Flow-Charts for the KPROG2 Program for Human Carrying Capacity Estimation on Brazil's Transamazon Highway

Fluxogramas para o Programa KPROG2 para Estimativa de Capacidade de Suporte Humano na Rodovia Transamazônica

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2003

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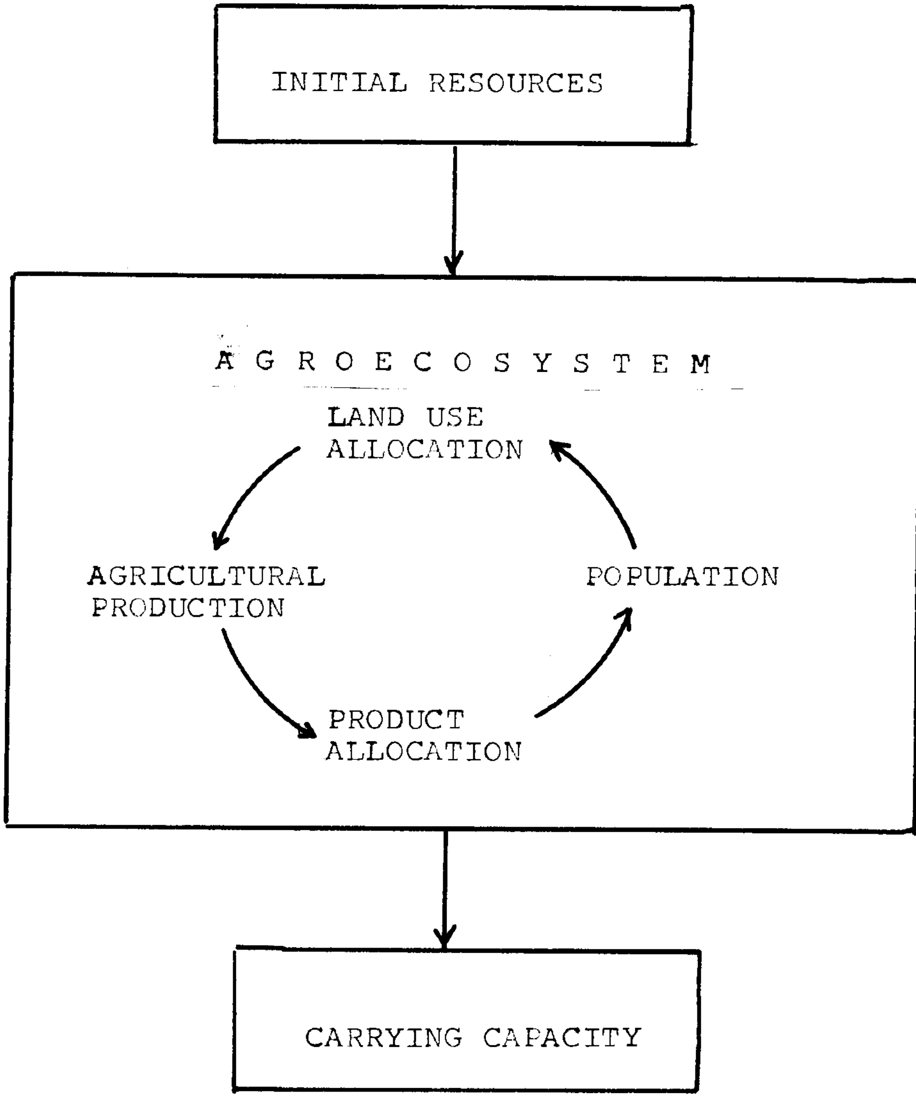
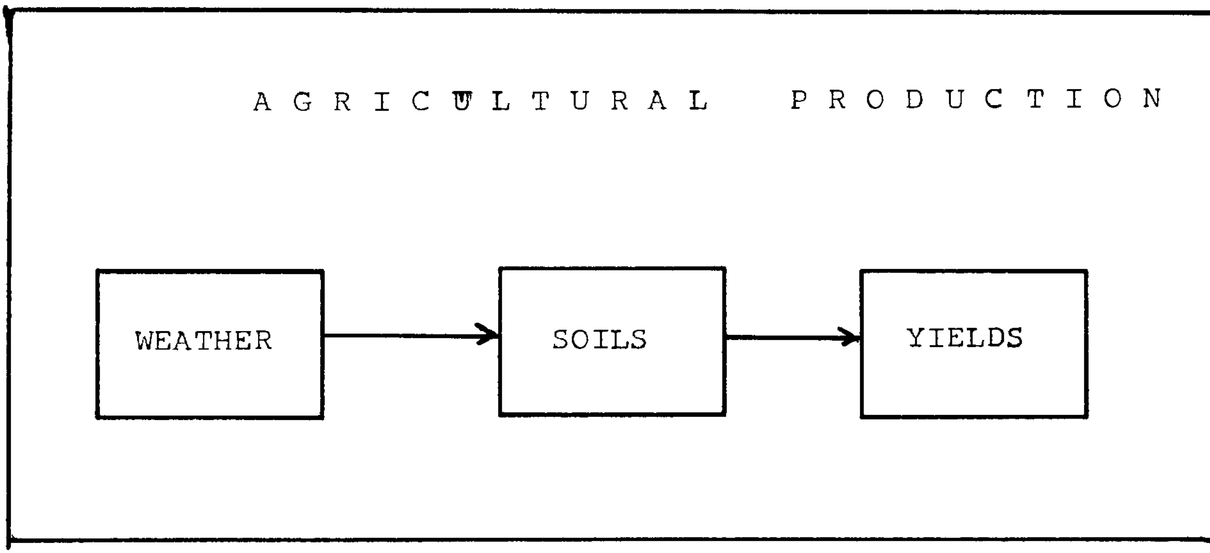
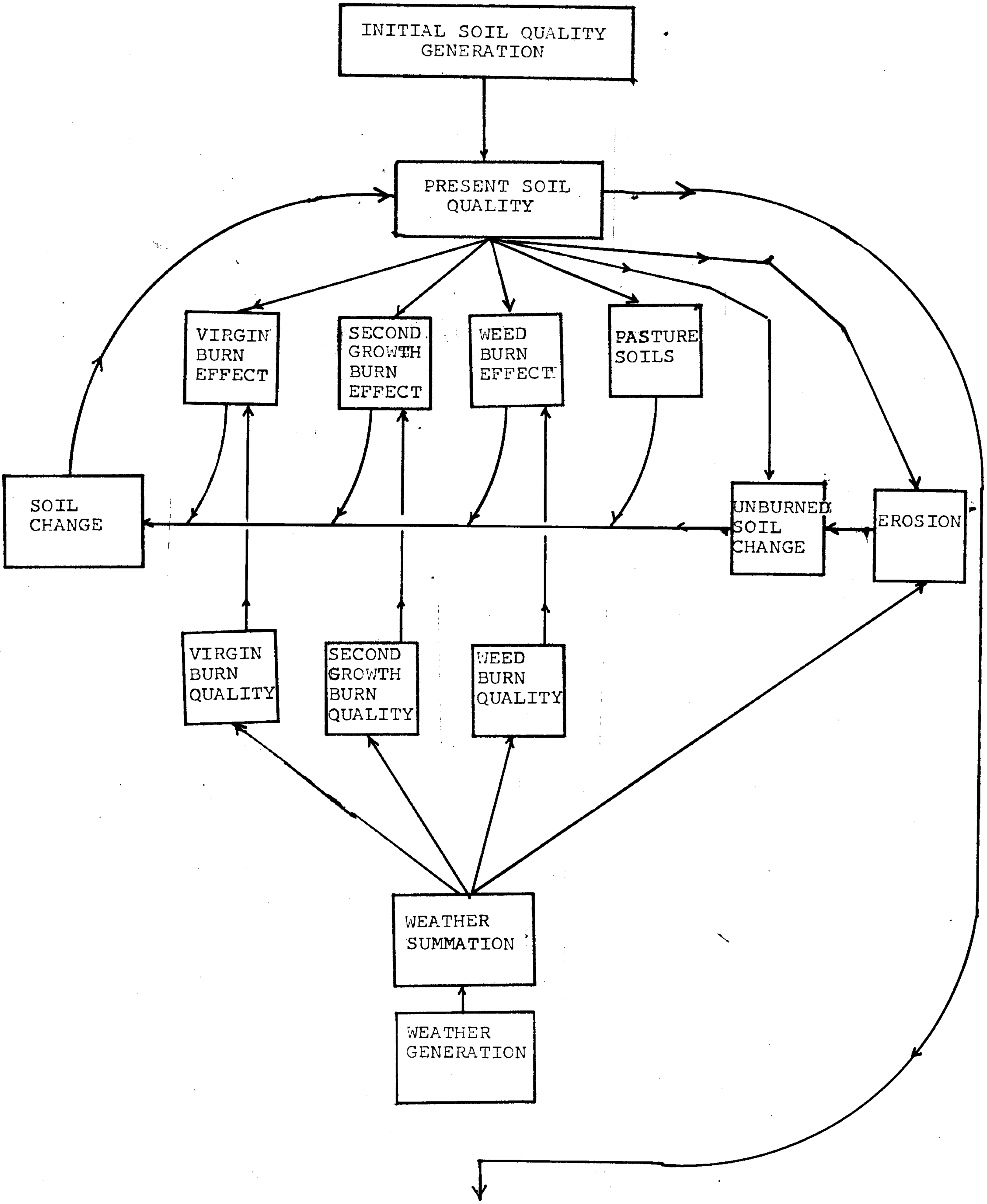
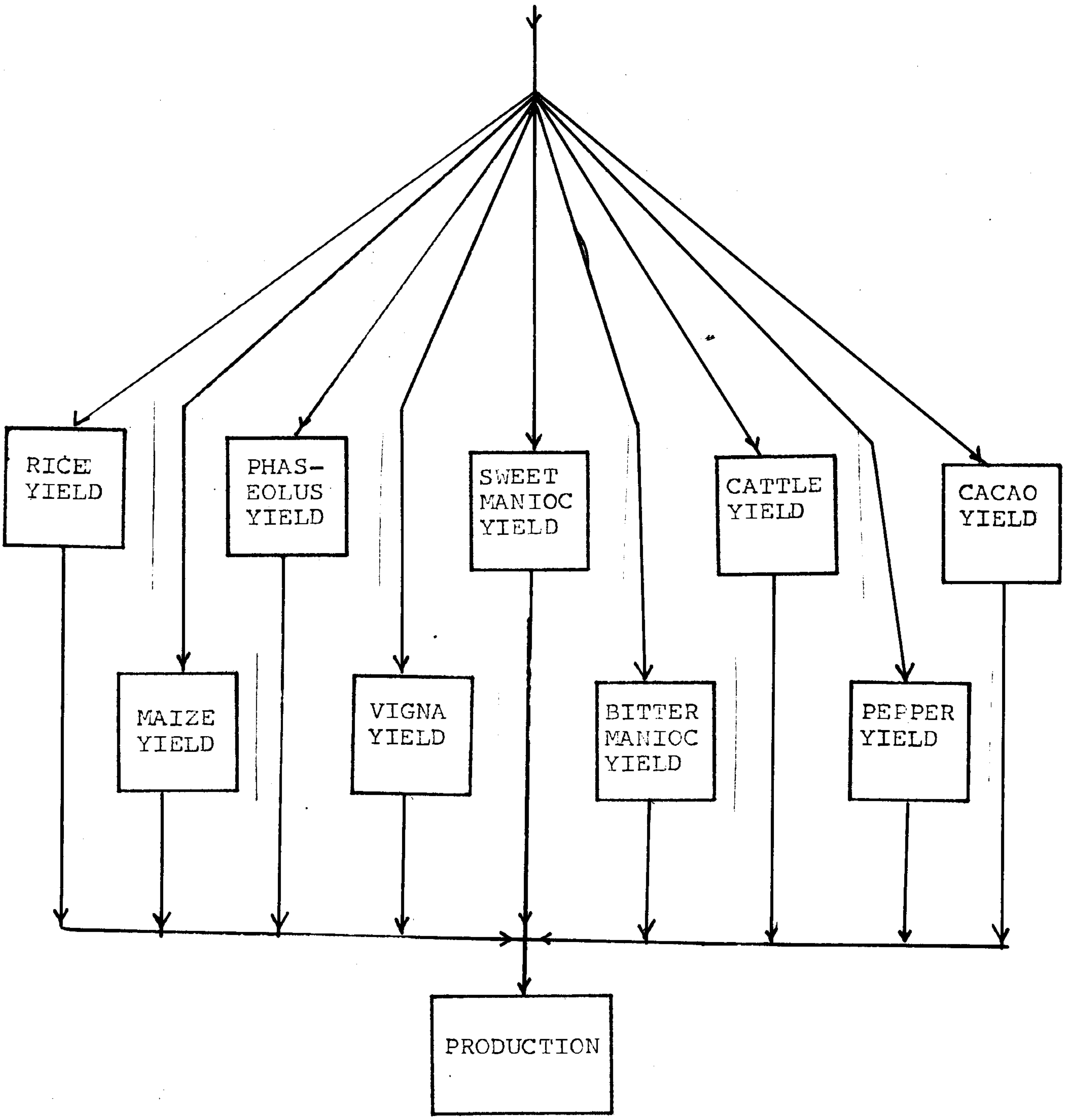

INITIAL RESOURCES
A G R O E C O S Y S T E M
LAND USE ALLOCATION
AGRICULTURAL PRODUCTION
POPULATION
PRODUCT ALLOCATION
CARRYING CAPACITY

ULTURAL PRODUCTION SECTOR SUMMARY



SUMMARY OF AGRICULTURAL PRODUCTION SECTOR




RICE YIELD
MAIZE YIELD
PHASEOLUS YIELD
VIGNA YIELD
SWEET MANIOC YIELD
BITTER MANIOC YIELD
CATTLE YIELD
PEPPER YIELD
CACAO YIELD
PRODUCTION

UNBURNED SOIL CHANGE

START

↓

pH Unburned Change ← 1.90 − 0.356 * pH of Before Field − 6.45 * 10^{-4} * Days Tree Crops + 4.98 * 10^{-4} * Days Fallow − 3.80 * 10^{-2} * Predicted Erosion (mm)

SE = 0.683

↓

ALUMINUM UNBURNED CHANGE (ME/100g) ← 0.189 − 0.189 * Aluminum of before field (ME/100g) − 1.06 * pH Change

SE = 1.21

↓

PHOSPHORUS UNBURNED CHANGE (ppm) ← 3.91 − 0.628 * Phosphorus of before field (ppm) − 0.145 * PREDICTED EROSION (mm) + 2.73 * pH Change

SE = 3.73

↓

$$\text{NITROGEN UNBURNED CHANGE (\% dry wt.)} \leftarrow 9.16 * 10^{-2} * \text{Carbon of before field (\% dry wt.)} - 0.771 * \text{Nitrogen of before field (\% dry wt.)}$$

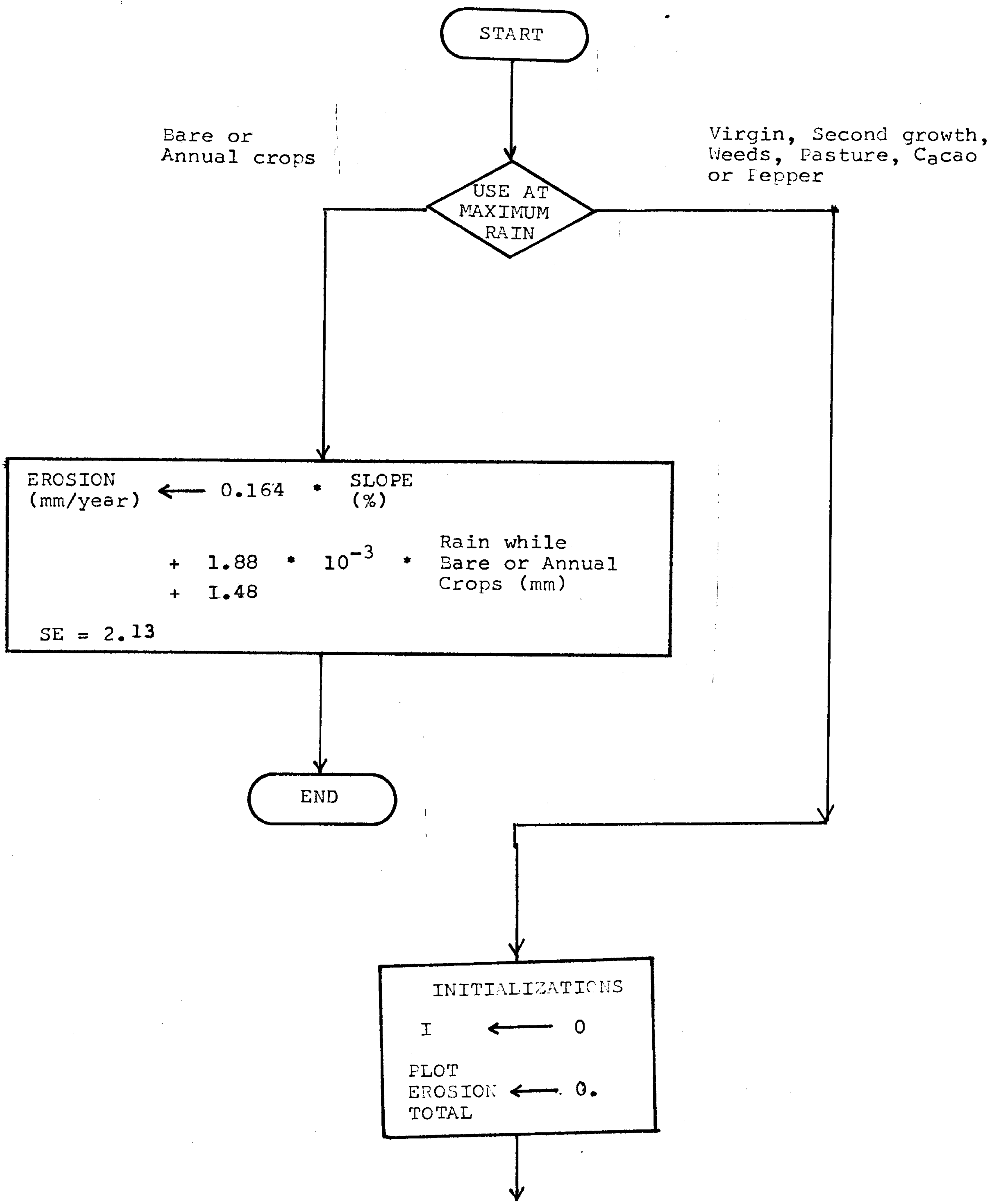
$$- 3.68 * 10^{-5} * \text{Days Annual Crops} + 1.30 * 10^{-2} * \text{pH of before field}$$

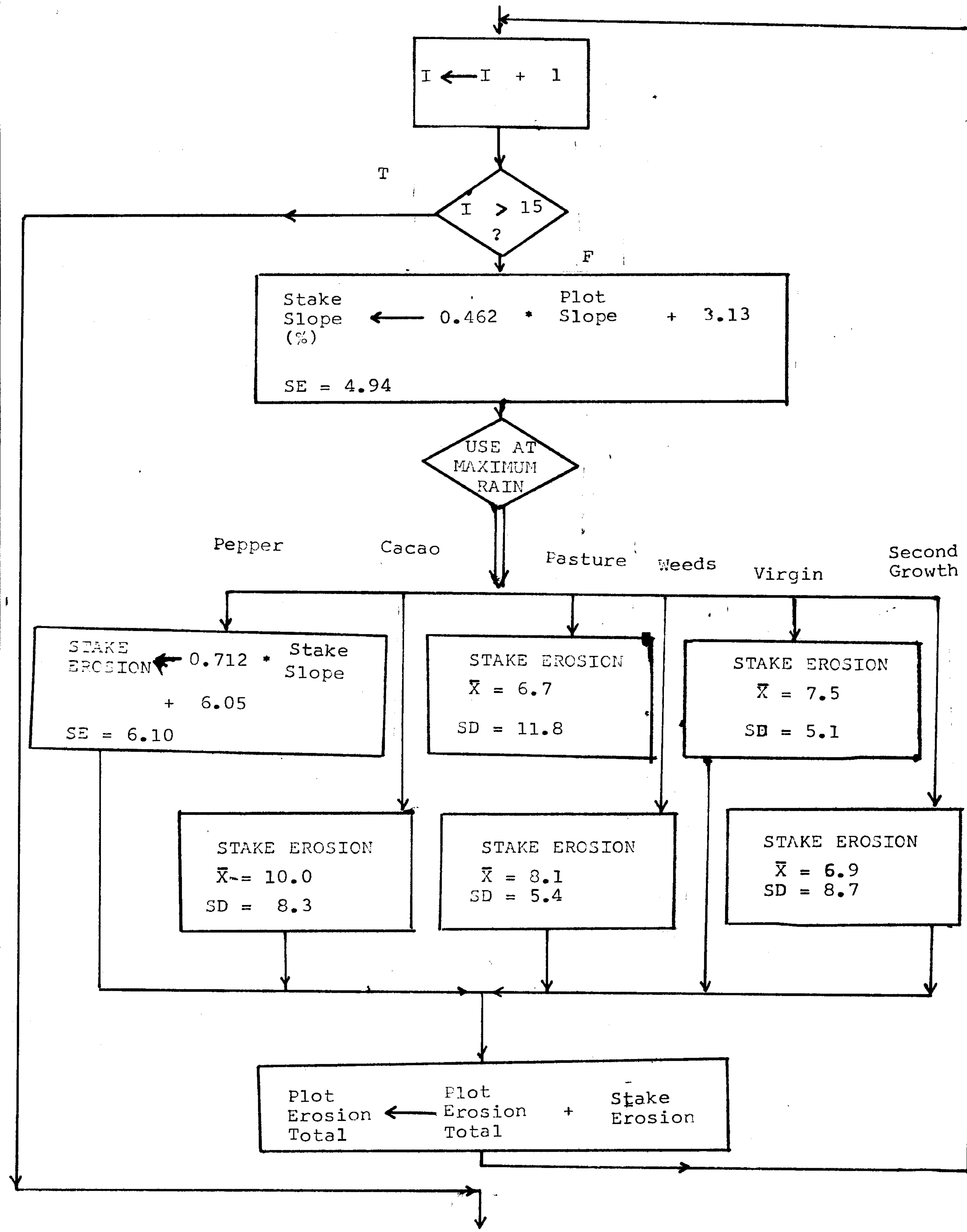
$$+ 4.18 * 10^{-5} * \text{Days Fallow} - 7.04 * 10^{-2}$$

$SE = 3.61 * 10^{-2}$

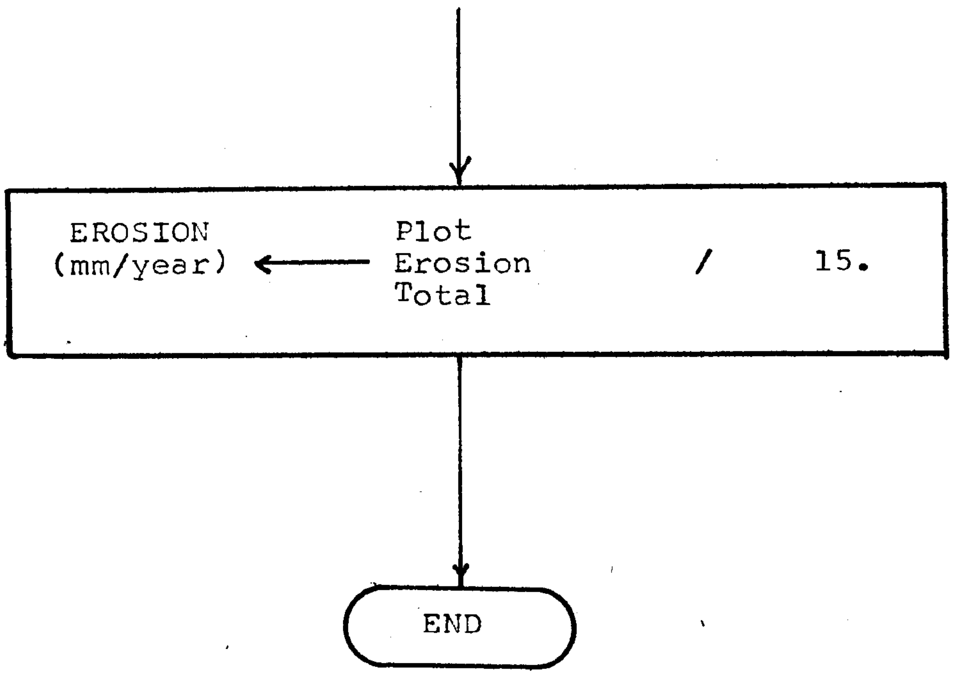
END

EROSION


START
Bare or
Annual crops
Virgin, Second growth,
Weeds, Pasture, Cacao
or Pepper
USE AT
MAXIMUM
RAIN
EROSION
(mm/year)
0.164
*
SLOPE
(%)
+ 1.88 * 10-3 *
Rain while
Bare or Annual
Crops (mm)
+ 1.48
SE = 2.13
END
INITIALIZATIONS
I
0
PLOT
EROSION
TOTAL
0.



I ← I + 1
T
I > 15 ?
F
Stake Slope (%) ← 0.462 * Plot Slope + 3.13
SE = 4.94
USE AT MAXIMUM RAIN
Pepper
Cacao
Pasture
Weeds
Virgin
Second Growth
STAKE EROSION ← 0.712 * Stake Slope + 6.05
SE = 6.10
STAKE EROSION
X̄ = 6.7
SD = 11.8
STAKE EROSION
X̄ = 7.5
SD = 5.1
STAKE EROSION
X̄ = 10.0
SD = 8.3
STAKE EROSION
X̄ = 8.1
SD = 5.4
STAKE EROSION
X̄ = 6.9
SD = 8.7
Plot Erosion Total ← Plot Erosion Total + Stake Erosion


EROSION
(mm/year)
Plot
Erosion
Total
/
15.
END

Philip M. Fearnside
Aug. 12, 1977

SUMMARY OF EROSION REGRESSIONS:

1.) ORIGINAL DATA SET: 47 plots of 15 stakes each * 2 measurements

2.) CULLING THE DATA SET:

a) INVALID DATA:

- any of the following disturbances or special circumstances:
  - stake stepped on (by man or animals)
  - stake burned affecting mark
  - soil level changed by hoeing
  - soil by stake pushed up by root growth
  - stake level moved by man
  - soil disturbed by pigs or chickens
  - soil level disturbed by measurement crew
  - stake in gully
  - stake in deposition in wake of root
  - stake burried due to manioc harvesting
  - pigs in erosion plot

- measurements from second observation not used due to suspected inconsistencies in the notation of whether or not some stakes were rezeroed by measurement crew at time of first measurement.

