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Subject: CAgM Information Report No. 2

A GUIDE TO THE ACQUISITION OF CROP/WEATHER DATA FOR INTERNATIONAL EXPERIMENTS

The Guide on the Acquisition of Crop/Weather Data by Mr. S.N. Edey, a member of the CAgM Working Group on International Experiments for the Acquisition of Wheat/Weather Data, has been recommended by the President of CAgM. A copy of the report is therefore attached for information.* It should be noted that this report is not to be considered as an official publication of either WMO or CAgM.

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#2

A GUIDE TO THE ACQUISITION OF CROP/WEATHER DATA FOR INTERNATIONAL EXPERIMENTS

by

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A GUIDE TO THE ACQUISITION OF CROP/WEATHER DATA FOR INTERNATIONAL EXPERIMENTS

1. PREFACE

This guide had its origin in Geneva at the fifth session of the Commission for Agricultural Meteorology. At this session, the Commission decided to establish a Working Group on International Experiments for the Acquisition of Crop/Weather Data with the following terms of reference:

(a) To develop instructions for the observations of the developmental stages of plant (such as wheat) yields and climatic data, as required for the interpretation of crop-weather relationships;

(b) To assemble these data through the collaboration of participating agrometeorologists and agencies;

(c) To compile the data by using facilities and staff available to the participants.

The Working Group consisted of:

Professor J. Seemann (Federal Republic of Germany) (Chairman);

Mr. M. Frère (FAO);

Dr. A.D. Kleschenko (U.S.S.R.);

Mr. J. Lomas (Israel);

Dr. F.S. da Mota (Brazil);

Professor B. Opsahl (Norway);

Professor A.J. Pascale (Argentina);

Mr. G.W. Robertson (Canada).

In autumn 1973, Mr. Robertson retired and was replaced by years and has placed agrometeorology in a relatively retarded position as to providing practical agrometeorological help and guidance to the farmer or grower. Thus, it is most appropriate that an emphasis is now being placed on the acquisition of old-style phenology in terms of everyday farm activities, involving such matters as seeding, plant developmental stages, harvest dates and yield. In addition, ordinary climatological data will be supplemented by soil moisture and soil temperature data. The accuracy and adequacy of all observational data must be precise and homogenous in order that agrometeorologists may maximize their efforts and truly make valid progress.

Professor J. Seemann

2. PLANNING OF THE EXPERIMENT

2.1 General

A study of the influence of weather on yield and quality of a crop is not a new kind of experiment. Many investigations have been made in the past in order to establish relationships between crop production and the weather. However this does not diminish the current needs of agrometeorology and prompted the organization of a program of systematic experiments to be carried out in different climatic areas. The aim is to collect

Republic of Germany, Israel, Italy, Norway and the U.S.S.R.

2.2 Selection of Experimental Sites

The experimental site will be located on a soil representative of the area. Consideration will also be given to the meteorological aspects and the avoidance of mesoscale bias, i.e. slopes, hollows, etc.

The soil will be fertile, free of stones (to facilitate soil moisture determinations) and be without impermeable layers (hard pan, rock layers) to a depth of 150 cm.

2.3 Plot Size and Arrangement

Uniform soil conditions rarely exist even over a small portion of a field. Soils vary in texture, depth, drainage, moisture and nutrients from meter to meter. Such soil heterogenity is a principal source of error in field experiments and is universal the world over.

Only one test site is used as shown in Appendix A. If greater statistical confidence is required, it is recommended that a minimum of four replications be used (see Appendix B). The individual size of each plot is 8 x 4 m with the length of each plot, as well as wheat rows, oriented N-S. The border area should be 10 m wide. The total dimensions of the field including plot replications and a border area of 10 m wide will be 55.5 x 53.5 =

*Optimum fertilizer is defined by a soil nutrient test in parts per million (ppm):

Nitrogen (as water soluble N)
6-12 ppm = normal range;

Phosphorus (as water soluble P)
6-12 ppm = normal range;

Potassium (as water soluble K)
20-60 ppm = normal range;

pH of soil should be 6.4 to 7.4 range.

