2
42	38	27	3
43	13	31	25
44	13	14	39
45	13	39	31
46	39	32	31
47	37	15	32
48	15	39	14
49	15	17	33
50	15	33	32
51	17	18	17
52	17	34	33
53	19	22	35
54	19	35	34
55	22	21	47
56	22	40	35
57	24	21	40
58	24	40	41
59	24	36	41
60	21	22	36
61	24	39	30
62	24	12	29
63	20	27	12
64	7	26	12
65	3	28	9
66	3	27	28
67	17	19	34



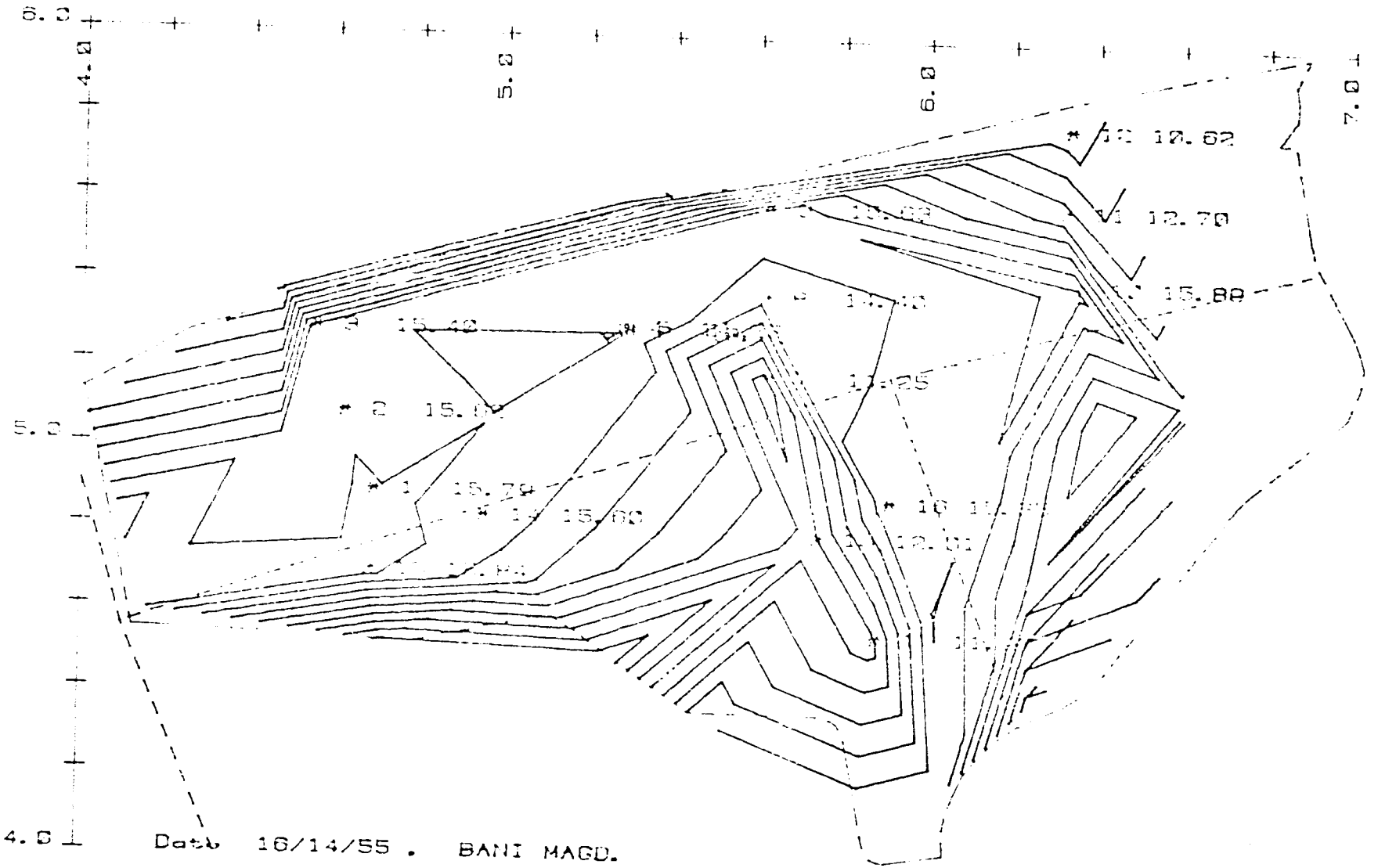
Date 16/14/55 . BANI MAGD.

Dim. with K. Meter X-dim. +620 . Y-dim. +810

computer system by: HELAL

------ irrigation syst.

——— drainage syst.



Date 16/14/55 . BANI MAGD.

Dim. with K. Meter X-dim. +020 . Y-dim. +810

Pump Star system by: HELAL

------ irrigation syst.

——— drainage syst.

USERS' INSTRUCTIONS

WATER TABLE CONTOUR PROGRAM

1. a. Turn on the calculator, disk drive, printer and plotter

   b. Put the disk in the disk drive

   c. Install paper in the plotter and locate the points P1 and P2 to define whatever plot area is desired.

2. a. Type get "File Name"

   b. Press EXECUTE

3. Press RUN

4. When "Cont = 1, well data = 2, Mesh = 3" appear either

   a. Type 1 to produce a contour plot with exisiting data

   b. Press CONTINUE, go to Step #40

   or

   a. Type 2 to input a new set of daily water depths

   b. Press CONTINUE, go to Step #29

   or

   a. Type 3 to add or modify existing well data or mesh

   b. Press CONTINUE

5. When "Add new well, y or n" appear

   a. Type y to add new well

   b. Press CONTINUE

   or

   a. Type n for no addition

   b. Press CONTINUE

   c. go to Step #9

6. When "X coordinate of well 1" appear

   a. Type the X coordination of the new well

   b. Press CONTINUE

7. When "Y coordinate of well I" appear

   a. Type the Y coordinate

   b. Press CONTINUE

8. When "Measure Pt. elev. of well I" appear

   a. Type the datum of the elevation

   b. Press CONTINUE

   c. Go to Step #5

9. When "change Mesh, Y or n" appear

   either

   a. Type Y for change Mesh

   b. Press CONTINUE

   or

   a. Type n for no changing

   b. Press CONTINUE

   c. Go to Step #17

10. When "single element(s), whole Mesh (m)" appear

    either

    a. Type s to change 1 mesh element

    b. Press CONTINUE

    or

    a. Type m to change all the meshs

    b. Press CONTINUE

    c. Go to Step #12

11. When "change/add elem' t # (neg. of end)"

    either

    a. Type the # of mesh

    b. Press CONTINUE

    or

a. Type neg. # for no changes

b. Press CONTINUE

c. Go to Step #17

12. When "well I of Mesh" appear

either

a. Type 1st well of mesh element #I

b. Press CONTINUE

13. When "well J of Mesh I" appear

a. Type the 2nd well of mesh element #I

b. Press CONTINUE

14. When "well K of Mesh I" appear

a. Type the 3rd well of mesh element #I

b. Press CONTINUE

15. If change whole mesh go to Step #11

16. Go to Step #11

17. A list of all wells and meshs are printed

18. When "Are value correct, y or n" appear

either

a. Type n to make corrections

b. Press CONTINUE

or

a. Type y for no corrections

b. Press CONTINUE

c. Go to Step #28

19. When "Well (w), Mesh (m), or correct (c)" appear

either

a. Type w for well corrections

b. Press CONTINUE

or

a. Type m for mesh corrections

b. Press CONTINUE

c. Go to Step #24

or

a. Type c for no corrections

b. Press CONTINUE

c. Go to Step #17

20. When "Well #" appear

a. Type the well #

b. Press CONTINUE

21. When "X" appear

a. Type the x dimension

b. Press CONTINUE

22. When "Y" appear

a. Type the Y dimension

b. Press CONTINUE

23. When "Z" appear

a. Type the Z dimension

b. Press CONTINUE

c. Go to Step #19

24. When "Element #" appear

a. Type the # of mesh element

b. Press CONTINUE

25. When "I" appear

a. Type 1st well

b. Press CONTINUE

26. When "J" appear

    a. Type 2nd well

    b. Press CONTINUE

27. When "K" appear

    a. Type 3rd well

    b. Press CONTINUE

    C. Go to Step #17

28. When "New daily well depths, y or n" appear

    either

    a. Type y to enter new daily well depthes

    b. Press CONTINUE

    or

    a. Type n for no entering

    b. Press CONTINUE

    c. Go to Step #39

29. When "New (n)/change exist well data (c)"

    either

    a. Type n for new well data

    b. Press CONTINUE

    or

    a. Type c for change well data

    b. Press CONTINUE

30. When "Date; DDMMYY" appear

    a. Type the date

    b. Press CONTINUE

31. For change existing well data go to Step #33

32. When "depth of well I" appear, i=1 to 100

either

a. Type depth on day DDMMYY

b. Press CONTINUE

c. Go to Step # 32

or

at end of wells go to step # 35

33. When "well # (neg if end)"

either

a. Type the well #

b. Press CONTINUE

or

a. Type neg. # for no more entering

b. Press CONTINUE

c. Go to Step # 35

34. When "depth at well I" appear

a. Type the depth

b. Press CONTINUE

c. Go to Step # 33

35. A table of the depth and elevation of each well is printed

36. When "are values correct, y or n" appear

either

a. Type y for no corrections

b. Press CONTINUE

c. Go to Step # 39

or

a. Type n for corrections

b. Press CONTINUE

37. When "Well number I: appear

either

a. Type the well #

b. Press CONTINUE

or

a. Type neg. #

b. Press CONTINUE

c. Go to Step #39

38. When "depth of well well I" appear

a. Type the depth

b. Press CONTINUE

c. Go to Step #36

39. When "Do you want contour Map, y or n" appear

either

a. Type y for making contour map

b. Press CONTINUE

c. Go to Step #40

or

a. Type n for no contour map

b. Press CONTINUE

c. Stop

40. When "Elev. (e) or elev. difference (d)" appear

either

a. Type e for elevations on one day

b. Press CONTINUE

or

a. Type d for differences in elevations on two days.

b. Press CONTINUE

c. Go to Step # 42

41. When "elev. on day, DDMMYY" appear

a. Type the date

b. Press CONTINUE

c. Go to Step # 47

42. When "Day 1, DDMMYY (elev diff = day 1 - day 2)appear

a. Type the 1st day date

b. Press CONTINUE

43. When "day 2, DDMMYY (elev diff = day 1 - day 2)appear

a. Type 2nd day date

b. Press CONTINUE

44. The results are printed

45. When "area of study region, sq. meters" appears

a. Enter the area in square meters

b. Press CONTINUE

46. When "specific yield" appears

a. Enter the specific yield

b. Press CONTINUE

47. When "Tot area = 1, Blwn wells = 2, limit = 3" appear either

a. Type 1 for total area

b. Press CONTINUE

c. Go to Step #51

or

a. Type 2 for between wells

b. Press CONTINUE

or

a. Type 3 for limit

b. Press CONTINUE

c. Go to Step #50

48. When "between well #" appear

a. Type 1st well #

b. Press CONTINUE

49. When "And well #" appear

a. Type 2nd well #

b. Press CONTINUE, go to Step #51

50. When "Min X", "Max X", "Min Y" and "Max Y" appear sequentially

a. Type these values each time

b. Press CONTINUE

51. When "Axes plotted, y or n?" appear

either

a. Type y for plotting axes

b. Press CONTINUE

or

a. Type n for plotting without axes

b. Press CONTINUE

52. When "even (e) or set (s) contours" appear

either

a. Type e to have a fixed # of contours

b. Press CONTINUE

or

a. Type s to have a fixed contour interval

b. Press CONTINUE

c. Go to Step #54

53. When "# of contours" appears

    a. Type the # of contours

    b. Press CONTINUE

    c. Go to Step #56

54. When "Ho, the lowest contour value" appear

    a. Type the lowest value

    b. Press CONTINUE

55. When "contour difference" appear

    a. Type the contour difference

    b. Press CONTINUE

56. A plotting is done

    when "Another plot, y or n" appear

    either

    a. Type y for plotting

    b. Press CONTINUE

    c. Go to Step #40

    or

    a. Type n for no plotting

    b. Press CONTINUE

    c. STOP

```
0: dim S$[5],A,A$[8],A[100],X[100,3],M[100,3],J[4],B,B$[8],B[100],C[100]
1: dim Y[2],Z[2],D[50],E[50],C$[10],D$[10]
2: wrt 701,"PGMI MAGDO", HYDROLOGIC UNIT"
3: wrt 701,"WATER TABLE ELEVATIONS"
4: ent "Cont=1,Well Data=2,Mesh=3",C
5: gto "CONTR";if C>1;gto "DATA";if C>2;gto "MESH";if C>3;gto "HODO"
6: "MESH":asgn "C.D.M",1;sread 1,X[*],M[*]
7: ent "Add new well, y or n",S$;0>I;if S$="n";gto "MESH1"
8: I+1>I;if X[I,1]#-100;jmp 0
9: dsp "X coordinate of Well",I;ent "",X[I,1]
10: dsp "Y coordinate of Well",I;ent "",X[I,2]
11: dsp "Measure Pt. Elev. of Well",I;ent "",X[I,3];jmp -4
12: "MESH1":ent "Change Mesh, y or n",S$;if S$="n";gto "LIST"
13: ent "Single Element(e),Whole Mesh(m)",S$;if S$="m";1>I;jmp 2
14: ent "Change/Add Elem't #(neg if end)",I;if I<0;gto "LIST"
15: dsp "Well I of Mesh",I;ent "",M[I,1]
16: if M[I,1]<0;-100>M[I,1];gto "LIST"
17: dsp "Well J of Mesh",I;ent "",M[I,2]
18: dsp "Well K of Mesh",I;ent "",M[I,3];if S$="m";I+1>I;jmp -3
19: jmp -5
20: "LIST":
21: fmt 1,z,10x,"WELL",75x,"MESH",/,6x,"#",7x,"X",9x,"Y",9x,"Z",49x,"$"
22: fmt 2,9x,"I",9x,"J",9x,"K",/;wrt 701.1;wrt 701.2;0>I
23: fmt 3,f8.0,3f10.2;fmt 4,76x,4f10.0;fmt 5,f8.0,3f10.2,30x,4f10.0
24: I+1>I
25: if X[I,1]#-100 and M[I,1]=-100;wrt 701.3,I,X[I,1],X[I,2],X[I,3];jmp -1
26: if X[I,1]#-100 and M[I,1]#-100;jmp 4
27: if X[I,1]=-100 and M[I,1]#-100;wrt 701.4,I,M[I,1],M[I,2],M[I,3];jmp -3
28: ent "Are values correct, y or n",S$;if S$="y";gto "DATA1"
29: jmp 2
30: wrt 701.5,I,X[I,1],X[I,2],X[I,3],I,M[I,1],M[I,2],M[I,3];jmp -6
31: ent "Well(w), Mesh(m), or Correct(c)",S$;if S$="c";gto "LIST"
32: if S$="w";ent "Well #",I;ent "X",X[I,1],"Y",X[I,2],"Z",X[I,3];jmp -1
33: ent "Element #",I;ent "I",M[I,1],"J",M[I,2],"K",M[I,3];jmp -2
34: "DATA1":asgn "C.D.M",1;sprt 1,X[*],M[*]
35: ent "New Daily Well Depths, y or n",S$;if S$="n";gto "CONTR1"
36: "DATA":asgn "C.D.M",1;sread 1,X[*],M[*]
37: ent "New(n)/Change Exist Well Data(c)",B$,"Date, DDMMYY",D$;val(D$)>B
38: cll "DATE"(B);if B$="c";asgn D$,1,0,X;sread 1,A,A$,A[*];jmp 6
39: for I=1 to 100
40: dsp "Depth @ Well",I;ent "",A[I]
41: if X[I+1,1]=-100;X[I,3]-A[I]>A[I];gto "LOAD"
42: X[I,3]-A[I]>A[I]
43: next I;jmp 2
44: ent "Well #(neg if end)",I;if I<0;jmp 2
45: dsp "Depth at Well",I;ent "",A[I];X[I,3]-A[I]>A[I];jmp -1
46: "LOAD":fmt 1,2/,10x,"Depths on Day",c10,c11;wrt 701.1,A$,B$
47: fmt 4,10x,"Elevation of Water Table"
48: wrt 701.4
49: if S$="d";fmt 2,/,"Well No.     Depth (meters)     Elevation (meters)",/
50: if S$="s";fmt 2,/,"Well No.      Diff.Depth(meters)"
51: wrt 701.2
52: fmt 3,f6.0,10x,f8.2,11x,f8.2
53: 1>I
54: if X[I,1]=-100;jmp 4
55: if S$="d";X[I,3]-A[I]>r99;wrt 701.3,I,A[I]
56: if S$="s";wrt 701.5,I,X[I,3]-A[I]>r99,A[I]
57: I+1>I;jmp 3
58: if S$="d";fmt 4,/,"Data Values Correct, y or n",S$;if S$="y";jmp 5
59: ent "Well Number",I;if I<0;jmp 4
60: dsp "Depth @ Well",I;ent "",A[I];X[I,3]-A[I]>A[I]
61: X[I,3]-A[I]>r99
62: fmt 5,"Well",f5.0," has a Water Depth of",f8.3;wrt 701.5,I,r99;jmp -4
63: if B$="n";gto 12
64: open D$,5
```

BEST AVAILABLE DOCUMENT

```
66: asgn D$,1,0,X
67: sprt 1,A,A$,A[*],"end"
68: "CONTR1":ent "Do you want Contour Map, y or n",S$;if S$="n";stp
69: "CONTR":if L#3;asgn "C.D.M",1;sread 1,X[*],M[*]
70: ent "Elev. (e) or Elev. Difference(d)",S$;0)J;if S$="d";1)J;jmp 3
71: ent "Elev.onDay,DDMMYY",D$;val(D$))E
72: asgn D$,1,0,X;sread 1,A,A$,A[*];jmp 7
73: ent "Day1,DDMMYY (Elev Diff=Day1-Day2",D$;val(D$))E
74: asgn D$,1,0,X;sread 1,A,A$,A[*]
75: fmt ,/,"DAY1=",c10;wrt 701,A$
76: ent "Day2 DDMMYY (Elev Diff=Day1-Day2",D$;val(D$))E
77: asgn D$,1;sread 1,B,B$,B[*]
78: fmt ,/,"DAY2=",c10;wrt 701,B$
79: "MISSING DATA":1)I
80: "MD1":if X[I,1]=-100;gto "spt1"
81: if X[I,3]=A[I]$-9;I+1)I;jmp -1
82: 1)J;0)r80
83: if X[J,1]=-100;jmp 4
84: if X[J,3]=A[J]=-9;J+1)J;jmp -1
85: (X[I,1]-X[J,1])^2+(X[I,2]-X[J,2])^2)D[J]
86: D[J]+r80)r80;J+1)J;jmp -3
87: 1)J,0)r81
88: if X[J,1]=-100;jmp 3
89: if X[I,3]=A[I]=-9;J+1)J;jmp -1
90: r80/D[J])E[J];E[J]+r81)r81;J+1)J;jmp -2
91: 1)J;0)r82
92: if X[J,1]=-100;jmp 3
93: if X[I,3]=A[I]=-9;J+1)J;jmp -1
94: E[J]/r81*A[J]+r82)r82;J+1)J;jmp -2
95: r82)A[I];I+1)I;gto "MD1"
96: "spt1":
97: if S$="e";gto "spt2"
98: 1)I
99: "MD2":if X[I,1]=-100;gto "spt2"
100: if X[I,3]=B[I]$-9;I+1)I;jmp -1
101: 1)J;0)r80
102: if X[J,1]=-100;jmp 4
103: if X[J,3]=B[J]=-9;J+1)J;jmp -1
104: (X[I,1]-X[J,1])^2+(X[I,2]-X[J,2])^2)D[J]
105: D[J]+r80)r80;J+1)J;jmp -3
106: 1)J;0)r81
107: if X[J,1]=-100;jmp 3
108: if X[I,3]=B[J]=-9;J+1)J;jmp -1
109: r80/D[J])E[J];E[J]+r81)r81;J+1)J;jmp -2
110: 1)J;0)r82
111: if X[J,1]=-100;jmp 3
112: if X[J,3]=B[J]=-9;J+1)J;jmp -1
113: E[J]/r81*B[J]+r82)r82;J+1)J;jmp -2
114: r82)B[I];I+1)I;gto "MD2"
115: "spt2":
116: if S$="e";jmp 12
117: fmt 7,10x,"Depth on Day",c10,30x,"Depth on Day",c11;wrt 701.7,A$,B$
118: wtb 701,"Well No.      Depth (meters)     Elevation (meters)      "
119: wtb 701,"Well No.      Depth (meters)      Elevation (meters";wtb 701,13,10
120: 1)I
121: I+1)I
122: if X[I,1]=-100;jmp 4
123: fmt 8,f2.0,10x,f6.2,11x,f8.2,10x,f6.0,10x,f8.2,11x,f8.2
124: wrt 701,8,I,X[I,3],A[I],A[I],I,X[I,3]-B[I],B[I]
125: gto 124
126: for I=1 to 100,A[I]-B[I]>A[I];next I
127: cll "MAPS"
128: sfg 0;gto "LOAD"
129: "spt3":
130: ent "Tot Area=1,Btwn Wells=2,Limit=3",C;if C=1;1)K;100)L;jmp 3
131: if C=2;ent "Between Well #",K,"And Well #",L;jmp 5
```

```
132: ent "MinX",W,"MaxX",X,"MinY",Y,"MaxY",Z;W)r1;X)r2;Y)r3;Z)r4;jmp 7
133: 0)I
134: I+1)I;if X[I,1]#-100;jmp 0
135: I-1)L
136: 10000000)W)Y;-W)X)Z;0)I
137: for I=K to L;min(W,X[I,1]))W;min(Y,X[I,2]))Y;max(X,X[I,1]))X
138: max(Z,X[I,2]))Z;next I
139: if C=3;1)K
140: 3)Q;2)R
141: 1)I;1)J[1];2)J[2];3)J[3];1)J[4]
142: ent "Axes plotted, y or n?",S$
143: pen# 4;.2)r80;4)r83;4)r84
144: 6)r81;4)r82
145: scl 3.8039,8.7604,3.8011,7.0905
146: csiz .9,1.5,.9,0
147: if S$="y";fxd 1;xax 6,.2,4,7,5;yax 4,.2,4,6,5;fxd 2
148: pen# 1;fxd 0;plt r83+r80,r84;lbl "Date  ",A$," , ",B$," BANI MAGD."
149: plt r83+r80,r84-.5r80;lbl "Dim. with K.Meter X-dim.+620 , Y-dim.+810"
150: plt r83+r80,r84-r80;lbl "computer system by: HELAL"
151: line 2,1;plt 4.33,4;plt 4.1,4.55;plt 4,4.91;pen
152: plt 4.1,4.55;plt 5.91,5.19;plt 6.9,5.46;pen
153: plt 5.91,5.19;plt 6.22,4.35;pen
154: plt r83+9r80,r84-r80;plt r83+10.8r80,r84-r80;lbl " irrigation syst."
155: pen# 2;line 5,5;plt 4.125,4.545;plt 4.517,4.534;plt 4.782,4.52
156: plt 5.066,4.583;plt 5.112,4.505;plt 5.135,4.576;plt 5.186,4.544
157: plt 5.32,4.448;plt 5.442,4.363;plt 5.75,4.36
158: plt 5.77,4.356;plt 5.79,4.345;plt 5.803,4.329;plt 5.811,4.31-
159: plt 5.862,4.037;plt 5.867,4.025;plt 5.88,4.015;plt 5.893,4.01
160: plt 5.907,4.007;plt 6.049,4.029;plt 6.047,4.083
161: plt 6.05,4.11;plt 6.056,4.135;plt 6.072,4.179;plt 6.094,4.227
162: plt 6.116,4.255;plt 6.144,4.286;plt 6.175,4.317;plt 6.215,4.346
163: plt 6.249,4.365;plt 6.288,4.383;plt 6.327,4.4;plt 6.36,4.422
164: plt 6.395,4.45;plt 6.42,4.48;plt 6.453,4.523;plt 6.73,4.895
165: plt 6.756,4.923;plt 6.985,5.12;plt 7.007,5.165;plt 7.02,5.205
166: plt 7.025,5.245;plt 7.013,5.285;plt 7,5.317;plt 6.926,5.455
167: plt 6.908,5.49;plt 6.9,5.522;plt 6.895,5.54;plt 6.850,5.774
168: plt 6.817,5.775;plt 6.86,5.836;plt 6.862,5.877;plt 6.857,5.92
169: plt 6.870,5.959;plt 6.888,5.987;plt 6.655,5.937;plt 6.34,5.865
170: plt 6.02,5.774;plt 5.592,5.654;plt 4.932,5.482;plt 4.694,5.4
171: plt 4.256,5.267
172: plt 4.005,5.127
173: plt 4.125,4.545;pen
174: plt r83+9r80,r84-1.5r80
175: plt r83+10.8r80,r84-1.5r80;lbl " drainage syst.";line ;pen# 1
176: 1000000)A;-A)B;0)N
177: for I=1 to 100;0)r1;for F=1 to 3;if M[I,F]#-100;M[I,F])C;jmp 2
178: jmp 5
179: if X[C,1]>=W and X[C,1]<=X and X[C,2]>=Y and X[C,2]<=Z;1)r1
180: next I
181: if r1=1;N+1)N;I)C[N];max(B,A[C]))B;min(A,A[C]))A
182: next I
183: fmt 8,"Max. Positive Change is",f8.3,/,"Max. Negative Change is",f8.3
184: fmt 9,"Max. Elevation is",f8.3,/,"Min. Elevation is",f8.3
185: if J=1;wrt 701.8,B,A
186: if J=0;wrt 701.7,B,A
187: ent "Even (e) or Set (s) contours",S$
188: if S$="e";ent "# of Contours",F;(B-A)/F)F
189: if S$="s";ent "Ho, the lowest contour value",W,"Contour Difference",F
190: fxd 0
191: pen# 1;for P=K to L;plt X[P,1],X[P,2],1;lbl "*",P;next P
192: pen# 2;fxd 2;for P=K to L;plt X[P,1],X[P,2];lbl "    ",A[P];next P
193: 0)P
194: pen# 3
195: for P=1 to N;C[P])R;A[M[R,1]])Z)Y
196: for Q=2 to 3;max(Z,A[M[R,Q]]))Z;min(Y,A[M[R,Q]]))Y;next Q
197: if S$="s";W)L
```

```
190: if S$="e";int(Y/F)*F)E
199: 0)M
200: for Q=1 to 3;M[R,J[Q]])K;M[R,J[Q+1]])L;A[L]-A[K])S
201: if S=0;jmp 7
202: (E-A[K])/S)T
203: if T<0 or T>1;jmp 7
204: M+1)M
205: X[K,1]+T*(X[L,1]-X[K,1]))Y[M];X[K,2]+T*(X[L,2]-X[K,2]))Z[M]
206: if M=2;jmp 5
207: jmp 3
208: if A[K]*0;jmp 2
209: X[K,1])r11;X[K,2])Z[1];X[L,1])Y[2];X[L,2])Z[2];2)M;jmp 2
210: next Q
211: if M#2;jmp 2
212: plt Y[1],Z[1],1;plt Y[2],Z[2],2
213: E+F)E;if E<=Z;jmp -14
214: next P
215: pen
216: if S$="s";plt r83+11r80,r84-.5r80;lbl "contour diff.    ",F
217: ent "Another plot, y or n",S$;if S$="y";gto "CONTR"
218: stp
219: "DATE":
220: int(p1/10000))r1;int(p1/100)-100r1)r2;p1-10000r1-100r2)r3
221: fxd 0;"              "]C$;str(r1))C$[1,3];str(r2))C$[4,6]
222: str(r3))C$[7,10];"/")C$[4,4])C$[7,7];C$[2,9])A$;ret
223: "MASS":asgn "C.D.M",1;sread 1,X[*],M[*]
224: 0)I)r70)r71)r72)r73)r74)r75)r76
225: "area":I+1)I
226: if M[I,1]=100;jmp 12
227: M[I,1])r51;M[I,2])r52;M[I,3])r53
228: 1000\((X[r51,1]-X[r52,1])^2+(X[r51,2]-X[r52,2])^2))r61
229: 1000\((X[r52,1]-X[r53,1])^2+(X[r52,2]-X[r53,2])^2))r62
230: 1000\((X[r53,1]-X[r51,1])^2+(X[r53,2]-X[r51,2])^2))r63
231: .5*(r61+r62+r63))r64
232: \(r64*(r64-r61)*(r64-r62)*(r64-r63)))r65
233: r65+r70)r70
234: (A[r51]+A[r52]+A[r53])/3)r66
235: r65*r66+r71)r71
236: r71/r70)r72
237: gto "area"
238: ent "area of study region,sq meters",r74
239: ent "specific yield",r75;r71*r75)r71
240: fmt ,2/,"Area bounded by wells=",f10.0," square meters"
241: wrt 701,r70
242: fmt ,"Average Water Table Elevation Change=",f6.3," meters",/
243: wrt 701,r72
244: fmt ,"Specific Yield=",f6.3;wrt 701,r75
245: fmt ,"Change in Water Volume Under Well Field",f10.0," cubic meters"
246: wrt 701,r71
247: fmt ,"Equiv Average Water Depth Change=",f6.3," meters",/
248: wrt 701,r72*r75)r73
249: fmt ,"Area of study region=",f10.0," square meters";wrt 701,r74
250: fmt ,"Total Change in Volume=",f10.0," cubic meters";wrt 701,r73*r74)r76
251: ret
252: end
253: ent "Date DDMMYY",D$;ent "No.of RECORDS",r99
254: open D$,r99
255: prt D$,r99,"is now opened"
256: end
#1540,
```

PROGRAM OPERATION

1. Turn on calculator and disk drive if program stored on disk
   A. Insert tape or disk
   B. Get "file name" for disk or trk#, ldf# for tape
2. Press RUN
3. When "Triangular 1
   Trapezoidal 2
   Rectangular 3" appears on calculator paper
   A. Type appropriate number for geometric shape of channel
   B. Press CONTINUE
4. When "Slope 1
   Discharge 2
   Depth 3
   Area 4
   Manning factor 5" appears on calculator paper
   A. Type appropriate number for variable to be determined
   B. Press CONTINUE
5. A set of known variables will appear on the calculator paper
   A. Enter each numerical value
   B. Press CONTINUE after each number until all known variables have been entered
6. Desired variable chosen on Step 4 will be printed on calculator paper

CHANNEL HYDRAULICS

This program is based on the metric version of Manning's Equation:

$$Q = \frac{1.0}{N} S^{1/2} R^{2/3} A$$

Where: Q = Discharge

N = Manning's fraction factor

S = Slope

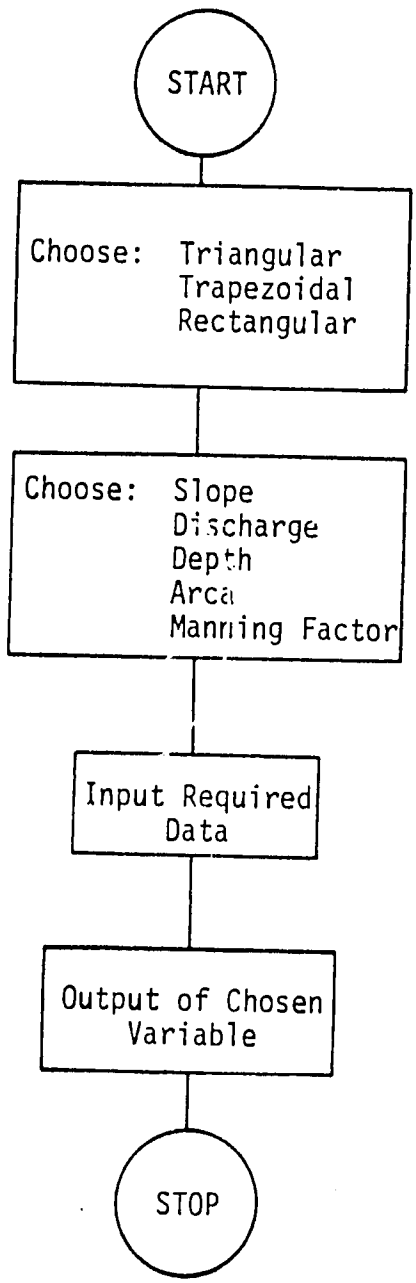
R = Hydraulic radius

A = Area

By rearranging the variables it is possible to solve for one knowing the other four. The program will solve any of the above variables for three different shapes; triangular, trapezoidal, and rectangular. Each of these shapes have various versions of area and hydraulic radius equations depending of their geometry. By selecting the proper geometric shape and dependent variable a list of known variables will be asked for by the calculator, after entering these variables the answer will appear.

```
 0: dsp "CHANNEL HYDRAULICS MANNING'S EQ.";wait 2500
 1: spc 2;prt "Triangular 1","Trapezoidal 2","Rectangular 3";spc 2;ent "",r1
 2: prt "Slope 1","Discharge 2","Depth 3","Area 4","Manning Factor 5"
 3: spc 2;ent "",r2
 4: dsp "Enter values in metric units";wait 1500
 5: if r1=1;gto "TRIANGULAR"
 6: if r1=2;gto "TRAPEZOIDAL"
 7: if r2=1;prt "Depth","Bottom Width","Manning's Factor","Discharge";spc 2
 8: if r2=1;ent "",D;ent "",B;ent "",P;1/P)R;ent "",Q;gto "SLOPE3"
 9: if r2=2;prt "Depth","Bottom Width","Slope","Manning's Factor";spc 2
10: if r2=2;ent "",D;ent "",B;ent "",S;ent "",P;1/P)R;gto "DISCHARGE3"
11: if r2=3;prt "Slope","Bottom Width","Discharge","Manning's Factor";spc 2
12: if r2=3;ent "",S;ent "",B;ent "",Q;ent "",P;1/P)R;gto "DEPTH3"
13: if r2=4;prt "Bottom Width","Depth";spc 2
14: if r2=4;ent "",B;ent "",D;gto "AREA3"
15: if r2=5;prt "Discharge","Slope","Bottom Width","Depth";spc 2
16: if r2=5;ent "",Q;ent "",S;ent "",B;ent "",D;gto "MANNING'S3"
17: "DEPTH3":
18: (Q/(R*B*S)^.6)A,A)D;0)C
19: ABS(D-C)>I,if I<.001;prt "Depth =",D;stp
20: D)C,((B*D+B)/B)^.4*A)D;jmp -1
21: "DISCHARGE3":
22: B*D/(B+2*D))H;if r2=1 or r2=5;ret
23: R*S*B*D*H^(2/3))Q;prt "Discharge =",Q;stp
24: "AREA3":
25: B*D)r1;if r2=5 or r2=1;ret
26: prt "Area =",r1;stp
27: "SLOPE3":
28: gsb "AREA3"
29: gsb "DISCHARGE3"
30: (Q/(R*H^(2/3)*r1))^2)S;fxd 5;prt "Slope =",S;fxd 2;stp
31: "MANNING'S3":
32: gsb "AREA3"
33: gsb "DISCHARGE3"
34: H^(2/3)*r1*S/Q)P;prt "Manning's Friction Factor =",P;stp
35: "TRIANGULAR":
36: if r2=1;prt "Depth","Side Slope","Manning's Factor","Discharge";spc 2
37: if r2=1;ent "",D;ent "",Z;ent "",P;1/P)R;ent "",Q;gto "SLOPE1"
38: if r2=2;prt "Depth","Side Slope","Manning's Factor","Slope";spc 2
39: if r2=2;ent "",D;ent "",Z;ent "",P;1/P)R;ent "",S;gto "DISCHARGE1"
40: if r2=3;prt "Side Slope","Manning's Factor","Discharge","Slope";spc 2
41: if r2=3;ent "",Z;ent "",P;1/P)R;ent "",Q;ent "",S;gto "DEPTH1"
42: if r2=4;prt "Depth","Side Slope";spc 2
43: if r2=4;ent "",D;ent "",Z;gto "AREA1"
44: if r2=5;prt "Slope","Depth","Side Slope","Discharge";spc 2
45: if r2=5;ent "",S;ent "",D;ent "",Z;ent "",Q;gto "MANNING'S1"
46: "DEPTH1":
47: (1/(Z*R))^(3/8)/((Z/(2*(Z^2+1)^.5))^.25)D
48: D*(Q/S)^(3/8))D;prt "Depth =",D;stp
49: "AREA1":
50: D^2*Z/A,if r2=3 or r2=1 or r2=5;ret
51: prt "Area =",A;stp
52: "DISCHARGE1":
53: gsb "AREA1"
54: (A/(1+D*Z*(Z+1)^.5))^(2/3)*A*R)F;if r2=1;ret
55: F*S)Q;prt "Discharge =",Q;stp
56: "SLOPE1":
57: gsb "DISCHARGE1"
58: (Q/F)^2)S;fxd 5;prt "Slope =",S;fxd 2;stp
59: "MANNING'S1":
60: gsb "AREA1"
```

```
61: (A/(2*D*(Z^2+1)^.5))^(2/3)*A*\S/Q)P
62: prt "Manning's Friction Factor =",P;stp
63: "TRAPEZOIDAL":
64: if r2=1;prt "Discharge","Bottom Width","Side Slope","Depth"
65: if r2=1;prt "Manning's Factor";spc 2;ent "",Q;ent "",B;ent "",Z;ent "",D
66: if r2=1;ent "",P;1/P)R;gto "SLOPE2"
67: if r2=2;prt "Side Slope","Depth","Bottom Width","Manning's Factor"
68: if r2=2;prt "Slope";spc 2;ent "",Z;ent "",D;ent "",B;ent "",P;1/P)R
69: if r2=2;ent "",S;gto "DISCHARGE2"
70: if r2=3;prt "Discharge","Manning's Factor","Slope","Bottom Width"
71: if r2=3;prt "Side Slope";spc 2;ent "",Q;ent "",P;1/P)R;ent "",S;ent "",B
72: if r2=3;ent "",Z;gto "DEPTH2"
73: if r2=4;prt "Side Slope","Depth","Bottom Width";spc 2
74: if r2=4;ent "",Z;ent "",D;ent "",B;gto "AREA2"
75: if r2=5;prt "Slope","Discharge","Depth","Side Slope","Bottom Width"
76: if r2=5;spc 2;ent "",S;ent "",Q;ent "",D;ent "",Z;ent "",B
77: if r2=5;gto "MANNING'S2"
78: "DEPTH2":
79: (Q/(R*\S))^.6)A;A/B^.6)D;0)C
80: ABS((D-C)/D))I;if I<.001;prt "Depth =",D;stp
81: D)C;A*(D*2*(Z^2+1)^.5+B)^.4/(D*Z+B))D;jmp -1
82: "AREA2":
83: (Z*D+B)*D)A;if r2=1 or r2=2 or r2=5;ret
84: prt "Area =",A;stp
85: "DISCHARGE2":
86: gsb "AREA2"
87: (A/(2*D*(Z^2+1)^.5+B))^(2/3)*R*A)F;if r2=1;ret
88: F*\S)Q;prt "Discharge =",Q;stp
89: "SLOPE2":
90: gsb "DISCHARGE2"
91: (Q/F)^2)S;fxd 5;prt "Slope =",S;fxd 2;stp
92: "MANNING'S2":
93: gsb "AREA2"
94: \S*A*(A/(B+2*D*(1+Z^2)^.5))^(2/3)/Q)P
95: prt "Manning's Friction Factor =",P;stp
*21942
```


START
Choose: Triangular
Trapezoidal
Rectangular
Choose: Slope
Discharge
Depth
Area
Manning Factor
Input Required Data
Output of Chosen Variable
STOP

REDUCTION OF AUGER HOLE DATA BY ERNST METHOD

To calculate the hydraulic conductivity, we use both equations

$$K = \frac{4{,}000\ r^2}{Y(H + 20r)\ (2 - (Y/H))} \frac{\Delta y}{\Delta t}$$

and

$$K = \frac{3{,}600\ r^2}{(H + 10r)\ (2 - (Y/H)} \frac{\Delta y}{\Delta t}$$

where the 1st equation gives min. value of K and 2nd gives max. value where

r: the radias of the auger hole

y: distance in cm between WT and water level in hole

H: distance in cm between WT and hole bottom

t: time in sec.

$\frac{\Delta y}{\Delta t}$: slope of the curve

K: Hydraulic conductivity in m/day

y must be between y_0 and $.8\ y_0$ where y_0 is the distance at t = o

To calculate K we use a program which plots the reading points and fits the points to the eqn $y = a + b\sqrt{X}$ then calculate $\frac{\Delta y}{\Delta t}$ for discrete points and calculate K max. and K min.

User Instructions:

* Set the calculator on and the plotter
* Insert the tape cartridge, put a blank paper in the plotter and set P1 and P2.
* Type ldf 8

  Press EXECUTE

  Press RUN

1. When "NO. OF DATA PTS?" appears

   A. Type the total no. of data points

   B. Press CONTINUE

2. When X(I) appears when I is the no. of data point

   A. Type the time in sec.

   B. Press CONTINUE

3. When Y(I) appears

   A. Type the y value in cm

   B. Press CONTINUE

   C. Go to Step 2 until I> no. of data pts.

4. When "CHANGES? Yes = Y, No = N" appears

   either

   A. Type Y for change in the input data

   B. Press CONTINUE

   or

   A. Type N if all inputs are correct

   B. Press CONTINUE

   C. Go to Step 8

5. When "DATA PT. NO.?" appears

   A. Type the # of the incorrect data point

   B. Press CONTINUE

6. When "X(I)" appears

   A. Type the correct value of t

   B. Press CONTINUE

7. When "Y(I)" appears

   A. Type the correct value of Y

   B. Press CONTINUE

   C. Go to Step 4

8. When "PLOT? Yes = Y, No = N" appears

   either

   A. Type Y to make a plot of the data points

   B. PRESS CONTINUE

   or

   A. Type N if do not want a plot

   B. Press CONTINUE

   C. Go to Step 11

9. When each of "X-MIN"

   "X-MAX"

   "Y-MIN"

   "X-TIC WIDTH" and

   "Y-TIC WIDTH" appears

   A. Enter these value for drawing the axies

   B. Press CONTINUE each time

   * A plotting of the input points is done and A, B, R SQUARE, S(Y/X) are printed to solve the eqn. $Y = A + 5\sqrt{X}$

10. When "PLOT? Yes = Y, No = N" appears

    either

    A. Type Y to get a plot of the fitting curve

    B. Press CONTINUE

    or

    A. Type N if do not want the curve

    B. Press CONTINUE

11. When "NO. OF DERIVS?" appears

    A. Enter the no. of data points needed to get its derivative

    B. Press CONTINUE

12. When "T(I)" appears where I is the # of the point

    A. Enter the time of this point in sec.

    B. Press CONTINUE

13. When "H(I)" appears

    A. Enter y value of this point in cm

    b. Press CONTINUE

14. When "CHANGES?" Yes = Y, No = N" appears

    either

    A. Type Y to make changes

    B. Press CONTINUE

    or

    A. Type N if all the points are correct

    B. Press CONTINUE

    C. Go to Step 18

15. When "OUTPUT ARG NO?" appears

    A. Enter the no. of the incorrect points

    B. Press CONTINUE

16. When "T(I)" appears

    A. Enter the time value of this point in sec

    B. Press CONTINUE

17. When "H(I)" appears

    A. Enter the y value of this point in cm

    B. Press CONTINUE

    C. Go to Step 14

18. When "E PSILON?" appears

either

Press CONTINUE; if you want the error tolerance to be 10^{-6}

or

A. Enter the error tolerance to which the simultaneous equations will be solved.

B. Press CONTINUE

The derivative of the input points will be calculated and then printed.

