

INTERNATIONAL NETWORK OF
AGRONOMIC TRIALS

GENERAL INSTRUCTIONS BULLETIN
1977



CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAIZ Y TRIGO

INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

México

INTERNATIONAL NETWORK OF
AGRONOMIC TRIALS

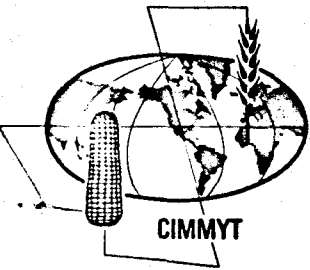
GENERAL INSTRUCTIONS BULLETIN
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INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

Londres 40, México 6, D. F.
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Cable: CENCIMMYT

July, 1977.

Dear Colleague:

Enclosed please find the information on the International Network of Agronomic Trials on Maize as a model to be carried out in farmer's fields, as agreed in the San José, Costa Rica, meeting on the 16th and 17th of March, 1976.

We feel that the formation of this network of trials is a positive step in the efforts to increase maize production in this region. It complements the international network of trials on experimental varieties and progenies that have been developing in cooperation with national programs in Central America and the Caribbean.

We will appreciate your prompt return of the enclosed field book request blank. Please indicate how many you would like to receive. We kindly request you to send trial data and information as soon as harvest is over.

Awaiting your news, we remain cordially yours,

Willy Villena D.
Maize Breeding

Roberto F. Soza
Maize Production

Enc.
WV/RFS:mept

REGIONAL MAIZE PROGRAM FOR CENTRAL AMERICA AND THE
CARIBBEAN
INTERNATIONAL NETWORK OF AGRONOMIC TRIALS
GENERAL INSTRUCTIONS BULLETIN

Crop: Maize

Place: Farmer's field

Objective: The International Agronomic Trial Network is designed to test, gather, share technical information, and to economically raise maize yields in the Central American and Caribbean countries. It pretends to standardize the research system which is applied in the farmer's fields so that more efficient and practical results can be spread quickly among the farmers with less technical training in each of the countries of the region.

Procedure: Annual work sessions will be held with scientists responsible for the national maize production and research in each country. The purpose will be to exchange experiences, outline necessary research and plan the production strategies which shall be followed.

In the meeting held in San José, Costa Rica, on March 16 - 17, 1976, scientists representing each country agreed to develop production programs based on the massive conduction of demonstrations and production research trials on farmers' fields. This is by applying a standardized system to facilitate the conduction and later the exchange of results.

In accordance with the results obtained in the 1975 production program, scientists approved the design and execution of the following demonstration and production research trials at farmer's field:

- 1) Simple Demonstration Trial (Verification).
- 2) Evaluation Trial of Production Factors.
- 3) Superior Varieties Trial.

- 4) Fertilizers x Densities Trial.
- 5) Insect Control Trial.
- 6) Weed Control Trial.
- 7) No - tillage Trial.
- 8) Grain Storage Trial.

These trials are standardized according to the system; nevertheless, the technical details of the treatments must be formulated by the responsible national scientists in accordance with the existing basic national research and the availability of production products in the markets in each country.

CIMMYT committed itself to prepare and distribute the field books in the amount required by the national programs in accordance with the corresponding trials. So that summaries, conclusions and recommendations can be drawn and presented, we urge that cost and harvest report forms be filled out, in accordance with the instructions, and be immediately sent to CIMMYT.

Following, trials are described indicating design and execution instructions for each of them.

TRIAL NO. 1Simple Demonstration Trial

(Verification of Technological Alternatives)

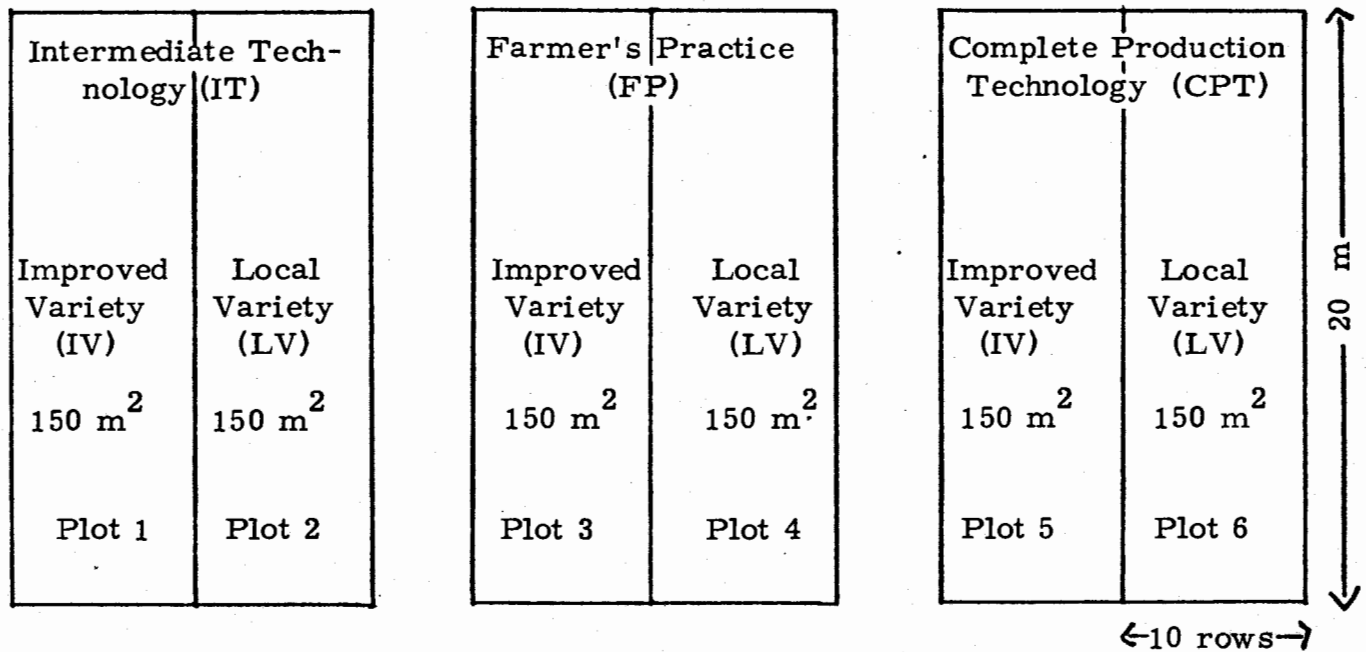
Crop: MaizePlace: Farmer's Field.

Objective: To compare grain yield and the net economic income per unit area in accordance with three cropping methods: 1) Farmer's Practice, 2) Intermediate Technology (Minimum Cost) and 3) Complete Production Technology. In each of these three types of cropping methods, the performance of the Local Variety (Criollo) and the Improved Variety (Hybrid), which has been locally adapted, is tested in order to quantify the advantages of the last one over the first one. It is suggested that this trial be conducted in large numbers (over 100) in each country since this trial is in itself the key to the rapid and direct transfer of technology to the farmers. It is important that the demonstration trials be distributed in an approximately equidistant manner in the area selected for execution; this is so that the radius of separation amongst them will not be too big, and, therefore, an effective technological influence will be exercised on the area farmers.

Plot No.T R E A T M E N T S

- | | |
|---|--|
| 1 | Improved Variety (IV) with "Intermediate Technology" (IT). |
| 2 | Local Variety (LV) with "Intermediate Technology" (IT). |
| 3 | Improved Variety (IV) with "Farmer's Practice" (FP). |
| 4 | Local Variety (LV) with "Farmer's Practice" (FP). |
| 5 | Improved Variety (IV) with "Complete Production Technology" (CPT). |
| 6 | Local Variety (LV) with "Complete Production Technology" (CPT). |

DESIGN OF SIMPLE DEMONSTRATION TRIAL



Approximate area: 1000 m²

The test plots are distributed in this manner so that farmers can easily see the differences in color, plant development and yield differences at harvest between plots cultivated with their production practice (plots 3 and 4 in the center), plots 5 and 6 on the right, with the recommended technology, and plots 1 and 2 on the left, which follow the "intermediate technology".

Plot's Size: Plots 20 m long by 10 rows wide and separation between rows of 75 cm; (150 m² per plot). The area of plots 3 and 4 will depend on the distance between rows used by the farmers, (from 90 to 120 cm).

Total area of the trial: Approximately 1000 m².

DESCRIPTION OF THE PLOTS

Plot No.	Plot's Size m ²	Number of rows	Rows' Length	Distance between rows cm	Distance between plants cm	Number of seeds per hill	Thin to
1	150	10	20	75	50	2 a 3	2
2	150	10	20	75	50	2 a 3	2
3	Depends on the distance used by the farmer.	10	20	Depends on the distance used by the farmer.	farmer's practice	farmer's practice	
4		10	20				
5	150	10	20	75	50	2 a 3	2
6	150	10	20	75	50	2 a 3	2

PLANTING PROCEDURE AND DESCRIPTION OF FARMER'S PRACTICE,
INTERMEDIATE TECHNOLOGY AND COMPLETE
PRODUCTION TECHNOLOGY

Site and Soil Selection for the Trial.

Special care should be taken in the selection of sites for planting trials, so climate, soil and topography characteristics be representative of each area. Select easy access sites for local farmers. Plots must be flat or with uniform slope without depressions, so that water will not stand there. Its texture, as well as its structure, must be uniform. It should be sufficiently far away from irrigation ditches or creeks that would present a flooding threat. They must be away from fences and trees that would create shadows. It is advisable to obtain soil samples before planting so that a chemical analysis be conducted with the purpose of determining the amount of nutrients and to correlate the results from grain yield with the analysis. In order to obtain the samples, follow the instructions given by the soil laboratories of the respective countries.

A) FARMER'S PRACTICE (FP) (Plots 3 and 4).

- 1) First, plant the plots assigned to the farmer's practice; number them 3 and 4.
- 2) Place these two plots in the center of the area which was chosen for the trial.

- 3) Proceed to plant these two plots in the way accustomed by the farmer. It is very important that these plots be planted first so that the farmers will not be influenced by the Intermediate or Complete Production Technologies. This influence has been observed several times when plots assigned with technologies were planted first. This would mislead the objective and the results of the demonstration trial. The "Production Specialists" who are in charge of the trial should observe and take notes on the procedure employed by the farmer. This will allow later comparison as well as evaluation on the advances in adoption of the recommended technology.

It is recommended that the "Production Specialists" physically participate in planting these plots and that they carefully follow the guidance of the farmers in order to show them that the test implies team work and cooperation in all of its phases and that the success or failure of it will fall on both sides.

B) INTERMEDIATE TECHNOLOGY (IT) (Plots 1 and 2).

- 1) Once the planting of plots 3 and 4 has been finished, plots 1 and 2 should be planted. Special care must be taken in explaining in detail to the farmers the procedures that they must follow and one must work beside them so mistakes be avoided.
- 2) The "Intermediate Technology" will be formulated in accordance with the Farmer's Practice. Production factors will be improved in such a way that they will not affect much the total costs, such as good plant density and distribution, better manual weed control, use of an efficient insecticide and intermediate application of fertilizers which will be between the dose used by the farmer and the one recommended by the "Complete Production Technology", this is 50 kg/ha of nitrogen and no phosphorous applications.

C) COMPLETE PRODUCTION TECHNOLOGY (CPT) (Plots 5 and 6).

This technology must be in agreement with the recommendations given by the National Institute of Agricultural Research or by related agencies responsible

for research for specific areas in each country. The following is an example of this:

1) Soil Preparation:

Soil preparation for plots 1, 2, 5 and 6 must be done prior to the planting by the participating farmers to make sure that the soil is as level as possible, soft, and free of clods.