- incomplete data

b) EXCLUDED CATEGORIES OF VALID DATA: none

3.) EROSION REGRESSIONS

a) PLOTS EITHER BARE OR IN ANNUAL CROPS AT TIME OF MAXIMUM RAINFALL IN 24 HOURS:

$$\text{Erosion (mm/year)} = 0.164 * \text{Slope (\%)} + 1.88 * 10^{-3} * \text{Rain while bare or Annual crops (mm)} + 1.48$$

$p = 0.0000$

$r = 0.89$

$r^2 = 0.79$

SE = 2.13

N = 17 plot means

Plot mean erosion data rather than individual stake measurements were used since plot-level characters (plot slope and rain while bare or in annual crops) were used as independent variables.

b) WEEDS AT TIME OF MAXIMUM RAINFALL IN 24 HOURS:

(note: "weeds" defined as less than or equal to 8 months fallow)

(Note: The means of stake erosion for weeds, second growth, virgin and pasture are not significantly different, but the variances are significantly different: $p=0.0000$ $F=25$ $df=3,144710$)

Stake erosion $\bar{X} = 8.1$ mm/yr
SD = 5.4
N = 56 stakes

c) SECOND GROWTH AT TIME OF MAXIMUM RAINFALL IN 24 HOURS:

(note: "second growth" defined as over 8 months fallow)

Stake Erosion $\bar{X} = 6.9$ mm/yr
SD = 8.7
N = 68 stakes

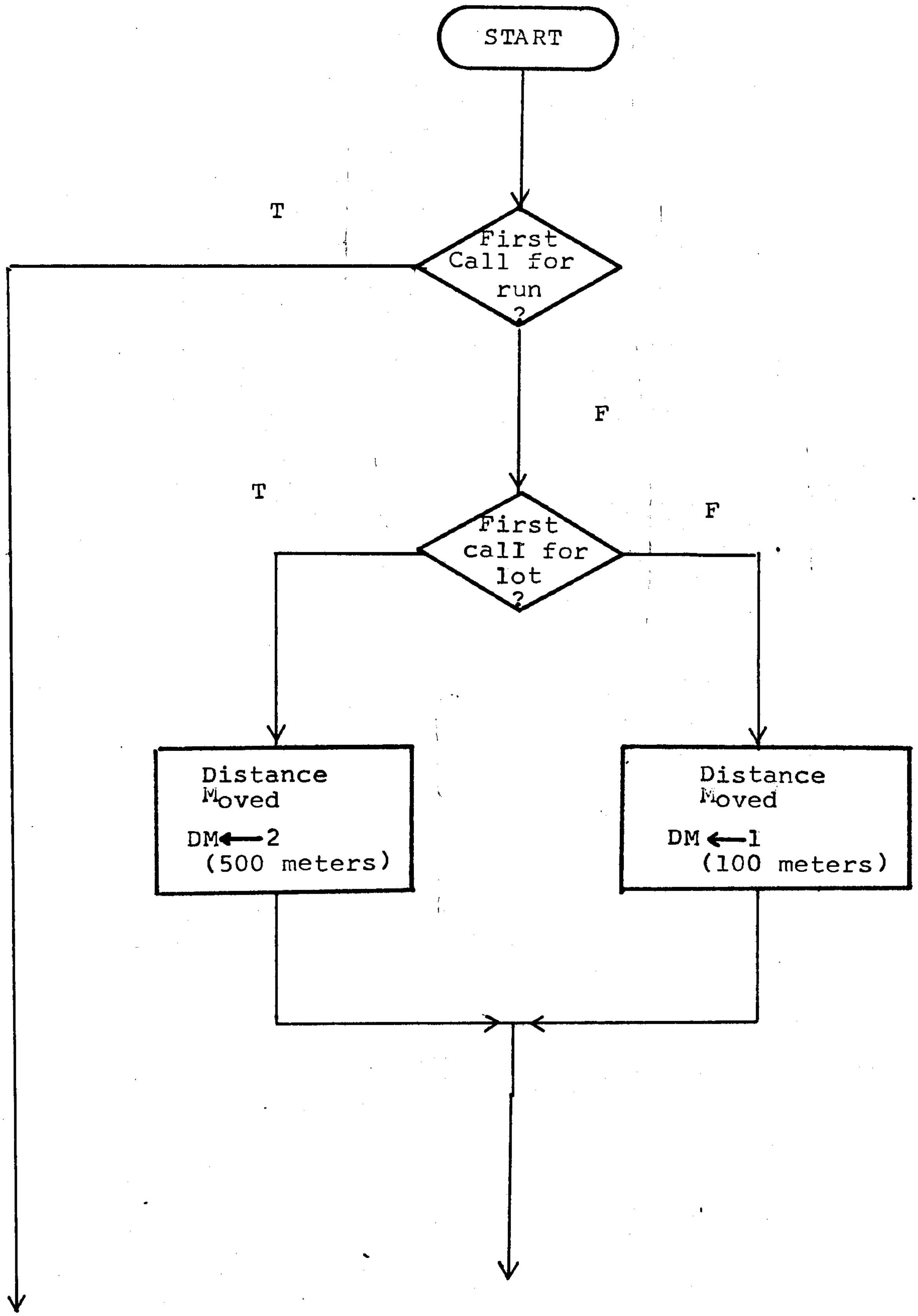
d) PASTURE AT TIME OF MAXIMUM RAINFALL IN 24 HOURS:

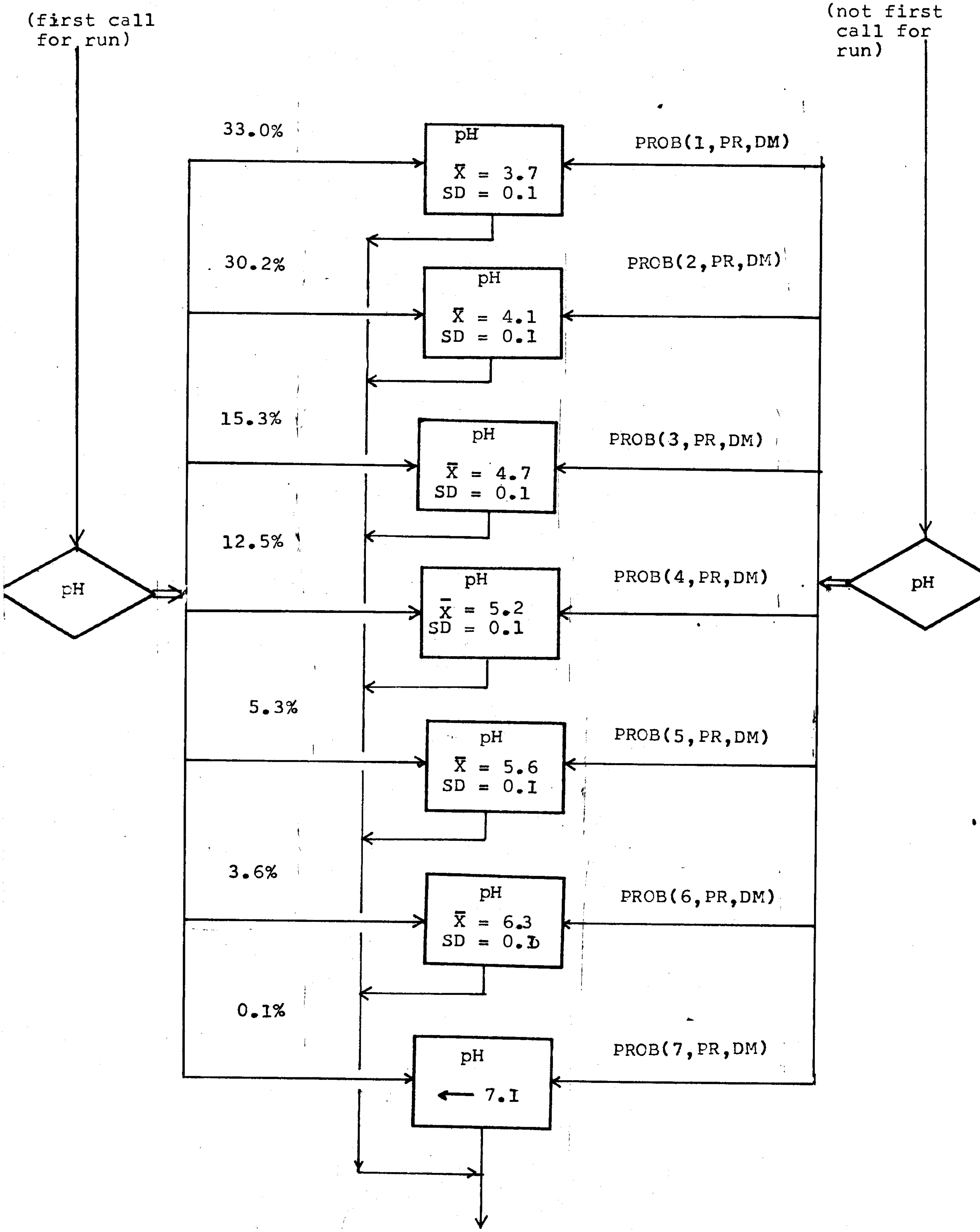
Stake erosion $\bar{X} = 6.7$ mm/yr
SD =11.8
N = 105 stakes

e) VIRGIN FOREST AT TIME OF MAXIMUM RAINFALL IN 24 HOURS:

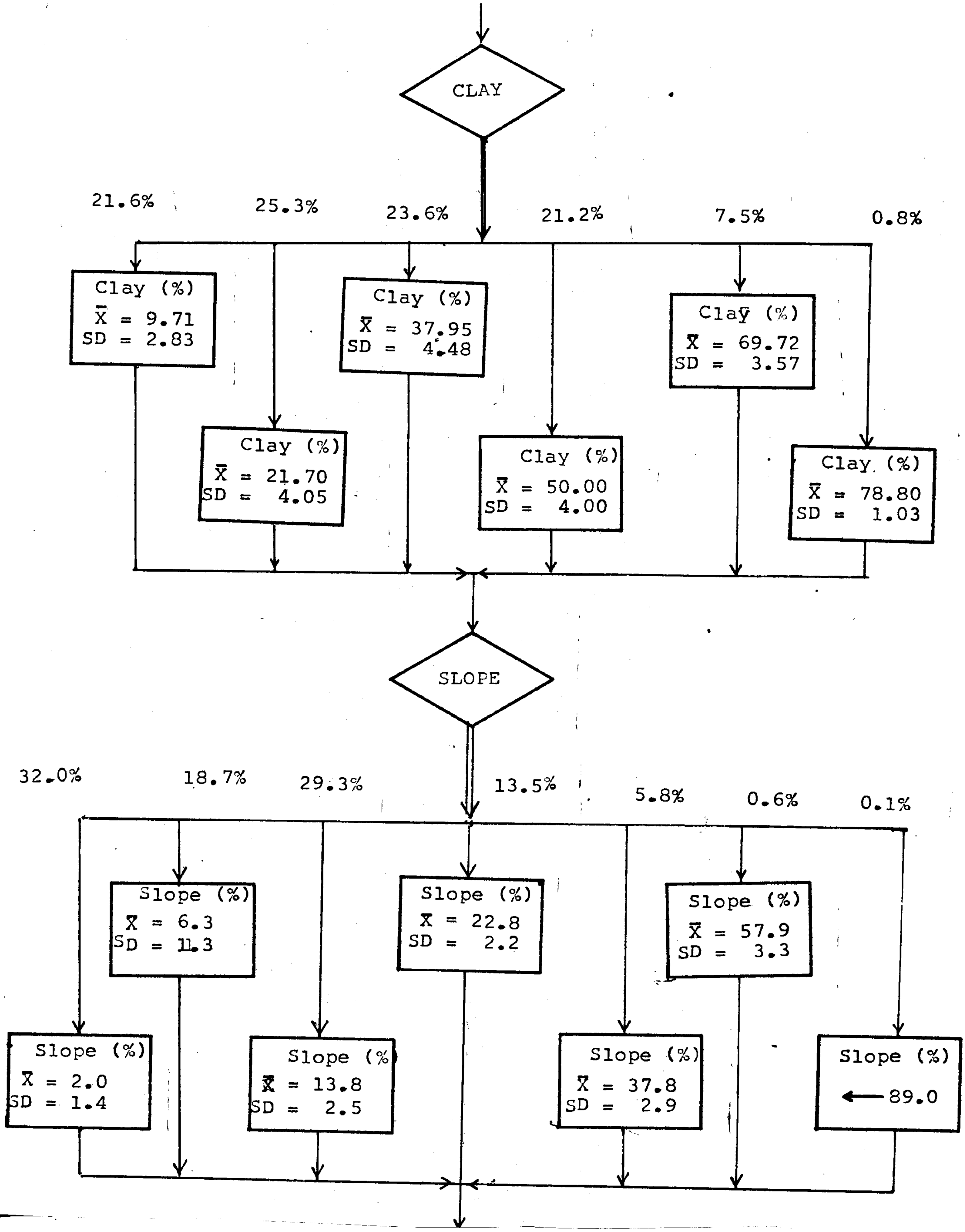
Stake erosion $\bar{X} = 7.5$ mm/yr
SD = 5.1
N = 75 Stakes

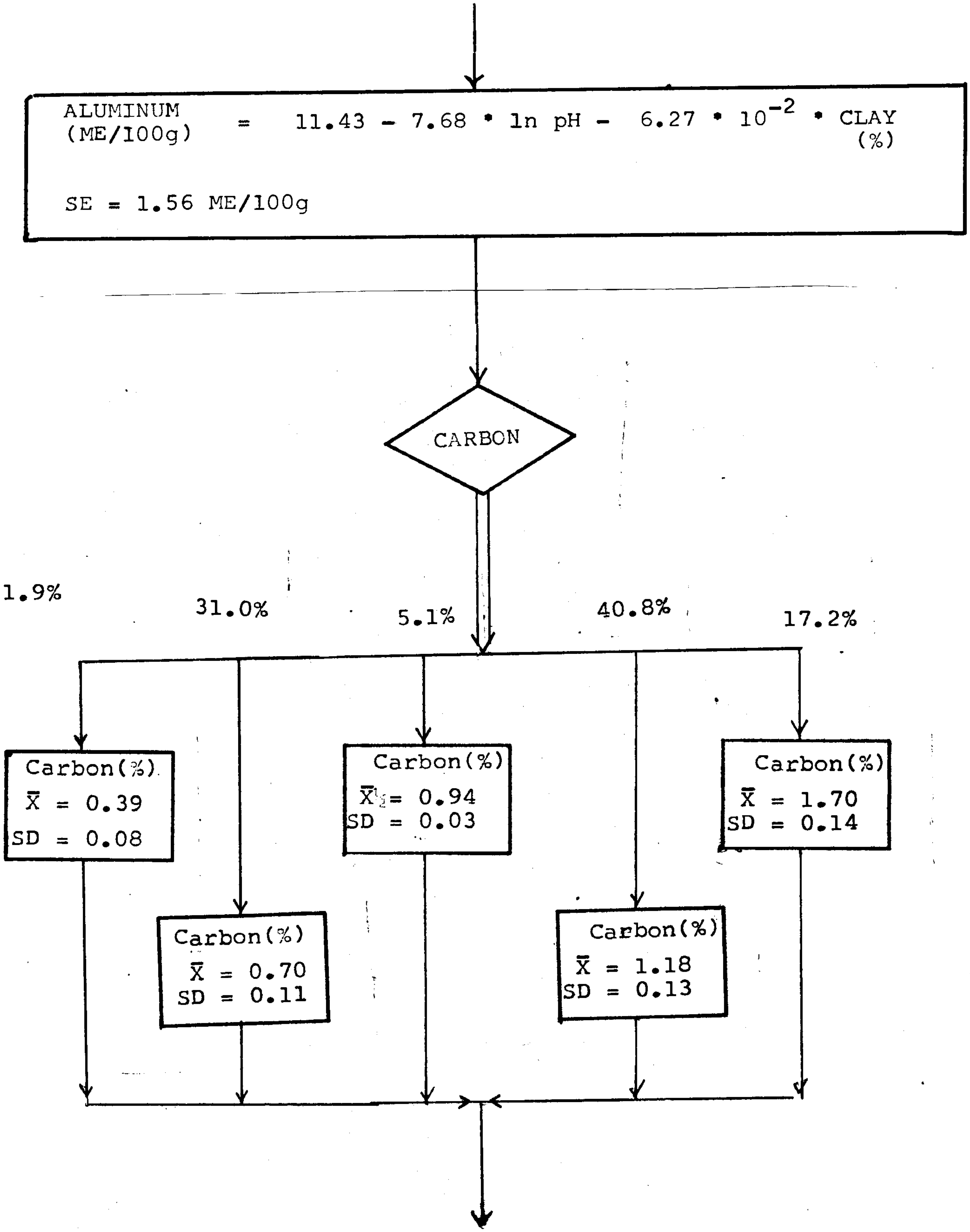
INITIAL SOIL QUALITY

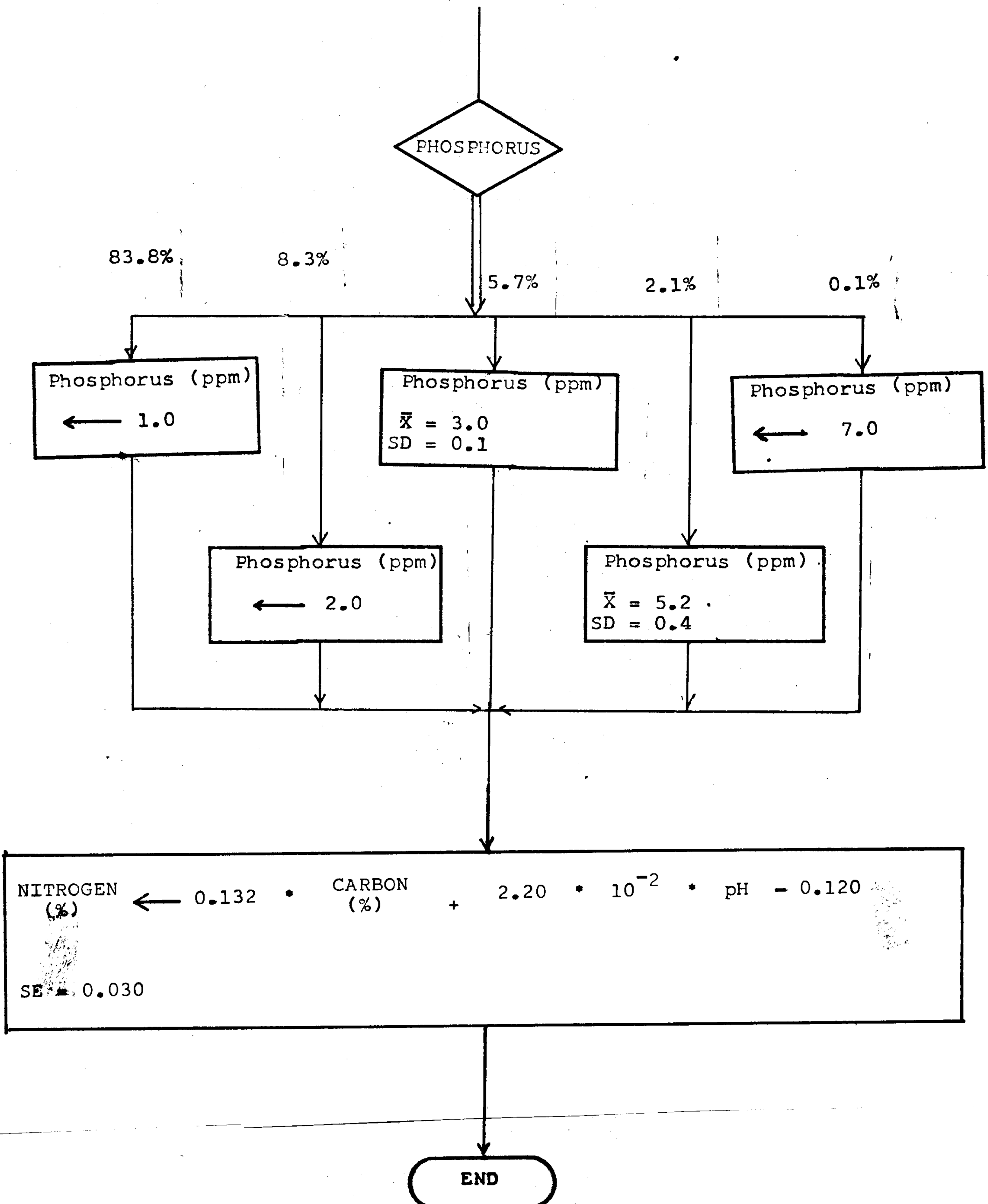




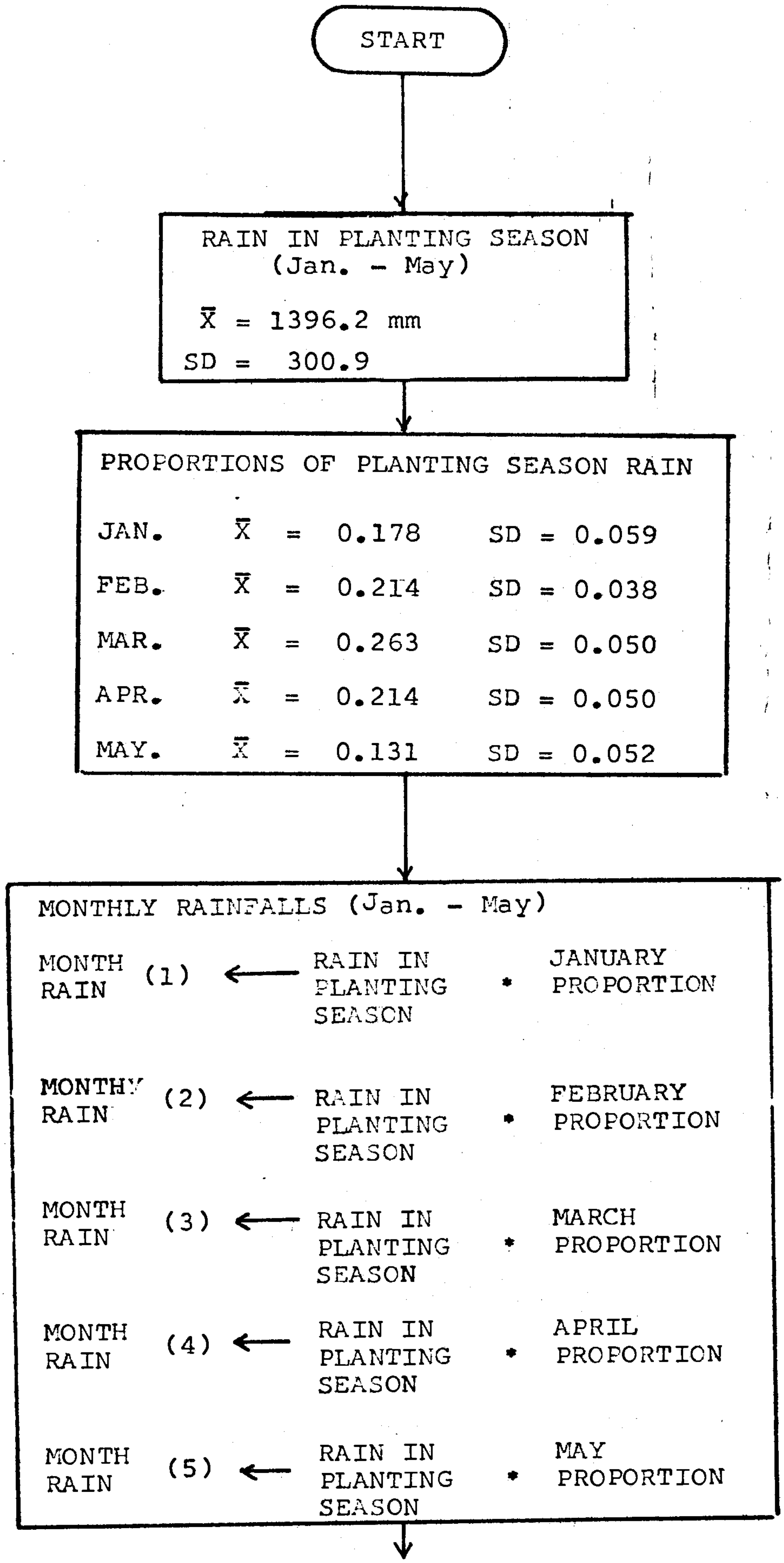
(first call for run)
(not first call for run)
33.0%
pH X̄ = 3.7 SD = 0.1
PROB(1,PR,DM)
30.2%
pH X̄ = 4.1 SD = 0.1
PROB(2,PR,DM)
15.3%
pH X̄ = 4.7 SD = 0.1
PROB(3,PR,DM)
12.5%
pH X̄ = 5.2 SD = 0.1
PROB(4,PR,DM)
pH
pH
5.3%
pH X̄ = 5.6 SD = 0.1
PROB(5,PR,DM)
3.6%
pH X̄ = 6.3 SD = 0.1
PROB(6,PR,DM)
0.1%
pH ← 7.1
PROB(7,PR,DM)


CLAY
21.6%
25.3%
23.6%
21.2%
7.5%
0.8%
Clay (%) X̄ = 9.71 SD = 2.83
Clay (%) X̄ = 21.70 SD = 4.05
Clay (%) X̄ = 37.95 SD = 4.48
Clay (%) X̄ = 50.00 SD = 4.00
Clay (%) X̄ = 69.72 SD = 3.57
Clay (%) X̄ = 78.80 SD = 1.03
SLOPE
32.0%
18.7%
29.3%
13.5%
5.8%
0.6%
0.1%
Slope (%) X̄ = 2.0 SD = 1.4
Slope (%) X̄ = 6.3 SD = 11.3
Slope (%) X̄ = 13.8 SD = 2.5
Slope (%) X̄ = 22.8 SD = 2.2
Slope (%) X̄ = 37.8 SD = 2.9
Slope (%) X̄ = 57.9 SD = 3.3
Slope (%) ← 89.0


ALUMINUM (ME/100g) = 11.43 - 7.68 • ln pH - 6.27 • 10^-2 • CLAY (%)
SE = 1.56 ME/100g
CARBON
1.9%
31.0%
5.1%
40.8%
17.2%
Carbon(%) X̄ = 0.39 SD = 0.08
Carbon(%) X̄ = 0.70 SD = 0.11
Carbon(%) X̄ = 0.94 SD = 0.03
Carbon(%) X̄ = 1.18 SD = 0.13
Carbon(%) X̄ = 1.70 SD = 0.14


PHOSPHORUS
83.8%
8.3%
5.7%
2.1%
0.1%
Phosphorus (ppm)
← 1.0
Phosphorus (ppm)
X̄ = 3.0
SD = 0.1
Phosphorus (ppm)
← 7.0
Phosphorus (ppm)
← 2.0
Phosphorus (ppm)
X̄ = 5.2
SD = 0.4
NITROGEN (%) ← 0.132 * CARBON (%) + 2.20 * 10⁻² * pH − 0.120
SE = 0.030
END

WEATHER GENERATION



MONTHLY RAINFALLS (Jun. – Aug.)

MONTH RAIN (6) $\bar{X}$ = 77.5 mm SD = 48.2

MONTH RAIN (7) $\bar{X}$ = 58.8 mm SD = 50.7

MONTH RAIN (8) $\bar{X}$ = 28.1 mm SD = 22.4

RAIN IN BURNING SEASON (Sept. – Dec.)

$\bar{X}$ = 281.7 mm

SD = 148.1 mm

PROPORTIONS OF BURNING SEASON RAIN

SEPT.	$\bar{X}$ = 0.186	SD = 0.109
OCT.	$\bar{X}$ = 0.199	SD = 0.107
NOV.	$\bar{X}$ = 0.185	SD = 0.138
DEC.	$\bar{X}$ = 0.429	SD = 0.103

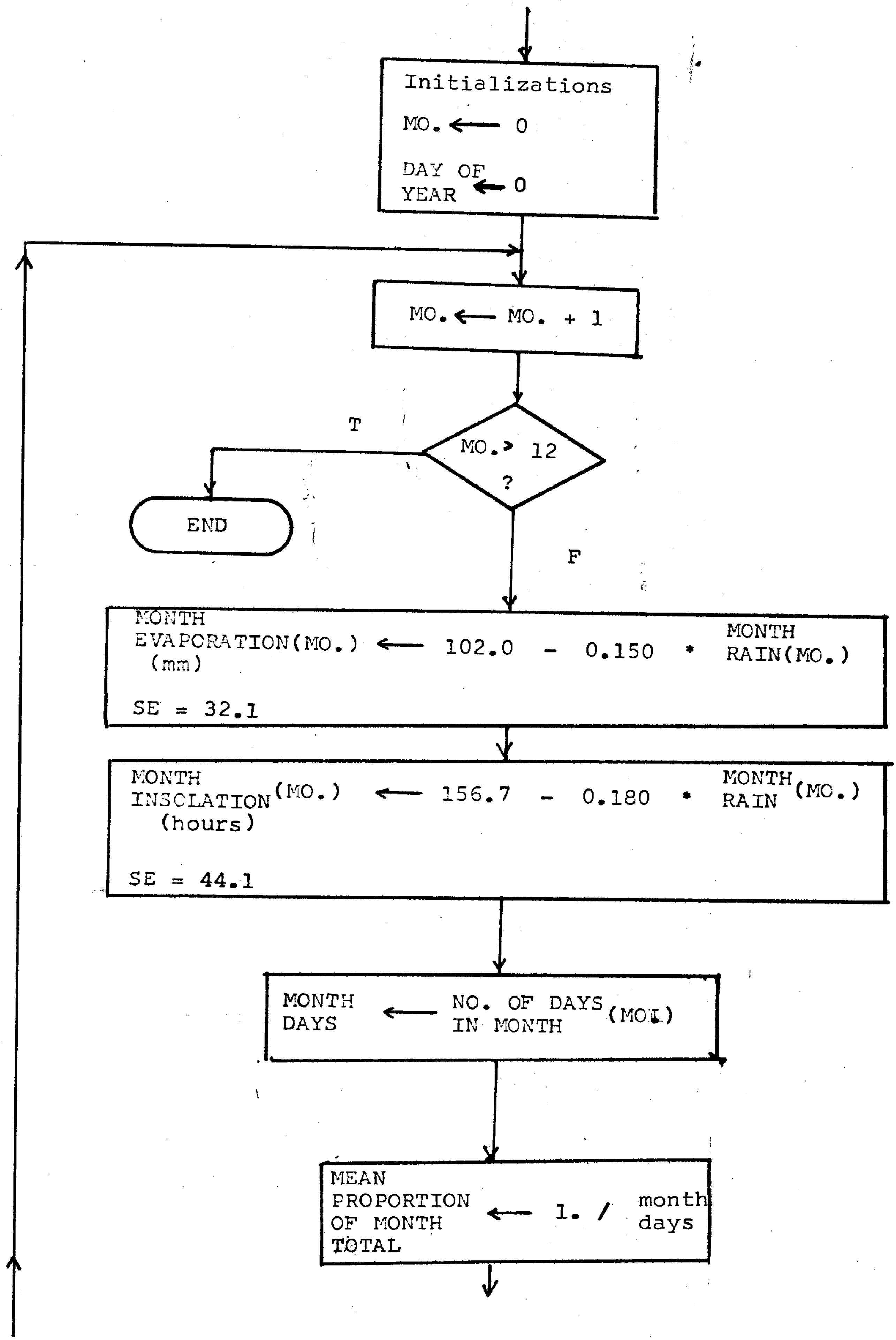
MONTHLY RAINFALLS (Sept. – Dec.)