19. When "r=?" appears

A. Enter the radias in cm of the auger hole

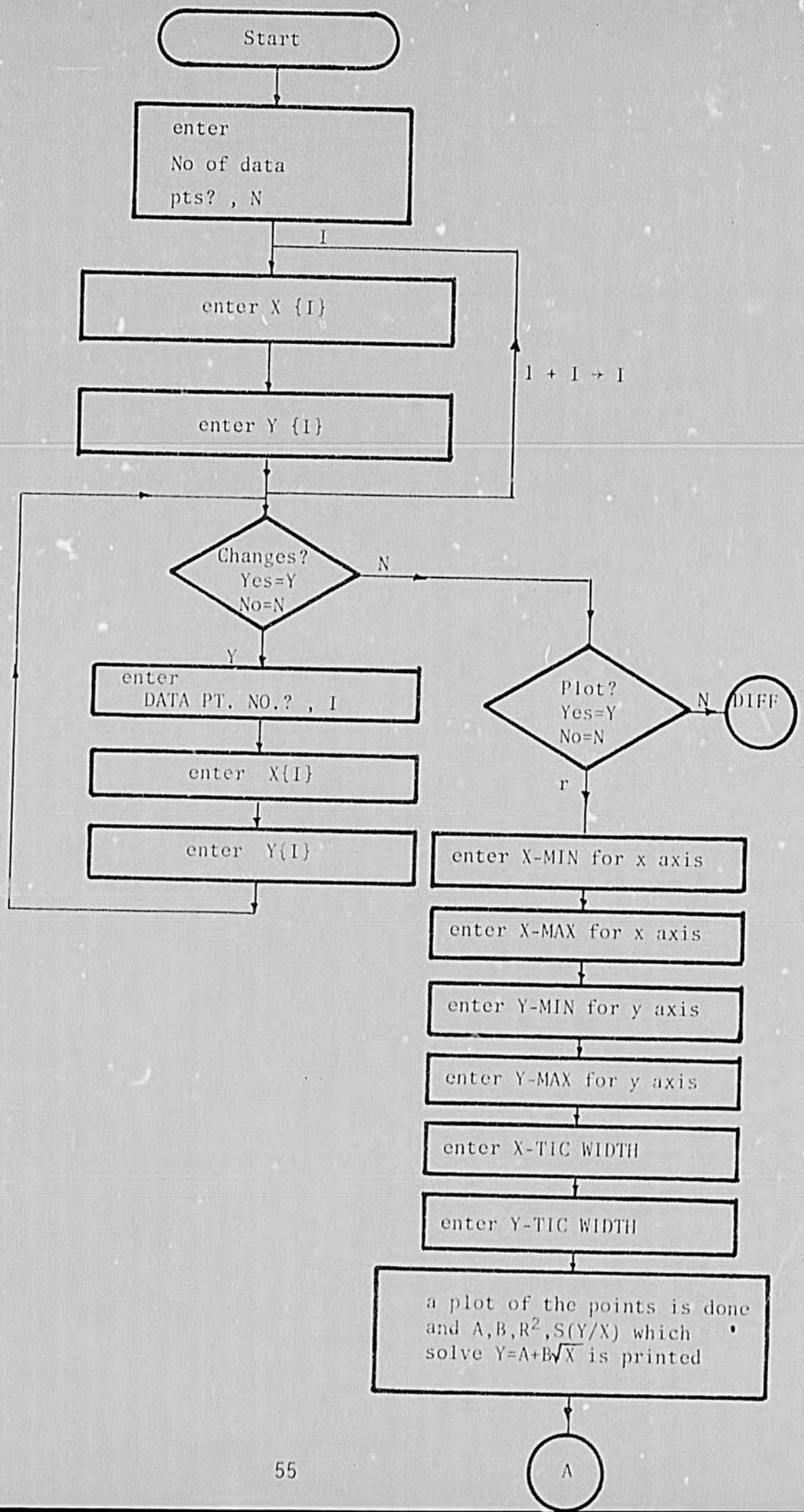
B. Press CONTINUE

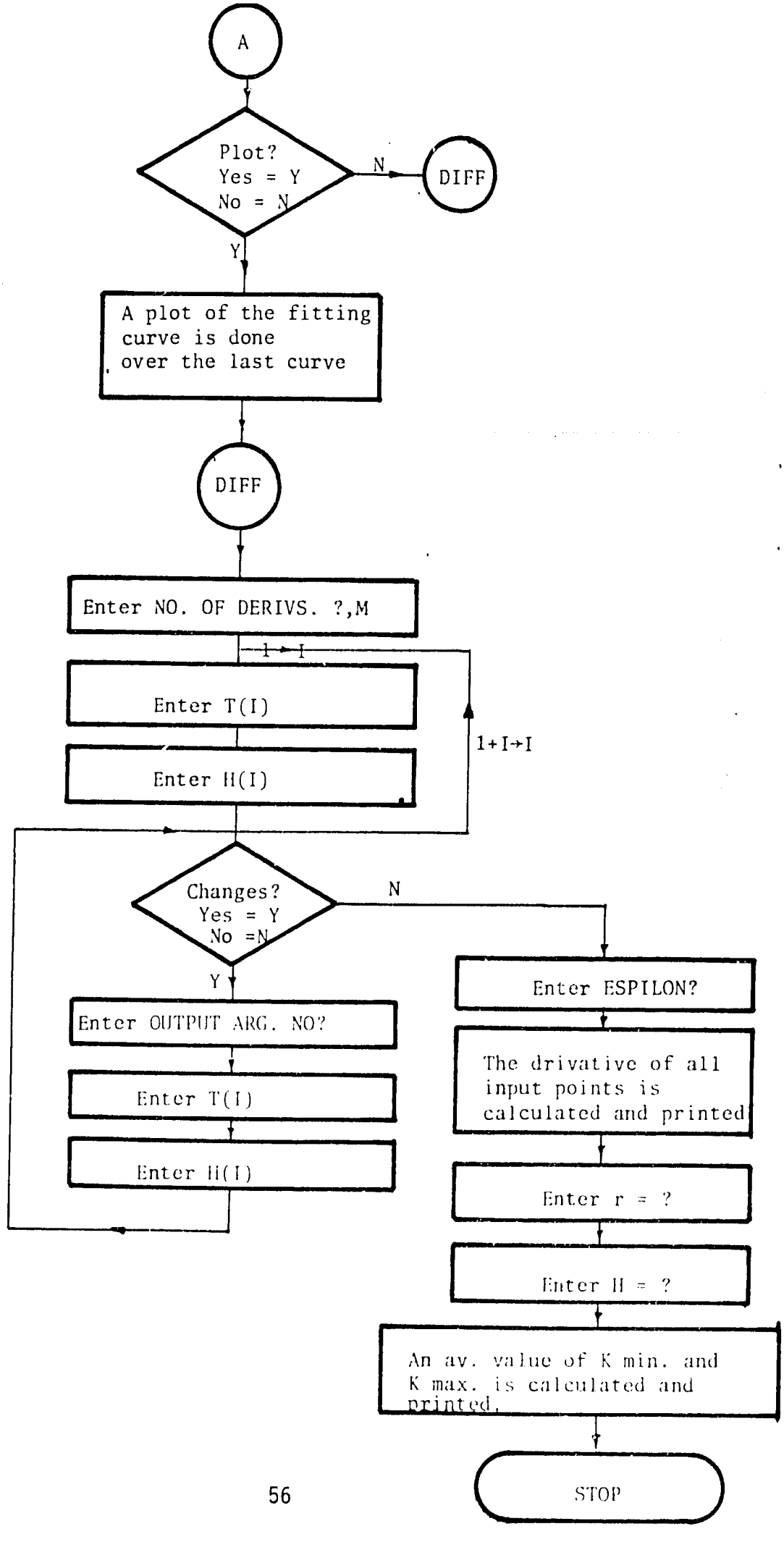
20. When "H=?" appears

A. Enter the H value in cm

B. Press CONTINUE

K min. and K max. will be calculated and then printed.


Start
enter
No of data
pts? , N
I
enter X {I}
enter Y {I}
1 + I → I
Changes?
Yes=Y
No=N
N
Y
enter
DATA PT. NO.? , I
enter X{I}
enter Y{I}
Plot?
Yes=Y
No=N
N
DIFF
r
enter X-MIN for x axis
enter X-MAX for x axis
enter Y-MIN for y axis
enter Y-MAX for y axis
enter X-TIC WIDTH
enter Y-TIC WIDTH
a plot of the points is done
and A,B,R2,S(Y/X) which
solve Y=A+B√X is printed
A


A
Plot?
Yes = Y
No = N
N
DIFF
Y
A plot of the fitting curve is done over the last curve
DIFF
Enter NO. OF DERIVS. ?,M
1→I
Enter T(I)
Enter H(I)
1+I→I
Changes?
Yes = Y
No =N
N
Y
Enter OUTPUT ARG. NO?
Enter T(I)
Enter H(I)
Enter ESPILON?
The drivative of all input points is calculated and printed
Enter r = ?
Enter H = ?
An av. value of K min. and K max. is calculated and printed.
STOP

```
0: enp "NO. OF DATA PTS?",N;spc ;if flg13;cfg 13;gto +0
1: dim X[N],Y[N];1)I
2: enp X[I];if flg13;cfg 13;gto +0
3: enp Y[I];if flg13;cfg 13;gto +0
4: if (I+1)I)<=N;spc ;gto -2
5: dim I$[2]
6: spc ;enp "CHANGES?YES=Y,NO=N",I$;if I$="N";gto +4
7: enp "DATA PT. NO.?",I;spc ;if flg13;cfg 13;gto +0 .
8: enp X[I];if flg13;cfg 13;gto +0
9: cfg 13;enp Y[I];gto +0;if not flg13;gto -3
10: "PLOT":enp "PLOT?YES=Y,NO=N",I$;if I$="N";gto "DIFF"
11: enp "X-MIN",Y;if flg13;gto +0
12: enp "X-MAX",X;if flg13;gto +0
13: prt "X-MIN",Y)J,"X-MAX",X)I
14: enp "Y-MIN",B;if flg13;gto +0
15: enp "Y-MAX",A;if flg13;gto +0
16: spc 2;prt "Y-MIN",B)L,"Y-MAX",A)K;spc 2
17: enp "X-TIC WIDTH",C;if flg13+(C(=0);gto +0
18: enp "Y-TIC WIDTH",r5;if flg13+(r5(=0);gto +0
19: scl -.2I,1.2X,-.2B,1.2A
20: gax 0,C,1,X,1
21: gax 0,r5,B,A,1
22: 0)r10)r11)r13)r7)r12
23: For I=1 to N;.0064(X-Y))r1;.0064(A-B))r2;plt X[I]-r1,Y[I]-r2
24: csiz 1.2B,1;lbl "+";pen;next I
25: for I=1 to N;r10+Y[I]\X[I])r10;r11+\X[I])r11;r13+Y[I])r13
26: r12+X[I])r12;r7+Y[I]Y[I])r7;next I
27: r10N r11r13)B;B/(Nr12-r11^2))B
28: (r13-Br11)/N)A;\abs((r7-Ar13-Br10)/(N-2)))r3
29: (Ar13+Br10-r13^2/N)/(r7-r13^2/N))r0
30: prt "A",A,"B",B,"RSQUARE",r0,"S(Y/X)",r3
31: prt "Y=A+B\X"
32: enp "PLOT?,YES=Y,NO=N",I$;if I$="N";gto "DIFF"
33: (X-Y)/100)r4;0)r5
34: plt r5,A+B\r5;jmp (r4+r5)r5))X
35: pen
36: "DIFF":enp "NO. OF DERIVS.?",M;spc ;if flg13;cfg 13;gto +0
37: 1)I,if M#0,dim T[M],H[M],K[M],Q[M]
38: cfg 13;enp T[I],H[I];gto +0;if not flg13;spc ;jmp (I+1)I))M
39: spc ;enp "CHANGES?,YES=Y,NO=N",I$;spc 2;if I$="N";gto +3
40: enp "OUTPUT ARG NO?",I;if flg13;cfg 13;gto +0
41: cfg 13;enp T[I],H[I];gto +0;if not flg13;spc ;gto -2
42: enp "EPSILON?",E;if flg13;1e-6)E
43: gsb "DER"
44: if flg3;stp
45: spc 2;prt "--DERIVATIVES--";spc ;1)J
46: prt "X=",T[J],"S'[X]=",D[J];spc ;jmp (J+1)J))M
47: spc 4;gto "H.CON"
48: "DER":cfg 3;if M>N;dim B[M];gto +2
49: dim B[N]
50: dim S[N],G[N-1];1)I
51: if (I+1)I)=N-1,gto +3
52: ...X[I] +[I-1])*)(X[I+1] X[I-1])H))B[I]
53: 2(X[I+1] T[I])/(X[I+1]-X[I])-(Y[I]-Y[I-1])/X)/H)T))S[I];3T)G[I];gto -2
54: B[S[1]/S[N];B-4\3)B
55: 0)U;2)I
56: W( S[I]-B[I]S[I-1]-(.5-B[I])S[I+1]+G[I]))T
57: if (abs(T)>H))U;H/U
58: S[I]+T)S[I]
59: if I#0 1 I+1)I;gto -3
```

```
60: if 0>I;gto -5
61: 0)I
62: if (I+1)I>>N-1;gto +2
63: (S[I+1]-S[I])/(X[I+1]-X[I]))G[I];gto -1
64: 0)J;dim D[M]
65: if (J+1)J>>M;ret
66: 1)I;if (T[J])I))=X[1];gto +2
67: sfg 3;dsp "ARG OUT OF BOUND";ret
68: if (I+1)I>>N;gto -1
69: if I>X[I];gto -1
70: I+1)I
71: I[J]-X[I])H;I[J]-X[I+1])I;HI)X
72: S[I]+HG[I])S
73: (1/6)Z)(S[I]+S[I+1]+S))U
74: (Y[I+1]-Y[I])/(X[I+1]-X[I]))W
75: W+(H+I)U+Z*G[I])D[J];gto -10
76: "H.CON":
77: 0)r91;0)r92
78: enp "r=?",R,"H=?",H
79: for I=1 to M;(H+20R)((2-H[I]/H)H[I]))K[I];4000*D[I]R^2/K[I])K[I]
80: K[I]+r91)r91
81: (H+10R)((2-H[I]/H)H[I]))Q[I];3600R^2*D[I]/Q[I])Q[I];Q[I]+r92)r92
82: next I
83: r91/M)r91;r92/M)r92
84: prt "K-MIN=",r91,"K-MAX=",r92
85: end
*25154
```

WEATHER DATA ENTRY

INTRODUCTION

The following programs can be used when the data needed by the pan evaporation method is not available or as a comparison to that method.

The first part uses the Blaney Criddle method to calculate ETo. The data required by this method is described in FAO Irrigation and Drainage Report #24 and are as follows:

1. Tav: Mean temperature
2. M/N Percentage of total daylight hours
3. RH min: Minimum relative humidity
4. V wind: Wind velocity

ETo calculates on a monthly bases in mm/day ETcrop parts one and two use the same method as King's programs, but are modified to handle different data storage files.

The relationship recommended, representing mean value over the given month is expressed as:

$$ETo = C[p(\cdot 46T+8] \text{ mm/day}$$

where:

ETo = reference crop evapotranspiration in mm/day for the month considered

T = mean daily temperature in ^{o}C over the month considered

P = mean daily percentage of total annual daytime hours for given month and latitude

C = adjustment factor depends on RH min, sunshine hours and daytime wind estimates

Attached: Table 1 shows mean daily percentage (P) of annual daytime hours for different latitudes. This data is stored in a data file and reading for different temperature and month is taken automatically.

Figure 1 shows the prediction of ETo from Blaney Criddle f factor for different conditions of minimum relative humidity, sunshine duration and day time wind.

This linear relation is also taken through the program automatically for certain RHmin, n/N and f value. There is also an example of how to calculate ETo for July step by step.

monthly humidity, wind and sunshine data (in this case obtained from published weather descriptions), the value of ETo for that month can be obtained using Figure 1. A format for the necessary calculation procedures is also given.

EXAMPLE:

Given:

Cairo, Arab Republic of Egypt; latitude 30°N; altitude 95 m; July.

Calculation:

(monthly data)

Tmax	Σ Tmax daily values/31	35 °C
Tmin	Σ Tmin daily values/31	22 °C
T daily mean	$\frac{\Sigma \text{ Tmean}}{31}$ or $\frac{\Sigma \text{ Tmax}}{31} + \frac{\Sigma \text{ Tmin}}{31} \div 2$	28.5 °C
p	from Table 1 for 30°N	0.31
p(0.46T + 8)	0.31(0.46 x 28.5 + 8)	6.6 mm/day
RHmin	from Climates of Africa, Griffith (1972)	medium
n/N	" " " " " "	high to medium
U2 daytime	" " " " " "	moderate
ETo	Fig. 1 - Block II and Block V (line 2)	8.0 mm/day

Yearly data (using measured temperature data)

	J	F	M	A	M	J	J	A	S	O	N	D
Tmean °C	14	15	17.5	21	25.5	27.5	28.5	28.5	26	24	20	15.5
p	0.24	0.25	0.27	0.29	0.31	0.32	0.31	0.30	0.28	0.26	0.24	0.23
p(0.46T + 8)	3.5	3.8	4.4	5.2	6.2	6.7	6.6	6.4	5.7	5.0	4.2	3.5

using general information and references on humidity, sunshine and wind (Climates of Africa, Griffith, 1972):

	RHmin	n/N	U daytime	Block Fig. 1	Line Fig. 1
Oct-March	medium	medium	light/mod	V	1-2 1/
April-May	low/med	high/med	moderate	IV, V 1 & II 1/	2
June-July	medium	high/med	moderate	II & V 1/	2
Aug-Sept	medium	high/med	light/mod	II & V 1/	1-2 1/

using Figure 1:

	J	F	M	A	M	J	J	A	S	O	N	D
ETo mm/day	2.8	3.3	4.1	6.5	8.0	8.2	8.0	7.2	6.2	4.6	3.5	2.7
mm/month	87	92	127	195	248	246	248	223	186	142	105	83

1/ interpolation required; for instance for May between Blocks IV, V, I and II of p(0.46T + 8) = 6.2 mm/day and ETo = (8.3 + 7.1 + 9.0 + 7.7) ÷ 4 = 8.0 mm/day.

Table 1 Mean Daily Percentage (p) of Annual Daytime Hours for Different Latitudes

Latitude North / South[1/]	Jan / July	Feb / Aug	Mar / Sept	Apr / Oct	May / Nov	June / Dec	July / Jan	Aug / Feb	Sept / Mar	Oct / Apr	Nov / May	Dec / June
60°	.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
58	.16	.21	.26	.32	.37	.40	.39	.34	.28	.23	.18	.15
56	.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
54	.18	.22	.26	.31	.36	.38	.37	.33	.28	.23	.19	.17
52	.19	.22	.27	.31	.35	.37	.36	.33	.28	.24	.20	.17
50	.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
48	.20	.23	.27	.31	.34	.36	.35	.32	.28	.24	.21	.19
46	.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
44	.21	.24	.27	.30	.33	.35	.34	.31	.28	.25	.22	.20
42	.21	.24	.27	.30	.33	.34	.33	.31	.28	.25	.22	.21
40	.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35	.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30	.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25	.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20	.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15	.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10	.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5	.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27

1/ Southern latitudes: apply 6 month difference as shown.

Format for Calculation of Blaney-Criddle Method

DATA	Country: UAR Period: July	Place: Cairo	Latitude: 30°N Longitude: 30	Altitude: 95 m
T mean 28.5°C	T mean	data	28.5	
latitude 30° month July	p	Table 1	0.31	
		calc p(0.46T + 8)	6.6	
RHmin %		estimate	med	
n/N		estimate	high/med	
U_2 daytime m/sec		estimate	Mod.	
		Fig. 1 Block/line	II, V: 2	
	ETo	Fig. 1		8.0 mm/day

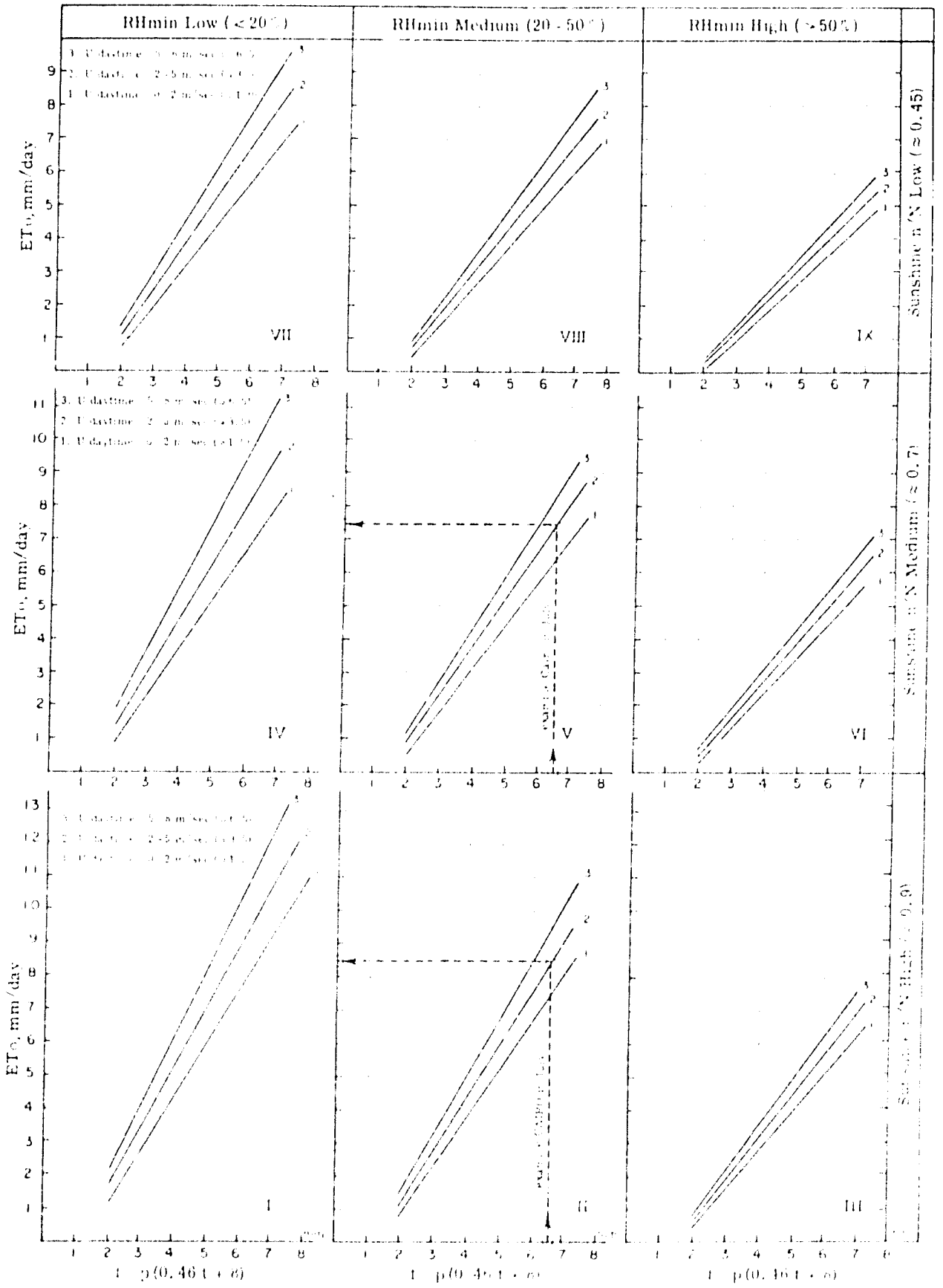


Fig. 1 Prediction of ETo from Blaney-Criddle f factor for different conditions of minimum relative humidity, sunshine duration and day time wind.

USERS' INSTRUCTIONS

WEATHER DATA ENTRY PROGRAM

Load program; press EXECUTE; press RUN

1. When "File name of weather data" appears
   a. Enter file name for weather data
   b. Press CONTINUE
2. When "have you already entered data" appear
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE; if yes go to Step 8
3. When "Month # of the data" F appear
   a. Enter number of month 1 thru 12
   b. Press CONTINUE
4. When "Length of the month" appear
   a. Enter number of days in the month
   b. Press CONTINUE
5. When "Enter" data type "data" appear, when data types are Tmax, Tmin, Wind Velocity, Epan, RHmax, RHmin (data types will appear in this order)
   a. Enter this data for each day of the month pressing CONTINUE after each days data
   b. Continue with sub step a until month is completed
6. When "Do you wish to continue data entry?" appear
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE; if yes go to Step 5 for next data type; if no go to Step 8

7. When "Do you wish to continue data entry?" appear

   a. Enter Ø for no or type 1 for yes

   b. Press CONTINUE; if yes go to Step 3 to enter data for another month

8. When "Do you want a current listing?" appear

   a. Enter Ø for no or 1 for yes

   b. Press CONTINUE

9. When "are there corrections?" appear

   a. Enter Ø for no or 1 for yes

   b. Press CONTINUE; for no corrections go to Step 11

10. For corrections

   a. First, enter data type No. 1 thru 6 in the order they appear in Step 5; press CONTINUE

   b. Second, enter day # consecutive from beginning of year; press CONTINUE

   c. Lastly enter data for that data type; press CONTINUE

   d. Go to previous Step 9

If data file is new data go to Step 12

11. When "Do you wish to enter additional data?" appear

   a. Enter Ø for no or 1 for yes

   b. Press CONTINUE; if yes go to Step 3

12. When "Do you want a current listing?" appear

   a. Enter Ø for no or 1 for yes

   b. Press CONTINUE; if yes go to Step 8

USERS' INSTRUCTIONS

ET_0 DATA OR OLD WEATHER DATA

1. Get "File Name", press EXECUTE
2. Press RUN
3. When "File Name of Old" data type "Data" appear
   A. Type file name of old ET_0 data, not more than six characters
   B. Press CONTINUE
4. When "Planted Date, DDMMYY" appear
   A. Enter planted date, DD=Day, MM=Month, and YY=Year
   B. Press CONTINUE
5. When "Harvest Date, DDMMYY" appear
   A. Enter harvest date, same form as Step 4
   B. Press CONTINUE
6. When "File Name to Store New" data type appear
   A. Enter new file name, not more than six characters
   B. Press CONTINUE
   C. STOP

```
0: "S0":dsp "Program ETo";wait 2000
1: dim A[6,366],A$[6],D$[6]
2: dim B[366]
3: dim C[3,4],D[4],A$[6],D$[6]
4: ent "file name of weather data",A$
5: asgn A$,1;spread 1,A[*]
6: ent "Pan in cropped area?Yes=1,No=0",G
7: if G=1;gto "SB1"
8: ent "windward distance of fallow",W;gto "SB2"
9: "SB1":ent "windward distance of crop",W
10: "SB2":if G=1 and W<=1;gto "SB3"
11: if G=1 and W<=10;gto "SB4"
12: if G=1;gto "SB5"
13: .  W<=1;gto "SB5"
14: if W<=10;gto "SB6"
15: "SB3":.55)C[1,1];.5)C[1,2];.45)C[1,3];.4)C[1,4];.65)C[2,1];.6)C[2,2]
16: .5)C[2,3];.45)C[2,4];.75)C[3,1];.65)C[3,2];.6)C[3,3];.5)C[3,4];gto "SB7"
17: "SB4":.65)C[1,1];.6)C[1,2];.55)C[1,3];.45)C[1,4];.75)C[2,1];.7)C[2,2]
18: .6)C[2,3];.55)C[2,4];.85)C[3,1];.75)C[3,2];.65)C[3,3];.6)C[3,4];gto "SB7"
19: "SB5":.7)C[1,1];.65)C[1,2];.6)C[1,3];.5)C[1,4];.8)C[2,1];.75)C[2,2]
20: .65)C[2,3];.6)C[2,4];.85)C[3,1];.8)C[3,2];.75)C[3,3];.65)C[3,4];gto "SB7"
21: "SB6":.6)C[1,1];.55)C[1,2];.5)C[1,3];.45)C[1,4];.7)C[2,1];.65)C[2,2]
22: .55)C[2,3];.5)C[2,4];.8)C[3,1];.7)C[3,2];.65)C[3,3];.55)C[3,4];gto "SB7"
23: "SB7":ent "Epan correction, Jan-Mar",D[1]
24: ent "Epan correction, Apr-Jun",D[2]
25: ent "Epan correction, Jul-Sep",D[3]
26: ent "Epan correction, Oct-Dec",D[4]
27: ent "Height of panometer (m)",H
28: if H<=.75;1.35)F;gto "S1"
29: if H<=1.25;1.15)F;gto "S1"
30: if H<=1.75;1.06)F;gto "S1"
31: if H<=2.5;1)F;gto "S1"
32: if H<=3.5;.93)F;gto "S1"
33: if H<=4.5;.88)F;gto "S1"
34: if H<=5.5;.85)F;gto "S1"
35: .83)F
36: "S1":1)L;90)M
37: fmt 1,2x,"Jay",5x,"RHavg",4x,"wind V",6x,"Epan",6x,"Cpan",7x,"ETo"
38: wrt 701,1
39: for K=1 to 366;if K)M;L+1)L;M+92)M
40: (A[5,K]+A[6,K])/2)B;86.4*F*A[3,K])C
41: if B<40;1)I;gto "S2"
42: if B<=70;2)I;gto "S2"
43: 3)I
44: "S2":if C<175;1)J;gto "S3"
45: if C<[illegible];2)J;gto "S3"
46: if C<700;3)J;gto "S3"
47: 4)J
48: "S3":C[I,J]+D[I]*A[4,K])B[K]
49: fmt 2,f5.0,5f10.2;wrt 701,2,K,B,C,A[4,K],C[I,J],B[K]
50: next K
51: ent "file name of reference ET data",D$
52: open D$,10;asgn D$,1;sprt 1,B[*]
53: end
*i5ii
```

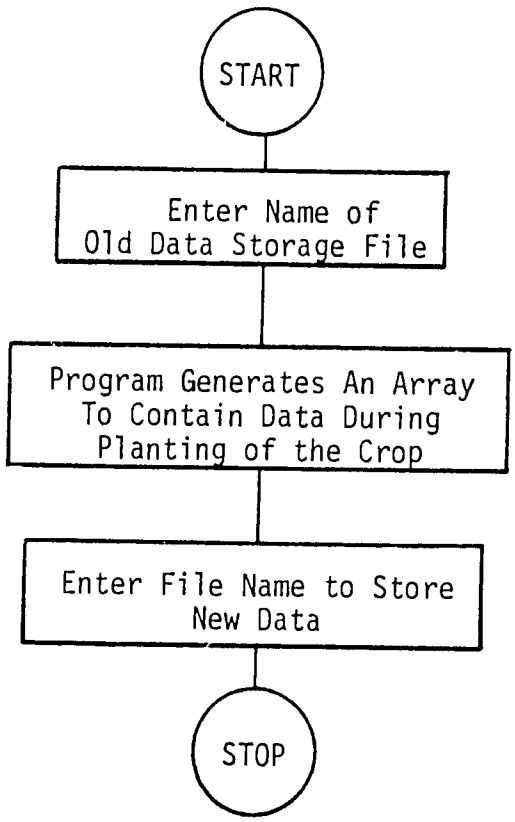
```
 0: "S0":dsp "Program ETcrop, Part 1";wait 2000
 1: dim A[6,366]
 2: dim X$[6],B[366],A,B
 3: dim D[9]
 4: dim E[5],F[3],Y$[6],A$[6]
 5: ent "file name of reference ET data",X$
 6: asgn X$,1;sread 1,B[*],A,B
 7: 1)E[1]
 8: for J=2 to 5
 9: dsp "length of growth stage",J-1;ent "",E[J]
10: E[J-1]+E[J])E[J];next J
11: ent "irrigation interval,initial stage",A
12: cll 'SUB'(A,D[1],D[2],D[3],D[4],D[5],D[6],D[7],D[8],D[9])
13: 0)S
14: for K=E[1] to E[2];S+B[K])S;next K
15: S/(E[2]-E[1]+1))S
16: if S<1;gto "S1"
17: if S>=9;gto "S2"
18: int(S))T;(S-T)*(D[T+1]-D[T])+D[T])F[1];gto "S3"
19: "S1":(D[2]-D[1])*(1-S))F[1];gto "S3"
20: "S2":D[9])F[1]
21: "S3":ent "file name of weather data",Y$
22: asgn Y$,1;sread 1,A[*],A,B
23: for L=3 to 4
24: 0)T;0)U
25: for K=E[L] to E[L+1]
26: T+A[3,K]*.5144)T;U+A[6,K])U;next K
27: E[L+1]-E[L]+1)V;T/V)T;U/V)U
28: dsp "wind",T,"RHmin",U,"stage",L
29: ent "",F[L-1];next L
30: ent "INRM FILE NAME",A$
31: open A$,4;asgn A$,1;sprt 1,E[*],F[*],X$
32: end
33: "SUB":if p1<=3;gto "SB1"
34: if p1<=5;gto "SB2"
35: if p1<=8;gto "SB3"
36: if p1<=15;gto "SB4"
37: .44)p2;.37)p3;.32)p4;.26)p5;.22)p6;.2)p7;.18)p8;.15)p9;.14)p10;ret
38: "SB1":1.06)p2;1)p3;.95)p4;.92)p5;.89)p6;.87)p7;.84)p8;.83)p9;.82)p10
39: ret
40: "SB2":.95)p2;.87)p3;.8)p4;.73)p5;.68)p6;.62)p7;.58)p8;.57)p9;.56)p10
41: ret
42: "SB3":.77)p2;.65)p3;.58)p4;.51)p5;.45)p6;.44)p7;.38)p8;.36)p9;.32)p10
43: ret
44: "SB4":.61)p2;.5)p3;.42)p4;.37)p5;.3)p6;.29)p7;.28)p8;.24)p9;.21)p10
45: ret
*28410
```

```
0: "S0":dsp "Weather Data Entry Program";wait 2000
1: dim A$[6],A[6,366]
2: dsp "when responding to questions,";wait 2000
3: dsp "enter 0 for no, 1 for yes";wait 2000
4: ent "File name of weather data",A$
5: ent "Have you already entered data?",B
6: if B=1;gto "S1"
7: open A$,71
8: "ENT":ent "month# of the data",F
9: 0)N;if F>1;31)N;if F>2;60)N
10: if F>3;91)N;if F>4;121)N
11: if F>5;152)N;if F>6;182)N
12: if F>7;213)N;if F>8;244)N
13: if F>9,274)N;if F>10;305)N
14: if F>11;335)N
15: ent "Length of the month",P
16: for I=1 to 6;cll 'SB1'(I)
17: for J=N+1 to N+P
18: ent A[I,J];if flg13;cfg 13;gto +0
19: next J
20: asgn A$,1;sprt 1,A[*];prt "LAST I",I,"LAST J",J
21: ent "Do you wish to continue data entry?",C
22: if C=0;gto "S2"
23: next I
24: ent "Do you wish to continue data entry?",C
25: if C=0;gto "S2"
26: gto "ENT"
27: "S1":asgn A$,1;sread 1,A[*]
28: "S2":ent "Do you want a current listing?",D
29: if D=0;gto "S3"
30: fmt 1,11x,"Tmax",6x,"Tmin",4x,"Vwind",6x,"Epan",5x,"RHmax",5x,"RHmin"
31: wrt 701,1
32: fmt 2,f5.0,6f10.2
33: for J=1 to 366;wrt 701,2,J,A[1,J],A[2,J],A[3,J],A[4,J],A[5,J],A[6,J]
34: next J
35: "S3":ent "Are there corrections?",E;if E=0;gto "S4"
36: ent I:ent J:ent A[I,J];gto "S3"
37: "S4":asgn A$,2;sprt 2,A[*]
38: if B=1;ent "Do you wish to enter additional data?",C
39: if C=1;gto "ENT"
40: ent "Do you want a current listing?",D
41: if D=1;gto "S2"
42: "S5":end
43: "SB1":
44: if p1=1;dsp "enter Tmax data";wait 2000;ret
45: if p1=2;dsp "enter Tmin data";wait 2000;ret
46: if p1=3;dsp "enter wind velocity data";wait 2000;ret
47: if p1=4;dsp "enter Epan data";wait 2000;ret
48: if p1=5;dsp "enter RHmax data";wait 2000;ret
49: if p1=6;dsp "enter RHmin data";wait 2000;ret
*2.0275
```

```
0: dim T$[6],E[12],D[13],D$[6],C[366],B[366],A,B,A$[6],B$[6]
1: ent "FILE NAME OF OLD ETo DATA",T$
2: asgn T$,1;sread 1,T$,E[*],D[*]
3: for I=1 to 12
4: D[I]>D;D[I+1]-1>r1
5: for J=D to r1;E[I]>C[J];next J;next I
6: ent "PLANTED DATE,DDMMYY",A$
7: ent "HARVEST DATE,DDMMYY",B$
8: val(A$[3,4])>M;val(A$[1,2])>D
9: val(B$[3,4])>A;val(B$[1,2])>B
10: D[M]+D>r1;D[A]+B>r2
11: if r2<r1;gto "CAL"
12: 1>I
13: for J=r1 to r2;C[J]>B[I];I+1>I;next J;gto "STR"
14: "CAL":1>I;for J=r1 to 366;C[J]>B[I];1+I>I;next J;for J=1 to r2;C[J]>B[I]
15: 1+I>I;next J
16: "STR":ent "FILE NAME TO STORE NEW ETo",D$;open D$,12;asgn D$,1
17: r1>A;r2>B;sprt 1,D$,B[*],A,B
*30875
```

```
0: dim D$[6],E[13],D[12],T$[6],T[4,366],E$[6],A[2,300]
1: ent "FILE NAME OF OLD WEATHER DATA",T$
2: asgn T$,1;sread 1,T[*]
3: ent "FILE NAME OF OLD ETo",D$;asgn D$,1;sread 1,D$,E[*],D[*]
4: ent "PLANTED DATE,DDMMYY",D$
5: ent "HARVEST DATE,DDMMYY",E$
6: val(D$[3,4])>M;val(D$[1,2])>D
7: val(E$[3,4])>A;val(E$[1,2])>B
8: D[M]+D>r1;D[A]+B>r2
9: if r2<r1;gto "CAL"
10: 1>I
11: for J=r1 to r2;T[3,J]>A[1,I];T[2,J]>A[2,I];I+1>I;next J;gto "STR"
12: "CAL":1>I;for J=r1 to 366;T[2,J]>A[2,I];T[3,J]>A[1,I];1+I>I;next J
13: for J=1 to r2;T[2,J]>A[2,I];T[3,J]>A[1,I];1+I>I;next J
14: "STR":ent "FILE NAME TO STORE NEW WETHER DATA",E$
15: r1>A;r2>B
16: open E$,20;asgn E$,1;sprt 1,E$,A[*],A,B
17: stp
*11011
```

ET_0 OR WEATHER DATA RESHAPING



USERS' INSTRUCTIONS

ET_0

1. Get "file name"; press EXECUTE
2. Press RUN
3. "For Temp. Data" and printed on thermal paper "for Temp. Data" will appear
4. When "Actual Data = A, Estimated Data = E" appear
   A. Enter A or E for proper data
   B. Press CONTINUE
5. For actual data go to 21
6. When "Temp. For Month" I appear
   A. Enter temperature for month I. I = 1 to 12
   B. Press CONTINUE after each tempeature
7. "For n/n Data" will appear in display and on thermal paper
8. When "Actual Data = A, Estimated Data = E" appear
   A. Enter A or E for proper data
   B. Pres CONTINUE
9. For actual data go to 21
10. When "Val. High = 2, Mid. = 1, Low = 0 for Mon." I appear
    A. Enter 0, 1, or 2 for anytime ratio for I = 1 to 12
    B. Press CONTINUE after each ratio
11. "For RH min. Data" will appear in display and on thermal paper
12. When "Actual Data = A, Estimated Data = E" appear
    A. Enter A or E for proper data
    B. Press CONTINUE
13. For actual data go to 21

14. When "Val. High = 2, Mid. = 1, Low = 0 for Mon." I appear

    A. Enter 0, 1, or 2 for relative humidity for I = 1 to 12

    B. Press CONTINUE after each relative humidity

15. "For V wind Data" will appear in display and on thermal paper

16. When "actual Data = A, Estimated Data = E" appear

    A. Enter A or # for proper data

    B. Press CONTINUE

17. For actual data go to 21

18. When "Val. High = 2, Mid. = 1, Low = 0 for mon." I appear

    A. Enter 0, 1 or 2 for wind speed

    B. Press CONTINUE after each wind speed

19. When "File name for ET_0 Data" appear

    A. Enter File name not more than 6 characters

    B. Press CONTINUE; for actual data STOP

20. For estimated data STOP

21. "Poor Data For" Data type "Month" I will appear on thermal paper and "Value =" Temp. will also appear

