PA-ABF-972

# AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT (ATIP)

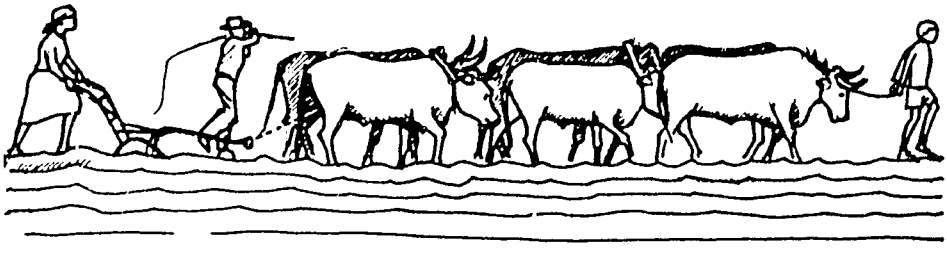
## DBASE III PLUS PROGRAMMES FOR ESTIMATING PLANT POPULATIONS AND YIELDS FROM PLOT QUADRAT DATA

BY

D. NORMAN AND J. SIEBERT

ATIP WORKING PAPER

ATIP WP-33



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A GOB / MIAC /USAID Project

PN-ABF-972
ISN 68066

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AGRICULTURAL CONSORTIUM
(MIAC)

JUNE 1989

PRINTED: June 6, 1990

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# DBASE III PLUS PROGRAMMES FOR ESTIMATING PLANT POPULATIONS AND YIELDS FROM PLOT QUADRAT DATA[1]

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[1]. The constructive suggestions of Dr. F. Worman on an earlier draft of this paper are gratefully acknowledged.

# INTRODUCTION

Plant population densities and crop yields are fundamental criteria in evaluating agronomic work. In FSR work obtaining accurate estimates of these in RMRI, RMFI and FMFI trials can be very time consuming. Several methods used by ATIP for collecting data to estimate these variables are described elsewhere (Worman, Norman and Ware-Snyder, 1990: p. 170-181). A number of methods are needed to take into account differences in the method of planting (such as broadcast versus row planting and sole versus mixed planting) and type of crop (such as grain, legume and fodder). In many of these techniques heavy emphasis is placed on systematic quadrat sampling within plots to obtain the necessary data for undertaking the estimating procedure.

Manipulating the data from the quadrats in order to derive estimates of plant population densities and yields per hectare can in itself be a time consuming process. Therefore dBase III Plus programmes have been designed to facilitate this process and reduce the potential for arithmetic errors. This working paper is devoted to documenting the procedure for obtaining these estimates. There are three basic steps in this estimation process:

(a). Plant stand and yield data need to be recorded in the field on specially designed forms.

(b). Data need to be transferred from the data collection forms directly into specially designed databases in dBase III Plus.

(c). After making sure the data have been entered accurately into the databases, the estimates of plant population densities and crop yields are obtained by running specifically designed dBase programmes.

Therefore there is a close relationship between the data collection forms, the structure of the databases, and the content of the dBase III Plus programmes. To provide the necessary documentation, examples of all three components are given in this working paper. The data collection forms presented are modified versions of those used in the 1988-89 National Tillage Trial. These in turn were based on those originally developed by ATIP Mahalapye. Estimating the plant population densities and crop yields are considered in separate sections (Sections A and B). It should be noted that the procedure for estimating yields only applies to cereal crops. In general it has been found that in the case of legumes -- the other major type of crop -- it is better to harvest the production of the whole plot since the plots are not generally very large (Worman, Norman and Ware Snyder, 1990: p. 175).

In order to be able to use the various forms, databases and programmes given in this paper, copies of all of them are available on a disk (i.e., disk W100) in the ATIP office at Sebele. The relevant files are listed in Appendix C. Copies can be made on to other disks and then the forms, databases and programmes delineated in this working paper can be used for collecting, entering and processing data.

Another approach to calculating the variables discussed in this working paper would be to set the programmes up on a spreadsheet in Lotus 123. Such an approach is probably reasonable if there are only a few plots. However, the advantage of the approach described in this report is that data from a large number of plots can be processed at once (i.e., in a batch) resulting in increased efficiency both in terms of time and storing of the results.

A final section to this working paper (Section C) discusses how data -- particularly the calculated variables -- can be transferred from the dBase files to Abstat, MSTAT or Lotus 123, so that statistical analyses can be undertaken.

## A. ESTIMATION OF PLANT POPULATION DENSITIES

### A.1 DATA COLLECTION AND ENTRY

Table A1 presents the form used for collecting data on plant stand densities. The methods used for collecting data using the systematic quadrat method is described elsewhere (Worman, Norman and Ware-Snyder, 1990: pp. 166-170).

TABLE A1: **FORM 05: PLANT STAND DENSITY DATA COLLECTION FORM**

VILLAGE: _____ *VILLNAME* _____

FARMER NAME: _____ *FARMNAME* _____

STAND DENSITY DATE: _____ *DATE* _____

| QUADRAT NUMBER | PLOT ___ | PLOT ___ | PLOT ___ | PLOT ___ | PLOT ___ | PLOT ___ | PLOT ___ | PLOT ___ |
|---|---|---|---|---|---|---|---|---|
| *Q01* | | | | | | | | |
| *Q02* | | | | | | | | |
| *Q03* | | | | | | | | |
| *Q04* | | | | | | | | |
| *Q05* | | | | | | | | |
| *Q06* | | | | | | | | |
| *Q07* | | | | | | | | |
| *Q08* | | | | | | | | |
| *Q09* | | | | | | | | |
| *Q10* | | | | | | | | |
| *Q11* | | | | | | | | |
| *Q12* | | | | | | | | |
| *Q13* | | | | | | | | |
| *Q14* | | | | | | | | |
| *Q15* | | | | | | | | |
| *Q16* | | | | | | | | |
| *Q17* | | | | | | | | |
| *Q18* | | | | | | | | |
| *Q19* | | | | | | | | |
| *Q20* | | | | | | | | |
| *NQUAD*[a] | | | | | | | | |
| *BCRP*[b] | | | | | | | | |
| *QDSZ*[c] | | | | | | | | |
| *RWSP*[d] | | | | | | | | |
| *NRIS*[d] | | | | | | | | |
| *RCOP*[e] | | | | | | | | |
| *ID* | | | | | | | | |

a. Entries on this line are the number of quadrats in the plot on which data were collected.
b. Entries on this line indicate whether the plot is broadcast (enter B) or row planted (enter R).
c. Entries on this line indicate the length of the side of the quadrat in metres.
d. Entries on these lines need to be completed only if the plot is row planted (i.e., R appears under variable *BCRP*). *RWSP* refers to the width rows are apart in metres, and *NRIS* to the number of rows sampled in a quadrat.
e. Entries on this line refer to the name of the crop.

Note: This form allows data to be entered from eight plots. If there is more than one crop per plot, then more than one column can be used for plant stand counts (e.g., two columns for plots containing two different crops). In such a case the plot identification at the head of the column needs to be differentiated in some way (e.g., plot 101S for the sorghum stand and 101C for the cowpea stand). Plot numbers could also be identified differently e.g., 101, 102, etc.

Data are entered straight from the form into a database called "FORM05" (i.e., "FORM05.DBF") which has the structure given in Table A2. As Table A2 indicates there is an identification variable (ID) which should be a unique character variable. The database, whenever it is loaded, should be loaded together with the index file "FM051D" (i.e., "FM051D.NDX") which is indexed on variable ID. The ID variable enables any record to be quickly accessed for editing. Often some combination of village name, farmer identification and plot number is used as an ID.[2] Since the report format in dBase III Plus is not very powerful, there is available, a Quickreport file called "FORM05" (i.e., "FORM05.QR") which can be used to print out the records in full to provide an easier format for checking the entries in the database. Careful checking, and if necessary, correction of the entries is important. Inaccurate entries could result in inaccurate estimates of plant stand densities as a result of running the programmes. Note that in entering data into the database, no entries are made for the variables beginning with C since these are variables calculated by the dBase programme. To aid in checking data it is important to enter the value of the ID variable on the data collection form itself once data entry in the database has begun. This eases checking and correction procedures.