NOTE: It is recommended that some trials be run without soil preparation. The objective is to evaluate and introduce the method of planting without soil preparation (no-tillage) which could bring great benefits from the economic point of view and time savings. One week before planting these trials, proceed to cut tall weeds and stubbles. Planting can be done immediately through the use of a handspike or furrow plowed with either oxen or tractor. Then, a mixture of 1.5 kg/ha of Gramoxone (18% Paraquat) and 1.5 kg/ha of Gesaprim 50 (Atrazine) should be applied. It is not recommended to burn the stubbles and weeds since a layer of vegetative residuous (mulch) has demonstrated to be an important factor for the no-tillage system. Drill furrow application of ammonium sulphate or nitrate is recommended to avoid volatilization losses of nitrogen. Urea can be used only when it is immediately covered with soil or when there is enough rainfall after application.

2) Fertilizers:

a) Nitrogen: 100 kg/ha of N; apply 50% at planting and 50% when plants reach 60 cm height (approximately 40 days after planting). If urea is used (46% N), then the total application must be around 218 kg/ha. Urea application at planting should be well distributed along the furrow (preferably per hill near the seed) and it should be covered with the soil edges of the furrows. The second application of urea can be done by drill or hill placement between the rows near the plants. Urea should be covered immediately in case of no moisture available at the soil surface. The amount of each application should be as follows:

	Urea Application kg/ha	Total Urea Application per trial kg	Urea Application per plot kg	Urea Application per 20 m long row gr	Localized urea applica- tion per hill (50 cm each) gr
At planting	109	3.3	1.6	163	224
40 days after	109	3.3	1.6	163	224
TOTAL	218	6.6	3.2	326	

NOTE: When handspike planting is done, fertilizers (nitrogen and phosphorus) can be localized applied at planting in holes about 10 cm deep immediately beside the holes for the seed. The second dose of nitrogen can be also localized applied in holes at 20 cm apart from the plant stem.

- b) Phosphorus: 40 kg/ha of P_2O_5 applied at planting (plots 5 and 6). If triple super phosphate (46% P_2O_5) is used, then the application must be approximately 87 kg/ha. This product should be applied well distributed along the furrow and covered with soil.

TPS Application kg/ha	Total TSP Application per trial kg	TSP Application per plot kg	TSP Application per 20 m long row gr	TSP Localized Application per hill gr
87	2.6	1.3	130	3.2

NOTE: If soil analysis, or previous experience with fertilization trials show that there is no response to phosphorus application, then nitrogen only should be used. It is advisable to previously prepare measuring cups per plot and rows so that the application of the fertilizers (N and P_2O_5) be facilitated. It is convenient to use plastic cups trimmed to hold the correct volume. Cups should be marked to identify them. If the fertilizer is applied per hill, then calibrated plastic spoons can be used.

3) Insect Control:

- a) Soil Application: Granular Aldrin at 20% (1 kg/ha a.i.) could be applied at the bottom of the hole where the seed is planted.

Total Aldrin kg/ha	Total Aldrin per trial gr	Total Aldrin per plot gr	Total Aldrin per 20 m row gr	Total Aldrin per hill gr
5	150	75	7.5	≈ 0.2

If systemic granular insecticides such as Furadan or Cyrolane are available in the local markets, then it will be preferable to use them because they are more effective in controlling insects than contact insecticides. Furadan or

Cyrolane should be applied per hill next to the seed. Application dose for these insecticides is 500 gr/ha (a.i.). This represents about 25 kg/ha of the commercial product when the active ingredient is 2% (the amount to be used is 1/4 of a tea spoon or 1 gr per hill with a separation between hills of 50 x 75 cm).

b) Foliage Application: To control foliar insects, such as the "Fall Army Worm" (Spodoptera Frugiperda), it would be convenient to apply to the plant's whorl one of the following products in its granular form and in accordance with its availability and cost: Sevin, Dipterex, Birlane, Cyrolane and Furadan. The application dose for these products, taking in consideration a 2% concentration of the active ingredient, should be approximately 12.5 kg/ha of the commercial product (1/8 of a tea spoon of the granular product or 1/4 gr per plant when the population is about 50,000 pl/ha). In areas of high incidence of foliage insect, two applications are advisable; the first should be two or three weeks after planting and the second one two or three weeks later. It is very important to constantly identify the presence of insects and the degree of foliage damage during the first stages of the crop's development. Application of the insecticide must be done as soon as damage is first detected in 2 from each 10 plants (20% attack).

4) Planting:

Plant 2 or 3 seeds per hill by using a stick or a handspike. They should be at a depth of about 5 cm or down to where humidity is available. Planting can also be done by opening the furrows every 75 cm with an oxen plow or with a tractor, placing the seed in the bottom of the furrows.

Distance between rows cm	Distance between hills cm	Total hills per 20 m long row	Number of seeds per hill	Final number of plants per hill	Number of plants per m
75	50	41	2-3	2	± 5

If thinning is needed, this must be done when hill plants are about 15 to 20 cm high, two plants should be left per hill or three plants in the adjacent hills in the case of lost hills.

The final expected population is around 50,000 plants per hectare. This requires approximately 0.6 kg of seed per plot. The total amount of seed required of improved variety is 2 kg for plots 1, 3 and 5. It is assumed that the farmer will provide seed of the local variety needed for plots 2, 4 and 6, which will also require 2 kg per trial.

Before proceeding with the planting, it is necessary to prepare markers to determine the distance between the rows and over the rows. A practical way of doing this is to use a metal frame made from two pipes which are both rigid and light weight (wooden frame can also be used). They should be 3.2 m long each, joined by four 1/4 inch nylon strings 20 m long and tied to the pipes with a 75 cm separation. Each nylon cord carries visible marks each 50 cm to determine the placement of seed, insecticide and fertilizers. On one side of the string the seed can go next to the insecticide and on the other side the fertilizer can be placed. The frame is fixed to the ground by means of 4 iron spikes to keep the strings taut.

5) Weed Control:

- a) Herbicides: Apply 2 kg/ha (a.i.) of Gesaprim 50 (Atrazine), or 4 kg/ha of the commercial product in a 400 lt/ha water solution. This represents 60 gr/plot of Gesaprim 50 diluted in 6 liters of water. The total amount of Gesaprim for the trial (plots 5 and 6) is 120 gr. If the farmer has crop rotation, which includes crops which are susceptible to Gesaprim, then Gesaprim-Combi should be used in the same proportion. The advantage of this product is that it has a lesser residual effect (about two months) than that of Gesaprim 50. Gesaprim-Combi contains 40% Atrazina and 40% Terbutrina.

b) Cultivation: No cultivation or furrow opening is advised since any soil disturbance eliminates the effect of herbicide and weeds start germinating. If it is difficult to obtain the suggested herbicides or if their application has no effect on some of the weeds (*Cyperus* sp.) then it will be necessary to eliminate them manually or mechanically. In that case the first cultivation could take place 10 or 15 days after planting. A second cultivation could be done from 30 to 40 days after planting. This will depend on the amount of weeds, however, it is recommended that no weeds be allowed in plots 5 and 6.

6) Harvest:

After the plants have gone past their physiological maturity (black layer formation), the two central rows in each plot must be harvested and the ears weighed without leaves. Ten ears should be kept to determine moisture. Grain yield should be calculated and reported in kg/ha at 15% moisture. No compensations for lost plants should be made.

Additionally, a sampling of the farmer's commercial plot should be taken in order to determine the real yield obtained normally in his fields. It has been observed in many trials that the plot where the farmer's practice was used was often superior in comparison with his commercial field. This shows that the farmer was making a greater effort taking care of this plot. In other words, the farmer was competing with the technician to show him that he also knew how to grow maize. With this sampling it is possible to identify and quantify the existing differences between his regular field and this test plot. The sampling consists in harvesting two adjacent 20 m long rows. This operation is repeated three times in areas randomly chosen in the farmer's field. Then an average of the data is made.

NOTE: It is necessary to measure the distance between row in order to determine the size of the plot.

FORMULA TO CALCULATE GRAIN YIELD (15% MOISTURE)

$$\text{Harvested Area}^* = \frac{\text{Number of rows (2)} \times \text{Average distance between rows (75 cm)} \times \text{Effective row length}^{**}}{100} = 30.75 \text{ m}^2$$

$$\text{Grain Yield} = \frac{\text{Field weight} \times 10,000 \text{ m}^2}{\text{Harvested area (30.75 m}^2)} \times \frac{(100 - \text{Moisture \%})}{100} \times \frac{80 \text{ (shelling \%)}}{100} \times \frac{100}{85}^{***}$$

$\text{Grain Yield} = \frac{\text{Field weight} \times 10,000 \text{ m}^2}{\text{Harvested area (30.75 m}^2)} \times \frac{100 - \text{Moisture \%}}{100} \times \frac{80}{85} = \text{_____ kg/ha}$
--

$\text{Dry Matter \%} = 100 - \text{Moisture \%}$

CONDENSED FORMULA

$\text{Grain Yield (15\% Moisture)} = \text{Field weight} \times \text{Dry Matter \%} \times 3.06 \text{ (Factor)} = \text{_____ kg/ha}$
--

* The size of the harvested area for plots 3 and 4 will depend on the distance between rows used by the farmers.

** The effective row length is equal to the distance between the first and last plants plus an average distance between plants.

*** Calculated factor to express yield at 15% moisture basis.

ACTIVITIES TO BE CARRIED OUT:

Field days: Special emphasis must be given to conducting numerous technical visits and field days with neighbouring farmers. These farmers must follow the development of the crop and observe the differences among the treatments as they take place. They should also cooperate with routine trial work. The following dates are suggested for organizing technical visits and field days:

- 1) At planting
- 2) During application of foliar insecticide.
- 3) During application of nitrogen.
- 4) At flowering.
- 5) During grain filling stage.
- 6) At harvest

The number of farmers attending field days should be recorded as well as their comments and questions which will help to improve the production program.

Trial's Information and Data

It is of great importance to collect a maximum of information and to register data with accuracy. This facilitates the collection of trials and allows to draw conclusions that can be safely used. Also they serve to advise on a scientific basis future related research. Each test has a field book and a copy, it has appropriate forms for the recording of data. Field books are standardized according to requirements that this will facilitate the analysis of the tests through the use of common language, in addition, to be able to summarize the results of large trials within a common frame. On the other hand the standardized forms allow the use of common language among the maize programists in the different countries which, in turn, makes presentation and dissemination of results more efficient during the technical meetings in the area.

We urgently request that all field books have been filled out in accordance with the instructions, they should be sent without delay to CIMMYT, so that they may be analysed together and technical conclusions can be drawn for each area involved in the production program.

TRIAL NO. 2Evaluation Trial on Production Factors

Crop: Maize

Place: Farmer's Field.

Objective: The purpose of this trial is to quantitatively evaluate the production factors which have greatest effect on grain yield and on the economic returns.

This trial has a base, the Complete Production Technology (CPT) which constitutes the first treatment. The remaining treatments are formed by subtracting a production factor each time in the manner later outlined. The Farmer's Practice is the last treatment used as a check in order to have a point of reference of the actual situation of production in the area under study.

The number of trials to be conducted could be 10% of the total number of demonstration trials conducted in each country.

These trials should be conducted simultaneously in all the program's production areas as well as, in an exploratory manner, in those areas not considered in the production program.

It is important to mention that the yield reduction effect of the production factors are not considered additive.

TREATMENTS

- 1) (CPT) Complete Production Technology (in agreement with the informations given by the National Agricultural Research Institute. See the CPT example shown in Trial No. 1).
- 2) (CPT) less Fertilizers (F).
- 3) (CPT) less Nitrogen (N).
- 4) (CPT) less Phosphorus (P).