22. When "Want Est. Value Yes = Y, No = N" appear

    A. For estimated value enter Y, if not enter N

    B. Press CONTINUE; if N go to 21 for I = 1 to 12 for I = 12 go to 24

23. If Step 22 Y "Est. Value = ?" will appear

    A. Enter estimated value

    B. Press CONTINUE; repeat Steps 21, 22 and 23 I = 1 to 16 times

24. For actual data for temp. go to 7

25. For actual data for n/n go to 11

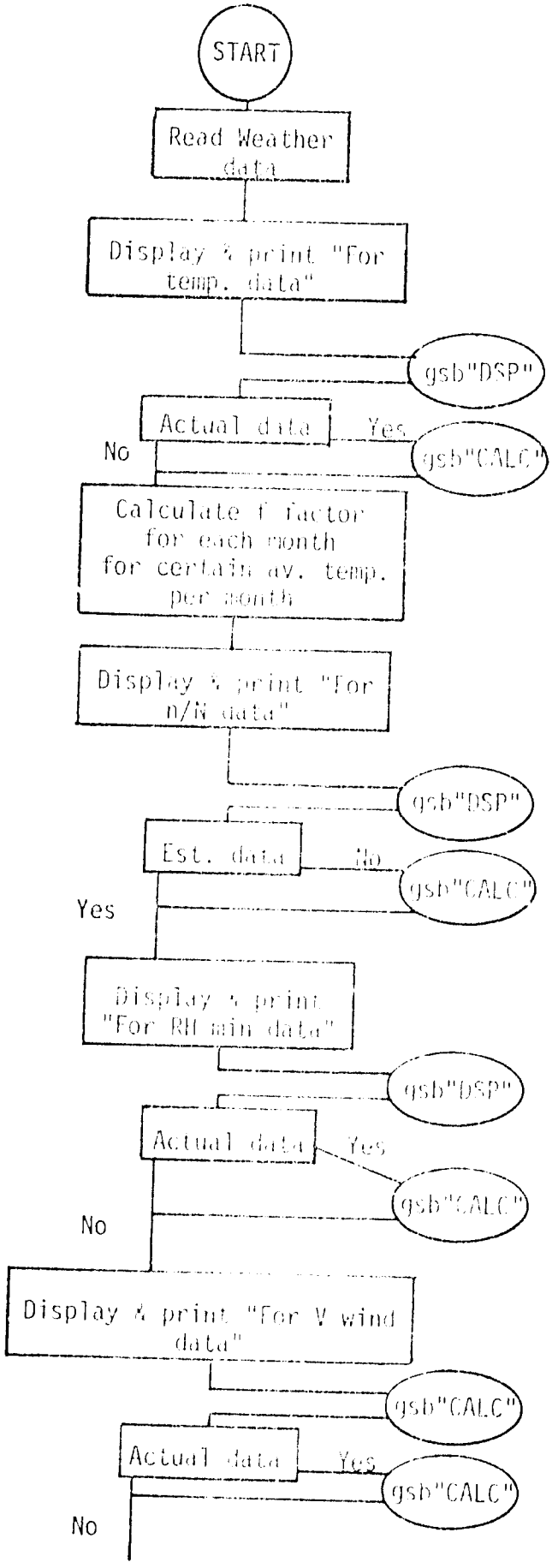
26. For actual data for RHmin. go to 15

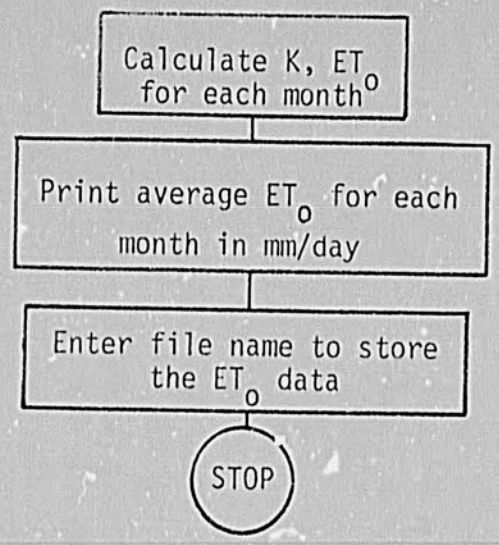
27. Go to 19

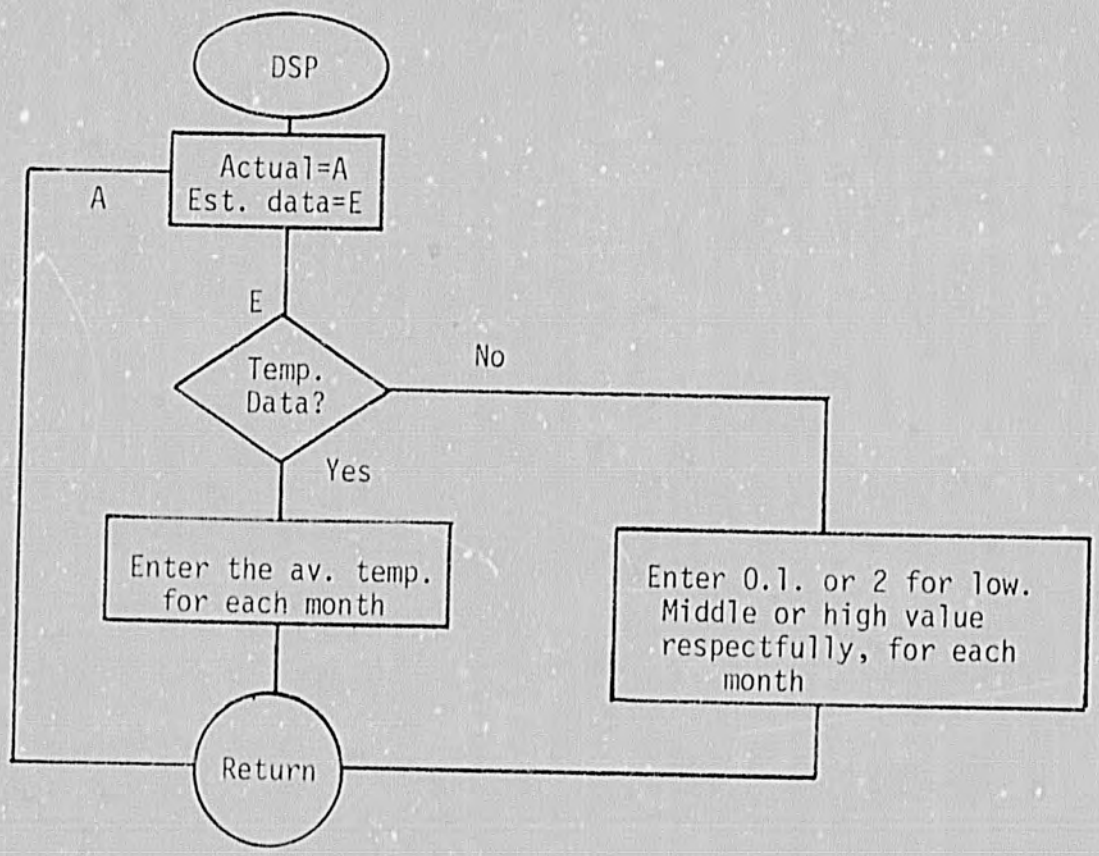
```
0: dim T[4,366],A[2,27],P[20,12],M[12],N[4,12]
1: dim I$[6],E[12],D[13],F[12],A$[1],S$[5]
2: asgn "W.DATA",1
3: sread 1,T[*],A[*],P[*]
4: 4)O;dsp "FOR TEMP.DATA";prt "FOR TEMP.DATA";spc 2;wait 1500;gsb "DSP"
5: if A$="A";gsb "CALC"
6: for I=1 to 12;60)J;1)K
7: if N[4,I]<=J+1;if N[4,I])J-1;gto +4
8: if J)40;J-2)J;1+K)K;gto -1
9: 1+K)K;J-5)J;if N[4,I]<=J+2.5;if N[4,I])J-2.5;gto +2
10: gto -1
11: P[K,I])F[I];next I
12: 1)O;dsp "FOR n/N DATA";prt "FOR n/N DATA";spc 2;wait 1500;gsb "DSP"
13: if A$="C";gto +2
14: gsb "CALC"
15: 2)O;dsp "FOR RHmin DATA";prt "FOR RHmin data";spc 2;wait 1500;gsb "DSP"
16: if A$="A";gsb "CALC"
17: 3)O;dsp "FOR Vwind DATA";prt "FOR Vwind data";spc 2;wait 1500;gsb "DSP"
18: if A$="A";gsb "CALC"
19: for I=1 to 12
20: 1+N[1,I]+3N[2,I]+9N[3,I])K
21: -A[1,K]+A[2,K]*F[I](.46N[4,I]+0.13))E[I]
22: next I
23: "PRT":
24: 1)I;"Jan. "))S$;gsb "WRT"
25: 2)I;"Feb. "))S$;gsb "WRT"
26: 3)I;"Mar. "))S$;gsb "WRT"
27: 4)I;"Apr. "))S$;gsb "WRT"
28: 5)I;"May  "))S$;gsb "WRT"
29: 6)I;"Jun  "))S$;gsb "WRT"
30: 7)I;"Jul. "))S$;gsb "WRT"
31: 8)I;"Aug. "))S$;gsb "WRT"
32: 9)I;"Sep. "))S$;gsb "WRT"
33: 10)I;"Oct. "))S$;gsb "WRT"
34: 11)I;"Nov. "))S$;gsb "WRT"
35: 12)I;"Dec. "))S$;gsb "WRT"
36: ent "FILE NAME FOR ETo DATA",T$;open T$,2;asgn T$,1;sprt 1,T$,E[*],D[*]
37: stp
38: "WRT":
39: fmt ,40x,c15,f12.2,c7
40: wrt 701,"ETo FOR ",S$," = ",E[I]," mm/day"
41: ret
42: "DSP":
43: ent "ACTUAL DATA=A,ESTIMATED DATA=E",A$
44: if A$="A";ret
45: for I=1 to 12
46: if O=4;dsp "TEMP. FOR MONTH",I;ent "",N[O,I];next I;ret
47: dsp "VAL.HIGH=2,MID.=1,LOW=0 FOR MON.",I
48: ent "",N[O,I];next I;ret
49: "EST1":
50: if O=1;prt "POOR DATA FOR n/N,MONTH",I
51: if O=4;prt "POOR DATA FOR Tav.,MONTH",I
52: if O=2;prt "POOR DATA FOR RHmin,MONTH",I
53: if O=3;prt "POOR DATA FOR Vwind,MONTH",I
54: spc 2;prt "VALUE=",N[O,I]
```

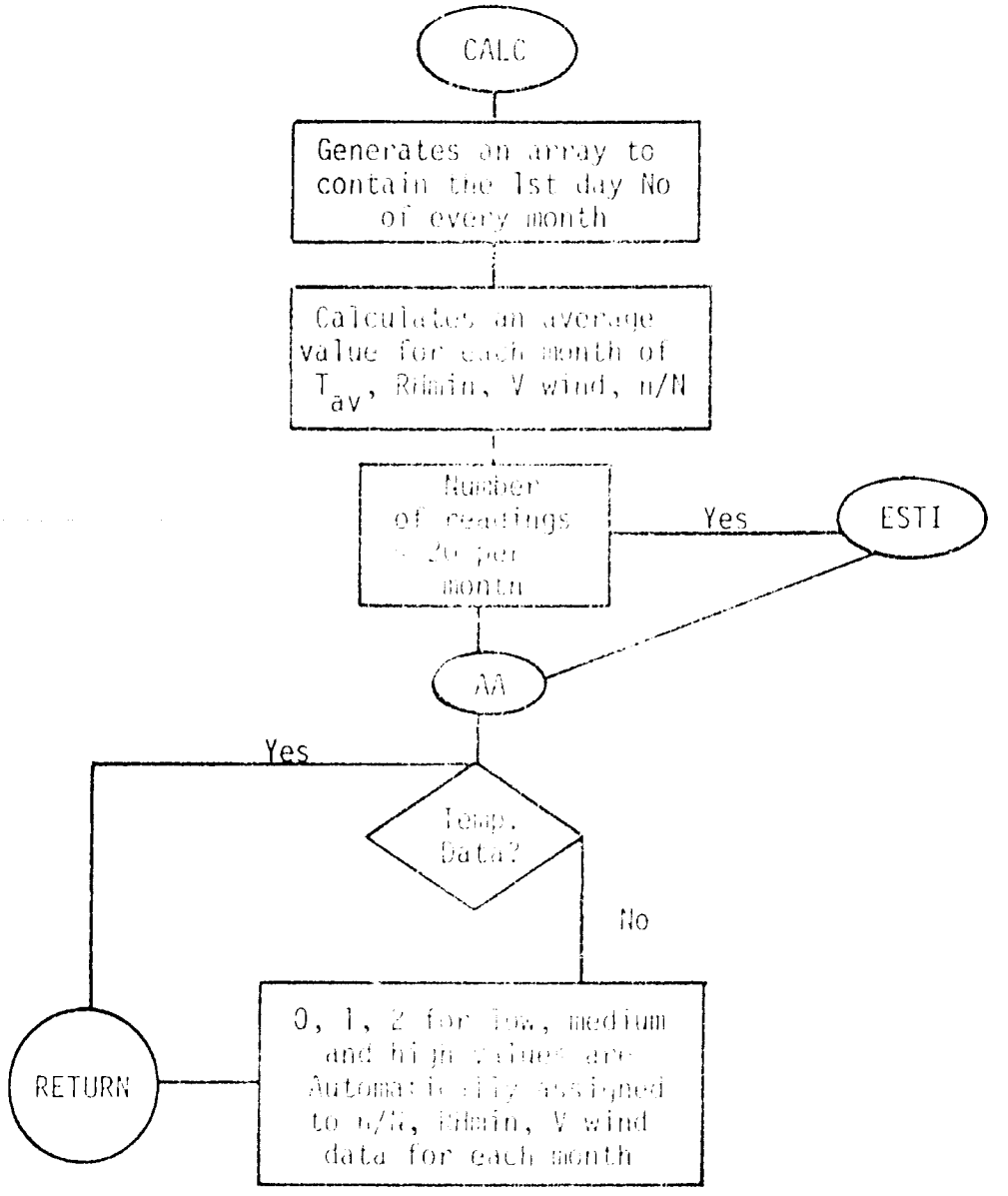
```
55: ent "WANT EST.VALUE YES=Y,NO=N",A$
56: if A$="N";gto 72
57: ent "EST.VALUE=?",NI0,I1;gto 72
58: "CALC":
59: 1→DI1;32→DI2;61→DI3;92→DI4;121→DI5
60: 153→DI6;183→DI7;214→DI8;245→DI9
61: 275→DI10;306→DI11;336→DI12;367→DI13
62: for I=1 to 12
63: DI1→D;DI1+1→d
64: for J=D to d;if U=4;gto "TEMP"
65: if TI0,J≤0;14→N;NI0,I→TI0,J→NI0,I
66: gto "NEXT"
67: "TEMP":if TI4,J=0;gto "NEXT"
68: 14→N;NI4,I→TI4,J→NI4,I
69: "NEXT":next J
70: if N=0;gto "EST1"
71: NI0,I/N→NI0,I;if N<=20;gto "EST1"
72: "NXT":N→N;next I
73: if U=4;ret
74: "REP":
75: if U=1;gto "n/N"
76: if U=2;gto "RHmin"
77: "Vwind":
78: for I=1 to 12
79: if NI3,I≥5;2→NI3,I;gto "V.W"
80: if NI3,I<2;0→NI3,I;gto "V.W"
81: 1→NI3,I;gto "V.W"
82: "V.W":next I;ret
83: "n/N":for I=1 to 12
84: if NI1,I>.5;2→NI1,I;next I
85: if NI1,I<.6;0→NI1,I;next I
86: 1→NI1,I;next I
87: ret
88: "RHmin":
89: for I=1 to 12
90: if NI2,I≥50;2→NI2,I;gto "LOOP"
91: if NI2,I<20;0→NI2,I;gto "LOOP"
92: if NI2,I>=20;if NI2,I<=50;1→NI2,I
93: "LOOP":next I
94: ret
*30738
```

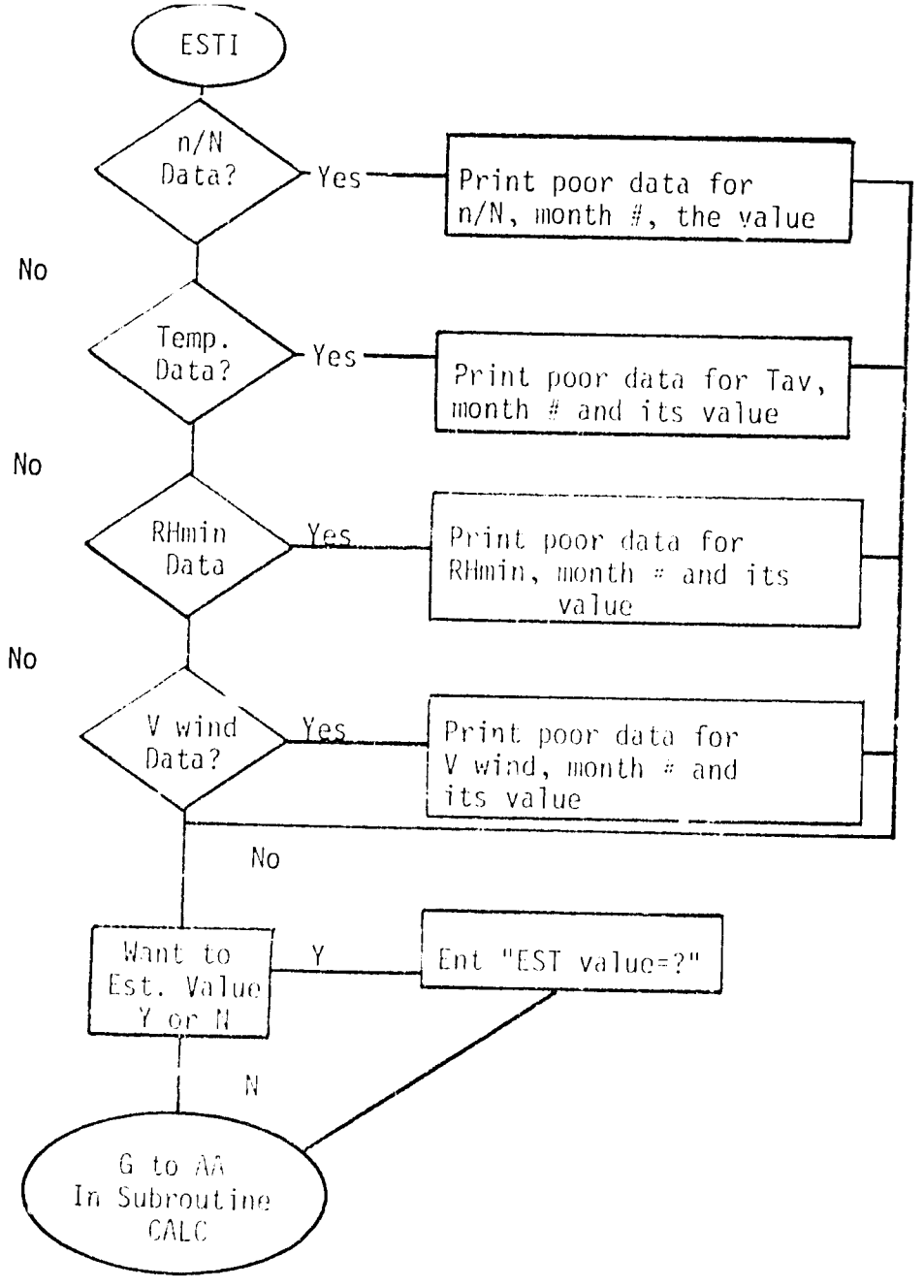
ET_o


START
Read Weather data
Display & print "For temp. data"
gsb"DSP"
Actual data
Yes
No
gsb"CALC"
Calculate f factor for each month for certain av. temp. per month
Display & print "For n/N data"
gsb"DSP"
Est. data
No
gsb"CALC"
Yes
Display & print "For RH min data"
gsb"DSP"
Actual data
Yes
gsb"CALC"
No
Display & print "For V wind data"
gsb"CALC"
Actual data
Yes
gsb"CALC"
No


Calculate K, ET_o for each month
Print average ET_o for each month in mm/day
Enter file name to store the ET_o data
STOP


DSP
Actual=A
Est. data=E
A
E
Temp. Data?
No
Yes
Enter the av. temp. for each month
Enter 0.1. or 2 for low. Middle or high value respectfully, for each month
Return


CALC
Generates an array to contain the 1st day No of every month
Calculates an average value for each month of T_{av}, Rhmin, V wind, n/N
Number of readings ≥ 20 per month
Yes
ESTI
AA
Yes
Temp. Data?
No
RETURN
0, 1, 2 for low, medium and high values are Automatically assigned to n/N, Rhmin, V wind data for each month


ESTI
n/N Data?
Yes
Print poor data for n/N, month #, the value
No
Temp. Data?
Yes
Print poor data for Tav, month # and its value
No
RHmin Data
Yes
Print poor data for RHmin, month # and its value
No
V wind Data?
Yes
Print poor data for V wind, month # and its value
No
Want to Est. Value Y or N
Y
Ent "EST value=?"
N
G to AA In Subroutine CALC

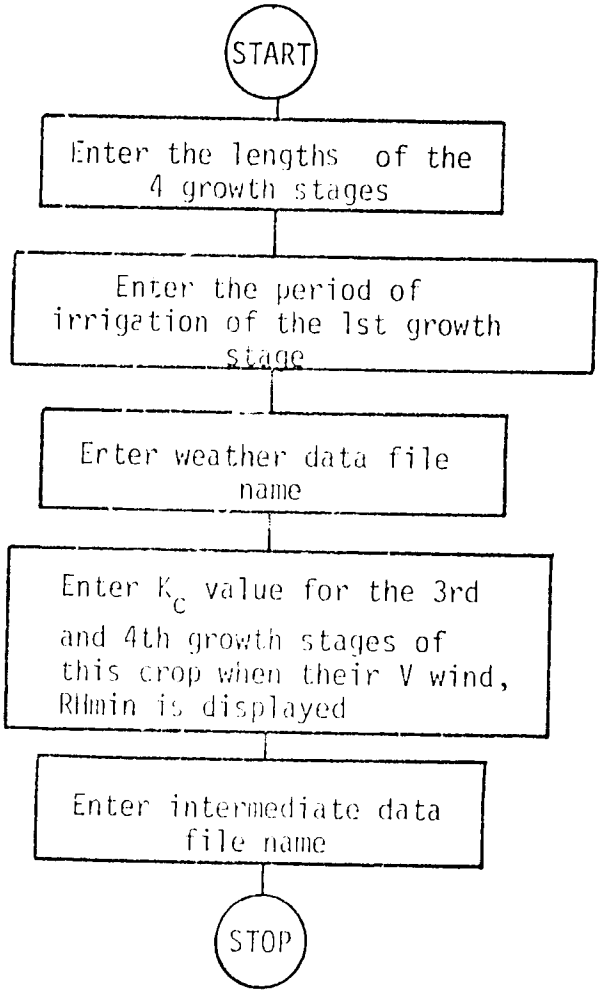
USERS INSTRUCTIONS

PROGRAM ET CROP

PART I

1. Get "file name," press EXECUTE
2. Press RUN
3. When "file name of reference ET data" appear
   A. Enter file name, not more than six characters
   B. Press CONTINUE
4. When "length of growth stage" stage no. appears
   A. Enter grown stage length in days in decimal form
   B. Press CONTINUE. Repeat Step 4 four times
5. When "Irrigation interval, Initial Stage" appears
   A. Enter irrigation interval in days in decimal form
   B. Press CONTINUE
6. When "file name of weatherdata" appears
   A. Enter file name, not more than six characters
   B. Press CONTINUE
7. When "wind" wind speed "RH man" humidity "stage" stage no. appear
   A. Enter Kc (crop coefficient) refer to Table 3.2
   B. Press CONTINUE, repeat Step #7 if display in Step #7 appears again
   C. STOP

ET_{crop} PART 1



```
0: "S0":dsp "Program ETcrop, Part 1";wait 2000
1: dim Y$[6],A[2,300],C,D
2: dim X$[6],B[366],A,B
3: dim D[9]
4: dim E[5],F[3]
5: ent "file name of reference ET data",X$
6: assgn X$,1;read 1,Y$,B[*],A,B
7: 1→E[1]
8: for J=2 to 5
9: dsp "length of growth stage",J-1;ent "",E[J]
10: E[J-1]+E[J]→E[J];next J
11: ent "irrigation interval,initial stage",A
12: cll "SUB"(A,D[1],D[2],D[3],D[4],D[5],D[6],D[7],D[8],D[9])
13: 0→S
14: for K=1 to E[2];S+B[K]→S;next K
15: S/(E[2]-E[1]+1)→S
16: if S>1,gto "S1"
17: if S=1,gto "S2"
18: int(S)→I;(S-I)*(D[I+1]-D[I])+D[I]→E[1];gto "S3"
19: "S1":(D[2]-D[1])*1→E[1];gto "S3"
20: "S2":D[2]→E[1]
21: "S3":ent "file name of weather data",Y$
22: assgn Y$,1;read 1,Y$,A[*],C,D
23: for L=3 to 4
24: 0→I;0→U
25: for K=E[L] to E[L+1]
26: I+B[K]→I;U+A[K]*B[K]→U;next K
27: E[L+1]-E[L]+1→E[L];I/E[L]→I;U/E[L]→U
28: dsp "wind",I,"humin",U,"stage",L
29: ent "",I,U,L;next L
30: kill "INFM"
31: open "INFM",1;prt 1,E[*],I[*],X$
32: stp
33: "SUB":if S1<0;gto "SB1"
34: if p1<0;gto "SB2"
35: if p1<.8;gto "SB3"
36: if p1<1;gto "SB4"
37: .44→p2;.37→p3;.32→p4;.26→p5;.22→p6;.2→p7;.18→p8;.15→p9;.14→p10;ret
38: "SB1":.1.06→p2;1→p3,.95→p4,.92→p5;.89→p6;.87→p7;.84→p8;.93→p9;.82→p10
39: ret
40: "SB2":.95→p2;.88→p3;.81→p4;.73→p5;.68→p6;.62→p7;.58→p8;.52→p9;.46→p10
41: ret
42: "SB3":.77→p2;.65→p3;.58→p4;.51→p5;.45→p6;.44→p7;.40→p8;.36→p9;.32→p10
43: ret
44: "SB4":.61→p2;.53→p3;.42→p4;.37→p5;.3→p6;.27→p7;.24→p8;.24→p9;.21→p10
45: ret
*****10
```

USERS' INSTRUCTIONS

PART 2

1. Get "file name," press EXECUTE

2. Press RUN

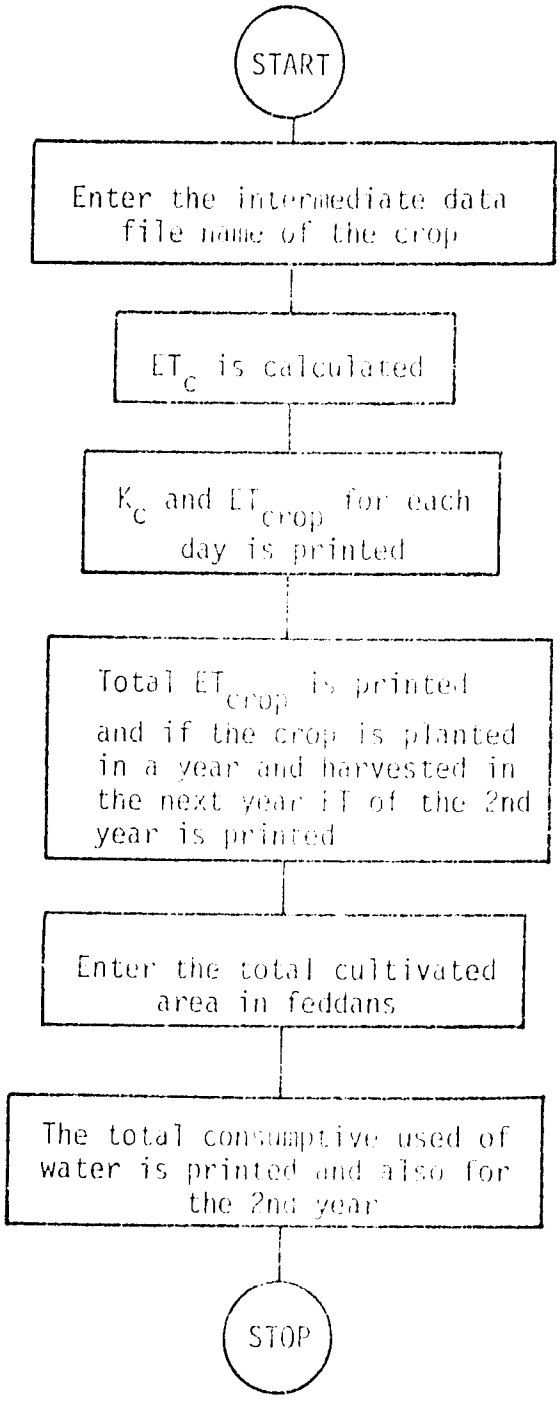
3. When "file name" for ET and Kc data appears

   A. Enter file name, not more than six characters

   B. Press CONTINUE

   C. STOP

ET_{crop} PART 2



```
0: "S4":dsp "Program Crop, Part 2";wait 2000
1: dim E[5],F[5],X$[6]
2: dim B[366] C,D,A[16]
3: ent "INPM FILE NAME?",A$
4: assgn A$,1;read 1,Z[4],F[*],X$
5: dim C[366]
6: dim Z$[6],G[300] H[300]
7: assgn X$,1;read 1,Z$,B[*],C,D
8: for K=G[1] to G[2];F[1]G[K];next K
9: (F[2]-F[1])/(E[3]-F[2]+1)→A
10: for K=G[2] to E[3];C[K-1+A]C[K];next K
11: for K=E[3] to E[4];F[2]C[K];next K
12: (F[5]-F[2])/(G[5]-F[4]+1)→B
13: for K=E[4] to G[5]-G[K] ;F[B]C[K];next K
14: 0→I,1→N
15: fmt 1,/z,"day",7x,"kc",5x,"Crop";wrt 701,1
16: fmt 2,f5.0,2f10.2
17: for K=1 to 365;B[K]→G[N],C[K]→H[N];N+1→N
18: B[K]*C[K]→I,I+I→I;wrt 701,2,C,C[K],I→I,1→L
19: if C>365,1→C;1→X
20: if X=1;L+1→A
21: next K
22: if X=1;fmt 3,z,"Used [] for this year:",f6.1," mm";wrt 701,3,A
23: fmt 3,z,"Total [] required:",f6.1," mm";wrt 701,3,I
24: cnt "Ditto Acre to [LBD.",B
25: I*.001*R*.0307→I
26: if X=1;G*.001*R*4200→V;V-V→I
27: fmt ,z,"Total CONSUMPTIVE USED WATER:",f10.3,"  MG";wrt 701,V
28: if X=1;fmt ,z,"TOTAL CONSUMPTIVE USED WATER FOR NEXT YEAR:",f10.3,"  MG"
29: if X=1;wrt 701,I
30: end
*7244.
```

CROP EVAPOTRANSPIRATION PROGRAM

INTRODUCTION

This set of programs consists of seven programs. The first two programs are data entry programs for precipitation and weather. The third is used to determine the daily evapotranspiration rate for a reference crop. The fourth program uses this information with crop specific data to calculate daily rates of potential evapotranspiration of particular crops. The fifth program simulates actual evapotranspiration under alternative patterns of soil moisture availability. It gives explicit consideration to the effect of the water table levels on evapotranspiration and crop development. The sixth program simulates advance and infiltration of irrigation water in a level border system. This program calculates the depth of water applied at a series of portions along the length of a level border. The seventh program simulates both soil-plant-water relationships and the application of water to the field. It generates information in water application efficiency, and crop yield.

---

* FAO Irrigation and Drainage Paper, "Crop Water Requirements" No. 24, 1975 and revised 1977.

* Computer Programs for the Simulation of On-Farm Water Management Alternatives by Robert King, Jim Loftis, Azza Nasr.

1. Precipitation data entry program stores precipitation data in a store file for use with any weather or crop data.
2. Weather data entry program stores temperature (maximum and minimum), wind velocity, pan evaporation and relative humidity (maximum and minimum) data.
3. Reference Crop Evapotranspiration Program
   - This program calculates reference crop evapotranspiration (CETo) on a daily basis using the pan evaporation method.
   - The program begins with the loading of weather data into the array A(6, 366), where:

A(1, i):	daily max. temp. (^{o}C)	i = 1-366
A(2, i):	daily min. temp. (^{o}C)	i = 1-366
A(3, i):	daily average wind velocity (knot)	i = 1-366
A(4, i):	daily pan evaporation (mm)	i = 1-366
A(5, i):	daily max. relative humidity	i = 1-366
A(6, i):	daily min. relative humidity	i = 1-366

   - Pan coefficient values for different relative humidity and wind velocity levels are then assigned in the array C(3, 4).
   - Because wind and humidity vary from season to season in Egypt, the relevant measurement adjustment factor is needed. So the user enters a different adjustment factor during the year into the array D(4).
   - Similarly, adjustments in wind velocity measurements are needed if the vanometer is not placed at a height of 2 m. The user enters the vanometer height in meters and the program selects a correction factor, F.

- The program then enters a loop in which ET_0 is calculated in a daily basis.
- Average relative humidity, B, is then calculated by the statement: (A(5, K) + A(6, K))/2 → B.
- The Wind velocity for day K is converted from knots to km/day by the statement:

  .852*24*F*A(3,K) → C

  Where F is the vanometer height correction factor and C is wind velocity in km/day.
- ET_0 for day K, B(K), is then calculated by the statement:

  C(I,J)*D(L)*A(4,K) → B(K)

  Where D(L) is the pan evaporation measurement correction factor.
- The day number, average relative humidity, wind velocity, pan evaporation, the pan coefficient, and ET_0 are then printed. The array of ET_0 is then recovered and this information serves as an input to the next program.

4. Potential Crop Evapotranspiration Program:

In this section two computer programs are used in combination to determine potential evapotranspiration on a daily basis for specific crops (ET_{crop}).

To account for differences in crop water requirements attributable to crop and growth stage specific characteristics, ET_0 is adjusted by a crop coefficient (K_c) which calculates ET_{crop}.

$ET_{crop} = K_c * ET_0$

Values of K_c vary during the crop growth stages.

- In the first program information about the beginning and end of each growth stage is established and K_c values for the initial growth stage, the mid season growth stage, and the final day of the late season stage are determined.
- The second program determines K_c values for each day, calculates total consumptive use requirements and creates a data file containing daily values of K_c and ET_o

Part 1

- The program begins with the loading of the reference ET data file. The daily ET_0 levels in the file are assigned to the elements of the array B(366).
- The user then enters the day number of the sowing date E(1) and the length of each of the four [illegible]omental growth stages. The program uses this information to calculate the final four values in the array E(5).
- The user then enters the typical interval between irrigations during the initial growth stage.
- This information is used in sub-routine SUB to assign values of K_c associated with integer initial growth stage daily ET_0 levels to the array D(99).
- After average ET_0 for the initial growth stage, S, is calculated by summing daily ET_0 and dividing by the number of days of this period, the K_c value, F(1), associated with that level of ET_0 is determined.
- Next K_c values for mid season and final season stages one determined.
- This segment of the program begins with loading the weather data file into the array A(6, 366). Then the program calculates average wind velocity and minimum relative humidity. The user enters an appropriate K_c value for each of the final two growth stages.

  Values of T (average wind velocity in m/sec) and U (average minimum relative humidity) are displayed with the appropriate growth stage number L and the user enters the K_c value which is assigned to F (L-1).

- Finally, the arrays E(5) and F(3) and X, the file number of the reference ET data are stored in a data file to be used for the second program.

Part 2

- The program begins with the loading of the input file from the first program and the reference ET data. In this segment of the program an array of daily K_c values for the entire growing, C(366), season is calculated. C(K) for the initial growth stage is set equal to F(1).

  C(K) values for the crop development stage are assumed to increase at a constant daily rate, A, defined by the statement:

  (F(2) - F(1))/(E(3) - E(1) + 1) → A

  Where

  F(1) and F(2) are the Kc values for the first and third growth stage.

  E(2) and E(3) are the starting and ending date of the crop development stage.

  C(K) values, then are defined by the expression c(k - 1) + A → C(K)

  During the mid-season stage - K from E(3) to E(4)

  C(K) values are all set equal to F(2)

  For the final growth stage C(K) values are assumed to decrease at a constant rate, B defined by the statement.

  (F(3) - F(2))/E(E(5) - E(4) + 1) → B

  Where F(2) and F(3) are the K_c values for the third growth stage and for the end of the fourth stage and E(4) and E(5) are the starting and ending date for the final growth stage.

  C(k) values are defined by the expression

  C(K-1) + B → C(K)

The program then prints the values of Kc and ET_o, for each day from the sowing date, E(1), to the harvest date, E(5). A file containing these arrays is created at the end of the program.

5. Plant-Soil-Water Simulation:

This program is designed to calculate the actual evapotranspiration, max. evapotranspiration and relative evapotranspiration for each growth stage of the crop using the previously calculated values of ET_o and K_c. The program starts with entering the required inputs. The required inputs are as follows:

# of sample observations (O)

# of irrigations (r5)

# of soil levels (s)

depth T(*), WHCR(*) and ISM T(*) of each soil level

# of growth stages (U) and length of each stage U(*)

max. root depth (A) and planting depth (B)

days to max. root depth C

critical SM depletion P

The user then enters the file # of ET_o and K_c data, which are calculated by the previous program. Then enter # of precip. data which contains the date of rainfall and the depth of rain. Then the program enters a loop to calculate the daily root depth for each sample observation.

$$\text{Rate of root depth growth (E)} = \frac{A-B}{C}$$

If root depth > WT for 2 days, it is assumed that the root depth = WT depth.

The next section of the program is used to calculate actual

evapotranspiration using the following equations:

$$\text{if } Q \geq (1-P)^* R \rightarrow Y = H(L)$$

$$\text{if } Q \leq (1-P)^* R \rightarrow Y = \frac{Q}{(1-P)^*R} H(L)$$

Where Q : current SM

P : Critical SM depletion

R : Current WHC

Y : Actual K_c

H(L) : K_c max., L : day indicator

Then ET_a : min. (Q, Y*G(L)

Where Q : represents the current SM

Y*G(L) : represent what we want to put in the soil

G(L) : ET_o

Also, if $Z(L) \leq T(X)$ then $ET_o = G(L)*H(L) = ET$ max.

This means that if WT level is less than the current soil level

$ET_a = K_c$ max. ET_o

Next to this the program calculates ET_a, ET max. and ET_r for each growth stage of each sample observation where

$$ET_r = \frac{Eta}{Et\ max}$$

Then the program writes the results of ET_a, $ET_{max.}$ and ET_r

6. Level Border Simulation Program:

The level border irrigation simulation program estimates the average depth of water applied to each of several field divisions from (one to twenty) average depths are then calculated for the desired number of field divisions.

The infiltrated depth F is estimated by the equation

$$F = a\ T_o^{\ b} + C$$

Where a, b and c are the infiltration constants.

T_o is the intake opportunity time in minutes. The infiltration constants are entered directly into the program.

In the beginning section of the program, the required input information is entered by the user.

The metric quanlities are converted to English units.

The length of advance at successive times is then calculated using this equation:

$$L_t = \frac{720\ Q_u\ T_t}{\frac{a\ Tt^b}{1+b} + C + 18.6n^{0.375}\ Q_u^{0.5625}\ T_t^{\ 0.1875}}$$

The above variables are described in the following table:

Variable	Description	HPL Notation
L_t	Length of advance in (ft)	V(N)
Q_u	Flow rate/unit width (ft/sec/A)	r31
T_t	Time of advance in minutes	r32
	Time increment in minutes	c
	r32 = N*C	
a, b, C	Infiltration constants	r11, r12, r13
n	roughness coefficient	0

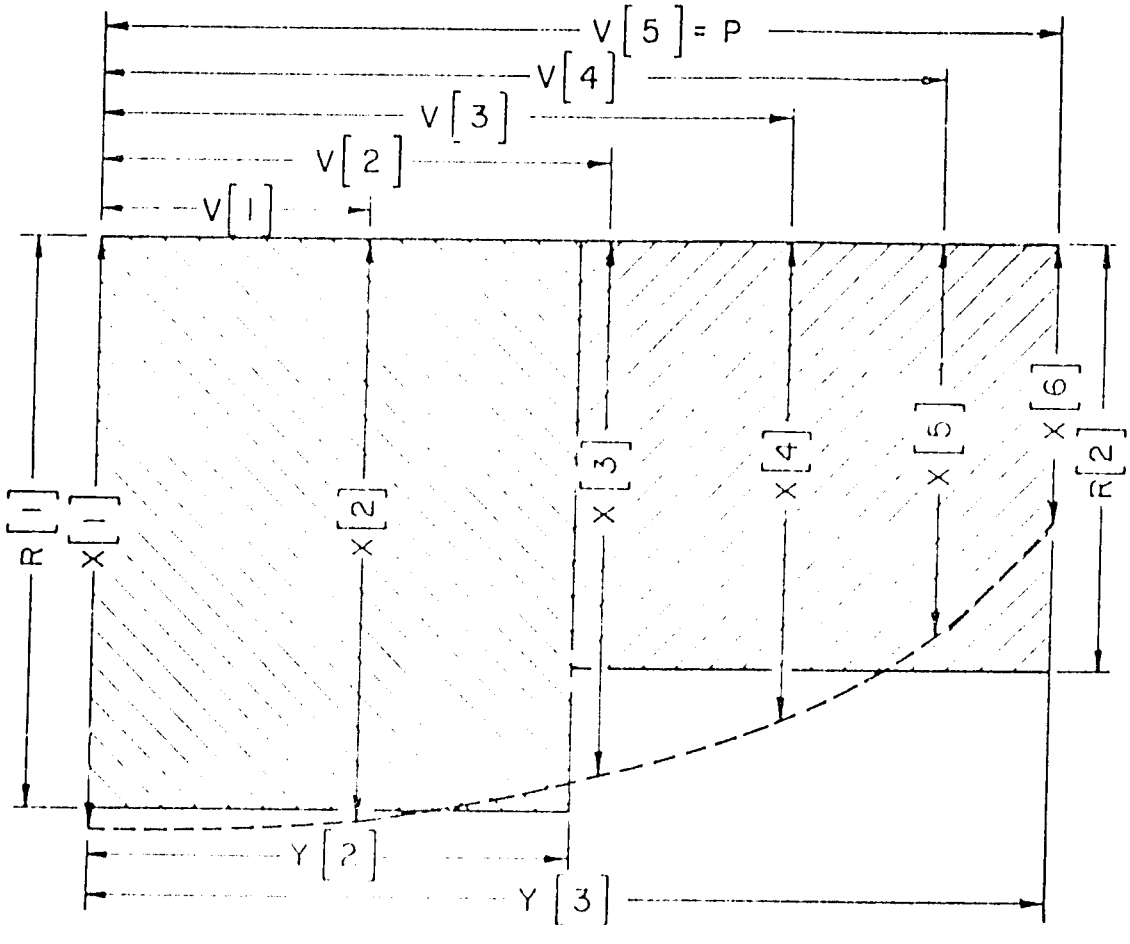
Advance distances are computed for successive time steps until the length of advance exceeds the length of the border. Then the current value of U(N) is set equal to the length of the border, P, and the total time of advance, r38, is found by linear reduction of r32.

Next, the time required for the net depth of irrigation, r14, to enter the soil after the end of advance is calculated and stored as r37 using $T_o = \frac{(F-C)}{a}^{1/b}$

The intake opportunity times W(L) are then computed at each advance point, L. The opportunity time at each point is equal to total time of advance + time of infiltration - the time of advance to this point.

Using the infiltration equation and opportunity times, depth of infiltration is then calculated and stored in X(*) array. Next, the average depth applied is calculated for each of the field divisions beginning at the head of the border.