TABLE A2: STRUCTURE OF DBASE III PLUS FILE FOR PLANT POPULATION DATA

Name of file: FORM05.DBF

| FIELD NAME | TYPE | WIDTH | DECIMAL | FIELD NAME | TYPE | WIDTH | DECIMAL |
|---|---|---|---|---|---|---|---|
| ID | C | 5 | | NQUAD | N | 3 | |
| VILLNAME | C | 15 | | BCRP | C | 3 | |
| FARMNAME | C | 15 | | QDSZ | N | 4 | 2 |
| DATE | Date | 8 | | RWSP | N | 4 | 2 |
| PLOT | C | 4 | | NRIS | N | 3 | |
| Q01A | N | 3 | | RCOP | C | 10 | |
| Q02A | N | 3 | | CAPLTPQ | N | 5 | 2 |
| : | : | : | | CAPLTPHA | N | 12 | 4 |
| : | : | : | | CSQPDN | N | 14 | 4 |
| : | : | : | | CSQPDPH | N | 14 | 4 |
| Q19A | N | 3 | | CMULT | N | 10 | 4 |
| Q20A | N | 3 | | | | | |

## A.2 RUNNING THE DBASE PROGRAMME

When the data have been correctly entered in the dBase file "FORM05" it is time to run the dBase programme "NTFM05G" (i.e., "NTFM05G.PRG"). This programme can be accessed by writing at the DOS prompt DO NTFM05G[3]. The only requirement is that the database and the programme should be on the same disk. It is possible to get to the DOS prompt by pressing <Esc>[4] to get out of the ASSIST dBase system. After pressing the <Return>[5] key, the programme will then process all the records in the file and enter figures for the calculated variables in the appropriate positions in the records. The variables calculated are defined as follows:

CAPLTPQ -- Average number of plants per quadrat.
CSQPDN -- Standard deviation of plants per quadrat.
CMULT -- Calculates multiplication factor to express variables in per hectare terms.
CAPLTPHA -- Average number of plants per hectare. This uses as input the number of plants in each quadrat.
CSQPDPH -- Standard deviation of plants per hectare.

The programme, as it is at the moment, calculates the variables for all the records in the file. If there is only one or there are a few records that need to be recalculated as a result of corrections, there is a short cut to calculating the variables in all the records again. This is done by typing MODIFY COMM

---

2. If the there is more than one crop in the plot then the crop may also be identified in some way (see note in Table A1).

3. This programme specifies that "FORM05" is to be used and therefore can be written whether or not database "FORM05" is loaded at the time.

4. The symbols < and > refer to pressing the key marked with characters between the symbols.

5. Sometimes called the <Enter> key.

NTFM05G at the DOS prompt and inserting GOTO, followed by the number of the record that needs to be modified just after the USE FORM05 statement. The file can then be saved by simultaneously pressing the <Ctrl> and <End> keys (the <Fn> key as well if you are using a Zenith laptop), and the programme can then be run. It will start running at the record number stated. In order to stop the programme after completing the calculations for that record press the <Esc> key. It will then stopping calculating the variables for all the following records in the file. Be sure to change the programme "NTFM05G" back to the original structure before stopping work. This is done by using the same approach as delineated above for inserting the GOTO statement.

If a list of the values of the calculated variables is wanted, this can be obtained either by running Quickreport "FORM05" or using the report format in dBase III Plus for printing out specified variables. For example, this can be done for specified variables at the DOS prompt by writing:

LIST ID,CAPLTPQ,CAPLTPHA TO PRINT

Any number of variables can be specified using the above format. The list will be printed. If you wish after this to return to the ASSIST mode from the DOS prompt, then this can be accomplished by pressing the <F2> key.

## B. ESTIMATION OF CROP YIELDS

### B.1 FILLING IN THE DATA COLLECTION FORM

Table B1 is the form used for collecting data on cereal crop yields. The methods involved in collecting data using the systematic quadrat method are described elsewhere (Worman, Norman and Ware-Snyder, 1990: pp. 171-172). Some additional points to note about obtaining the information for completing this form are as follows:

(a). It is necessary to complete one form for each plot. If the plot has more than one crop a separate sheet will be required for each crop.

(b). If possible 20 quadrat sub-samples are taken in a systematic pattern from each plot. Three people are needed to work with each quadrat sampling. Two carry the rigid quadrat. When locating sub-sample positions in the plot, the front quadrat carrier directs the movement along the correct sampling line. The rear quadrat carrier counts paces and stops the movement at each sub-sample position. To avoid bias, this rear carrier needs to walk somewhat blindly. When he/she stops at a sub-sample position, the quadrat should be gently lowered and placed immediately in front of his/her toe. The third person records data and carriers sample bags and the plant height measurement stick. Quadrat carriers assist in making counts and harvesting heads.

(c). As indicated earlier the form is designed for use with grain crops. Experience has shown that with legumes it is better to harvest the production of the whole plot since the plots are not generally very large. For cereal crops, field assessments are made and recorded for the total number of plants alive within the quadrat, the number of these plants that have produced grain, and the average plant height. Average plant height is for productive plants in the quadrat only, and is based on visual gauging of average height to the base of the main panicles.

(d). All cereal heads, or signs of cereal heads, within the quadrat are counted. These are recorded as follows:

HR -- Heads which were harvested by the farmer before the sampling date. Signs of cutting will be evident on each stalk.

MT -- Heads which are present and ready for harvest.

GR -- Heads which are still immature but which, in the judgement of the research staff, could still be harvested at a later date. GR heads are more likely to be a factor in broadcast plots which tend to have a wider range of maturity.

TABLE B1: **FORM11: HARVEST ASSESSMENTS ON PLANT STAND, PRODUCTIVE PLANT NUMBER, GRAIN HEAD WEIGHT AND GRAIN YIELD**

*ID* _____

VILLAGE: _____ *VILLNAME* _____

FARMER NAME: _____ *FARMNAME* _____

PLOT NUMBER: _____ *PLOT* _____

HARVEST ASSESSMENT DATE: _____ *HVDA* _____

COMPLETE THRESHING DATE: _____ *CTDA* _____

| Quadrat No. | Total # Plants | # Prod. Plants | FIELD ASSESSMENTS Plant Ht. (Cms) | Plant Head Numbers HR | MT | GR | GZ |
|---|---|---|---|---|---|---|---|
| *Q01* | | | | | | | |
| *Q02* | | | | | | | |
| *Q03* | | | | | | | |
| *Q04* | | | | | | | |
| *Q05* | | | | | | | |
| *Q06* | | | | | | | |
| *Q07* | | | | | | | |
| *Q08* | | | | | | | |
| *Q09* | | | | | | | |
| *Q10* | | | | | | | |
| *Q11* | | | | | | | |
| *Q12* | | | | | | | |
| *Q13* | | | | | | | |
| *Q14* | | | | | | | |
| *Q15* | | | | | | | |
| *Q16* | | | | | | | |
| *Q17* | | | | | | | |
| *Q18* | | | | | | | |
| *Q19* | | | | | | | |
| *Q20* | | | | | | | |
| Codes | *TNQ* | *PNQ* | *PTQ* | *HRQ* | *MTQ* | *GRQ* | *GZQ* |

Notes On Definitions:

HR -- Heads already harvested
MT -- Heads ready for harvesting
GR -- Immature heads that are likely to mature in time
GZ -- Grazed heads

Note That For Each Quadrat

"# Prod. Plants" should never be more than the "Total # Plants"

"# Prod. Plants" should never be more than the sum of the heads in in the HR, MT, GR and GZ columns

Further Definition:

NOQ -- Number of quadrats measured

TOTAL MT HEADS: WEIGHT UNTHRESHED (GRAMS) *MTUT* _____

WEIGHT THRESHED (GRAMS) *MTTR* _____

| *NOQ__* | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

THRESHING FLOOR SAMPLE (USE ONLY IF NEEDED):
TOTAL WEIGHT OF THRESHED THIRTY HEADS (GRAMS): *TFWT* _____

GRAIN MOISTURE CONTENT (E.G., 12.54% ENTERED AS 0.1254): *GNMT* _____

BROADCAST (B) OR ROW PLANTED (R): *BCRP* _____

LENGTH OF SIDE OF QUADRAT (METRES): *QDSZ* _____

IF PLOT IS ROW PLANTED: WIDTH ROWS ARE APART (METRES): *RWSP* _____

NUMBER OF ROWS SAMPLED IN QUADRAT: *NRIS* _____

GZ -- Heads which are missing and stalk or panicle shows signs of feeding by livestock. Partially damaged heads will be treated as MT heads.

(e). After counting and recording the MT heads on the data collection form, they are cut and put in a large burlap bag and labelled with the ID and PLOT number. The bag should be closed to prevent heads from falling out.

(f). Head samples can be oven dried in the bag. When sun drying, heads must be removed from the bag. A large protected space is required for sun drying samples.

(h). When head samples are at a uniform threshing moisture,[6] the sample is weighed and then threshed. After threshing the grain is weighed. Data from the two weighings are recorded on the data collection sheet. The burlap bag is used to hold the grain sample through the weighing step[7].