- 5) (CPT) less Insecticide (I).
 - 6) (CPT) less Herbicide (H). (Weeds are controlled with the farmer's own custom).
 - 7) (CPT) less Plant Density and Distribution recommended (PD). Planting is conducted in accordance with the farmer's customs.
 - 8) (CPT) less Improved Variety (IV) . (The farmer's variety is used).
 - 9) (CPT) less soil preparation (SP). *
 - 10) Farmer's Practice (FP).
- * Planting with no soil preparation (Zero-tillage). For more information for this planting method refer to Trial No. 7.

Experimental Design: Complete randomized block design with four replications.

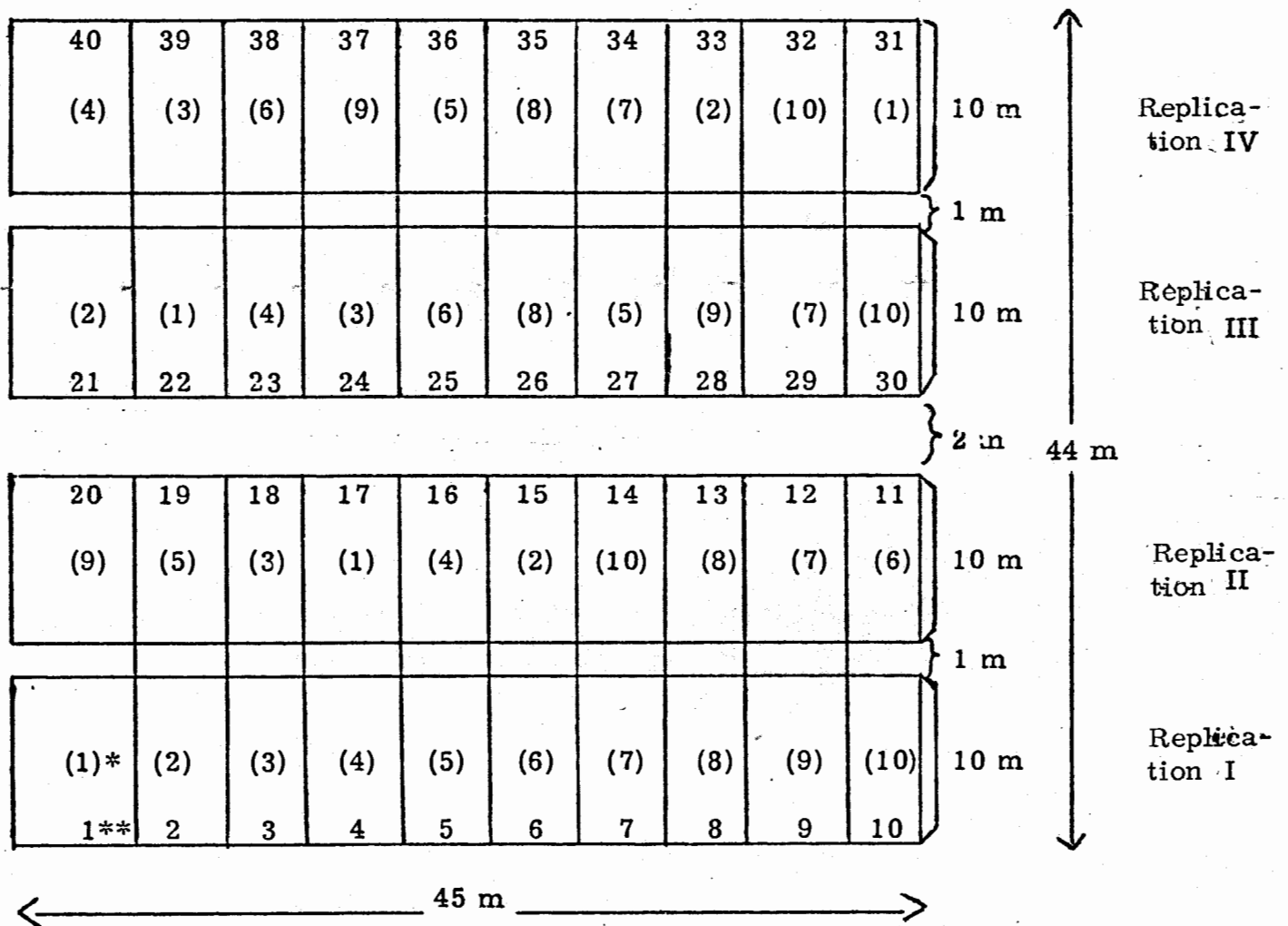
Size of the Plot: Plots with six 10 meter long rows with 75 cm between them.

The two central rows are harvested.

Plot's Distribution: The distribution of plots in the first repetition can be arranged in the same order in which the treatments previously described appear. This will facilitate observations on the field. In the remaining replications, the distribution of plots will be at random in each block.

DISTRIBUTION OF PLOTS AND TREATMENTS

EXAMPLE:



* No. of Treatment.

** No. of Plot.

SUMMARY TABLETRIAL NO. 2

1) Trial Area: 10 treatments with 4 replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	450 m ²	1800 m ²

2) Planting:

Distance between rows	Distance between hills	Hills per row	No. of Seeds per hill	Final No. of plants per hill	Plant Density per ha
75 cm	50 cm	21	3	2	\pm 50,000

3) Nitrogen Application: 100 kg/ha of N as Urea (46% N)

	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m long row	Urea per hill (each 50 cm)
At planting	109 kg	13.7 kg	489 gr	82 gr	3.9 gr
40 days after	109 kg	13.7 kg	489 gr	82 gr	3.9 gr
T O T A L	218 kg	27.4 kg			

4) Phosphorus Application: 40 kg/ha of P₂O₅ as Triple Superphosphate (TSPH)
(46% of P₂O₅)

TSPH per ha	TSPH per Trial	TSPH per Plot	TSPH per 10 m long row	TSPH per hill (each 50 cm)
87 kg	11.00 kg	391 gr	65 gr	3.1 gr

5) Insecticide Application:A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill (each 50 cm)
5 kg	720 gr	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Granular Furadan o Cytrrolane 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per Trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill (each 50 cm)
25 kg	3.6 kg	112.5 gr	19 gr	(0.89)gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cytrrolane, Furadan, etc. (granular) 2% (250 gr/ha a.i.)

Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant (+ 50,000 pl/ha)
12.5 kg	1.8 kg	56.5 gr	9.5 gr	\approx 0.25 gr

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	576 gr (57.6 lt water)	18 gr (1.8 lt water)

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 cm x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15 % Moisture)
--

TRIAL NO. 3
Superior Varieties Trial

Crop: Maize

Place: Farmer's Field

Objective: To determine performance in grain yield and agronomic characteristics of the national superior varieties (or introduced ones) and of local varieties (criollas) under the farmer's normal production conditions.

T R E A T M E N T S

<u>No.</u>	<u>Variety Name</u>	<u>Origin</u>
1)	_____	_____
2)	_____	_____
3)	_____	_____
4)	_____	_____
5)	_____	_____
6)	_____	_____
7)	_____	_____
8)	_____	_____
9)	_____	_____
10)	_____	_____

Experimental Design: Randomized complete block design with four replications.

Plot's Size: Six rows 10 meter long 75 cm apart.

Planting: Plant three grains each 50 cm on the row. Thin to 2 plants 10 to 15 days after planting.

Plant Density: Approximately 50,000 pl/ha.

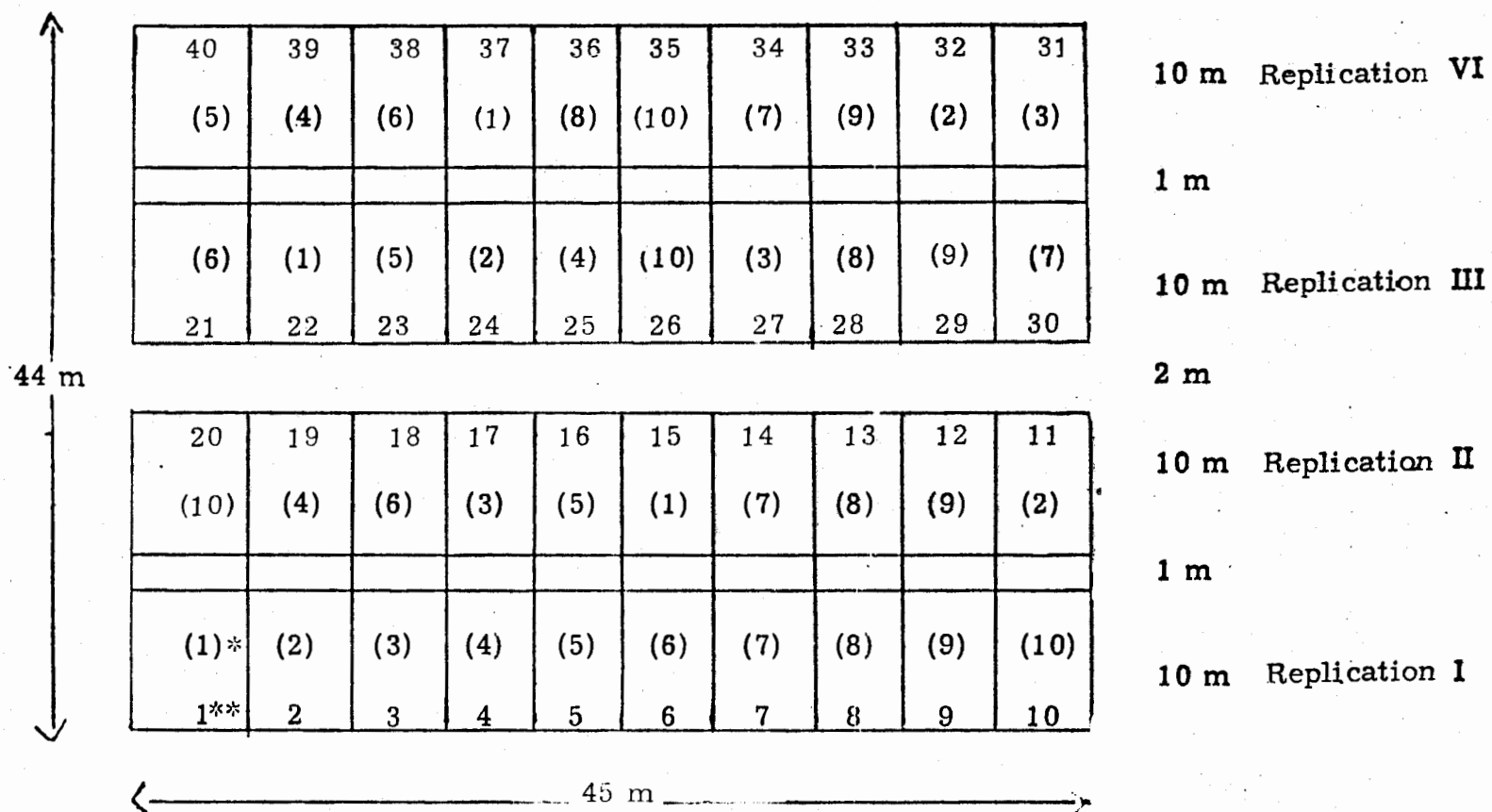
Production Technology: Follow the technical recommendations given by the National Agricultural Research Institute. (See the example from the Complete Production Technology as shown on Trial No. 1). It is suggested to make some variety trials by levels of technology, using the Complete Production Technology (CPT) and the Intermediate Technology (IT) as per description of Trial No. 1. The expe-

rimental design would be split plots, considering the variety as principal plot and the technology levels as sub-plots. This kind of trial is convenient to determine the performance of the varieties under different technological levels. In this case it is convenient to reduce the number of varieties that are tested.