The calculation procedure is illustrated using the following figure which is labeled with the appropriate HPL variable names.



For each of the four divisions or segments, the average depth applied over the segment is equal to the area above the dotted depth of advance divided by the length of the segment. The total volume of water applied is calculated, the total time of irrigation is the found by dividing the total volume applied by the flow rate.

Finally, the time of irrigation, total volume of water applied and average depth applied for each field division are printed as output.

7. Irrigation Simulation Program:

This program combines level border simulation program with plant-soil simulation program. It starts with entering the same data required for the last two programs cost and return data. After loading all the necessary data, the program calculates the daily root depth, adjust K_c value, calculate ET_a, ET_r for each field division and then calculates the time required for irrigation and the average infiltration depth for each field division. It then calculates the total applied water. Then if this day is rain day, the program adds the depth of rain to the infiltrated depth. Then the program calculates the yield of each field division. Finally, the program calculates the application efficiency, requirement efficiency, total water applied and the net return at the end of the program. A list of these results are printed.

Crop Coefficient (kc) for Field and Vegetable Crops for Different Stages of Crop Growth and Prevailing Climatic Conditions

Crop	Humidity		RHmin >70%		RHmin <20%	
	Wind m/sec		0-5	5-8	0-5	5-8
	Crop stage					
All field crops	initial	1	Use Fig. 7			
"	crop dev.	2	by interpolation			
Artichokes (perennial-clean cultivated)	mid-season at harvest or maturity	3	.95	.95	1.0	1.05
		4	.9	.9	.95	1.0
Barley		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2
Beans (green)		3	.95	.95	1.0	1.05
		4	.85	.85	.9	.9
Beans (dry) Pulses		3	1.05	1.1	1.15	1.2
		4	.3	.3	.25	.25
Beets (table)		3	1.0	1.0	1.05	1.1
		4	.9	.9	.95	1.0
Carrots		3	1.0	1.05	1.1	1.15
		4	.7	.75	.8	.85
Castorbeans		3	1.05	1.1	1.15	1.2
		4	.5	.5	.5	.5
Celery		3	1.0	1.05	1.1	1.15
		4	.9	.95	1.0	1.05
Corn (sweet) (maize)		3	1.05	1.1	1.15	1.2
		4	.95	1.0	1.05	1.1
Corn (grain) (maize)		3	1.05	1.1	1.15*	1.2
		4	.55	.55	.6*	.6
Cotton		3	1.05	1.15	1.2	1.25
		4	.65	.65	.65	.7
Crucifers (cabbage, cauliflower, broccoli, Brussels sprout)		3	.95	1.0	1.05	1.1
		4	.80	.85	.9	.95
Cucumber Fresh market		3	.9	.9	.95	1.0
		4	.7	.7	.75	.8
Machine harvest		4	.85	.85	.95	1.0
Egg plant (aubergine)		3	.95	1.0	1.05	1.1
		4	.8	.85	.85	.9
Flax		3	1.0	1.05	1.1	1.15
		4	.25	.25	.2	.2
Grain		3	1.05	1.1	1.15	1.2
		4	.3	.3	.25	.25
Lentil		3	1.05	1.1	1.15	1.2
		4	.3	.3	.25	.25
Lettuce		3	.95	.95	1.0	1.05
		4	.9	.9	.9	1.0
Melons		3	.95	.95	1.0	1.05
		4	.65	.65	.75	.75
Millet		3	1.0	1.05	1.1	1.15
		4	.3	.3	.25	.25

Crop	Humidity		RHmin > 70%		RHmin < 20%	
	Wind m/sec		0-5	5-8	0-5	5-8
Oats	mid-season	3	1.05	1.1	1.15	1.2
	harvest/maturity	4	.25	.25	.2	.2
Onion (dry)		3	.95	.95	1.05	1.1
		4	.75	.75	.8	.85
(green)		3	.95	.95	1.0	1.05
		4	.95	.95	1.0	1.05
Peanuts		3	.95	1.0	1.05	1.1
(Groundnuts)		4	.55	.55	.6	.6
Peas		3	1.05	1.1	1.15	1.2
		4	.95	1.0	1.05	1.1
Peppers (fresh)		3	.95	1.0	1.05	1.1
		4	.8	.85	.85	.9
Potato		3	1.05	1.1	1.15	1.2
		4	.7	.7	.75	.75
Radishes		3	.8	.8	.85	.9
		4	.75	.75	.8	.85
Safflower		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2
Sorghum		3	1.0	1.05	1.1	1.15
		4	.5	.5	.55	.55
Soybeans		3	1.0	1.05	1.1	1.15
		4	.45	.45	.45	.45
Spinach		3	.95	.95	1.0	1.05
		4	.9	.9	.95	1.0
Squash		3	.9	.9	.95	1.0
		4	.7	.7	.75	.8
Sugarbeet		3	1.05	1.1	1.15	1.2
		4	.9	.95	1.0	1.0
	no irrigation last month	4	.6	.6	.6	.6
Sunflower		3	1.05	1.1	1.15	1.2
		4	.4	.4	.35	.35
Tomato		3	1.05	1.1	1.2	1.25
		4	.6	.6	.65	.65
Wheat		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2

NB: Many cool season crops cannot grow in dry, hot climates. Values of kc are given for latter conditions since they may occur occasionally, and result in the need for higher kc values, especially for tall rough crops.

USERS' INSTRUCTIONS

PROGRAM ET_o

Load Program; press EXECUTE: press RUN

1. When "File name of weather data" appears

   a. Type the file name which includes daily max. temp., min. temp., av. wind velocity, pan evaporation, max, and min. relative humidity.

   b. Press CONTINUE

2. When "Pan in cropped area? Yes = 1, No = 0" appears

   either

   a. Type 1 if the pan is in cropped area

   b. Press CONTINUE

   c. Go to Step 4

   or

   a. Type 0 if the pan is not in cropped area

   b. Press CONTINUE

3. When "Windward distance of fallow" appears

   a. Type this distance in meters

   b. Press CONTINUE

   c. Go to Step 5

4. When "Windward distance of crop" appears

   a. Type this distance in meters

   b. Press CONTINUE

5. When "Epan corrections, Jan-Mar,"

   "Epan corrections, Apr-June,"

   "Epan corrections, July-Sep," and

   "Epan corrections, Oct-Dec," appears

   each time

a. Type the Epan corrections of each interval

b. Press CONTINUE

6. When "height of manometer (m)" appears

a. Type the height of the manometer in meters

b. Press CONTINUE

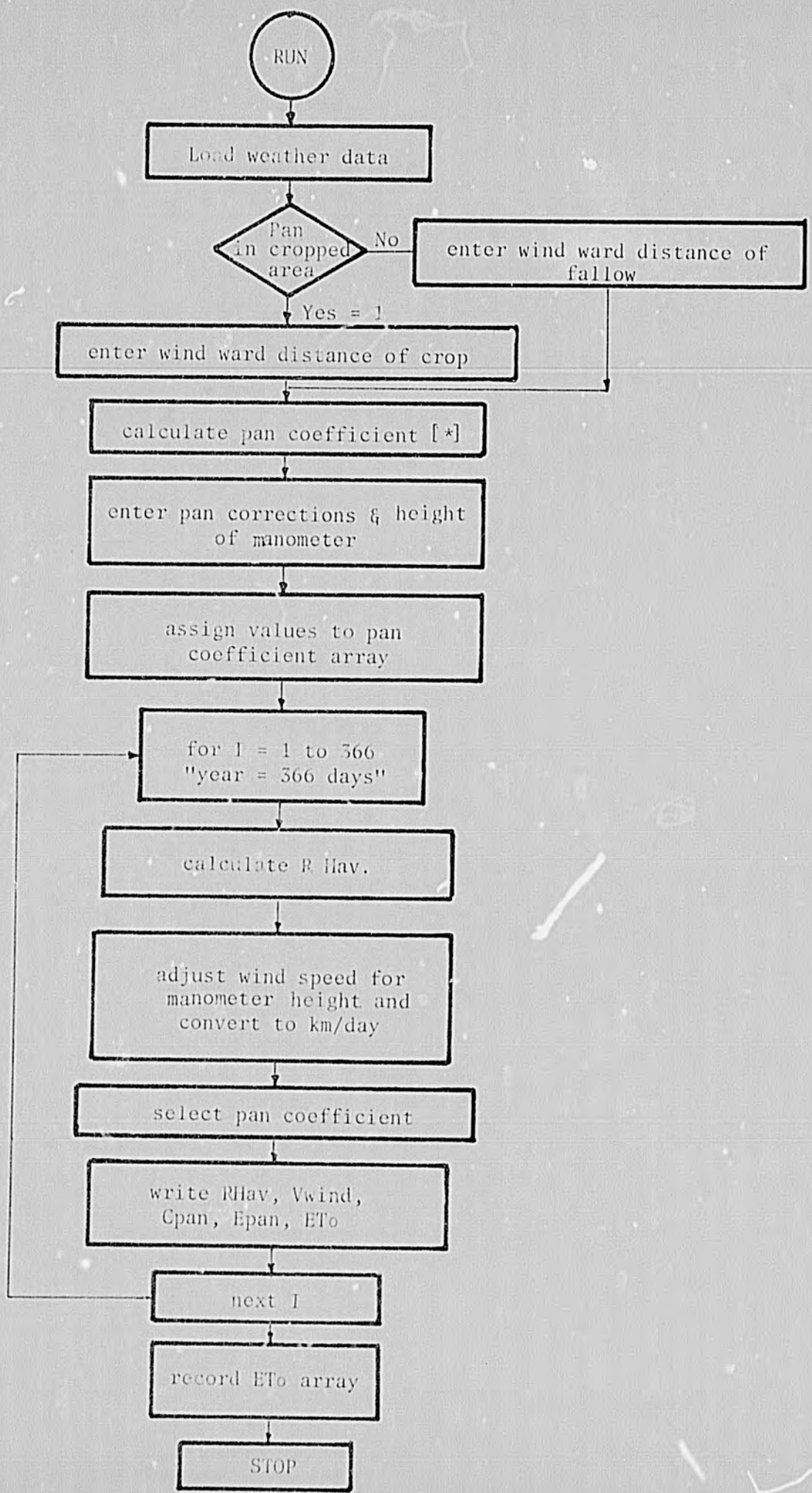
7. A list of the av. relative humidity, wind velocity, Epan, Cpan, ET_0 per day along the whole year is print

8. When "File name of reference ET data" appears

a. Type the file name to store ET_0

b. Press CONTINUE

ETo Flow Chart



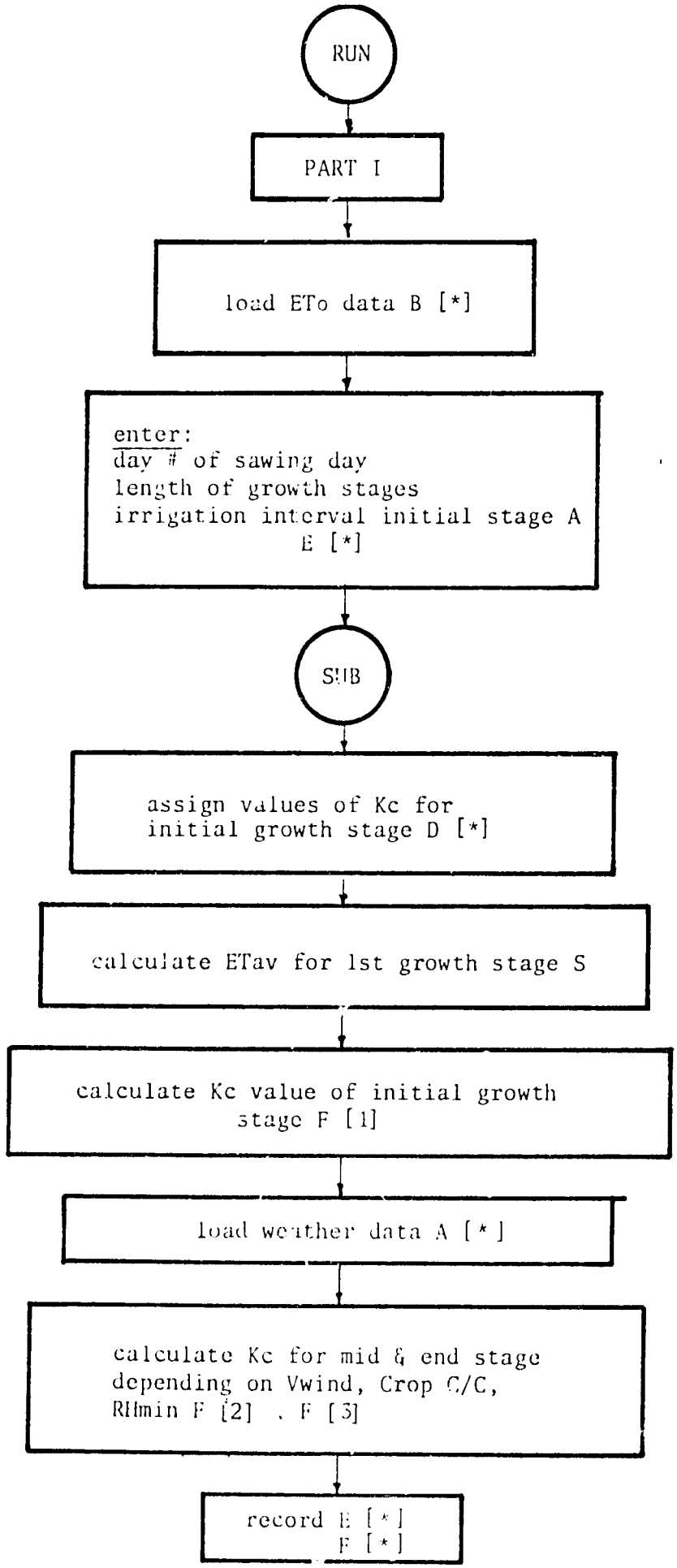
```
0: "S0":dsp "Program ETo";wait 2000
1: dim A$,366],A$[6],D$[6]
2: dim B[366]
3: dim C[3,4],D[4],A$[6],D$[6]
4: ent "File name of weather data",A$
5: asgn A$,1;read 1,A[*]
6: ent "Pan in cropped area?Yes=1,No=0",G
7: if G=1;gto "SB1"
8: ent "Windward distance of fallow",W;gto "SB2"
9: "SB1":ent "Windward distance of crop",W
10: "SB2":if G=1 and W<=1;gto "SB3"
11: if G=1 and W<=10;gto "SB4"
12: if G=1;gto "SB5"
13: if W<=1;gto "SB5"
14: if W<=10;gto "SB6"
15: "SB3":.55)C[1,1];.5)C[1,2];.45)C[1,3];.4)C[1,4];.65)C[2,1];.6)C[2,2]
16: .5)C[2,3];.45)C[2,4];.75)C[3,1];.65)C[3,2];.6)C[3,3];.5)C[3,4];gto "SB7"
17: "SB4":.65)C[1,1];.6)C[1,2];.55)C[1,3];.45)C[1,4];.75)C[2,1];.7)C[2,2]
18: .6)C[2,3];.55)C[2,4];.85)C[3,1];.75)C[3,2];.65)C[3,3];.6)C[3,4];gto "SB7"
19: "SB5":.7)C[1,1];.65)C[1,2];.6)C[1,3];.5)C[1,4];.8)C[2,1];.75)C[2,2]
20: .65)C[2,3];.6)C[2,4];.85)C[3,1];.8)C[3,2];.7)C[3,3];.65)C[3,4];gto "SB7"
21: "SB6":.6)C[1,1];.55)C[1,2];.5)C[1,3];.45)C[1,4];.7)C[2,1];.65)C[2,2]
22: .55)C[2,3];.5)C[2,4];.8)C[3,1];.7)C[3,2];.65)C[3,3];.55)C[3,4];gto "SB7"
23: "SB7":ent "Epan correction, Jan-Mar",D[1]
24: ent "Epan correction, Apr-Jun",D[2]
25: ent "Epan correction, Jul-Sep",D[3]
26: ent "Epan correction, Oct-Dec",D[4]
27: ent "Height of manometer (m)",H
28: if H<=.75;1.35)F;gto "S1"
29: if H<=1.25;1.15)F;gto "S1"
30: if H<=1.75;1.06)F;gto "S1"
31: if H<=2.5;1)F;gto "S1"
32: if H<=3.5;.93)F;gto "S1"
33: if H<=4.5;.88)F;gto "S1"
34: if H<=5.5;.85)F;gto "S1"
35: .83)F
36: "S1":1)L;90)M
37: fmt 1,2x,"day",5x,"RHavg",4x,"wind V",6x,"Epan",6x,"Cpan",7x,"ETo"
38: wrt 701,1
39: for K=1 to 366;if K>M;L+1)L;M+92)M
40: (A[5,K]+A[6,K])/2)B;86.4*F*A[3,K])C
41: if B<40;1)I;gto "S2"
42: if B<=70;2)I;gto "S2"
43: 3)I
44: "S2":if C<125;1)J;gto "S3"
45: if C<425;2)J;gto "S3"
46: if C<700;3)J;gto "S3"
47: 4)J
48: "S3":C[I,J]+D[L]*A[4,K])B[K]
49: fmt 2,f5.0,5f10.2;wrt 701,2,K,B,C,A[4,K],C[I,J],B[K]
50: next K
51: ent "File name of reference ET data",D$
52: open D$,10;asgn D$,1;sprt 1,B[*]
53: end
*13511
```

USERS' INSTRUCTIONS

PROGRAM ET CROP, PART 1

Load program; press EXECUTE, press RUN

1. When "File name of reference ET data" appears
   a. Type the file name of ET_o which is stored by program in Part A
   b. Press CONTINUE
2. When "Length of growth stage" J appears where J changes from 1 to 4
   a. Type the length of each growth stages each time (in days).
   b. Press CONTINUE; go to Step 3 until J equals 4
3. When "Irrigation interval, inital stage" appears
   a. Type the period between two irrigations during the 1st stage
   b. Press CONTINUE
4. When "File name of weather data" appears
   a. Type the file name of the weather data
   b. Press CONTINUE
5. When "Wind" T "RH min." U "stage" L appears where L = 3, 4
   a. Enter K_c for different growth stages from Table 22 FAO Irrigation & Drainages Papers (Table enclosed)
   b. Press CONTINUE; go to Step 6 for L = 4
6. The length of all growth stages and their ET_c are stored at file #3


RUN
PART I
load ETo data B [*]
enter:
day # of sawing day
length of growth stages
irrigation interval initial stage A
E [*]
SUB
assign values of Kc for
initial growth stage D [*]
calculate ETav for 1st growth stage S
calculate Kc value of initial growth
stage F [1]
load weather data A [*]
calculate Kc for mid & end stage
depending on Vwind, Crop C/C,
RHmin F [2] , F [3]
record E [*]
F [*]

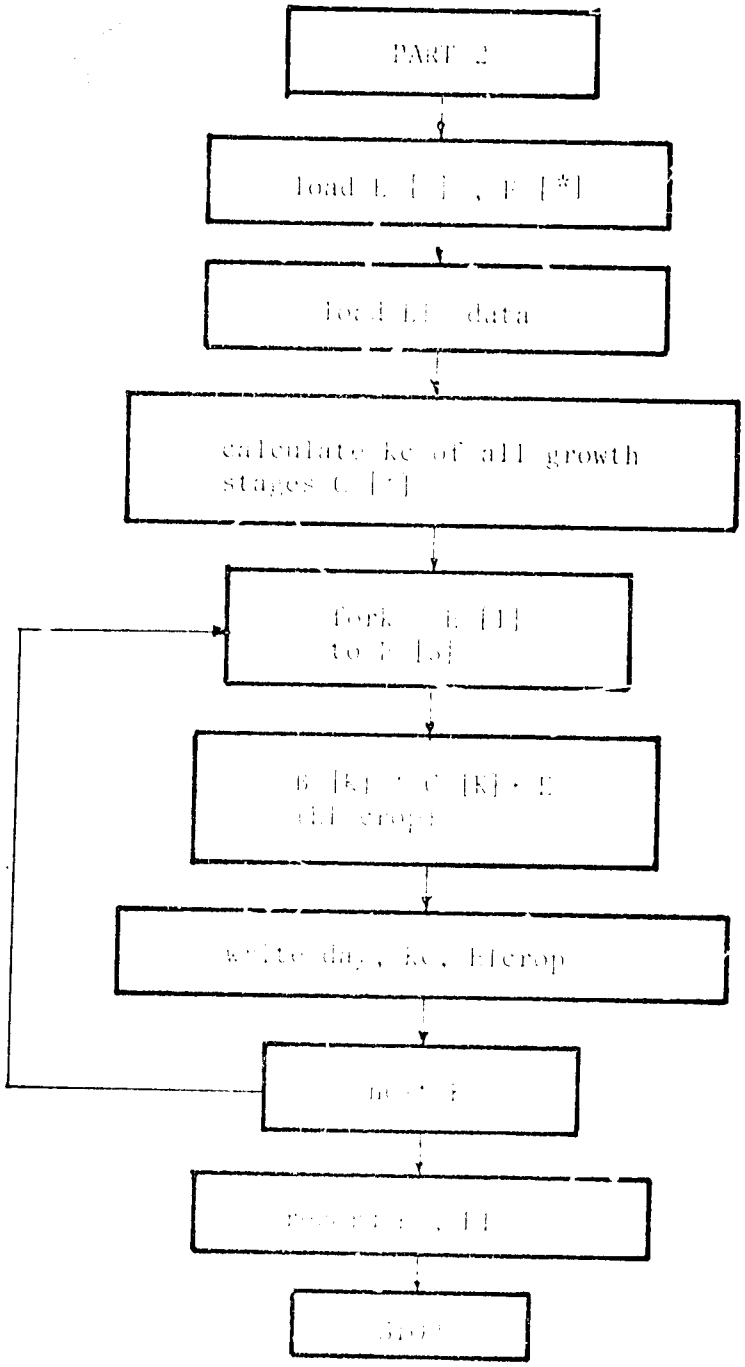
```
0: "S0":dsp "Program ETcrop, Part 1";wait 2000
1: dim A[6,366]
2: dim X$[6],B[366],A,B
3: dim D[9]
4: dim E[5],F[3],Y$[6],A$[6]
5: ent "file name of reference ET data",X$
6: asgn X$,1;sread 1,D[*],A,B
7: 1)E[1]
8: for J=2 to 5
9: dsp "length of growth stage",J-1;ent "",E[J]
10: E[J-1]+E[J])E[J];next J
11: ent "irrigation interval,initial stage",A
12: cll 'SUB'(A,D[1],D[2],D[3],D[4],D[5],D[6],D[7],D[8],D[9])
13: 0)S
14: for K=E[1] to E[2];S+B[K])S;next K
15: S/(E[2]-E[1]+1))S
16: if S<1;gto "S1"
17: if S>-9;gto "S2"
18: int(S))T;(S-T)*(D[T+1]-D[T])+D[T])F[1];gto "S3"
19: "S1":(D[2]-D[1])*(1-S))F[1];gto "S3"
20: "S2":D[9])F[1]
21: "S3":ent "file name of weather data",Y$
22: asgn Y$,1;sread 1,A[*],A,B
23: for L=3 to 4
24: 0)T;0)U
25: for K=E[L] to E[L+1]
26: T+A[3,K]*.5144)T:U+A[6,K])U:next K
27: E[L+1]-E[L+1])V;T/V)T;U/V)U
28: dsp "wind",T,"RHmin",U,"stage",L
29: ent "",F[L-1];next L
30: ent "INPM FILE NAME",A$
31: open A$,4;asgn A$,1;sprt :,E[*],F[*],X$
32: end
33: "SUB":if p1<=5;gto "SB1"
34: if p1<=5;gto "SB2"
35: if p1<=8;gto "SB3"
36: if p1<=15;gto "SB4"
37: .44)p2;.37)p3;.32)p4;.26)p5;.22)p6;.2)p7;.18)p8;.15)p9;.14)p10;ret
38: "SB1":1.06)p2;1)p3;.95)p4;.92)p5;.89)p6;.87)p7;.84)p8;.83)p9;.82)p10
39: ret
40: "SB2":.95)p2;.87)p3;.8)p4;.73)p5;.68)p6;.62)p7;.58)p8;.57)p9;.56)p10
41: ret
42: "SB3":.77)p2;.65)p3;.58)p4;.51)p5;.45)p6;.44)p7;.38)p8;.36)p9;.32)p10
43: ret
44: "SB4":.61)p2;.5)p3;.42)p4;.37)p5;.3)p6;.29)p7;.28)p8;.24)p9;.21)p10
45: ret
*28418
```

USERS' INSTRUCTIONS

PROGRAM ET_{crop}, PART 2

Load program; press EXECUTE; press RUN

1. A list of K_c and ET_{crop} per day is printed
2. When "File name for ET and K_c data" appears
   a. Type the file name to store this data
   b. Press CONTINUE


PART 2
load E [ ] , F [*]
load LI data
calculate Kc of all growth stages C [*]
fork E [1] to F [5]
write day, Kc, Etcrop

```
0: "S4":dsp "Program ETcrop, Part 2";wait 2000
1: dim E[5],T[3],X$[6]
2: dim B[366],C,D
3: assgn "INRM",1;sread 1,E[*],T[*],X$
4: dim A[366]
5: dim Z$[6],G[3001],H[3001]
6: assgn X$,1;read 1,X$,B[*],C,D
7: for K=T[1] to T[2];E[K]=C[K];next K
8: (T[2]-T[1])/(E[3]-E[2])*100
9: for K=T[2] to T[3];C[K]=A*C[K];next K
10: for K=T[3] to T[4];E[K]=C[K];next K
11: (T[3]-T[2])/(E[5]-E[4])*100
12: for K=T[4] to T[5];C[K]=A*C[K];next K
13: 0[1];1*0
14: fmt 1,2/,"day",2/,"ET",2/,"ETcrop";wrt 701,1
15: fmt 2,f5.0,/f10.2
16: for K=T[1] to E[5];K-T[1]+1;G[N]=C[K];H[N]=B[K]*C[K]/D;N=N+1;next K
17: B[K]*C[K]/D;L=L+1;wrt 701,2,K,C[K],L;next K
18: fmt 3,"total ET requirement:",f6.1," mm";wrt 701,3,T
19: ent "file name for ET and Kc data",Z$
20: open Z$,20;assgn Z$,1;prt 1,Z$,G[*],H[*]
21: end
*20302
```

USERS' INSTRUCTIONS

IRRIGATION SIMULATION PROGRAM

Load program, press EXECUTE, press RUN

1. When "number of field divisions" appears
   a. Type the # of field divisions
   b. Press CONTINUE
2. When "A," "B," "C" and Roughness coefficient" appears
   a. Enter those roughness constants· refer to equation in Step 5 Part D
   b. Press CONTINUE each time
3. When "B0" and B1" appears
   a. Enter those water table parameter
4. When "file name of soil data" appears
   a. Enter the file name of soil data either to store it or to get it which contains the depths of each soil level and its WHC.
   b. Press CONTINUE
5. When "are data on file? 0=N, 1=Y" appears

   either
   a. Type 0 for new data
   b. Press CONTINUE

   or
   a. Type 1 for old data
   b. Press CONTINUE
   c. Go to Step 9
6. When "number of soil levels" appears
   a. Enter # of S.L.
   b. Press CONTINUE

7. When "depth (cm), level I" appears, where I from 1:# S.L.

   a. Enter depth of level I

   b. Press CONTINUE

8. When "whc (cm) level I" appears

   a. Enter whc for level #I

   b. Press CONTINUE

   c. Go to Step 7 until I = # S.L.

9. When "file name of crop data" appears

   a. Enter the file name of crop data either to store it or get it back

   b. Press CONTINUE

10. When "are data on file? 0=N, 1+Y" appears

    either

    a. Type 0 for new data

    b. Press CONTINUE

    or

    a. Type 0 for old data

    b. Press CONTINUE

    c. Go to Step 18

11. When "number of growth stages" appears

    a. Type the # of growth stages

    b. Press CONTINUE

12. When "length of growth stage" I appears where I from 1 to # of growth stages

    a. Type the length of this growth stage

    b. Press CONTINUE

13. When "yield reduction parameter stage" I appears

    a. Enter the yield reduction parameter for this stage

    b. Press CONTINUE

    c. Go to Step 12 until I = no of growth stages

14. When "max. root depth (cm)" appears

    a. Enter the max. root depth in (cm)

    b. Press CONTINUE

15. When "initial root depth (cm)" appears

    a. Type the planting depth

    b. Press CONTINUE

16. When "days to max. root depth" appears

    a. Enter the days to max. root depth

    b. Press CONTINUE

17. When "critical soil moisture depletion" appears

    a. Enter CSM

    b. Press CONTINUE

18. When "potential yield" appears

    a. Enter the potential yield in ardeb/feddan

    b. Press CONTINUE

19. When "file name of ET_0 and K_c data" appears

    a. Enter the file name of ET_0 and K_c

    b. Press CONTINUE

20. When "file name of precip. data" appears

    a. Enter the file name of rain data

    b. Press CONTINUE

21. When "product price per ardab" appears

    a. Enter the price per fodder

    b. Press CONTINUE

22. When "expected return from fodder" appears

    a. Enter the price per fodder

    b. Press CONTINUE

23. When "irrigation labor cost per hour" appears

    a. Enter this cost

    b. Press CONTINUE

24. When "irrigation operation cost per hour" appears

    a. Enter this cost

    b. Press CONTINUE

25. When "non-irrigation variable cost per feddan" appears

    a. Enter this cost

    b. Press CONTINUE

26. When "border length (meter)" appears

    a. Enter the length of border

    b. Press CONTINUE

27. When "border width (meter)" appears

    a. Enter the border width

    b. Press CONTINUE

28. When "flow rate (L/sec)" appears

    a. Enter the flow rate

    b. Press CONTINUE

29. When "irrigation interval (days), stage" I appears

    a. Enter the irrigation interval of this stage

    b. Press CONTINUE

30. When "irrigation depth (cm), stage" I appears

    a. Enter the irrigation depth of this stage

    b. Press CONTINUE

    c. Go to Step 29 until I = # of growth stages

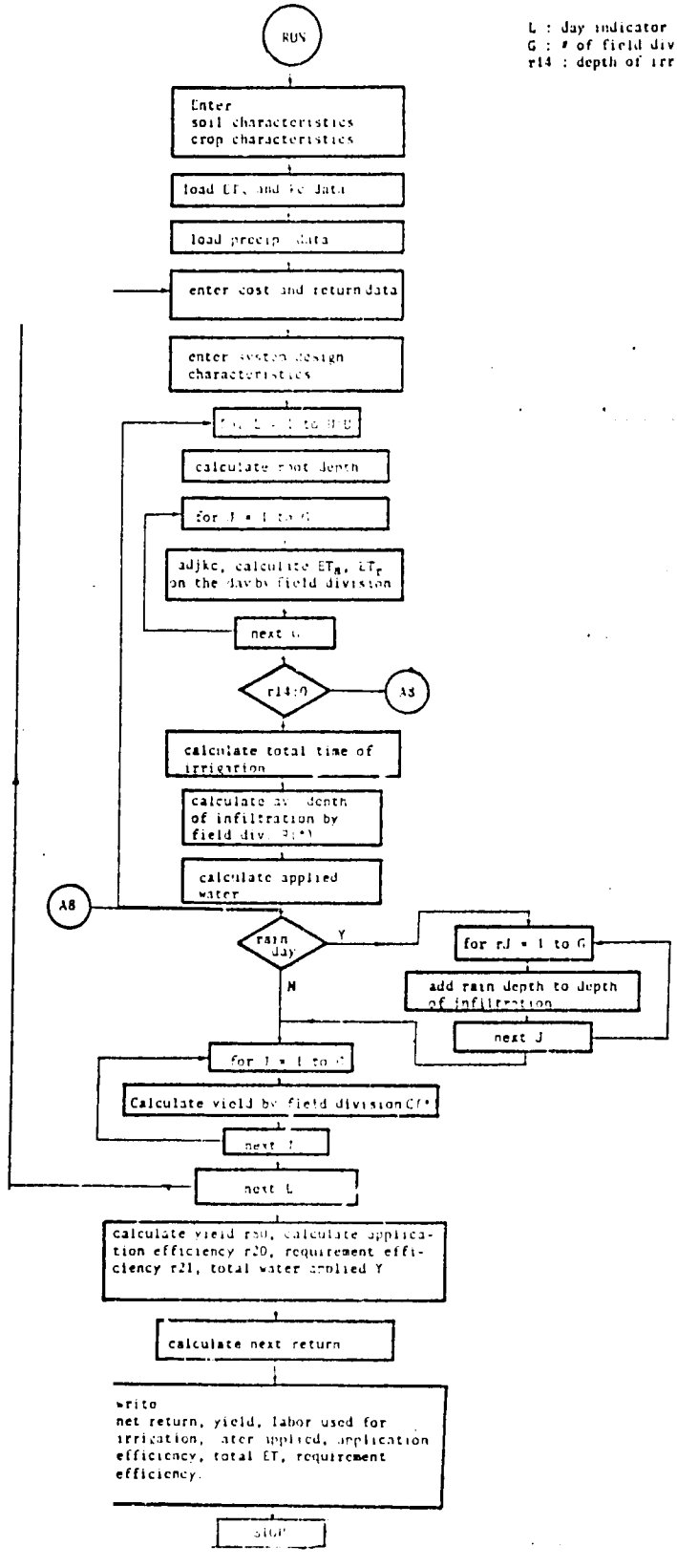
31. Calculation is done and a list of outputs is done

the outputs are:

- net return (LE/feddan)
- yield (ardabs/feddan)
- labor used for irrigation (hrs)
- water applied (hrs)
- application efficiency (percent)
- total Et (cm)
- requirement efficiency (percent)
- for each growth stage the irrigation interval (day) and the irrigation depth (cm).

IRRIGATION SIMULATION PROGRAM

L : day indicator
G : # of field division
r14 : depth of irrigation



```
0: "SU":dsp "IRRIGATION SIMULATION PROGRAM":wait 2000
1: fmt 1,10x,"IRRIGATION SIMULATION":wrt 701.1
2: ent "number of field divisions",G
3: dsp "soil infiltration constants":wait 2000
4: ent "A",r11,"B",r12,"C",r13,"roughness coefficient",O
5: dsp "water table parameters";wait 2000
6: ent "WO",r9,"R1",r10
7: ent "file name of soil data",Z$
8: dim R[10],T[10]
9: dsp "are data on file?0=N,1=Y";ent "",r99;if r99=1;gto "I1"
10: ent "number of soil levels",S
11: for I=1 to S;dsp "depth(cm),level",I
12: ent "",T[I];dsp "whc(cm)level",I;ent "",R[I]
13: next I
14: open Z$,4;asgn Z$,1;sprt 1,R[*],T[*],S;gto "I3"
15: "I1":asgn Z$,2;sread 2,R[*],T[*],S
16: "I3":dim I[10],S[10,10],V[100],W[100],X[100],Y[11],Z[11],Q[10]
17: for I=1 to S
18: R[I]>I[I];for J=1 to G;I[I]>S[I,J];next J
19: next I;I[1]>M;for J=1 to G;S[1,J]>Q[J]
20: fmt 1,"Soil Characteristics";wrt 701.1
21: fmt 1,5x,"number of soil layers=",f4.0,"depth of soil profile=  f6.0,"cm"
22: wrt 701.1,S,T[S]
23: fmt 1,5x,"A=",f7.4,5x,"B=",f7.4,5x,"C=",f7.4
24: wrt 701.1,r11,r12,r13
25: fmt 1,5x,"roughness coefficient=",f5.2;wrt 701.1,O
26: ent "file name of crop data",Z$
27: dim F[6],U[6]
28: dsp "are data on file?0=N,1=Y";ent "",r99;if r99=1;gto "I2"
29: ent "number of growth stages",U
30: for K=1 to U;dsp "length of growth stage",K;ent "",U[K]
31: dsp "yield reduction parameter stage",K;ent "",F[K]
32: if K>1;U[K-1]+U[K]>U[K]
33: next K
34: ent "max.root depth(cm)",A;ent "initial root depth(cm)",B
35: ent "days to max. root depth",C;ent "critical soil moisture depletion",F
36: open Z$,4;asgn Z$,3;sprt 3,F[*],U[*],U,K,A,B,C,F;jmp 1
37: "I2":asgn Z$,4;sread 4,F[*],D[*],UU,K,A,B,C,F
38: ent "potential yield",D;(A-B)/C>E
39: fmt 1,"Crop Characteristics";wrt 701.1
40: fmt 1,5x,"potential yield=",f4.0," ardeb/feddan"
41: fmt 1,5x,"yield reduction parameters";wrt 701.1
42: fmt 1,10x,"growth stage",f4.0,5x,"F=",f7.4
43: for K=1 to U;wrt 701.1,K,F[K];next K
44: dim A[11],B[10],C[10],D[6],E[6]
45: for J=1 to G;D>C[J];0>A[J];next J
46: dim G[300],H[300]
47: ent "file name of ETo and Kc data",Z$
48: asgn Z$,5;sread 5,G[*],H[*]
49: dim P[2,30]
50: ent "file name of precip data",Z$
51: asgn Z$,6;sread 6,P[*]
52: ent "product price per ardeb",r90;ent "expected return from fodder",r91
53: ent "irrigation labor cost per hour",r92
54: ent "irrigation operation cost per hour",r93
55: ent "non-irrigation variable cost per feddan",r94
56: fmt 1,"Cost and Retern Data";wrt 701.1
57: fmt 1,z,5x,"product price =",f6.2," LE/ardeb"
58: fmt 7,5x,"expected fodder return=",f6.2," LE/feddan"
59: fmt 2,z,5x,"irrigation labor cost=",f5.2," LE/hour"
60: fmt 8,5x,"irrigation operation cost=",f5.2," LE/feddan"
61: fmt 3,5x,"non-irrigation variable cost",f7.2," LE/feddan"
62: wrt 701.1,r90;wrt 701.7,r91;wrt 701.2,r92;wrt 701.8,r93;wrt 701.3,r94
63: ent "border length(meter)",P;ent "border width(meter)",Q
64: ent "flow rate(L/sec)",R;P*Q/4200.8>r50;r50/G>r51
65: fmt 1,"System Design Characteristics";wrt 701.1
66: fmt 1,z,5x,"border length",f4.0," m",5x,"border width",f4.0," m"
67: fmt 2,5x,"flow rate",f4.0," L/sec"
68: wrt 701.1,P,Q;wrt 701.2,R
69: fmt 1,"Irrigation Strategy";wrt 701.1
70: fmt 2,5x,"stage",f4.0,5x,"interval",f4.0," days",5x,"depth",f4.0," cm"
71: for K=1 to U;dsp "irrigation interval(days),stage",K;ent "",D[K]
```

```
72: disp "irrigation n.;pth(cm),stage",K;ent "",E[K]
73: wrt 701,2,K,D[K],E[K];next K
74: 1)r29;R/28.36)R;Q*3.281)Q;P*3.281)P;R/Q)r31
75: 1)V;0)W;1)X;1)T;0)H;0)Y;0)r52
76: 0)r53;0)r54;0)r55;0)r56;r2)r8
77: for L=1 to U[U];if L>U[V];V+1)V
78: B+E)B;if B>A;A)B
79: if B<r8;0)W
80: if B>=r8;1+W)W
81: if W>=2;r8)B
82: if B>T[X];X+1)X
83: if X>1;if B<T[X-1];X-1)X
84: for J=1 to G;if Q[J]>=(1-F)*M;H[L])r57
85: if Q[J]<(1-F)*M;H[L]*Q[J]/((1-F)*M))r57
86: min(Q[J],r57*G[L]))r58
87: if r8<=T[X];G[L]*H[L])r58
88: A[J]+r58)A[J];Y+r58/G)Y;r58)B[J]
89: next J
90: r56+G[L]*H[L])r56;H+G[L]*H[L])H
91: r52+1)r52;0)r14
92: if D[V]<=r52;E[V])r14;0)r52
93: if U[U]-L<=10;0)r14
94: 0)r16;0)r30;for J=1 to G;0)Z[J];next J
95: if r14=0;gto "A8"
96: r14/2.54)r14;R/Q)r31;0)V[1];2)N;r29)r32
97: "A1":720*r31*r32)r33;r11*r32^r12/(1+r12))r34
98: 18.6*U^.375*r31^.5625*r32^.1875)r35
99: r33/(r34+r13+r35))V[N];if V[N]>=P;gto "A2"
100: N+1)N;r32+r29)r32;gto "A1"
101: "A2":r32-(V[N]-P)/(V[N]-V[N-1])*r29)r38
102: P)V[N];N)r36;((r14-r13)/r11)^(1/r12))r37
103: r37+r38)r32;r11*r32^r12+r13)X[1]
104: for I=1 to r36;r29*I)r39;r37+r38-r39)W[I]
105: if W[I]<0;0)W[I]
106: W[I])r32;r11*r32^r12+r13)X[I+1];next I
107: 0)Y[1];2)N;G+1)G
108: for J=2 to G;Y[J-1]+P/(G-1))Y[J];next J;2)J
109: X[1])r42;X[2])r40;0)r43;V[2])r44;0)r41
110: "A3":if V[N]>Y[J];gto "A5"
111: r41+(r40+r42)/2*(r44-r43))r41
112: r40)r42;r44)r43;N+1)N;X[N])r40;V[N])r44
113: if N=r36;gto "A6"
114: gto "A3"
115: "A5":(Y[J]-r43)/(r44-r43)*(r40-r42)+r42)r40
116: Y[J])r44
117: r41+(r40+r42)/2*(r44-r43))r41
118: r40)r42;r44)r43;X[N])r40;V[N])r44
119: "A6":r41/(Y[J]-Y[J-1]))Z[J];0)r41
120: if J>=G;gto "A7"
121: J+1)J;gto "A3"
122: "A7":Q/3.281)r45;P/3.281/(G-1))r46
123: for J=2 to G;Y[J]/3.281)Y[J-1];Z[J]*2.54)Z[J-1]
124: r16+Z[J-1]*r45*r46*10)r16;next J
125: r16/(R*28.36*3600))r30;G-1)G
126: "A8":r53+r16)r53;r55+r30)r55
127: if L=P[1,T];for J=1 to G;Z[J]+.1P[2,T])Z[J];next J;T+1)T
128: for J=1 to G;.1B[J])r27;for I=1 to X
129: min(r27,S[I,J]))r24;r27-r24)r27
130: S[I,J]-r24)S[I,J];if r27<=0;gto "S1"
131: next I
132: "S1":Z[J])r28;0)r17;if r28=0;gto "S2"
133: for I=1 to S;if r8<T[I];R[I])S[I,J]
134: min(R[I]-S[I,J],r28))r60;S[I,J]+r60)S[I,J];r28-r60)r28
135: if r28<=0;gto "S2"
136: next I
137: r28)r17
138: "S2":0)M;0)Q[J];for I=1 to X;M+R[I])M
139: Q[J]+S[I,J])Q[J];next I
140: r54+r17*r45*r46*10)r54;next J
141: r9+r10*ln(r52+1))r8
142: if L#U[V];gto "S3"
143: for J=1 to G;C[J]*(A[J]/r56)^E[V])C[J];0)A[J];next J;0)r56
```

```
144: "S3":next L
145: 0)r80;for J=1 to G;r80+C[J]/G)r80;next J
146: 100*I/H)r21;.1*Y)Y;r55/r50)r55;100*(r53-r54)/r53)r20
147: r53/1000/r50)r53
148: r90*r80)r91-r92*r55-r93*r55-r94)r19
149: fmt 7,14x,"*******OUTPUT SUMMARY*******"
150: wrt 701,7
151: fmt ,5x,"Net return                    =",f9.2," LE/feddan ";wrt 701,r19
152: fmt ,5x,"Yield                         =",f9.2," LE/feddan ";wrt 701,r80
153: fmt ,5x,"Labor used for irrigation=",f9.2," hrs";wrt 701,r55
154: fmt ,5x,"Water applied                 =",f9.2," cu. meters/feddan"
155: wrt 701,r53
156: fmt ,5x,"Application efficiency  =",f9.2," percent"
157: wrt 701,r20
158: fmt ,5x,"Total ET                      =",f9.2," cm"
159: wrt 701,Y
160: fmt ,5x,"Requirement efficiency   =",f9.2," percent"
161: wrt 701,r21
162: end
*19298
```

PLANT-SOIL-WATER SIMULATION PROGRAM

Load program; press EXECUTE; press RUN

1. When "Number of sample observations" appears
   a. Type the number of sample observations
   b. Press CONTINUE
2. When "number of irrigations" appears
   a. Type the number of irrigations
   b. Press CONTINUE
3. When "Number of soil levels" appears
   a. Type the number of soil levels
   b. Press CONTINUE
4. When "Soil depth (cm), level" I appears
   where I varies from 1 to # of soil levels
   a. Type the soil depth in cm for each level
   b. Press CONTINUE
5. When "Water holding capacity (cm)" appears
   a. Type WHC for this level in cm
   b. Press CONTINUE
6. When "initial soil moisture (cm)" appears
   a. Type the ISM (cm) for this soil level
   b. Press CONTINUE
   c. Go to Step 4 until I = # of soil level
7. When "number of growth stage" appears
   a. Type the # of growth stage
   b. Press CONTINUE
8. When "length of growth stage" J appears
   where J varies from 1 to no. of growth stage

a. Type the length of this growth stage in days

b. Press CONTINUE

C. Go to Step 8 to do for all growth stages

9. When "maximum root depth (cm)" appears

a. Type the max. root depth in cm

b. Press CONTINUE

10. When "Planting depth (cm)" appears

a. Type the depth of planting the seeds in cm

b. Press CONTINUE

11. When "Days to maximum root depth" appears

a. Type the days to max. root depth

b. Press CONTINUE

12. When "Critical soil moisture depletion" appears

a. Type CSM in cm

b. Press CONTINUE

13. When "File name of experimental data" appears

a. Type the file name which contains the data of the water applied by each irrigation for each sample observation, the yield by each sample observation, the data of each irrigation, and the water table levels during all seasons.

b. Press CONTINUE

14. When "File name of ET_0 and K_c data" appears

a. Enter the file name of ET_0 and K_c data

b. Press CONTINUE

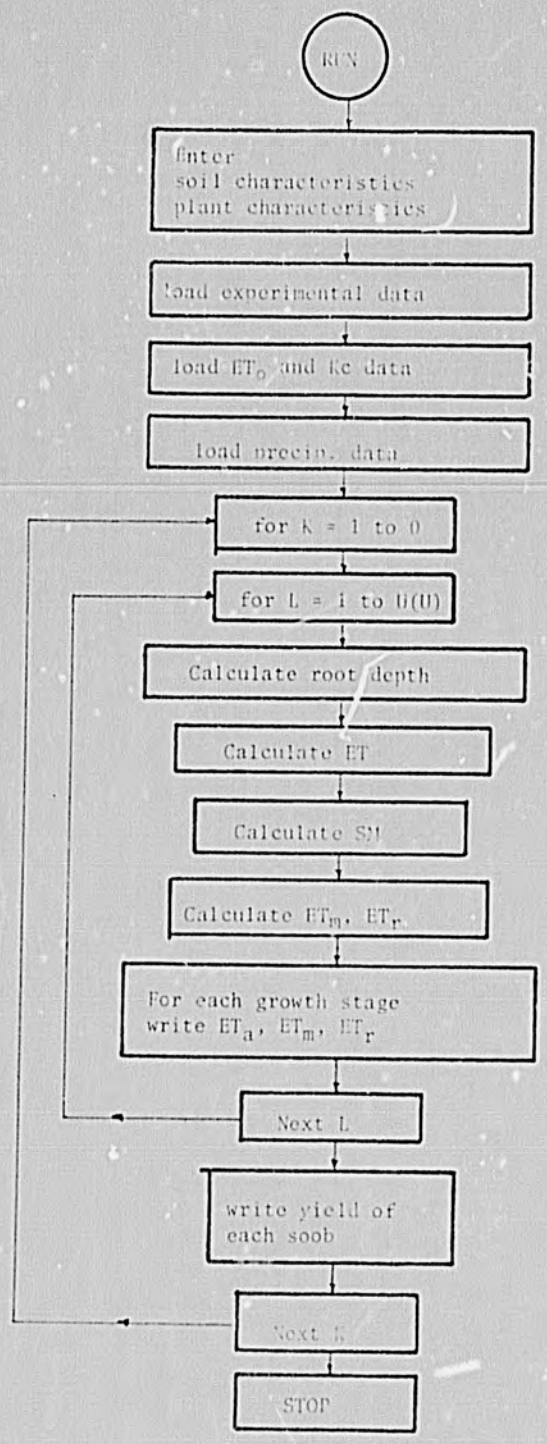
15. When "File name of precip. data" appears

a. Enter the file name of precip. data which contains the rain date and the amount of rain

b. Press CONTINUE

16. A list of accumulated ET_a, ET_{max} and ET_r in (cm/day) per sample observation per growth stage is printed and the yield per sample observation is printed.