(i). In the unfortunate situation where the host farmer has already partially harvested plots, a sample of thirty heads is taken from the threshing floor that were harvested from the trial area. The average weight of these threshed heads can be used to estimate the grain already harvested from stalks that show harvest cutting.

(j). Grain per quadrat is calculated as follows:

(average weight (gm)/head of threshed sample heads x MT head count)
+ (average weight (gm)/head of threshing floor sample x HR head count)
+ (average weight (gm)/head of threshed sample heads x GZ head count)

GR head production can be factored in by adding an estimate of average GR head weight x GR head count. The estimate of average GR head weight could be that of the MT heads sampled[8] or the average of additional sampling later in the season. GR head production is not usually an important factor in trials where researchers control the timing of harvest.

## B.2 ENTERING THE DATA INTO THE DATABASE

Data are entered straight from the form into two databases called:

"FORM11A" (i.e., "FORM11A.DBF")
"FORM11B" (i.e., "FORM11B.DBF")

Two databases are necessary because of the amount of data that have to be entered from the data collection form.

These databases have the structures given in Table B2. As Table B2 indicates there is an identification variable (ID) in both databases which should be a unique character variable. The databases, whenever they are loaded, should be loaded together with the associated index file, that is:

"FM11AID" (i.e., "FM11AID.NDX") with database "FORM11A"
"FM11BID" (i.e., "FM11BID.NDX") with database "FORM11B"

---

6. Occasionally grain moisture is estimated at threshing. If this is done, there is provision on the form for entering it (i.e., variable GNMT). If no estimation is done, the grain moisture is assumed to be 12% and this figure should be entered on the form.

7. In some ATIP work, samples from the individual quadrats have been kept separate and threshed separately, thereby making it possible to derive figures for threshed grain per quadrat. However, this greatly increases the time for collecting the data, and entering it and processing it on the microcomputer. Therefore in the interest of efficiency, this is no longer recommended.

8. This is, in fact, assumed in the programme given in Appendix B.

TABLE B2: STRUCTURE OF DBASE III PLUS FILES FOR YIELD DATA

Name of file: FORM11A.DBF

| FIELD NAME | TYPE | WIDTH | DECIMAL | FIELD NAME | TYPE | WIDTH | DECIMAL |
|---|---|---|---|---|---|---|---|
| ID | C | 6 | | HRQ01 | N | 3 | |
| VILLNAME | C | 15 | | HRQ02 | N | 3 | |
| FARMNAME | C | 15 | | : | : | 3 | |
| PLOT | C | 4 | | : | : | 3 | |
| HVDA | Date | 8 | | : | : | 3 | |
| CDTA | Date | 8 | | HRQ19 | N | 3 | |
| TNQ01 | N | 3 | | HRQ20 | N | 3 | |
| TNQ02 | N | 3 | | MTQ01 | N | 3 | |
| : | : | : | | MTQ02 | N | 3 | |
| : | : | : | | : | : | : | |
| : | : | : | | : | : | : | |
| TNQ19 | N | 3 | | : | : | : | |
| TNQ20 | N | 3 | | MTQ19 | N | 3 | |
| PNQ01 | N | 3 | | MTQ20 | N | 3 | |
| PNQ02 | N | 3 | | GRQ01 | N | 3 | |
| : | : | : | | GRQ02 | N | 3 | |
| : | : | : | | : | : | : | |
| : | : | : | | : | : | : | |
| PNQ19 | N | 3 | | : | : | : | |
| PNQ20 | N | 3 | | GRQ19 | N | 3 | |
| PTQ01 | N | 3 | | GRQ20 | N | 3 | |
| PTQ02 | N | 3 | | | | | |
| : | : | : | | | | | |
| : | : | : | | | | | |
| PTQ19 | N | 3 | | | | | |
| PTQ20 | N | 3 | | | | | |

Name of file: FORM11B.DBF

| FIELD NAME | TYPE | WIDTH | DECIMAL | FIELD NAME | TYPE | WIDTH | DECIMAL |
|---|---|---|---|---|---|---|---|
| ID | C | 6 | | CHRKH | N | 8 | 2 |
| VILLNAME[a] | C | 15 | | CMTKH | N | 8 | 2 |
| FARMNAME[a] | C | 15 | | CGRKH | N | 8 | 2 |
| PLOT[a] | C | 4 | | CGZKH | N | 8 | 2 |
| HVDA[a] | Date | 8 | | CHYKH | N | 8 | 2 |
| CDTA | Date | 8 | | CHYSDPH | N | 14 | 2 |
| GZQ01 | N | 3 | | CPYKH | N | 8 | 2 |
| GZQ02 | N | 3 | | CPOKH | N | 8 | 2 |
| : | : | : | | CTNHH | N | 12 | 2 |
| : | : | : | | CTNSDPH | N | 14 | 2 |
| : | : | : | | CPNHH | N | 12 | 2 |
| GZQ19 | N | 3 | | CHRHH | N | 12 | 2 |
| GZQ20 | N | 3 | | CMTHH | N | 12 | 2 |
| MTUT | N | 12 | 2 | CGRHH | N | 12 | 2 |
| MTTR | N | 12 | 2 | CGZHH | N | 12 | 2 |
| NOQTN | N | 3 | | CPOHH | N | 12 | 2 |
| NOQPN | N | 3 | | CPOSDH | N | 14 | 2 |
| NOQPT | N | 3 | | CWTPHM | N | 8 | 2 |
| NOQHR | N | 3 | | CTPHC | N | 5 | 2 |
| NOQMT | N | 3 | | CPLHTAV | N | 7 | 2 |
| NOQGR | N | 3 | | CHRKHA | N | 8 | 2 |
| NOQGZ | N | 3 | | CMTKHA | N | 8 | 2 |
| TFWT | N | 12 | 1 | CGRKHA | N | 8 | 2 |
| GNMT | N | 6 | 4 | CGZKHA | N | 8 | 2 |
| BCRP | C | 1 | | CHYKHA | N | 8 | 2 |
| QDSZ | N | 4 | 2 | CPYKHA | N | 8 | 2 |
| RWSP | N | 4 | 2 | CPOKHA | N | 8 | 2 |
| NRIS | N | 4 | 2 | CMULT | N | 9 | 2 |
| CTILL1 | N | 10 | 2 | | | | |
| CTILL2 | N | 10 | 2 | | | | |
| CTILL3 | N | 10 | 2 | | | | |
| CTILL4 | N | 10 | 2 | | | | |

a. In a sense entering these variables again in this database is redundant, since they also appear in the first database (FORM11A.DBF). This is because the two databases are run together in the programme calculations. Only one variable is needed to link the records on the two databases. This is the ID variable.

Both index files are indexed on variable ID. The ID variable serves two purposes in enabling:

(a). The databases to be linked by means of a common variable.
(b). Any record to be quickly accessed for editing.

Often some combination of village name, farmer identification and plot number is used as an ID. Usually the ID is assigned at the beginning of the trial and is entered on the form before data are collected. In any case, to aid in checking data it is a good idea to make sure the the ID variable is on the data collection form itself once data entry in the database has begun.

Since the report format in dBase III Plus is not very powerful, there are available, two Quickreport files called:

"FORM11A" (i.e., "FORM11A.QR") for database "FORM11A"
"FORM11B" (i.e., "FORM11B.QR") for database "FORM11B"

These report formats can be used to print out the records in full to provide an easier way for checking the entries in the databases. Careful checking and, if necessary, correction of the entries is important. Inaccurate entries could result in inaccurate estimates of yields. Note that in entering data into database 'FORM11B", no entries are made for the variables beginning with C since these are variables calculated by the dBase programmes associated with databases "FORM11A" AND "FORM11B".

## B.3 RUNNING THE DBASE PROGRAMMES

When the data have been correctly entered in the dBase files "FORM11A" and "FORM11B", the data are ready for processing by the associated dBase programmes. The programme which is to be run is called:

"NTFM11" (i.e., "NTFM11.PRG")

This programme, which is given in detail in Appendix B, is accessed by writing at the DOS prompt:

DO NTFM11

It is possible to get to the DOS prompt by pressing the <Esc> key to get out of the ASSIST dBase system. The programme will then process all the records in the file and enter figures for the calculated variables in the appropriate positions in the records.

The variables calculated are defined in Table B3.

The programme NTFM11 has two sub-programs. These are as follows:

NTTILF11 -- Calculates the tillering variables.
NTTOTF11 -- Calculates various plant and head counts.

These are accessed automatically during the execution of the NTFM11 programme.

A number of points about the NTFM11 programme and its related sub-programmes are as follows:

(a). Although it is recommended that data from 20 quadrats are taken in each plot, on occasion this may not occur. Therefore provision is made to calculate estimates of yields from different numbers of quadrats (i.e., variable NOQ in Table B1).