2.4 Soil Preparation

All plots receive the same soil preparation as commonly practiced in the region. Cultural operations should be at right angles to the direction of the plot rows so far as practicable. Fertilizer is applied by machinery rather than by hand methods because of the more uniform distribution.

2.5 Control of Weeds, Insects and Birds

Weed control is carried out by hand as much as possible. If serious problems develop, pesticides and herbicides may be used, however they may affect the plant growth and ultimate yield. If birds are a problem, most likely during the periods of seeding and harvesting, effective control may be obtained through the use of large mesh (2-3 cm) netting suspended 1-1½ meters above the crop. Stakes or poles driven vertically into the ground are used to keep the netting free of the plants.

and purity. The border is sown with the home variety on or about the same date as the first seeding. Seeding rate is the same as the plots.

3. DESCRIPTION OF THE EXPERIMENT SITE (See Data Sheet No. 1)

3.1 Country

Province or state.

3.2 Location of the Site

3.2.1 Name and address of the station

3.2.2 Latitude, longitude, elevation above the mean sea level (m).

3.2.3 General description of site to include topography and overview of soil characteristics.

3.3 Soil Physical Properties

3.3.1 Profile of soil texture by set intervals to a depth of 100 cm and to a depth of 150 cm in arid climates.

Each soil horizon will include:

a) bulk density determination, the ratio of the oven-dry weight (48 hrs at 10°C) to the volume (g/cm^3);

b) field capacity, 1/3 atmosphere tension expressed in % of dry soil weight;

c) wilting point, 15 atmosphere tension expressed in % of dry soil weight.

The field capacity and wilting point percentages are two very useful moisture retention characteristics of soil as they define the available plant water range (see Appendix D).

integrated scales of observations are involved. Firstly is the macroscale or standard climatic observation and secondly is the mesoscale or site observation which are more definitive and details the differences in climates of smaller areas from that of the macroclimate of the region. It is most advantageous to compare the meso-climate, usually determined over a short period of observation, with the long-term standard or macroclimatic observations. Such an approach permits the establishment of the limits of comparable conditions and also to extra-polate the long-term observations to the mesoscale areas.

For this reason, the locating of the experimental site adjacent to or near an established climatological station is of great advantage.

4.1 Climatological Observations

The climatological station is to be situated 5-100 m from the experimental site.

Instrumentation and observational practices will be according to existing WMO practices and standards (see Guide to Meteorological Instruments and Practices, WMO Publication No. 8).

4.2 Instrumentation

The equipment of the station will include the following:

4.4 Soil Moisture Observations

Various devices have been used to determine the moisture content of soil. However, the ideal instrument is yet to be developed. In order to retain a compatibility of the observed data, soil moisture observations will be restricted to a gravimetric determination.

Example:		
	Weight of field sample	36.5 g
	Weight of oven-dried sample	28.7 g
	Loss of weight by drying	7.8 g

Soil moisture is then expressed as a percentage of water of the oven-dried weight:

$$SM = \frac{100 \times 7.8}{28.7} = 27.2\%$$

Samples are oven-dried at 105°C for 36 hours.

Soil moisture observations are made on the following plots on a 7-day interval basis during the growing season:

a) Home variety (Plot No. 2);
b) Mexican variety (Plot No. 4), first planting;
c) Mexican variety (Plot No. 6), second planting.