Plant-Soil-Water Simulation



K : sample observation
L : day indicator
O: # of sample observation
U(U): last day of the last growth stage

```
0: "SU":dsp "Plant-Soil-Water Simulation,Ver.1";wait 2000
1: dim G[300],H[300]
2: dim I[10],R[10],S[10],T[10],U[6]
3: dim P[2,30]
4: ent "number of sample observations",O
5: ent "number of irrigations",rS
6: dim W[O,rS],Y[O],X[rS],Z[300]
7: ent "number of soil levels",S
8: for I=1 to S;dsp "soil depth(cm),level",I;ent "",T[I]
9: dsp "water holding capacity(cm)";ent "",R[I]
10: dsp "initial soil moisture (cm)";ent "",I[I];next I
11: ent "number of growth stages",U
12: for J=1 to U;dsp "length of growth stage",J;ent "",U[J]
13: if J>1;U[J]+U[J-1]→U[J]
14: next J
15: ent "maximum root depth(cm)",A;ent "planting depth(cm)",B
16: ent "days to maximum root depth",C
17: (A-B)/C→E
18: ent "critical soil moisture depletion",P
19: ent "file name of experimental data",Z$
20: asgn Z$,1;sread 1,W[*],Y[*],X[*],Z[*]
21: ent "file name of ETo and Kc data",Z$
22: asgn Z$,2;sread 2,G[*],H[*]
23: ent "file name of precip data",Z$
24: asgn Z$,3;sread 3,P[*]
25: for K=1 to O
26: fmt 1,5x,"Observation",f3.0;wrt 701.1,K;B→D
27: I[1]→Q;R[1]→R;1→V;0→W;1→X;0→G;0→H;1→N,1→T
28: for I=1 to S;I[I]→S[I];next I
29: for L=1 to U[U];if L>U[V];V+1→V
30: D+E→D;if D>A;A→D
31: if D<Z[L];0→W
32: if D>Z[L];W+1→W
33: if W>=2;Z[L]→D
34: if D>T[X];X+1→X
35: if X>1;if D<T[X-1];X-1→X
36: if Q>=(1-P)*R;H[L]→Y
37: if Q<=(1-P)*R;Q*H[L]/((1-P)*R)→Y
38: min(Q,Y*G[L])→F
39: if Z[L]<=T[X];G[L]*H[L]→F
40: F+G→G;H+G[L]*H[L]→H
41: fmt 2,z,10x,"growth stage",f3.0,"  ETa",f7.2,"  ETm",f7.2,"  ETr",f7.4
42: fmt 4,"  lnETr",f7.6
43: if L=U[V];G/H→M;ln(M)→r6;wrt 701.2,V,G,H,M;wrt 701.4,r6;0→G;0→H
44: .1*F→r1;for I=1 to X;min(r1,S[I])→r2
45: r1-r2→r1;S[I]-r2→S[I];if r1<=0;gto "S1"
46: next I
47: "S1":0→r3;if L=X[N];W[K,N]→r3;N+1→N
48: if N>=S;S→N
49: if L=P[1,T];r3+P[2,T]*.1→r3;T+1→T
50: if r3=0;gto "S2"
51: for I=1 to S;min(R[I]-S[I],r3)→r4
52: S[I]+r4→S[I];r3-r4→r3;if Z[I]<=T[I];R[I]→S[I]
53: next I
54: "S2":0→Q;0→R
55: for I=1 to X;Q+S[I]→Q;R+R[I]→R;next I
56: next L
57: fmt 3,5x,"yield=",f10.2,"  log of yield=",f9.6;wrt 701.3,Y[K],ln(Y[K])
58: next K
59: end
*31619
```

USERS' INSTRUCTIONS

LEVEL BORDER SIMULATION PROGRAM

Load program, press EXECUTE, press RUN

1. When "border length (meters)" appears
   a. Type the length of the border
   b. Press CONTINUE
2. When "border width (meters)" appears
   a. Type the width of the border
   b. Press CONTINUE
3. When "flow rate (L/sec)" appears
   a. Type the flow rate
   b. Press CONTINUE
4. When "number of field divisions" appears
   a. Type the # of field divisions into borders
   b. Press CONTINUE
5. When "A," "B," "C" each of them appears
   a. Enter those constants represented in this eq$^{\underline{m}}$

$$F = A\ T_o^{\ B} + C$$

   where F is the accumulative depth infiltrated in inches

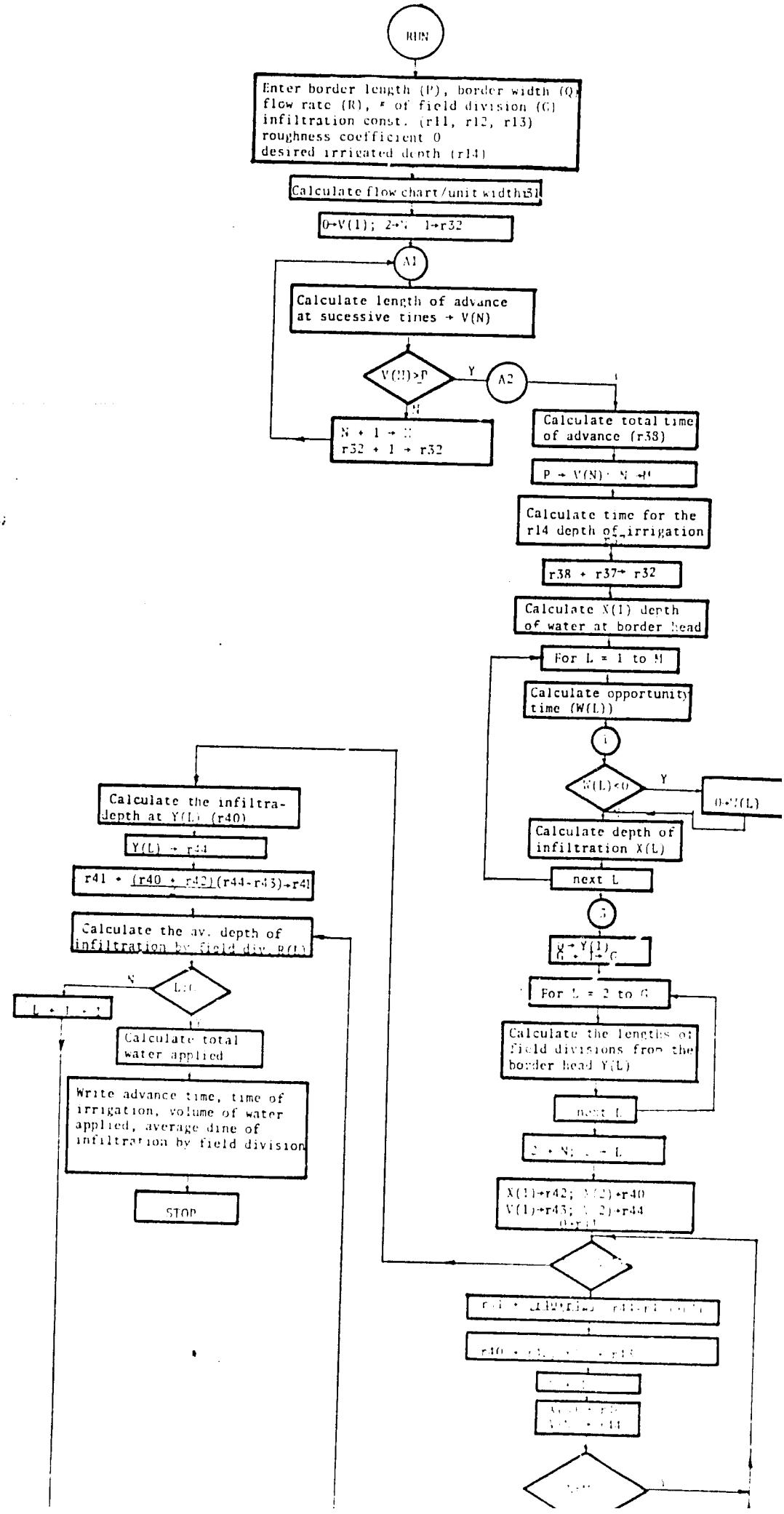
   T_o is the intake opportunity time in minutes

   b. Press CONTINUE
6. When "roughness coefficient" appears
   a. Enter the roughness coefficient
   b. Press CONTINUE
7. When "desired irrigation depth (cm)" appears
   a. Enter the desired irrigation depth in cm by the end of the field
   b. Press CONTINUE
8. The advance time (min), the irrigation time (hrs), the volume of water applied in (cu meters) and the av. depth of infiltration by field division (cm) are printed.

LEVEL BORDER SIMULATION

```
0: dim R[20],Y[20],X[100],V[100],W[100]
1: dsp "Level Border Simulation";wait 2000
2: fmt 1,10x,"LEVEL BORDER SIMULATION";wrt 701.1
3: ent "border length (meters)",P;ent "border width (meters)",Q
4: ent "flow rate (l/sec)",R
5: ent "number of field divisions",G
6: fmt 1,"System Design Characteristics";wrt 701.1
7: fmt 1,z,5x,"border length",f4.0," m",5x,"border width",f4.0," m",5x
8: fmt 2,"flow rate",f4.0," l/sec"
9: wrt 701.1,P,Q;wrt 701.2,R
10: dsp "soil infiltration constants";wait 2000
11: ent "A",r11;ent "B",r12;ent "C",r13
12: ent "roughness coefficient",O
13: fmt 1,"Soil Characteristics";wrt 701.1
14: fmt 1,5x,"A=",f7.4,5x,"B=",f7.4,5x,"C=",f7.4
15: fmt 2,5x,"roughness coefficient=",f5.2
16: wrt 701.1,r11,r12,r13;wrt 701.2,O
17: ent "desired irrigation depth (cm)",r14
18: fmt 1,"Desired Irrigation Depth",f7.0," cm";wrt 701.1,r14
19: 1)C;R/28.36)R;Q*3.281)Q;P*3.281)P
20: 0)r16;0)r30
21: for M=1 to G;0)R[M];next M
22: r14/2.54)r14;R/Q)r31;0)V[1];2)N;C)r32
23: "A1":720*r31*r32)r33;r11*r32^r12/(1+r12))r34
24: 18.6*O^.375*r31^.5625*r32^.1875)r35
25: r33/(r34+r13+r35))V[N];if V[N])=P;gto "A2"
26: N+1)N;r32+C)r32;gto "A1"
27: "A2":r32-(V[N]-P)/(V[N]-V[N-1])*C)r38
28: P)V[N];N)M;1/r12)r50;((r14-r13)/r11)^r50)r37
29: r37+r38)r32;r11*r32^r12+r13)X[1]
30: for L=1 to M;C*L)r39;r37+r38-r39)W[L]
31: if W[L](0;0)W[L]
32: W[L])r32
33: r11*r32^r12+r13)X[L+1];next L
34: 0)Y[1];2)N;G+1)G
35: for L=2 to G;Y[L-1]+P/(G-1))Y[L];next L;2)L
36: X[1])r42;X[2])r40;0)r43;V[2])r44;0)r41
37: "A3":if V[N])Y[L];gto "A5"
38: r41+(r40+r42)/2*(r44-r43))r41
39: r40)r42;r44)r43;N+1)N;X[N])r40;V[N])r44
40: if N=M;gto "A5"
41: gto "A3"
42: "A5":(Y[L]-r43)/(r44-r43)*(r40-r42)+r42)r40
43: Y[L])r44
44: r41+(r40+r42)/2*(r44-r43))r41
45: r40)r42;r44)r43;X[N])r40;V[N])r44
46: "A6":r41/(Y[L]-Y[L-1]))R[L];0)r41
47: if L)=G;gto "A7"
48: L+1)L;gto "A3"
49: "A7":Q/3.281)r45;P/3.281/(G-1))r46
50: for L=2 to G;Y[L]/3.281)Y[L-1];R[L]*2.54)R[L-1]
51: r16+R[L-1]*r45*r46*10)r16;next L
52: r16/(R*28.36*3600))r30;G-1)G
53: "A8":fmt 1,5x,"advance time",f5.0," min";wrt 701.1,r30
54: fmt 1,5x,"length of irrigation=",f5.2," hrs"
55: wrt 701.1,r30;r16/1000)r16
56: fmt 2,5x,"volume of water applied=",f6.2," cu. meters"
57: wrt 701.2,r16
58: fmt 3,5x,"average depth of infiltration by field division";wrt 701.3
59: fmt 4,5x,"field division",f3.0,10x,"depth=",f5.2," cm"
60: for I=1 to G;wrt 701.4,I,R[I];next I
*32480
```

BORDER IRRIGATION



USERS' INSTRUCTIONS

PRECIPITATION DATA ENTRY

1. Load program and press RUN
2. When "File name of precip. data" appears
   a. Enter file name
   b. Press CONTINUE
3. When "Have you already entered data?" appears
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE; if yes go to Step 7
4. When "Day number of rain" appears
   a. Enter the day number from beginning of year which rain occurred
   b. Press CONTINUE
5. When "Amount of precipitation (mm)" appears
   a. Enter the amount of rainfall in mm
   b. Press CONTINUE
6. When "More rain days?" appears
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE; if yes go to Step 4
7. When "Do you want a current listing?" appears
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE
8. When "Are there corrections?"
   a. Enter Ø for no or 1 for yes
   b. Press CONTINUE; if no STOP

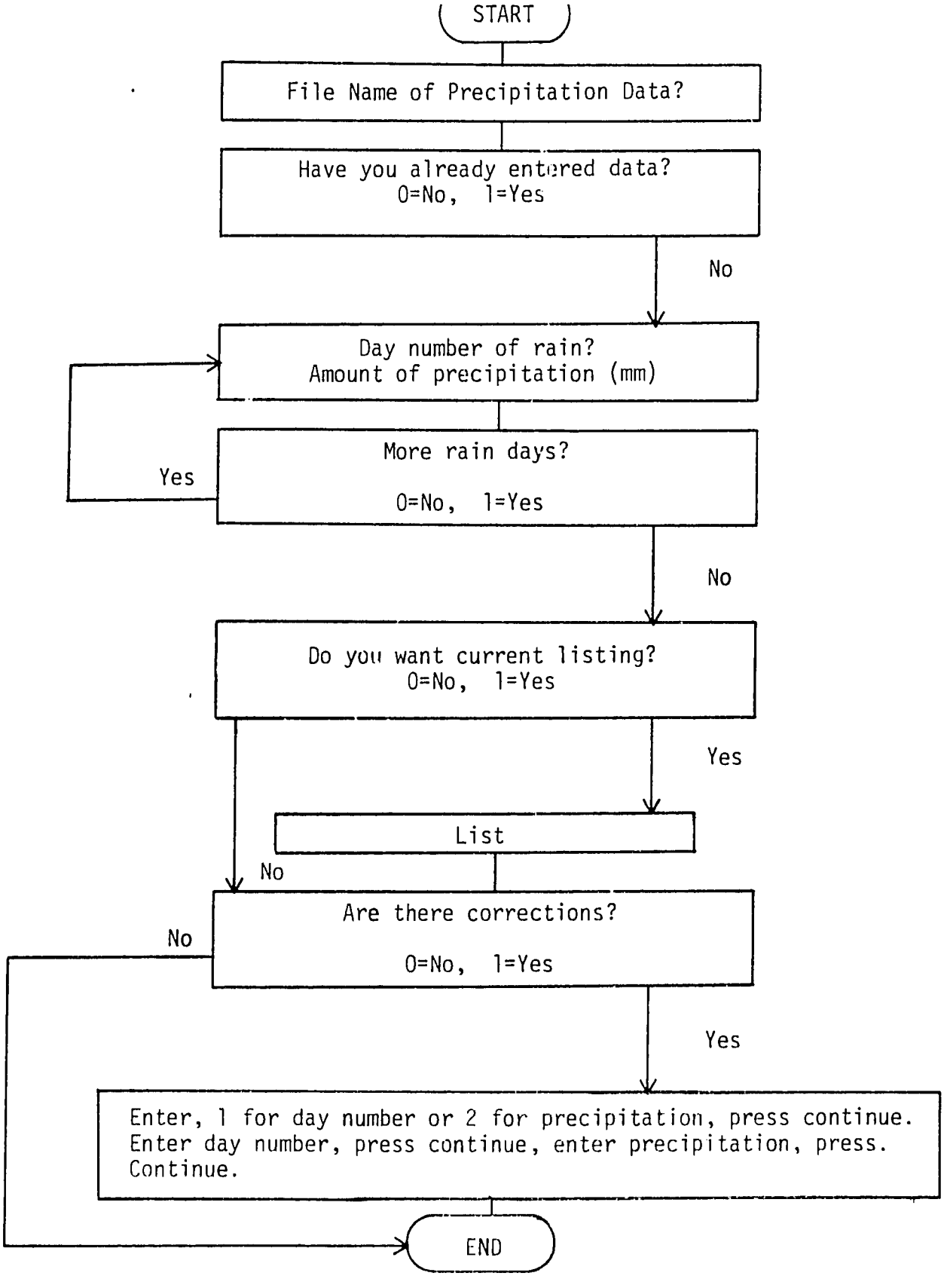
9. For corrections

   a. Enter 1 to correct day number or 2 to correct amount of precipitation (I value); press CONTINUE

   b. Enter number 1 to 30 which indicates where in the array the correction is to be applied. (K value); press CONTINUE

   c. Enter the correct day number or amount of precipitation (P(I,K)); press CONTINUE

   d. STOP


START
File Name of Precipitation Data?
Have you already entered data?
0=No, 1=Yes
No
Day number of rain?
Amount of precipitation (mm)
More rain days?
0=No, 1=Yes
Yes
No
Do you want current listing?
0=No, 1=Yes
Yes
List
No
Are there corrections?
0=No, 1=Yes
No
Yes
Enter, 1 for day number or 2 for precipitation, press continue.
Enter day number, press continue, enter precipitation, press.
Continue.
END

```
0: "S0":dsp "Precipitation Data Entry Program
1: dim P[2,365]
2: dsp "When responding to questions,";wait 2
3: dsp "enter 0 for no, 1 for yes";wait 2000
4: ent "File name of precipitation data",A$
5: ent "Have you already entered data?",B
6: if B=1;ldf A,P[*];gto "S2"
7: 13K
8: "S1":dsp "day number of rain",K;ent "",P[1,
9: ent "amount of precipitatin (mm)",P[2,K]
10: K+13K:ent "More rain days?",C;if C=1;gto '
11: "S2":ent "Do you want a current listing?",
12: if D=0;gto "S3"
13: fmt 1,7x,"day",4x,"precip";wrt 701,1
14: fmt 2,f10.0,f10.2
15: for K=1 to 30;wrt 701,2,P[1,K],P[2,K];next
16: "S3":ent "are there corrections?",E;if E=0
17: ent I;ent K;ent P[I,K];gto "S3"
18: "S4":rcf A,P[*]
19: end
*9669
```

To make corrections in weather data follow the format here:

1. Enter 1 for Tmax

   2 for Tmin

   3 for wind velocity

   4 for Epah

   5 for RHmax

   6 for RHmin

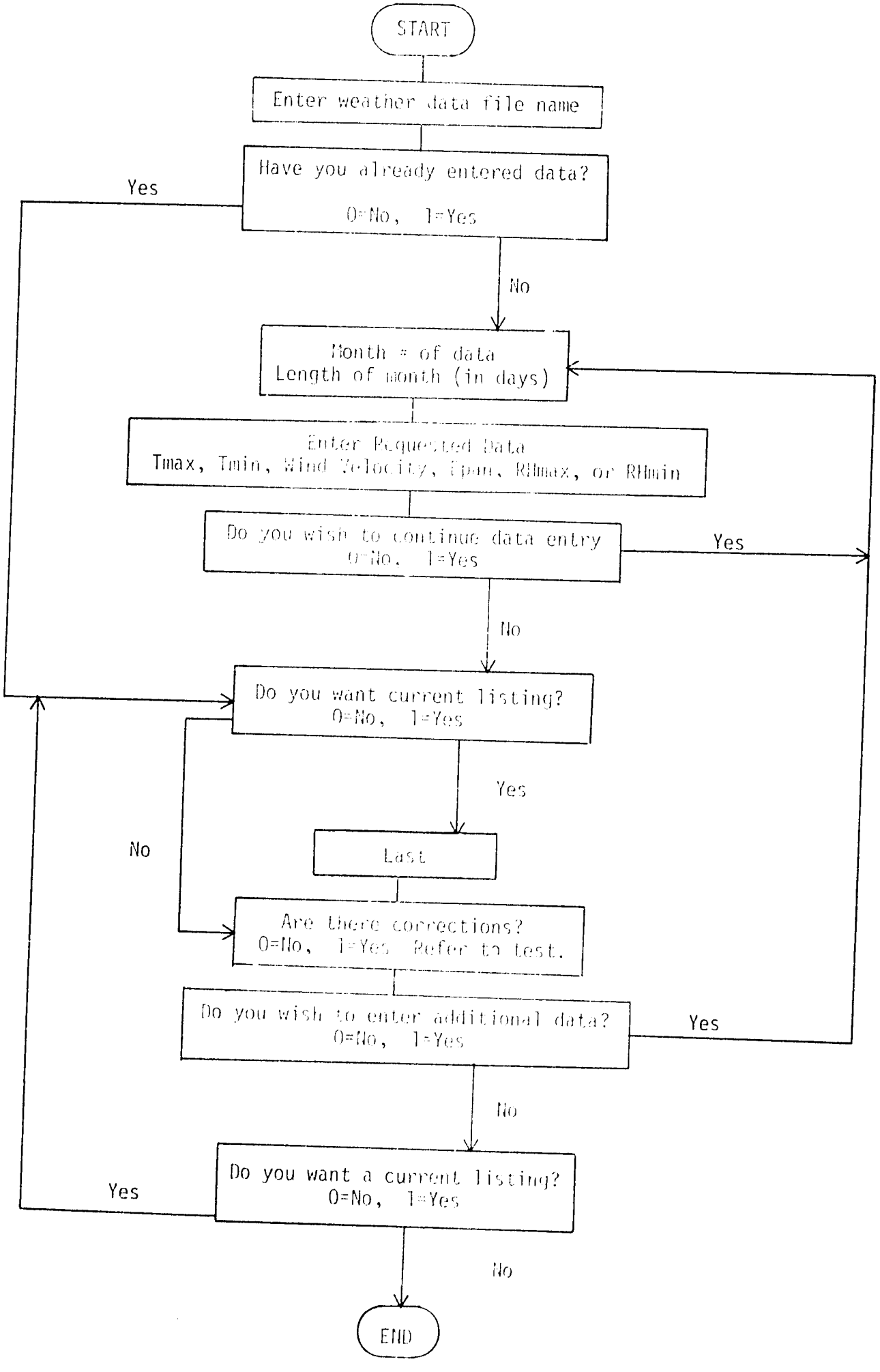
   Press: CONTINUE

2. # of year

   Press: CONTINUE

3. Enter data correction.

   Press: CONTINUE


START
Enter weather data file name
Have you already entered data?
0=No, 1=Yes
Yes
No
Month # of data
Length of month (in days)
Enter Requested Data
Tmax, Tmin, Wind Velocity, Epan, RHmax, or RHmin
Do you wish to continue data entry
0=No, 1=Yes
Yes
No
Do you want current listing?
0=No, 1=Yes
Yes
No
Last
Are there corrections?
0=No, 1=Yes Refer to test.
Do you wish to enter additional data?
0=No, 1=Yes
Yes
No
Do you want a current listing?
0=No, 1=Yes
Yes
No
END

WATER LIFTING PROGRAM*

This program presents an analytical method of comparing alternative systems for lifting water from tertiary delivery canals to farmer's fields.

BACKGROUND

AN ANALYTICAL MODEL

An analytical model for computing water lifting cost functions has been developed to assist in evaluating alternative systems.[1/] Twenty-three variables have been indentified and integrated into the model. Each variable is subject to change through time as a result of economic, technical or political considerations.

Each variable, included in the DATA INPUT FORM - WATER LIFTING COSTS, shown on next page is discussed below. It is especially important for policy makers to understand these variables since they are not simply "facts". Considerable latitude exists for assigning values to some of these variables depending on what assumptions one makes and what national policies one wished to advocate. Consequently, policy makers should be involved in determining the values assigned to each variable.

---

* Hassan Wahby, Gene Quenemoen and Mohamed Helal; "A Procedure for evaluating the Cost of Lifting Water for Irrigation in Egypt" - EWUP-Staff Paper #23 June 1980.

1/ This model is an adaptation of previous EWUP work reported in McConnen, R. J., Mohamed Helal, Ahmed Bayoumi, Gamal Ayad, James Loftis, and M. E. Quenemoen "Calculation of Machinery Costs for Egyptian Conditions", Staff Paper #8, Egypt Water Use and Management, Cairo, December 1979

DATA INPUT FORM - WATER LIFTING COSTS

Data prepared by _____ Date _____

Tape ; Track ; File

A$ (*)	
1. Name of machine .....(19)	1. _____
2. Make .....(19)	2. _____
3. Model .....(9)	3. _____
4. Size .....(9)	4. _____
5. Power source (DIES. ELEC. ANIM.)	5. _____
6. Date (day, month, year) DDMMYY .....(12)	6. _____
A *	
1. Present replacement price in Egypt, LE .....(12)	1. _____
2. Wearout life, hours .....(12)	2. _____
3. Expected average repair cost, LE/hour .....(12)	3. _____
4. Fuel consumption, liters/hour .....(12)	4. _____
5. Fuel cost, LE/liter .....(12)	5. _____
6. Oil cost, LE/100 hours .....(12)	6. _____
7. Grease cost, LE/100 hours .....(12)	7. _____
8. Electric energy required, kilowatt hours 2/ .....(12)	8. _____
9. Electricity cost, LE/kilowatt hour .....(12)	9. _____
10. Salvage value at end of wearout life, LE .....(12)	10. _____
11. Taxes, license, permits, rent, etc., LE/year .....(12)	11. _____
12. Interest rate, percent .....(12)	12. _____
13. Operator or labor cost, LE/hour .....(12)	13. _____
14. Discharge of pump, cubic meters/hour .....(12)	14. _____
15. Animal energy cost, LE/hour .....(12)	15. _____
16. Overall efficiency, decimal from .01 to 1.0.....(12)	16. _____
17. Engine efficiency, decimal from .01 to 1.0.....(12)	17. _____
18. Static head, meters 3/ .....(12)	18. _____
19. Dynamic head, meters 4/ .....(12)	19. _____
20. Water duty per year, cubic meters/feddan .....(12)	20. _____
21. Maximum time system will run per day, hours .....(12)	21. _____
22. Minimum irrigation interval, days .....(12)	22. _____
23. Maximum water required per irrigation, cu. meters/fed.(12)	23. _____

1/ Maximum characters allowed.

2/ Kilowatt hours = $\frac{\text{Discharge in } m^3/hr \times \text{Dynamic head in m.}}{362 \times \text{Overall Efficiency} \times \text{Engine Efficiency}}$

3/ Static head is defined as the distance between the water level in the delivery canal or pump station well and the water level required in field distribution ditch.

4/ Dynamic head is defined as the difference between the water level in the delivery canal or pump station well at the point of suction and the discharge point of the pump plus losses.

Users of the model may make adaptations to other specifications which they consider important. For example, the model does not explicitly consider field irrigation efficiency and design of field ditches. It might be argued that larger flow rates, possible with electric and diesel pumps, result in higher field irrigation efficiency and require less land for field ditches and bunds. This could be accounted for by adjusting water application variables, items 20 and 23 below and also making a rental charge in item 11 for land devoted to ditches and bunds.

Components of the Model

1. Present replacement cost in Egypt. This is a relatively sensitive variable, especially if high interest rates are used. The "cost" of a water lifting system depends on equipment quality, customs taxes, government subsidies and related infrastructure. In the case of an electric powered system should the initial cost include transformers and transmission lines? Such questions should be considered before assigning capital costs to the analytical model.

2. Wearout life is difficult to determine but not highly sensitive in the total analysis. It is related to maintenance or repair costs and initial quality of the equipment used in the system.

3. Expected average repair cost. Reasonable estimates of repair costs should be used. Records of existing systems provide the best basis for making this estimate. Training programs for machine operators can help to minimize maintenance and repair costs.

4. Fuel consumption is specified by the manufacturer of internal combustion engines. Records from engine users are helpful in determining fuel consumption under field conditions.

5. Fuel cost is often affected by government subsidies. For example, diesel fuel presently costs Egyptian farmers L.E. 0.03 per liter while the international price for diesel fuel is at least L.E. 0.14 per liter.[1/] Policy makers may wish to use projected future energy prices in evaluating alternative systems.

6. Oil cost varies for different types of internal combustion engines. Follow manufacturer's recommendations. Use of adequate, clean lubrication minimizes repair and maintenance costs.

7. Grease cost is usually a minor item, but also related to repair and maintenance cost and wearout life.

8. Electric power required to operate a water lifting system is related to the condition of the equipment. It should be consistent with the other parameters of the system. The equation shown as footnote 2 on the data input form, Appendix C is used to determine electrical energy requirements.

9. Electricity cost. In Egypt electricity is produced and distributed by the government. The price charged to farmers does not necessarily reflect the cost of producing and distributing electricity. Currently, small consumers are charged L.E. 0.015 per kilowatt hour. One report from 1977 indicates the cost of producing and distributing new power in Egypt with petroleum fuel is L.E. 0.0932 per kilowatt hour.[1/] Increases in the international price for petroleum since 1977 have undoubtedly made thermal generation of electricity more expensive.

1/ For a discussion of the difference between financial and economic costs see Pacific Consultants, "New Lands Productivity in Egypt--Technical and Economic Feasibility," AID Contract No. AID/NE-C-1645, Project No. 263-0042, January 1980, pp. 17-18.

The appropriate price to charge for electricity to lift water is debatable. Some argue that daytime use of electricity will help to ". . . obtain the optimum use of Rural Electrification . . ." in Egypt.[2/] As in the case of diesel fuel policy makers will perhaps wish to make long run price projections.

10. Salvage value is included as a variable in the model to handle the wearout life difference in system components. For example, a motor may wearout in 10,000 hours while the pump may have a life of 20,000 hours. In this case the value of the pump at the end of 10,000 hours can be considered as salvage value for the total system. Unit costs for long-life water lifting systems are not likely to be highly sensitive to alternative salvage values.

11. Annual taxes, license, permits, land rent, etc. includes all the possible fixed charges that may be imposed or otherwise required for owning a system. In the case of sakias a convenient method of charging for the land occupied by the sakia is to use the annual market rate of land rent for the specified area.

12. Interest rate. Capital usually has alternative uses. The opportunity interest cost of investing in a water lifting system is the rate of return capital would earn in its next best alternative.

1/ Technical and Economic Feasibility of Electrifying Tertiary Pumping Means in Middle and Upper Egypt, Ministry of Irrigation, Mechanical and Electrical Department, Louis Berger International, Inc., 1977, see pages 135-136. Also see Pacific Consultants, op.cit., p. 18

2/ Nasser, Abdel Hady Bary, "Feasibility Study of Electrification of Irrigation Means: Animal Driven Water Wheels and Diesel Pumps, In Menoufia Governorate," Engineering Research Bulletin, Vol. 1, Part 1, Menoufia University, Faculty of Engineering and Technology, Shebin El-Kom, 1978, page 72.

Although somewhat subjective, this principle can serve policy makers as a guide in assigning a capital charge to investment alternatives. If the capital is available as a loan and other alternatives are not to be considered, then use the interest rate according to the terms of the loan. If, on the other hand, financing is to be provided out of limited funds that could also be used for other purposes, it is important to use an interest rate which reflects the estimated return from the alternative purposes. This is the concept of "opportunity cost".

13. Operator or labor cost. All water lifting systems require some labor. In the case of a sakia a laborer is required to drive the animal. In the case of diesel or electric pumps, labor is required for pump attendants, to keep pipes clean and attend other details necessary for efficient operation. If a highly trained technician serves only one lifting system the hourly cost will be relatively high. If he can serve more than one system and/or perform other labor while operating the system, the cost will be appropriately reduced. There is a relationship between labor cost and other variables such as repairs and wearout life. Well paid, highly trained labor may tend to offset some other costs.

14. Discharge of the pump. An important assumption regarding the discharge of sakias and pumps is that the delivery canal must maintain a uniform water level at the pumping station. Data showing the discharge of sakias often reflects the effects of a fluctuating head. Conversely, the discharge assigned to electric and diesel pumps may reflect the manufacturer's specifications at constant head. The delivery canal must be an integral part of any lifting system. In order for any system to operate efficiently and at capacity it must have an adequate supply

of water at the point of suction, preferable of a uniform head.

15. Animal power cost is one of the most difficult variables to measure. It is common knowledge that most farmers depend on animals for transportation since field access roads are very limited. They also keep animals for the production of meat, milk, fuel, fertilizers and as a store of wealth or capital. However, the measurement of these factors is often quite illusive.

If one assumes animals are kept primarily for power and all animal production costs are assigned to power, then the cost is relatively high. On the other hand if one assumes animals are kept more for the other uses and assigns only the marginal costs to power, then the cost is relatively small. In some cases where the work on a sakia is very light and spread among many animals it may be trivial. Some farmers believe a small amount of work only fulfills normal exercise for the animal and costs nothing.

There is also an assumption made by some that if the work requirement for animals were eliminated they would be replaced by animals specialized in meat and milk production. This could increase meat and milk production from a given feed base, but may require a substantial training program to introduce new breeds, new feeding technologies, new marketing systems, etc.

Another possibility is that reducing the work requirement for animals will permit reduction of livestock numbers and production of human food on land formerly used to produce animal feed. Whether this would happen is also, of course, debatable.

Since there are only limited empirical data regarding these issues it is natural that wide variations exist in estimates of animal power

costs. EWUP is engaged in further study of this issue. Literature reviews are in progress and reserach is planned to compare areas of gravity irrigation (where animals are not used for lifting water) with areas that are dependent on animal driven sakias for irrigation.

16. Overall efficiency refers to the pump and the drive (system of coupling between the engine and pump). Pump efficiency is specified by most pump manufacturers, but may be adjusted downward to reflect efficiency under average field conditions. Standard engineering references suggest efficiencies for direct drive, right angle drive, vee belts, flat belts, etc. The overall efficiency is the product of the pump efficiency and the drive efficiency.

17. Engine efficiency is usually specified by the manufacturer for electric and diesel engines. It may be adjusted downward to properly reflect average field conditions. In the case of sakias, efficiencies can be calibrated to electric pumps where efficiencies and discharge rates are known. This is shown in Appendix B.

18. Static head is defined, for purposes of this model, as the distance between the water level in the canal or pump station well and the water level in the field distribution ditch.

19. The dynamic head includes the static head plus pumping system losses.

20. The water duty per year is the amount of water that must be lifted from a delivery canal to a field given a particular crop rotation. Of course, it can be adjusted for specified locations, cropping sequences, and crop yields during a given year. It should include water needed for evapotranspiration plus leaching requirements under given conditions of field irrigation efficiency.

21. Maximum time the system will run per day should reflect the realities of farm and village cultural patterns. Longer period of operation per day will reduce unit costs of lifting water and will increase maximum area to be served, but the system will not operate as planned unless it is compatible with values of farmers. The government, of course, may use various methods of coercion or reward systems to get farmers to comply with alternative working day lengths.

22. Minimum Irrigation Interval. This variable, expressed in days, effects the size of the area to be served by the system.

If during the peak irrigation season, the system operates at the capacity consistent with its discharge rate, water requirement and time parameters, a certain number of days will be required to cover a specified area. The first area irrigated will then have gone without water for that number of days. This is the concept of "minimum irrigation interval". If the number of days in the interval is lowered then the area served by the system will be reduced accordingly by the program. Under water rotation turns ("off" and "on" periods) the minimum interval should be the same as the days in the "on" period if it is desired that the system have capacity to irrigate all the land served with a "maximum irrigation" during one "on" period.

The cropping pattern and the consumptive use of specified crops during the peak irrigation period also influences the value which should be placed on this variable. For example, shallow rooted crops require frequent, but light irrigations, especially during July and August.

23. Maximum water required per irrigation. This variable also is part of the equation for setting the limit on the area to be served by the system. It is related to "minimum time between irrigations" in that

shallow rooted crops may require less water per irrigation, but more frequent irrigations. It is also dependent on water application efficiency.

Equations Utilized in the Model

Before turning to an illustration of the analytical model some readers may wish to examine the equations used in the model. They are shown here.