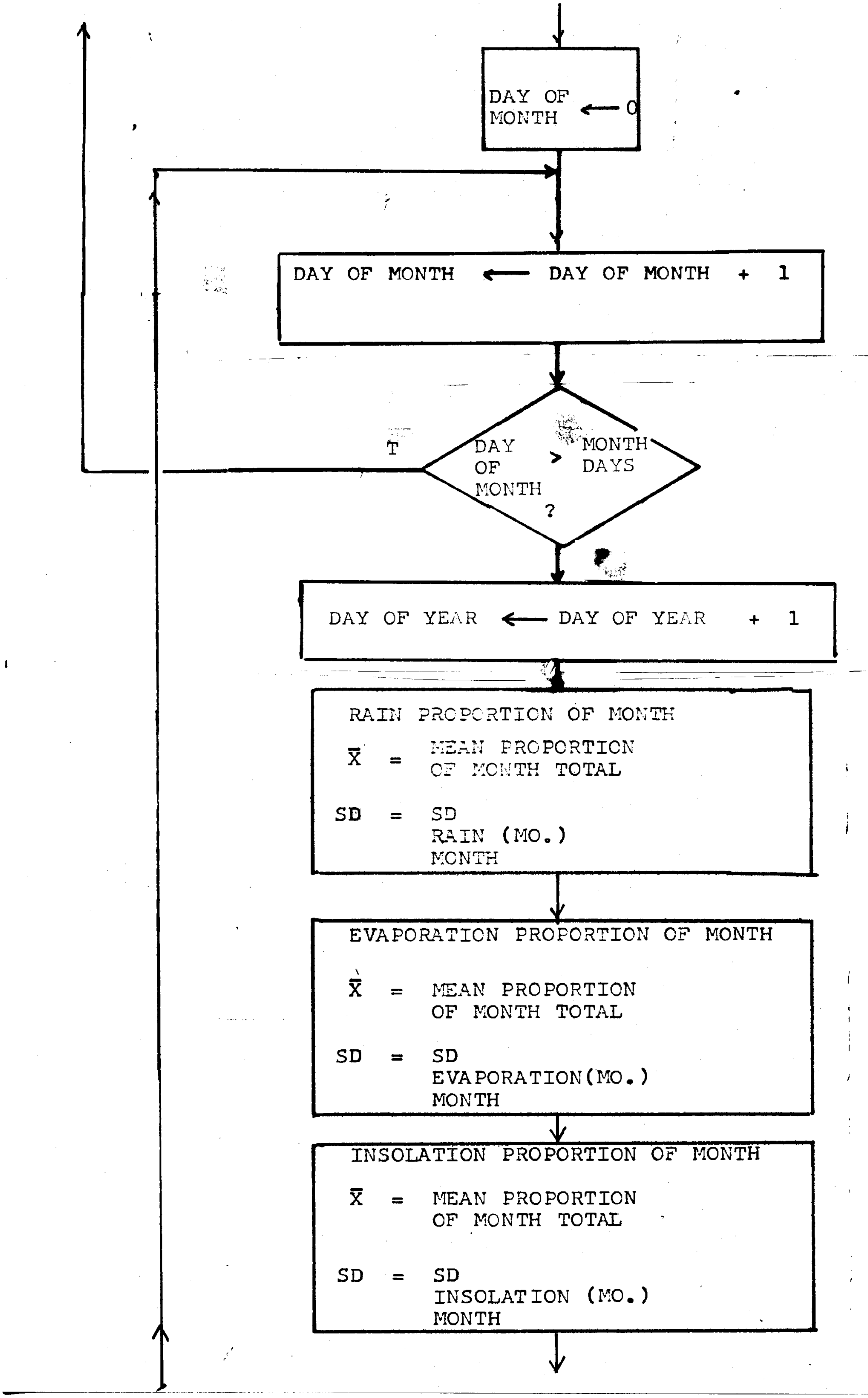
MONTH RAIN (9) ← RAIN IN BURNING SEASON • SEPTEMBER PROPORTION

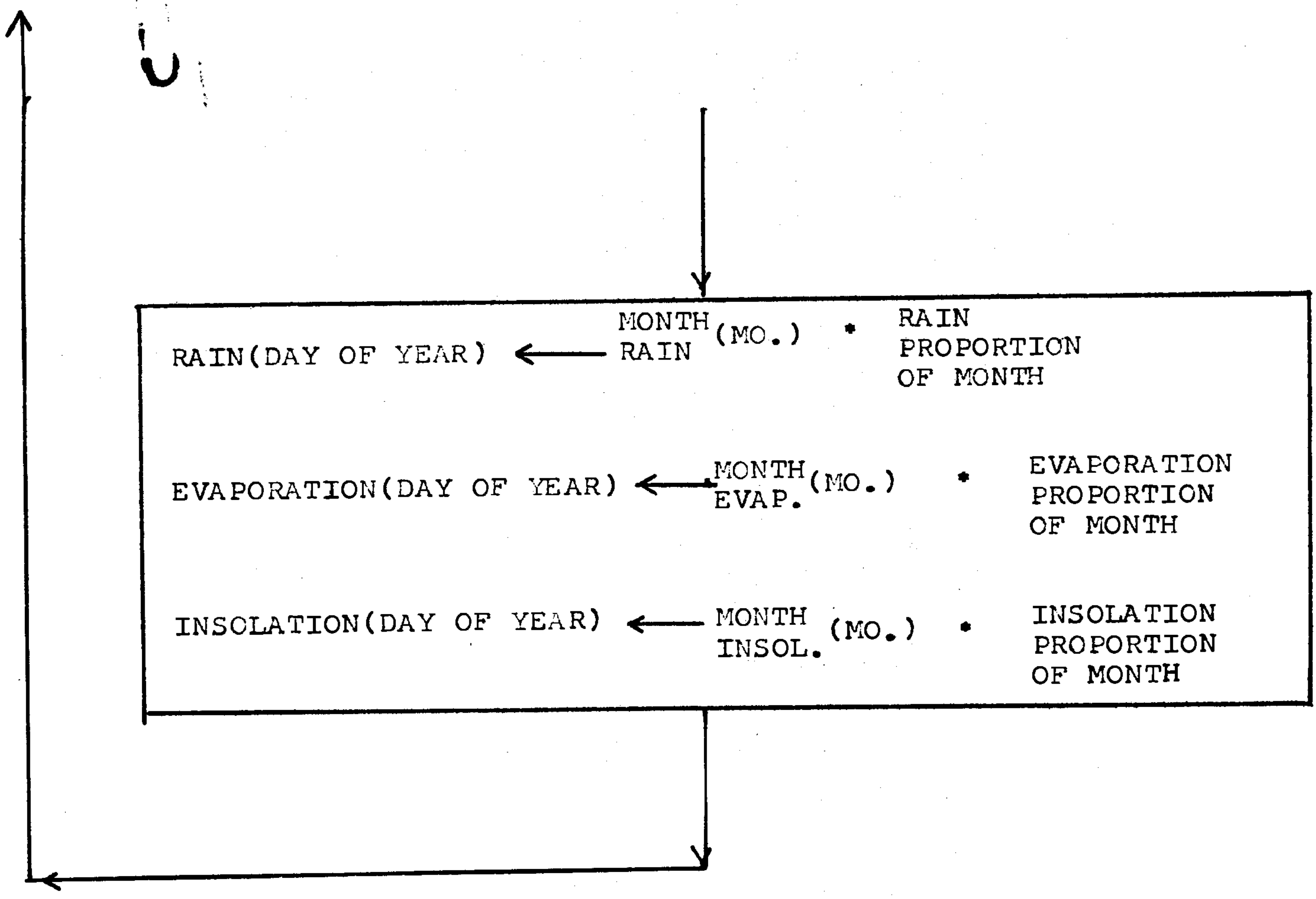
MONTH RAIN (10) ← RAIN IN BURNING SEASON • OCTOBER PROPORTION

MONTH RAIN (11) ← RAIN IN BURNING SEASON • NOVEMBER PROPORTION

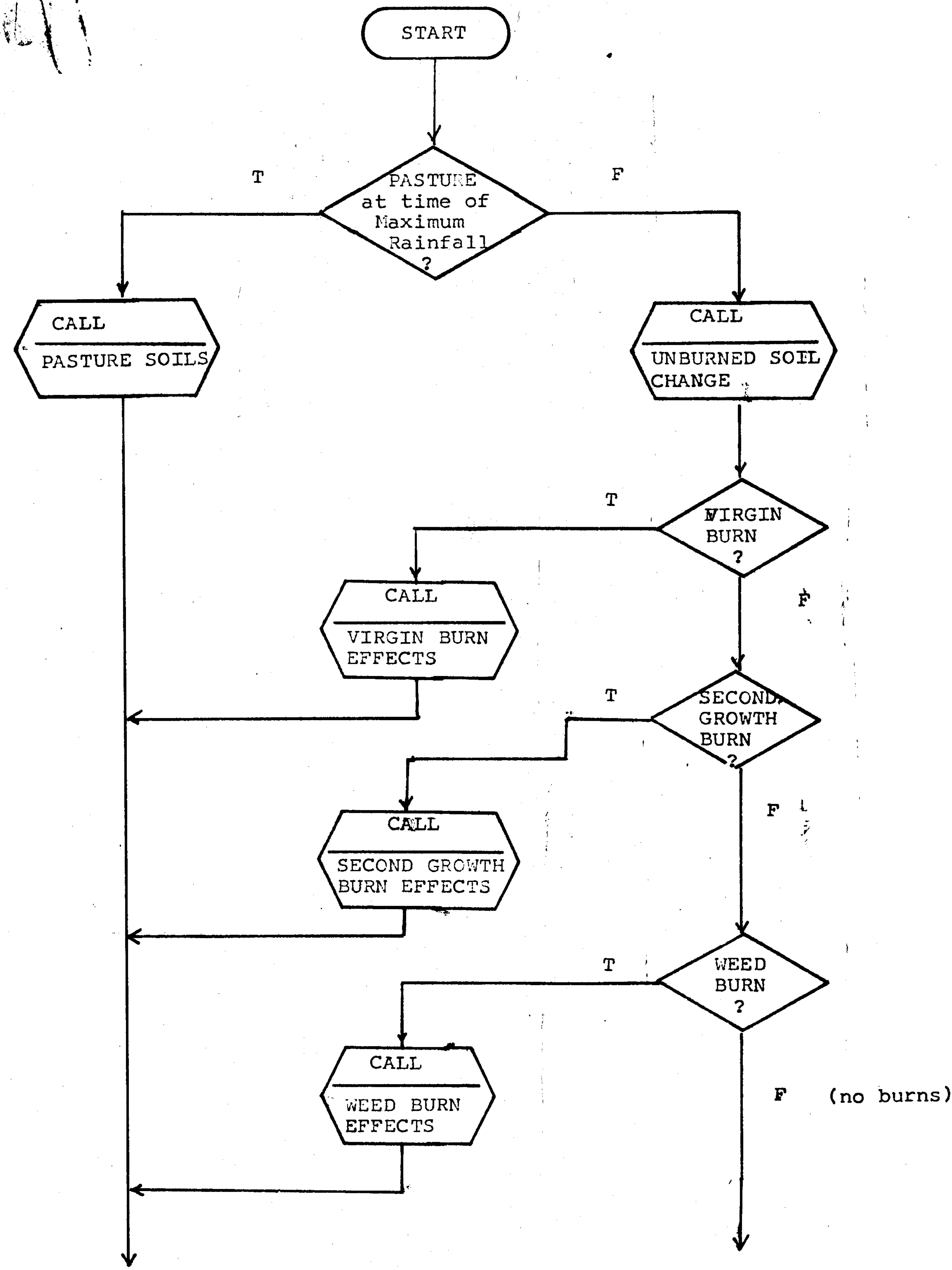
MONTH RAIN (12) ← RAIN IN BURNING SEASON • DECEMBER PROPORTION


Initializations
MO. ← 0
DAY OF YEAR ← 0
MO. ← MO. + 1
MO. > 12 ?
T
F
END
MONTH EVAPORATION(MO.) (mm) ← 102.0 - 0.150 * MONTH RAIN(MO.)
SE = 32.1
MONTH INSOLATION(MO.) (hours) ← 156.7 - 0.180 * MONTH RAIN (MO.)
SE = 44.1
MONTH DAYS ← NO. OF DAYS IN MONTH (MO.)
MEAN PROPORTION OF MONTH TOTAL ← 1. / month days

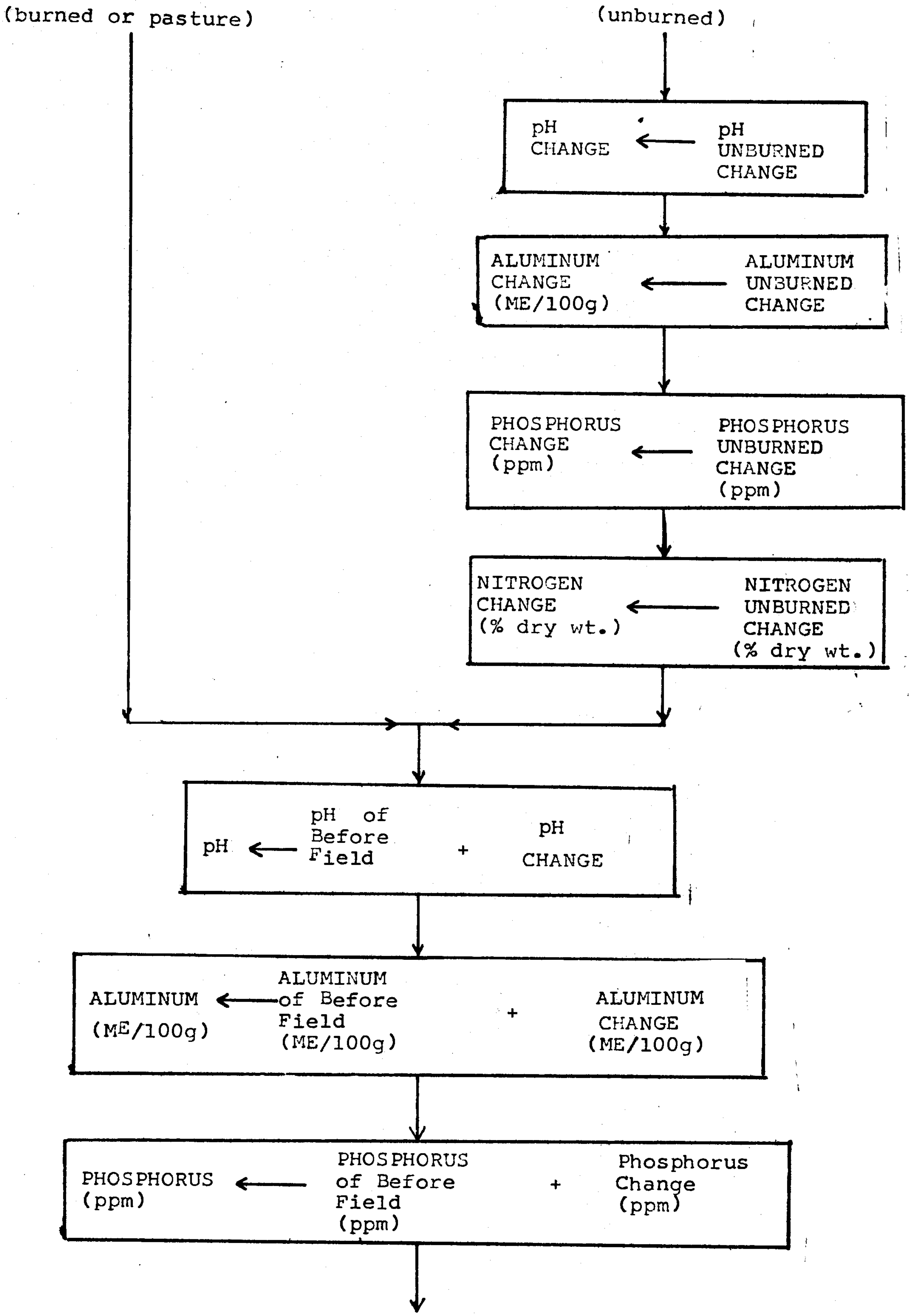

DAY OF MONTH ← 0
DAY OF MONTH ← DAY OF MONTH + 1
T
DAY OF MONTH > MONTH DAYS ?
DAY OF YEAR ← DAY OF YEAR + 1
RAIN PROPORTION OF MONTH
X̄ = MEAN PROPORTION OF MONTH TOTAL
SD = SD RAIN (MO.) MONTH
EVAPORATION PROPORTION OF MONTH
X̄ = MEAN PROPORTION OF MONTH TOTAL
SD = SD EVAPORATION(MO.) MONTH
INSOLATION PROPORTION OF MONTH
X̄ = MEAN PROPORTION OF MONTH TOTAL
SD = SD INSOLATION (MO.) MONTH

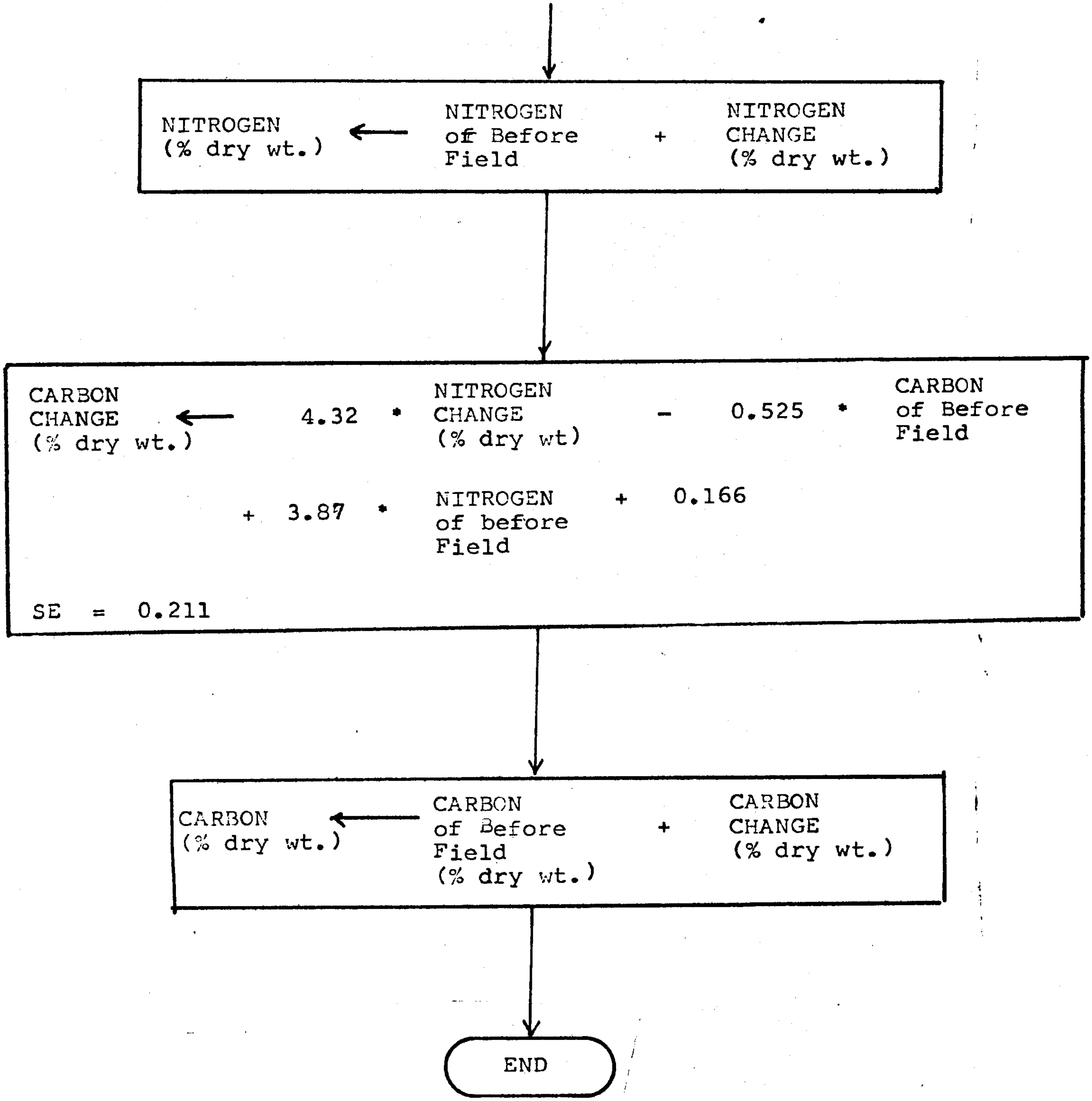

RAIN(DAY OF YEAR) ← MONTH RAIN (MO.) * RAIN PROPORTION OF MONTH
EVAPORATION(DAY OF YEAR) ← MONTH EVAP. (MO.) * EVAPORATION PROPORTION OF MONTH
INSOLATION(DAY OF YEAR) ← MONTH INSOL. (MO.) * INSOLATION PROPORTION OF MONTH

SOIL CHANGE

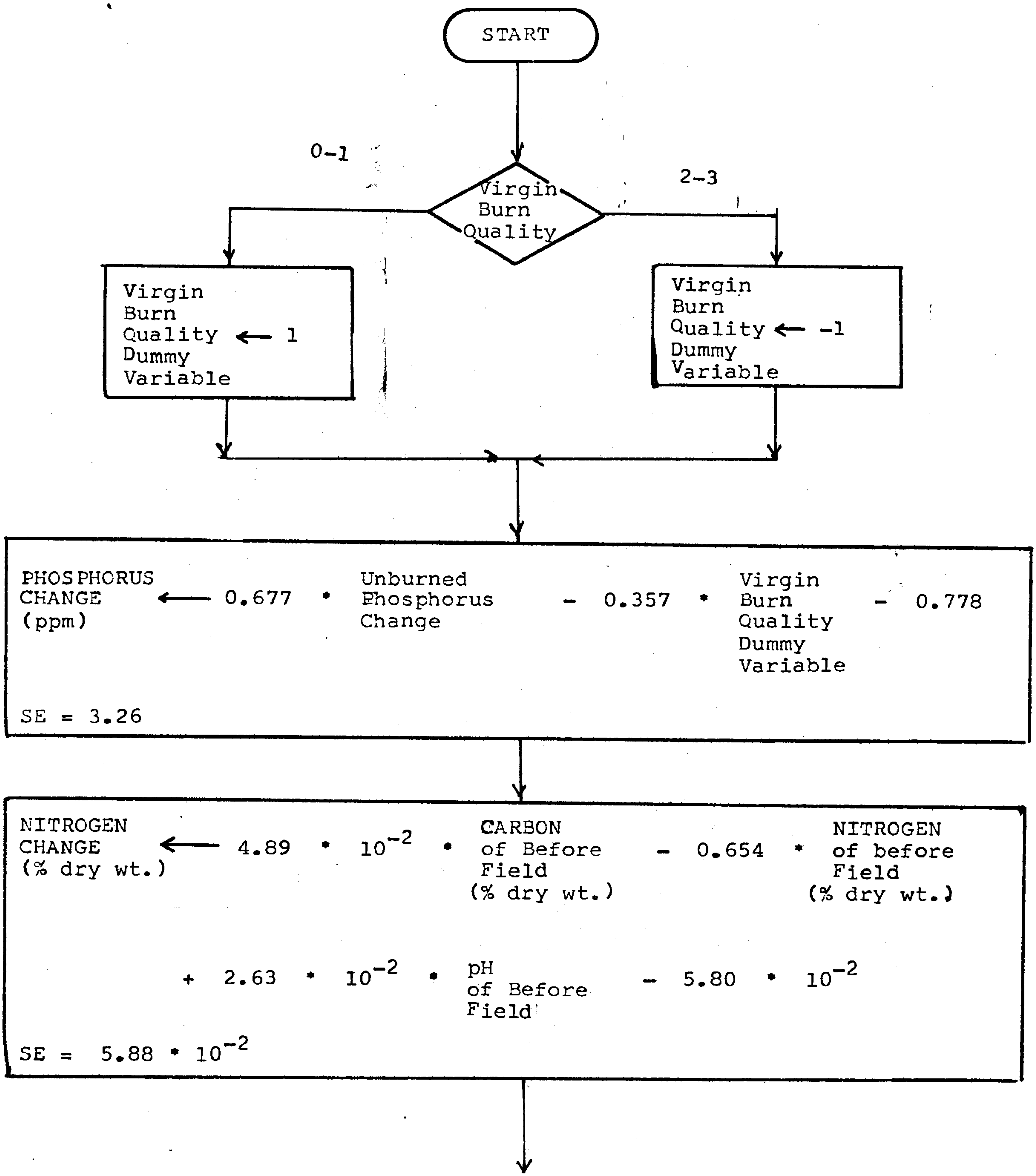


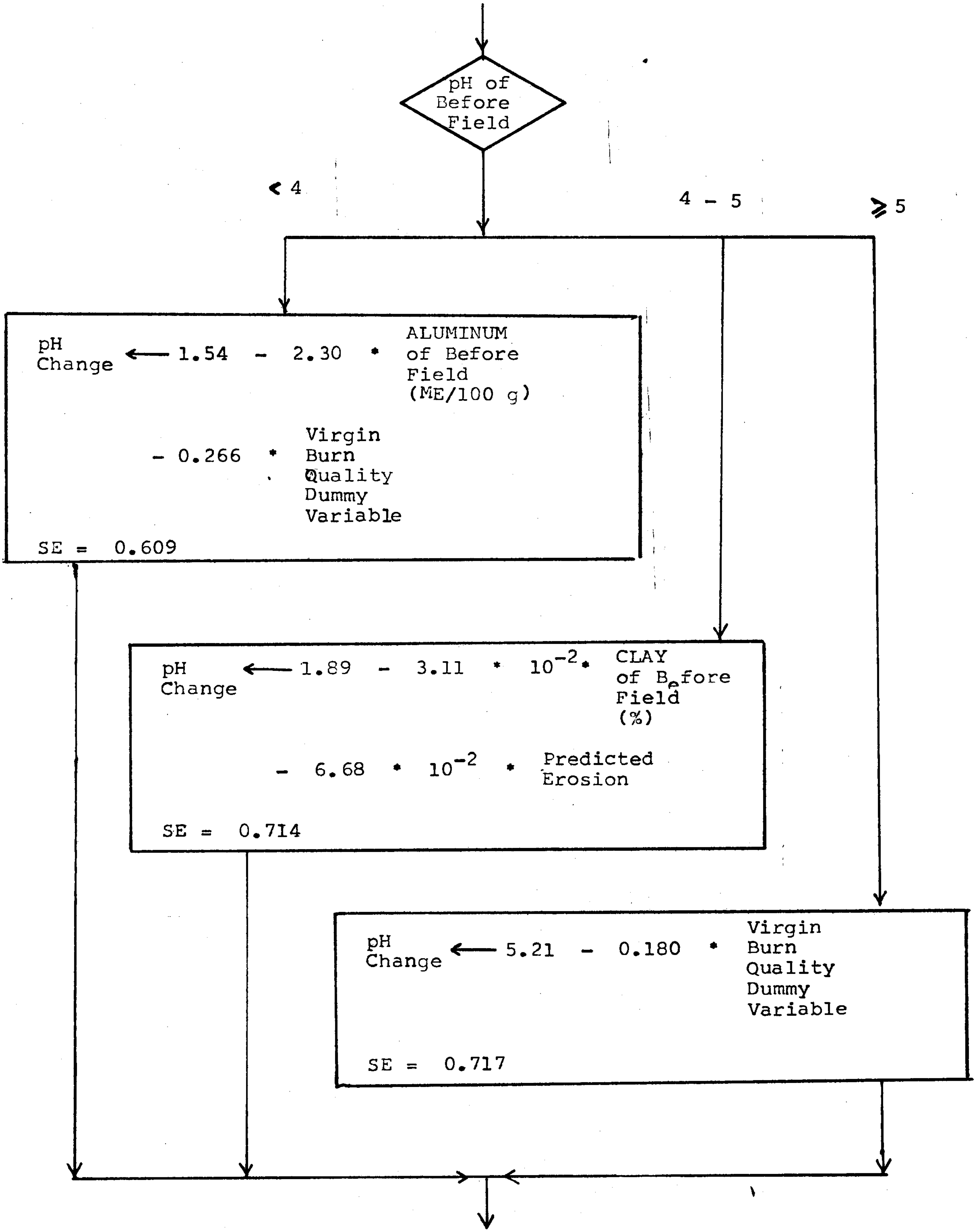
START
PASTURE at time of Maximum Rainfall ?
T
F
CALL
PASTURE SOILS
CALL
UNBURNED SOIL CHANGE
VIRGIN BURN ?
T
F
CALL
VIRGIN BURN EFFECTS
SECOND GROWTH BURN ?
T
F
CALL
SECOND GROWTH BURN EFFECTS
WEED BURN ?
T
F
(no burns)
CALL
WEED BURN EFFECTS

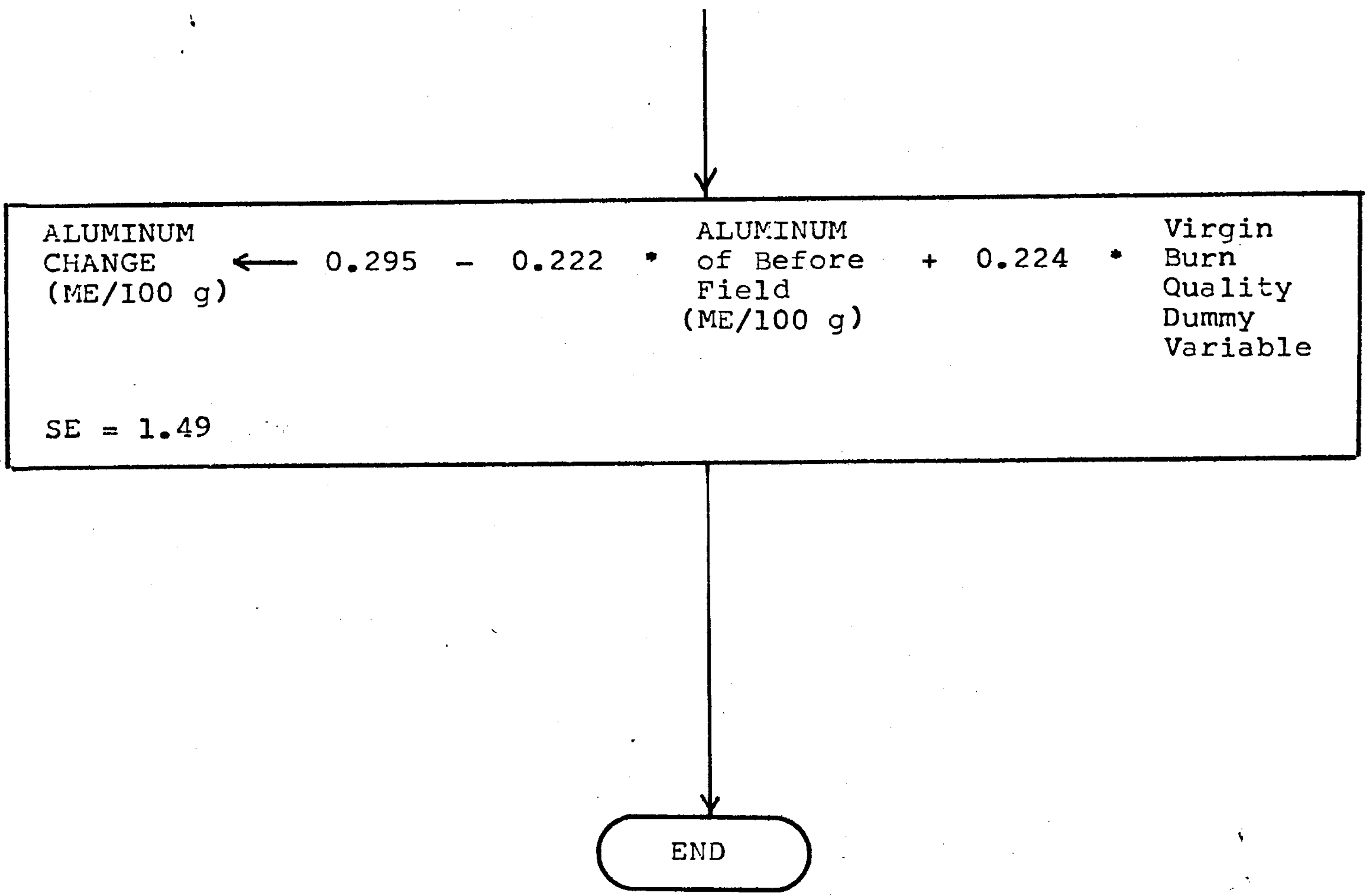

(burned or pasture)
(unburned)
pH CHANGE
pH UNBURNED CHANGE
ALUMINUM CHANGE (ME/100g)
ALUMINUM UNBURNED CHANGE
PHOSPHORUS CHANGE (ppm)
PHOSPHORUS UNBURNED CHANGE (ppm)
NITROGEN CHANGE (% dry wt.)
NITROGEN UNBURNED CHANGE (% dry wt.)
pH
pH of Before Field
+
pH CHANGE
ALUMINUM (ME/100g)
ALUMINUM of Before Field (ME/100g)
+
ALUMINUM CHANGE (ME/100g)
PHOSPHORUS (ppm)
PHOSPHORUS of Before Field (ppm)
+
Phosphorus Change (ppm)


NITROGEN (% dry wt.) ← NITROGEN of Before Field + NITROGEN CHANGE (% dry wt.)
CARBON CHANGE (% dry wt.) ← 4.32 * NITROGEN CHANGE (% dry wt) − 0.525 * CARBON of Before Field
+ 3.87 * NITROGEN of before Field + 0.166
SE = 0.211
CARBON (% dry wt.) ← CARBON of Before Field (% dry wt.) + CARBON CHANGE (% dry wt.)
END