Obtention of Data: Follow the general instructions. Fill out the report forms.

FIELD LAYOUT (PLOT DISTRIBUTION AND TREATMENTS):

EXAMPLE:



* No. of Treatment.

** No. of Plot.

SUMMARY TABLETRIAL NO. 3

1) Trial Area: 10 treatments with 4 replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	450 m ²	1,800 m ²

2) Planting:

Distance between rows	Distance between hills	Hills per row	No. of Seeds per hill	Final No. of plants per hill	Plant Density per ha
75 cm	50 cm	21	2 - 3	2	+ 50,000

3) Nitrogen Application: 100 kg/ha of N as Urea (46% N)

	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m long row	Urea per hill (each 50 cm)
At planting	109 kg	19.6 kg	489 gr	82 gr	3.9 gr
40 days after	109 kg	19.6 kg	489 gr	82 gr	3.9 gr
T O T A L	218 kg	39.2 kg			

4) Phosphorus Application: 40 kg/ha of P₂O₅ as Triple Superphosphate (TSPH)
(46% of P₂O₅)

TSPH per ha	TSPH per Trial	TSPH per Plot	TSPH per 10 m long row	TSPH per hill (each 50 cm)
87 kg	15.7 kg	391.5 gr	65 gr	3.1 gr

5) Insecticide Application:A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill (each 50 cm)
5 kg	0.9 kg	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Granular Furadan o Cyrolane 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per Trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill (each 50 cm)
25 kg	4.5 kg	112.5 gr	19 gr	(0.89)gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cyrolane, Furadan, etc. (granular) 2% (250 gr/ha a.i.)

Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant (+ 50,000 pl/ha)
12.5 kg	2.3 kg	56.5 gr	9.5 gr	\approx 0.25 gr

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	720 gr (72 lt water)	18 gr (1.8 lt water)

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 m x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15 % Moisture)
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TRIAL NO. 4Fertilizers x Plant Density Trial

Crop: Maize

Place: Farmer's Field

Objective: To determine the performance of a superior variety or hybrid, under different fertilizer levels and plant density. This trial serves to obtain information on soil fertilizer requirements of different regions. It also shows to the less technified farmer the benefits derived from using fertilizers at the appropriate type and dose.

Experimental Design: Complete randomized block design with four replications. The experimental unit is composed of 6 rows 10 meters long, using the two rows of the center in the obtention of yield data.

Fertilizers: a) Nitrogen is the element of major importance, especially under low tropical soil conditions.

Suggested Nitrogen Levels:

N	0 kg/ha
N	50 kg/ha
N	100 kg/ha
N	150 kg/ha

b) Phosphorous must be tested in regions where soil analysis and previous research have shown that exists defficiency to this element. This generally occurs in the high and cold regions.

Suggested Phosphorous Levels (P_2O_5):

P	0 kg/ha
P	40 kg/ha
P	80 kg/ha

NOTE: The more economic levels of N and P_2O_5 must be determined in relation with research experience as obtained in different environmental conditions and soil characteristics. In many cases it has been determined that the sole addition of 50 to 100 Nitrogen units has been translated into a drastic increase

in maize production. Response to Potassium is exceptional and it is only produced in very few soils lacking this element and in the presence of high Nitrogen and Phosphorous doses.

Plant Density: Plant density as accustomed by farmers varies from region to region. The degree of technical development is of major influence; for less development there is a corresponding smaller plant density. Plant density of 50,000 pl/ha has generally given best results and this is obtained with two plants per hill of 50 cm apart and at a row distance of 75 cm.

To simplify and reduce the size of trial No. 4, it has been divided into two trials (4A and 4B). Nitrogen at 4 levels and 3 levels of phosphorous are tested in trial 4A. Plant density is kept constant in this trial. Trial 4B consist in testing 4 levels of nitrogen and 3 levels of plant density. Phosphorous levels are kept constant. Follows the description of trials 4A and 4B.

TRIAL NO. 4ANitrogen x Phosphorous

Plant density is maintained constant at 50,000 pl/ha in this trial.

TREATMENTS

<u>No.</u>	<u>N (kg/ha)</u>	<u>P₂O₅ (kg/ha)</u>
1	0	0
2	0	40
3	0	80
4	50	0
5	50	40
6	50	80
7	100	0
8	100	40
9	100	80
10	150	0
11	150	40
12	150	80
*13	Soil Laboratory's Recommendation	

* Treatment No. 13 should be only included when National Soil Laboratory's recommendation greatly differs from the proposed treatment levels, or when this recommendation shows the need of applying Potash.

Area of the Trial: 2,340 m² (4 replications without considering alleys).

TRIAL NO. 4BNitrogen x Plant Density

Nitrogen levels are 0, 50, 100 and 150 kg/ha. Phosphorous is kept constant at the level of 40 kg/ha.

Suggested Plant Density:

Densities Number	Distance between rows cm	Distance between hills cm	Number of hills per row	Number of seeds per hill	Trial Number of plants per hill	Approximate number of plants per ha
1	75	100	11	2 - 3	2	25,000
2	75	50	21	2 - 3	2	50,000
3	75	50	21	3 - 4	3	75,000

Thinning should be done when plants reach 15 to 20 cm plant height. To compensate in case of missing hills, do not thin adjacent hills.

TREATMENTS

<u>No.</u>	<u>N (kg/ha)</u>	<u>Densidades No.</u>
1	0	1
2	0	2
3	0	3
4	50	1
5	50	2
6	50	3
7	100	1
8	100	2
9	100	3
10	150	1
11	150	2
12	150	3

Area of the Trial: 2,160 m² (4 replications without considering alleys).

General Observations

Choosing of the participating farmer: This trial must be conducted with farmers who are technically able and responsible. These characteristics should have been previously demonstrated by their participation in the production program.

Selection of the trial soil: Special care must be taken in the selection of the trial soil site. Soil must be uniform in texture and structure and in the previous crop rotation in order to avoid differences in fertility which, if existent, would confuse the effect of the treatments. In addition, the site must be level and depression free in order to avoid the fertilizers from washing down or the water from accumulating.

The trial site must be at least 10 meters away from roads, ditches and trees in order to avoid the negative influence of these elements. The trial site must be protected with a fence to avoid animal damages.

Trial's Production Technique: The technique and the production factors must be in accordance with the information available in the national research institutes. (See the example of the Complete Production Technology (CPT) as it appears on Trial No. 1).

Data taking: Follow the general instructions. Fill out the accompanying report forms.

SUMMARY TABLETRIAL NO. 4 A

1) Trial Area: 13 treatments with 4 replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	585 m ²	2340 m ²

2) Planting:

Distance between rows	Distance between hills	Hills per row	No. of Seeds per hill	Final No. of plants per hill	Plant Density per ha
75 cm	50 cm	21	2 - 3	2	+ 50,000

3) Nitrogen Application: According to the treatments. Urea 46% N. (Without considering treatment No. 13).

	Treatment	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m row	Urea per hill each 50 cm
Planting *	N50	109 kg	5.9 kg	489 gr	82 gr	3.9 gr
Planting 40 days after	N100	109 kg 109 kg	5.9 kg 5.9 kg	489 gr 489 gr	82 gr 82 gr	3.9 gr 3.9 gr
Planting 40 days after	N150	163 kg 163 kg	8.8 kg 8.8 kg	734 gr 729 gr	122 gr 122 gr	5.8 gr 5.8 gr
TOTAL			35.5 kg			

* Nitrogen application of 50 kg/ha should be done in one dose at planting time.

4) Phosphorous Application: According to treatments. SFT 46% of P₂O₅. (Without considering treatment No. 13).

Treatments	TSPh per ha	TSPh per Trial	TSPh per Plot	TSPh per 10 m row	TSPh per hill (each 50 cm)
P40	87 kg	4.7 kg	391 gr	65 gr	3.1 gr
P80	173.9 kg	9.4 kg	783 gr	130 gr	6.2 gr

5) Insecticide Application:A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill (each 50 cm)
5 kg	1.2 kg	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Granular Furadan o Cytrolane 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per Trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill (each 50 cm)
25 kg	5.9 kg	112.5 gr	19 gr	(0.89)gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cytrolane, Furadan, etc. (granular) 2% (250 gr/ha a.i.)

Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant (+ 50,000 pl/ha)
12.5 kg	2.9 kg	56.5 gr	9.5 gr	\approx 0.25 gr

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	936 gr (93.6 lt water)	18 gr (1.8 lt water)

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 m x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15 % Moisture)
--

SUMMARY TABLETRIAL NO. 4B

1) Trial Area: 12 treatments with four replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	540 m ²	2160 m ²

2) Planting:

Suggested Plant Density:

Densities No.	Distance between rows cm	Distance between hills cm	Hills per row	Number of seeds per hill	Final number of plants per hill	Approximate plant number per ha.
1	75	100	11	2 - 3	2	25,000
2	75	50	21	2 - 3	2	50,000
3	75	50	21	3 - 4	3	75,000

3) Nitrogen Application: According to the treatments. Urea 46% N.

	Treatments	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m row	Urea per hill each 50 cm
Planting *	N50	109 kg	5.9 kg	489 gr	82 gr	3.9 gr
Planting 40 days after	N100	109 kg 109 kg	5.9 kg 5.9 kg	489 gr 489 gr	82 gr 82 gr	3.9 gr 3.9 gr
Planting 40 days after	N150	163 kg 163 kg	8.8 kg 8.8 kg	734 gr 734 gr	122 gr 122 gr	5.8 gr 5.8 gr
TOTAL						

* Nitrogen application of 50 kg/ha should be done in one dose at planting time.

4) Phosphorous Application: According to the treatments. TSPh 46% of P_2O_5 .

Treat-ment	TSPh per ha	TSPh per trial	TSPh per plot	TSPh per 10 m row	TSPh per hill each 50 cm
P40	87 kg	18.8 kg	391 gr	65 gr	3.1 gr

5) Insecticide Application:

A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill each 50 cm
5 kg	1.1 kg	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Furadan or Cytrolane granular at 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill each 50 cm
25 kg	5.4 kg	112.5 gr	19 gr	(0.89) gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cytrolane, etc. (granular) at 2% (250 gr/ha a.i.)

Treat-ments	Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant
25,000	6.25 kg	450 gr	28 gr	4.7gr	\approx 0.2 gr
50,000	12.5 kg	909 gr	56.5 gr	9.5gr	\approx 0.2 gr
75,000	18.75 kg	1,350 gr	84.5 gr	14.1 gr	\approx 0.3 gr
TOTAL		2,700 gr			

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	864 gr 86.4 lt water	18 gr (1.8 lt water)

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 m x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15% Moisture)

TRIAL NO. 5Trial on Insect Control

Crop: Maize

Place: Farmer's field

Objective: To determine a more practical and economical insect control under the normal conditions in which the farmers commercially produce maize crops.

General Guidelines to formulate the Trials: When insect control trials are to be formulated, the following factors should be considered:

- 1) Time of Planting. Spring plantings generally have less problems with insects than latter ones.
- 2) Evaluation and Selection of Insecticides. A constant program must be conducted at a national research level for evaluating and selecting the available insecticides in the national market. The purpose is to find the most efficient and relatively less expensive insecticides. It is convenient to include in the evaluation some products which eventhough may not be available then, could later be obtained through importation, in accordance with their usefulness.

Those insecticides which are highly toxic to humans and might present a hazard in their application procedure, must be discarded. (Those with very low LD50).

- 3) Type of Insecticides and Formulas. Planting application of systemic insecticides, because of their characteristics, give good protection to the plants in their early development stages. When these insecticides are later applied to the foliage, their systemic action is reduced and they act as contact insecticides. Generally systemic insecticides are more expensive than contact ones. When there is a high population of soil insects, it is necessary to apply contact insecticides (Aldrin) in such a way that there will be a protective barrier around the seedlings which will avoid damage from cutting insects.