EQUATIONS FOR WATER LIFTING COST PROGRAM*

1. $K = \text{Hrs. PER FEDDAN PER YEAR} = \frac{\text{Water Duty Per Year}}{\text{Discharge of Pump}}$
2. $\text{Annual Fixed Costs} = [\frac{\text{Present Replacement Price in Egypt + Salvage Value}}{2}]\ [\text{Interest Rate}] + \text{Taxes, etc.}$
3. $\text{Depreciation} = [\frac{\text{Present Replacement Price in Egypt - Salvage Value}}{\text{Wearout Life}}]\ [K]\ [\text{No. of feddans}]$
4. $\text{Repairs} = [\text{Expected Average Repair Cost}]\ [K]\ [\text{No. of Feddans}]$
5. $\text{Energy Cost if Diesel} = [\text{Fuel Consumption}]\ [\text{Fuel Cost}]\ [K]\ [\text{No. of Feddans}]$
6. $\text{Energy Cost if Electric} = [\text{Electric Energy Required}]\ [\text{Electric Energy Cost}]\ [K]\ [\text{No. of Feddans}]$
7. $\text{Energy Cost if Animal} = [\text{Animal Cost}]\ [K]\ [\text{No. of Feddans}]$
8. $\text{Grease and Oil} = [\frac{\text{Oil Cost per 100 hours + Grease Cost per 100 hours}}{100}]\ [K]\ [\text{No. of Feddans}]$
9. $\text{Operator Cost} = [\text{Operator or Labor Cost}]\ [K]\ [\text{No. of Feddans}]$
10. $\text{Total Annual Cost} = \text{Annual Fixed Cost + Depreciation + Repairs + Energy Cost + Grease and Oil + Operator Cost}$
11. $\text{Annual Cost Per Feddan} = \frac{\text{Total Annual Cost}}{\text{No. of Feddans}}$
12. $\text{Output Horsepower Hours} = [\frac{\text{Discharge of Pump x Static Head}}{270}]\ [K]\ [\text{No. of Feddans}]\ (\text{Work Accomplished})$
13. $\text{Cost per HP Hour} = \frac{\text{Total Annual Cost}}{\text{Output HP Hours}}$
14. $\text{Max. System Capacity} = \frac{\text{Minimum Irrigation Interval x Max. Time per Day x Discharge of Pump}}{\text{Max. Water Required per Irrigation}}$
15. $\text{Brake Horsepower Required at Max. System Capcity} = \frac{\text{Discharge of Pump x Dynamic Head}}{270\ \text{Overall Efficiency}}$
16. $\text{Total Time Required} = [\text{Max. System Capacity}]\ [K]$
17. $\text{Total Energy Required at Max. System Capacity} = \text{Brake HP Req. at Max. System Capacity x Total Time Required}$

---

*See DATA INPUT FORM - WATER LIFTING COSTS on page 6 for unit specifications.

WATER LIFTING COST

DATA PREPARED BY
Tape 3 ; Track 1 ; File 1

NAME OF MACHINE CATAPILLAR

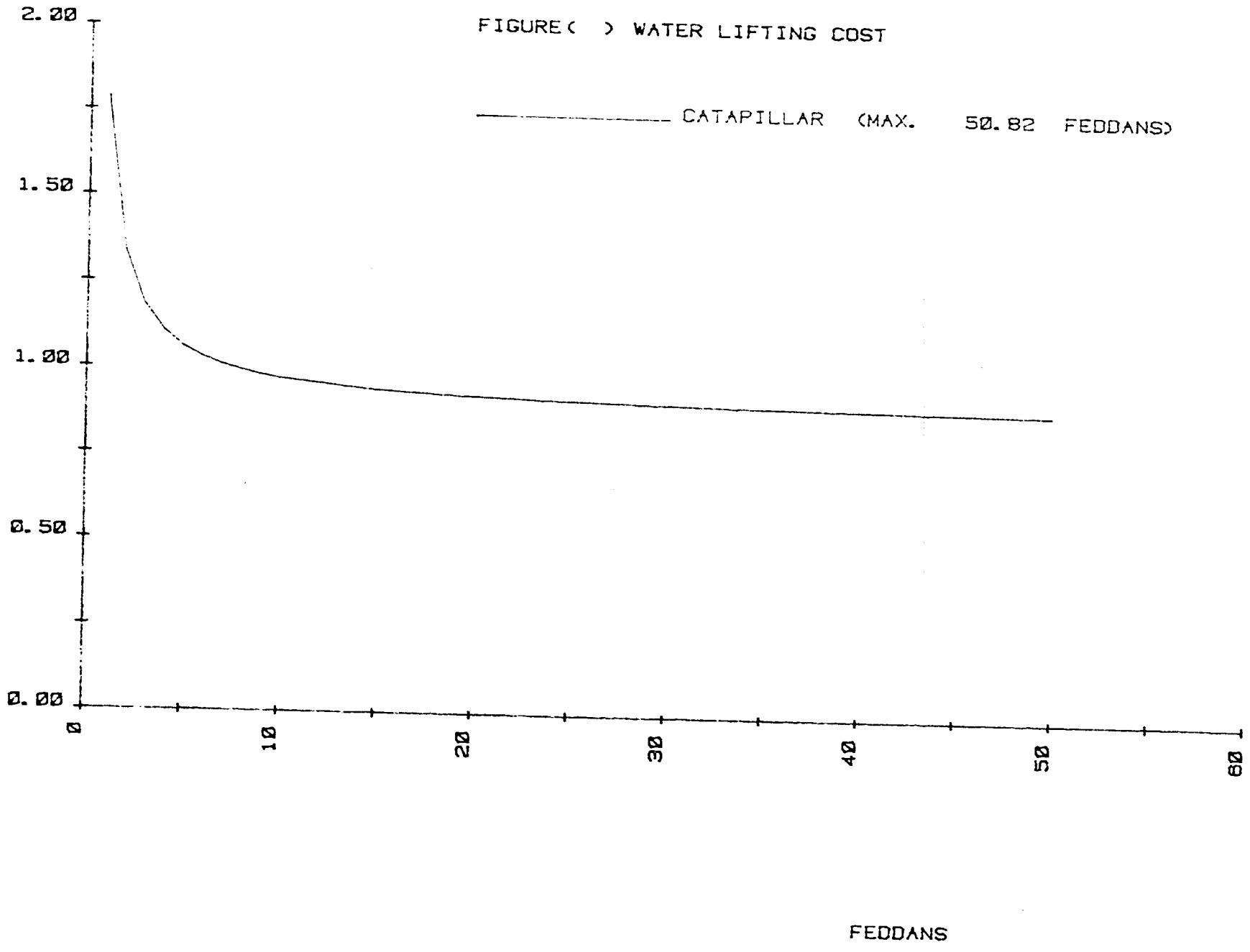
MAKE MODEL 650 SIZE 6.5 HP
POWER SOURCE DIES.

DATE 240655

PRESENT REPLACEMENT COST IN EGYPT, LE	450.000
WEAR OUT LIFE IN HOURS	10000.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.013
FUEL CONSUMPTION LITERS PER HOUR	1.640
FUEL COST LE/LITER	0.076
OIL COST LE/ 100 HOURS	2.779
GREASE COST LE /100 HOURS	0.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	300.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	6.000 %
OPERATOR COST LE/hr	0.794
Hrs PER FEDDAN PER YEAR	22.667
DISCHARGE OF PUMP,cubic mt./hr	300.000
EFFICIONCY OF PUMP	0.700
EFFICIONCY OF DRIVER	0.050
STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	3.500
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	12.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/fd	OUTPT HP Hrs.	COST HP HOUR
1.00	22.500	0.189	0.295	2.825	0.630	17.997	44.436	44.436	24.872	1.7866
2.00	22.500	0.378	0.589	5.650	1.260	35.995	66.372	33.186	49.744	1.3343
3.00	22.500	0.567	0.884	8.476	1.890	53.992	88.308	29.436	74.616	1.1835
4.00	22.500	0.756	1.179	11.301	2.520	71.989	110.244	27.561	99.488	1.1081
5.00	22.500	0.944	1.473	14.126	3.150	89.987	132.180	26.436	124.360	1.0629
6.00	22.500	1.133	1.768	16.951	3.779	107.984	154.116	25.686	149.232	1.0327
7.00	22.500	1.322	2.063	19.776	4.409	125.981	176.052	25.150	174.104	1.0112
8.00	22.500	1.511	2.357	22.601	5.039	143.979	197.988	24.748	198.976	0.9950
9.00	22.500	1.700	2.652	25.427	5.669	161.976	219.924	24.436	223.848	0.9825
10.00	22.500	1.889	2.947	28.252	6.299	179.973	241.860	24.186	248.720	0.9724
15.00	22.500	2.833	4.420	42.378	9.449	269.960	351.540	23.436	373.080	0.9423
20.00	22.500	3.778	5.893	56.503	12.598	359.947	461.219	23.061	497.440	0.9272
25.00	22.500	4.722	7.367	70.629	15.748	449.933	570.899	22.836	621.800	0.9181
30.00	22.500	5.667	8.840	84.755	18.897	539.920	680.579	22.686	746.159	0.9121
35.00	22.500	6.611	10.313	98.881	22.047	629.907	790.259	22.579	870.519	0.9078
40.00	22.500	7.556	11.787	113.007	25.196	719.893	899.939	22.498	994.879	0.9046
45.00	22.500	8.500	13.260	127.133	28.346	809.880	1009.619	22.436	1119.239	0.9021
50.00	22.500	9.444	14.733	141.259	31.495	899.867	1119.298	22.386	1243.599	0.9000
55.00	22.500	10.389	16.207	155.385	34.645	989.853	1228.978	22.345	1367.959	0.8984
60.00	22.500	11.333	17.680	169.510	37.794	1079.840	1338.658	22.311	1492.319	0.8970
65.00	22.500	12.278	19.153	183.636	40.944	1169.827	1448.338	22.282	1616.679	0.8959
70.00	22.500	13.222	20.627	197.762	44.093	1259.813	1558.018	22.257	1741.039	0.8949
75.00	22.500	14.167	22.100	211.888	47.243	1349.800	1667.698	22.236	1865.399	0.8940
80.00	22.500	15.111	23.573	226.014	50.393	1439.787	1777.378	22.217	1989.759	0.8933
85.00	22.500	16.056	25.047	240.140	53.542	1529.773	1887.057	22.201	2114.119	0.8926
90.00	22.500	17.000	26.520	254.266	56.692	1619.760	1996.737	22.186	2238.478	0.8920
95.00	22.500	17.944	27.993	268.391	59.841	1709.747	2106.417	22.173	2362.838	0.8915
100.00	22.500	18.889	29.467	282.517	62.991	1799.733	2216.097	22.161	2487.198	0.8910

MAX. SYSTEM CAPACITY = 50.824 FED./YEAR
POWER REQUIRED AT MAX = 6.455 BRAKE HORSPOUR
TOTAL TIME REQUIRED = 1152.000 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX = 7435.776HP Hrs/YEAR 5547.909 KW Hrs/YEAR


FIGURE( ) WATER LIFTING COST
CATAPILLAR (MAX. 50.82 FEDDANS)
COST/HP HOUR L.E.
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
60
FEDDANS

USERS' INSTRUCTIONS

WATER LIFTING COST

1. Set the calculator on, the printer and the plotter
2. Install the tape cartridge #3
3. a. Type trk #, ldf #

   b. Press EXECUTE
4. Press RUN
5. When "New data 1, old data 2" appear

   either

   a. Type 1 for new data

   b. Press CONTINUE

   or

   a. Type 2 for old date

   b. Press CONTINUE
6. When "TRACK #: and "FILE #" appear respectively

   a. Type the track # and the file # for storing data

   b. Press CONTINUE

7. For old data go to Step # 12
8. When each of the following statements appears enter the answer then press CONTINUE respectively

   "DATA PREPARED BY"

   "name of m/c"

   "make"

   "model"

   "size"
9. When "POWER SOURCE ANIM. DIES. ELEC" appears

   either

a. Type ANIM for animal power source

b. Press CONTINUE

or

a. Type DIES. for diesel power source

b. Press CONTINUE

or

a. Type ELEC. for electric power source

b. Press CONTINUE

10. When "data preparing date DDMMYY" appears

a. Enter the date of preparing the data in the form of DDMMYY

b. Press CONTINUE

11. When each of the following statement display enter its value if exist then press CONTINUE or press CONTINUE direct if its value is zero.

"Present replacement price in EGYPT"

"Wearout life, hours"

"Expected av. repair cost, LE/hr."

"Fuel consumption liter/hour"

"Fuel cost, LE/liter"

"Oil cost, LE/100 hours"

"Grease cost, LE/100 hours"

"Electric energy required, kw hr."

"Electricity cost, LE/kw Hr."

"Salvage value at end of life:LE"

"Annual taxes, license and permits:LE" Taxes, license, permits, rent, LE/yr.

"Interest rate, percent"

"Operator or Labor cost, LE/hr."

"Discharge of pump, cubic m/hr."

"Animal energy cost, LE/hr"

"Overall efficiency, .01 to 1.0"

"Engine efficiency, .01 to 1.0"

"Static head, meters"

"Dynamic head meters"

"Water duty per year, cubic m/feddan"

"Maximum hours/day"

"Minimum irrigations interval, days"

"Maximum water required/irrig. cub. m/ fed

12. When "data correct yes y, no n" appear

either

a. Type n to make corrections

b. Press CONTINUE

or

a. Type y for no corrections

b. Press CONTINUE

c. Go to Step # 14

13. When "Make" appear

either

a. Type correction

b. Press EXECUTE

c. Go to Step # 13

or

Press CONTINUE for no more corrections; go to Step #14

14. When "MORE COPIES 1 yes" appear

either

a. Type 1 for another list

b. Press CONTINUE

c. Copy is printed

or

a. Type 0 for no more list

b. Press CONTINUE

15. The new data is stored

16. New data is stored for old data that is changed when "changes recorded, yes 1"

a. Type 1 for changes to be stored

b. Press CONTINUE

or

a. Type 0 to continue without storing changes

b. Press CONTINUE

17. When "USED PLOT yes y, no n" appear

either

a. Type y for using the plotter

b. Press CONTINUE

or

a. Type n for no plot

b. Stop

18. When ANOTHER GRAPH SUPERIMPOSED 5 YES" appear

either

a. Type 5 to make a graph on other graph

b. Press CONTINUE

c. When "line #" appears, type the line #, press CONTINUE, then go to Step 26

or

Press CONTINUE

19. When "X AXIS FROM" appear

a. Enter the min. value in the x axis

b. Press CONTINUE

20. When "TO" appear

a. Enter the max. value in the x axis

b. Press CONTINUE

21. When "TIC" appear

a. Enter the increment value in x axis to put mark along x axis

b. Press CONTINUE

22. When "STEP" appear

a. Enter the # of steps to write the value of x along x axis

b. Press CONTINUE

23. When "Y intercept" appear

a. Enter the x value at where x axis cross y axis

b. Press CONTINUE

24. Do the same for y axis as that of x axis when each of these statements appear (from Step # 19-23)

"y axis from"

"TO"

"TIC"

"STEP"

"X intercept"

25. When "WITHOUT AXES 1 yes" appear

either

a. Type 1 to have a graph without axis

b. Press CONTINUE

or

Press CONTINUE

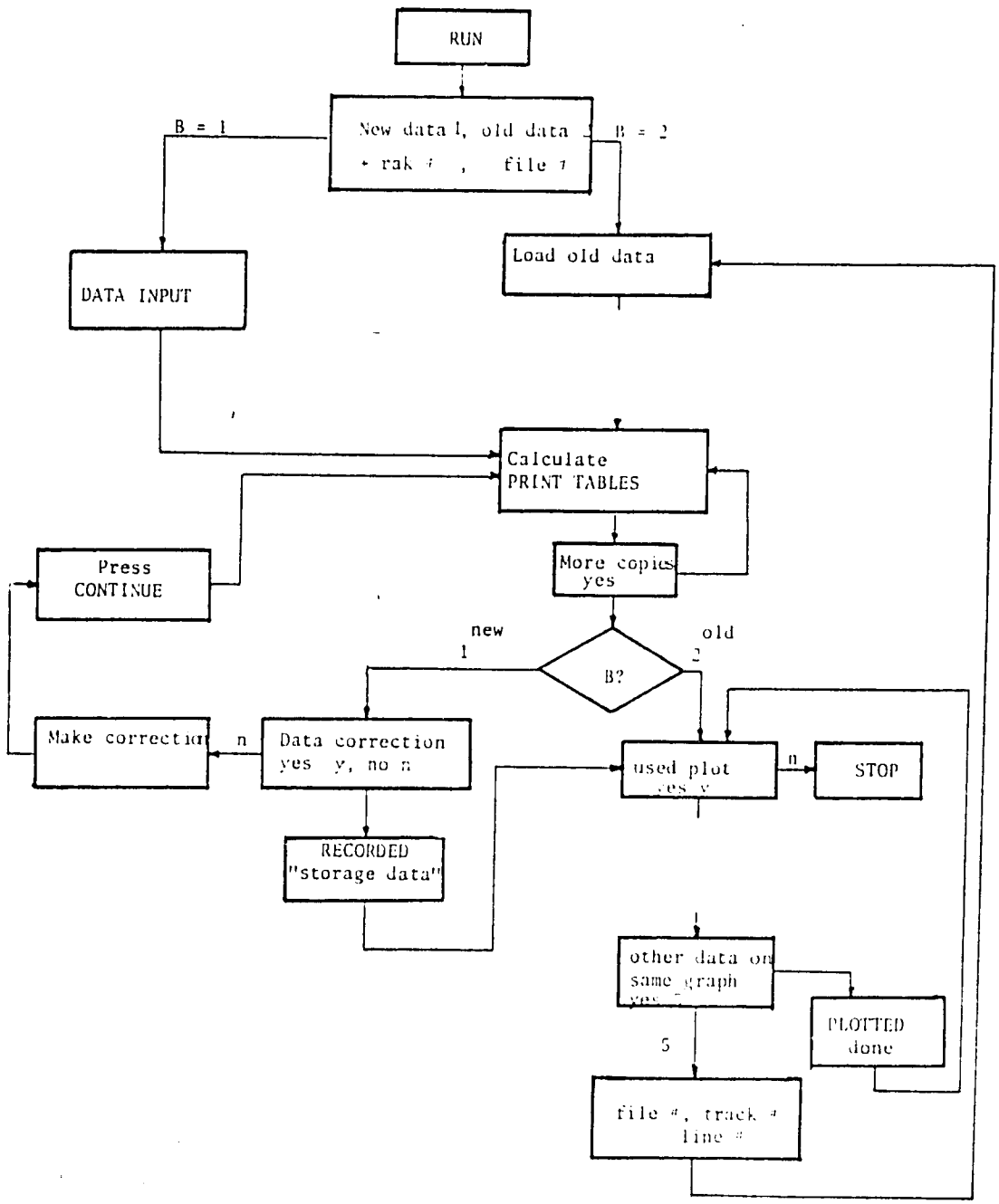
26. The plotter must be on at this step and a graph is done, after the end of the graph go to Step # 17

```
0: dim T[100],A[50],A$[7,20],F[100]
1: dim S$[2],E$[2],D[100],R[100],Y[100],X[100],Z[100],S[100],P[100],B[100]
2: dsp "WATER LIFTING COST";wait 1500
3: ent "NEW DATA 1, OLD DATA 2",B
4: ent "TRACK#",M;ent "FILE #",N
5: if B=2;ldf N,T[*],A[*],A$,F[*]
6: if B=2;gto "PRINT"
7: ent "DATA PREPARED BY",A$[7]
8: ent "name of m/c",A$[1]
9: ent "make",A$[2]
10: ent "model",A$[3]
11: ent "size",A$[4]
12: ent "POWER SOURCE ANIM. DIES. ELEC.",A$[5]
13: ent "Data preparing date DDMMYY",A$[6]
14: ent "present replacement price in EGYPT",A[1]
15: ent "Wearout life, hours",A[2]
16: ent "Expected av. repair costs,LE/hr",A[3]
17: ent "Fuel consumption, liter/hr",A[4]
18: ent "Fuel cost LE/Liter",A[5]
19: ent "oil cost, LE/100 hours",A[6]
20: ent "grease cost, LE/100 hours",A[7]
21: ent "electric energy required, Kw Hr",A[8]
22: ent "electricity cost, LE/Kw Hr",A[9]
23: ent "salvage value at end of life:LE",A[10]
24: ent "Taxes,License,permits,rent,LE/yr",A[11]
25: ent "interest rate, percent",A[12]
26: ent "Operator or Labor cost, LE/hour",A[13]
27: ent "Discharge of pump, cubic m./hr",A[14]
28: ent "Animal energy cost/hr. L.E.",A[15]
29: ent "Overall efficiency, .01to 1.0",A[16]
30: ent "Engine efficiency .01 to 1.0",A[17]
31: ent "Static head, meters",A[18]
32: ent "Dynamic head, meters",A[19]
33: ent "Water duty/year, Cubic m./Feddan",A[20]
34: ent "Maximum hours/day",A[21]
35: ent "Minimum irrigation iterval, day",A[22]
36: ent "Max. Water Req./irrig. cub.m/fed",A[23]
37: 0)I
38: I+1)I
39: if B=1;if I=1;1)F[1];jmp -1
40: if B=1;if F[I-1]<10;F[I-1]+1)F[I];jmp -2
41: if B=1;F[I-1]+5)F[I];if F[I]<100;jmp -3
42: if B=1;-12)F[I+1]
43: "PRINT":
44: A[20]/A[14])A[24];0)R
45: A[12](A[11]+A[10])/200)R
46: R+A[11])A[30]
47: A[4]A[5])A[27]
48: if A$[5]="ELEC.";A[9]A[8])A[27]
49: if A$[5]="ANIM.";A[15])A[27]
50: A[27]A[24])A[50]
51: A[24](A[11]-A[10])/A[2])A[48]
52: .01A[24](A[6]+A[7])A[49]
53: A[13]A[24])A[26]
54: .3]A[24])A[28]
55: fmt 3,/,/;wrt 701.3
56: fmt 3,/,/;wrt 701.3
57: fmt 3,/,/
58: wrt 701,"in:5k0$"
59: fmt 4,10x,"IMPLE( ) WATER LIFTING COST";wrt 701.2
60: wrt 701,"in:5k0$"
61: if A[13]=0;fmt 5,20x,"not including cost of machine operator";wrt 701.5
62: fmt 7,5x,"DATA PREPARED BY",c20;wrt 701.7,A$[7]
63: fmt 7,5x,"Tape 3 ; Track",f2.0," ; File",f3.0;wrt 701.7,M,N
64: fmt 3,/;wrt 701.3
65: fmt 7,"NAME OF MACHINE",5x,c20;wrt 701.7,A$[1]
```

```
66: fmt 3,/;wrt 701
67: fmt 7,"MARK",c10,5x,"MODEL",c17,5x,"SIZE",c10;wrt 701.7,A$[2],A$[3],A$[4]
68: fmt 7,"POWER SOURCE",5x,c10;wrt 701.7,A$[5]
69: fmt 3,/;wrt 701
70: fmt 4,"DATE                    ",15x,c6
71: wrt 701.4,A$[6]
72: fmt 7,"PRESENT REPLACEMENT COST IN EGYPT, LE",8x,f10.3;wrt 701.7,A[1]
73: fmt 7,"WEAR OUT LIFE IN HOURS",23x,f10.3;wrt 701.7,A[2]
74: fmt 7,"EXPECTED AVERAGE REPAIR COST LE /HOUR   ",5x,f10.3;wrt 701.7,A[3]
75: if A[4]=0;jmp 3
76: fmt 7,"FUEL CONSUMPTION LITERS PER HOUR",13x,f10.3;wrt 701.7,A[4]
77: fmt 7,"FUEL COST LE/LITER     ",23x,f10.3;wrt 701.7,A[5]
78: fmt 7,"OIL COST LE/ 100 HOURS   ",20x,f10.3;wrt 701.7,A[6]
79: fmt 7,"GREASE COST LE /100 HOURS   ",17x,f10.3;wrt 701.7,A[7]
80: if A[8]=0;jmp 3
81: fmt 7,"ELECTRIC POWER REQUIRED ,Kw hour   ",10x,f10.3;wrt 701.7,A[8]
82: fmt 7,"ELECTRICITY COST LE /Kw.hour",17x,f10.3;wrt 701.7,A[9]
83: fmt 7,"SALVAGE VALUE AT END OF WEAR OUT LIFE:LE",5x,f10.3;wrt 701.7,A[10]
84: fmt 7,"ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE",5x,f10.3;wrt 701.7,A[11]
85: fmt 7,"INTEREST RATE,PERCENT  ",22x,f10.3,2x,"%";wrt 701.7,A[12]
86: if A[13]=0;fmt 7,"OPERATOR COST LE/hr     ",21x,f10.3;wrt 701.7,A[13]
87: fmt 7,"Hrs PER FEDDAN PER YEAR",22x,f10.3;wrt 701.7,A[24]
88: fmt 7,"DISCHARGE OF PUMP,cubic mt./hr",15x,f10.3;wrt 701.7,A[14]
89: if A$[5]$"ANIM.";jmp 2
90: fmt 7,"ANIMAL POWER COST LE/hr",22x,f10.3;wrt 701.7,A[15]
91: if A[16]>0;fmt ,"EFFICIONCY OF PUMP",27x,f10.3;wrt 701,A[16]
92: fmt "EFFICIONCY OF DRIVER",25x,f10.3;wrt 701,A[17]
93: fmt ,"STATIC HEAD (METERS)",25x,f10.3;wrt 701,A[18]
94: fmt "DYNAMIC HEAD (METERS)",24x,f10.3;wrt 701,A[19]
95: fmt 7,"WATER DUTY PER YEAR,cubic mt/fd",14x,f10.3;wrt 701.7,A[20]
96: fmt 7,"MAX. TIME SYSTEM WILL RUN PER DAY,hours",6x,f10.3;wrt 701.7,A[21]
97: fmt 7,"MIN. TIME BETWEEN IRRIGATION,days",12x,f10.3;wrt 701.7,A[22]
98: fmt ,"MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd",3x,f10.3;wrt 701,A[23]
99: wrt 701.5
100: gto "FEDD"
101: ent "DATA correct yes y , no n",E$;if E$="n";dsp "MAKE";stp
102: ent "MORE COPIES  1 yes",T;if T=1;gto 43
103: if B=0;if E$ "n";ent "CHANGES RECORDED, yes 1",R;if R$1;jmp 2
104: if R=1;trk M;rew;rcf N,T *],A[*],A$,F[*]
105: if B=1;trk M;rew
106: if B=1;rcf N,T[*],A[*],A$,F[*]
107: ent "USE PLOT, yes y, no n",G$;if G$="n";stp
108: if G=5;gto 124
109: ent "ANOTHER GRAPH SUPERIMPOSED 5 YES",G
110: if G=5;ent "TRACK #",M;ent "FILE #",N,"line#",r11;2)B;gto 5
111: ent "X AXIS FROM",r1,"TO",r2,"TIC",r3,"STEP",r4,"Yintercept",r5
112: ent "Y AXIS FROM",r6,"TO",r7,"TIC",r8,"STEP",r9,"Xintercept",r0
113: ent "WITHOUT AXIES 1 yes",J;if J=1;gto 124
114: pen# 1
115: scl r1,r2,r6,r7
116: line
117: fxd 0;xax r5,r3,r1,r2,r4
118: fxd 2;yax r0,r8,r6,r7,r9
119: csiz 1.65,2,1,0
120: plt r11+.5(r2-r1)/3,r6-2.5r8,0;lbl "FEDDANS"
121: plt .5(r2+r1)-2r3,r7,0;lbl "FIGURE(  ) WATER LIFTING COST  ",A$[7]
122: csiz 1.65,2,1,90
123: plt r1-.5(r2-r1)/2,r6+(r7-r6)/2,0;lbl "COST/HP HOUR  L.E."
124: scl r1,r2,r6,r7
125: pen# 3;csiz 1.65,2,1,0
126: if r11>0;line r11,r9
127: plt .5(r2+r1)-2r3,r7-(r11+1)r8;plt .5(r1+r2),r7-(r11+1)r8;lbl " ",A$[1]
128: lbl "  (MAX.  ",F[100],"  FEDDANS)"
129: 0)I
130: if H=3;gto 133
131: csiz 1.65,2,1,0
```

```
132: cplz 1.65,2,1,0
133: 1+I)I;if F[I])F[100];pen;gto 109
134: plt I[I],B[I]
135: jmp -2
136: "FEDD":
137: wrt 701,3
138: fmt ,z,1x;wrt 761
139: wtb 701,"FEDD.        ANNUAL        DEPRECIA.        REPAIRS        ENERGY    "
140: wtb 701,"  GREASE    OPERATOR    TOTAL ANNUAL      ANNUAL    "
141: wtb 701,"   OUTPT        COST     "
142: wtb 701,13,10
143: wtb 701,"            FIXED COST                                    "
144: wtb 701,"COST      AOIL       COST            COST"
145: wtb 701,"          COST/fd     HP Hrs.     HP HOUR"
146: wtb 701,13,10
147: 0)I
148: 1+I)I;if F[I]<0;gto 158
149: A[30]+F[I](A[48]+A[20]+A[50]+A[49]+A[26]))A[45]
150: A[45]/F[I])/[I];A[40]F[I])A[41]
151: A[28]F[I])A[47];A[50]F[I])A[42]
152: A[49]F[I])A[43];A[26]F[I])A[44]
153: A[22]A[21]A[14]/A[23])F[100]
154: A[14]A[10]A[20]F[I]/273.4A[14])P[I];A[45]/P[I])B[I]
155: fmt 1,f6.2,f13.3,f14.3,f14.3,f12.3,f10.3,f10.3,f16.3,f12.3,f12.3,f11.4
156: wrt 701.1,F[I],A[30],A[41],A[47],A[42],A[43],A[44],A[45],Z[I],P[I],B[I]
157: gto 148
158: fmt "MAX. SYSTEM CAPACITY      =",f10.3," FED./YEAR";wrt 701,F[100]
159: fmt "POWER REQUIRED AT MAX     =",f10.3," BRAKE HORSPOUR"
160: A[14]A[19]/273.4A[16]A[17])A[40];wrt 701,A[40]
161: fmt "TOTAL TIME REQUIRED       =",f10.3," Hrs/YEAR";wrt 701,F[100]A[24]
162: fmt "TOTAL ENERGY REQ. AT MAX =",f10.3,"HP Hrs/YEAR",f10.3," KW Hrs/YEAR"
163: wrt 701,A[40]A[24]F[100],.746A[40]A[24]F[100]
164: gto 101
165: stp ;end
166: A[22])A[23];A[21])A[22];A[20])A[21];A[19])A[20];A[10])A[19];1)A[18])B
167: stp
168: spc
169: fxd 3;prt A$[1],A$[7];prt "OUTPUT HP REQ.";for I=1 to 28;prt P[I];next I
170: spc
171: fxd 3;prt A$[1],A$[7];prt "COST HP HOUR";for I=1 to 28;prt B[I];next I
*/107
```

FLOW CHART


RUN
New data 1, old data 2
+ rak #, file #
B = 1
B = 2
DATA INPUT
Load old data
Calculate
PRINT TABLES
Press
CONTINUE
More copies
yes
new
1
old
2
B?
Make correction
n
Data correction
yes y, no n
used plot
yes y
n
STOP
RECORDED
"storage data"
other data on
same graph
PLOTTED
done
5
file #, track #
line #

MACHINERY COST PROGRAM*

PROGRAM*

Data Preparation

The data input form is presented on the next page. The items are identified by the symbols A$(1), A$(2),....A$(5), A(2),....A(17). These symbols also identify the name of the variables used in the computer program and are used in the process of both correcting any errors that might occur in recording data and in conducting sensitivity analysis. Sensitivity analysis involves the systematic changing of the value of some set of variables such as cost of fuel and then using the program to calculate the impact of machinery costs. This last characteristic makes the porgram especially useful in exploring a wide range of interesting and relevant problems associated with machinery cost.

If no data are entered for one of the items on the data form, the blank will either be ignored (most A$(*) items) or treated as zero (some A(*) items). This feature helps make the program a general program which can be used to analyze costs for items that range from a manpowered shaduf to large modern earthmoving equipment. The numbers in brackets (e.g. (19) for item A$(1)) indicates the maximum number of characters which can be used to assign either a name or value to a variable.

---

* Calculation of Machinery Costs for Egyptian Conditions; EWUP Staff Paper #8.

DATA INPUT FORM

MACHINE COST

DATA PREPARED BY _____ DATE _____

Tape # Track # File #

A $ [*]

		1/	
1.	Name of machine	(19)	1. _____
2.	Make	(19)	2. _____
3.	Model	(9)	3. _____
4.	Size	(19)	4. _____
5.	Power Source	(9)	5. _____

A *

1.	Date preparing data (day/mo./yr.)		1. _____
2.	Present replacement price in Egypt L.E.	(12)	2. _____
3.	Wearout life in hours	(12)	3. _____
4.	Av. expected repair cost/hr. L.E.	(12)	4. _____
5.	Fuel consumption/hr	(12)	5. _____
6.	Fuel cost/liter L.E.	(12)	6. _____
7.	Oil cost/100/hr. L.E.	(12)	7. _____
8.	Grease cost/100 hr. L.E.	(12)	8. _____
9.	Electric power required/hr. kw	(12)	9. _____
10.	Electric cost/kw L.E.	(12)	10. _____
11.	Salvage value, at end of wearout life L.E.	(12)	11. _____
12.	Annual taxes, license and permit L.E.	(12)	12. _____
13.	Interest rate in percent	(12)	13. _____
14.	Operator cost per hr. L.E.	(12)	14. _____
15.	Hrs. per feddan per year	(12)	15. _____
16.	Cubic meter per hr.	(12)	16. _____
17.	Animal Power Cost/hr L.E.	(12)	17. _____

1/ Maximum characters allowed.

MACHINERY COST STUDY

DATA PREPARED BY GENE QUENEMOEN
tape 2 ; track 1 ; file 0
design&analysis by HELAL&Mc CONNEN

NAME OF MACHINE CATAPILLAR

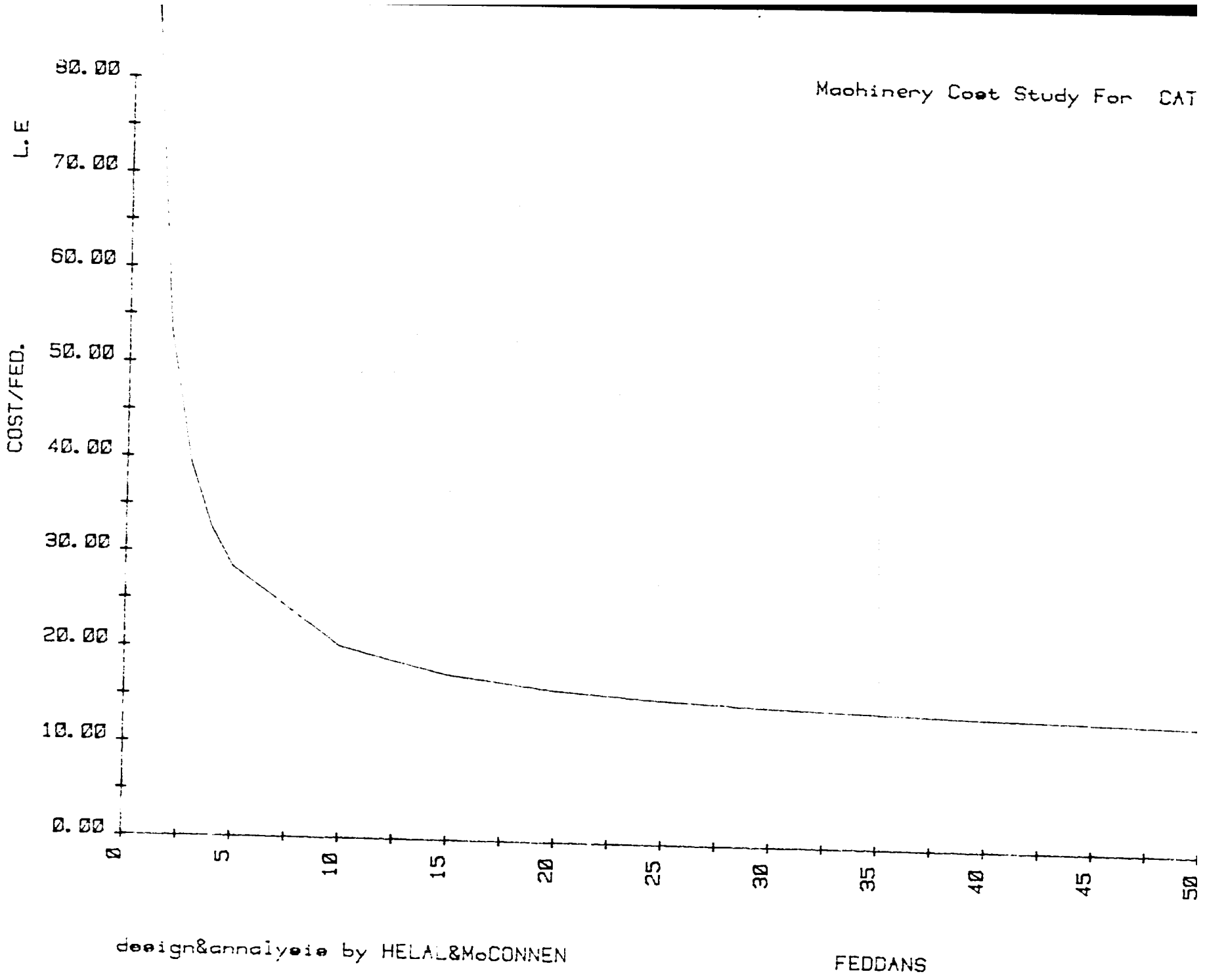
MAKE 650 MODEL 650 SIZE 6.5 HP
POWER SOURCE DIES.