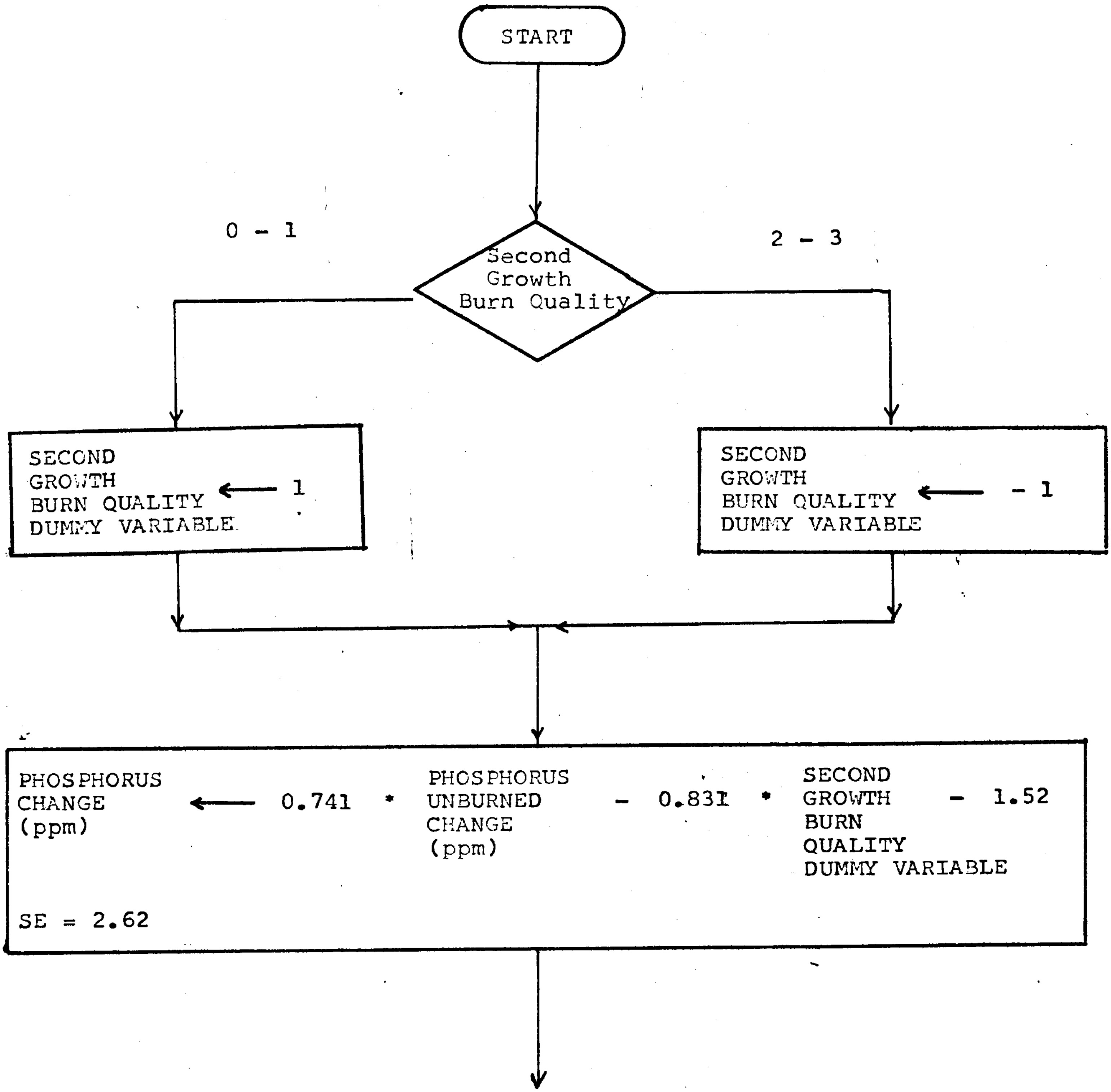
VIRGIN BURN EFFECTS

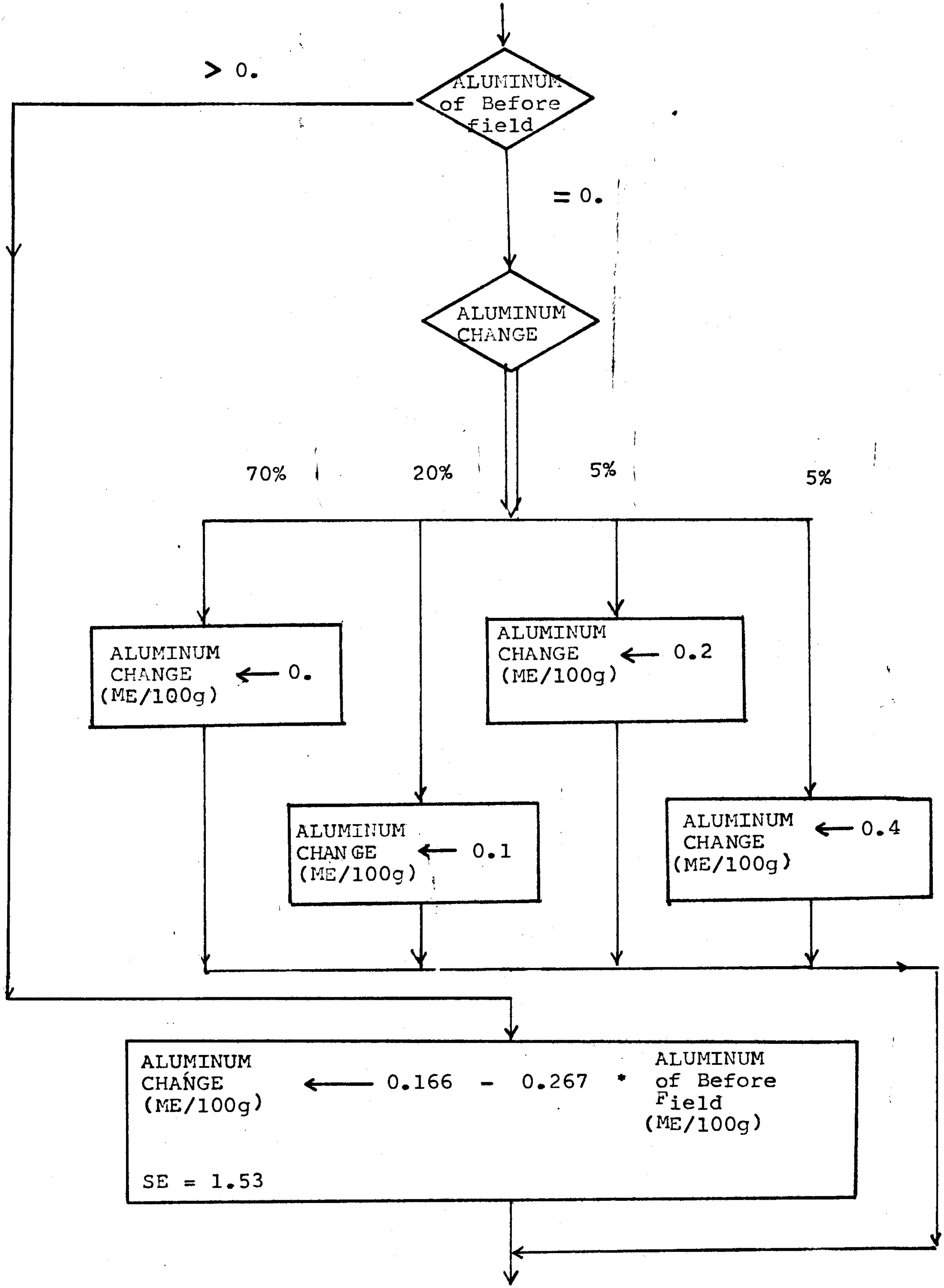



pH of Before Field
< 4
4 - 5
≥ 5
pH Change ← 1.54 - 2.30 * ALUMINUM of Before Field (ME/100 g)
- 0.266 * Virgin Burn Quality Dummy Variable
SE = 0.609
pH Change ← 1.89 - 3.11 * 10^-2 * CLAY of Before Field (%)
- 6.68 * 10^-2 * Predicted Erosion
SE = 0.714
pH Change ← 5.21 - 0.180 * Virgin Burn Quality Dummy Variable
SE = 0.717


ALUMINUM CHANGE (ME/100 g) ← 0.295 − 0.222 * ALUMINUM of Before Field (ME/100 g) + 0.224 * Virgin Burn Quality Dummy Variable
SE = 1.49
END

SECOND GROWTH BURN EFFECT





ALUMINUM of Before field
> 0.
= 0.
ALUMINUM CHANGE
70%
20%
5%
5%
ALUMINUM CHANGE (ME/100g) ← 0.
ALUMINUM CHANGE (ME/100g) ← 0.1
ALUMINUM CHANGE (ME/100g) ← 0.2
ALUMINUM CHANGE (ME/100g) ← 0.4
ALUMINUM CHANGE (ME/100g) ← 0.166 - 0.267 * ALUMINUM of Before Field (ME/100g)
SE = 1.53

pH CHANGE ← 3.48 − 0.226 * ALUMINUM of Before Field (ME/100g) − 0.231 * ALUMINUM CHANGE (ME/100g) − $3.37 * 10^{-4}$ * DAYS ANNUAL CROPS

SE = 0.646

NITROGEN WEED-SECOND GROWTH BURN EFFECT

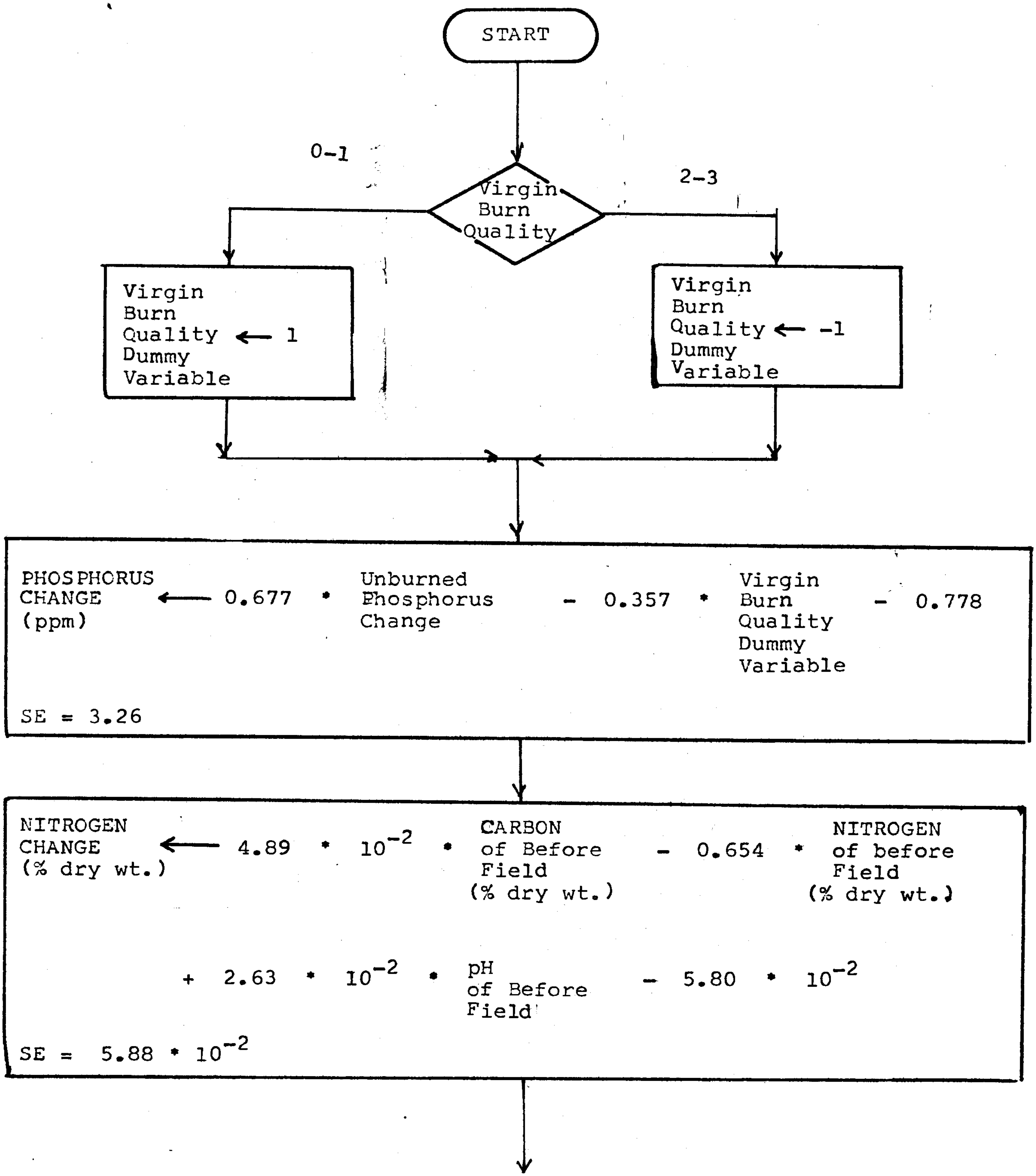
$\bar{X}$ = − 0.033 (% dry wt.)

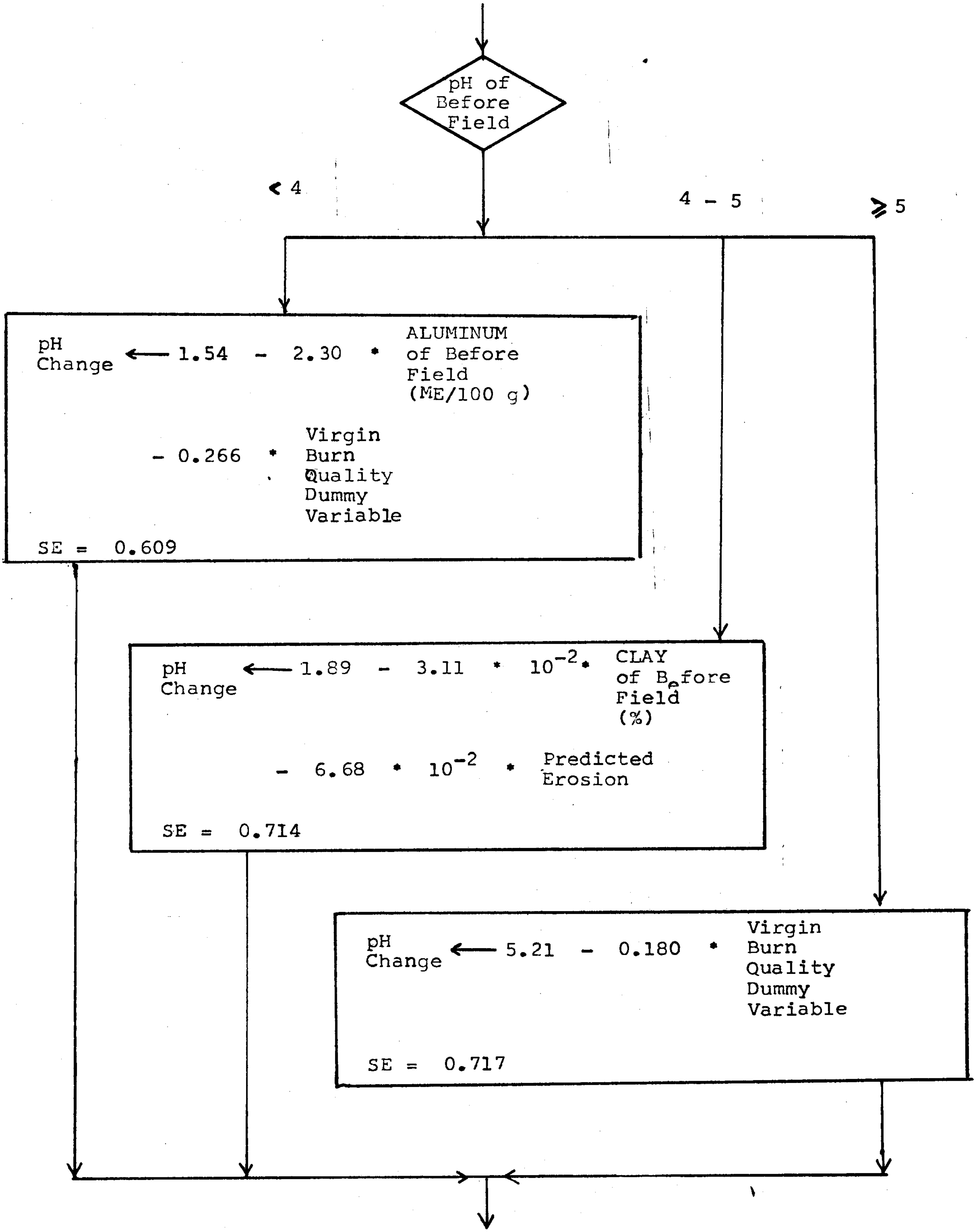
SD = 0.058

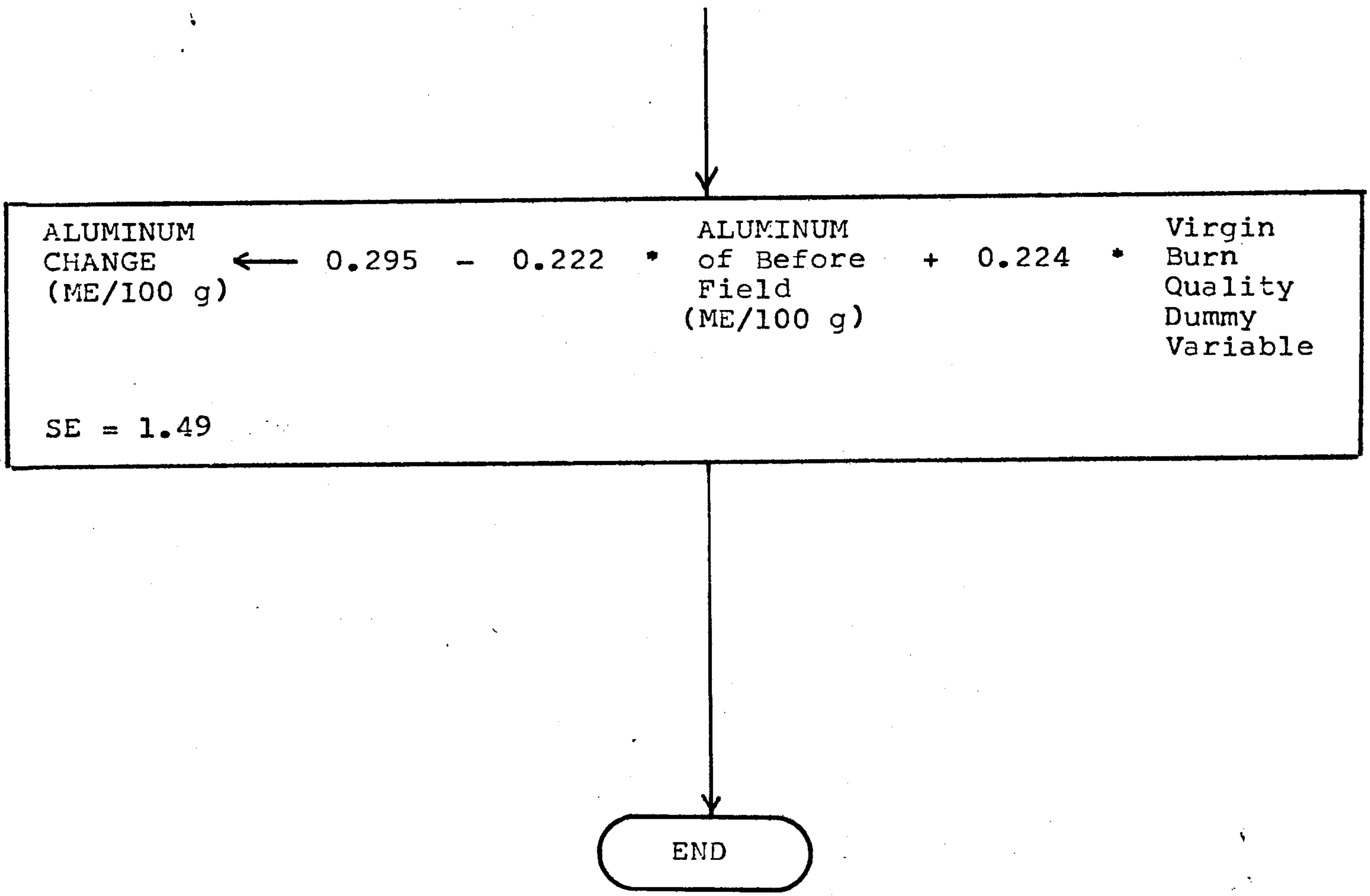
NITROGEN CHANGE (% dry wt.) ← NITROGEN UNBURNED CHANGE (% dry wt.) + NITROGEN WEED-SECOND GROWTH BURN EFFECT

END

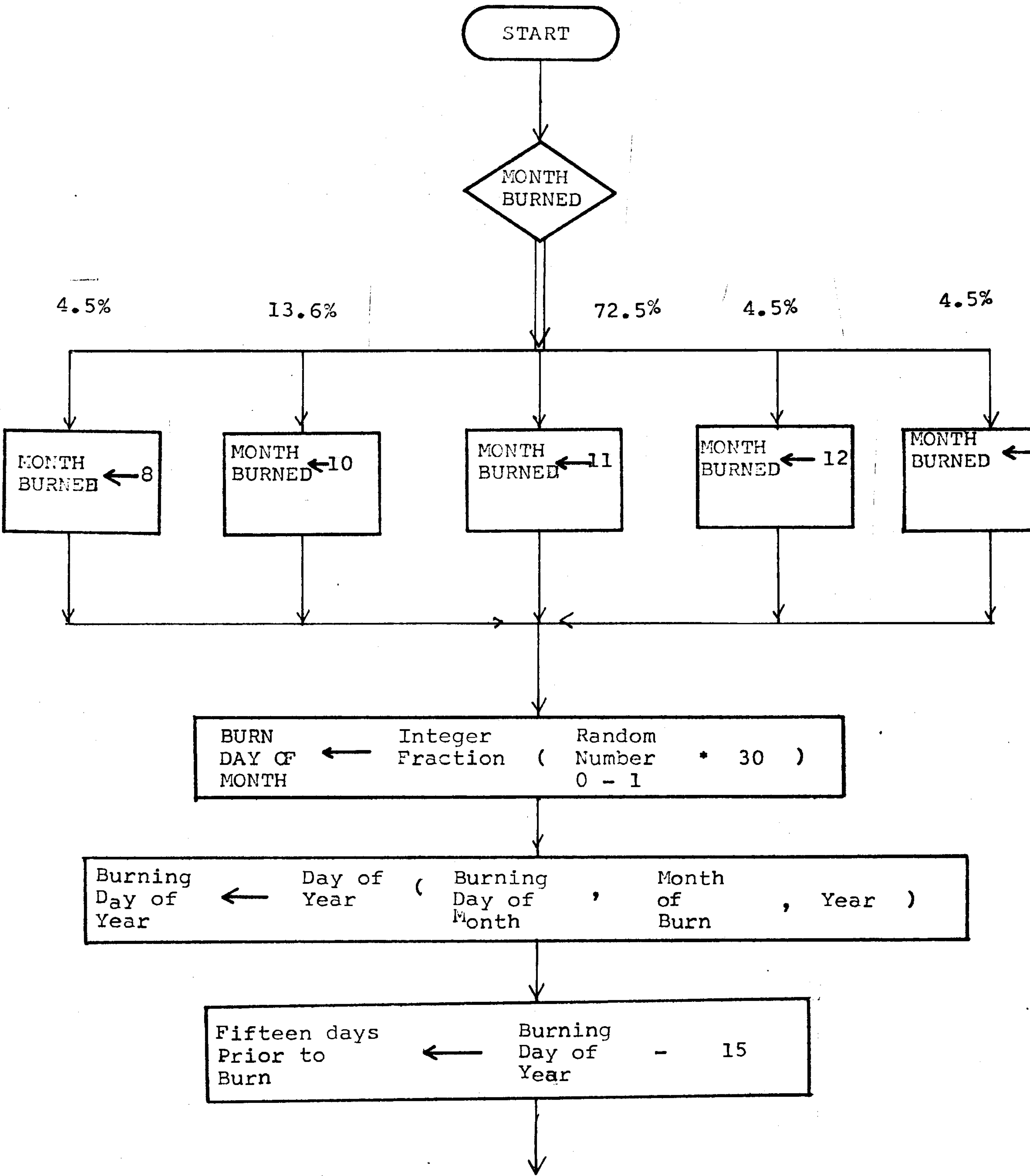
VIRGIN BURN EFFECTS




pH of Before Field
< 4
4 - 5
≥ 5
pH Change ← 1.54 - 2.30 * ALUMINUM of Before Field (ME/100 g)
- 0.266 * Virgin Burn Quality Dummy Variable
SE = 0.609
pH Change ← 1.89 - 3.11 * 10^-2 * CLAY of Before Field (%)
- 6.68 * 10^-2 * Predicted Erosion
SE = 0.714
pH Change ← 5.21 - 0.180 * Virgin Burn Quality Dummy Variable
SE = 0.717


ALUMINUM CHANGE (ME/100 g) ← 0.295 − 0.222 * ALUMINUM of Before Field (ME/100 g) + 0.224 * Virgin Burn Quality Dummy Variable
SE = 1.49
END

WEED BURN QUALITY



Rain in Fifteen days Prior to burn ← WEATHER (Rain , Fifteen days Prior to Burn , Burn Day of Year)

Evaporation in Fifteen days Prior to burn ← WEATHER (Evaporation , Fifteen days Prior to Burn , Burn Day of Year)

Insolation in Fifteen days Prior to burn ← WEATHER (Insolation , Fifteen days Prior to Burn , Burn Day of Year)

↓

GOOD BURN DISCRIMINATOR ← 7.07 * 10^{-2} * Rain in Fifteen days Prior to burn

+ 0.566 * Evaporation in Fifteen days Prior to burn

+ 7.59 * 10^{-2} * Insolation in Fifteen days Prior to burn − 15.98

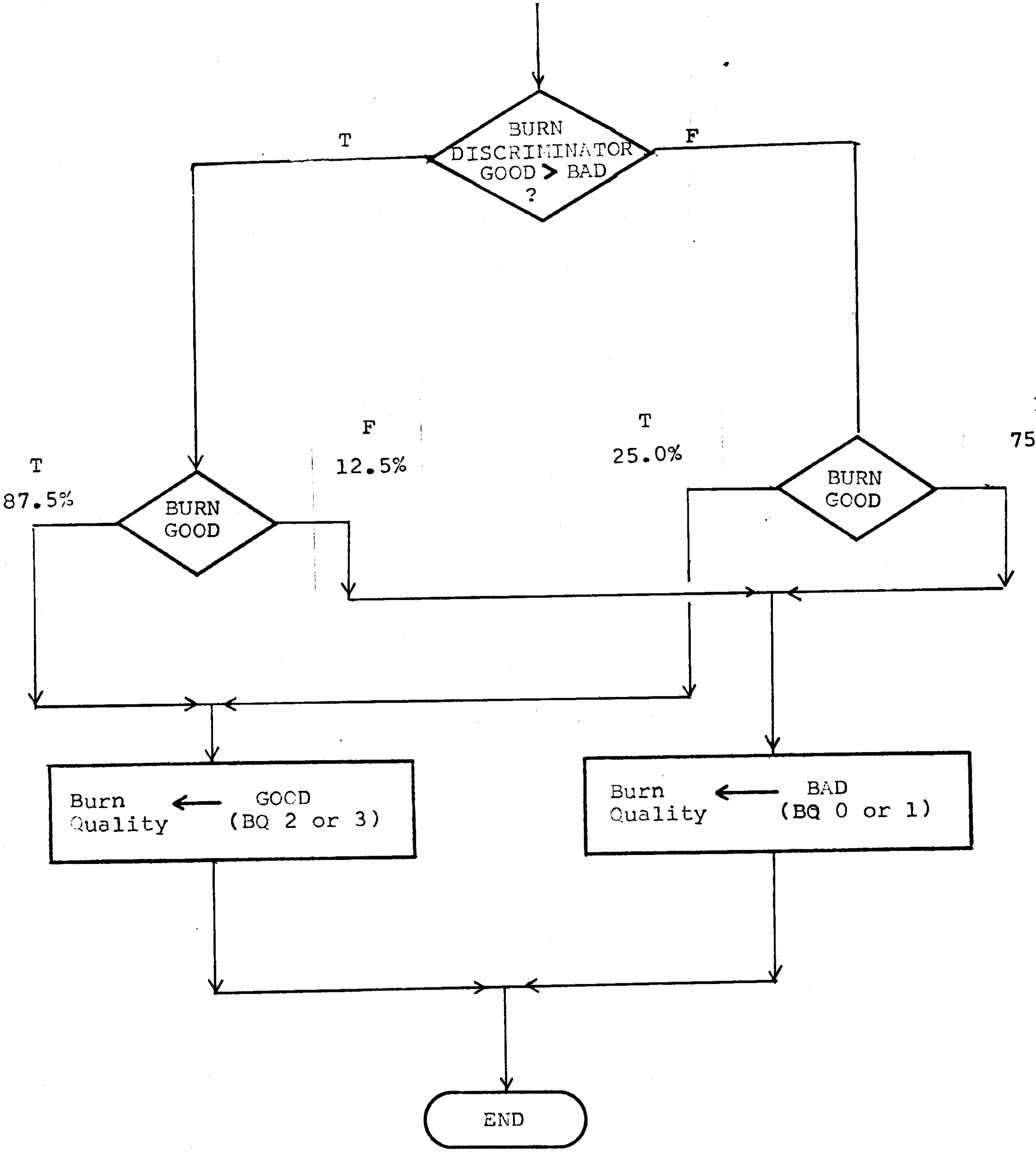
↓

BAD BURN DISCRIMINATOR ← 5.59 * 10^{-2} * Rain in Fifteen days Prior to burn

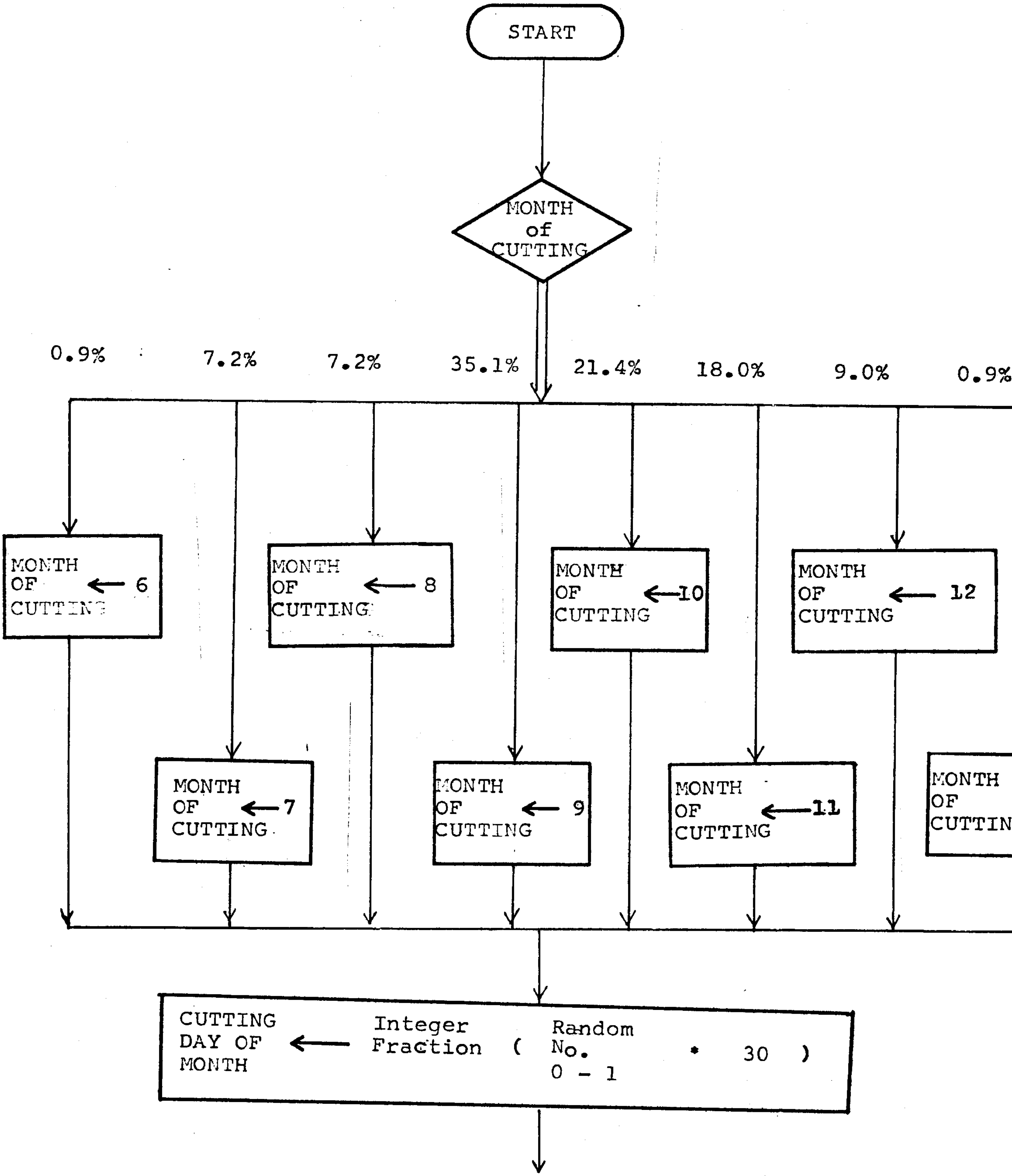
+ 0.456 * Evaporation in Fifteen days Prior to burn