During the fall and winter season, a 14-day observational interval is used if soil remains unfrozen and permits sampling. Three samples are taken from each of Plots 2, 4 and 6, for every 10 cm interval. The results are averaged to give a mean value per plot for the following 6 levels:

0 - 10 cm
10 - 20
20 - 40
40 - 60
60 - 100
100 - 150.

g) Date of heading (when 50% complete ear emergence (Stage 10.5) is observed from 4 samples of 20 plants each);

h) Date of flowering (when 50% complete flowering (Stage 10.5.2) is observed from 4 samples of 20 plants each);

i) Date of milk stage (when 50% watery ripe (Stage 10.5.4) is observed from 4 samples of 20 plants each);

j) Date of soft dough stage (when 50% mealy ripe (Stage 11.2) is observed from 4 samples of 20 plants each);

k) Date of total ripeness (when 50% hard kernel (Stage 11.3) is observed from 4 samples of 20 plants each).

5.2 Crop Evaluation

Observations during the growing period of a crop may be as valuable as the yield data. Differences due to disease, irregular loss of plants, winter survival, etc. may account for the variation in yield.

Observations will be made for each variety and for different treatments (Plots 1, 3, 5, 7, 8).

a) Average number of plants in a 50 cm section of row from 4 random rows taken 10 days after emergence;

b) Average number of plants in a 50 cm section of row from 4 random rows taken after wintering and just prior to resuming spring growth;

c) Average number of ears in a 50 cm section of row from 4 random rows taken at the soft dough stage;

d) Average number of unproductive tillers in a 50 cm section of row from 4 random rows taken at the soft dough stage;

e) Numerical assessment re disease and pests. A oven-dried for 72 hours at 85°C and weighed again. This will give a dry matter percentage of the straw for each plot.

After threshing, the grain will be used in the determination of the following (See Data Sheet No.2):

A/ Total weight of grain kg/ha

B/ Weight of a 1000 kernels (gm)

C/ Kernel-water percentage at time of threshing. The 1000 kernel sample from (B) is oven-dried for 72 hours at 85°C and then weighed. The percentage water can then be determined from the two values. Conversely, the percentage dry matter can be determined.

D/ Weight of straw in kg/ha (oven-dried weight). This value can be obtained by the following equation:

(total harvest weight of m^2 sample) - (weight of grain from m^2 sample) X (% dry matter of staw)

= weight of oven-dried straw from m^2 sample.

This value is multiplied by 1,000 to obtain the weight in kg/ha.

Additional grain samples of 2.5 kg size will be gathered from plots 1, 3, and 7. This includes the home variety and the Mexican variety for both normal and delayed planting dates. Such samples will be used for laboratory determinations of protein content, baking quality and similar tests. In the case of standard laboratory techniques, e.g. protein content, the participating country will be responsible for each test. However, some tests, e.g. baking quality must be made by one central laboratory in order to

Data Sheet No. 1

Description of Experimental Site

1. Country .... Station No.....

2. Name of Station ....

   Address ....

   Latitude .... Longtitude .... Elevation (MSL) ....

3. Soil Data

   Type and Texture ....

   Soil Constants

Depth	Bulk Density (GM/CM³)	Field Capacity (%)	Wilting Point (%)
0-10 cm			
10-20			
20-40			
40-60			
60-100			
100-150			

Data Sheet No. 2

Station Name ....
Plot No. ....

Crop Yield and Quality Data Sheet

(A data sheet is completed for plot numbers 1,3,5,7 and 8).

a) Total weight of grain/kg/ha ....

b) Weight of 1000 kernels (gm) ....

c) Kernel-water percentage at time of threshing ....

d) Weight of straw/kg/ha (dry) ....

e) Dry matter content at jointing (gm/m^2) ....

..... 2 weeks later ....

..... 4 weeks later ....