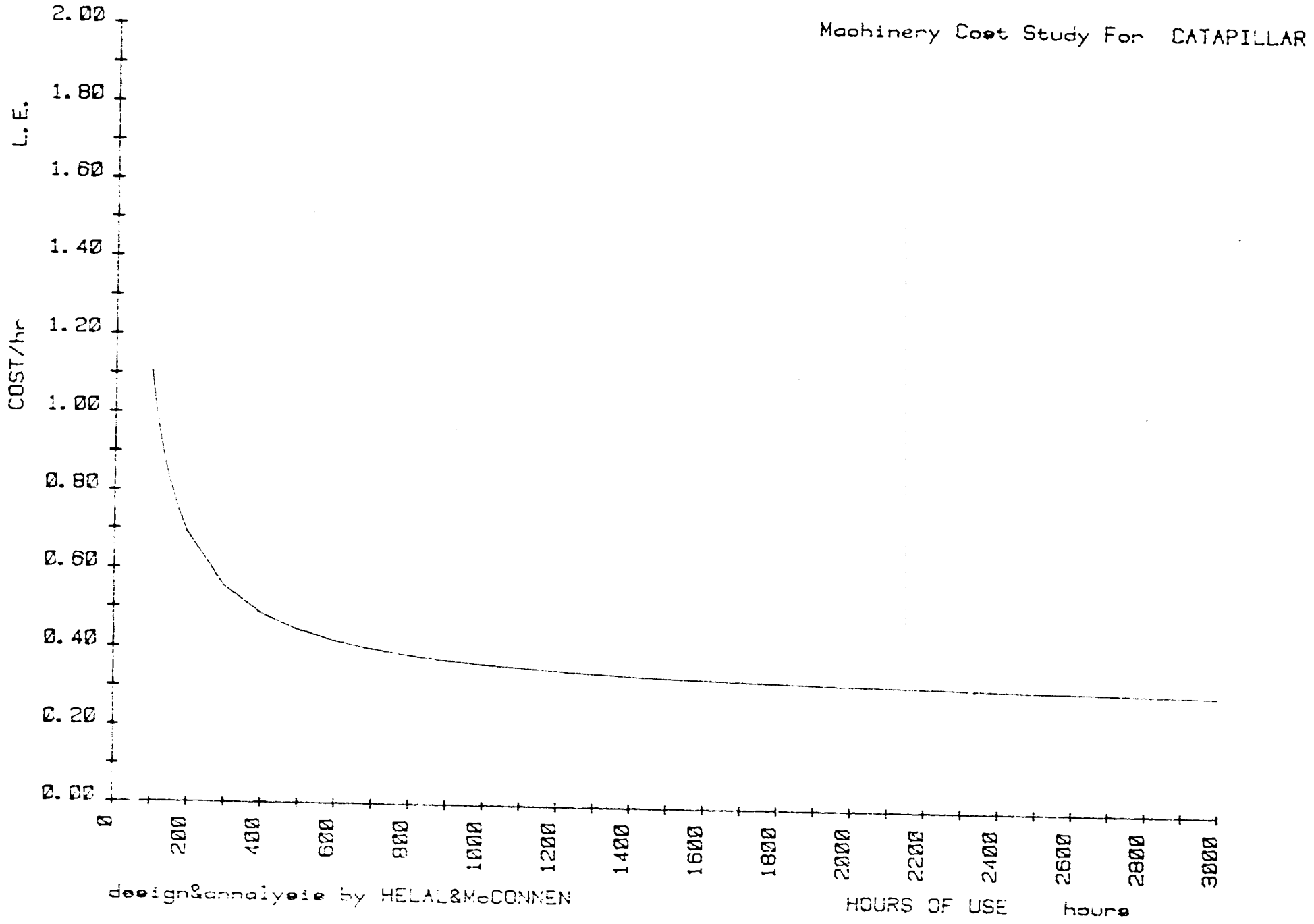
DATA PREPARING DATE: 12/ 5/79

PRESENT REPLACEMENT PRICE IN EGYPT	900.000
WEAR OUT LIFE IN HOURS	15000.000
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.060
FUEL CONSUMPTION LITERS PER HOUR	1.427
FUEL COST PER LITER:LE	0.025
OIL COST PER 100 HOURS:LE	1.500
GREASE COST PER 100 HOURS:LE	1.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES , LICENSE AND PERMIT:LE	15.000
INTEREST RATE	15.000 %
OPERATOR COST PER hr.:LE	0.100
Hrs PER FEDDAN	42.672
CUBIC METERS PER hr	150.000
ANIMAL POWER COST/hr:LE	0.000

AN.HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	ANNUAL COST/fd	COST/c.mt
100	82.500	6.000	6.000	3.573	2.500	10.000	110.573	1.106	47.103	0.0074
110	82.500	6.600	6.600	3.930	2.750	11.000	113.300	1.031	43.903	0.0069
120	82.500	7.200	7.200	4.287	3.000	12.000	116.187	0.968	41.316	0.0065
130	82.500	7.800	7.800	4.644	3.250	13.000	118.994	0.915	39.059	0.0061
140	82.500	8.400	8.400	5.002	3.500	14.000	121.802	0.870	37.125	0.0058
150	82.500	9.000	9.000	5.359	3.750	15.000	124.609	0.831	35.449	0.0055
175	82.500	10.500	10.500	6.252	4.375	17.500	131.627	0.752	32.096	0.0050
200	82.500	12.000	12.000	7.145	5.000	20.000	138.645	0.693	29.501	0.0046
300	82.500	18.000	18.000	10.718	7.500	30.000	166.718	0.556	23.714	0.0037
400	82.500	24.000	24.000	14.290	10.000	40.000	194.790	0.487	20.700	0.0032
500	82.500	30.000	30.000	17.863	12.500	50.000	222.863	0.446	19.020	0.0030
600	82.500	36.000	36.000	21.435	15.000	60.000	250.935	0.418	17.846	0.0028
700	82.500	42.000	42.000	25.008	17.500	70.000	279.008	0.399	17.008	0.0027
800	82.500	48.000	48.000	28.580	20.000	80.000	307.080	0.384	16.380	0.0026
900	82.500	54.000	54.000	32.153	22.500	90.000	335.153	0.372	15.891	0.0025
1000	82.500	60.000	60.000	35.725	25.000	100.000	363.225	0.363	15.500	0.0024
1250	82.500	75.000	75.000	44.656	31.250	125.000	433.406	0.347	14.795	0.0023
1500	82.500	90.000	90.000	53.588	37.500	150.000	503.588	0.336	14.326	0.0022
1750	82.500	105.000	105.000	62.519	43.750	175.000	573.769	0.328	13.991	0.0022
2000	82.500	120.000	120.000	71.450	50.000	200.000	643.950	0.322	13.739	0.0021
2500	82.500	150.000	150.000	89.313	62.500	250.000	784.313	0.314	13.387	0.0021
3000	82.500	180.000	180.000	107.175	75.000	300.000	924.675	0.308	13.153	0.0021

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/fd	COST/hr	COST/c.mt
1.00	82.500	2.560	2.560	1.524	1.067	4.267	94.479	94.479	2.214	0.0148
2.00	82.500	5.121	5.121	3.049	2.134	8.534	106.458	53.229	1.247	0.0083
3.00	82.500	7.681	7.681	4.573	3.200	12.802	118.437	39.479	0.925	0.0062
4.00	82.500	10.241	10.241	6.098	4.267	17.069	130.416	32.604	0.764	0.0051
5.00	82.500	12.802	12.802	7.622	5.334	21.336	142.395	28.479	0.667	0.0044
10.00	82.500	25.603	25.603	15.245	10.660	42.672	202.291	20.229	0.474	0.0032
15.00	82.500	38.405	38.405	22.867	16.002	64.008	262.106	17.479	0.410	0.0027
20.00	82.500	51.206	51.206	30.489	21.336	85.344	322.082	16.104	0.377	0.0025
25.00	82.500	64.008	64.008	38.111	26.670	106.680	381.977	15.279	0.358	0.0024
30.00	82.500	76.810	76.810	45.734	32.004	128.016	441.073	14.729	0.345	0.0023
40.00	82.500	102.413	102.413	60.978	42.672	170.688	561.664	14.042	0.329	0.0022
50.00	82.500	128.016	128.016	76.223	53.340	213.360	681.455	13.629	0.319	0.0021


Machinery Cost Study For CAT
COST/FED. L.E
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
5
10
15
20
25
30
35
40
45
50
FEDDANS
design&analysis by HELAL&McCONNEN


Machinery Cost Study For CATAPILLAR
COST/hr L.E.
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
HOURS OF USE hours
design&analysis by HELAL&McCONNEN

USERS' INSTRUCTIONS

MACHINE POWER COST

1. Set the calculator on, the printer and the plotter
2. Install the tape cartridge #3
3. a. Type tr1#; ldf#

   b. Press EXECUTE
4. Press RUN
5. When "New data 1, old data 2" appear

   either

   a. Type 1 for new data

   b. Press CONTINUE

   or

   a. Type 2 for old date

   b. Press CONTINUE
6. When "TRACK #: and "FILE #" appear respectively

   a. Type the track # and the file # for storing data

   b. Press CONTINUE
7. For new data go to Step #8

   When "TIME, FEDD2, Both 3

   a. Type 1 if you need table of cost/hr or

      Type 2 if you need table of cost/feddan or

      Type 3 if you need both

   b. Press CONTINUE

   c. Go to Step #14
8. When each of the following statements appears enter the answer

   then press CONTINUE respectively

   "DATA PREPARED BY"

   "name of m/c"

"electricity cost/kwh:LE"

"salvage value at end of wear out life:LE"

"annual taxes, license and permit:LE"

"interest rate in percent"

"OPERATOR COST PER hr:LE"

"Hrs. per feddan per year

"cubic meter per hr"

"animal power cost/hr.LE"

12. When "HOURS OF USE, neg if end" appear

either

a. Enter hours number of use

b. Press CONTINUE

c. Go to Step #12

or

a. Enter neg. # for no more hour of use

b. Press CONTINUE

13. When "FEDDANS negative at end" appear

either

a. Enter the number of feddans

b. Press CONTINUE

c. Go to Step #13

or

a. Enter neg # for no more feddans

b. Press CONTINUE

14. When "CHANGE TIME or FEDD. yes 1"

either

a. Type 1 for changing

b. Press CONTINUE

or

a. Type 0 for no change

b. Press CONTINUE

c. Go to Step #18

15. When "I" appear

a. Enter the item #

b. Press CONTINUE

16. When "T (I) appear

a. Enter the # of hours

b. Press CONTINUE

17. When "F (I)" appear

a. Enter the # of feddans

b. Press CONTINUE and go to Step #14

18. Some calculations is done and the input data is printed

19. When "DATA correct yes y, no n" appear

either

a. Type n to make corrections

b. Press CONTINUE

or

a. Type y for no corrections

b. Press CONTINUE

c. Go to Step #21

20. When "Make" appear

either

a. Type the correction

b. Press EXECUTE

c. Go to Step #23

or

Press CONTINUE for no more corrections; go to Step #18

21. When "MORE COPIES 1 yes" appear

either

a. Type 1 for another list

b. Press CONTINUE

c. Go to Step #14

or

a. Type 0 for no more list

b. Press CONTINUE

22. If no changes were made to old data go to #24, new data go to #23

When "changes recorded, yes 1" appear

a. Type 1 if changes made in Steps 14 or 19 are to be recorded on tape

b. Press CONTINUE

or

c. Type CONTINUE if recording of changes if any is not desired

23. The new data is stored

24. When "USES PLOT. yes y, no n" appear

either

a. Type y for using the plotter

b. Press CONTINUE

25. When "SECOND CURVE ON SAME GRAPH 5 YES"

either

a. Type 5 to put another graph with other data on the same paper

b. Press CONTINUE

or

a. Press CONTINUE

b. Go to Step #28

26. For the other graph to be done when "file #", "track #", appear

a. Enter the value of these statements respectively

b. Press CONTINUE after each statement

27. For superimposed graph when "copy of second set of data, yes 1" appear

a. Type 1 for superimposed to be printed. If second set of data has to be corrected, 1 must be entered; go to Step 14

b. Type Ø

c. Press CONTINUE; go to Step 35

28. When "PLOT (TIME) 1, PLOT (FEDDAN) 2, appear

a. Type 1 to have a graph of cost/hr or

Type 2 to have a graph of cost/feddan

b. Press CONTINUE

29. When "X AXIS FROM" appear

a. Enter the min. value in the x axis

b. Press CONTINUE

30. When "TO" appear

    a. Enter the max. value in the x axis

    b. Press CONTINUE

31. When "T.C" appear

    a. Enter the increment value in x axis to put makr along x axis

    b. Press CONTINUE

32. When "STEP" appear

    a. Enter the # of steps to write the value of x along x axis

    b. Press CONTINUE

33. When "Y intercept" appear

    a. Enter the x value at where x axis cross y axis

    b. Press CONTINUE

34. Do the same for y axis as that of x axis when each of these statements appear (from step #29-33)

    "y axis from"

    "TO"

    "TIC"

    "STEP"

    "X intercept

35. When "WITHOUT AXES 1 yes" appear

    either

    a. Type 1 to have a graph without axis

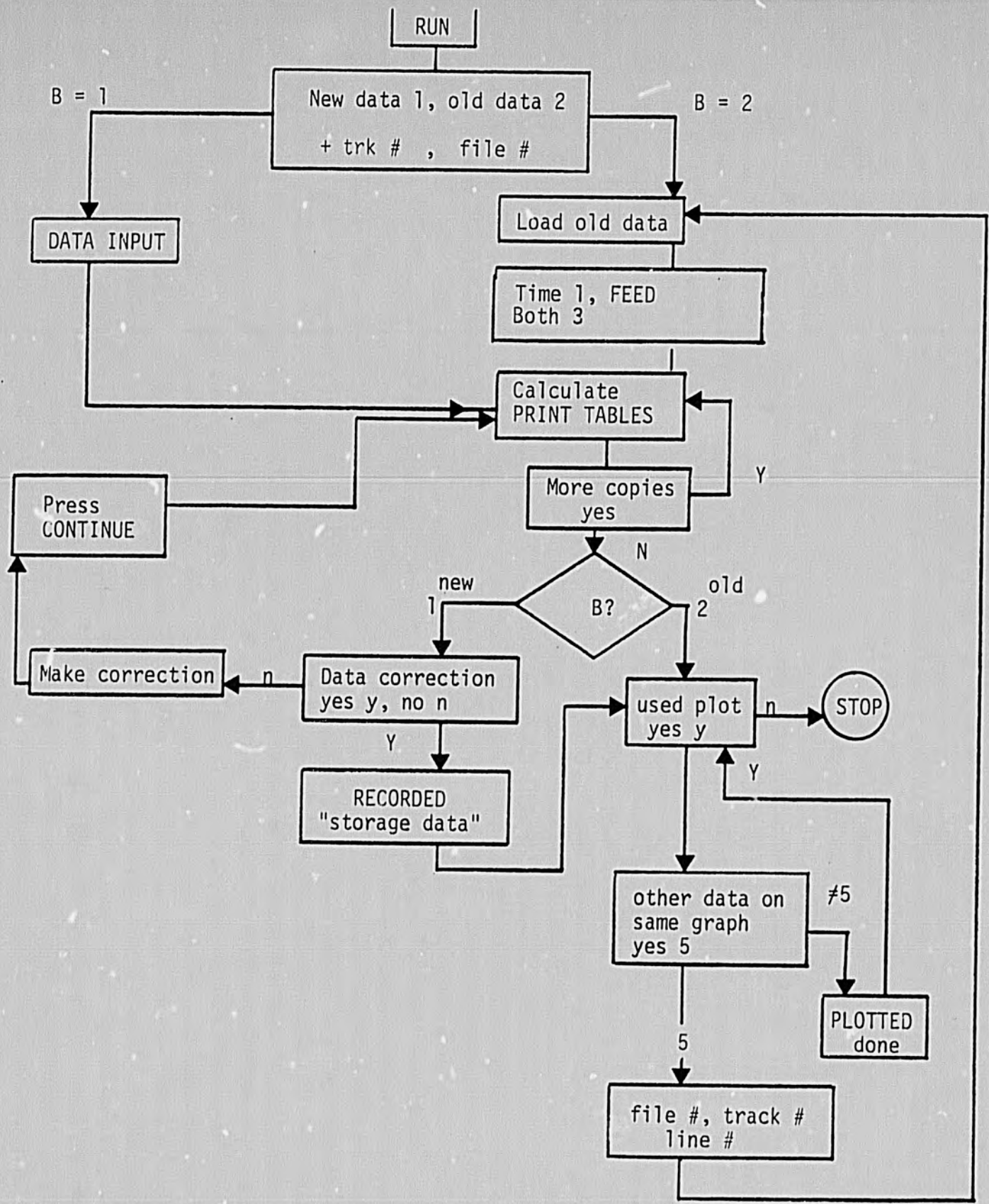
    b. Press CONTINUE

    or

    Press CONTINUE

36. The plotter must be on at this step and a graph is done

    After the end of the graph go to Step #24


RUN
New data 1, old data 2
+ trk # , file #
B = 1
B = 2
DATA INPUT
Load old data
Time 1, FEED
Both 3
Calculate
PRINT TABLES
Press
CONTINUE
More copies
yes
Y
N
new
1
B?
old
2
Make correction
n
Data correction
yes y, no n
used plot
yes y
n
STOP
Y
RECORDED
"storage data"
Y
other data on
same graph
yes 5
≠5
PLOTTED
done
5
file #, track #
line #

```
0: dim T[100],A[50],A$[7,20],F[100]
1: dim S$[2],L$[2],Q[100],R[100],Y[100],X[100],Z[100],S[100]
2: dsp "MACHINE POWER COST";wait 500
3: ent "NEW DATA 1, OLD DATA 2",B
4: ent "TRACK#",M;ent "FILE #",N
5: if B=2;trk M;rew
6: if B=2;ldf N,T[*],A[*],A$,F[*]
7: if B=1;3)S
8: if B=2;ent "TIME 1 ,FEDD 2 , BOTH 3",S
9: 0)P
10: if B=2;gto "PRINT"
11: ent "DATA PREPARED BY",A$[6]
12: ent "name of m/c",A$[1]
13: ent "make",A$[2]
14: ent "model",A$[3]
15: ent "size",A$[4]
16: ent "POWER SOURCE ANIM. DIES. ELEC.",A$[5]
17: ent "Data preparing date DDMMYY",A[1]
18: ent "present replacement price in EGYPT",A[2]
19: ent "wear out life in hours",A[3]
20: ent "av.expected repair costs/hr:LE",A[4]
21: ent "fuel consumption/hr",A[5]
22: ent "Fuel cost/liter:LE",A[6]
23: ent "oil cost/100hr:LE",A[7]
24: ent "grease cost/100hr:LE",A[8]
25: ent "electric power required/hr:Kw",A[9]
26: ent "electricity cost/kwh:LE",A[10]
27: ent "salvage value at end of wear out life:LE",A[11]
28: ent "annual taxes,license and permits:LE",A[12]
29: ent "interest rate in percentt",A[13]
30: ent "OPERATOR  COST PER hr:LE",A[14]
31: ent "Hrs per Feddan per year",A[15]
32: ent "Cubic Meter per hr",A[16]
33: ent "Animal power cost/hr. L.E.",A[17]
34: int(A[1]/10000))A[30];int((A[1]-10000A[30])/100))A[39]
35: int(A[1]-10000A[30]-100A[39]))A[40]
36: 0)I
37: 1+I)I
38: if B=1;ent "HOURS OF USE ,neg if end",T[I];if T[I]<0;gto 40
39: jmp -2
40: 0)I
41: I+1)I
42: if B=1;ent "FEDDANS negative at end",F[I];if F[I]<0;gto 44
43: jmp -2
44: "PRINT":
45: A[13](A[2]+A[11])/200)R
46: R+A[12])A[30]
47: A[5]A[6])A[22]
48: if A$[5]="ELEC.";A[10]A[9])A[22]
49: if A$[5]="ANIM.",A[17])A[22]
50: A[22]A[15])A[30]
51: A[13](A[2]-A[11])/A[3])A[48]
52: .01A[13](A[2]-A[11])A[3]))A[49]
53: (A[2]-A[11])/A[3])A[21]
54: .01(A[2]-A[11]))A[23]
55: fmt 3,,/;wrt 701,3
56: fmt 3,/,/;wrt 701,3
57: conv 1,4,"
58: wrt 701,"[12]"
59: fmt 2,10x,"TABLE( ) MACHINERY COST STUDY";wrt 701,2
```

```
60: wrt 701,"!n!AkOS"
61: if A[14]=0;fmt 5,20x,"not including cost of machine operator";wrt 701.5
62: fmt 7,5x,"DATA PREPARED BY",c20;wrt 701.7,A$[6]
63: fmt 7,5x,"tape 2 ; track",f2.0," ; file",f3.0;wrt 701.7,M,N
64: fmt 7,5x,"designAannalysis by HELALAMc CONNEN";wrt 701.7
65: fmt 3,/;wrt 701.3
66: fmt 7,"NAME OF MACHINE",5x,c20;wrt 701.7,A$[1]
67: fmt 3,/;wrt 701
68: fmt 7,"MAKE",c10,5x,"MODEL",c17,5x,"SIZE",c10;wrt 701.7,A$[2],A$[3],A$[4]
69: fmt 7,"POWER SOURCE",36x,c10;wrt 701.7,A$[5]
70: fmt 3,/;wrt 701
71: fmt 4,"DATA PREPARING DATE:",15x,f2.0,"/",f2.0,"/",f2.0
72: wrt 701.4,A[30],A[39],A[40]
73: fmt 7,"PRESENT REPLACEMENT PRICE IN EGYPT",11x,f10.3;wrt 701.7,A[2]
74: fmt 7,"WEAR OUT LIFE IN HOURS",23x,f10.3;wrt 701.7,A[3]
75: fmt 7,"AVAREGE EXPECTED REPAIR COST PER HOUR:LE",5x,f10.3;wrt 701.7,A[4]
76: if A[5]=0;jmp 3
77: fmt 7,"FUEL CONSUMPTION LITERS PER HOUR",13x,f10.3;wrt 701.7,A[5]
78: fmt 7,"FUEL COST PER LITER:LE",23x,f10.3;wrt 701.7,A[6]
79: fmt 7,"OIL COST PER 100 HOURS:LE",20x,f10.3;wrt 701.7,A[7]
80: fmt 7,"GREASE COST PER 100 HOURS:LE",17x,f10.3;wrt 701.7,A[8]
81: if A[9]=0;jmp 3
82: fmt 7,"ELECTRIC POWER REQUIRED PER HOUR:Kw",10x,f10.3;wrt 701.7,A[9]
83: fmt 7,"ELECTRICITY COST PER Kw.h:LE",17x,f10.3;wrt 701.7,A[10]
84: fmt 7,"SALVAGE VALUE AT END OF WEAR OUT LIFE:LE",5x,f10.3;wrt 701.7,A[11]
85: fmt 7,"ANNUAL TAXES , LICENSE AND PERMIT:LE",9x,f10.3;wrt 701.7,A[12]
86: fmt 7,"INTEREST RATE            ",22x,f10.3,2x,"%";wrt 701.7,A[13]
87: if A[14]#0;fmt 7,"OPERATOR COST PER hr.:LE",21x,f10.3;wrt 701.7,A[14]
88: fmt 7,"Hrs PER FEDDAN           ",22x,f10.3;wrt 701.7,A[15]
89: fmt 7,"CUBIC METERS PER hr",26x,f10.3;wrt 701.7,A[16]
90: fmt 7,"ANIMAL POWER COST/hr:LE",22x,f10.3;wrt 701.7,A[17]
91: wrt 701.3
92: if S=2;gto "FEDD"
93: "TIME":
94: fmt ,z,1x;wrt 701
95: wtb 701,"AN.HOURS     ANNUAL        DEPRECIA.       REPAIRS       POWER    "
96: wtb 701,"  GREASE    OPERATOR    TOTAL ANNUAL      COST/hr   "
97: wtb 701,"  ANNUAL     COST/c.mt"
98: wtb 701,13,10
99: wtb 701," OF USE     FIXED COST                                        COST"
100: wtb 701,"       AOIL       COST            COST"
101: wtb 701,"                    COST/fd  "
102: wtb 701,13,10
103: 0)I
104: 1+I;I;if I[I]<0;jmp 10
105: A[30]/I[I])Y[I];A[4]I[I])Q[I]
106: A[7]+.01(A[7]+A[8])+(A[2]-A[11])/A[3]+A[4]+A[14]+Y[I])R[I]
107: I[I]A[21])A[31];A[22]I[I])A[32];A[23]I[I])A[33];A[14]I[I])A[34]
108: R[I]I[I])A[35];R[I]A[15])A[36]
109: if A[16])0;R[I]/A[16])A[37]
110: if A[16]=0;0)A[37]
111: fmt 1,1x,f4.0,f14.3,f14.3,f14.3,f12.3,f10.3,f10.3,f16.3,f12.3,f12.3,f11.4
112: wrt 701.1,I[I],A[30],A[31],Q[I],A[32],A[33],A[34],A[35],R[I],A[36],A[37]
113: jmp -9
114: if S#1;gto "FEDD"
115: ent "change TIME or FEDD. yes 1",O;if O=1;1)P;ent I;ent I[I],F[I];jmp 0
116: ent "DATA correct yes y , no n",E$;if E$="n";dsp "MAKE";stp
117: ent "MORE COPIES  yes 1",I;if I=1;gto 44
118: if R 1;jmp 3
119: if P=1;ent "CHANGES RECORDED, yes 1",R;jmp 2
120: if E$="n";ent "CHANGES RECORDED, yes 1",R
121: if R=1,trk M;rew
122: if R=1;rct N,I[*],A[*],A$,F[*]
123: if R 1;trk M;rew
124: if R 1;rct N,I[*],A[*],A$,F[*]
125: if G=5;gto +11
```

```
126: ent "USE PLOT. yes y, no n",S$;if S$="n";stp
127: if G-5;gto +2
128: if G#5;ent "SECOND CURVE ON SAME GRAPH 5 YES",G
129: if G 5;ent "track #",M;ent "file #",N;trk M;rew;2DB
130: if G=5;rcf N,I[*],A[*],A$,F[*]
131: if G=5,ent "COPY OF SECOND SET OF DATA,yes 1",Z;if Z=1;gto 45
132: if G=5;gto +4
133: ent "PLOT(TIME)1 , PLOT(FEDDAN)2",H
134: ent "X AXIS FROM",r1,"TO",r2,"TIC",r3,"STEP",r4,"Yintercept",r5
135: ent "Y AXIS FROM",r6,"TO",r7,"TIC",r8,"STEP",r9,"Xintercept",r0
136: ent "WITHOUT AXIES 1 yes",J;if J=1;gto 152
137: pen# 4
138: scl r1,r2,r6,r7
139: line
140: fxd 0;xax r5,r3,r1,r2,r4
141: fxd 2;yax r0,r8,r6,r7,r9
142: csiz 1.65,2,1,0
143: if H=1;plt r1+2(r2-r1)/3,r6-2.5r8,0;lbl "HOURS OF USE    hours"
144: if H=2;plt r1+2(r2-r1)/3,r6-2.5r8,0;lbl "FEDDANS"
145: plt r1,r6-2.5r8,0;lbl "designAannalysis by HELAL&McCONNEN"
146: plt r1+(r2-r1)/2,r7,0;lbl "FIGURE(  ) Machinary Cost Study For ",A$[1]
147: if A[14]>0;jmp 2
148: plt r1+(r2-r1)/2,r7-r8,0;lbl "not including cost of machine operator"
149: csiz 1.65,2,1,90
150: if H=1;plt r1-2.55r3,r6+(r7-r6)/2,0;lbl "COST/hr              L.E."
151: if H=2;plt r1-2r3,r6+(r7-r6)/2,0;lbl "COST/FED.               L.E"
152: if G=5;scl r1,r2,r6,r7
153: if G=5;csiz 1.65,2,1,0
154: if G=5;plt r1+(r2-r1)/2,r7-2r8,0;lbl "(.....)                 For ",A$[1]
155: if G=5;line 1,.7
156: pen# 3
157: if G=5;stp
158: 0)I
159: if H=2;gto 163
160: 1+I)I;if F[I]<0;pen;gto 126
161: plt E[I],R[I]
162: jmp -2
163: 1+I)I;if F[I]<0;pen;gto 126
164: plt F[I],Z[I]
165: jmp -2
166: stp
167: "FEDD":
168: if F[1]<0;gto 116
169: wrt 701.3
170: fmt ,z,1x;wrt 701
171: wtb 701,"FEDD.        ANNUAL       DEPRECIA.       REPAIRS        POWER    "
172: wtb 701,"  GREASE    OPERATOR    TOTAL ANNUAL      ANNUAL    "
173: wtb 701,"  COST/hr    COST/c.mt"
174: wtb 701,13,10
175: wtb 701,"            FIXED COST                                  "
176: wtb 701,"COST       &OIL       COST            COST"
177: wtb 701,"            COST/fd"
178: wtb 701,13,10
179: 0)I
180: 1+I)I;if F[I]<0;gto 115
181: A[30]=F[I]*F[I];A[4]A[15]F[I])S[I]
182: A[50]=A[15]<.01(A[2]+A[10])+(A[2]-A[11])/A[3]+A[4]+A[14])+X[I])/I]
183: F[I]A[40])A[41];A[50]F[I])A[42];A[49]F[I])A[43];A[14]A[15]F[I])A[44]
184: if A[16]>0;if A[15]>0;Z[I]/A[15])A[46];Z[I]/A[16]A[15])A[47]
185: Z[I]F[I])A[45]
186: fmt 1,f6.2,f13.3,f14.3,f14.3,f12.3,f10.3,f10.3,f16.3,f12.3,f12.3,f11.4
187: wrt 701 1,F[I],A[30],A[41],S[I],A[42],A[43],A[44],A[45],Z[I],A[46],A[47]
188: jmp -8
189: end
*EX
```

SUMMARY FARM RECORD PROGRAM

This program has been designed to store the summary of the data which has been obtained from the farm records for the study cases at the three sites, so we can use these stored data for farm record analysis these outputs can help in farm management and in our economic activity.

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* Abdel Al, Farouk and Melvin Skold, "Farm Record Summary and Analysis for Study cases at Abu Raya and Mansouria sites. EWUP Technical Report, 1980. Staff Paper #26.

FARM RECORD SUMMARY

Farm Economics Team

Summarized by: CS[1]
Agricultural Year: A\$[1]-A\$[2]
Farmer #: 1
Farmer's name: 25
Location: ABUDWA MENIA GOVERNORATE

Reviewed by: CS[2]

Farm size, including: C
Owned: [6,1] Rented: E[7,1] Shared: F[6,2]

INVENTORY CHANGES

ITEM	Beginning LE	End LE	Change LE	Remarks
1 Implements				
2 Livestock				
3 Poultry				
4 Grain & Forage	E[I,1]	E[I,2]		
5 Land\Real Estate				
Total				

ANIMAL AND CROP PRODUCTION

Animal Products				Crop Products			
Animal Feed LE	Home Use LE	Sales LE	Total LE	Animal Feed LE	Home use LE	Sales LE	Total LE
F[I,1]	F[I,2]	F[I,3]		G[I,1]	G[I,2]	G[I,3]	
Sum							

Number of Crops = 0

Crop Expenses

Crop	Field No	Area Fed.	Labor LE	Equipment LE	Organic Fert LE	Chemical Fert LE	Seed LE	Pesticide LE	Other LE	Total LE
GS[I]	HS[I]	H[I,8]	H[I,1]	H[I,2]	H[I,3]	H[I,4]	H[I,5]	H[I,6]	H[I,7]	
Total LE										

Non-Crop Expenses

Kind of Expense	LE
1 Purchased Animal Feed	
2 Land Rent	
3 Taxes	
4 IS[4]	
5 IS[5]	
Total Non-Crop Expense	

Summary of Income		Summary of Expenses	
Animal Products		Crop Expenses	
Crop Products		Non-Crop Expenses	
Capital Sales	J[3]	Capital Purchases	K[3]
Inventory Change if +		Inventory Change if	
Off-Farm Income	J[5]	Non-purchased Animal Feed	
Total Gross Income LE		Total Gross Expense	

NET FARM INCOME (with land appreciation) = LE
NET FARM INCOME (without land appreciation) = LE

Work Done by Animals

Kind					Work Hours					
Cow	Buffalo	Camel	Horse	Donkey	Plowing	Leveling	Ridding	Irrigation	Total	Transport
M[1]	M[2]	M[3]	M[4]	M[5]	N[1]	N[2]	N[3]	N[4]		M[6]

Farm Record Program:

Turn the calculator ON and the printer

Insert the tape cartridge

1. a. Load program; tape must be inserted

   b. Press EXECUTE

   c. Press RUN

2. When "Farm record number" appear

   a. Type the # of the farm record

   b. Press CONTINUE

3. When "Table number 1, 2, ...,7" appear

   a. Type 1 for recording Farm Data

      or 2 for inventory Recording

      or 3 for recording the Animal and Crop Production

      or 4 for recording the Crop Expenses

      or 5 for recording the Non-Crop Expenses

      or 6 for recording the Summary of Income and Expenses

      or 7 for recording work done by animals

   b. Press CONTINUE

4. When "1 = new data, 2 = old data" appear

   either

   a. Type 1 for new data

   b. Press CONTINUE

   c. For table number 2 go to Step #12, 3 Step #18, 4 Step #25, 5 Step #37, 6 Step #41, and 7 Step #45

   or

   a. Type 2 for old data

   b. Press CONTINUE

c. When "1 = If correction needed"

d. Type 1 for corrections

or

e. Type 2 for no corrections

f. Press CONTINUE

g. Go to 11, 17, 24, 36, 40, 44, 47 in this order; refer to these numbers respectively with respect to table number (e.g. table number 3, start at Step #24 then to 36 and 40 on)

5. When "Summarized By:" appear

   a. Enter person who summarized data

   b. Press CONTINUE

6. When "Reviewed BY" appear

   a. Enter person who reviewed data

   b. Press CONTINUE

7. When "beginning date" appear

   a. Enter the beginning of the agricultural year

   b. Press CONTINUE

8. When "ending date" appear

   a. Enter the ending date of the agricultural year

   b. Press CONTINUE

9. When "farmer's name" appear

   a. Enter the farmer's name

   b. Press CONTINUE

10. When "farm size, feddans" appear

    a. Enter the farm size in feddans

    b. Press CONTINUE

16. When "remarks" appear

    a. Enter the remarks of this item

    b. Press CONTINUE

    c. Go to Step #14 until I = 5

17. When "make corrections" appear

    either

    a. Make the corrections

    b. Press EXECUTE

    c. Go to Step #17

    or

    a. Press CONTINUE for no corrections

    b. Go to 18 for new data

    For old data with corrections when "check corrections, yes 1" appear

    a. Type 1 for second or more copies

    b. Press CONTINUE; go to Step #17

    or

    a. Type Ø for no corrections

    b. Press CONTINUE; go to Step #24

18. When "A - Animal feed, LE I" appear, I varies from 1 to 3

    a. Enter the price of the animal feed from the animal production

    b. Press CONTINUE

19. When "A: Home use, LE I" appear

    a. Enter the price of the home use from the animal product

    b. Press CONTINUE

20. When "A: Sales, LE I" appear

    a. Enter the price of the sales of animal product

    b. Press CONTINUE

21. When "C: Animal feed, LE I" appear

    a. Enter the price of animal feed from the crop production

    b. Press CONTINUE

22. When "C: Home use, LE I" appear

    a. Enter the come use price of the crop production

    b. Press CONTINUE

23. When "C" Sales, LE I" appear

    a. Enter the sales price from crop production

    b. Press CONTINUE

    c. Go to Step #18 until I = 3

24. When "make corrections" appear

    either

    a. Make the needed corrections

    b. Press EXECUTE

    c. Go to Step #24

    or

    a. Press CONTINUE

    b. Go to 25 for new data

    For old data with corrections when "Check corrections, yes 1" appear

    a. Type 1 for second or more copies

    b. Press CONTINUE; go to Step #24

    or

    a. Type 0 for no copies

    b. Press CONTINUE; go to Step #36

25. When "number of crops" appear

    a. Type the number of crops

    b. Press CONTINUE

26. When "Crop I" appear where I varies from 1 to # of crops

    a. Enter the crop name

    b. Press CONTINUE

27. When "field number I" appear

    a. Enter the number of the fields which produce this crop

    b. Press CONTINUE

28. When "field area, feddans I" appear

    a. Enter the area of the field that produce this crop

    b. Press CONTINUE

29. When "labor LE I" appear

    a. Enter the salary of the labors for this crop

    b. Press CONTINUE

30. When "equipment LE I" appear

    a. Enter the equipment cost of this crop

    b. Press CONTINUE

31. When "organic fertilizer LE I" appear

    a. Enter the cost of the organic fertilizer of this crop

    b. Press CONTINUE

32. When "chemical fertilizer LE I" appear

    a. Enter the cost of the chemical fertilizer

    b. Press CONTINUE

33. When "seed LE I" appear

    a. Enter the cost of the seed

    b. Press CONTINUE

34. When "insecticide LE I" appear

    a. Enter the cost of insecticide

    b. Press CONTINUE

35. "Other LE I" appear

    a. Enter the other cost

    b. Press CONTINUE

    c. Go to Step #26 until I = # of crops

36. When "Make corrections" appear

    either

    a. Make the corrections of needed

    b. Press EXECUTE

    c. Go to Step #36

    or

    a. Press CONTINUE

    b. Go to 37 for new data

    For old data with corrections when 'check corrections, yes 1" appear

    a. Type 1 for second or more copies

    b. Press CONTINUE; go to Step #36

    or

    a. Type 0 for no copies

    b. Press CONTINUE; go to Step #40

37. When "name of 4th expense" appears

    a. Enter the name of the 4th expense

    b. Press CONTINUE

38. When "name of 5th expense" appears

    a. Enter the name of the 5th expense

    b. Press CONTINUE

39. When "amount LE I" appears where I from 1 to 5

a. Enter the amount LE of item #I

b. Press CONTINUE

c. Go to Step #39 until I = 5

40. When "make corrections" appears

either

a. Make the corrections

b. Press EXECUTE

c. Go to Step #40

or

a. Press CONTINUE

b. Go to Step #41 for new data

For old data with corrections when "check corrections, yes 1" appear

a. Type 1 for second or more copies

b. Press CONTINUE; go to Step #40

or

a. Type 0 for no copies

b. Press CONTINUE; go to Step #44

41. When "capital sales" appear

a. Enter the capital sales

b. Press CONTINUE

42. When "off-farm income" appear

a. Enter the off-farm income

b. Press CONTINUE

43. When "capital purchases" appear

    a. Enter the capital purchases

    b. Press CONTINUE

44. When "make corrections" appear

    either

    a. Make the correction

    b. Press EXECUTE

    c. Go to Step #44

    or

    a. Press CONTINUE if no corrections

    b. Go to 45 for new data

    For old data with corrections when "check corrections, yes = 1" appear

    a. Type 1 for second or more copies

    b. Press CONTINUE; go to Step #44

    or

    a. Type 0 for no copies

    b. Press CONTINUE; go to Step #47

    or

    a. Type 2 for old data

    b. Press CONTINUE

    c. Go to Step #45

45. When each one of the following appear

    "cow"

    "buffalo"

    "camel"

    "horse"

    "donkey"

a. Enter the # of the animal

b. Press CONTINUE

46. When each one of the following appear

"plowing"

"leveling"

"pudding"

"irrigation"

"transportation"

a. Enter the # of hours of work done by animals

b. Press CONTINUE

47. When "make corrections" appears

either

a. Make the corrections

b. Press EXECUTE

c. Go to Step #47

or

a. Press CONTINUE

for old data with corrections when "check corrections, yes 1"

appear

a. Type 1 for second or more copies

b. Press CONTINUE; go to Step #47

or

a. Type 0 for no copies

b. Press CONTINUE

```
0: dim A$[2,15],B$[40],C,D$[40],C$[2,20]
1: dim E$[7,40],E[7,3],F$[7,40]
2: dim F[3,3],G[3,3]
3: dim G$[30,20],H$[30,3],H[30,8],O
4: dim I$[10,30],I[10]
5: dim J[5],K[5]
6: dim M[6],N[6]
7: trk 0;ent "Farm record number ",r99;if r99>225;r99-225)D;trk 1;jmp 6
8: if r99>200;r99-200)D;jmp 5
9: if r99>150;r99-150)D;trk 1;jmp 4
10: if r99>100;r99-100)D;jmp 3
11: if r99>25;r99-25)D;trk 1;jmp 2
12: if r99>.99;r99)D
13: if r99>200;"ABORAIA K. EL SHEIKH GOVERNORATE")D$;jmp 4
14: if r99>150;"ELHAMMAMI MANSOURIA  GIZA GOVERNORATE")D$;jmp 3
15: if r99>101;"BANIMAGDOUL MANSOURIA  GIZA GOVERNORATE")D$;jmp 2
16: "ABUGHA  MENIA GOVERNORATE")D$
17: ent "Table number 1,2,...7",A
18: ent "1= NEW DATA ; 2= OLD DATA",B;if B=2;ent "1=IF CORRECTION NEEDED",S
19: if A=1;gto "FARMER"
20: if A=2;gto "INVENT"
21: if A=3;gto "PRODUCT"
22: if A=4;gto "CROPXP"
23: if A=5;gto "NCRPXP"
24: if A=6;gto "SUMM"
25: if A=7;gto "ANLAB"
26: "FARMER":7(D-1)+1)A
27: if B=2;idf A,A$,B$,C,D$,C$;gto "TB1"
28: ent "Summarized by:",C$[1],"Reviewed by:",C$[2]
29: ent "Beginning date",A$[1];ent "Ending date",A$[2]
30: ent "Farmer's name",B$;ent "Farm size,feddans",C
31: "TB1":
32: wtb 701,27,38,107,49,83
33: wtb 701,"                                    FARM RECORD SUMMARY",B
34: wtb 701,27,38,107,48,83,13,10,10
35: fmt ,95x,"FWUP Economics Team";wrt 701
36: wtb 701,"Summarized by:",C$[1]
37: fmt ,z,30x;wrt 701;wtb 701,"Reviewed by:",C$[2],13,10
38: wtb 701,"Agricultural Year  ",A$[1]," to ",A$[2],13,10
39: fmt ,"Farmer's:",f5.0;wrt 701,r99
40: wtb 701,"Farmer's name:",B$,13,10
41: wtb 701,"Location: ",D$,"                    Farm size, feddans:"
42: fmt ,f5.2
43: wrt 701,C
44: if S=1 or B=1;dsp "make corrections";stp
45: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB1"
46: if B=1 or S=1,rcf A,A$,B$,C,D$,C$
47: "INVENT":7(D-1)+2)A
48: if B=2;idf A,E$,E[*],F$,gto "TB2"
49: "1 Equipments")E$[1]
50: "2 Livestock")E$[2]
51: "3 Poultry")E$[3]
52: "4 Grain & Forage")E$[4]
53: "5 Land&Real Estate")E$[5]
54: ent "Owned area=",E[6,1];ent "Rented area=",E[7,1]
55: ent "Shared area=",E[6,2]
56: for I=1 to 5
57: dsp "Beg.Balance[",E$[I];ent "",E[I,1]
58: dsp "End balance[",E$[I];ent "",E[I,2]
59: E[I,3]=E[I,1]-E[I,2]
60: dsp "Remov.",E$;ent "",E[I,4]
61: next I
62: "TB2":
63: fmt ,z,74x,c8,f5.2,c9
64: wrt 701,"Owned:",E[6,1],"  Rented:"
65: fmt ,f5.2,c9,f5.2
```

```
66: wrt 701,E[7,1],"  Shared:",E[6,2]
67: wtb 701,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64,10
68: wtb 701,"                    "
69: fmt ,10x,"                                        INVENTORY CHANGES";wrt 701
70: wtb 701,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64
71: wtb 701,10,"          ITEM                                  "
72: wtb 701,"             Beginning LE    End LE      Change LE"
73: wtb 701,"                        Remarks",10,13
74: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,10
75: 0)r2)r3
76: for I=1 to 5
77: E[I,2]-E[I,1])E[I,3]
78: wtb 701,F$[I],13
79: fmt ,z,40x,f10.2,f13.2,f12.2;wrt 701,E[I,1],E[I,2],E[I,3]
80: wtb 701,"      ",F$[I],13,10
81: E[I,1]+r2)r2;E[I,2]+r3)r3
82: next I
83: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
84: fmt ,"Total",35x,f10.2,f13.2,f12.2
85: wrt 701,r2,r3,r3-r2
86: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,10,10
87: if S=1 or R=1;dsp "make corrections";stp
88: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB2"
89: if R=1 or S=1;rcf A,E$,E[*],F$
90: "PRODUCT":7(D-1)+3)A
91: if R=2;ldf A,F[*],G[*];gto "TB3"
92: for I=1 to 3
93: dsp "A: Animal feed, LE",I;ent "",F[I,1]
94: dsp "A: Home use, LE",I;ent "",F[I,2]
95: dsp "A: Sales, LE",I;ent "",F[I,3]
96: dsp "C: Animal feed, LE",I;ent "",G[I,1]
97: dsp "C: Home use, LE",I;ent "",G[I,2]
98: dsp "C: Sales, LE",I;ent "",G[I,3]
99: next I
100: "TB3":0)r9
101: fmt ,40x,"          ANIMAL AND CROP PRODUCTION";wrt 701
102: wtb 701,13,10
103: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
104: wtb 701,"                    Animal Products"
105: wtb 701,"                                                    Crop Products",13,10
106: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
107: wtb 701,"Animal Feed LE   Home use LE   Sales LE   Total LE    "
108: wtb 701,"          Animal Feed LE   Home use LE   Sales LE   Total LE",13,10
109: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
110: 0)r25)r9
111: for I=1 to 3
112: F[I,1]+F[I,2]+F[I,3])r4;G[I,1]+G[I,2]+G[I,3])r5
113: fmt ,4x,f7.2,8x,f7.2,4x,f7.2,4x,f7.2,17x,f7.2,8x,f7.2,5x,f7.2,3x,f9.2
114: wrt 701,F[I,1],F[I,2],F[I,3],r4,G[I,1],G[I,2],G[I,3],r5
115: r4+r25)r25;r5+r9)r9
116: next I
117: 0)r6)r7)r8)r96)r97)r98
118: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
119: wtb 701,"Sum",13
120: for I=1 to 3;F[I,1]+r6)r6;F[I,2]+r7)r7;F[I,3]+r8)r8
121: G[I,1]+r96)r96,G[I,2]+r97)r97;G[I,3]+r98)r98;next I
122: fmt ,4x,f7.2,8x,f7.2,4x,f7.2,4x,f7.2,17x,f7.2,8x,f7.2,5x,f7.2,3x,f9.2
123: wrt 701,r6,r7,r8,r25,r96,r97,r98,r9
124: wtb 701,27,38,100,60;fmt 115x;wrt 701;wtb 701,27,38,100,64,13,10
125: if R=1 or S=1;dsp "make corrections";stp
126: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB3"
127: if R=1 or S=1;rcf A,E$,E[*],G[*]
128: 1 ent "Number of crops",D-1)+3)A
129: 0)r11)r12)r13)r14)r15)r16)r17)r18)r19
130: if R=2;ldf A,C$,H$,H[*],O;gto "TB4"
131: ent "Number of crops",O
```