Granular formulations, either for the systemic insecticides or for the contact

ones, are more practical for applying than the liquid or powder ones. This is particularly true when trying to control fall army worms (Spodoptera frugiperda) because the granules, due to their density and weight, easily penetrate to the bottom of the whorl of the plant. This is where the larve generally is causing the greatest damage to the plant.

4) Application Doses of Insecticides. General recommendation doses generally given by the manufacturers are, with some exceptions, close to the following: for soil application 500 gr/ha of the active ingredient (a.i.) and 250 gr/ha (a. i.) for the foliage. It is assumed that the national research program will determine the best doses for different insecticides by testing to evaluate and select these products. The commercial dose recommended by the manufacturers should be compared to half the doses and also with the dose increased by 50% (50%, 100% and 150% of the commercial dose.)

Experimental Design: Complete randomized block design with four replications.

Plot Size: Plots with six 10 m long rows. To obtain the data on insect damage and grain yield, the two central rows must be used.

Treatments: The following treatments are suggested:

<u>No.</u>	<u>D E S C R I P T I O N</u>
1	Control (without application of insecticide).
2	Seed treatment with 500 gr/ha (a.i.) of Furadan (according to description on page 41).
3	Soil treatment with 500 gr/ha (a.i.) of granular Furadan or Cy-trolane applied together with the seed (per hill).
4	Seed treatment with 500 gr/ha (a.i.) of granular Furadan, according to accompanying description plus foliar application of 250 gr/ha (a.i.) of Sevin or Diptorex, in granular form, 2 or 3 weeks after emergence.
5	Soil treatment with 500 gr/ha (a.i.) of granular Furadan or Cy-trolane applied with the seed (per hill) plus a foliage application

- 6 Soil treatment of 1 kg/ha (a.i.) of granular Aldrin applied at planting.
- 7 Soil treatment of 1 kg/ha (a.i.) granular Aldrin applied during planting plus foliar application of 250 gr/ha (a.i.) of granular Sevin or Dipterex 2 or 3 weeks after emergence.
- 8 Soil treatment with 1 kg/ha (a.i.) of granular Aldrin, applied at planting, plus two foliar applications 250 gr/ha (a.i.) each of granular Sevin or Dipterex at 2 or 3 weeks and 4 or 5 weeks after emergence.
- 9 Foliar treatment of 250 gr/ha (a.i.) application of granular Sevin or Dipterex 2 or 3 weeks after emergence.
- 10 Foliar treatment of two applications of 250 gr/ha (a.i.) of granular Sevin or Dipterex 2 or 3 weeks and 4 or 5 weeks after emergence.
- 11 Foliar treatment with a 250 gr/ha (a.i.) application of granular Furadan or Cytrrolane 2 or 3 weeks after emergence.
- 12 Foliar treatment with two applications of 250 gr/ha (a.i.) each of granular Furadan or Cytrrolane 2 or 3 weeks and 4 and 5 weeks after emergence.

SUMMARY TABLE

<u>Treatments</u>	<u>SEED</u>	<u>SOIL</u>	<u>FOLIAGE</u>
1	Control	Control	Control
2	Furadan 500 gr/ha (a.i.)	-----	-----
3	-----	Furadan or Cytolane 500 gr/ha (a.i.)	-----
4	Furadan 500 gr/ha (a.i.)	-----	1 application of Sevin or Dipterex 250 gr/ha (a.i.)
5	-----	Furadan or Cytolane 500 gr/ha (a.i.)	1 application of Sevin or Dipterex 250 gr/ha (a.i.)
6	-----	Aldrin 1 kg/ha (a.i.)	-----
7	-----	Aldrin 1 kg/ha (a.i.)	1 application of Sevin or Dipterex 250 gr/ha (a.i.)
8	-----	Aldrin 1 kg/ha (a.i.)	2 applications of Sevin or Dipterex 250 gr/ha (a.i.) each
9	-----	-----	1 application of Sevin or Dipterex 250 gr/ha (a.i.)
10	-----	-----	2 applications of Sevin or Dipterex 250 gr/ha (a.i.) each
11	-----	-----	1 application of Furadan or Cyto- lane 250 gr/ha (a.i.)
12	-----	-----	2 applications of Furadan or Cyto- lane 250 gr/ha (a. i.) each

NOTE: Seed treatment procedure is according to the description from page 41.
Soil and granular insecticides used should be in granular form.

Plant Density: Plant exactly two seeds each 50 cm on the row and 75 cm distance between rows. This gives an approximate density of 50,000 pl/ha. Special care must be taken to use seed with high germination percentage so that soil insect damage can be detected.

Production Technology: Follow the technical recommendations given by the National Agricultural Research Institute. (See the example shown in trial No. 1).

INSECT EVALUATION

The observations must be taken from the two central rows in each plot. The objective is to determine in particular the damage of cutworms, borers and fall army worms insects to evaluate the degree of protection provided by the different treatments. The following observations should be taken:

- Initial counting of live plants and foliar damage caused by fall army worm before the first application of foliar insecticide.
- One week after the first application of foliar insecticide, count the number of live plants and plants with damage in the 3 or 4 new leaves of the whorl.
- Repeat the same count, before the second application of the foliar insecticide.
- Repeat the same count, one week after the second application of the insecticide.

In the case of attack by other insects, it is convenient to evaluate the damage caused by *Diabrotica*, aphids, and stunt symptoms caused by *Dalbulus sp.*

Determine, at harvest time, the damage caused by borers (*Diatraea saccharalis* F.) Count the total number of internodes in each plant and determine the number of internodes that have been damaged. To clearly observe the damage, it is necessary to peel the stalks in such a way that holes made by borers can be seen. Damage is expressed as a percentage of internodes that were perforated.

In addition, the total number of ears must be counted as well as the number of

ears damaged by the ear worm (Heliothis) and by borers. In the case of field infestation of weevils (Sitophilus), a counting should also be made.

SUMMARY TABLETRIAL NO. 5

1) Trial Area: 12 treatments with 4 replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	540 m ²	2,160 m ²

2) Planting:

Distance between rows	Distance between hills	Hills per row	No. of Seeds per hill	Final No. of plants per hill	Plant Density per ha
75 cm	50 cm	21	2 - 3	2	+ 50,000

3) Nitrogen Application: 100 kg/ha of N as Urea (46% N)

	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m long row	Urea per hill (each 50 cm)
At planting	109 kg	23.5 kg	489 gr	82 gr	3.9 gr
40 days after	109 kg	23.5 kg	489 gr	82 gr	3.9 gr
T O T A L	218 kg	47 kg			

4) Phosphorus Application: 40 kg/ha of P₂O₅ as Triple Superphosphate (TSPH)
(46% of P₂O₅)

TSPH per ha	TSPH per Trial	TSPH per Plot	TSPH per 10 m long row	TSPH per hill (each 50 cm)
87 kg	18.8 kg	391 gr	65 gr	3.1 gr

5) Insecticide Application:A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill (each 50 cm)
5 kg	270 gr	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Granular Furadan o Cytrolane 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per Trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill (each 50 cm)
25 kg	900 gr	112.5 gr	19 gr	(0.89)gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cytrolane, Furadan, etc. (granular) 2% (250 gr/ha a.i.)

Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant (+ 50,000 pl/ha)
12.5 kg	1.8 kg	56.5 gr	9.5 gr	\approx 0.25 gr

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	864 gr (86.4 lt water)	18 gr (1.8 lt water)

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 m x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15 % Moisture)
--

DESCRIPTION OF SEED TREATMENT

Method for treating 1 kg of seed:

Materials:

- 20 gr. of lacquer flakes
- 20 cc. of Ethyl Alcohol at 95%
- 100 cc. of acetone
- 25 gr. Furadan (Carbofuran) wettable powder at 75%
- 2 gr. Arasan (Thiram) wettable powder at 75%

Procedure: Dissolve the lacquer flakes in the alcohol and acetone solution. Stir for an hour or let it dissolve overnight. Add afterwards the indicated amounts of Furadan and Arasan and stir until everything is completely mixed. Treat the seed by moistening it completely in the solution and allowing the excess liquid to drain. To do this, use a container with a fine mesh on the bottom. It should retain the seeds and allow the draining of the solution. Since the mixture dries very quickly, it will be necessary to stir the container during drying time.

Precautions: Since Furadan is a systemic insecticide and when it is used in a high concentration (75%) is toxic to humans. Gloves and a mask should be used during seed treatment. In case there is skin contact, the affected region should be washed with acetone, soap and water.

The lacquer fixes the product to the seed very strongly, therefore, planting can be done manually without risk.

PREPARATION OF INSECTICIDE BAITS

Insecticide baits are often used for controlling cutworms because a bait requires less insecticide per hectare, and may be the only feasible method of administering sufficient insecticide to kill a large cutworm larva.

Ingredients per hectare:

- 1.5 kg carbaryl (Sevin) 80% W.P.
- 45 kg wheat bran

5 large oranges or lemons
 7.5 litres molasses
 10-20 litres water

Mixing:

Make 2 mixtures, one containing insecticide and bran, the other of molasses + water + mashed fruit.

Add the liquid mixture slowly to the insecticide/bran mixture, stirring it constantly, until a pasty texture is obtained. Wear gloves during mixing.

Application:

Wearing gloves, sprinkle freshly made, moist bait in the field during the hours of darkness.

PREPARATION OF GRANULAR FORMULATIONS OF INSECTICIDE

A wettable powder formulation can be made into a simple granular formulation to permit application without the need of a sprayer and a large quantity of water. However, these granules will not have the advantage of slow release of insecticide which is a characteristic of some commercial granules.

Method of making 2% carbaryl (Sevin) granules from 80% W.P.

Small-grained sand is required; if it is dirty, wash it and allow to dry.

Make a concentrated solution of sugar in a small quantity of water.

In order to make 1 kg granules, weigh out

$$1000 \times \frac{2}{100} \times \frac{100}{80} = 25 \text{ gr}$$

insecticide, and $1000 - 25 = 975$ g sand.

Place the dry sand in a covered container (e.g. glass jar with screw top).

Add a small quantity (1-2 ml) of sugar solution, shake to mix

It is important not to apply too much moisture; after shaking, the sand should feel slightly damp when rubbed between the finger tips and only a slight amount of moisture should be left on the fingers.

Then place the insecticide in the jar and shake again until the sand is completely coated with insecticide.

Remove from the jar and spread out to dry.

NOTE: If the right amount of sugar solution is used, prolonged drying will not be necessary. If excess is used, the insecticide will become lumpy and the sand will be poorly coated.

TRIAL NO. 6
Weed Control Trial

Crop: Maize

Place: Farmer's field

Objective: To determine the most practical and economic way of controlling weeds under the normal conditions in which farmers commercially produce their maize crops.

When designing trials on weed control, the following factors must be considered:

- 1) Type and Concentration of Weeds. It must be considered the type and concentration of weeds which are predominant in each area. Broad weed leaves, narrow leaves, annuals and perennials usually require different systems of control.
- 2) Evaluation and Selection of Herbicides. A constant program at a national research level of evaluation and selection of available herbicides in the local markets must be conducted. The objective is to determine which herbicides will be more effective and relatively less costly. It is convenient to include in the evaluation some products, which even though are not available in the market at the time, could be later obtained through importation, depending on their advantages.
- 3) Type of Herbicides. Many commercial herbicides are available today for controlling weeds in the maize crop. The classification of these herbicides is not rigid since many of them can belong to more than one group. The general classification criteria is based on the following:
 - a) Crops selectivity and kind of weeds that control.
 - b) Period of application.
 - c) Type of action.
 - a) Herbicides are closely related to crop's selectivity and type of weeds that control. Crops and weeds can be classified according to their leaves characteristic. That is broad leaves and narrow leaves (gramineous). According to this classification, herbicides can be classified as selective and non-selective. Selective herbicides can be specifically for broad leaf weeds or for narrow leaf weeds and, at the same time, indicated for certain

kinds of crops. Non-selective ones control all kinds of weeds as well as for all kinds of crops; that is, if certain precautions are not taken to avoid that their application reach the crop. The selective herbicides can operate as non-selective if a high dose is used in their application.

b) Herbicides can be applied in the following periods related to the stage of the maize crop:

Pre-planting: Herbicides can be applied to the weed's foliage before soil preparation (Glyphosphate, Paraquat) or to the soil (mixed in) either during or after soil preparation (Sutan).