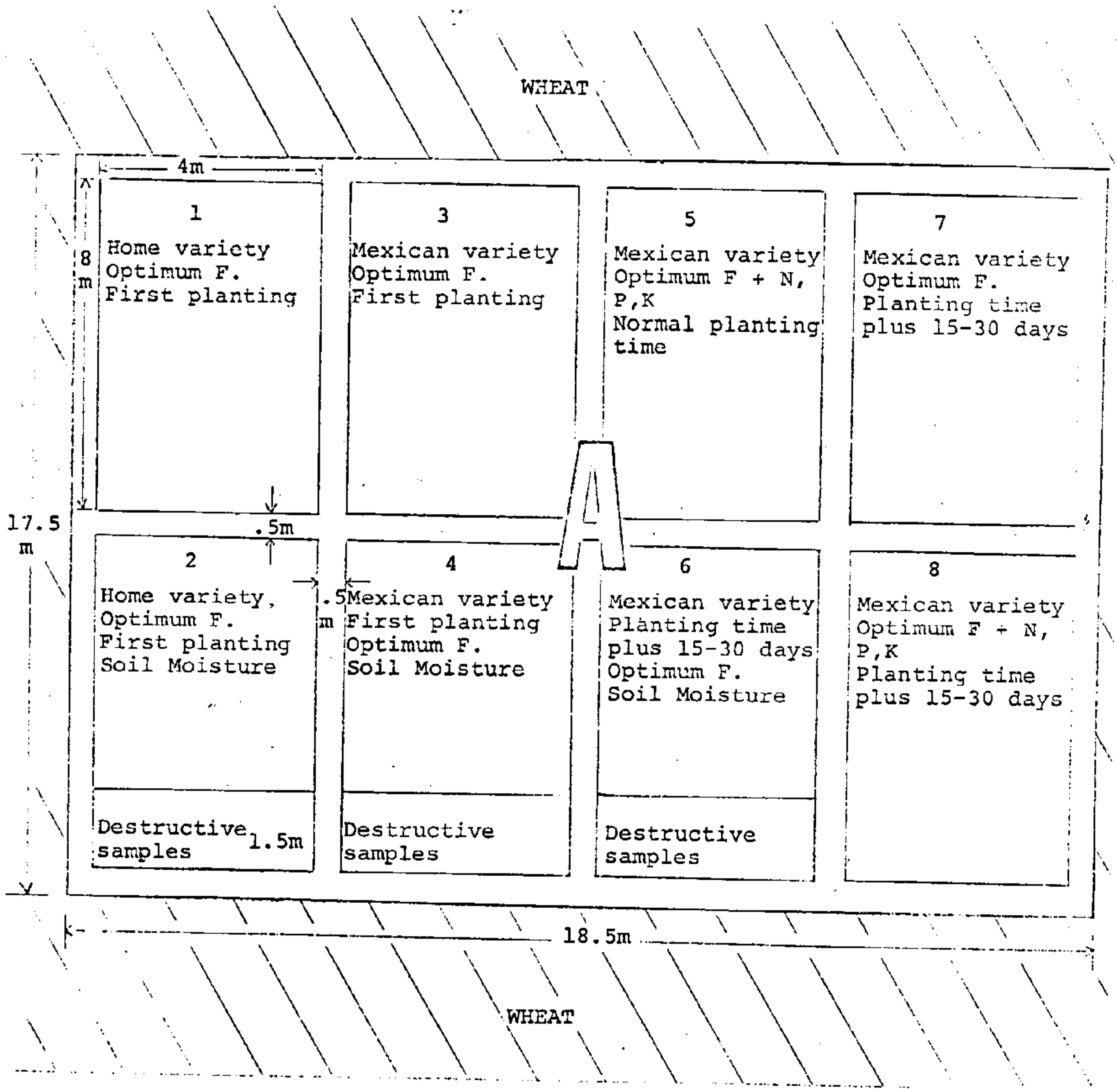
..... 6 weeks later (or harvest) ....

f) Average height of plants just before harvesting ....