BEST AVAILABLE DOCUMENT

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132: for I=1 to U
133: dsp "Crop",I;ent "",G$[I]
134: dsp "Field number",I;ent "",H$[I]
135: dsp "Field area, feddans",I;ent "",H[I,0];H[I,0]+r18)r18
136: dsp "Labor LE",I;ent "",H[I,1];H[I,1]+r10)r10
137: dsp "Equipment LE",I;ent "",H[I,2];H[I,2]+r11)r11
138: dsp "Organic fertilizer LE",I;ent "",H[I,3];H[I,3]+r12)r12
139: dsp "Chemical fertilizer LE",I;ent "",H[I,4];H[I,4]+r13)r13
140: dsp "Seed LE",I;ent "",H[I,5];H[I,5]+r14)r14
141: dsp "Pesticide LE",I;ent "",H[I,6];H[I,6]+r15)r15
142: dsp "Other LE",I;ent "",H[I,7];H[I,7]+r16)r16
143: next I
144: "TB4":0)r17)r19
145: wtb 701,13,"                    "
146: fmt ,10x,"                                        Crop Expenses";wrt 701
147: wtb 701,13,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
148: wtb 701,"          Crop          Field          Area    Labor   Equipment    "
149: wtb 701,"Organic   Chemical      Seed    Pesticide    Other    Total",13,10
150: wtb 701,"                        No.        Fed.      LE          "
151: wtb 701,"LE        Fert.LE    Fert.LE    LE          LE        LE        LE"
152: wtb 701,10,13,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64,10
153: for I=1 to U
154: H[I,1]+H[I,2]+H[I,3]+H[I,4]+H[I,5]+H[I,6]+H[I,7])r17
155: wtb 701,G$[I],13;wtb 701,"                                    ",H$[I],13
156: wtb 701,"                                    "
157: fmt 1,f13.2,f7.1,4x,f6.1,5x,f6.1,4x,f6.1,2x,f8.1,2x,f7.1,2x,f8.1,2x,f7.1
158: wrt 701.1,H[I,0],H[I,1],H[I,2],H[I,3],H[I,4],H[I,5],H[I,6],H[I,7],r17
159: r17+r17)r19;H[I,0]+r18)r18;H[I,1]+r10)r10;H[I,2]+r11)r11;H[I,3]+r12)r12
160: H[I,4]+r13)r13;H[I,5]+r14)r14;H[I,6]+r15)r15;H[I,7]+r16)r16
161: next I
162: wtb 701,13,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
163: wtb 701,"Total LE                    "
164: wrt 701.1,r18,r10,r11,r12,r13,r14,r15,r16,r19
165: wtb 701,13,27,38,100,60;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
166: if B=1 or S=1;dsp "make corrections";stp
167: if S=1;ent "Check Corrections,yes 1",P;if P=1;gto "TB4"
168: if B=1 or S=1;ref A,G$,H$,H[*],U
169: "NCRPXP":Z(D-1)+5)A
170: if B=2;lof A,I$,I[*];gto "TB5"
171: "1 Purchased Animal Feed")I$[1]
172: "2 Land Rent")I$[2]
173: "3 Taxes")I$[3]
174: ent "Name of 4th expense",I$[4]
175: ent "Name of 5th expense",I$[5]
176: "4 ")I$[7];"5 ")I$[8];I$[7]&I$[4])I$[4];I$[8]&I$[5])I$[5]
177: for I=1 to 5
178: dsp "Amount LE",I$[I];ent "",I[I];next I
179: "TB5":
180: fmt ,20x,"                                        Non-Crop Expenses";wrt 701
181: wtb 701,27,38,100,60;fmt ,115x;wrt 701
182: wtb 701,27,38,100,64,10
183: wtb 701,"   Kind of Expense                                    LE",13,10
184: wtb 701,27,38,100,60;fmt ,115x;wrt 701
185: wtb 701,27,38,100,64,10
186: 0)r20
187: for I=1 to 5
188: wtb 701," ",I$[I],13;fmt ,31x,f7.2;wrt 701,I[I]
189: I[I]+r20)r20
190: next I
191: wtb 701,"",38,100,60;fmt ,115x;wrt 701
192: wtb 701,27,38,100,64,10
193: fmt ,"Total Non-Crop Expense          ",f7.2;wrt 701,r20
194: wtb 701,27,38,100,60;fmt ,115x;wrt 701
195: wtb 701,27,38,100,64,10
196: if B=1 or S=1;dsp "make corrections";stp
197: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB5"
```

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198: if B=1 or S=1;rcf A,I*,I[*]
199: "SUMM":7(D-1)+6)A
200: if B=2;ldf A,J[*],K[*];gto "TB6"
201: r25)J[1];r9)J[2]
202: ent "Capital sales",J[3]
203: if r3-r2)0;r3-r2)J[4]
204: if r3-r2(0;r3-r2)K[4]
205: ent "Off-farm income",J[5]
206: r20)K[2]
207: r19)K[1]
208: ent "Capital purchases",K[3]
209: r96)K[5]
210: "TB6":
211: fmt ,"        Summary of Income ",20x,"   Summary of Expenses";wrt 701
212: wtb 701,13,27,38,100,68;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
213: fmt ," Animal Products        ",f7.1,15x,"Crop Expenses              ",f7.1
214: wrt 701,J[1],K[1]
215: fmt ," Crop Products          ",f7.1,15x,"Non-Crop Expenses          ",f7.1
216: wrt 701,J[2],K[2]
217: fmt ," Capital Sales          ",f7.1,15x,"Capital Purchases          ",f7.1
218: wrt 701,J[3],K[3]
219: fmt ," Inventory Change if + ",f7.1,15x,"Inventory Change if -     ",f7.1
220: wrt 701,J[4],-K[4]
221: fmt ," Off-Farm Income        ",f7.1,15x,"Non-Purchased Animal Feed",f7.1
222: wrt 701,J[5],K[5]
223: J[1]+J[2]+J[3]+J[4]+J[5])r21
224: K[1]+K[2]+K[3]+abs(K[4])+K[5])r22
225: wtb 701,13,27,38,100,68;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
226: fmt ," Total Gross Income LE ",f8.1,15x,"Total Gross Expense       ",f8.1
227: wrt 701,r21,r22
228: wtb 701,13,27,38,100,68;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
229: wtb 701,10
230: wtb 701,27,38,107,49,83
231: fmt ," NET FARM INCOME (with land appreciation)   =",f8.1," LE"
232: wrt 701,r21-r22)r23
233: fmt ," NET FARM INCOME (without land appreciation)=",f8.1," LE"
234: E[5,21-E[5,1])L
235: wrt 701,r23-L
236: wtb 701,13,27,38,100,68;fmt ,58x;wrt 701;wtb 701,27,38,100,64,13,10
237: wtb 701,27,38,107,48,83,13
238: if B=1 or S=1;dsp "make corrections";stp
239: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB6"
240: if B=1 or S=1;rcf A,J[*],K[*]
241: "ANLAB":7(D-1)+7)A
242: if B=2;ldf A,M[*],N[*];gto "TB7"
243: ent "Cow",M[1]
244: ent "Buffalo",M[2]
245: ent "Camel",M[3]
246: ent "Horse",M[4]
247: ent "Donkey",M[5]
248: ent "Plowing",N[1]
249: ent "Leveling",N[2]
250: ent "Buddling",N[3]
251: ent "Irrigation",N[4]
252: ent "Transportation",N[6]
253: "TB7":
254: fmt ,50x,"Work Done by Animals";wrt 701
255: wtb 701,13,27,38,100,68;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
256: fmt ,"                    Kind",52x,"Work Hours",/,/;wrt 701
257: fmt ,z,"       Cow    Buffalo  Camel   Horse  Donkey",16x;wrt 701
258: fmt ,"Plowing  Leveling  Buddling  Irrigation  Total  Transport";wrt 701
259: wtb 701,10
260: N[1]+N[2]+N[3]+N[4])N[5]
261: fmt ,z,5f8.0;wrt 701,M[1],M[2],M[3],M[4],M[5]
262: fmt ,13x,f11.1,f9.1,f9.1,f11.1,f10.1,f8.1
263: wrt 701,N[1],N[2],N[3],N[4],N[5],N[6]
264: wtb 701,13,27,38,100,68;fmt ,115x;wrt 701;wtb 701,27,38,100,64,13,10
265: if B=1 or S=1;dsp "make corrections";stp
266: if S=1;ent "Check Corrections, yes 1",P;if P=1;gto "TB7"
267: if B=1 or S=1;rcf A,M[*],N[*]
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FARM RECORD SUMMARY

Summarized by: C$[1]
Agricultural Year A$[1]-A$[2]
Farmer's #: 1
Farmer's name: B$
Location: ABUDHA MENIA GOVERNORATE

Reviewed by: C$[2]

EWUP Economics Team

Farm size, feddans: C

Owned: E[6,1] Rented: E[7,1] Shared: E[6,2]

INVENTORY CHANGES

ITEM	Beginning LE	End LE	Change LE	Remarks
1 Equipments				
2 Livestock				
3 Poultry				
4 Grain & Forage	E[I,1]	E[I,2]		
5 Land&Real Estate				
Total				

ANIMAL AND CROP PRODUCTION

Animal Products				Crop Products			
Animal Feed LE	Home use LE	Sales LE	Total LE	Animal Feed LE	Home use LE	Sales LE	Total LE
F[I,1]	F[I,2]	F[I,3]		6[I,1]	G[I,2]	G[I,3]	
Sum							

Number of Crops = 0

Crop Expenses

Number of Crops = 0

Crop Expenses

Crop	Field No.	Area Fed.	Labor LE	Equipment LE	Organic Fert.LE	Chemical Fert.LE	Seed LE	Pesticide LE	Other LE	Total LE
GS[I]	HS[I]	H[I,8]	H[I,1]	H[I,2]	H[I,3]	H[I,4]	H[I,5]	H[I,6]	H[I,7]	
Total LE										

Non-Crop Expenses

Kind of Expense	LE
1 Purchased Animal Feed	
2 Land Rent	
3 Taxes	
4 IS[4]	
5 IS[5]	
Total Non-Crop Expense	

Summary of Income		Summary of Expenses	
Animal Products		Crop Expenses	
Crop Products		Non-Crop Expenses	
Capital Sales	J[3]	Capital Purchases	K[3]
Inventory Change if +		Inventory Change if -	
Off-Farm Income	J[5]	Non-Purchased Animal Feed	
Total Gross Income LE		Total Gross Expense	

NET FARM INCOME (with land appreciation) == LE
NET FARM INCOME (without land appreciation) == LE

Work Done by Animals

Kind					Work Hours					
Cow	Buffalo	Camel	Horse	Donkey	Plowing	Leveling	Buddling	Irrigation	Total	Transport
M[1]	M[2]	M[3]	M[4]	M[5]	N[1]	N[2]	N[3]	N[4]		M[6]

ENTERPRISE COST PROGRAM*

The variable cost elements are useful data for management purposes. In planning for short-time production periods of one year or less, the variable costs are the key considerations relative to production volume and methods.

Enterprise records can be helpful to the manager or decision maker in several ways. These records can pinpoint the level of profitability and the factors affecting this profitability during the enterprise accounting period, and if the records are kept over time, the level of performance from year to year can also aid the manager in making wide decisions relative to the future.

Crop production analysis would normally be on the basis of one production cycle or on a calendar year basis. Where is some double-cropping, deviation from this may be feasible. In crop enterprise analysis it must be realized that land is a fixed cost to the operator. It is necessary to include land costs, it may be on the basis of an interest change on the land if it is owned, cash rent if it is rented, or a shave of the crop if under a crop-shave lease. The decisions on crop production may be on an annual basis in some instances and on a length of rotation basis in others. Two concepted problems arise when constructing enter-

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* Sidney, James C. and Everette Stoneberg, "Farm Accounting and Business Analysis". Second Edition, Chapter 8.

* Miller, Thomas H. and Melvin Skold, "Uses and Users of Costs and Returns Data". A needs for analysis is proceeding. Great Plains Committee on Farm Management and Production Economics; GPC-10 Lincoln, Nebraska, 1980.

* Abdel Al, Farouk and Melvin Skold, "Farm Record Summary and Analysis for Study Cases at Abu Raia and Mansouria Sites. EWUP Technical Report, 1980.

prise costs and returns. One is an allocation problem; it is concerned with how general purpose equipment and general farm overhead items are allocated among alternative enterprises. The second is a distribution problem. It is concerned between the various items used in the production process.

Economists differ as to how the allocation and distribution problems are handled.

In developing these enterprise budgets of Egyptian crops, these problems were faced in our discussions of the budgets, we shall attempt to be as explicit as possible in describing how the allocation and distribution issues were met.

CROP ENTERPRISE COST STUDY

Title of Study: G $ (one line, 45 spc.)

Prepared by: H $ (one line, 20 spc.)

Identifier Code: J $ (one line, 14 spc.)

Date Prepared: I $ (one line, 20 spc.)

Item	Unit	Number of Units	Price or value per unit L.E.	Total Income or costs L.E.
Income				
A $ [I]	D $ [I]	A [1,1]	A [1,2]	
Up to 5 lines, 20 spc. each	12 spc.	14 spc.	14 spc.	
Total income				
Variable Costs				
B $ [I]	E $[I]	B [I,1]	B [I,2]	
Up to 50 lines, 30 spc. each	12 spc.	14 spc.	14 spc.	
Total variable cost				
Return above variable costs				
Fixed Costs				
C $ [I]	F $ [I]	C [I,1]	C [I,2]	
Up to 6 lines, 30 spc. each	12 spc.	14 spc.	14 spc.	
Total fixed costs				
G d total costs				
Return above all costs				

Footnotes:

L $ [I]

Up to 12 lines, 90 spc. each

LABOUR DISTRIBUTION

Title of Study: G $ (one line, 45 spc.)
Prepared by: H $ (one line, 20 spc.)
Identifier Code: J $ (one line, 14 spc.)
Date Prepared: I $ (one line, 20 spc.)

	Man hours	Woman hours	Boy/girl hours
October	D [I]	E [I]	F [I]
September	10 spc.	10 spc.	10 spc.
Total			

WATER DISTRIBUTION, CU METERS

	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	G [I]	H [I]	I [I]	J [I]
September	10 spc.	10 spc.	10 spc.	10 spc.
Total water applied = xx CU meters				

[M$] I

Up to 12 lines, 90 spaces each

CROP ENTERPRISE COST STUDY *

TOMATOES AT BANI MAGDOUL AREA(1)

Prepared by: LOTFI NAGR&FAROUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: TP-1
Date Prepared: December 1978

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Tomatoes fruits	KG.	13000.0	0.035	455.00
Total Income				455.00
Variable Costs				
Plow by tracter	Tracter hour	4.0	1.500	6.00
Labor to balance ferrows	Man hour	36.0	0.250	9.00
Nursary plants	Thousand	12.0	1.500	18.00
Labor for transplanting	Man hour	18.0	0.250	4.50
Chemical fertilizer		0.0	0.000	0.00
Super phosphate (0:15.5:0)	KG.	500.0	0.027	13.50
Ammonium nitrate(33-0-0)	KG.	400.0	0.050	20.00
Labor to spread chem. fert.	Girl hour	90.0	0.100	9.00
Hoeing,weeding (5 times)	Man hour	132.0	0.250	33.00
Irrigation: (2)		0.0	0.000	0.00
Cow or buffle rent	C.or B.hour	72.0	0.330	23.76
Sakia rent	Sakia hour	72.0	0.050	3.60
Boy to observe the sakia	Boy hour	72.0	0.050	3.60
Labor to spread water	Man hour	72.0	0.250	18.00
Insecticides:		0.0	0.000	0.00
Fiaxon & Malathion	Liter	10.0	1.450	14.50
Sprayer rent	Sprayer hour	60.0	0.050	3.00
Labor to spray	Man hour	60.0	0.250	15.00
Fungicide	Can	3.0	5.000	15.00
Labor to spread fungicide	Man hour	36.0	0.250	9.00
Harvesting (3)		0.0	0.000	0.00
Labor for harvesting	Man hour	192.0	0.250	48.00
Total Variable Costs				266.46
Return Above Variable Costs				188.54
Fixed Costs				
Land rent*	Month	8.0	15.000	120.00
Mangement charge	Month	8.0	2.000	16.00
Total Fixed Costs				136.00
Grand Total Costs				402.46
Return Above All Costs				52.54

FOOTNOTES:

* This study for an area of one feddan.
(1) Tomato is grown in almost equal areas during the thrie cropping season but the yields are higher in the summer
(2) Tomato need from 7 to 8 irrigations one before planting for 8 hours the others for 6 hours irrigation each 12 day intervals

1st irrigations before planting	8 hours
2nd irrigation after 3 days	4 hours
then one irrigation each 12 day	60 hours
Total time for irrigation	72 hours

(3) one labor (man, woman, boy, or girl)' can harvest 2 loads (140 KG.)

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	72	0	12	240	240	0	0
November	90	0	18	240	240	0	0
December	66	0	12	240	240	0	0
January	42	0	6	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
June	60	0	12	0	0	0	0
July	60	0	36	320	160	0	0
August	66	0	36	240	240	0	0
September	90	0	30	240	240	0	0
Total	546	0	162	Total Water Applied=		2080 cu meters	

FOOTNOTES:

-Water requirements based on Engineering office paper dated 7.15.1978
-1 Manday = 6 hours

USERS INSTRUCTIONS

Enterprise Cost Program

*Set the calculator ON and the printer.

1. Insert tape #1

2. Track # 0 or 1 and load file #

   a. Type trk 0; ldf 1

   b. Press EXECUTE

3. Press RUN

4. When "file number for desired study" appears

   a. Type an odd # of an empty file to store data

   b. Press CONTINUE

5. When "new study = 1, old study = 2" appears

   either

   a. Type 1 for new study

   b. Press CONTINUE

   or

   a. Type 2 for old study

   b. Press CONTINUE, go to Step #27

6. When "title of study" appears

   a. Type the name of the study (max. 18 spaces)

   b. Press CONTINUE

7. When "prepared by" appears

   a. Type the name of who prepared the data (max. 28 spaces)

   b. Press CONTINUE

8. When "identifier code" appears

   a. Type the identifier code (max. 14 spaces)

   b. Press CONTINUE

9. When "date (spelled out)" appears

   a. Type the date of running the program in the way of DDMMYY (Max. 20 spaces)

   b. Press CONTINUE

10. When "income component" appears

    either

    a. Type the income component not exceeding 20 spaces and up to 5 lines

    b. Press CONTINUE

    or

    Press CONTINUE if no. income component, go to Step # 15

11. When "unit appears

    a. Type the unit

    b. Press CONTINUE

12. When "number of units" appears

    a. Type the # of units

    b. Press CONTINUE

13. When "price or value per unit, L.E." appears

    a. Type the value of one unit

    b. Press CONTINUE

14. Go to Step #10

15. When "variable cost component" appears

    either

    a. Type the variable cost component up to 30 lines each of 30 spaces

    b. Press CONTINUE

    Or Press CONTINUE if no more entering data, go to Step # 20

16. When "unit" appears

    a. Type the name of the variable unit up to 12 spaces

    b. Press CONTINUE

17. When "number of units" appears

    a. Type the number of units

    b. Press CONTINUE

18. When "price or value per unit, L.E." appears

    a. Type the price of 1 unit

    b. Press CONTINUE

19. Go to Step #15

20. When "fixed cost component" appears

    either

    a. Type the name of the fixed cost component up to 6 lines each 30 spaces

    b. Press CONTINUE

    Or Press CONTINUE if no more entering data, go to Step #25

21. When "unit" appears

    a. Type the name of the unit up to 12 spaces

    b. Press CONTINUE

22. When "number of units" appears

    a. Type the number of units

    b. Press CONTINUE

23. When "price or value per unit, L.E." appears

    a. Type the price of 1 unit

    b. Press CONTINUE

24. Go to 20

25. When "footnote line" appears

either

a. Type your footnote up to 12 lines each 20 spaces

b. Press CONTINUE: Go to 25

or

Press CONTINUE if no more footnotes, go to 26

26. Title of data will appear in display.

a. If correct press CONTINUE

b. If incorrect press STOP and run again

27. When "corrections needed, yes = 1, no = 2" appears

either

a. Type 1 for corrections

b. Press CONTINUE

or

a. Type 2 for no corrections

b. Press CONTINUE, go to 29

28. When "make corrections" appears

a. Make the needed corrections, refer to correction sheet and replace string variable that needs to be corrected. Example, to change units on fixed cost; "month" F$(I), I is the number of the line

b. Press EXECUTE, go to 27

or

c. If no more corrections press CONTINUE

***The data and results are printed, and other corrections can be made.

29. When "corrections needed, 1 = yes, 2 = no" appears

either

a. Type 1 for making corrections

b. Press CONTINUE

or

a. Type 2 for no corrections

b. Press CONTINUE, go to Step #30

30. When "make corrections" appears

a. Make the correction

b. Press EXECUTE, go to Step #29

Or press CONTINUE

31. For running old data go to Step #41

32. When "labor, man hours for month I", I varies from 1 to 12 appears

a. Type the labor man hours for this month

b. Press CONTINUE

33. When "labor, woman hours for month I", I varies from 1 to 12 appears

a. Type the labor woman hours for this month

b. Press CONTINUE

34. When "labor, boy/girl hours month I" appears

a. Type the labor boy/girl hours for this month

b. Press CONTINUE

35. When "water applied 1st irrigation mo I" appears

a. Type the amount of irrigation water in cubic meters

b. Press CONTINUE

36. When "water applied 2nd irrigation mo I" appears

a. Type the amount of irrigation water in cubic meters

b. Press CONTINUE

37. When "water applied 3rd irrigation mo I" appears

    a. Type the amount of 3rd irrigation water in cubic meters

    b. Press CONTINUE

38. When "water applied 4th irrigation mo I" appears

    a. Type the amount of 4th irrigation water on cubic meters

    b. Press CONTINUE

39. If I less than 12 go to Step #30

40. When "footnote line" appears

    either

    a. Type the footnote line up to 12 lines, 90 spaces each

    b. Press CONTINUE

    or

    a. Press CONTINUE

    b. Go to Step #41

41. When "correction?, yes = 1, no = 2" appears

    either

    a. Type 1 for corrections

    b. Press CONTINUE

    or

    a. Type 2 for no corrections

    b. Press CONTINUE

    c. Go to Step #45

42. When "make corrections" appears

    a. Make the corrections

    b. Press EXECUTE to make other corrections and go to Step #42

    or

    a. Press CONTINUE for no more corrections

43. A list is printed

When "corrections, 1 = yes, 2 = no" appears

either

a. Type 1 for corrections

b. Press CONTINUE

or

a. Type 2 for no corrections

b. Press CONTINUE

c. Go to Step #45

44. When "make corrections" appears

a. Make the corrections

b. Press EXECUTE to make another correction

c. Go to Step #45

or

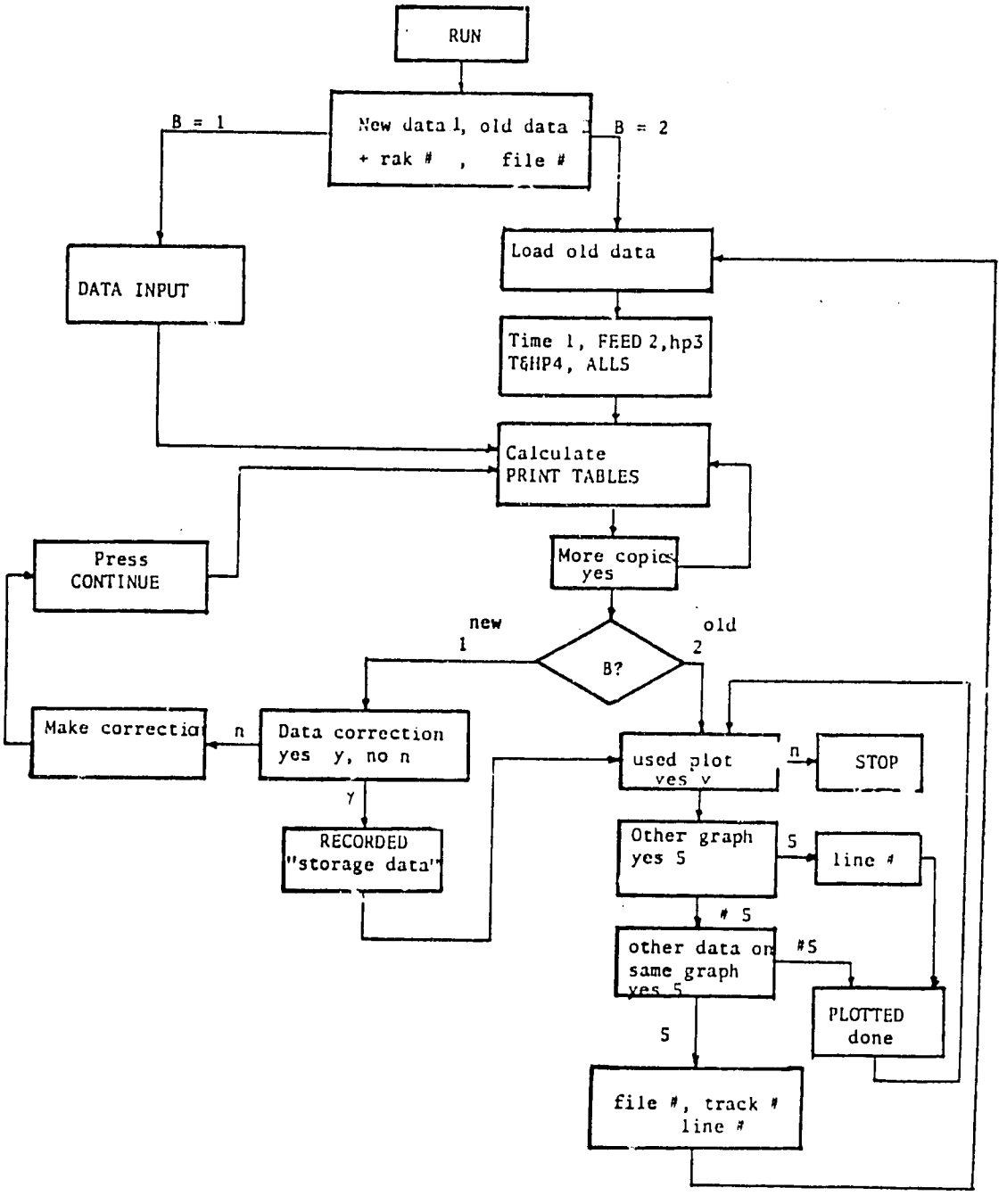
a. Press CONTINUE for no more corrections

b. Go to Step #45

45. When "program completed" appears

Both data and results are printed and stored in the tape

FLOW CHART


RUN
New data 1, old data 2
+ rak # , file #
B = 1
B = 2
DATA INPUT
Load old data
Time 1, FEED 2,hp3
T&HP4, ALLS
Calculate
PRINT TABLES
Press
CONTINUE
More copies
yes
new
1
old
2
B?
Make correction
n
Data correction
yes y, no n
y
RECORDED
"storage data"
used plot
yes y
n
STOP
Other graph
yes 5
5
line #
5
other data on
same graph
yes 5
#5
PLOTTED
done
5
file #, track #
line #

```
0: dim A$[5,20],B$[50,30],C$[6,30],D$[5,12],E$[50,12],F$[6,12],A[5,2]
1: dim B[50,2],C[6,2],G$[80],H$[25],I$[20],J$[14],L$[12,90]
2: dim D[12],E[12],F[12],G[12],H[12],I[12],J[12],M$[4,90]
3: dim K$[12,9]
4: dsp "CROP ENTERPRISE COST STUDY";wait 4000
5: ent "file number for desired study",K
6: ent "new study=1,old study=2",A;if A=2;gto "LOAD"
7: ent "title of study",G$;ent "prepared by",H$
8: ent "identifier code",J$;ent "date (spelled out)",I$
9: 1)I
10: "INCOME":
11: if I>5;gto "VARIABLE"
12: dsp "income component,",I;ent "",A$[I]
13: if A$[I]="";gto "VARIABLE"
14: dsp "unit",I;ent "",D$[I];dsp "number of units",I;ent "",A[I,1]
15: dsp "price or value per unit,L.E.",I;ent "",A[I,2]
16: I+1)I;gto "INCOME"
17: "VARIABLE":1)I;0)r2
18: "var2":
19: if I>50;gto "FIXED"
20: dsp "variable cost component",I;ent "",B$[I]
21: if B$[I]="";gto "FIXED"
22: dsp "unit",I;ent "",E$[I];dsp "number of units",I;ent "",B[I,1]
23: dsp "price or value per unit,L.E",I;ent "",B[I,2]
24: I+1)I;gto "var2"
25: "FIXED":1)I
26: "fix2":
27: dsp "fixed cost component ",I;ent "",C$[I]
28: if C$[I]="";gto "FINOTE"
29: dsp "unit",I;ent "",F$[I];dsp "number of units",I;ent "",C[I,1]
30: dsp "price or value per unit,L.E.",I;ent "",C[I,2]
31: if I=6;gto +3
32: I+1)I;gto "fix2"
33: 1)I
34: "FINOTE":for I=1 to 12
35: dsp "footnote line ",I;ent "",L$[I]
36: if L$[I]="";gto "LIST"
37: next I;if I<=12;jmp -2
38: gto "LIST"
39: "LOAD":
40: ldf B,A$,B$,C$,D$,E$,F$,A[*],B[*],C[*],G$,H$,I$,J$,L$
41: ldf B+1,D[*],E[*],F[*],G[*],H[*],I[*],J[*],M$
42: dsp G$;stp
43: "LIST":ent "CORRECTIONS NEEDED ?,yes=1,no=2",Q
44: if Q=1;dsp "MAKE CORRECTIONS";stp
45: "LIST":
46: wtb 701,10,10,10,10
47: wtb 701,27,38,107,42,83,"                    CROP ENTERPRISE COST STUDY *",13,10
48: wtb 701,13,10,"      ",G$
49: wtb 701,27,38,107,48,83
50: wtb 701,13,10,10
51: wtb 701,"      Prepared by:       ",H$,"                    EGYPT WATER USE A "
52: wtb 701,"MANAGEMENT PROJECT",13,10
53: wtb 701,"      Identifier Code:   ",J$,13,10
54: wtb 701,"      Date Prepared:     ",I$,13,10
55: fmt ,/;wrt 701
56: wtb 701,"                          Item"
57: wtb 701,"                           Unit"
58: wtb 701,"              Number of    Price or Value    Total income",13,10
59: fmt ,z,5x;wrt 701
60: wtb 701,"Unit                per unit L.E.     or Costs L.E.",13,10
61: fmt ,z,5x;wrt 701
62: wtb 701,27,38,100,68;fmt ,94x;wrt 701;wtb 701,27,38,100,64
63: fmt ,z,17,5x;wrt 701
64: wtb 701,27,38,100,68,"Income",13,10
65: wtb 701,27,38,100,64
```

```
66: wtb 701,"      ",27,49
67: wtb 701,"                                        ",27,49,13,10
68: 1)I;0)r1
69: "L1":if I>5;I-1)I;gto "L2"
70: if A$[I]="";gto "L2"
71: wtb 701,9,A$[I],9,D$[I],13
72: fmt ,50x,f14.1,2x,f15.3,f15.2;wrt 701,A[I,1],A[I,2],A[I,1]*A[I,2])D
73: D+r1)r1
74: I+1)I;gto "L1"
75: "L2":fmt ,/,5x,"Total Income",68x,f11.2;wrt 701,r1
76: fmt ,z,5x;wrt 701
77: wtb 701,27,38,100,68;fmt ,94x;wrt 701;wtb 701,27,38,100,64
78: fmt z,1/,5x;wrt 701
79: wtb 701,27,38,100,68;fmt ,"Variable Costs",/;wrt 701;1)I;0)r2
80: wtb 701,27,38,100,64
81: "L3":if I>50;I-1)I;gto "L4"
82: if B$[I]="";gto "L4"
83: wtb 701,9,B$[I],9,E$[I],13
84: fmt 1,50x,f14.1,2x,f15.3,f15.2;wrt 701.1,B[I,1],B[I,2],B[I,1]*B[I,2])E
85: r2+E)r2;I+1)I;gto "L3"
86: "L4":fmt ,/,5x,"Total Variable Costs",60x,f11.2;wrt 701,r2
87: fmt ,5x,"Return Above Variable Costs",53x,f11.2;wrt 701,r1-r2)r3
88: fmt ,z,5x;wrt 701
89: wtb 701,27,38,100,68;fmt ,94x;wrt 701;wtb 701,27,38,100,64
90: fmt ,z,1/,5x;wrt 701
91: wtb 701,27,38,100,68;fmt ,"Fixed Costs",/;wrt 701;1)I;0)r4
92: wtb 701,27,38,100,64
93: "L5":if I>6;I-1)I;gto "L6"
94: if C$[I]="";gto "L6"
95: wtb 701,9,C$[I],9,F$[I],13
96: fmt ,50x,f14.1,2x,f15.3,f15.2;wrt 701,C[I,1],C[I,2],C[I,1]*C[I,2])F
97: F+r4)r4;I+1)I;gto "L5"
98: "L6":fmt ,1/,5x,"Total Fixed Costs",63x,f11.2;wrt 701,r4
99: fmt ,5x,"Grand Total Costs",63x,f11.2;wrt 701,r2+r4)r5
100: fmt ,z,5x;wrt 701
101: wtb 701,27,38,100,68;fmt ,94x;wrt 701;wtb 701,27,38,100,64
102: fmt ,/,5x,"Return Above All Costs",46x,f23.2;wrt 701,r1-r5)r6
103: fmt ,z,5x;wrt 701
104: wtb 701,27,38,100,68;fmt ,94x;wrt 701;wtb 701,27,38,100,64
105: wtb 701,"  ",13,10
106: wtb 701,"      FOOTNOTES:",13,10
107: wtb 701,"  ",13,10
108: wtb 701,"        * This study for an area of one feddan.",13,10
109: 1)I
110: wtb 701,"      ",L$[I],13,10
111: if L$[I]="";jmp 3
112: I+1)I;if I>12,jmp 2
113: jmp -3
114: fmt ,z,/,5x;wrt 701;wtb 701,27,38,100,68;fmt ,94x;wrt 701
115: wtb 701,27,38,100,64
116: ent "corrections needed? 1=yes 2=no",C
117: if C=1;dsp "make corrections";stp ;gto "LIST"
118: rcf B,A$,B$,C$,D$,E$,F$,A[*],B[*],C[*],G$,H$,I$,J$,L$
119: if A=2;gto "PRINT"
120: for I=1 to 12
121: dsp "labor,man hours for month",I;ent "",D[I]
122: dsp "labor, woman hours for month",I;ent "",E[I]
123: dsp "labor, hourly hours month",I;ent "",F[I]
124: dsp "water applied 1st irrig mo",I;ent "",G[I]
125: dsp "water applied 2nd irrig mo",I;ent "",H[I]
126: dsp "water applied,3rd irrig mo",I;ent "",I[I]
127: dsp "water applied, 4th irrig mo",I;ent "",J[I]
128: next I
129: for I=1 to 4
130: dsp "footnote line",I;ent "",M$[I]
131: if M$[I]="";gto "PRINT"
```

```
132: next I
133: ent "CORRECTIONS WANTED ? YES=1,NO=2",Q
134: if Q=1;dsp "MAKE CORRECTIONS";stp
135: "PRINT":
136: fmt ,1/,24x,"LABOR DISTRIBUTION",13x,"WATER DISTRIBUTION, CU METERS"
137: wrt 701
138: fmt ,z,/,18x,"Man",7x,"Woman",5x,"Boy/Girl",6x,"First",5x,"Second"
139: wrt 701;fmt ,4x,"Third",5x,"Fourth";wrt 701
140: fmt ,z,18x,"Hours",5x,"Hours",5x,"Hours",9x,"Irrig.",4x,"Irrig.";wrt 701
141: fmt ,4x,"Irrig.",4x,"Irrig.";wrt 701
142: fmt ,z,4x;wrt 701
143: wtb 701,27,38,100,68;fmt ,84x;wrt 701;wtb 701,27,38,100,64
144: "October   "]K$[1];"November  "]K$[2];"December  "]K$[3]
145: "January   "]K$[4];"February  "]K$[5];"March     "]K$[6]
146: "April     "]K$[7];"May       "]K$[8];"June      "]K$[9]
147: "July      "]K$[10];"August    "]K$[11];"September"]K$[12]
148: 0]r10]r11]r12]r13]r14]r15]r16
149: for I=1 to 12
150: wtb 701,"     ",K$[I]
151: fmt ,3f10.0,4x,4f10.0;wrt 701,D[I],E[I],F[I],G[I],H[I],I[I],J[I]
152: r10+D[I]]r10;r11+E[I]]r11;r12+F[I]]r12
153: r13+G[I]]r13;r14+H[I]]r14;r15+I[I]]r15;r16+J[I]]r16
154: next I
155: fmt ,z,4x;wrt 701
156: wtb 701,27,38,100,68;fmt ,84x;wrt 701;wtb 701,27,38,100,64
157: wtb 701,10,"     Total     "
158: fmt ,z,3f10.0,7x;wrt 701,r10,r11,r12
159: fmt ,"Total Water Applied=",f7.0," cu meters"
160: wrt 701,r16+r15+r14+r13]r17
161: fmt ,z,4x;wrt 701
162: wtb 701,27,38,100,68;fmt ,84x;wrt 701;wtb 701,27,38,100,64
163: wtb 701," ",13,10
164: wtb 701,"     FOOTNOTES:",13,10
165: wtb 701," ",13,10
166: for I=1 to 4;wtb 701,"     ",M$[I],13,10;next I
167: ent "corrections? 1=yes 2=no",C
168: if C=1;dsp "make corrections";stp ;gto "PRINT"
169: rcf B+1,D[*],E[*],F[*],G[*],H[*],I[*],J[*],M$;rew
170: dsp "PROGRAM COMPLETED";stp
171: end
*7585
```

INVENTORY PROGRAM

This program lists supplies and equipment received in Cairo from the USA and shows their distribution to the areas, laboratories, or stores of the CWUP.

STORE PROGRAM

1. Set the calculator on, the printer and the disc drive.
2. Install the disc inside the disc drive and close the door.
3. A. Type get "STORE"
   B. Press EXECUTE
   C. Press RUN
4. When "NEW DATA 1 OLD DATA 2 OLD D. 3" appear either
   A. Type 1 for new data or 2 for more than 1 old box data or 3 for 1 old box data
   B. Press CONTINUE
5. For old data 2 go to Step #12
6. When "BOX #" appear
   A. Type box #
   B. Press CONTINUE
   C. For old data 3 to to Step #14
7. When "contents" appears
   A. Type the description of this element
   B. Press CONTINUE
8. When "QUANT" appears
   A. Type the quantity of this element
   B. Press CONTINUE

9. When "MAIN OFF" appears

   either

   A. Type the quantity in main office

   B. Press CONTINUE

   or

   A. Press CONTINUE for no element there

10. When "KAFR EL SH", "EL MINYA", "EL MANSOURIA", "WATER LAB", "STORE" or "SOIL LAB" appear

    either

    A. Type the quantity in this area

    B. Press CONTINUE

    or

    A. Press CONTINUE for no item in this area

11. When "At end 2" appears

    either

    A. Press CONTINUE to enter another item

    B. Go to Step #7

    or

    A. Type 2 for no more items, go to Step #14

12. When "from box #" appears

    A. Type the 1st box #

    B. Press CONTINUE

13. When "to box#" appears

    A. Type the last box #

    B. Press CONTINUE

14. A list of the box contents is printed

15. For new data 1

    When "correct data yes" appears

either

A. Type 1 for no corrections

B. Press CONTINUE

C. Stop

or

A. Type 0 for corrections

B. Press CONTINUE

16. When "Make" appears

A. Type the corrections

B. Press EXECUTE

C. For more corrections go to Step #16

D. For no more corrections press CONTINUE

E. Go to Step #14

EWUP STORED EQ.

BOX#	CONTENTS	QUANT.	MAIN O.	MACR S.	LIBRAIS.	ELMENTA	W.LAB.	P.STORE	S.LAB.
AS	BS[K]	CS[K]	DS[K]	ES[K]	FS[K]	GS[K]	HS[K]	IS[K]	JS[K]

EWUP STORED EQ.

BOX#	CONTENTS	QUANT.	MAIN O.	KAFR S.	ELMANS.	ELMENIA	W.LAB.	P.STORE	S.LAB
162	Arlex transparencies	11						11*	
	Transparency film	12	12						
	Ultrafine flair pens	72	72						
	Graph Paper	5	5						
	Correction Ribbon/6 ribbons	6	6						
	Insertion tool	5						5	
	Vacuum Dial Gauges	2						2	
	Airmail Envelopes	8						8*	

```
1: dim F$[40,4],G$[40,4],H$[40,4],I$[40,4],J$[40,4],S,Q$[5]
2: ent "NEW DATA 1 OLD DATA 2 OLD D. 3",A;if A=2;gto "LOAD"
3: ent "BOX#",A$;if A=3;A$)Q$;gto "LOAD1"
4: 0)K
5: 1+K)K)5
6: dsp "Contents",K;ent "",B$[K]
7: dsp "QUANT",K;ent "",C$[K]
8: dsp "MAIN OFF",K;ent "",D$[K]
9: dsp "KAFE ILSH",K;ent "",E$[K]
10: dsp "ELMENIA",K;ent "",G$[K]
11: dsp "ELMANSORIA",K;ent "",F$[K]
12: dsp "WATER LAB.",K;ent "",H$[K]
13: dsp "STORE",K;ent "",I$[K]
14: dsp "SOIL LAB.",K;ent "",J$[K]
15: ent "At end 2",B;if B#2;gto 5
16: gto "PRINT"
17: "LOAD":
18: ent "from Box#",Q$;val(Q$))I)N
19: ent "To Box#",R
20: "LOAD1":
21: assgn Q$,1,X
22: srend 1,A$,B$,C$,D$,E$,F$,G$,H$,I$,J$,S
23: "PRINT":
24: if A=3,gto 36
25: if A=2;if I(R;if I)N;gto 37
26: wtb 701,10,10,10,10
27: wtb 701,27,38,107,49,83,"          EWUP STORED EQ.",13,10
28: wtb 701,27,38,107,40,83
29: wtb 701,13,10,10
30: wtb 701,10,10,10,10
31: wtb 701,27,38,100,68
32: wtb 701,"     BOX#                CONTENTS                QUANT.    "
33: wtb 701,"MAIN O.   KAFE S.   ELMANS.   ELMENIA   W.LAB.  P.STORE  S.LAB."
34: wtb 701,27,38,100,65
35: wtb 701,13,10
36: fmt ,/,/;wrt 701
37: 0)K
38: 1+K)K
39: fmt 5,5x,c4,2x,c30,3x,c4,6x,c4,5x,c4,7x,c4,6x,c4,5x,c4,5x,c4,3x,c4
40: if K=1;wrt 701.5,A$,B$[K],C$[K],D$[K],E$[K],F$[K],G$[K],H$[K],I$[K],J$[K]
41: if K=1;jmp 3
42: fmt 7,11x,c30,3x,c4,6x,c4,5x,c4,7x,c4,6x,c4,5x,c4,5x,c4,3x,c4
43: wrt 701.7,B$[K],C$[K],D$[K],E$[K],F$[K],G$[K],H$[K],I$[K],J$[K]
44: if K<5,gto 38
45: if I(R;str(val(Q$)+1))Q$;val(Q$))I;gto "LOAD1"
46: if A=2;stp
47: if A=1;ent "correct data yes",M;if M#1;dsp "Make";stp
48: if A=1;if M#1;gto "PRINT"
49: if A=1;open A$,11
50: assgn A$,1,0,X
51: sprt 1,A$,B$,C$,D$,E$,F$,G$,H$,I$,J$,S
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