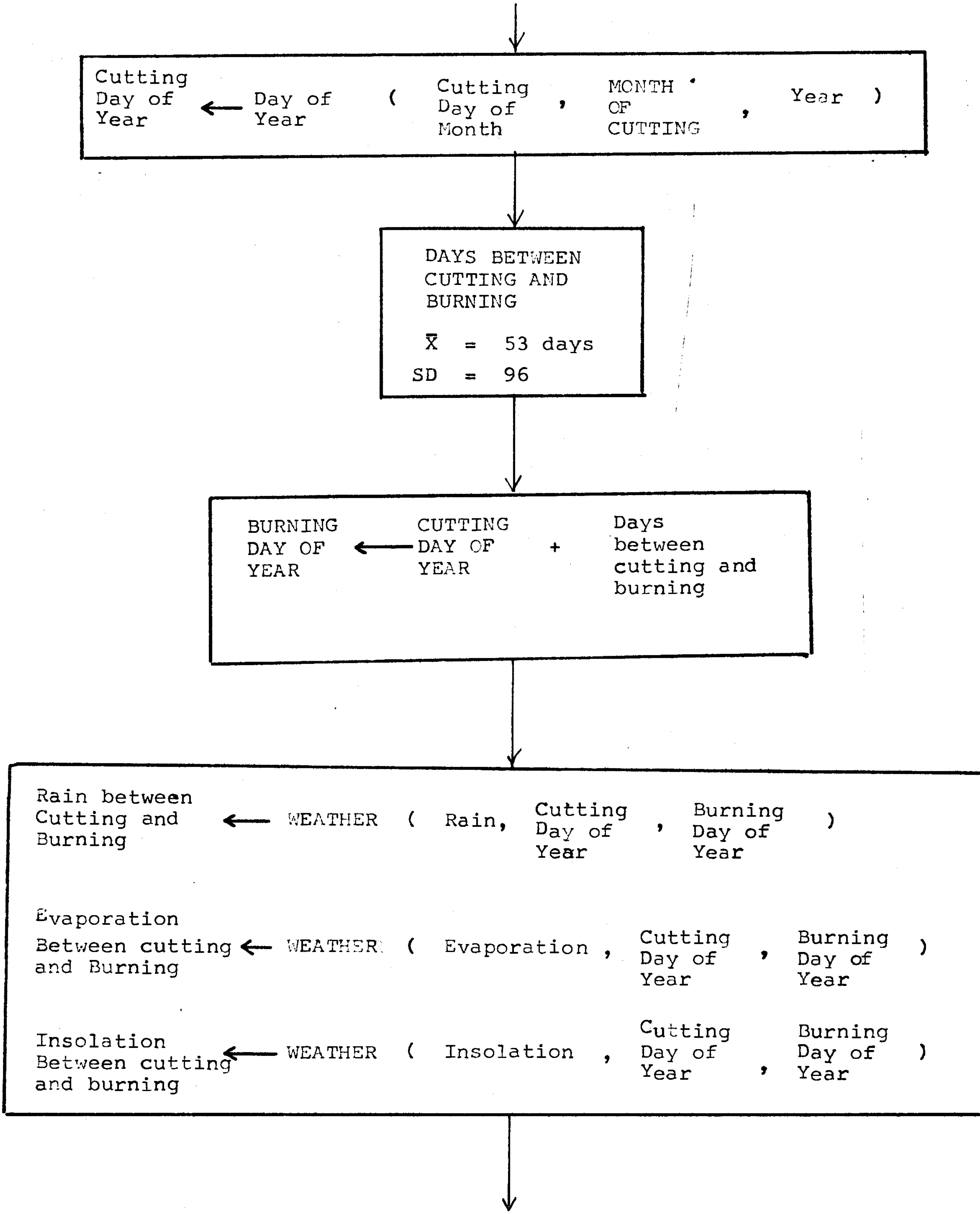
+ 0.140 * Insolation in Fifteen days Prior to burn − 14.70

↓


T
BURN
DISCRIMINATOR
GOOD > BAD
?
F
T
87.5%
BURN
GOOD
F
12.5%
T
25.0%
BURN
GOOD
75
Burn
Quality
GOOD
(BQ 2 or 3)
Burn
Quality
BAD
(BQ 0 or 1)
END

SECOND GROWTH BURN QUALITY





Cutting Day of Year ← Day of Year (Cutting Day of Month , MONTH OF CUTTING , Year)
DAYS BETWEEN CUTTING AND BURNING
X̄ = 53 days
SD = 96
BURNING DAY OF YEAR ← CUTTING DAY OF YEAR + Days between cutting and burning
Rain between Cutting and Burning ← WEATHER (Rain, Cutting Day of Year , Burning Day of Year)
Evaporation Between cutting and Burning ← WEATHER (Evaporation , Cutting Day of Year , Burning Day of Year)
Insolation Between cutting and burning ← WEATHER (Insolation , Cutting Day of Year , Burning Day of Year)

GOOD BURN DISCRIMINATOR ← $-3.38 * 10^{-3} *$ Rain between cutting and burning

$+ 2.06 * 10^{-2} *$ Evaporation between cutting and Burning

$+ 6.09 * 10^{-4} *$ Insolation Between cutting and burning $- 1.00$

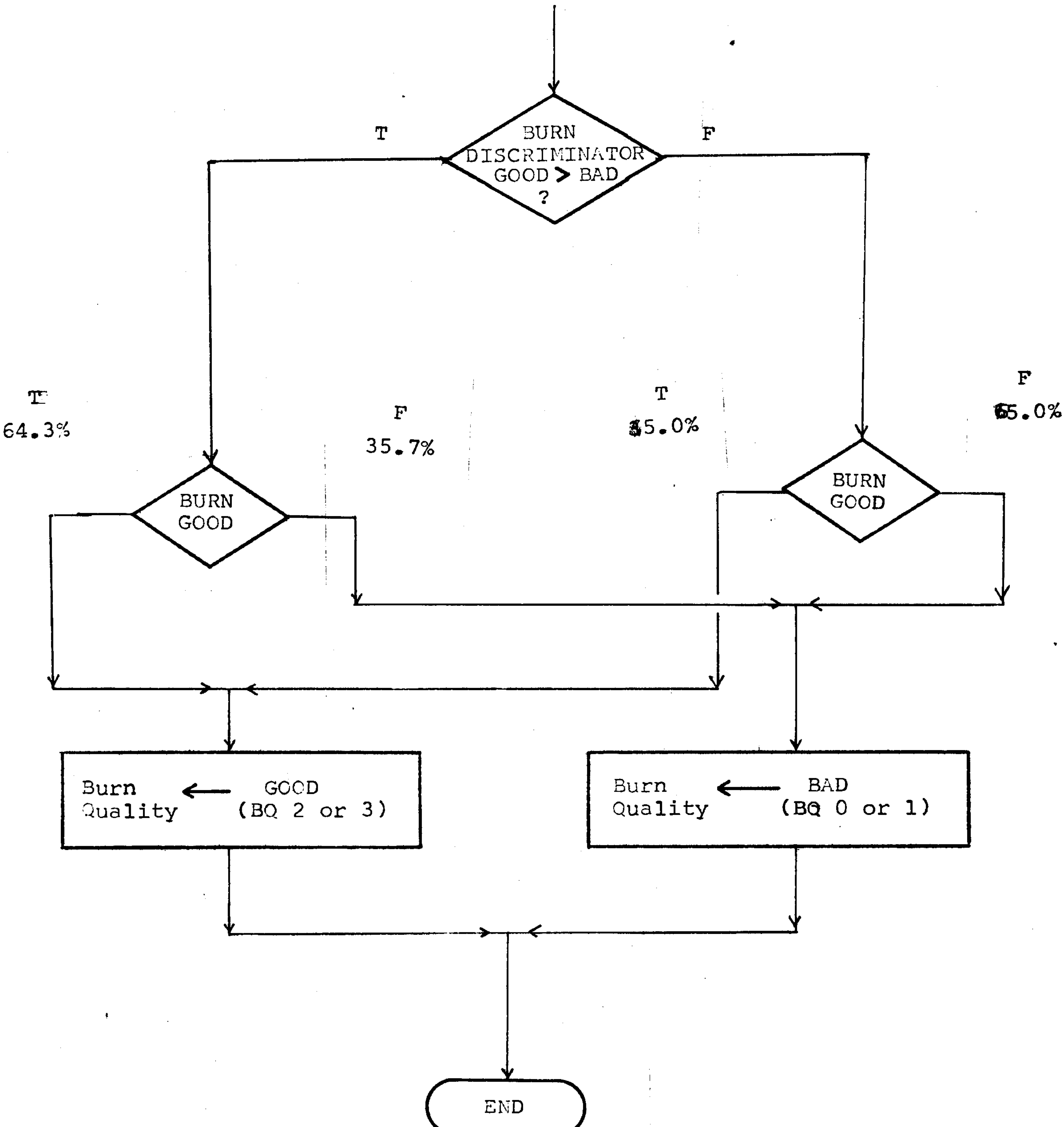
↓

BAD BURN DISCRIMINATOR ← $-4.84 * 10^{-4} *$ Rain between Cutting and Burning

$+ 1.39 * 10^{-2} *$ Evaporation Between cutting and burning

$- 2.90 * 10^{-3} *$ Insolation Between cutting and burning $- 0.237$

↓


BURN
DISCRIMINATOR
GOOD > BAD
?
T
F
T
64.3%
F
35.7%
T
35.0%
F
65.0%
BURN
GOOD
BURN
GOOD
Burn
Quality
GOOD
(BQ 2 or 3)
Burn
Quality
BAD
(BQ 0 or 1)
END

Philip M. Fearnside
July 24, 1977

SUMMARY OF RICE YIELD REGRESSION:

1.) ORIGINAL DATA SET: 306 cases

2) CULLING THE DATA SET:

a) INVALID DATA:

- field areas less than 1 hectare
- questionable data due to noted contradictions or vagueness in colonist response
- estimated yields where colonist estimated yield of rice which had been harvested and piled but not yet threshed and sacked
- incomplete data for yield, areas, density, maize density, carbon, phosphorus or aluminum
- planting densities outside range of experiment station density studies

b) EXCLUDED CATEGORIES OF VALID DATA:

- fields interplanted with manioc
- fields interplanted with pasture (no actual cases in useable data categories)
- fields interplanted with "other crops" (other than maize, manioc or pasture)
- fields with toppling reported
- fields with germination problems reported (no actual cases in useable data categories)
- fields with planting dates other than in December, January or February
- varieties other than IAC-101, IAC-1246 or Canela de ferro

3) ADJUSTMENTS AND TRANSFORMATIONS OF THE DATA:

a) Yields are expressed as proportions of the predicted yield from interpolating from the results of agricultural experiment station studies done in the Altamira area testing the effects of variety and planting density.

b) Carbon is "adjusted to 2.0" meaning that values of percent carbon higher than 2.0 are assigned values of 2.0. This is in accord with the "linear response and plateau" model for predicting crop yields from soil nutrients.

4.) RICE YIELD REGRESSION:

$$\text{Rice yield (proportion of experiment station yield)} = 0.60 * \underset{(\%)}{\text{Carbon}} - 1.52 * 10^{-5} * \underset{(\text{plants/ha})}{\text{Maize Density}}$$
$$+ 1.67 * 10^{-2} * \underset{(\text{ppm})}{\text{Phosphorus}}$$
$$- 9.47 * 10^{-2} * \underset{(\text{mE/100g})}{\text{Aluminum}} - 6.03 * 10^{-3}$$

$p = 0.0165$

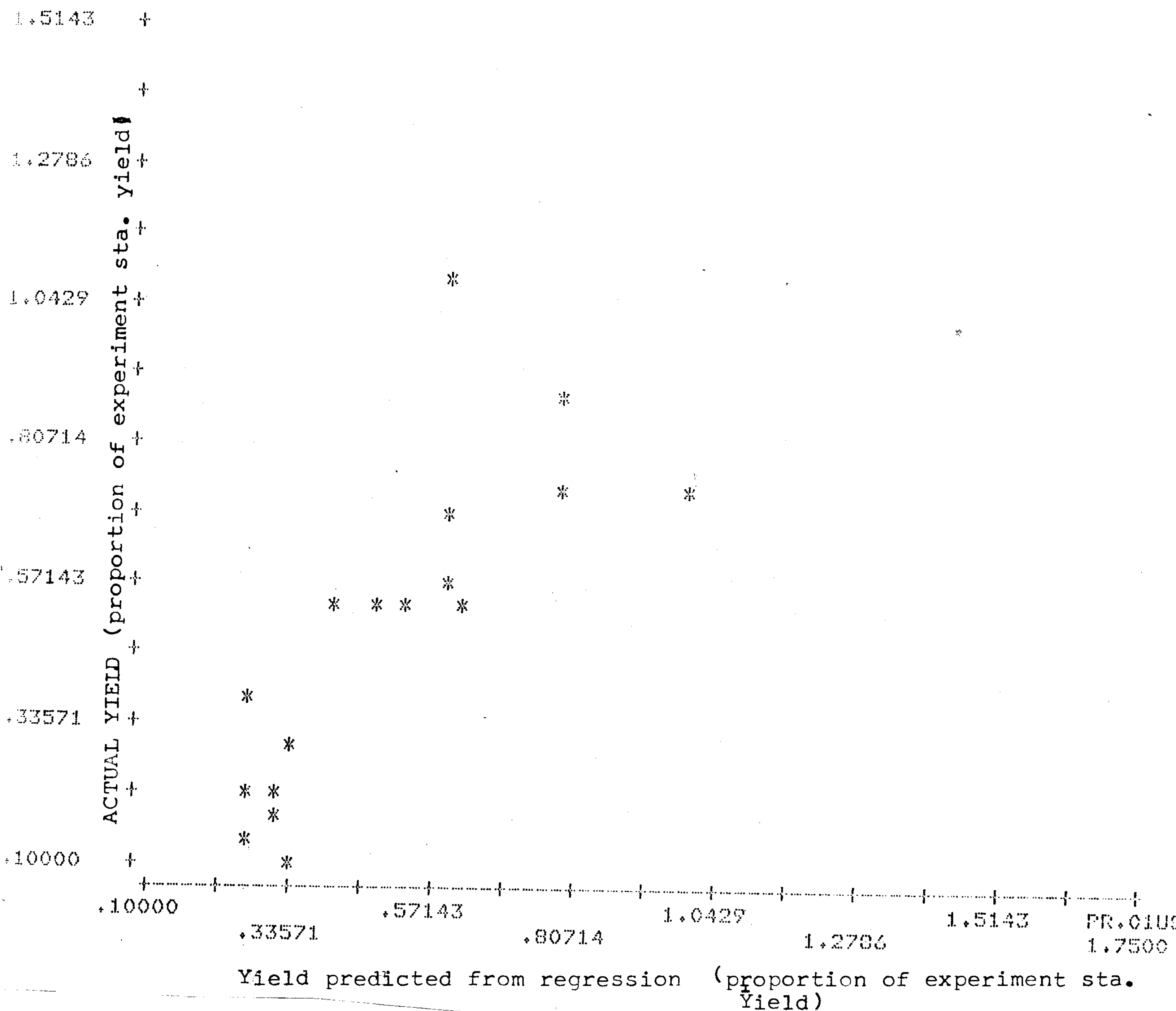
$r = 0.7808$

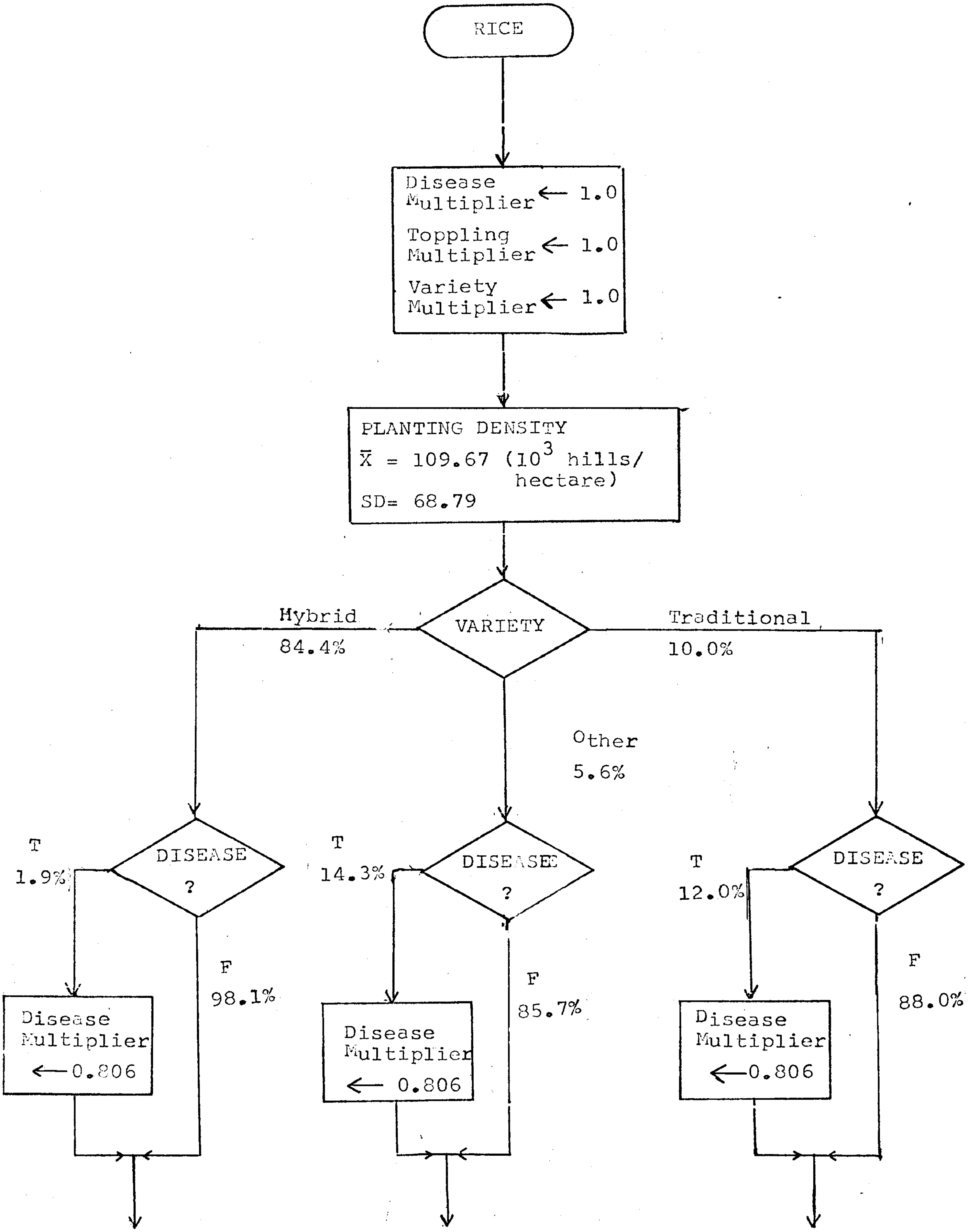
$r^2 = 0.6096$

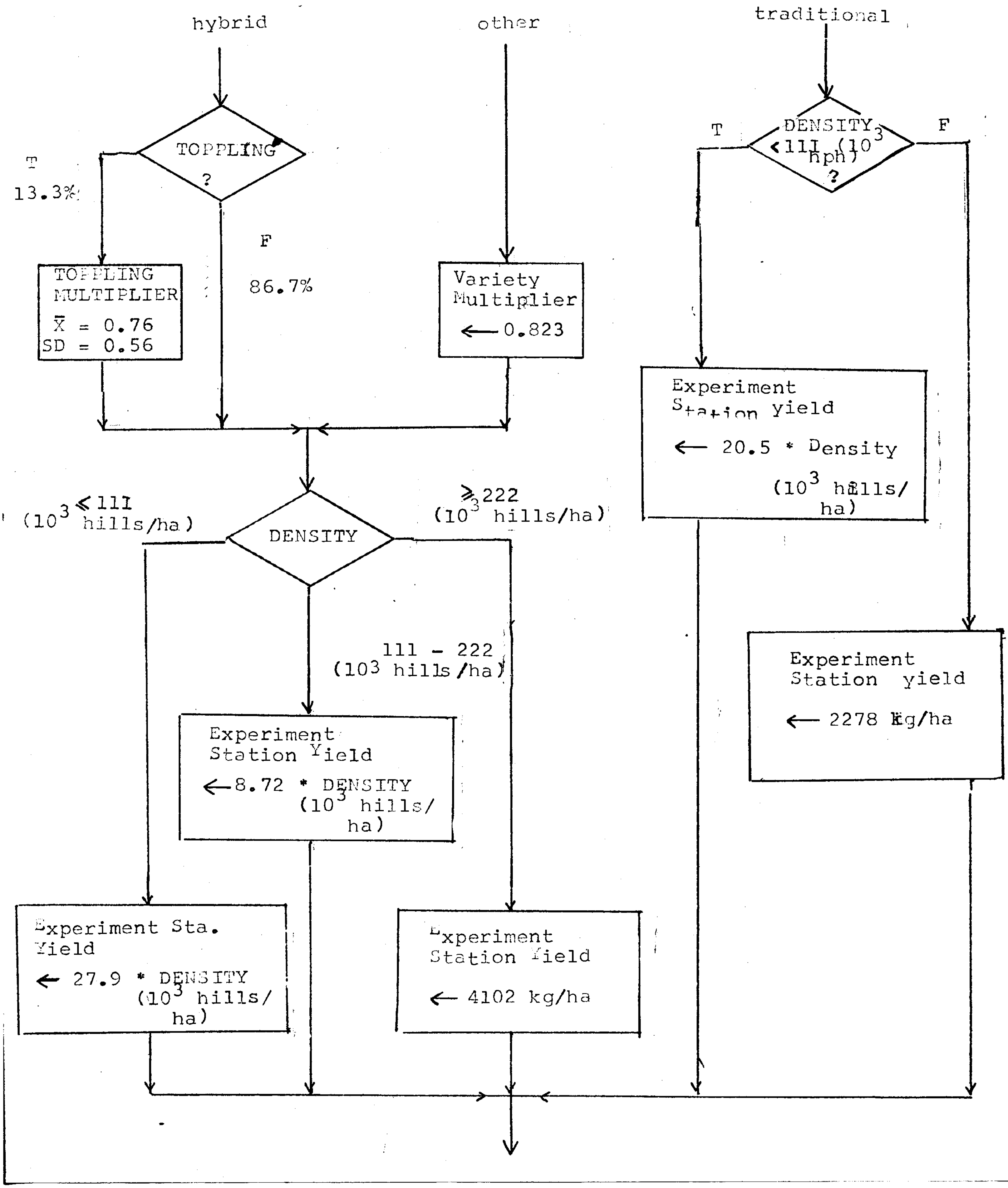
$SE = 0.2029$

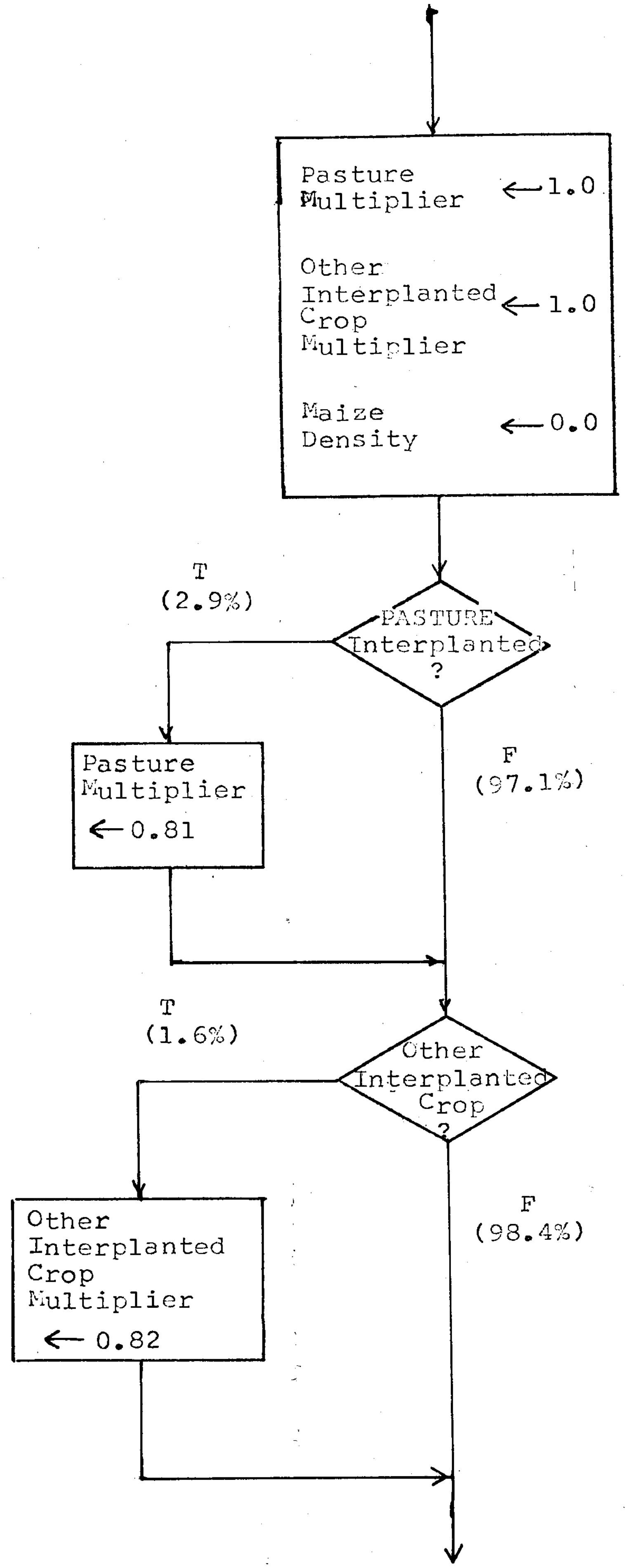
$N = 17$

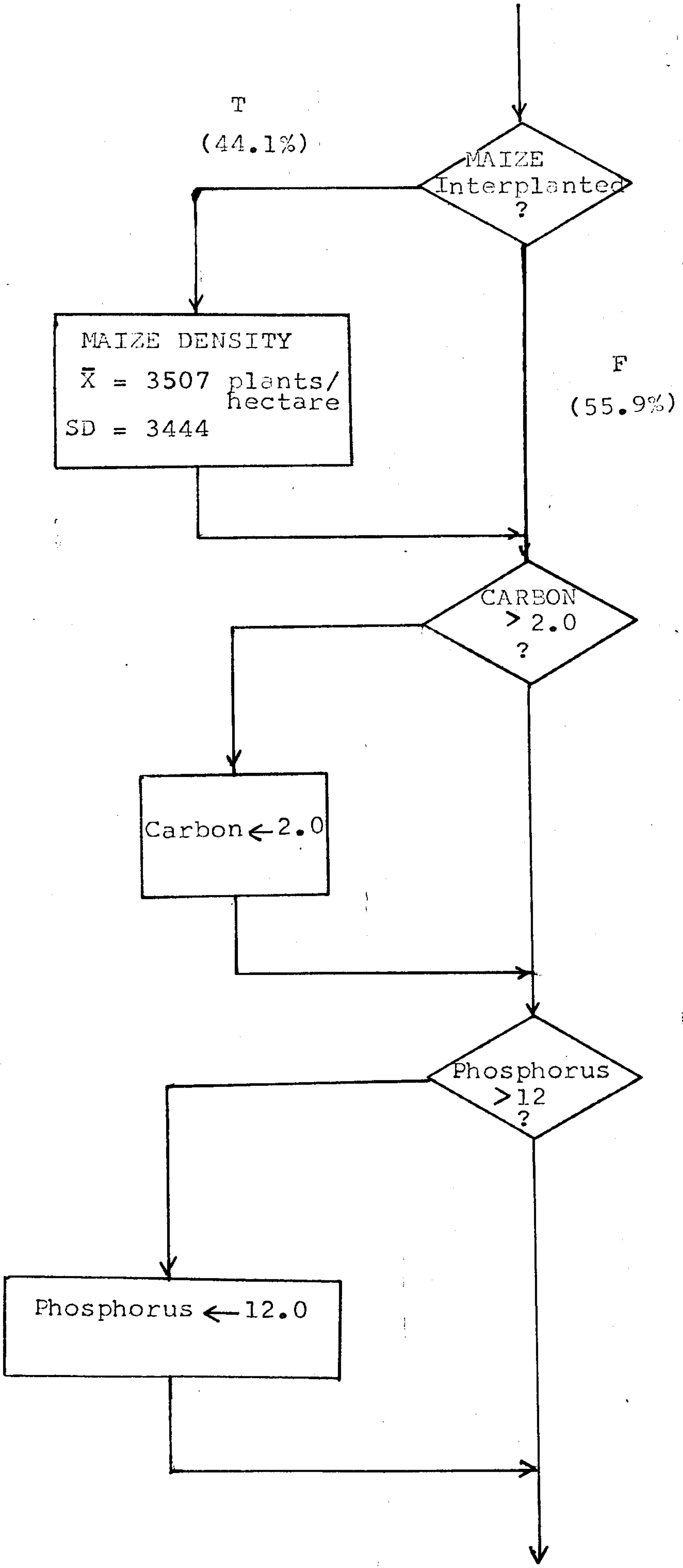
RICE ACTUAL YIELDS VS YIELDS PREDICTED FROM REGRESSION