(To be completed later by laboratory)

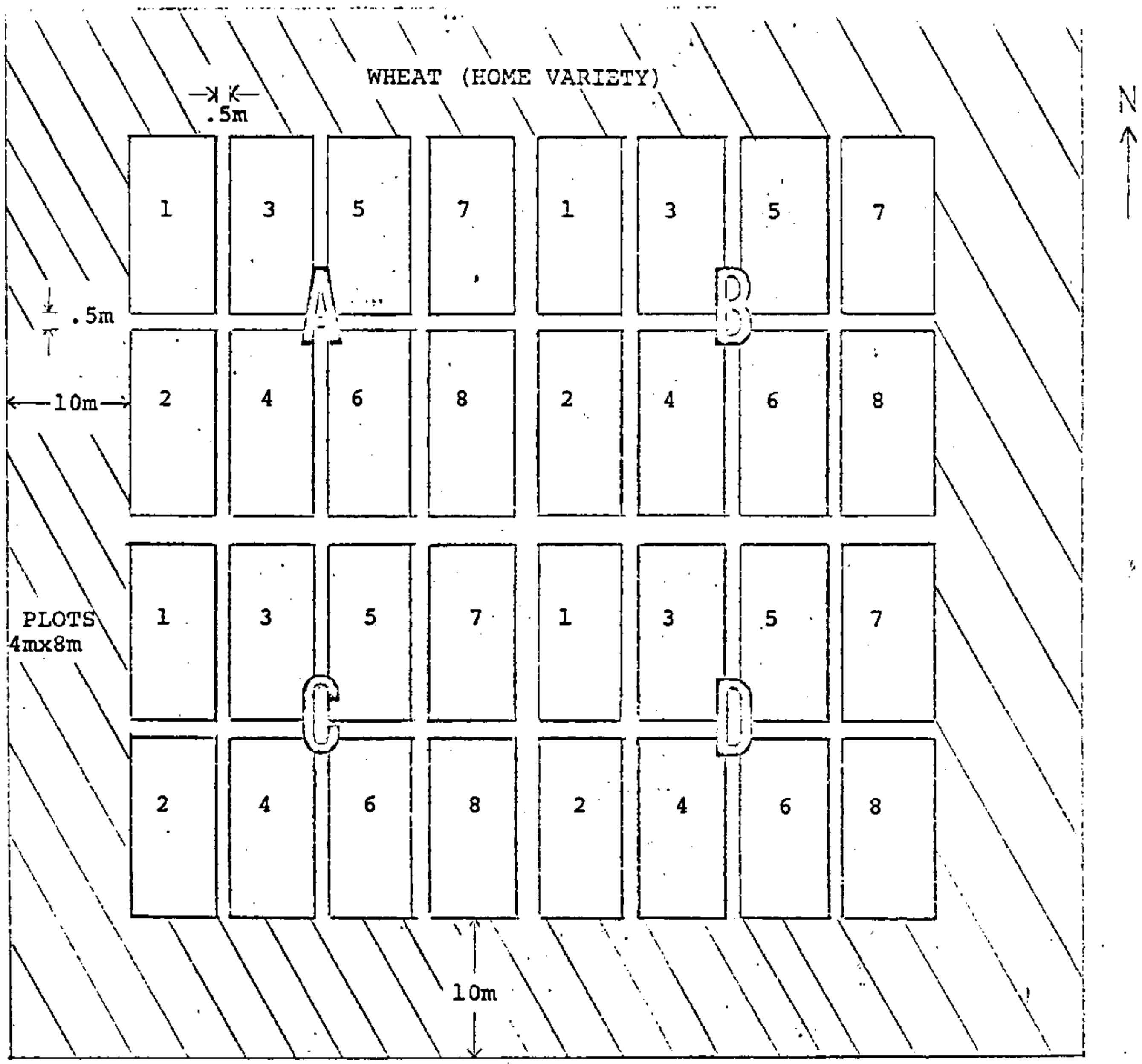
g) Protein determination ....

h) Baking capacity ....



Plan of the individual plot replica showing the various treatments.

APPENDIX A



Plan of the experimental site showing the four replications with a total of 32 individual plots and the border zone of 10 metres.