(b). All the MT heads are harvested from quadrats sampled. The bulked sample is weighed just before and just after threshing. From this information it is possible to calculate the threshing percentage (CTHPC)[9] and the weight of threshed grain per MT head (CWTPHM). If the crop has already been harvested, the average amount of grain per head from 30 heads on the threshing

[9]. This is entered as zero if either the unthreshed (MTUT) or threshed weights (MTTR) are missing.

TABLE B3: DEFINITIONS OF CALCULATED VARIABLES IN DATABASE "FORM11B"[a]

| ACRONYM | DEFINITION |
|---|---|
| ***Tillering Variables:*** | |
| CTILL1 | The total number of heads (HR+MT+GR+GZ) divided by the total number of productive plants (PN). This is calculated as the average of the figures calculated for each quadrat. |
| CTILL2 | The total number of heads (HR+MT+GR+GZ) divided by the total number of all plants (TN). This is calculated as the average of the figures calculated for each quadrat. |
| CTILL3 | The total number of harvested heads (HR+MT) divided by the total number of productive plants (PN). This is calculated as the average of the figures calculated for each quadrat. |
| CTILL4 | The total number of harvested heads (HR+MT) divided by the total number of all plants (TN). This is calculated as the average of the figures calculated for each quadrat. |
| ***Yield Variables (Not Adjusted According To Grain Moisture):*** | |
| CHRKH | HR yield in kilogrammes per hectare. |
| CMTKH | MT yield in kilogrammes per hectare. |
| CGRKH | GR yield in kilogrammes per hectare. |
| CGZKH | GZ yield in kilogrammes per hectare. |
| CHYKH | Harvested (HR+MT) yield in kilogrammes per hectare. |
| CHYSDPH | Standard deviation of harvested (HR+MT) yield in kilogrammes per hectare. Information from the individual quadrats was used in the calculation. |
| CPYKH | Produced (HR+MT+GZ) yield in kilogrammes per hectare. |
| CPOKH | Potential (HR+MT+GZ+GR) yield in kilogrammes per hectare. |
| ***Plant Stands At Harvesting:*** | |
| CTNHH | TN plants per hectare. Information from the individual quadrats was used in the calculation. |
| CTNSDPH | Standard deviation of all plants (TN) per hectare. Information from the individual quadrats was used in the calculation. |
| CPNHH | PN plants per hectare. Information from the individual quadrats was used in the calculation. |
| CHRHH | HR heads per hectare. Information from the individual quadrats was used in the calculation. |
| CMTHH | MT heads per hectare. Information from the individual quadrats was used in the calculation. |
| CGRHH | GR heads per hectare. Information from the individual quadrats was used in the calculation. |
| CGZHH | GZ heads per hectare. Information from the individual quadrats was used in the calculation. |
| CPOHH | Total heads (HR+MT+GZ+GR) per hectare. Information from the individual quadrats was used in the calculation. |
| CPOSDH | Standard deviation of total heads (HR+MT+GZ+GR) per hectare. Information from the individual quadrats was used in the calculation. |
| ***Threshed Weight And Percentage:*** | |
| CWTPHM | Average threshed weight per head (grams per head threshed). This is calculated by dividing the threshed weight in grams from the MT heads (MTTR) by the total number of MT heads which were threshed. |
| CTHPC | Threshing percentage based on MT heads. |
| ***Average Plant Height:*** | |
| CPLHTAV | Average plant height (cms) |
| ***Yield Variables (Adjusted To 10% Grain Moisture):*** | |
| CHRKHA | HR yield in kilogrammes per hectare adjusted to 10% moisture. |
| CMTKHA | MT yield in kilogrammes per hectare adjusted to 10% moisture. |
| CGRKHA | GR yield in kilogrammes per hectare adjusted to 10% moisture. |
| CGZKHA | GZ yield in kilogrammes per hectare adjusted to 10% moisture. |
| CHYKHA | HR + MT yield in kilogrammes per hectare adjusted to 10% moisture. |
| CPYKHA | HR + MT + GZ yield in kilogrammes per hectare adjusted to 10% moisture. |
| CPOKHA | HR + MT + GZ + GR yield in kilogrammes per hectare adjusted to 10% moisture. |
| ***Multiplication Factor:*** | |
| CMULT | Calculates multiplication factor to express variables in per hectare terms |

a. All the variables that have as a first letter C -- in database FORM11B -- are calculated variables. The definitions are presented in the order they appear in database FORM11B.

floor (WTPHS) is used as a substitute for CWTPHM[10].

(c). Harvested (CHYKH and CHYKHA), produced (CPYKH and CPYKHA), and potential (CPOKH and CPOKHA) yields all contain, as a component, HR heads. In these aggregate yields, CWTPHM is used rather than WTPHS which is preferred for individual estimates of HR yield (CHRKH and CHRKHA). Therefore, there may be a small discrepancy between the aggregate yields and the sum of the individual components of the yields. However, this is unlikely to be very significant unless HR heads are a major component of the aggregate production estimates.

(d). The programme, as it is designed, calculates a number of different estimates of yield. However, it does have the flexibility to calculate fewer estimates. For example, if only counts of MT heads were recorded, it will only calculate the estimates in which MT heads are included. All the rest of the estimates will be zero.

(e). There is provision for adjusting all yields to 10% moisture. If no GNMT readings were taken it assumes that the grain was threshed at 12% moisture.

(f). It is important to note that if the NTFM11 programme requires editing, be sure to do it in WordPerfect 5.0, since it is too big to load into the dBase III Plus word processor. This is done by exiting dBase III plus and loading it in WordPerfect 5.0 as a DOS text file and also saving it as one, after editing. The programme, as it is at the moment, calculates the variables for all the records in the file. If there is only one or there are a few records that need to be recalculated as a result of corrections, there is a short cut to calculating the variables in all the records again. This is done by loading NTFM11.PRG (the NTFM11 programme) into WordPerfect 5.0, as described above. A GOTO followed by the number of the record that needs to be modified is inserted just after the USE FORM11A statement. The file can then be saved as a DOS text file and the programme run after exiting WordPerfect and loading dBase III Plus again. It will start running at the record number stated. In order to stop the programme after completing the calculations for that record press the <Esc> key. It will then stopping calculating the variables for all the following records in the file. It is important to change the "NTFM11" programme back to the original structure before stopping work. This is done by using the same approach as delineated above for inserting the GOTO statement.

(g). The programme calculates all the variables for the different plots as a batch. Since this takes some time to do it is a good idea to go away and do something else while it is running!

Finally, if a list of the values of the calculated variables is wanted, this can be obtained either by running Quickreport "FORM11B" or by using the report format in dBase III Plus for printing out specified variables. For example, this can be done for specified variables at the DOS prompt by writing:

LIST ID,MTTR,CHRKH,CMTKH,CHRHH,CMTHH TO PRINT

Any number of variables can be specified using the above format. The list will be printed.

## C. TRANSFERRING DATA OUT OF DBASE III PLUS

Data from dBase III Plus can be transferred to other software for further data manipulation or statistical analysis. In this section a number of transfer routines are outlined. Only the method of transfer is explained. Basic knowledge of the routines within software packages can be obtained by looking at the documentation for those packages. The following transfer routines are briefly described in this section.

(a). dBase III Plus to Abstat
(b). dBase III Plus to Lotus 123
(c). dBase III Plus to Ascii (through WordPerfect 5.0) to MSTAT.
(d). Abstat to Lotus 123
(e). Abstat to Ascii to MSTAT

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[10]. The only time WTPHS is used in preference to CWTPHM is for estimating the yield from HR heads.

**Even though all data transfer routines outlined can work, we strongly recommend going through Abstat when transferring data from dBase III Plus to MSTAT (i.e., routine (a) followed by routine (e)). This is because the editing (cleaning) required in routine (c) can be tedious.**

## C.1 DBASE III PLUS TO ABSTAT

Data are read from dBase III Plus into Abstat through an Abstat import routine. Variables for transfer are selected in the Abstat programme.

The steps are as follows:

1. Load Abstat programme.
2. Select DATA command.
3. Select CREATE command.
4. Enter name for new Abstat file (the .AB6 extension is automatically given).
5. Enter number of variables in dat a transfer.
6. Select DBREAD command.
7. Enter dBase III Plus file name that will be imported.
8. Select dBase III Plus variables (e.g., villname, plot, etc., or type "all").
9. Select which records wanted (usually "all").
10. Enter value to be considered missing (usually CR -- carriage return is pressed).
11. Select SAVE to save new Abstat file to disk.