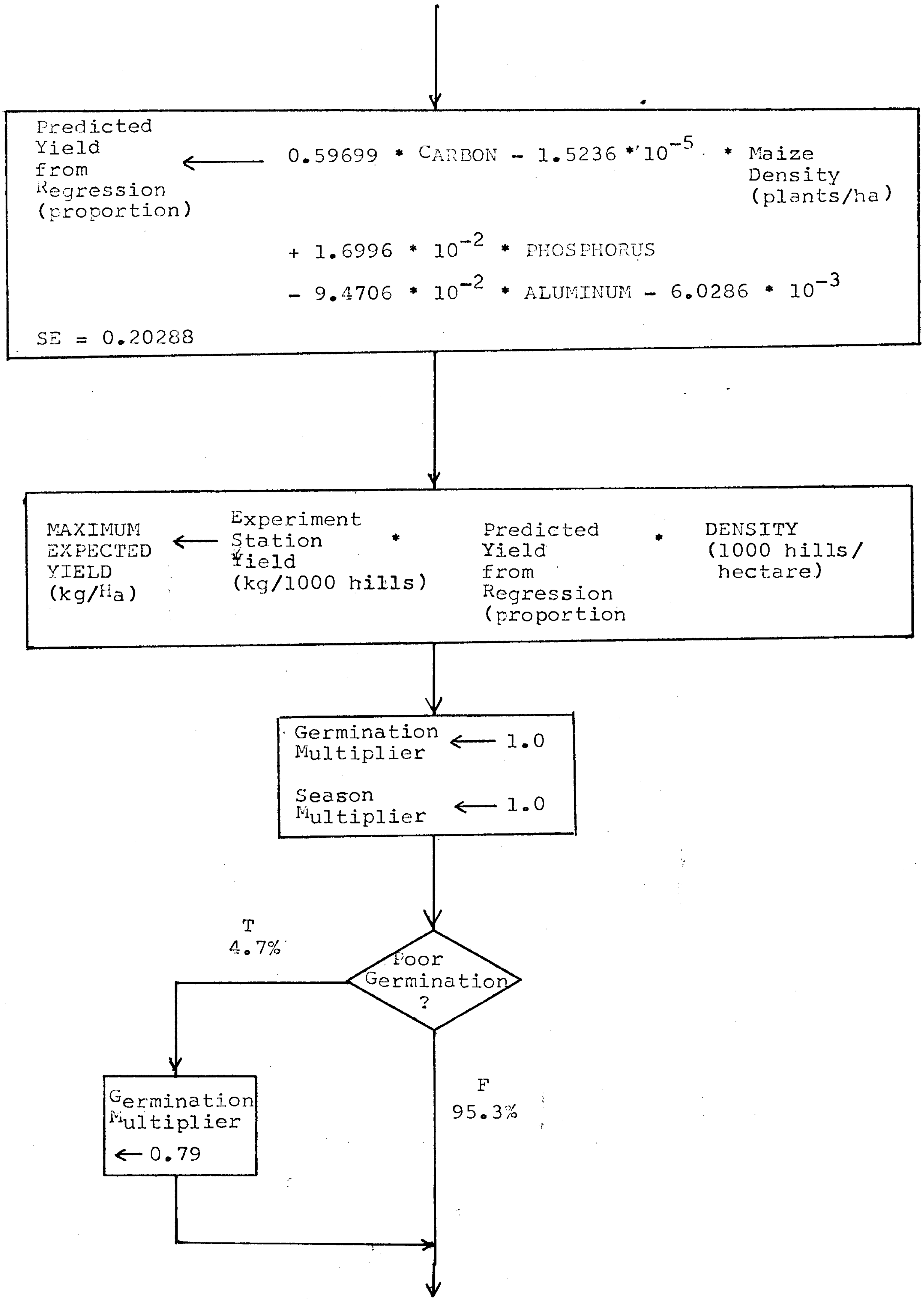


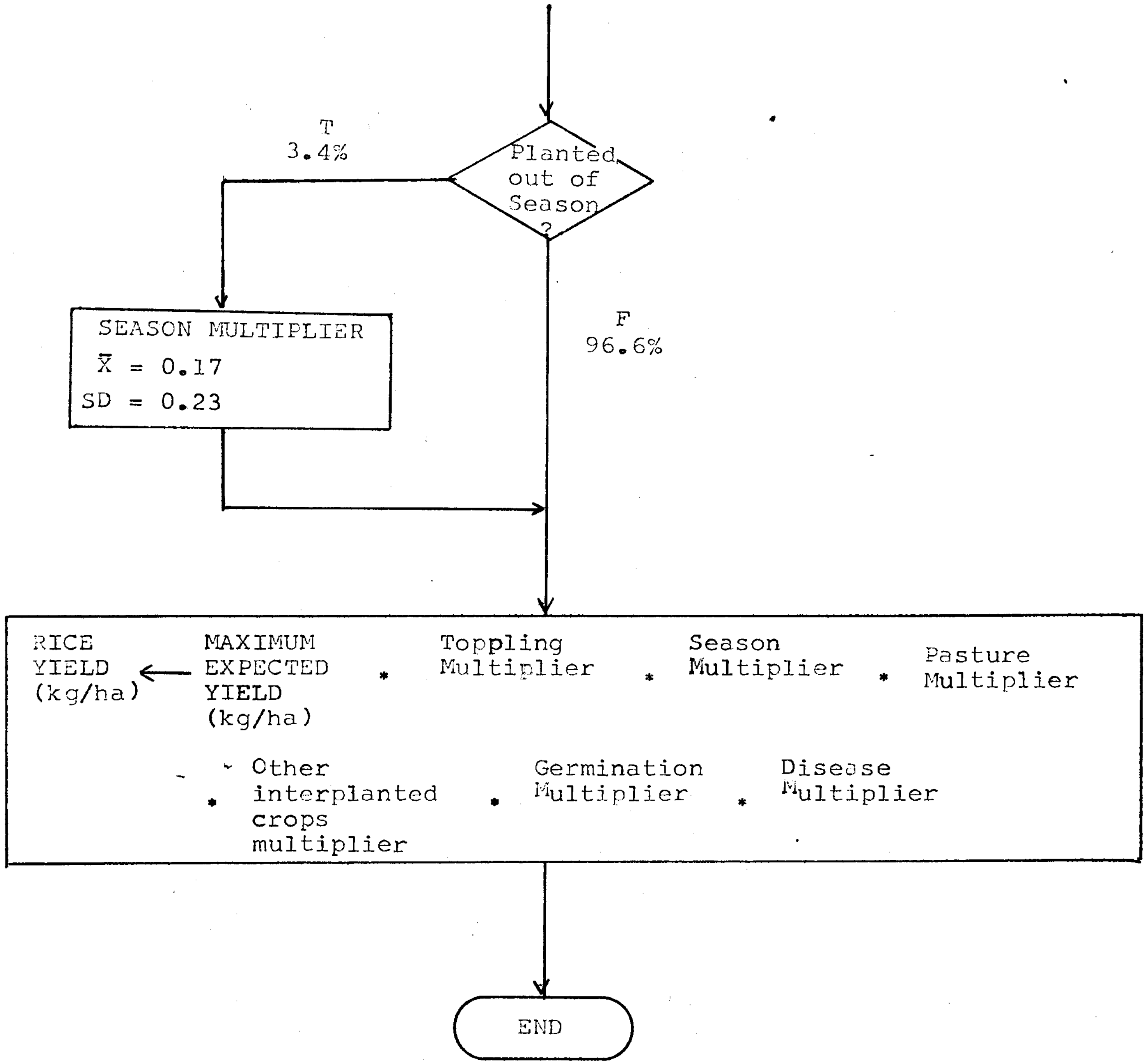

RICE
Disease Multiplier ← 1.0
Toppling Multiplier ← 1.0
Variety Multiplier ← 1.0
PLANTING DENSITY
X̄ = 109.67 (10³ hills/hectare)
SD= 68.79
VARIETY
Hybrid
84.4%
Traditional
10.0%
Other
5.6%
DISEASE ?
T
1.9%
F
98.1%
Disease Multiplier ← 0.806
DISEASE ?
T
14.3%
F
85.7%
Disease Multiplier ← 0.806
DISEASE ?
T
12.0%
F
88.0%
Disease Multiplier ← 0.806


hybrid
other
traditional
TOPPLING ?
T 13.3%
F 86.7%
TOPPLING MULTIPLIER
X̄ = 0.76
SD = 0.56
Variety Multiplier
← 0.823
DENSITY <111 (10^3 hph) ?
T
F
Experiment Station yield
← 20.5 * Density (10^3 hills/ha)
Experiment Station yield
← 2278 kg/ha
DENSITY
≤ 111 (10^3 hills/ha)
111 - 222 (10^3 hills/ha)
≥ 222 (10^3 hills/ha)
Experiment Station Yield
← 8.72 * DENSITY (10^3 hills/ha)
Experiment Sta. Yield
← 27.9 * DENSITY (10^3 hills/ha)
Experiment Station Yield
← 4102 kg/ha


Pasture Multiplier ← 1.0
Other Interplanted Crop Multiplier ← 1.0
Maize Density ← 0.0
PASTURE Interplanted ?
T (2.9%)
F (97.1%)
Pasture Multiplier ← 0.81
Other Interplanted Crop ?
T (1.6%)
F (98.4%)
Other Interplanted Crop Multiplier ← 0.82


T
(44.1%)
MAIZE
Interplanted
?
MAIZE DENSITY
$\bar{X}$ = 3507 plants/hectare
SD = 3444
F
(55.9%)
CARBON
> 2.0
?
Carbon ← 2.0
Phosphorus
>12
?
Phosphorus ← 12.0


Predicted Yield from Regression (proportion)
0.59699 * CARBON - 1.5236 * 10^-5 * Maize Density (plants/ha)
+ 1.6996 * 10^-2 * PHOSPHORUS
- 9.4706 * 10^-2 * ALUMINUM - 6.0286 * 10^-3
SE = 0.20288
MAXIMUM EXPECTED YIELD (kg/Ha)
Experiment Station Yield (kg/1000 hills)
*
Predicted Yield from Regression (proportion
*
DENSITY (1000 hills/ hectare)
Germination Multiplier
1.0
Season Multiplier
1.0
Poor Germination ?
T
4.7%
F
95.3%
Germination Multiplier
0.79


T
3.4%
Planted out of Season ?
SEASON MULTIPLIER
$\bar{X}$ = 0.17
SD = 0.23
F
96.6%
RICE YIELD (kg/ha)
MAXIMUM EXPECTED YIELD (kg/ha)
* Toppling Multiplier
* Season Multiplier
* Pasture Multiplier
* Other interplanted crops multiplier
* Germination Multiplier
* Disease Multiplier
END

July 24, 1977

SUMMARY OF MAIZE YIELD REGRESSION:

1) ORIGINAL DATA SET: 224 cases

2) CULLING THE DATA SET:

a) INVALID DATA:

- field areas less than 1 hectare
- questionable data due to noted contradictions or vagueness in colonist response
- cases where soil sample did not come from location of field but from a similar nearby location with the same history
- cases with incomplete data for any of the regression variables: pH, planting density, interplanted rice density and interplanted manioc density

b) EXCLUDED CATEGORIES OF VALID DATA:

- cases reporting rat damage of intensity 3 or 4 in any stage of the life cycle
- cases with poor germination noted
- cases with disease noted

3) MAIZE YIELD REGRESSION:

Maize yield (kg/1000 plants) = $1.25 \cdot 10^{-4} \cdot$ pH (adjusted to 6.0)

$- 2.92 \cdot 10^{-8} \cdot$ Maize density (plants / Ha)

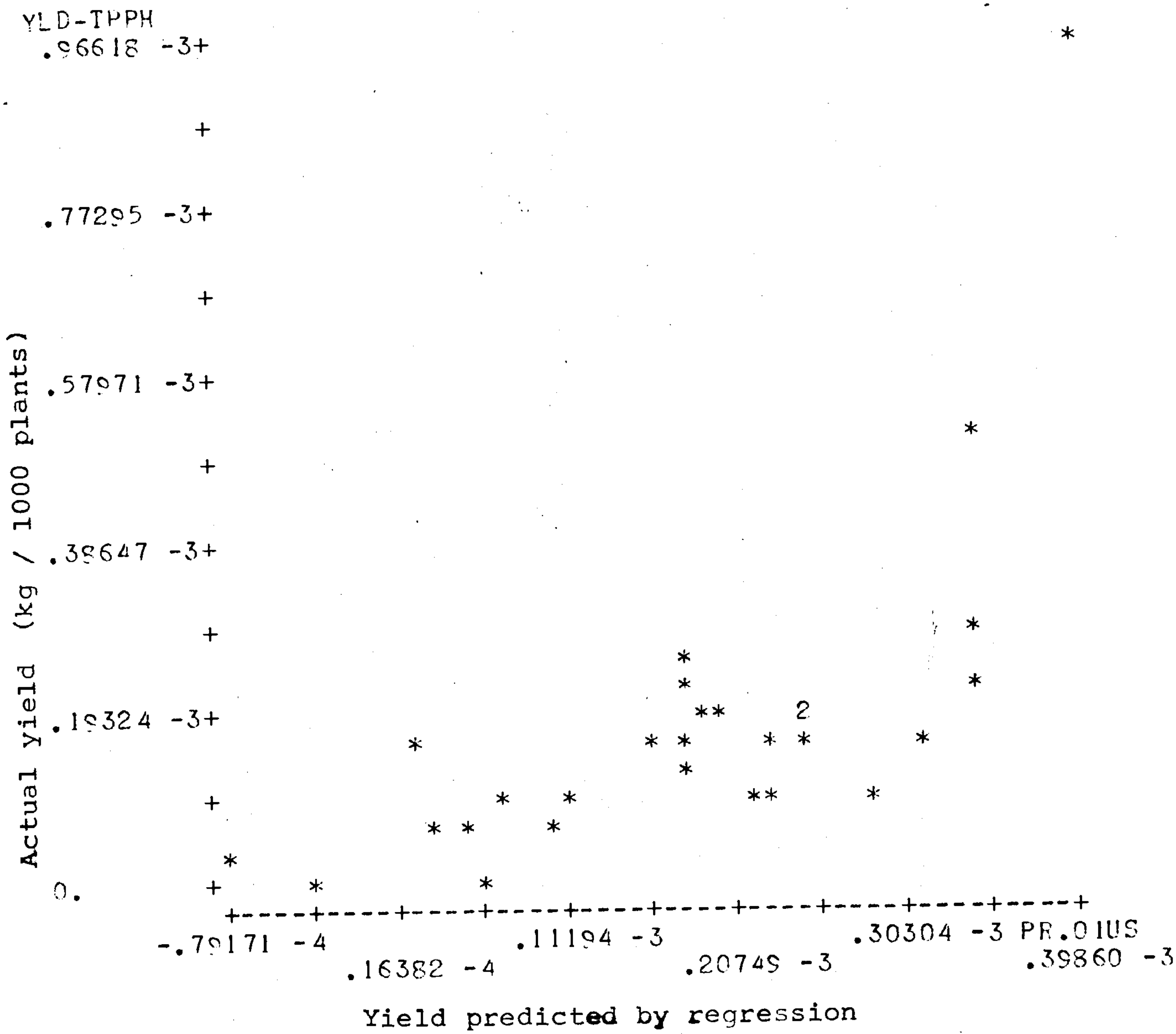
$- 2.22 \cdot 10^{-8} \cdot$ Manioc density (plants / ha)

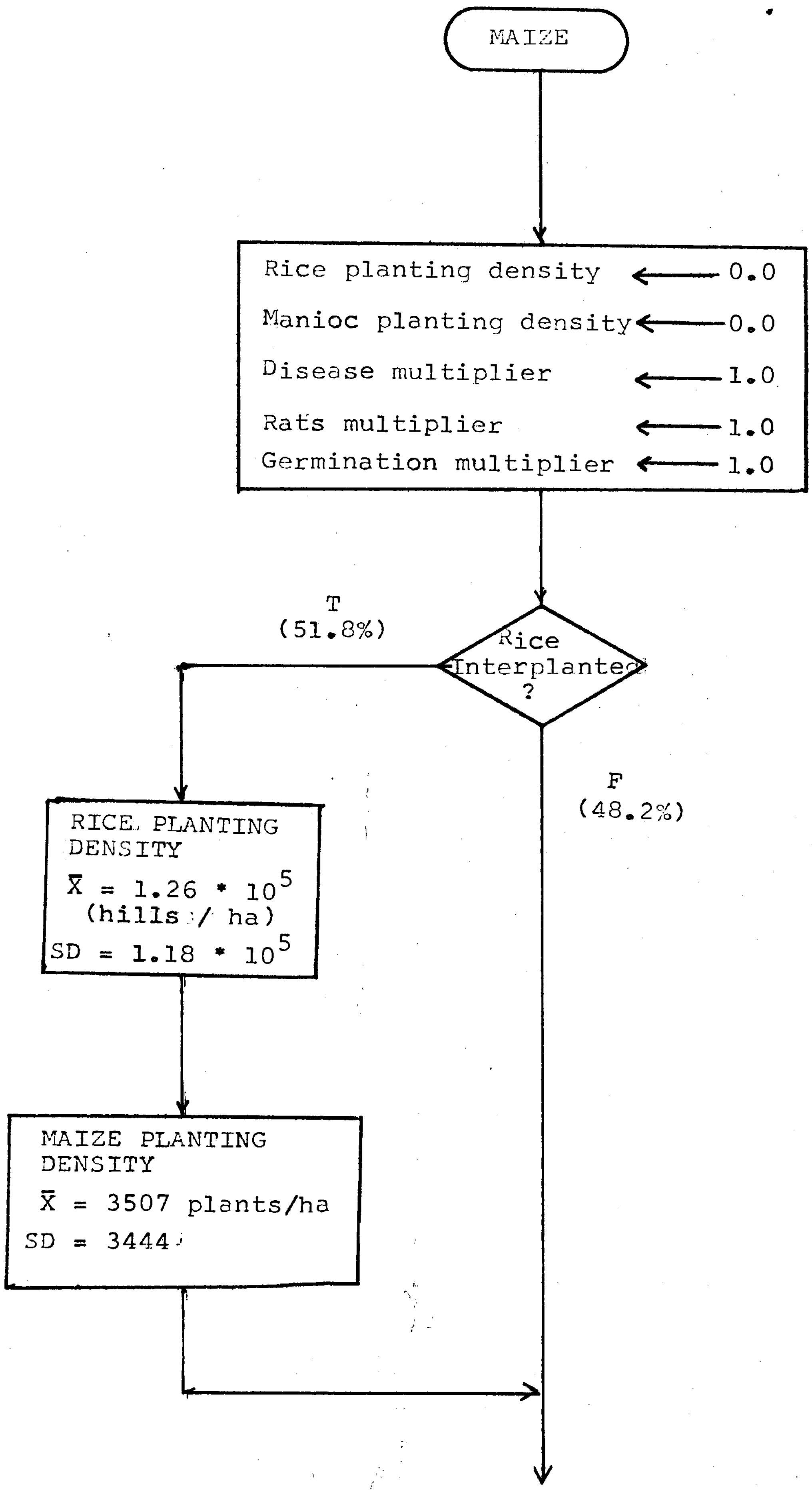
$- 8.16 \cdot 10^{-10} \cdot$ Rice density (hills/ha) $+ 3.30 \cdot 10^{-4}$

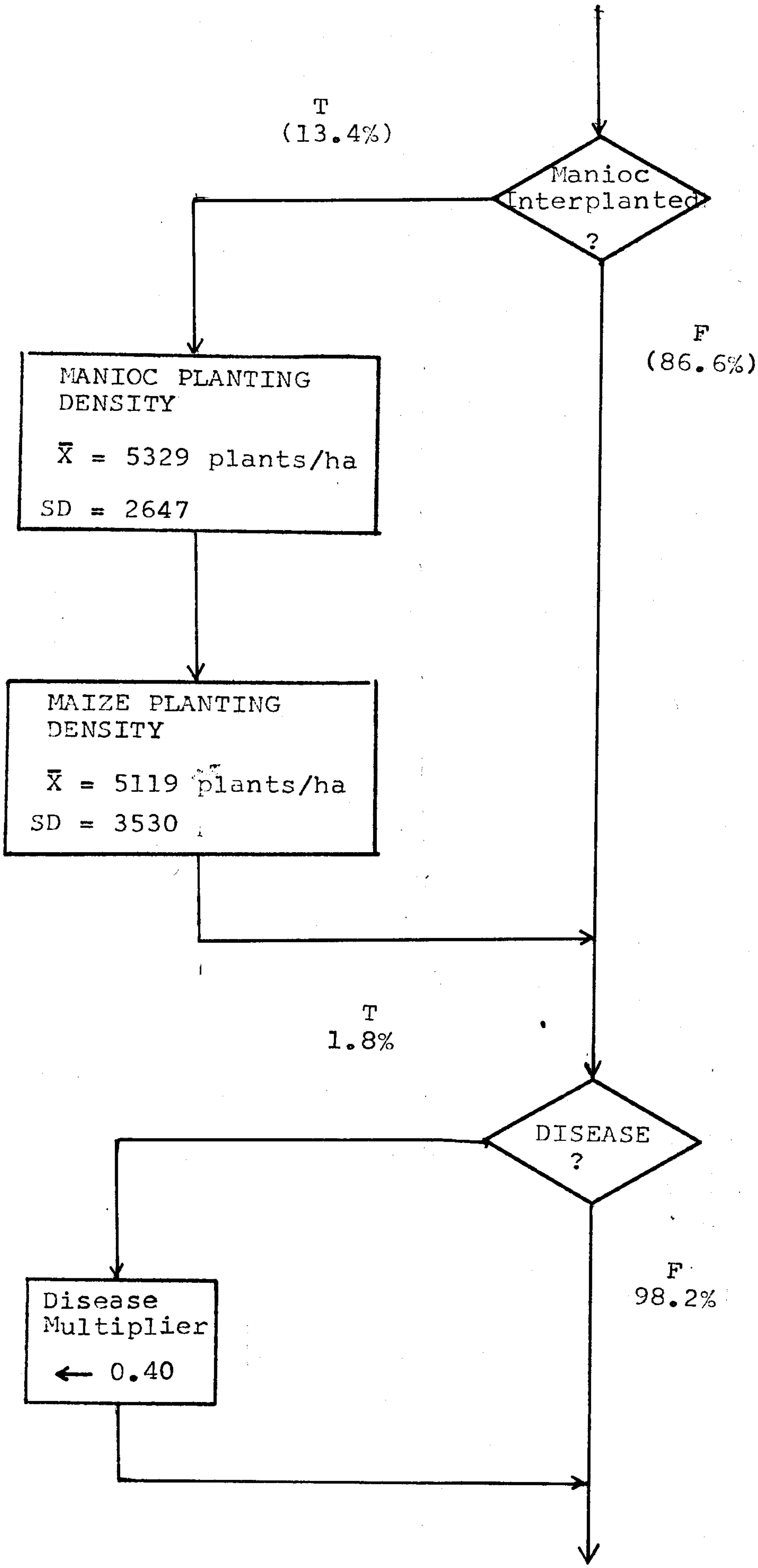
$p = 0.0109$
$r = 0.6487$
$r^2 = 0.4208$
$SE = 1.5069 \cdot 10^{-4}$
$N = 28$

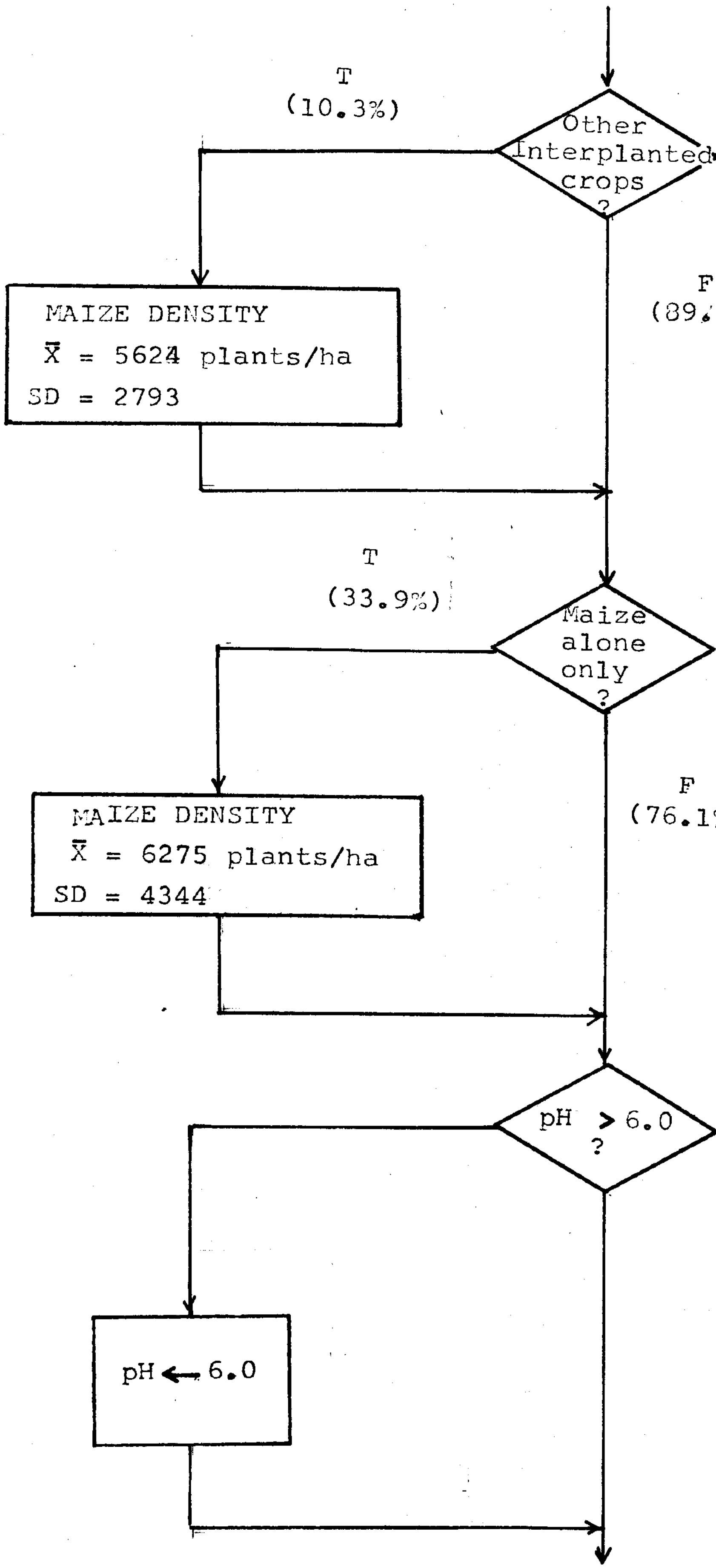
SCATTER PLØT MAIZE ACTUAL YIELDS IN KG PER THØUSAND PLANTS VS PREDICTED YIELDS FRØM REGRESSIØN ØN PH (ADJUSTED TØ 6.0) PLANTING DENSITY - INTERPLANTED RICE DENSITY AND INTERPLANTED MANIØC DENSITY

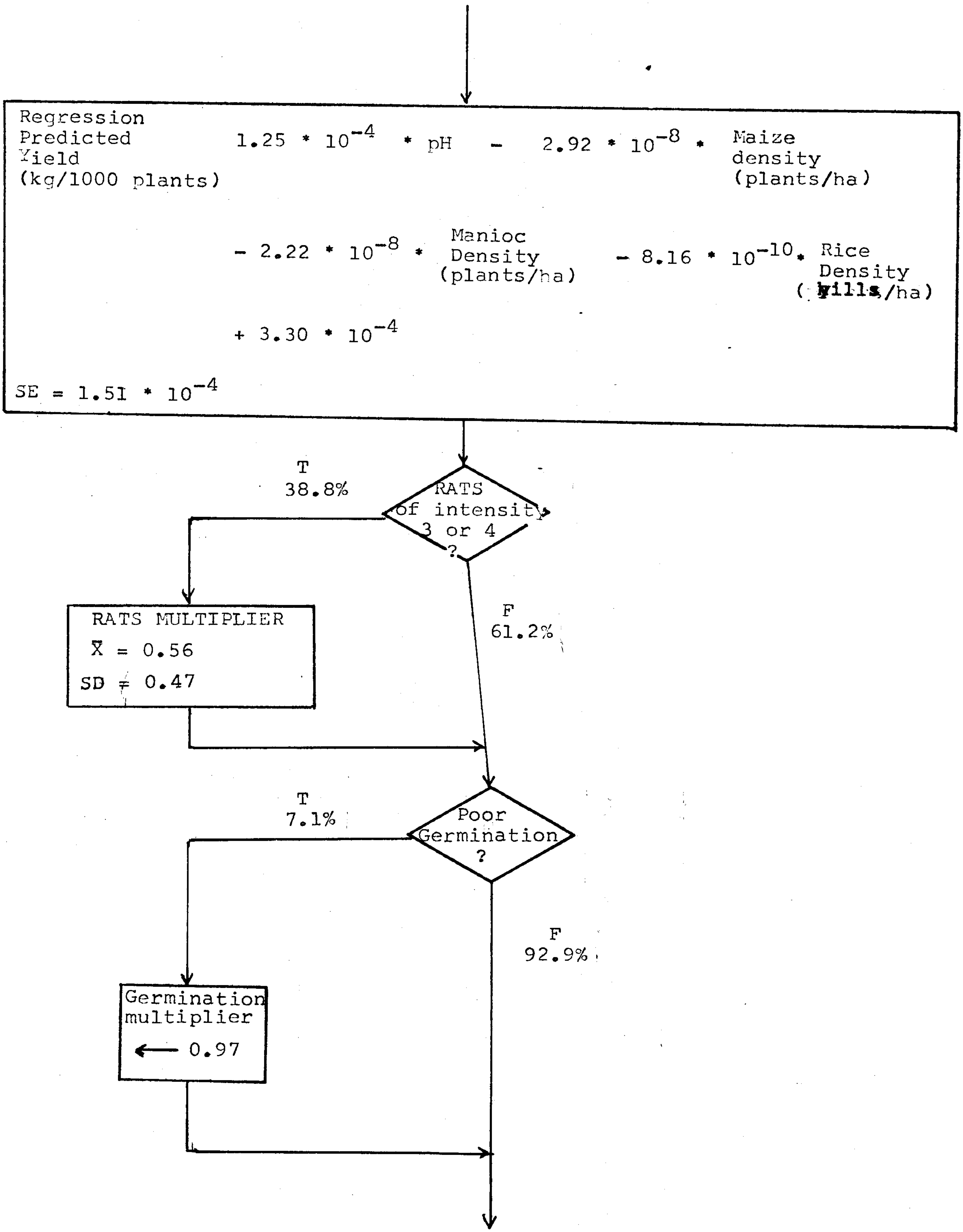
N= 28 ØUT ØF 224 9004.YLD-TPPH VS. 9811.PR.01US