APPENDIX B

APPENDIX C

Drills for Small Grain

Oyjord (Norwegian Institute of Agricultural Engineering) batch-type, self-cleaning plot drill, distributing a limited quanity of seed completely and evenly. Can be tractor mounted or self propelled.

SD5-8T (Walter and Wintersteiger KG) conventional fluted-wheel metering principle with easy dumping of unused seed. Two-wheeled self-propelled machine, lightweight.

Hassia plot seed drill, conventional fluted-wheel metering principle. Two-wheeled, self-propelled.

Sembdner: one row sowing machine useful for many purposes.

Ordinary tractor mounted seed drills, preferably those with cogged feed rollers and a gearbox for regulating the rate of seed.

Fertilizer Spreaders

Conventional tractor mounted spreaders are used for ordinary top-dressings.

Disc-type spreaders with tray-shaped discs, give very even distribution in small plots.

Threshers

Vogel (Allen Machine Co) self cleaning universl (all-crop) thresher with peg drum cylinder, 50 cm width, straw shaker and fan.

2TD (Saatund Erntetecknick GmbH) self cleaning of unconventional design with enclosed bar drums. Straw and threshed grain blown by a fan into a cyclone separated.

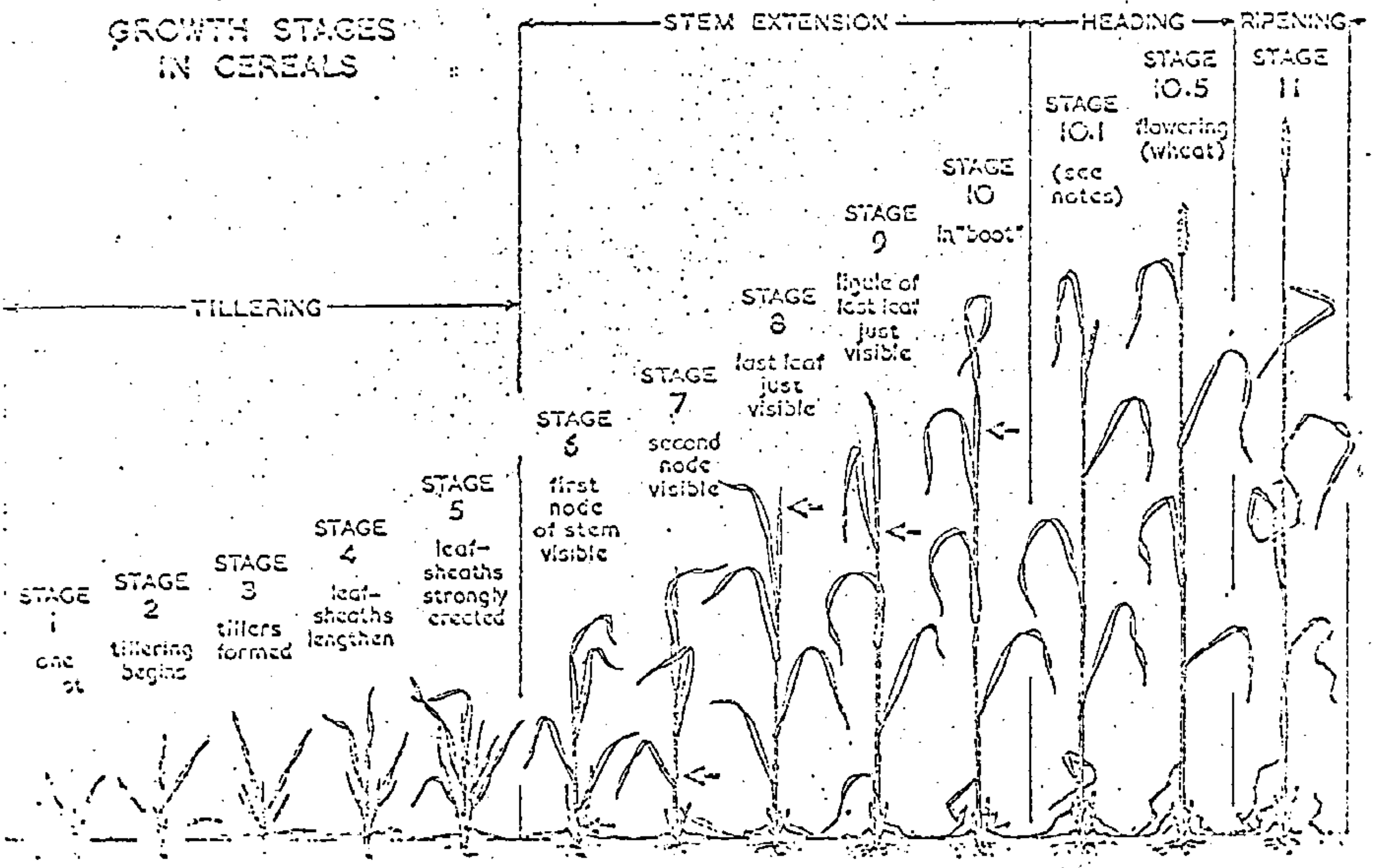
Appendix D

FIELD MOISTURE CAPACITY or field capacity is defined as the percentage of moisture (dry soil basis) that a well-drained soil will retain in the field two or three days after it has been thoroughly wetted and the rate of downward movement has materially decreased. In other words, field capacity is the upper limit of moisture that can be stored in soil in the field. Many laboratory methods have been proposed as approximations of field capacity however in this case only the 1/3 atmosphere percentage method is discussed.