## C.2 DBASE III PLUS TO LOTUS 123

When a portion of a dBase III Plus file is to be transferred to Lotus 123, the portion is first copied to create a new dBase III Plus file. DBase III Plus files can be read and translated into a spreadsheet format by Lotus 123.

The steps involved are as follows:

1. Load dBase III Plus.
2. Load the dBase III Plus data file. Note that index specifications are not needed in the transfer.
3. Select ORGANIZE/COPY.
4. Select drive to save copy of file.
5. Enter new dBase III Plus file name with .DBF extension.
6. Select "Construct A Field List".
7. Select fields for transfer.
8. Select "Execute The Command".
9. When copy routine is complete quit dBase III Plus.
10. Load Lotus 123.
11. Select TRANSLATE which is on the first menu that appears.
12. Select dBase III Plus.
13. Select "Translate To 1-2-3 Release 2".
14. Press the <Esc>key.
15. Press the <Esc> key to enter name of dBase III Plus copy file as source file.
16. Enter drive where dBase III Plus file is located.
17. Press the <Return> key.
18. Select file from list.
19. Press the <Return> key.
20. If the drive and new file name is satisfactory press the <Return>. If not, correct it and then press the <Return> key.
21. Proceed with the translation.
22. After conversion is completed, press the <Esc> key two times in succession.
23. Leave translate utility by indicating "yes" when asked if want to leave TRANSLATE.

## C.3 DBASE III PLUS TO ASCII (THROUGH WORDPERFECT 5.0) TO MSTAT

Data are transferred from dBase III Plus to an Ascii output file. The Ascii file is retrieved into WordPerfect 5.0 using Text In/Out, and cleaned up. The "clean" file is saved as a Text File and then loaded (now called an Ascii File) into MSTAT. Note that MSTAT requires that a file with defined variables be active before the Ascii File can be retrieved. Note that this method is cumbersome and is not recommended.

The steps are as follows:

1. Load dBase III Plus programme.
2. Load dBase III Plus data file. Note that index specifications are not needed in the transfer.
3. Press the <Esc> key to leave ASSIST and go to the DOS prompt line.
4. Enter "Set Alternate To {Enter the Name Of The Ascii File}" and press the <Return> key (e.g., alternate to B:DATA.[11]
5. Enter "Set Alternate On" and press the <Return> key.
6. Enter "Set Fields To {Enter the List Of Variables With Commas Separating Them}" and press the <Return> key. Note that this saves the list of variables for the MSTAT procedure.
7. Enter "Set Fields On".
8. Enter "List". The data are transferred.
9. Enter "Close Alternate".
10. Quit dBase III Plus.
11. Load WordPerfect 5.0.
12. Select F5 to list files.
13. Locate transfer file and select number 5 for Text In.
14. Edit file: remove all labels and place single space or comma as delimiter between variables, and leave no spaces within variables. Also delete the record numbers.
15. Select <Cntrl-F5> for Text In/Out.
16. Select number 1 for DOS Text.
17. Select number 1 for Save.
18. Save updated file as replacement of previous text file.
19. Exist WordPerfect 5.0 without resaving file.
20. Load MSTAT.
21. Select MENU and then select the MANAGER.
22. Enter name for the file receiving data. It is better for the file to have a different name from the one being imported.
23. Create new receiving file.
24. Enter file width to accommodate variables being transferred. In MSTAT, all numeric variables equal four characters, and in the case of character variables the number equals the number of characters assigned.
25. Select number 9 to import Ascii File (Text File).
26. Select number 3 to read an Ascii File into active data file
27. Enter name of Ascii File (e.g., A:TRANS.TXT). Note the Ascii File to be imported will always have the label .TXT.
28. Enter delimiter used (i.e., space or ,).
29. Establish variables in receiving file (i.e., use the same variables as transferred from the dBase III Plus file).
30. Specify the precise number of variables to transfer (i.e., * equals all variables).
31. Add data beginning at case number 1.
32. Enter that Ascii File is from a data logger.
33. Say "No" to "Include Line" question until the first line of data appears.
34. Data transferred.
35. Number of cases transferred is indicated.
36. Exit Ascii sub-routine and return to sub-programme menu.

---

[11]. The { type of bracket indicates that something needs to be entered between the brackets, but during the entry process the {} should be deleted.

## C.4 ABSTAT TO LOTUS 123

Once data are in Abstat, a routine readily transfers the Abstat file (memory image of floating point numbers) to a Lotus 123 file (fixed position file).

The following steps are necessary:

1. Load Abstat software package.
2. Retrieve the file to be transferred with the FETCH command.
3. Select WRITE command.
4. Enter file name with extension WK1 or .WKS (e.g., B:Data.wk1).
5. Enter which variables to transfer.
6. Lotus 123 file is saved.
7. Quit Abstat.
8. Load Lotus 123.
9. Select /FILE.
10. Select and load transferred Lotus 123 file.

## C.5 ABSTAT TO ASCII TO MSTAT

Once data are in Abstat, a routine readily transfers the Abstat file (memory image of floating point numbers) to an Ascii File (comma delimited file) which can be read into a pre-prepared file by MSTAT.

The following steps are required:

1. Load Abstat software package.
2. Retrieve the file to be transferred with the FETCH command.
3. Select WRITE command.
4. Enter file name without extensions (e.g., B:DATA). For transfer to MSTAT it does not appear to matter if the extension .TXT is, or is not, added.
5. Enter which variables to transfer. Note that this saves list of variables for MSTAT procedure.
6. Select not to include variable names.
7. Ascii file is saved.
8. Quit Abstat.
9. Load MSTAT.
10. Select MENU and then MANAGER.
11. Enter name for file receiving data. Specify the drive and file name. It is better for the file to have a different name from the one being imported.
12. Create new receiving file.
13. Enter file width to accommodate variables being transferred. Note that in MSTAT all numeric variables equal four characters and character variables are equal to the number of characters assigned to the variable.
14. Select number 9 for import Ascii File (Text File).
15. Select number 3 to read an Ascii File into active data file.
16. Enter name of Ascii file (e.g., A:TRANS.TXT). Note that the Ascii file may or may not have the suffix or extension .TXT (see point 4 above).
17. To the request "Enter Delimiter Used (Space Or ,)", enter ",".
18. Establish variables in receiving file, that is, use the same variables as transferred from the Abstat file.
19. Specify variables to transfer. Note that * means all variables.
20. Add data beginning at case number 1.
21. Enter that the Ascii File is from a data logger.
22. Say "No" to "Include Line" question until first line of data appears. Note that missing values in Abstat that are indicated as "--" transfer into MSTAT as "%-10E+%5" and will need editing.
23. Data transferred.
24. Number of cases transferred is indicated.
25. Exit Ascii sub-routine and return to sub-programme menu.

## REFERENCE

Worman, F., D. Norman, and J. Ware-Snyder (Eds.), 1990. Farming Systems Research Handbook for Botswana. *ATIP RP 3*. Gaborone: ATIP, DAR.

## APPENDIX A: PROGRAMME FOR ESTIMATING PLANT STAND DENSITIES PER HECTARE

```
*NTFM05G.PRG
*Calculation of average plants/ha (CAPLTQ) and SD of plants/ha
*(CSQPDPH)
CLEAR
SET TALK OFF
USE FORM05
DO WHILE .NOT. EOF()
STORE 00000.0000 TO CMULT
IF BCRP = "R"
REPLACE CMULT WITH (10000/(QDSZ*RWSP*NRIS))
ELSE
REPLACE CMULT WITH (10000/(QDSZ*QDSZ))
ENDIF
STORE 0000000000.0000 TO SUMPLT1,SUMPLT2
STORE 0000000000.0000 TO SST1,SST2
STORE 0000000000.0000 TO SUMPL,SSSUMPL
  SUMPLT1 = (Q01 + Q02 + Q03 + Q04 + Q05 + Q06 +;
Q07 + Q08 + Q09 + Q10)
  SUMPLT2 = (Q11 + Q12 + Q13 + Q14 + Q15 + Q16 +;
Q17 + Q18 + Q19 + Q20)
  SUMPL = (SUMPLT1 + SUMPLT2)
REPLACE CAPLTPQ WITH (SUMPL/NQUAD)
REPLACE CAPLTPHA WITH (CAPLTPQ*CMULT)
    SST1 = ((Q01*Q01)+(Q02*Q02)+(Q03*Q03)+(Q04*Q04)+;
(Q05*Q05)+(Q06*Q06)+(Q07*Q07)+(Q08*Q08)+(Q09*Q09)+;
(Q10*Q10))
    SST2 = ((Q11*Q11)+(Q12*Q12)+(Q13*Q13)+(Q14*Q14)+;
(Q15*Q15)+(Q16*Q16)+(Q17*Q17)+(Q18*Q18)+(Q19*Q19)+;
(Q20*Q20))
    SSUMPL = (SST1+SST2)
REPLACE CSQPDN WITH;
(SQRT((SSUMPL-((SUMPL*SUMPL)/NQUAD))/(NQUAD-1)))
    REPLACE CSQPDPH WITH (CSQPDN*CMULT)
SKIP
ENDDO
SET TALK ON
*End of program
```