Pre-emergence: The application is generally done immediately after planting by spraying the soil completely and leaving a film on it that will prevent the germination of weeds, (Atrazina, Simazina, etc). The soil must be well prepared, free of clods. The herbicide must be applied with sufficient water in order to facilitate its action, (200 to 400 lt/ha of water).

Post-emergence: An application can be made to both the crop and the weeds (Atrazina), or by spraying directed only to the weeds (2, 4D), it all depending on the growth stage of the crop.

c) Type of action. The herbicides can enter through the leaves or through the roots. According to this, they can be divided as follows:

Contact: These herbicides are generally effective both on broad weed leaves and on narrow ones (Paraquat, kerosen, etc.) They work on contact, affecting only the portion of the foliage that was reached by the product. If weeds are already well established and the roots have

enough food reserves, regrowth will occur. These herbicides have an action similar to pruning. To use contact herbicides in a selective manner, it is necessary to make directed applications, using protective screens in order to protect the crop, or through applications during periods when the crop will tolerate them. Late applications of Paraquat, when the maize stalk is already developed, will not affect the plant unless the application is directed toward the leaves.

Translocation: Translocation or systemic herbicides are absorbed by the plant and they move through the plant vascular tissue. These herbicides are particularly useful in controlling perennial weeds. The action is generally restricted to one of the two kinds of weeds (either broad or narrow weed leaves). These kind of herbicides must not be mixed with the contact type due to the fact that the foliage destruction action of the contact ones prevents plant absorption and therefore their effect is lost.

Soil action herbicides. These herbicides can act as sterilizers (non-selective) when they are applied in high doses. In normal doses their action is selective. The soil texture considerably affects the action of these herbicides. Soils with a high clay content, or organic matter, tend to partially deactivate the herbicides due to absorption. In these cases higher doses of herbicide should be used.

Soil action herbicides (Atrazina) require high amounts of water so that their application can be done effectively (400 lt/ha of water). The amount of water can decrease in case the soil is humid or if there are rainfalls afterwards. Volatile herbicides must be incorporated by mixing them with the soil to prevent loss by volatili-

zation (Sutan).

4) Herbicide Application Dose: The doses recommended by the manufacturers must be tested in the following manner: 50% of the commercial dose, the commercial dose (100%), 150% of the commercial dose and 200% of the commercial dose. (A check or control should be included).

Experimental Design: Randomized complete block with four replications.

Plot's Size: Plots with six 10 meter long rows. To obtain the data on weeds and grain yield, the center two rows should be used.

Treatments: The following treatments are suggested.

No.	<u>D E S C R I P T I O N</u>
1	Control (without the application of herbicide). Weeds are not controlled in order to determine the kind and quantity of weeds and their effect on grain yield.
2	Normal weed control as practiced by the farmer.
3	Total manual or mechanical weed control.
4	Pre-emergence application of Gesaprim-Combi (50%) in a dose of 2 kg/ha (a.i.) with 200-400 lt/ha of water.
5	Pre-emergence application of Gesaprim 50 (50%) in a dose of 2 kg/ha (a.i.) with 200-400 lt/ha of water.
6	Pre-emergence application of mixture of Gesaprim 50 (50%) in a dose of 1.5 kg/ha (a.i.) + Lazo (alachlor) in a dose of 1.5 kg/ha with 200 - 400 lt/ha of water.
7	Pre-emergence application of Gesaprim 500 Flowable. This product comes in a 5 lt container which serves as tank for the pump. It is dissolved in water in the proportion of 2:3. A mixture of 5 lt is enough for half an hectare application.
8	Application of 2, 4D to the foliage of the weeds in the following manner: a) Spray the field with 2, 4D in a 1.0 lt/ha (a.i.) dose with 200 - 400 lt/ha of water immediately after the emergence of the weeds or just before the maize plants have 4 leaves. b) Spray 2, 4D in a 1.0 lt/ha (a.i.) dose with 200 - 400 lt/ha of

water directed to the weed's foliage, between the rows, when maize has 30 to 40 cm in height.

NOTE: Pass of cultivator should not be done on treatments 1, 4, 5, 6, 7, and 8.

Plant Density: Plant three seeds every 50 cm over the row with 75 cm separation between rows. When the plants are 10 - 20 cm height, leave two plants per position only.

Production Technology: Follow technical recommendations given by the National Agricultural Research Institute. (See the example shown in trial No. 1).

Data Taken: Follow general instructions. Fill out the attached report forms.

SUMMARY TABLETRIAL NO. 6

1) Trial Area: 8 treatments with 4 replications.

Row Length	Distance between rows	No. of rows per plot	Plot Area	Replication Area	Total Area (without alleys)
10 m	75 cm	6	45 m ²	360 m ²	1,440 m ²

2) Planting:

Distance between rows	Distance between hills	Hills per row	No. of Seeds per hill	Final No. of plants per hill	Plant Density per ha
75 cm	50 cm	21	2 - 3	2	± 50,000

3) Nitrogen Application: 100 kg/ha of N as Urea (46% N)

	Urea per ha	Urea per Trial	Urea per Plot	Urea per 10 m long row	Urea per hill (each 50 cm)
At planting	109 kg	15.7 kg	489 gr	82 gr	3.9 gr
40 days after	109 kg	15.7 kg	489 gr	82 gr	3.9 gr
T O T A L	218 kg	31.4 kg			

4) Phosphorus Application: 40 kg/ha of P₂O₅ as Triple Superphosphate (TSPH)
(46% of P₂O₅)

TSPH per ha	TSPH per Trial	TSPH per Plot	TSPH per 10 m long row	TSPH per hill (each 50 cm)
87 kg	12.5 kg	391 gr	65 gr	3.1 gr

5) Insecticide Application:A) Soil: Granular Aldrin 20% (1 kg/ha a.i.)

Aldrin per ha	Aldrin per Trial	Aldrin per Plot	Aldrin per 10 m row	Aldrin per hill (each 50 cm)
5 kg	720 gr	22.5 gr	3.8 gr	(0.18)gr \approx 0.2 gr

- Granular Furadan o Cytrolane 2% (500 gr/ha a.i.)

Furadan per ha	Furadan per Trial	Furadan per Plot	Furadan per 10 m row	Furadan per hill (each 50 cm)
25 kg	3.6	112.5 gr	19.7 gr	0.94 gr \approx 1 gr

B) Foliar Application: Sevin, Dipterex, Birlane, Cytrolane, Furadan, etc. (granular) 2% (250 gr/ha a.i.)

Sevin per ha	Sevin per Trial	Sevin per Plot	Sevin per 10 m row	Sevin per plant (+ 50,000 pl/ha)
12.5 kg	1.8 kg	56.5 gr	9.5 gr	\approx 0.25 gr

6) Herbicide Application: Gesaprim 50 (Atrazine 50%) 2 kg/ha (a.i.) or 4 kg/ha of commercial product in 400 lt water solution.

Gesaprim per ha	Gesaprim per Trial	Gesaprim per Plot
4 kg (400 lt water)	72 gr (7.2 lt water)	18 gr (1.8 lt water)

2,4 D (50%) 1 lt/ha (i.a.) or 2 lt/ha of the commercial product in water solution of:

Application	2,4 D per ha	2,4 D per Trial	2,4 D per Plot
First	2 lt	36 cc	9 cc
Second	2 lt	36 cc	9 cc
TOTAL	4 lt	72 cc	18 cc

7) Harvest and Yield Calculation: Harvested area: 2 rows x 0.75 cm x 10.5 m = 15.75 m².

Grain Yield = Field Weight x % Dry Matter x 5.98 (factor) = _____ kg/ha (15 % Moisture)
--

WEED EVALUATION

Observations must be taken in the two central rows in each plot. The object is to determine the kind and quantity of weeds in order to evaluate the effectiveness of the treatments. To effect the count it is convenient to use a wire frame, 50 x 50 cm, throwing it at random in the plots.

- Initial count before the maize has 4 leaves. Determine the number of each kind of weeds (broad leaf, narrow leaf) and express the amount as percentage. Identify, if possible, the name of predominant weeds.
- Count before passing of cultivator (treatments 2 and 3). Do the same as above and cut the weeds inside the wire frame to determine their weight as dry matter.
- Count at the time of flowering. Same as above.
- Count at harvest time. Same as above.

From the practical point of view, it is recommended that a visual evaluation be conducted estimating the percentage of the plot's area which is covered by weeds. (5 - 20 - 50 or 100% coverage). At the same time an estimate of broad and narrow weed leaves percentage can be done.

TRIAL NO. 7No-Tillage Planting Trial

Crop: Maize

Place: Farmer's field.

Objective: To determine differences in grain yield, time and labor cost between systems of "traditional planting" and "no-tillage planting" (Zero-tillage).

Background: No-tillage planting is a very old system. Primitive farmers use to plant without tillage. Low technified farmers, specially those with scarce economical resources and with excessive slope soils, are still planting without soil preparation. Once farmers obtain more resources and flatter lands, soil preparation or tillage increase noticeable with not necessarily increases in yields due to this fact.

Soil preparation has evolved in both directions through history. From no-tillage, originally, to a large number of tillage operations with the development of modern tractors and implements. Afterwards, with the use of efficient herbicides, tillage operations have been reduced largely. So new systems for planting were developed, first minimum tillage and later no-tillage. Scientists, when eliminating tillage operations, have had the objective of reducing time and cost of crop production to a maximum extent without affecting yield levels.

Efficient herbicides, today available, have been a key factor for the no-tillage planting system development. Any type of tillage could be avoided by using a contact herbicide (Gramoxone) to destroy already developed weeds and with systemic herbicides (Gesaprim) to prevent new weeds from emerging. A layer of vegetal matter (mulch) is formed on top of the soil with the chemical weed control method. This layer protects soil from erosion and losses of moisture, also it reduces the germination and growth of new weeds.

Plot Size: To facilitate the planting of the trial, 10 rows of 20 m long plots without replications are used. To obtain grain yield the two central rows on each plot are harvested.

Treatments: The following treatments are suggested:

<u>NO.</u>	<u>D E S C R I P T I O N</u>
1	Control. Planting with the traditional soil preparation method used by the local farmers. Weeds should be controlled according to what farmers normally do.
2	Cut stubble and weeds from 10 to 15 cm above soil level about a week before planting.
3	Cut stubbles and weeds from 10 to 15 cm above soil level about a week before planting. Leave the vegetable cutting scattered all over the soil surface. Make furrows each 75 cm and plant covering the seed with the feet. Apply immediately after a mixture of Gramoxone (1.6 kg/ha a.i.) and Gesaprim (1.5 kg/ha a.i.).
4	Apply Gramoxone (1.5 kg/ha a.i.) a week before planting. Plant with a handspike and apply Gesaprim (1.5 kg/ha a.i.) immediately after.
5	Apply Gramoxone (1.5 kg/ha a.i.) a week before planting. Make furrow each 75 cm and plant covering the seed with the feet. Apply Gesaprim (1.5 kg/ha a.i.) immediately after.
6	Apply 2, 4D (1.5 kg/ha a.i.) a week before planting. Plant with a handspike and apply Gesaprim (1.5 kg/ha a.i.) immediately after.
7	Apply 2, 4D (1.5 kg/ha a.i.) a week before planting. Make furrows each 75 cm and plant covering the seed with the feet.
8	Plant with a hand spike and apply a mixture of Gramoxone (1.5 kg/ha a.i.) and Gesaprim (1.5 kg/ha a.i.) immediately after.
9	Make furrow every 57 cm and plant covering the seed with the feet. Apply a mixture of Gramoxone (1.5 kg/ha a.i.) and Gesaprim (1.5 kg/ha a.i.) immediately after.
10	Cut stubbles and weeds according the farmer's procedure. Plant with a handspike and manually control weeds.