The 1/3 - atmosphere percentage method is the percent moisture (dry soil basis) retained in a saturated sieved soil sample that has been brought to equilibrium on a porous membrane at a tension of 1/3 atm. The soil is passed through a 2-mm. round hole sieve, using a rubber pestle if necessary. The whole sample is thoroughly mixed on a plastic-coated cloth. A small scoop is used to remove small portions of soil from various sections of the pile. The soil collected in this manner is placed in sample retaining rings on a pressure membrane. The rings should be 1cm in height and about 5 cms in diameter.

Determinations are made in duplicate. The soil is leveled in the retaining rings and the samples are allowed to stand for at least 6 hours with an excess of water on the membrane. At the completion of the wetting process, the excess water is removed

APPENDIX E



Stage		
1	One shoot (number of leaves can be added) = "braiding"	Tillering
2	Beginning of tillering	
3	Tillers formed, leaves often twisted spirally. In some varieties of winter wheats, plants may be "creeping" or prostrate	
4	Beginning of the erection of the pseudo-stem, leaf sheaths beginning to lengthen	
5	Pseudo-stem (formed by sheaths of leaves) strongly erected	
6	First node of stem visible at base of shoot	Stem Extension
7	Second node of stem formed, next-to-last leaf just visible	
8	Last leaf visible, but still rolled up, ear beginning to swell	
9	Ligule of last leaf just visible	
10	Sheath of last leaf completely grown out, ear swollen but not yet visible	
10.1	First ears just visible (awns just showing in barley, ear escaping through split of sheath in wheat or oats)	Heading
10.2	Quarter of heading process completed	
10.3	Half of heading process completed	
10.4	Three-quarters of heading process completed	
10.5	All ears out of sheath	
10.5.1	Beginning of flowering (wheat)	Flowering (Wheat)
10.5.2	Flowering complete to top of ear	
10.5.3	Flowering over at base of ear	
10.5.4	Flowering over, kernel watery ripe	
11.1	Milky ripe	Ripening
11.2	Mealy ripe, contents of kernel soft but dry	
11.3	Kernel hard (difficult to divide by thumb-nail)	
11.4	Ripe for cutting. Straw dead	