## APPENDIX B: PROGRAMME FOR ESTIMATING VARIOUS YIELD ESTIMATES

### B.1 THE NTFM11 PROGRAMME

```
*NTFM11.PRG
*Does Various Calculations On Harvest Forms
CLEAR
SET TALK OFF
SELECT 1
USE FORM11A
SELECT 2
USE FORM11B INDEX  FM11BID
DO WHILE .NOT. EOF()
SELECT 1
SET RELATION TO ID INTO FORM11B
SELECT 1
STORE 000 TO HY01,HY02,HY03,HY04,HY05,HY06,HY07,HY08,HY09,HY10
STORE 000 TO HY11,HY12,HY13,HY14,HY15,HY16,HY17,HY18,HY19,HY20
*Calculation Of Harvest Heads (HY) By Quadrat
*i.e., HRQ + MTQ (01 to 20)
HY01 = HRQ01 + MTQ01
HY02 = HRQ02 + MTQ02
HY03 = HRQ03 + MTQ03
HY04 = HRQ04 + MTQ04
HY05 = HRQ05 + MTQ05
HY06 = HRQ06 + MTQ06
HY07 = HRQ07 + MTQ07
HY08 = HRQ08 + MTQ08
HY09 = HRQ09 + MTQ09
HY10 = HRQ10 + MTQ10
HY11 = HRQ11 + MTQ11
HY12 = HRQ12 + MTQ12
HY13 = HRQ13 + MTQ13
HY14 = HRQ14 + MTQ14
HY15 = HRQ15 + MTQ15
HY16 = HRQ16 + MTQ16
HY17 = HRQ17 + MTQ17
HY18 = HRQ18 + MTQ18
HY19 = HRQ19 + MTQ19
HY20 = HRQ20 + MTQ20
STORE 000 TO PY01,PY02,PY03,PY04,PY05,PY06,PY07,PY08,PY09,PY10
STORE 000 TO PY11,PY12,PY13,PY14,PY15,PY16,PY17 PY18,PY19,PY20
SELECT 2
*Calculation Of Constant To Calculate Per Hectare Variables
STORE 000 TO CMULTT
IF BCRP = "R"
REPLACE CMULT WITH (10000/(QDSZ*RWSP*NRIS))
ELSE
REPLACE CMULT WITH (10000/(QDSZ*QDSZ))
ENDIF
CMULTT = CMULT
*Calculation Of Produced Heads (PY) (Gms) By Quadrat
*i.e., HRQ + MTQ + GZQ (01 to 20)
PY01=HY01+GZQ01
PY02=HY02+GZQ02
PY03=HY03+GZQ03
PY04=HY04+GZQ04
PY05=HY05+GZQ05
PY06=HY06+GZQ06
PY07=HY07+GZQ07
PY08=HY08+GZQ08
```

```
PY09=HY09+GZQ09
PY10=HY10+GZQ10
PY11=HY11+GZQ11
PY12=HY12+GZQ12
PY13=HY13+GZQ13
PY14=HY14+GZQ14
PY15=HY15+GZQ15
PY16=HY16+GZQ16
PY17=HY17+GZQ17
PY18=HY18+GZQ18
PY19=HY19+GZQ19
PY20=HY20+GZQ20
SELECT 1
*Calculation Of Potential Heads (PO) Per Quadrat
*i.e., HT + MT + GZ + GR, That Is Total Heads
PO01=PY01+GRQ01
PO02=PY02+GRQ02
PO03=PY03+GRQ03
PO04=PY04+GRQ04
PO05=PY05+GRQ05
PO06=PY06+GRQ06
PO07=PY07+GRQ07
PO08=PY08+GRQ08
PO09=PY09+GRQ09
PO10=PY10+GRQ10
PO11=PY11+GRQ11
PO12=PY12+GRQ12
PO13=PY13+GRQ13
PO14=PY14+GRQ14
PO15=PY15+GRQ15
PO16=PY16+GRQ16
PO17=PY17+GRQ17
PO18=PY18+GRQ18
PO19=PY19+GRQ19
PO20=PY20+GRQ20
SELECT 1
* Calculation Of Various Tillering Types
DO NTTILF11
SELECT 1
SUMMT=MTQ01+MTQ02+MTQ03+MTQ04+MTQ05+MTQ06+MTQ07+MTQ08+;
MTQ09+MTQ10+MTQ11+MTQ12+MTQ13+MTQ14+MTQ15+MTQ16+MTQ17+;
MTQ18+MTQ19+MTQ20
SELECT 2
WTPHM=MTTR/(SUMMT+0.00000001)
REPLACE CWTPHM WITH WTPHM
IF MTUT>0
REPLACE CTHPC WITH (MTTR/MTUT)*100)
ELSE
REPLACE CTHPC WITH 0.00
ENDIF
WTPHS=TFWT/30
*HR Yield (HRKH) In Kg/Ha, i.e, HR
SELECT 1
SUMHR=HRQ01+HRQ02+HRQ03+HRQ04+HRQ05+HRQ06+HRQ07+HRQ08+;
HRQ09+HRQ10+HRQ11+HRQ12+HRQ13+HRQ14+HRQ15+HRQ16+HRQ17+;
HRQ18+HRQ19+HRQ20
SELECT 2
HRKH = IIF (WTPHS>0,WTPHS,WTPHM)*SUMHR*(CMULTT/1000)
REPLACE CHRKH WITH (HRKH/(NOQHR+0.00000001))
*MT Yield (MTKH) In Kg/Ha, i.e, MT
SELECT 1
```

```
SUMMT=MTQ01+MTQ02+MTQ03+MTQ04+MTQ05+MTQ06+MTQ07+MTQ08+;
MTQ09+MTQ10+MTQ11+MTQ12+MTQ13+MTQ14+MTQ15+MTQ16+MTQ17+;
MTQ18+MTQ19+MTQ20
SELECT 2
MTKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMMT*(CMULTT/1000)
REPLACE CMTKH WITH (MTKH/(NOQMT+0.00000001))
*GR Yield (GRKH) In Kg/Ha, i.e, GR
SELECT 1
SUMGR=GRQ01+GRQ02+GRQ03+GRQ04+GRQ05+GRQ06+GRQ07+GRQ08+;
GRQ09+GRQ10+GRQ11+GRQ12+GRQ13+GRQ14+GRQ15+GRQ16+GRQ17+;
GRQ18+GRQ19+GRQ20
SELECT 2
GRKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMGR*(CMULTT/1000)
REPLACE CGRKH WITH (GRKH/(NOQGR+0.00000001))
*GZ Yield (GZKH) In Kg/Ha, i.e, GZ
SELECT 2
SUMGZ=GZQ01+GZQ02+GZQ03+GZQ04+GZQ05+GZQ06+GZQ07+GZQ08+;
GZQ09+GZQ10+GZQ11+GZQ12+GZQ13+GZQ14+GZQ15+GZQ16+GZQ17+;
GZQ18+GZQ19+GZQ20
GZKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMGZ*(CMULTT/1000)
REPLACE CGZKH WITH (GZKH/(NOQGZ+0.00000001))
*Harvest Yield (HYKH) In Kg/Ha, i.e, HR + MT (HYYLD) And Stand. Dev.
SELECT 2
SUMHY=HY01+HY02+HY03+HY04+HY05+HY06+HY07+HY08+;
HY09+HY10+HY11+HY12+HY13+HY14+HY15+HY16+HY17+;
HY18+HY19+HY20
SUMHYT=SUMHY*WTPHM
HYKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMHY*(CMULTT/1000)
REPLACE CHYKH WITH (HYKH/(NOQMT+0.00000001))
STORE 0000000000.0000 TO SSHYT1,SSHYT2
STORE 0000000000.0000 TO SSHY,HYSDQ,CHYSDPH
SSHYT1 = (HY01*WTPHM)*(HY01*WTPHM)+((HY02*WTPHM)*(HY02*WTPHM))+;
((HY03*WTPHM)*(HY03*WTPHM))+((HY04*WTPHM)*(HY04*WTPHM))+;
((HY05*WTPHM)*(HY05*WTPHM))
SSHYT2 = ((HY06*WTPHM)*(HY06*WTPHM))+((HY07*WTPHM)*(HY07*WTPHM))+;
((HY08*WTPHM)*(HY08*WTPHM))+((HY09*WTPHM)*(HY09*WTPHM))
SSHYT3 = ((HY10*WTPHM)*(HY10*WTPHM))+((HY11*WTPHM)*(HY11*WTPHM))+;
((HY12*WTPHM)*(HY12*WTPHM))+((HY13*WTPHM)*(HY13*WTPHM))
SSHYT4 = ((HY14*WTPHM)*(HY14*WTPHM))+;
((HY15*WTPHM)*(HY15*WTPHM))+((HY16*WTPHM)*(HY16*WTPHM))+;
((HY17*WTPHM)*(HY17*WTPHM))
SSHYT5 = ((HY18*WTPHM)*(HY18*WTPHM))+((HY19*WTPHM)*(HY19*WTPHM))+;
((HY20*WTPHM)*(HY20*WTPHM))
     SSHY =   (SSHYT1+SSHYT2+SSHYT3+SSHYT4+SSHYT5)
     HYSDQ =   (SQRT((SSHY-((SUMHYT*SUMHYT)/;
(NOQMT+0.00000001)))/((NOQMT+0.00000001)-1)))
REPLACE CHYSDPH WITH (HYSDQ*(CMULT/1000))
*Produced Yield (PYKH) In Kg/Ha, i.e, HR + MT + GZ
SELECT 2
SUMPY=PY01+PY02+PY03+PY04+PY05+PY06+PY07+PY08+;
PY09+PY10+PY11+PY12+PY13+PY14+PY15+PY16+PY17+;
PY18+PY19+PY20
PYKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMPY*(CMULTT/1000)
REPLACE CPYKH WITH (PYKH/(NOQMT+0.00000001))
*Potential Yield (POKH) In Kg/Ha, i.e, HR + MT + GZ  +  GR
SELECT 2
SUMPO=PO01+PO02+PO03+PO04+PO05+PO06+PO07+PO08+;
PO09+PO10+PO11+PO12+PO13+PO14+PO15+PO16+PO17+;
PO18+PO19+PO20
POKH = IIF (WTPHM>0,WTPHM,WTPHS)*SUMPO*(CMULTT/1000)
REPLACE CPOKH WITH (POKH/(NOQMT+0.00000001))
```

```
*Adjusts Yields For Grain Moisture
IF GNMT = 0
REPLACE CHRKHA WITH (CHRKH * 1.10/1.12)
REPLACE CMTKHA WITH (CMTKH * 1.10/1.12)
REPLACE CGRKHA WITH (CGRKH * 1.10/1.12)
REPLACE CGZKHA WITH (CGZKH * 1.10/1.12)
REPLACE CHYKHA WITH (CHYKH * 1.10/1.12)
REPLACE CPYKHA WITH (CPYKH * 1.10/1.12)
REPLACE CPOKHA WITH (CPOKH * 1.10/1.12)
ELSE
REPLACE CHRKHA WITH (CHRKH * (1.10/(1 + GNMT)))
REPLACE CMTKHA WITH (CMTKH * (1.10/(1 + GNMT)))
REPLACE CGRKHA WITH (CGRKH * (1.10/(1 + GNMT)))
REPLACE CGZKHA WITH (CGZKH * (1.10/(1 + GNMT)))
REPLACE CHYKHA WITH (CHYKH * (1.10/(1 + GNMT)))
REPLACE CPYKHA WITH (CPYKH * (1.10/(1 + GNMT)))
REPLACE CPOKHA WITH (CPOKH * (1.10/(1 + GNMT)))
ENDIF
*Various Head Counts (Plants Per Hectare)
DO NTTOTF11
SELECT 1
SKIP
ENDDO
CLOSE ALL DATABASES
*End Program
```