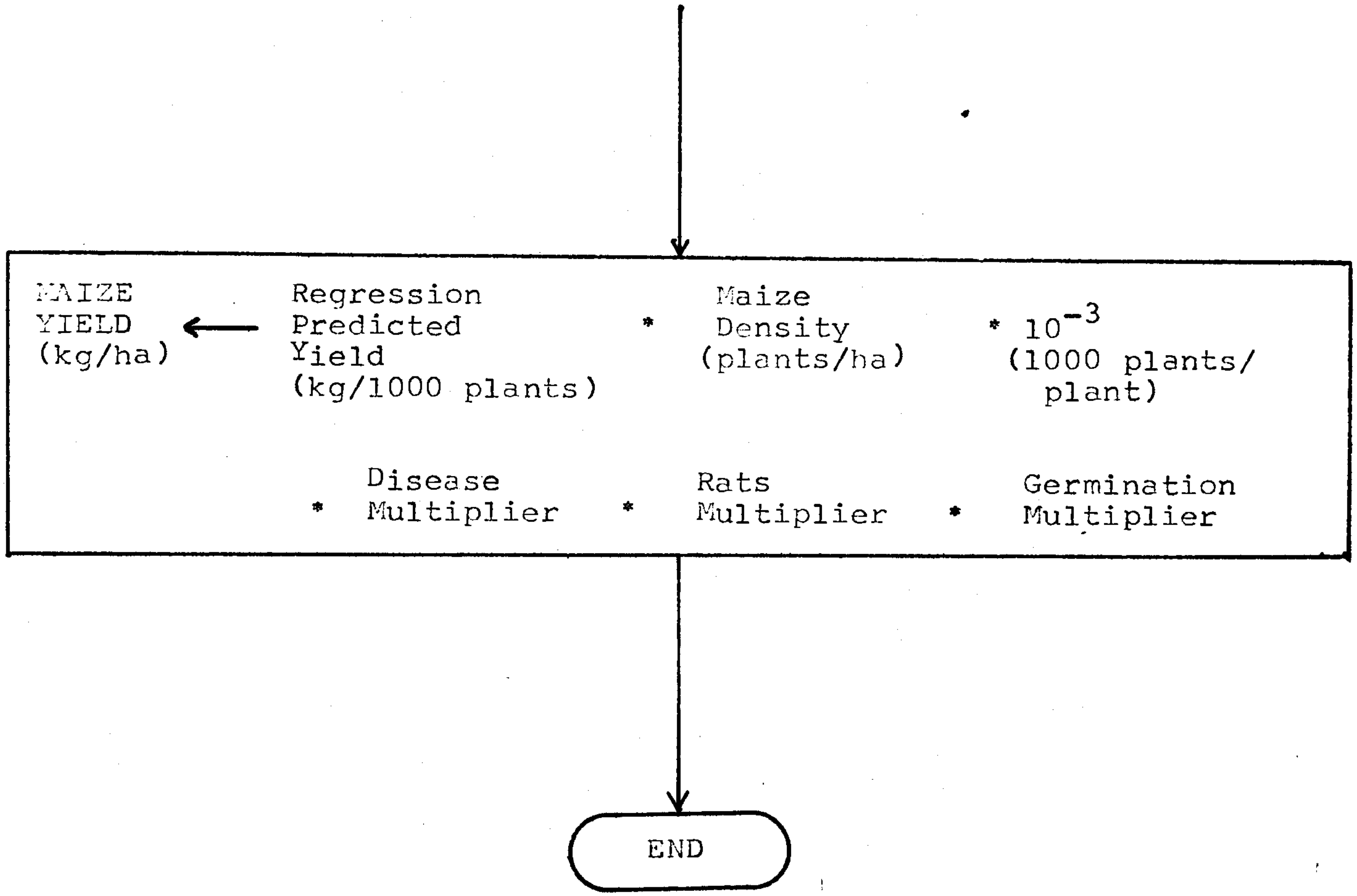



MAIZE
Rice planting density ← 0.0
Manioc planting density ← 0.0
Disease multiplier ← 1.0
Rats multiplier ← 1.0
Germination multiplier ← 1.0
T (51.8%)
Rice Interplanted ?
F (48.2%)
RICE PLANTING DENSITY
X̄ = 1.26 * 10^5 (hills / ha)
SD = 1.18 * 10^5
MAIZE PLANTING DENSITY
X̄ = 3507 plants/ha
SD = 3444


T
(13.4%)
Manioc
Interplanted
?
F
(86.6%)
MANIOC PLANTING
DENSITY
X̄ = 5329 plants/ha
SD = 2647
MAIZE PLANTING
DENSITY
X̄ = 5119 plants/ha
SD = 3530
T
1.8%
DISEASE
?
F
98.2%
Disease
Multiplier
← 0.40


T
(10.3%)
Other Interplanted crops ?
MAIZE DENSITY
X̄ = 5624 plants/ha
SD = 2793
F
(89.7%)
T
(33.9%)
Maize alone only ?
MAIZE DENSITY
X̄ = 6275 plants/ha
SD = 4344
F
(76.1%)
pH > 6.0 ?
pH ← 6.0


Regression Predicted Yield (kg/1000 plants)
1.25 * 10^-4 * pH - 2.92 * 10^-8 * Maize density (plants/ha)
- 2.22 * 10^-8 * Manioc Density (plants/ha) - 8.16 * 10^-10 * Rice Density (hills/ha)
+ 3.30 * 10^-4
SE = 1.51 * 10^-4
RATS of intensity 3 or 4 ?
T 38.8%
F 61.2%
RATS MULTIPLIER
X̄ = 0.56
SD = 0.47
Poor Germination ?
T 7.1%
F 92.9%
Germination multiplier
← 0.97


MAIZE YIELD (kg/ha)
Regression Predicted Yield (kg/1000 plants)
*
Maize Density (plants/ha)
* 10^-3 (1000 plants/ plant)
* Disease Multiplier
* Rats Multiplier
* Germination Multiplier
END

Philip M. Fearnside
July 25, 1977

SUMMARY OF PHASEOLUS YIELD REGRESSION:

1.) ORIGNINAL DATA SET: 120 cases

2.) CULLING THE DATA SET:

a) INVALID DATA:

- fields with areas less than 1.0 hectare
- questionable data (noted contradictions or vagueness in colonist responses) for yield, disease or areas
- incomplete data for yield, density, interplanted maize density, disease, or pH

b) EXCLUDED CATEGORIES OF VALID DATA:

- fields with disease of any intensity
- fields with poor germination reported

3.) ADJUSTMENTS AND TRANSFORMATIONS OF DATA:

- pH "adjusted to 5.7", meaning that pH values above 5.7 were reassigned the value 5.7. This corresponds to the expectations from the linear response-plateau model for yield prediction using a value from the literature as the critical value above which further increases in pH will have no effect on <u>Phaseolus</u> yield.
- the natural log of planting density is used

4.) REGRESSION EQUATION FOR PHASEOLUS YIELDS:

$$\underset{\text{(kg/kg seed sown)}}{\text{Phaseolus yield}} = 69.77 * \ln \underset{\text{(plants/ha)}}{\text{DENSITY}} * \underset{\text{(adjusted)}}{\text{pH}} - 1.50 * 10^{-3} * \underset{\text{(plants/ha)}}{\text{maize density}} + 267.64$$

$p = 0.0263$

$r = 0.7901$

$r^2 = 0.6242$

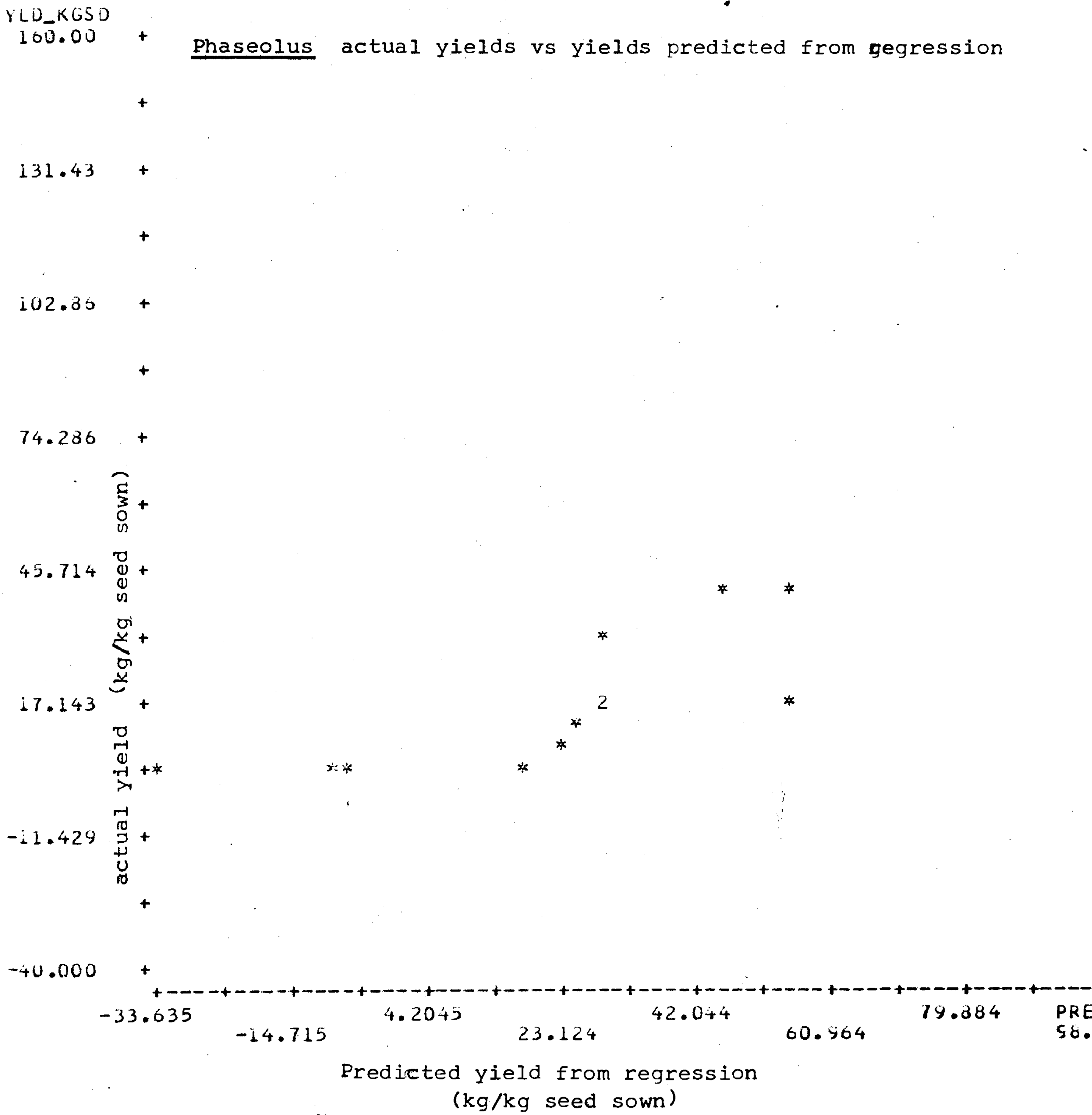
$SE = 29.802$

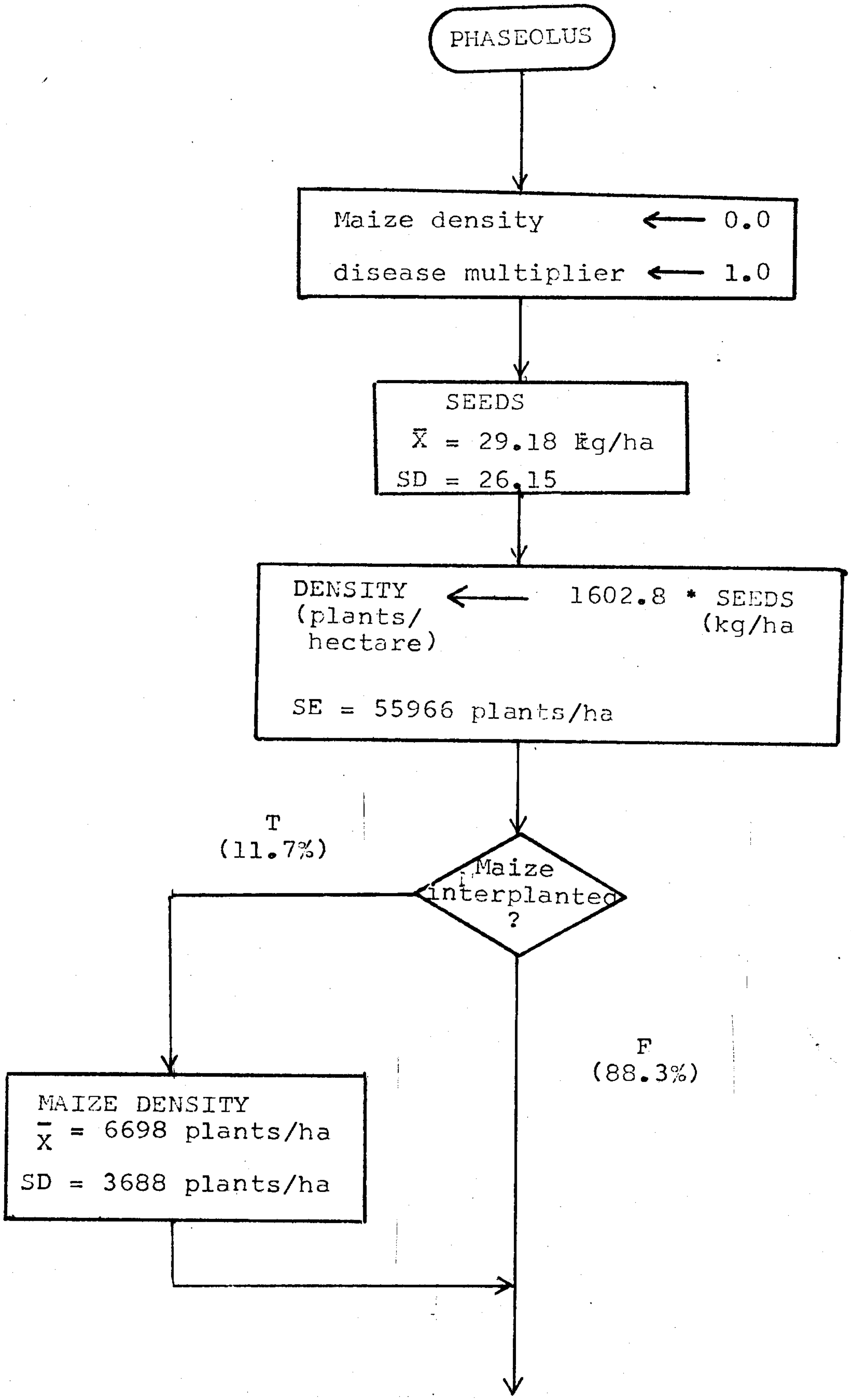
$N = 13$

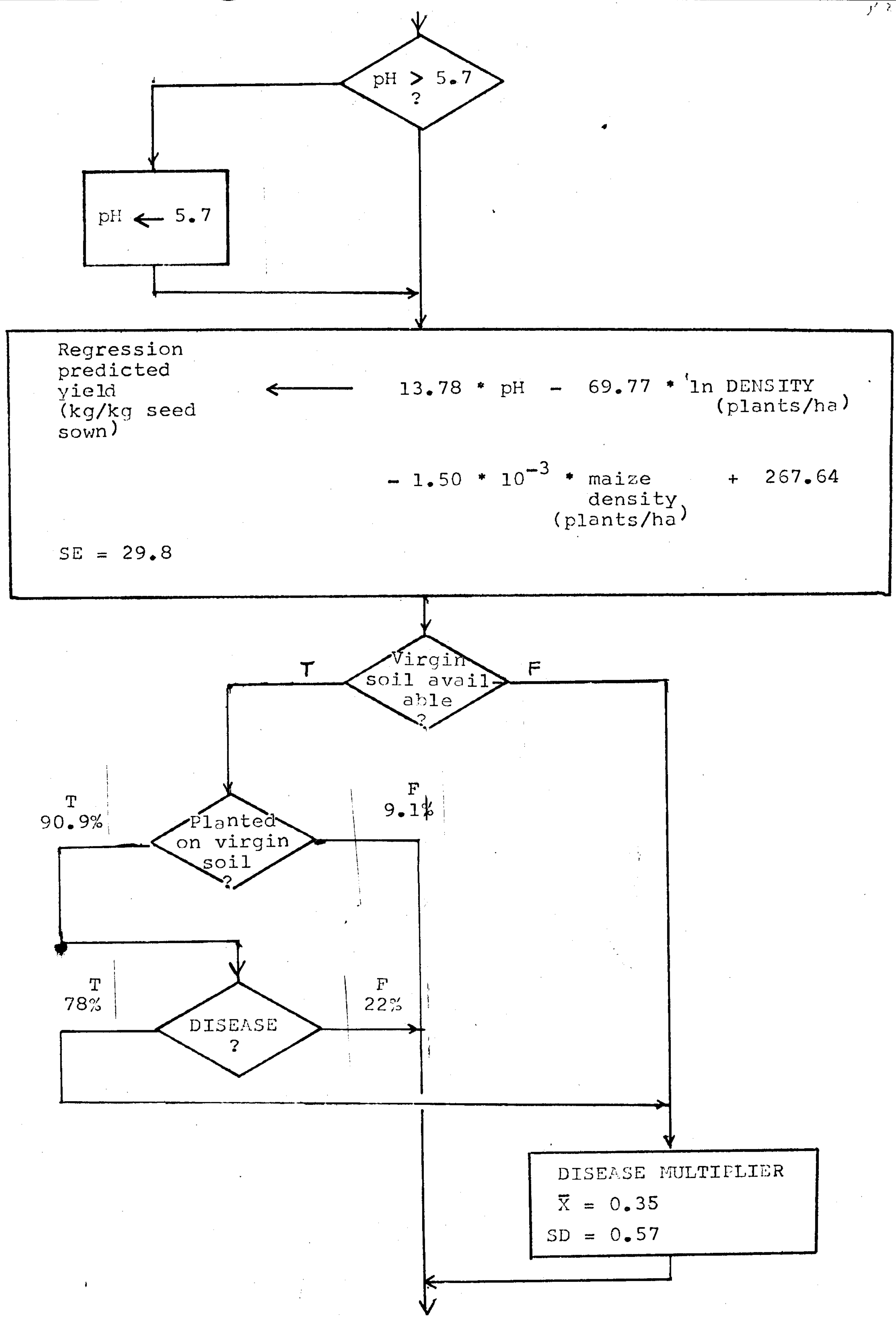
IS 0.62418 TO BE USED>

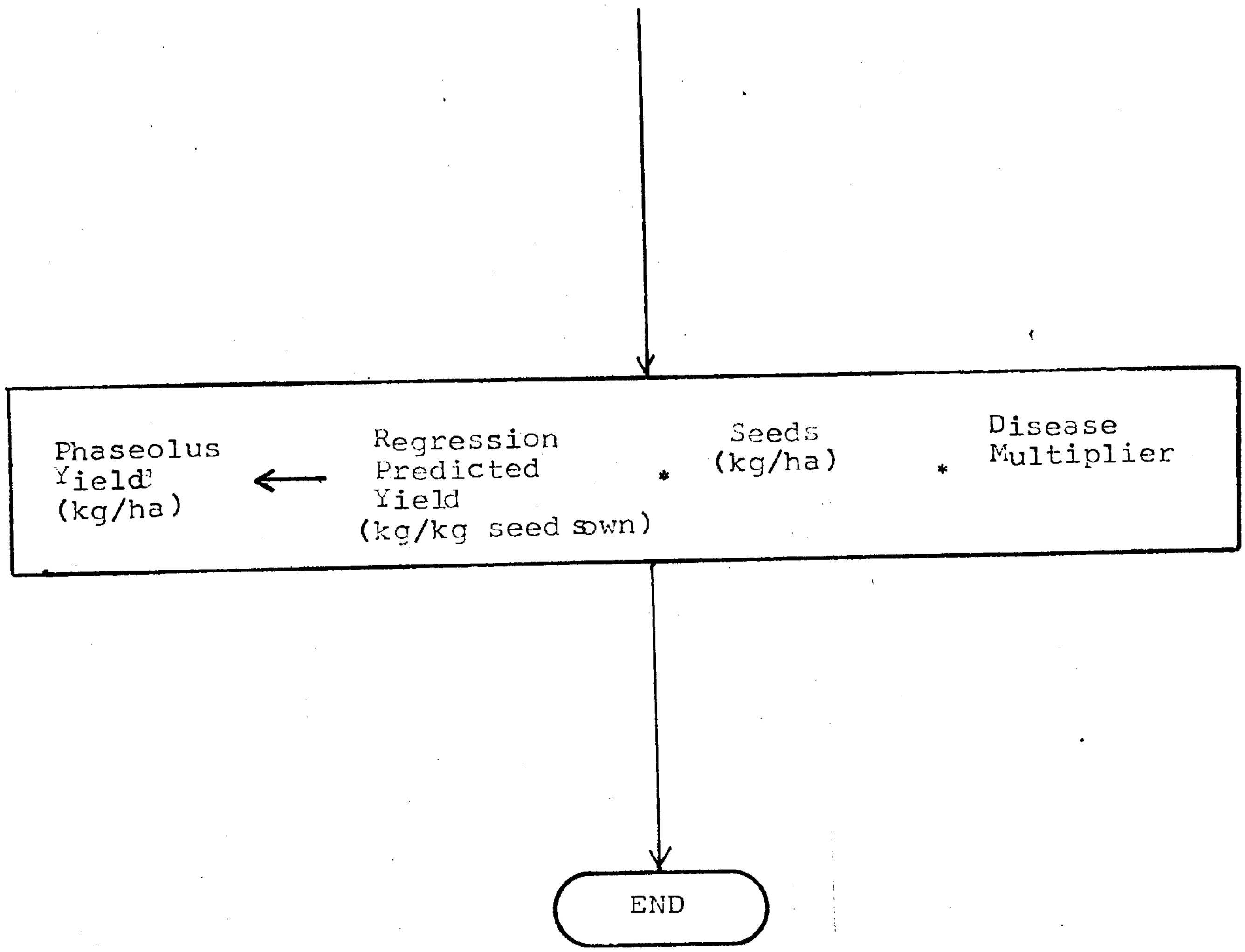
SCATTER PLOT PHASEOLUS ACTUAL VS PREDICTED YIELDS FROM REGRESSION ON LOG PLANTIN DENSITY AND PH (ADJUSTED TO 5.7) FOR FIELDS AT LEAST 1.0 HA IN AREA WITH NO DISEA PROBLEMS AND NO EXCLUDED DATA. SIGNIF IS 0.0263 R-SQR IS 0.62418 TO BE USED

N= 13 OUT OF 120 9003.YLD_KGSD VS. 9101.PRE3V1HA




PHASEOLUS
Maize density ← 0.0
disease multiplier ← 1.0
SEEDS
X̄ = 29.18 kg/ha
SD = 26.15
DENSITY (plants/hectare) ← 1602.8 * SEEDS (kg/ha
SE = 55966 plants/ha
Maize interplanted ?
T (11.7%)
F (88.3%)
MAIZE DENSITY
X̄ = 6698 plants/ha
SD = 3688 plants/ha


pH > 5.7 ?
pH ← 5.7
Regression predicted yield (kg/kg seed sown) ← 13.78 * pH − 69.77 * ln DENSITY (plants/ha) − 1.50 * 10^-3 * maize density (plants/ha) + 267.64
SE = 29.8
Virgin soil available ?
T
F
Planted on virgin soil ?
T 90.9%
F 9.1%
DISEASE ?
T 78%
F 22%
DISEASE MULTIPLIER
X̄ = 0.35
SD = 0.57


Phaseolus Yield (kg/ha)
Regression Predicted Yield (kg/kg seed sown)
*
Seeds (kg/ha)
*
Disease Multiplier
END

Philip M. Fearnside
July 25, 1977

SUMMARY OF VIGNA YIELD REGRESSION:

1.) ORIGINAL DATA SET: 34 cases

2.) CULLING THE DATA SET:

a) INVALID DATA:

- questionable data for yield, density or area
- cases where sample did not come from the Vigna field but from a nearby field with similar history
- fields less than 0.5 ha in area
- fields with yields estimated prior to sacking (no actual cases)
- fields with incomplete data for yields, area, disease or pH

b) EXCLUDED CATEGORIES OF VALID DATA:

- fields with disease
- fields with germination problems reported (no actual cases)
- fields with rabbit attack of intensity 3 or 4

3.) ADJUSTMENTS AND TRANSFORMATIONS OF DATA: none

4.) VIGNA YIELD REGRESSION:

$$\text{Vigna yield (kg/kg seed sown)} = 20.81 * \text{pH} - 84.40$$

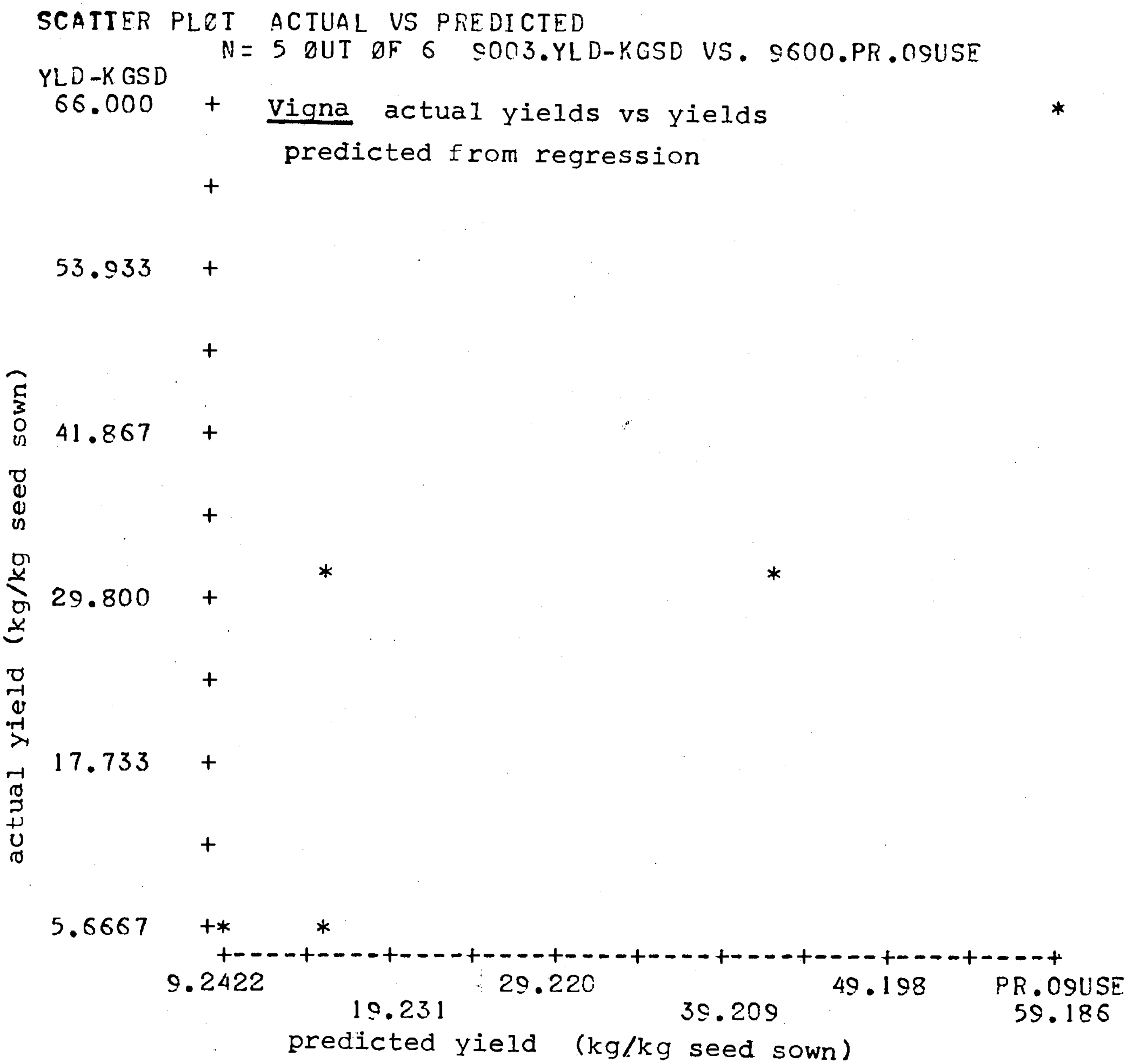
$p = 0.0535$

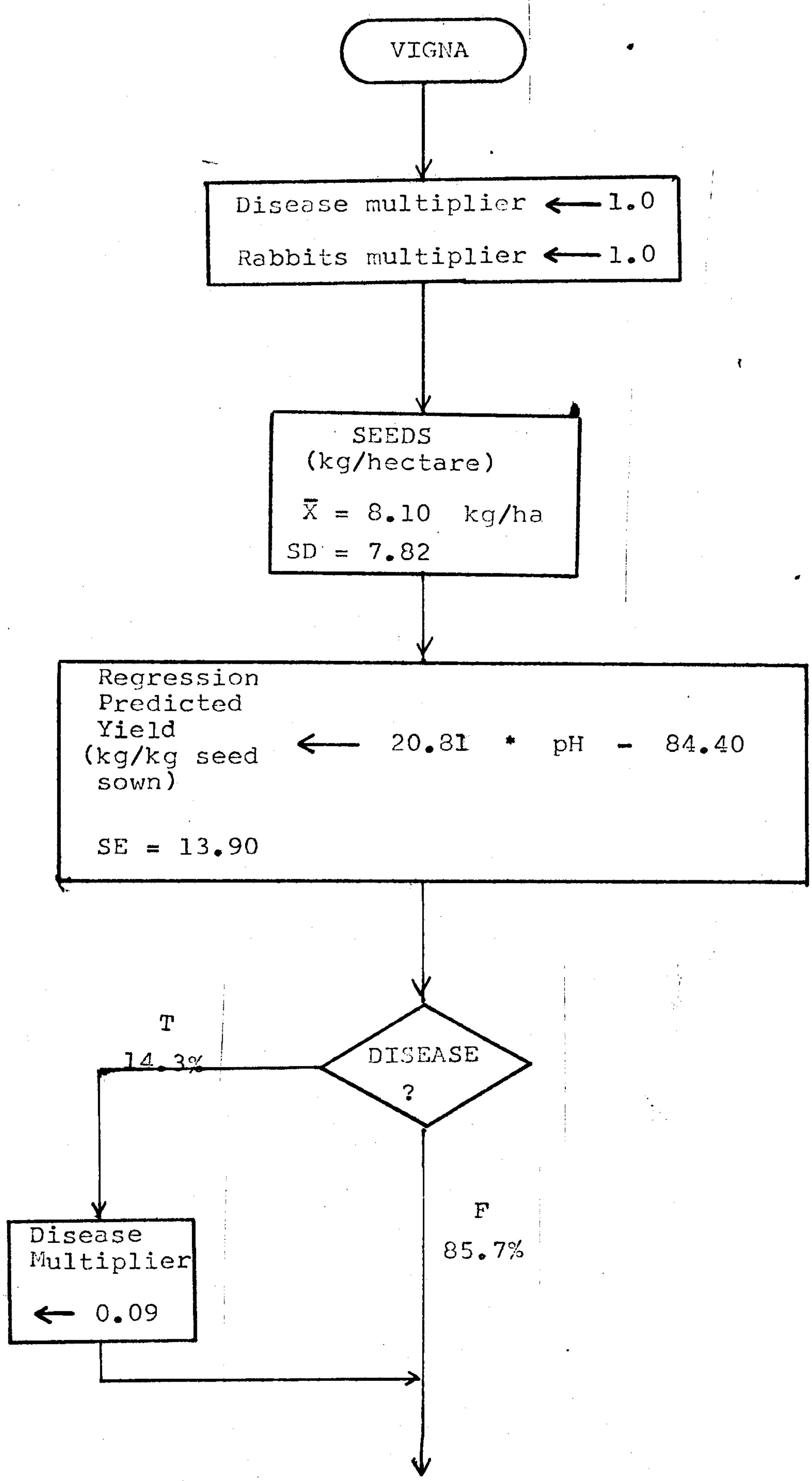
$r = 0.8726$

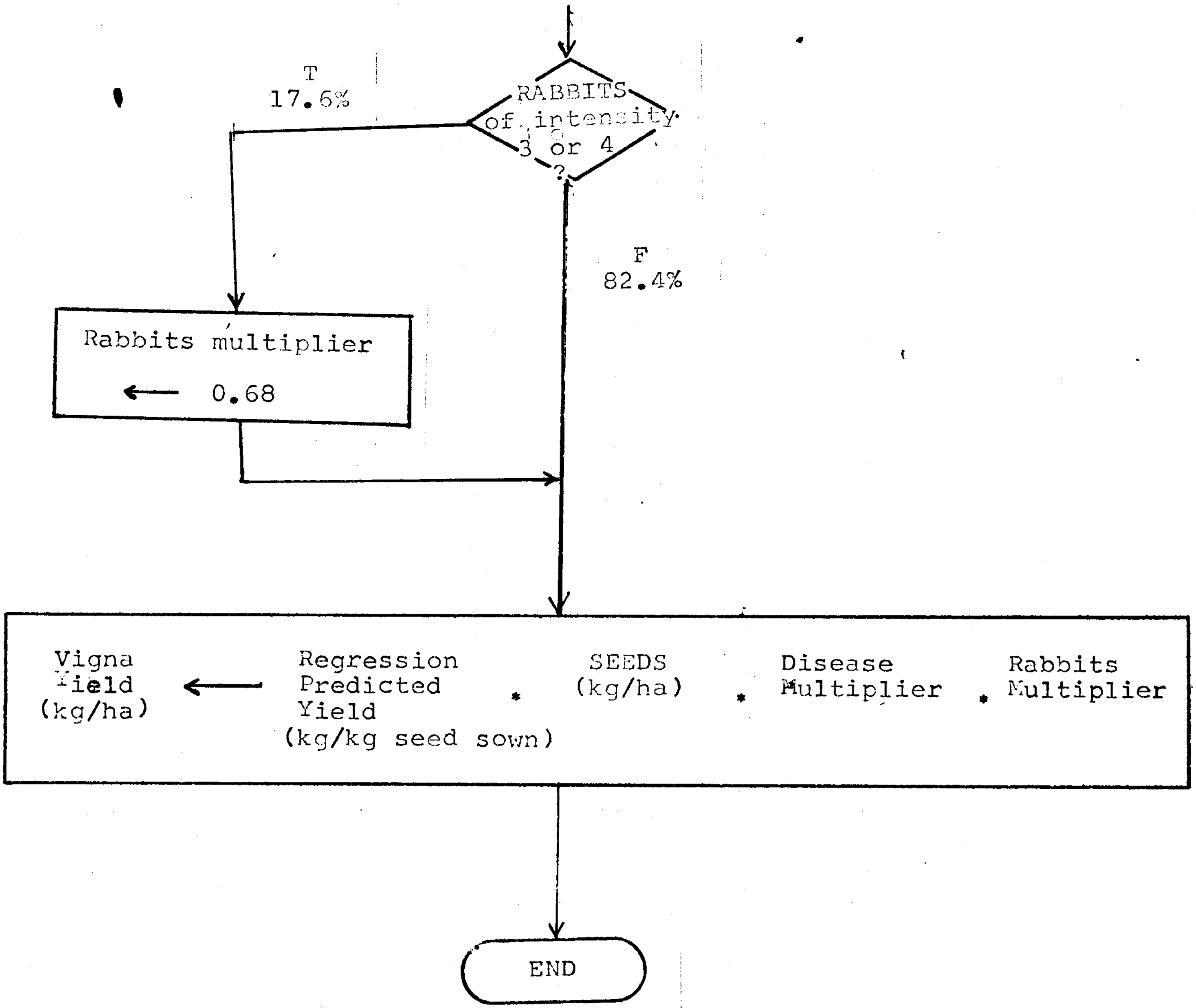
$r^2 = 0.7614$

$SE = 13.895$

$N = 5$


SCATTER PLØT ACTUAL VS PREDICTED
N= 5 ØUT ØF 6 S003.YLD-KGSD VS. S600.PR.09USE
YLD-KGSD
66.000
53.933
41.867
29.800
17.733
5.6667
9.2422
19.231
29.220
39.209
49.198
PR.09USE
59.186
Vigna actual yields vs yields predicted from regression
actual yield (kg/kg seed sown)
predicted yield (kg/kg seed sown)


VIGNA
Disease multiplier ← 1.0
Rabbits multiplier ← 1.0
SEEDS (kg/hectare)
X̄ = 8.10 kg/ha
SD = 7.82
Regression Predicted Yield (kg/kg seed sown) ← 20.81 * pH - 84.40
SE = 13.90
DISEASE ?
T
14.3%
F
85.7%
Disease Multiplier ← 0.09



RABBITS of intensity 3 or 4 ?
T 17.6%
F 82.4%
Rabbits multiplier ← 0.68
Vigna Yield (kg/ha) ← Regression Predicted Yield (kg/kg seed sown) * SEEDS (kg/ha) * Disease Multiplier * Rabbits Multiplier
END

Philip M. Fearnside
July 24, 1977

SUMMARY OF BITTER MANIOC YIELD REGRESSION:

1.) ORIGINAL DATA SET: 64 cases

2.) CULLING THE DATA SET:

a.) INVALID DATA:

- field areas less than 0.5 hectare
- incomplete data for growth period, yield or area

b.) EXCLUDED CATEGORIES OF VALID DATA:

- growth periods less than 1 year
- growth periods over 2 years

3.) ADJUSTMENTS AND TRANSFORMATIONS OF THE DATA:

- none, but pH can be considered to be adjusted to 5.0 since this is the highest pH value present in the culled data set. This is also a reasonable value for the critical pH above which further increases will not improve manioc yields.