NOTE: Treatments 2, 3, 4, 5, 6, 7, 8 and 9 should not have any weed control or/and deep cultivation after planting so natural soil conditions are not affected.

Herbicide applications (Gesaprim, Gramoxone and 2, 4D) should be done with 200 to 400 lt/ha of water.

SUMMARY OF TREATMENTS

<u>Treat- ments</u>	<u>Cutting*</u>	<u>Handspike Planting</u>	<u>Furrow, oxen, or tractor planting</u>	<u>HERBICIDE APPLICATION *</u>		
				<u>Gramoxone</u>	<u>Gesaprim</u>	<u>2, 4D</u>
1	TRADITIONAL		SOIL	PREPARATION.		
2	Before Planting	X		After Planting (mixture)	After planting (mixture)	
3	Before planting		X	After planting (mixture)	After planting (mixture)	
4		X		Before planting	After planting	
5			X	Before planting	After planting	
6		X			After planting	Before planting
7					After planting	Before planting
8		X		After planting	After planting	
9			X	After planting (mixture)	After planting (mixture)	
10	X	X		M A N N U A L C O N T R O L		

* When cutting before planting or apply herbicide before planting is indicated, this should be done a week before planting.

NOTE: This trial could be reduced to 6 treatments when only handspike or only furrow (oxen or tractor) planting is done in the area. This will depend on the most generalized planting method in each region.

Production Technology: Follow the technical recommendations given by the National Research Institute (as reference see the example shown in trial No. 1.)

Data Taken: Follow general instructions. Fill up the attached report forms.

TRIAL NO. 8
Grain Storage Trial

Crop: Maize

Place: Farmer's field.

Objective: To compare the grain conservation efficiency of the traditional type of storage used by farmers with improved grain storage methods.

Background: Farmers face a series of adverse factors during the maize crop development, such as diseases and insect attacks, weed's competition, drought, etc., which caused drastic decrease in grain yield. Once harvesting is completed, losses do not stop there, to the contrary, during the storage of the product, losses continue reaching levels of 20, 50 and even 100 percent of the grain. This is because storage used by farmers is generally very inefficient since they do not protect the grain from insect damage and rottenness due to moisture.

Metalic grain silos from the type used in Guatemala represent a good solution for grain storage. (Refer to the article "Asian Farmers Can Adopt Guatemala's Low-Cost Metal Silos" which is reproduced on page 59). Insecticide applications to the ears recently harvested, such as Lindano, Malathion, etc., could prevent large grain losses.

Procedure: First of all, determine the type of grain storage commonly used in the area of the program. Identify some farmers which are willing to participate in this trial.

Treatments: When designing the treatments it is suggested to consider the following possibilities:

- 1) Farmer's traditional storage.
- 2) Metalic silo system (reference: Guatemalan Metalic Silos). Grain is treated with insecticides which are described next.
- 3) Strong or heavy plastic sacs sealed hermetically.
- 4) Cages made of chickenwires used for placing ears with or without leaves and treated or untreated with insecticides before leaving them in the normal

grain storage of the farmer. Cages should be made with a capacity of 25 ears each.

Insecticides to be used:

a) Grain or ear application.

- Malathion 1000E in a dose of 3 cc diluted in 1 lt of water per 100 kg of grain or 60 kg of ears.
- Malathion (1% a.i.) in powder formulation applied in a dose of 120 g per 100 kg of grain.
- Lindano (0.1% a.i.) in powder formulation applied in a dose of 120 g per 100 kg of grain.

b) Fumigants.

- Methil bromide in a dose of 48 g per ton of grain per 1 day.
- Phosphine (Phostoxin = Aluminium phosphide) in a dose of 2 to 5 tablets per m³ per 800 kg of grain per 4 to 5 days.
- Carbon tetrachloride in dose of 0.6 lt per 1,000 kg of grain per 14 days.

NOTE: Both insecticides and dose to be used for grain treatment must be in agreement to the regulations given by the official authorities of each country.

According to the previous considerations the following example of possible treatments is described:

<u>NO.</u>	<u>DESCRIPTION OF TREATMENTS</u>
1	Farmer's traditional storage.
2	Metal silos. Treat the grain with a previously indicated fumigant.
3	Plastic sacs without insecticide.
4	Plastic sacs with insecticide.
5	Wire cages with ears with leaves without insecticide.
6	Wire cages with ears with leaves treated with insecticide.
7	Wire cages with ears without leaves without insecticide.
8	Wire cages with ears without leaves with insecticide.

Data Taken: To proceed to take data, it is necessary to determine the following information:

- What is the average time that the farmer keeps the grain for consumption and for seed?
- For how long the farmer would like to keep the grain for consumption and for seed?
- According to the farmer's criteria, which type of damage would be light, medium or total?

Once these questions are answered, data taken should be adjusted to the real storage requirement of farmers.

It is suggested to take samples every two months when the farmer stores the grain for long time (more than 4 months) and one sampling when he stores for short time (less than 4 months). Special care should be taken when sampling metal silos or plastic sacs to avoid the entrance of insects when these deposits are opened. Samples should be, in these cases, of about 100 grains to determine easily the percentage of grain damage (rotten or perforated by insects).

When wire cages are sampled it is convenient to number ears (from 1 to 25) with indelible marker to determine the advance of the grain damage. To determine the degree of damage of the ears, a scale from 1 to 5 could be used (refer to the rating scale for ear damage which appears in page 66).

ASIAN FARMERS CAN ADOPT GUATEMALA'S LOW-COST METAL SILOS

by Steven A. Breth *

Possibly the best system of small-farm grain storage in the tropics is the one used by farmers in the hills of eastern Guatemala. Few farmhouses there can be found without three, four or five small metal silos under the eaves or locked into a grain room. The silos are locally made by village blacksmiths with simple methods and inexpensive materials, so even farmers who till as little as three hectares can afford them.

Blacksmiths construct the silos by bending and soldering together flat galvanized steel sheets. The silos range in capacity from 225 to 1,100 kilograms. To fill the silo the farmer funnels grain into a small opening in the roof of the silo; he removes grain through a small opening in the side of the silo near the base. Caps made of sheet metal fit snugly over the inlet and outlet openings. Farmers usually fumigate grain in the silos with an inexpensive chemical, but farmers in one locality get good results with no fumigant at all.

No one knows who invented the silos but they have been in use around Jutiapa for perhaps 40 years. Good grain storage is vital in the area because of periodic drought and high insect populations. Jutiapa usually gets 2000 mm of rain a year in a double-peak pattern, but about one year out of four the second peak fails, and so does the maize crop. Farmers hedge against the risk of periodic drought by interplanting sorghum with maize. Thus in drought years they are able to harvest the earlier maturing sorghum even if the maize withers up. They also try to store more maize than they consume in one year in case the following year is bad. This goal would be futile with traditional storage methods.

Another incentive for good grain storage is the constant threat of storage insects. With its year-round high humidity and high temperatures (annual average 20°C) Jutiapa has ideal conditions for rapid multiplication of insects. Farmers say that in cribs made from maize stalks -the traditional storage method in Guatemala- maize on the ear is destroyed by insects within six months. The local metal silos, however, can protect maize for two years and perhaps more.

The design of the silo varies little from blacksmith to blacksmith: a slightly conical top with a 10 cm opening in the center, and another 10 cm opening in the side of the silo about 4 cm from the bottom. Each opening can be closed tightly with a sheet metal cap which looks like an open tin can.

The silos are constructed from standard (2.5 x 1 m) flat galvanized steel sheets. The seams and joints of the silo are soldered. One silo-maker says he offers

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customers the choice of 26 or 30 gauge sheet, depending on how much they want to pay. Although silos up to 1,100 kilos capacity are available, the most widely purchased are the 550 and 800 kilo silos. A silo that holds 800 kilos of maize measures about two meters high and 80 cm in diameter. It takes three galvanized steel sheets. A silo that holds 500 kilos takes 2.5 sheets.

Small silos have a 5 cm wide metal band around the center to strengthen them. Large silos have two bands, one about a quarter of the way from the top and the other a quarter of the way from the bottom.

The cost of the silos is rather uniform: US\$2.25 per 100-kilos capacity for silos ranging from 450 kilos to 1,100 kilos. The unit cost of smaller silos is somewhat higher.

While ears stored in an open crib can have a fairly high moisture content because circulating air will dry them, grain placed in a silo must thoroughly dry (not more than 13% moisture) to prevent mold from developing.

To speed the drying of the grain, farmers in Guatemala, like their Mayan forebears, snap the maize stalk below the ear at maturity so that the ear hangs upside down. In this position the husk gives better protection against rain while the ear is drying out. After harvest, farmers who have metal silos dry the ears further on mats in the sun, then they shell the ears and pour the grain into the silos. Some farmers temporarily place ears in maize-stalk cribs if they don't have enough room to dump their harvest all at once.

Farmers wisely keep their silos under roofs-out of direct sunlight. In silos in the sun, migration of moisture in the grain would cause molding. When sunlight strikes one side of a metal grain storage structure, it heats the grain near that side and moisture from the grain moves to the side away from the sun which is cooler. Even if the grain has been well dried before it was placed in storage, the movement of moisture may raise portions of the grain to 15 or 16 percent moisture, causing mold.

In Jutiapa, when a silo is filled, farmers fumigate it with carbon disulfide. They half-fill a one-eighth-liter bottle (brandy bottles of this size are easy to find) with carbon disulfide, stuff a dry maize cob (i. e. a shelled ear), whittled to fit, in the mouth, and place the bottle on top of the grain. They then close the silo with a tight-fitting metal cap. Since carbon disulfide fumes are heavier than air, they move from the top of the silo to the bottom. Farmers say a half bottle (i. e. 60 milliliters) of carbon disulfide is enough to fumigate a silo holding 800 kilos of maize.

The rate of carbon disulfide that farmers use -7.5 milliliters per 100 kilos of grain- might seem inadequate. FAO recommends 20 milliliters of carbon disulfide per 100 kilos in a silo kept sealed for seven days. Nevertheless, since the effectiveness of a fumigant is determined by both the rate used and the time

that the grain is exposed to the fumigant, a dose of 7.5 milliliters per 100 kilos in a silo kept closed for 20 days would be equivalent to the rate FAO recommends.

Pharmacies in Jutiapa stock carbon disulfide solely for use as a grain fumigant. A 1-liter bottle of carbon disulfide costs US\$1.90. One liter is enough to fumigate 17 silos that have a 800-kilo capacity at a cost of about \$0.10 a silo. Pharmacists are willing to sell even as little as 10 cents worth of carbon disulfide.

In Jutiapa farmers fumigate maize, sorghum, and dry beans which are kept in metal silos. Rice, however, is kept in the hull in open drums and is not treated against insects.