## B.2 THE NTTILF11 SUB-PROGRAMME

```
CLEAR
*Subprogram NTTILF11, Calculates Various Measures Of Tillering
SELECT 1
* Calculation Of Various Tillering Types
TILL1T1 = (PO01/(PNQ01+0.00000001))+(PO02/(PNQ02+0.00000001))+;
(PO03/(PNQ03+0.00000001))+(PO04/(PNQ04+0.00000001))+;
(PO05/(PNQ05+0.00000001))+(PO06/(PNQ06+0.00000001))+;
(PO07/(PNQ07+0.00000001))+(PO08/(PNQ08+0.00000001))
TILL1T2 = (PO09/(PNQ09+0.00000001))+(PO10/(PNQ10+0.00000001))+;
(PO11/(PNQ11+0.00000001))+(PO12/(PNQ12+0.00000001))+;
(PO13/(PNQ13+0.00000001))+(PO14/(PNQ14+0.00000001))+;
(PO15/(PNQ15+0.00000001))+(PO16/(PNQ16+0.00000001))
TILL1T3 = (TILL1T1 + TILL1T2 +;
(PO17/(PNQ17+0.00000001))+(PO18/(PNQ18+0.00000001))+;
(PO19/(PNQ19+0.00000001))+(PO20/(PNQ20+0.00000001)))
SELECT 2
NOQPNT = IIF(NOQPN>0,NOQPN,0)
TILL1 = IIF(NOQPNT>0,TILL1T3/NOQPNT,0)
SELECT 1
TILL2T1 = (PO01/(TNQ01+0.00000001))+(PO02/(TNQ02+0.00000001))+;
(PO03/(TNQ03+0.00000001))+(PO04/(TNQ04+0.00000001))+;
(PO05/(TNQ05+0.00000001))+(PO06/(TNQ06+0.00000001))+;
(PO07/(TNQ07+0.00000001))+(PO08/(TNQ08+0.00000001))
TILL2T2 = (PO09/(TNQ09+0.00000001))+(PO10/(TNQ10+0.00000001))+;
(PO11/(TNQ11+0.00000001))+(PO12/(TNQ12+0.00000001))+;
(PO13/(TNQ13+0.00000001))+(PO14/(TNQ14+0.00000001))+;
(PO15/(TNQ15+0.00000001))+(PO16/(TNQ16+0.00000001))
TILL2T3 = (TILL2T1 + TILL2T2+;
(PO17/(TNQ17+0.00000001))+(PO18/(TNQ18+0.00000001))+;
(PO19/(TNQ19+0.00000001))+(PO20/(TNQ20+0.00000001)))
SELECT 2
NOQTNT = IIF(NOQTN>0,NOQTN,0)
```

```
TILL2 = IIF(NOQTNT>0,TILL2T3/NOQTNT,0)
SELECT 1
TILL3T1 = (HY01/(PNQ01+0.00000001))+(HY02/(PNQ02+0.00000001))+;
(HY03/(PNQ03+0.00000001))+(HY04/(PNQ04+0.00000001))+;
(HY05/(PNQ05+0.00000001))+(HY06/(PNQ06+0.00000001))+;
(HY07/(PNQ07+0.00000001))+(HY08/(PNQ08+0.00000001))
TILL3T2 = (HY09/(PNQ09+0.00000001))+(HY10/(PNQ10+0.00000001))+;
(HY11/(PNQ11+0.00000001))+(HY12/(PNQ12+0.00000001))+;
(HY13/(PNQ13+0.00000001))+(HY14/(PNQ14+0.00000001))+;
(HY15/(PNQ15+0.00000001))+(HY16/(PNQ16+0.00000001))
TILL3T3 = (TILL3T1 + TILL3T2 +;
(HY17/(PNQ17+0.00000001))+(HY18/(PNQ18+0.00000001))+;
(HY19/(PNQ19+0.00000001))+(HY20/(PNQ20+0.00000001)))
SELECT 2
NOQPNT = IIF(NOQPN>0,NOQPN,0)
TILL3 = IIF(NOQPNT>0,TILL3T3/NOQPNT,0)
SELECT 1
TILL4T1 = (HY01/(TNQ01+0.00000001))+(HY02/(TNQ02+0.00000001))+;
(HY03/(TNQ03+0.00000001))+(HY04/(TNQ04+0.00000001))+;
(HY05/(TNQ05+0.00000001))+(HY06/(TNQ06+0.00000001))+;
(HY07/(TNQ07+0.00000001))+(HY08/(TNQ08+0.00000001))
TILL4T2 = (HY09/(TNQ09+0.00000001))+(HY10/(TNQ10+0.00000001))+;
(HY11/(TNQ11+0.00000001))+(HY12/(TNQ12+0.00000001))+;
(HY13/(TNQ13+0.00000001))+(HY14/(TNQ14+0.00000001))+;
(HY15/(TNQ15+0.00000001))+(HY16/(TNQ16+0.00000001))
TILL4T3 = (TILL4T1 + TILL4T2 +;
(HY17/(TNQ17+0.00000001))+(HY18/(TNQ18+0.00000001))+;
(HY19/(TNQ19+0.00000001))+(HY20/(TNQ20+0.00000001)))
SELECT 2
NOQTNT = IIF(NOQTN>0,NOQTN,0)
TILL4 = IIF(NOQTNT>0,TILL4T3/NOQTNT,0)
REPLACE CTILL1 WITH TILL1
REPLACE CTILL2 WITH TILL2
REPLACE CTILL3 WITH TILL3
REPLACE CTILL4 WITH TILL4
RETURN
```