4.) BITTER MANIOC YIELD REGRESSION EQUATION:

Bitter manioc yield (kg farinha/ha) = 4124.4 * pH - 17369

$p = 0.0223$

$r = 0.9294$

$r^2 = 0.8639$

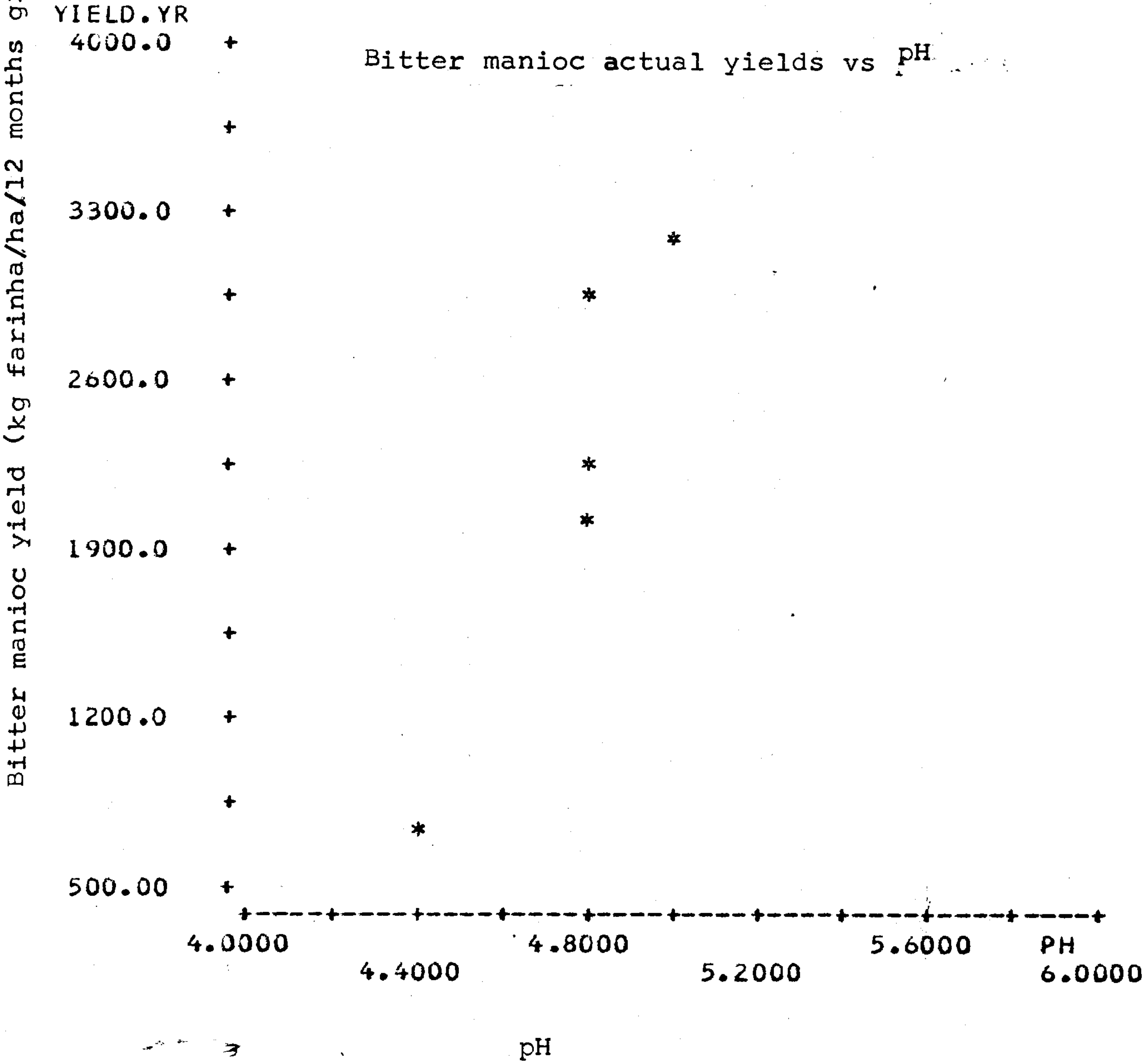
$SE = 414.22$

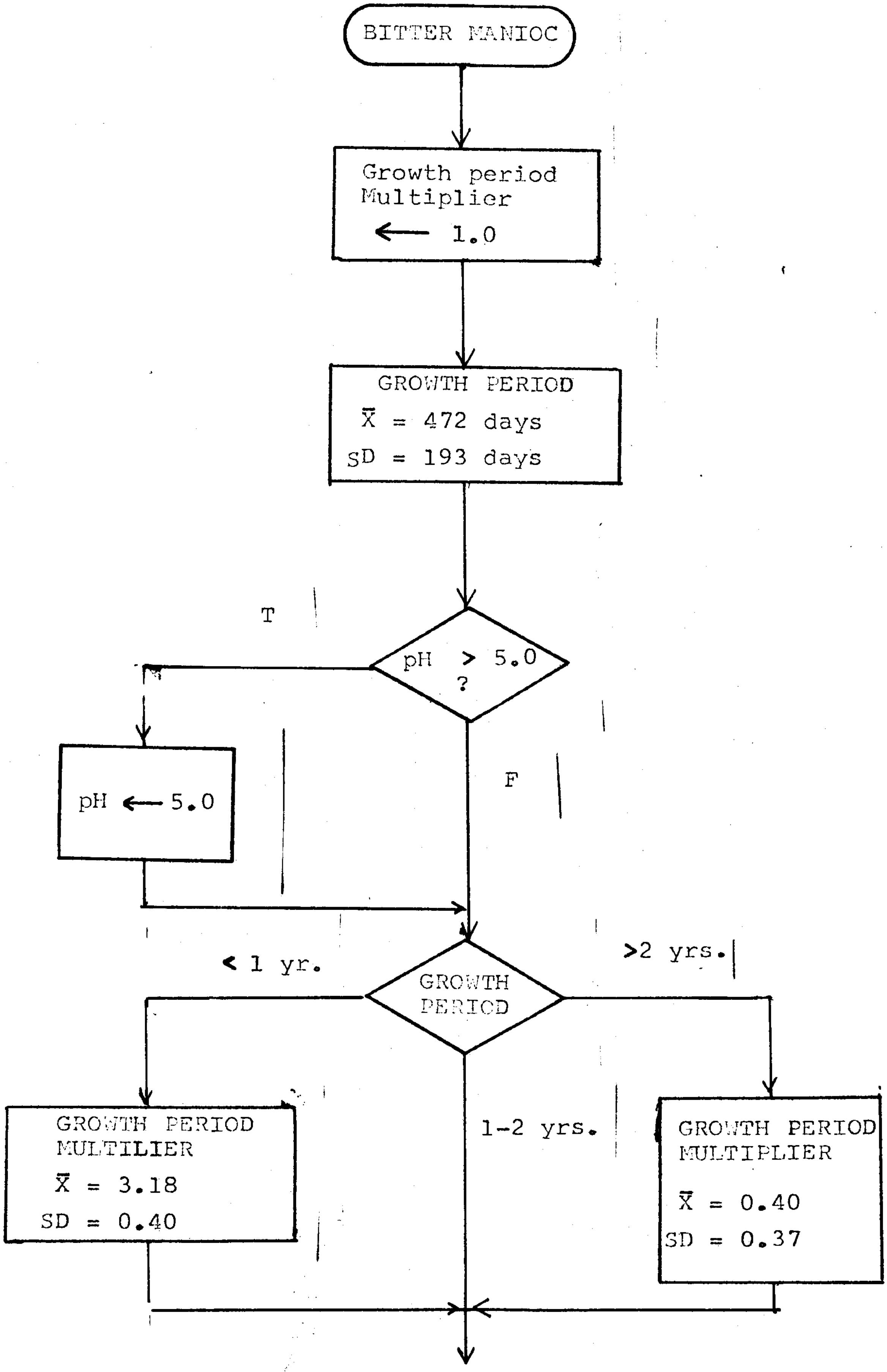
$N = 5$

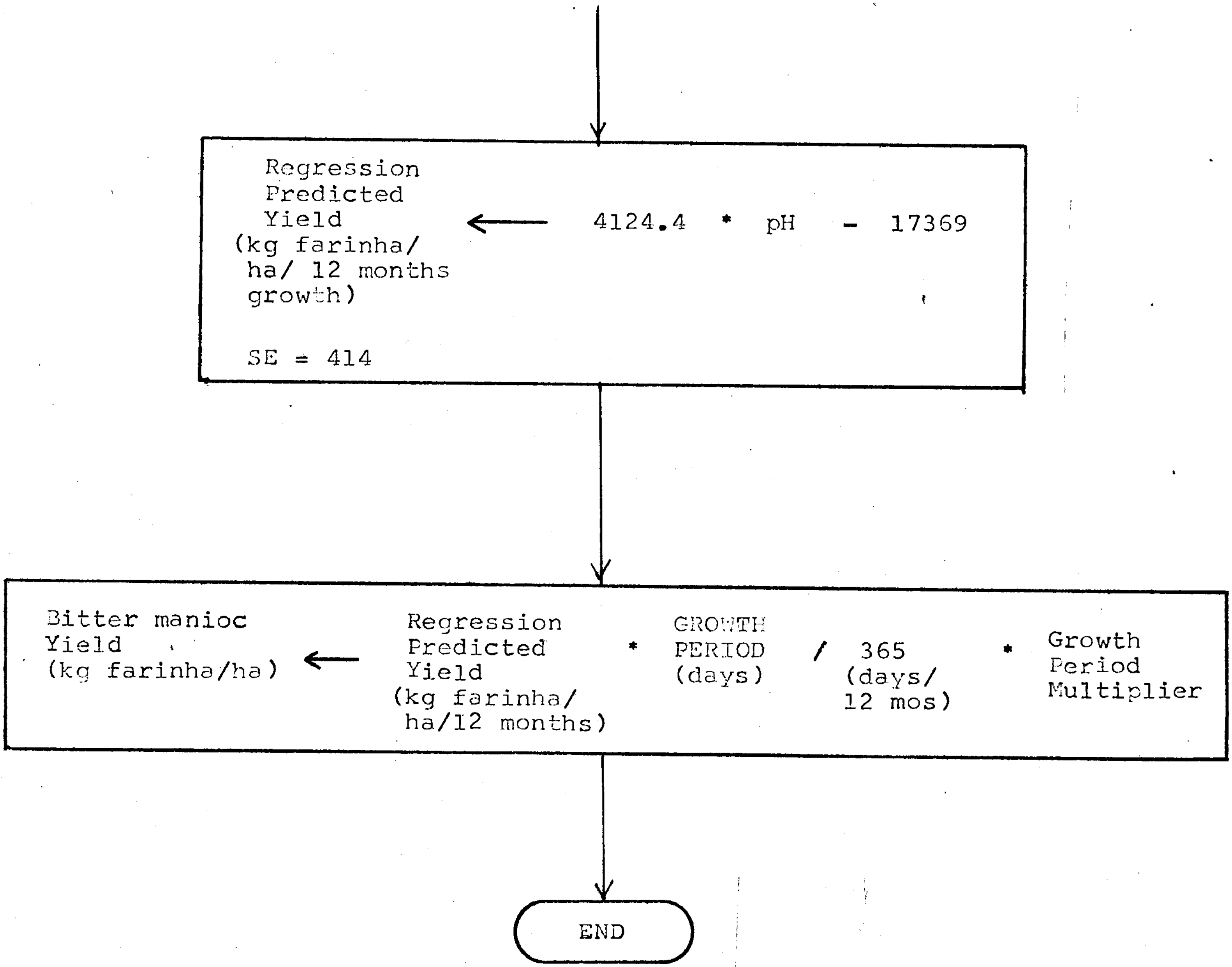
<SCAT VAR=9000;201 CASES=V9001:2*V9002:2-3 INTERVAL=(500,4000);(4.0,6.0) HEAD=BITTER MANIOC YIELDS PER 12 MONTHS GROWTH VS PH FOR FIELDS AT LEAST 0.5 HA IN AREA WITH GROWTH PERIODS OF 1-2 YEARS>

SCATTER PLOT BITTER MANIOC YIELDS PER 12 MONTHS GROWTH VS PH FOR FIELDS AT LEAST 0.5 HA IN AREA WITH GROWTH PERIODS OF 1-2 YEARS

N= 5 OUT OF 27 9000.YIELD.YR VS. 201.PH




BITTER MANIOC
Growth period Multiplier ← 1.0
GROWTH PERIOD
X̄ = 472 days
SD = 193 days
T
pH > 5.0 ?
F
pH ← 5.0
< 1 yr.
GROWTH PERIOD
>2 yrs.
1-2 yrs.
GROWTH PERIOD MULTILIER
X̄ = 3.18
SD = 0.40
GROWTH PERIOD MULTIPLIER
X̄ = 0.40
SD = 0.37



Regression Predicted Yield (kg farinha/ ha/ 12 months growth)
4124.4 * pH - 17369
SE = 414
Bitter manioc Yield (kg farinha/ha)
Regression Predicted Yield (kg farinha/ ha/12 months)
*
GROWTH PERIOD (days)
/ 365 (days/ 12 mos)
*
Growth Period Multiplier
END

Philip M. Fearnside
July 25, 1977

SUMMARY OF SWEET MANIOC YIELD REGRESSION:

1.) ORIGINAL DATA SET: 13 cases

2.) CULLING THE DATA SET:

a.) INVALID DATA:

- field areas less than 1.0 hectare (NB: larger minimum area required for sweet manioc than for bitter manioc due to bias in small fields from the practice of harvesting sweet manioc little by little for eating boiled or feeding to pigs.

- incomplete data for yield, growth period, area or pH

b.) EXCLUDED CATEGORIES OF VALID DATA:

- growth periods less than 1 year

- growth periods over 2 years (no actual cases)

3.) ADJUSTMENTS AND TRANSFORMATIONS OF THE DATA:

- pH "adjusted to 5.0" in accord with the linear response-plateau model for yield prediction.

- yield expressed as kg farinha / 12 months growth

4.) SWEET MANIOC YIELD REGRESSION EQUATION:

Sweet manioc yield (kg farinha/ha/12 months growth) = 587.53 * pH (adjusted to 5.0) - 1559.2

$p = 0.2557$

$r = 0.9204$

$r^2 = 0.8417$

$SE = 81.502$

$N = 3$

5.) REASONS FOR USING REGRESSION DESPITE SMALL SAMPLE SIZE:

There are several reasons for using the above regression despite the lack of statistical significance and the small sample size. The regression parallels the results for bitter manioc, except that sweet manioc yields are lower than predicted bitter manioc yields for a corresponding pH by a factor of 0.52. The regression also confirms field impressions.

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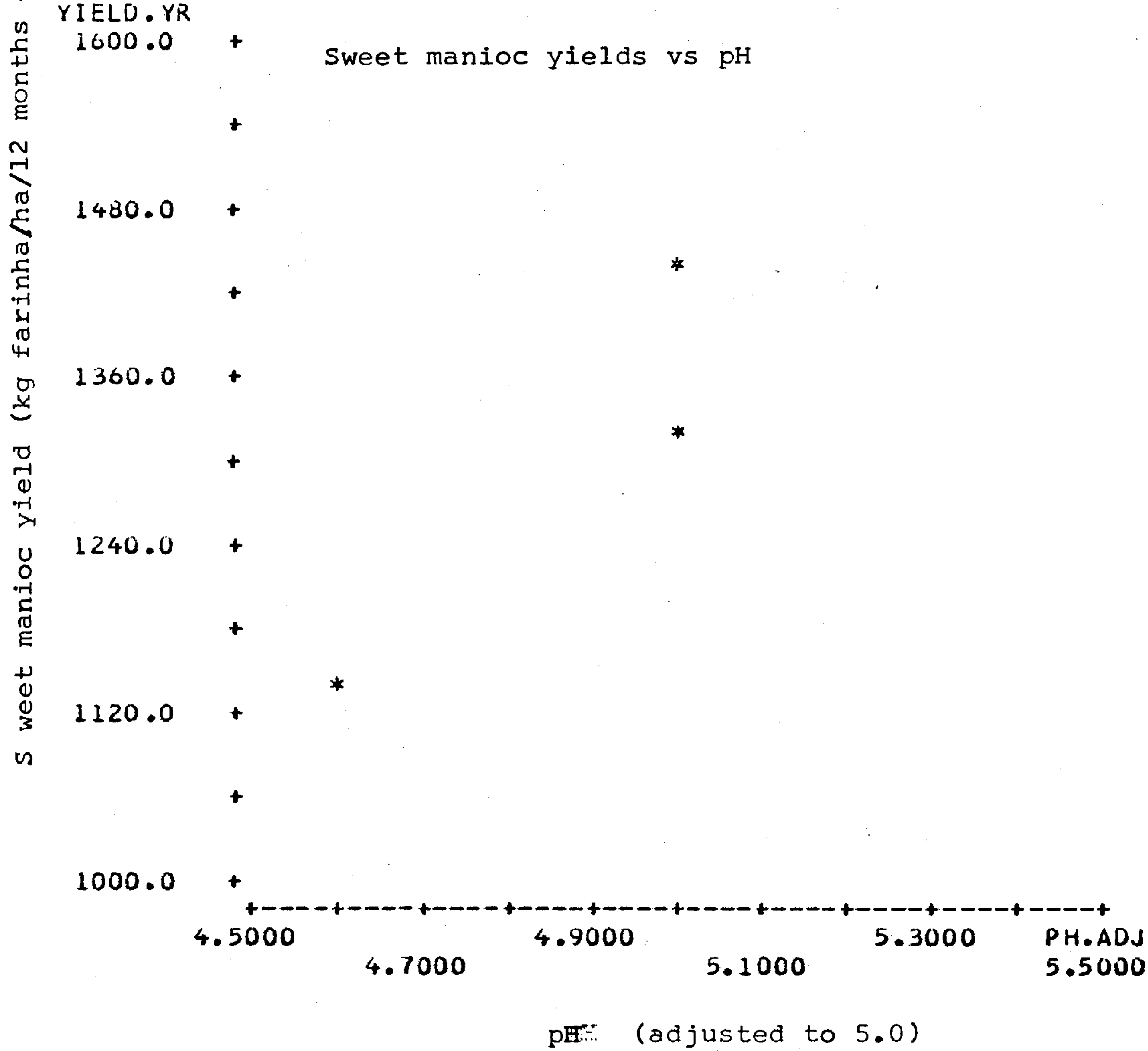
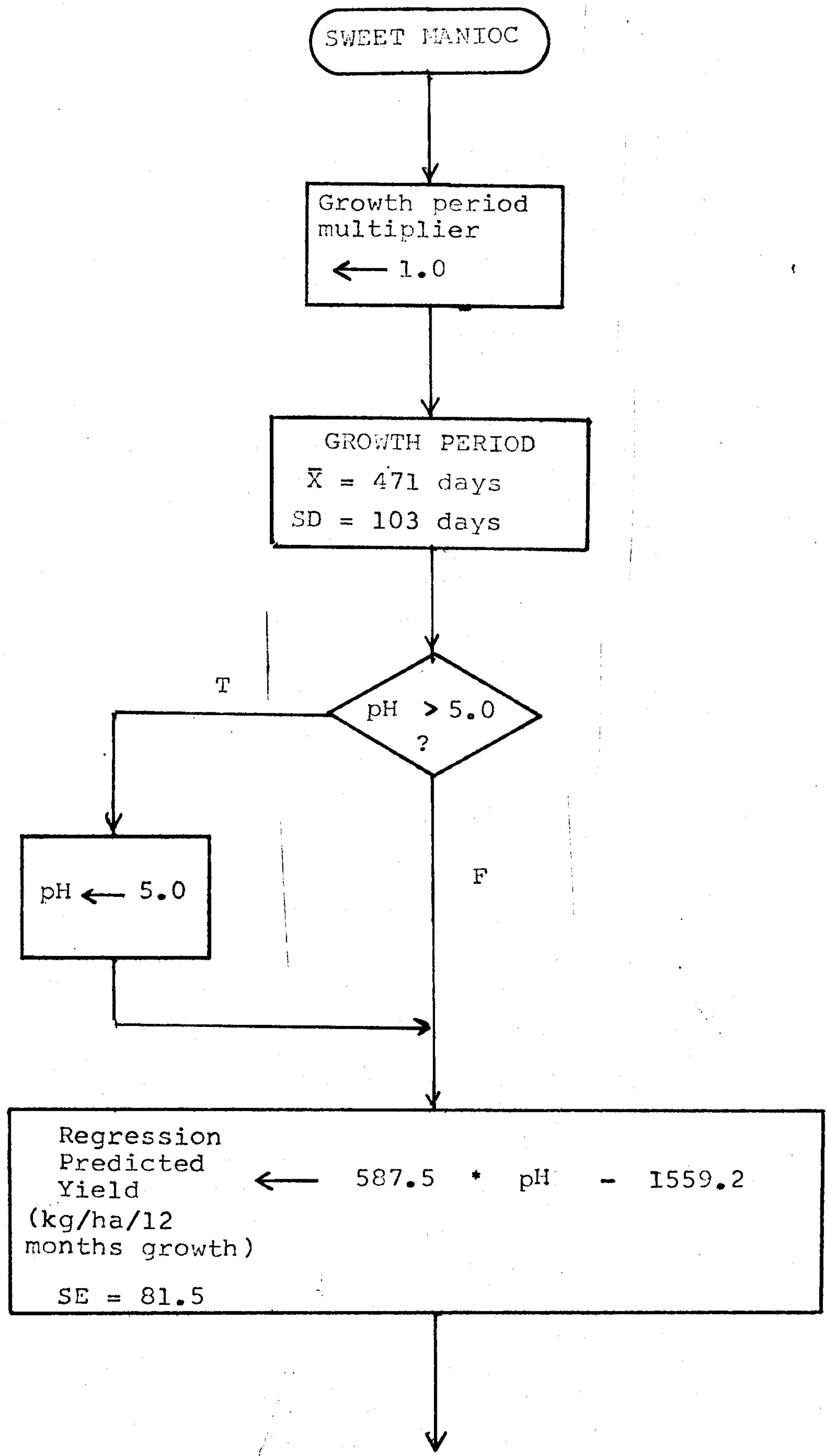
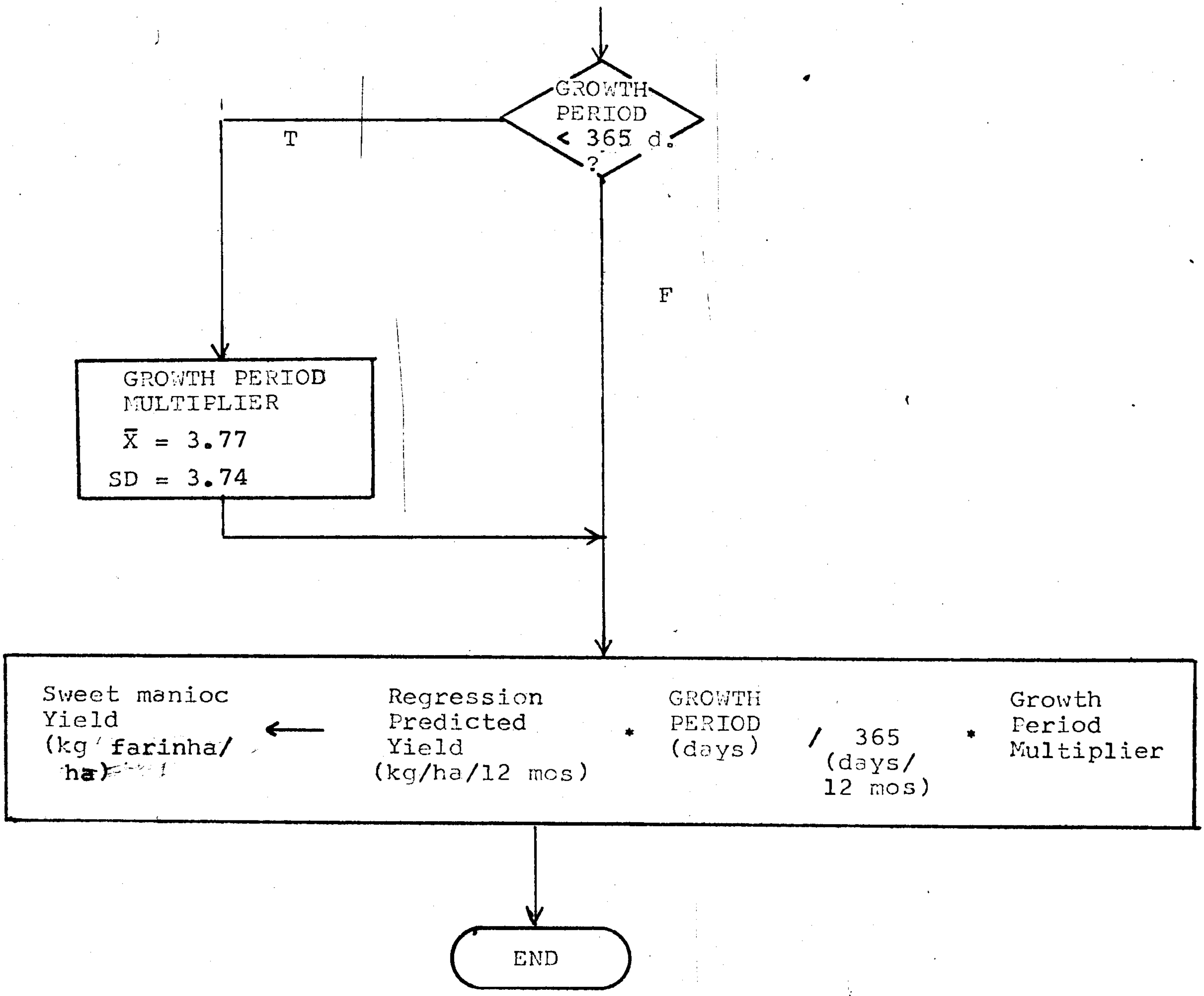
SCATTER PLOT SWEET MANIOC YIELDS PER 12 MONTHS GROWTH VS PH ADJUSTED TO 5.0 FOR FIELDS AT LEAST 1.0 HA IN AREA WITH GROWTH PERIODS OF 1-2 YEARS

N= 3 OUT OF 5 9000.YIELD.YR VS. 9008.PH.ADJ





SWEET MANIOC
Growth period multiplier ← 1.0
GROWTH PERIOD
X̄ = 471 days
SD = 103 days
pH > 5.0 ?
T
F
pH ← 5.0
Regression Predicted Yield (kg/ha/12 months growth) ← 587.5 * pH - 1559.2
SE = 81.5


GROWTH PERIOD < 365 d. ?
T
F
GROWTH PERIOD MULTIPLIER
$\bar{X}$ = 3.77
SD = 3.74
Sweet manioc Yield (kg farinha/ ha)
Regression Predicted Yield (kg/ha/12 mos)
*
GROWTH PERIOD (days)
/ 365 (days/ 12 mos)
*
Growth Period Multiplier
END