### B.3 THE NTTOTF11 SUB-PROGRAMME

```
*Subprogram NTTOTF11
*Various Head Counts (Plants Per Hectare)
*Total Plants (TN) And Standard Deviation
SELECT 1
TNHHT1 = (TNQ01 +TNQ02 + TNQ03 + TNQ04 + TNQ05 +TNQ06 + TNQ08 +;
TNQ09 + TNQ10 + TNQ11 + TNQ12 +TNQ13 + TNQ14 + TNQ15 +;
TNQ16 + TNQ17 + TNQ18 + TNQ19 + TNQ20 + TNQ07)
SELECT 2
TNHH = ((TNHHT1/(NOQTN+0.00000001))*CMULT)
REPLACE CTNHH WITH TNHH
STORE 0000000000.0000 TO SSTNT1,SSTNT2,SSTNT3,SSTNT4
STORE 0000000000.0000 TO SSTN,TNSDQ,CTNSDPH
SELECT 1
     SSTNT1 = ((TNQ01*TNQ01) + (TNQ02*TNQ02) + (TNQ03*TNQ03) +;
(TNQ04*TNQ04))
     SSTNT2 = ((TNQ05*TNQ05) + (TNQ06*TNQ06) + (TNQ07*TNQ07) +;
(TNQ08*TNQ08) + (TNQ09*TNQ09) + (TNQ10*TNQ10))
     SSTNT3 = ((TNQ11*TNQ11) + (TNQ12*TNQ12) + (TNQ13*TNQ13) +;
(TNQ14*TNQ14))
     SSTNT4 = ((TNQ15*TNQ15) + (TNQ16*TNQ16) + (TNQ17*TNQ17) +;
(TNQ18*TNQ18) + (TNQ19*TNQ19) + (TNQ20*TNQ20))
     SSTN  =  (SSTNT1+SSTNT2+SSTNT3+SSTNT4)
```

```
SELECT 2
        NOQTNT = IIF(NOQTN > 0, NOQTN, 2)
     TNSDQ =   (SQRT((SSTN-((TNHHT1*TNHHT1)/NOQTNT))/(NOQTNT-1)))
REPLACE CTNSDPH WITH (TNSDQ*CMULT)
*Total Number Productive Plants (PN)
SELECT 1
PNHHT1 = (PNQ01 +PNQ02 + PNQ03 + PNQ04 + PNQ05 +PNQ06 + PNQ08 +;
PNQ09 + PNQ10 + PNQ11 + PNQ12 +PNQ13 + PNQ14 + PNQ15 +;
PNQ16 + PNQ17 + PNQ18 + PNQ19 + PNQ20 + PNQ07)
SELECT 2
PNHH = ((PNHHT1/(NOQPN+0.00000001))*CMULTT)
REPLACE CPNHH WITH PNHH
*Total Number Of HR
SELECT 1
HRHHT1 = (HRQ01 +HRQ02 + HRQ03 + HRQ04 + HRQ05 +HRQ06 + HRQ08 +;
HRQ09 + HRQ10 + HRQ11 + HRQ12 +HRQ13 + HRQ14 + HRQ15 +;
HRQ16 + HRQ17 + HRQ18 + HRQ19 + HRQ20 + HRQ07)
SELECT 2
HRHH = ((HRHHT1/(NOQHR+0.0000001))*CMULT)
REPLACE CHRHH WITH HRHH
*Total Number Of MT
SELECT 1
MTHHT1 = (MTQ01 +MTQ02 + MTQ03 + MTQ04 + MTQ05 +MTQ06 + MTQ08 +;
MTQ09 + MTQ10 + MTQ11 + MTQ12 +MTQ13 + MTQ14 + MTQ15 +;
MTQ16 + MTQ17 + MTQ18 + MTQ19 + MTQ20 + MTQ07)
SELECT 2
MTHH = ((MTHHT1/(NOQMT+0.00000001))*CMULT)
REPLACE CMTHH WITH MTHH
*Total Number Of GR
SELECT 1
GRHHT1 = (GRQ01 +GRQ02 + GRQ03 + GRQ04 + GRQ05 +GRQ06 + GRQ08 +;
GRQ09 + GRQ10 + GRQ11 + GRQ12 +GRQ13 + GRQ14 + GRQ15 +;
GRQ16 + GRQ17 + GRQ18 + GRQ19 + GRQ20 + GRQ07)
SELECT 2
GRHH = ((GRHHT1/(NOQGR+0.00000001))*CMULT)
REPLACE CGRHH WITH GRHH
*Total Number Of GZ
SELECT 2
GZHHT1 = (GZQ01 +GZQ02 + GZQ03 + GZQ04 + GZQ05 +GZQ06 + GZQ08 +;
GZQ09 + GZQ10 + GZQ11 + GZQ12 +GZQ13 + GZQ14 + GZQ15 +;
GZQ16 + GZQ17 + GZQ18 + GZQ19 + GZQ20 + GZQ07)
SELECT 2
GZHH = ((GZHHT1/(NOQGZ+0.0000001))*CMULT)
REPLACE CGZHH WITH GZHH
*Total Heads (PO) And Standard Deviation
SELECT 2
POHHT1 = (PO01 +PO02 + PO03 + PO04 + PO05 +PO06 + PO08 +;
PO09 + PO10 + PO11 + PO12 +PO13 + PO14 + PO15 +;
PO16 + PO17 + PO18 + PO19 + PO20 + PO07)
SELECT 2
POHH = ((POHHT1/(NOQMT+0.00000001))*CMULT)
REPLACE CPOHH WITH POHH
STORE 0000000000.0000 TO SSPOT1,SSPOT2
STORE 0000000000.0000 TO SSPO,POSDQ,CPOSDPH
     SSPOT1 = ((PO01*PO01) + (PO02*PO02) + (PO03*PO03) +;
(PO04*PO04) + (PO05*PO05) + (PO06*PO06) + (PO07*PO07) +;
(PO08*PO08) + (PO09*PO09) + (PO10*PO10))
     SSPOT2 = ((PO11*PO11) + (PO12*PO12) + (PO13*PO13) +;
(PO14*PO14) + (PO15*PO15) + (PO16*PO16) + (PO17*PO17) +;
(PO18*PO18) + (PO19*PO19) + (PO20*PO20))
     SSPO  =   (SSPOT1+SSPOT2)
```

```
        NOQMTT = IIF(NOQMT > 0, NOQMT, 2)
      POSDQ  =   (SQRT((SSPO-((POHHT1*POHHT1)/NOQMTT))/(NOQMTT-1)))
REPLACE CPOSDH WITH (POSDQ*CMULT)
*Calculation Of Average Plant Height (CPLHTAV) (Cms)
SELECT 1
PTHTT  =(PTQ01+PTQ02+PTQ03+PTQ04+;
 PTQ05+PTQ06+PTQ07+PTQ08+PTQ09+PTQ10+;
 PTQ11+PTQ12+PTQ13+PTQ14+PTQ15+PTQ16+;
PTQ17+PTQ18+PTQ19+PTQ20)
SELECT 2
REPLACE CPLHTAV WITH (PTHTT/(NOQPT+0.0000001))
RETURN
```

## APPENDIX C: LIST OF FILES

The list of files on disk W100 that are relevant for entering the data and processing it are as follows:

(a). Data Collection Forms: Can be obtained from printing pages 2 and 5 from Working Paper 33 itself, i.e., file WP33.

(b). Database Files:

Plant Population Densities:

| | |
|---|---|
| Database file: | FORM05.DBF |
| Index file: | FM05ID.NDX |
| Quickreport files: | FORM05.QR |

Harvest Information:

| | |
|---|---|
| Database files: | FORM11A.DBF |
| | FORM11B.DBF |
| Index files: | FM11AID.NDX |
| | FM11BID.NDX |
| Quickreport files: | FORM11A.QR |
| | FORM11B.QR |

(c). Programmes for Calculating Variables:

| | | |
|---|---|---|
| Plant Population Densities: | Main programme: | NTFM05G.PRG |
| Harvest Information: | Main programme: | NTFM11.PRG |
| | Sub-programmes: | NTTILF11.PRG |
| | | NTTOTFII.PRG |