Tablets of aluminum phosphide are available from agricultural supply stores, but farmers say they use them only if they find moths flying in the silos. Aluminum phosphide tablets are sold in tubes of 30. This is probably a disadvantage for the small farmer. The farmer may need only five or six tablets to fumigate his silos, but once the tube is opened the unused tablets cannot be saved for the next crop.

To store maize for more than one year, one farmer said that he uses a double dose of carbon disulfide. He places one bottle in the silo when it is half full of maize, then he fills the silo and places another bottle on the top of the grain. Another farmer said that if he wishes to keep grain for more than one year, he removes the grain from the silo at the end of the first year, cleans out whatever grain dust may have accumulated, replaces the grain in the silo, and then puts in a new bottle of carbon disulfide before closing the silo.

Farmers in San Martín Jilotepec, a town 200 kilometers west of Jutiapa, rarely use a fumigant. But then they fill a silo they seal the inlet and outlet openings by taping the edges of the metal caps to the silo with plastic tape. San Martín is quite different from Jutiapa. It is at 2000 meters elevation, cooler (annual temperatures average 17 to 18°C), and although the rainfall is only 1000 mm a year it is evenly spread out and reliable. Like Jutiapa the area is humid. Silos have been used in San Martín for only the last eight years.

At the high elevation of San Martín, storage insects may be less of a problem than in Jutiapa, making fumigants unnecessary. On the other hand, storage scientists have shown that sealing a container air-tight can control insects by suffocating them. While no one has studied the sealed silos of San Martín to find out if they are air-tight, farmers in San Martín (and Jutiapa, too) are sharply aware of the need to keep the silos closed until the contents are about to be used. Farmers willingly allow grain in opened silos to be examined, but they refuse to permit examination of grain in full silos because, they say, "if the air gets in the silo, insects will grow in the grain."

DRUM BINS

In San Martín one farmer uses oil drums to store grain, a system similar to metal silos, but less practical. His grain bins are made from two 50-gallon oil drums welded together. Like metal silos the drum bins have an inlet opening at the top and an outlet opening on the side near the bottom. Both openings can be sealed.

One drawback of drum bins is that they are more expensive than metal silos. A two-drum bin holds only 300 kilos of maize and costs US\$12.50, or about \$4.00 per 100 kilos of capacity. Another drawback is that, as a system, drum bins are rather inflexible. For different sizes of drum bins, only the height can be varied because oil drums come in only one diameter. A 900 kilo capacity bin would require six drums and would be 4 meters high.

The metal silos can store grain perfectly. In Jutiapa and San Martín, an informal survey, conducted 10 months after the last harvest, uncovered no grain in metal silos that smelled of mold or had more than a few discolored kernels per handful. There was little sign of insect damage - kernels with holes were rare and no silos had dust at the bottom. A grain dealer showed maize that had been placed in storage 22 months earlier with carbon disulfide. It looked as good as if it had been just harvested.

No one seems to know where the idea of metal silos came from, but they have been in the Jutiapa area for well over 30 years. A pharmacist who has been in business since 1941 says that he has sold carbon disulfide for grain storage for the entire time. The grain dealer still uses one metal silo that her husband had before their marriage - 30 years ago.

Metal silos have been sold in San Martín since about 1966. At that time merchants began the annual practice of bringing a silo maker to San Martín from Jutiapa to construct silos for sale to local farmers.

Sales of carbon disulfide suggest how widespread the use of the silos is. Two pharmacies a block apart in Jutiapa each said they sold 75 gallons of carbon disulfide in the 3-month period after the last harvest. That's enough to treat 2,400 silos holding 800 kilos each or 2,000 metric tons of maize. And Jutiapa, a town of 10,000 has many pharmacies.

Sales of new silos move at a fast clip, too. One silo-maker in Jutiapa who has a capacity of four silos a day says he sold 100 silos during the three months following the last harvest. Another silo-maker in Jutiapa who has a six-silo-a-day capacity says he sold 450 silos in the four months after the last harvest. In San Martín, a cooperative organized by World Neighbours sold 150 silos to its members in 10 months. A merchant in San Martín says he sold 200 silos in the same period. He estimates that he has sold 1,000 silos in the last seven years.

Especially in Jutiapa, farmers tend to have more than one silo; five or more are not uncommon. Three 800-kilo-capacity silos hold enough to feed 13 adults 500 grams of maize a day for a year. Since most farmers say they sell little or no maize, it appears that many farmers try to store more maize than their families consume in a year, even if some silos are used for sorghum and beans.

Silo makers estimate that with care a silo should last 15 years. Silos that are 20 or 30 years old are not uncommon in Jutiapa. Probably the most frequent cause of damage is moving the silo from place to place. Two men can carry an empty 800-kilo-capacity silo with little effort, but silos are easily dented when empty. Farmers keep the silos under the eaves of their houses or inside storage rooms so rust is no great problem. Because the base of the silo is an unreinforced piece of sheet metal, the silos must be placed on a flat surface to keep the pressure of the grain evenly distributed. Farmers put the silos on cement floor or wooden platforms. A slightly raised platform makes removing the grain easier.

Assuming that the average life of a silo is 10 years, the cost of storing maize in the metal silo is \$0.22 per hundred kilos per year plus about \$0.01 per hundred kilos per year for carbon disulfide, if used.

Carbon disulfide is a dangerous chemical. All fumigants are poisonous, but carbon disulfide is also explosive. Like gasoline, carbon disulfide has a low flash point (20°C). But among a dozen farmers and pharmacists questioned in Jutiapa, none could recall ever hearing of anyone being hurt while using carbon disulfide. Carbon disulfide can be made less flammable if it is mixed with carbon tetrachloride, a chemical which is itself a fumigant.

Not every area in Guatemala is using small metal silos to store grain, but the silos are spreading. Aside from San Martín, the silos are popping up in resettlement areas such as La Máquina on the south coast. Many of the residents of resettlement projects are from Jutiapa, which is densely populated, and they have taken along the idea, if not the silos themselves.

Since the smallest silos require an investment of only \$6.00 or \$7.00, silos are a technological advance that even farmers with little capital can try. If the farmer likes his first silo, he can add whatever storage capacity he can afford whenever he wishes. It seems like an idea that farmers in many countries could profit from.

INSTRUCTIONS FOR DATA TAKING

Each field book includes report forms to facilitate the record of data and to obtain the necessary information for the analysis, evaluation and drawing of conclusions for each trial.

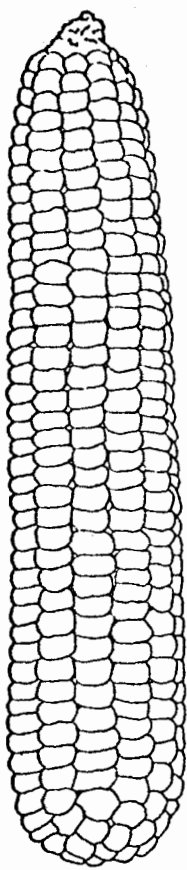
The analysis of the data will be done through computer, therefore, we request that the filling out of these report forms be done with legible handwriting in order to avoid mistakes when the cards are punched.

Data Taking: The metric system, percentage and scales (1 to 5) should be used for each of the cases indicated below:

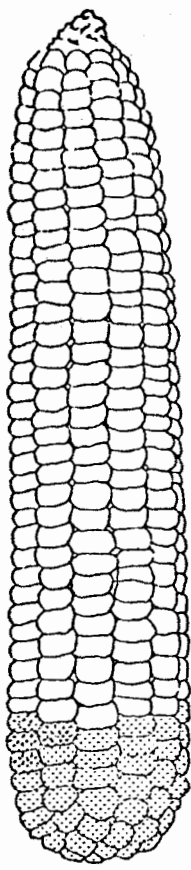
- 1) Days to flower: Number of days from planting to the presence of 50% of the stigmas.
- 2) Number of tillers: Total number of tillers of more than 30 cm in height.
- 3) Plant height: Average height of a 10 plant random sample, from the soil level to the base of the tassel (male inflorescence), expressed in centimeters.
- 4) Ear height: From a random sample of 10 plants, the average height is measured from the highest ear node insertion, expressed in centimeters.
- 5) Lodging at harvest:
 - Root: Number of plants with an inclination of more than 30° with respect to vertical.
 - Stalk: Number of plants with broken stalk under the ear.
- 6) Field Weight: Weight of harvested ears expressed in kilograms per plot. Round off to one decimal. (i. e. 5.8 kg).
- 7) Plants harvested: Total number of plants harvested, including barren plants (without ears).
- 8) Number of ears harvested:
 - Total ears: Total number of ears harvested including those rotten.
 - Rotten ears: Grade the degree of rottenness with a 1 to 5 scale as follows: 1:healthy; 5:totally rotten. Register only

whole numbers. (Refer to page 66 Rating Scale for Diplodia and Fusarium ear rot.)

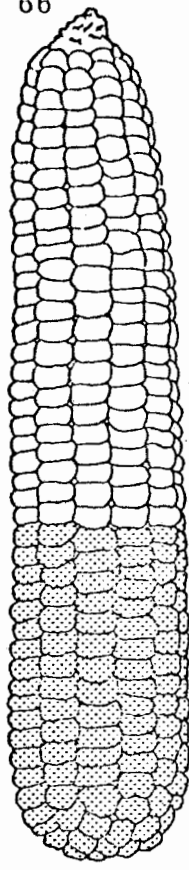
- 9) Moisture Percent: From a 10 ears random sample, report the percentage of moisture and round it off to one decimal (i. e. 38.2%).
- 10) Diseases: Register and grade the major foliar diseases with a 1 to 5 scale. (1: healthy, 5: very sick). Some of the major diseases are: Rust (Puccinia sorghi or polysora); Blight (Helminthosporium turcicum or maydis); Stunt (Phyllachora maydis); and Mildew (Sclerophthora sp.). In the report form there is space for three diseases.
- 11) Insects: Register and grade the amount of damage, from the major type of insects, on a similar scale to the one for diseases. Some of the more important insects are: Fall army worm (Spodoptera frugiperda); Borer (Diatraea saccharalis) and Ear Worm (Heliothis Zea).



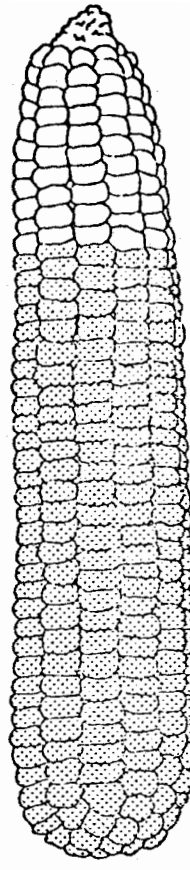
1



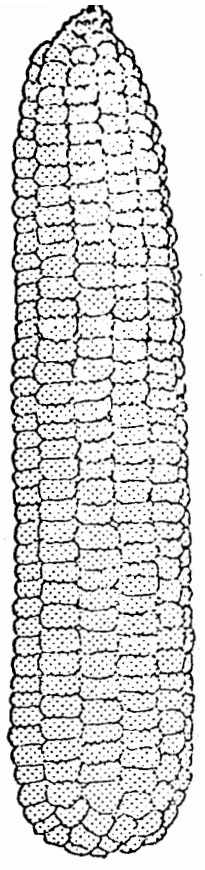
2



3



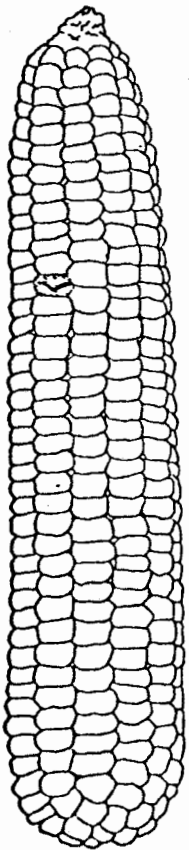
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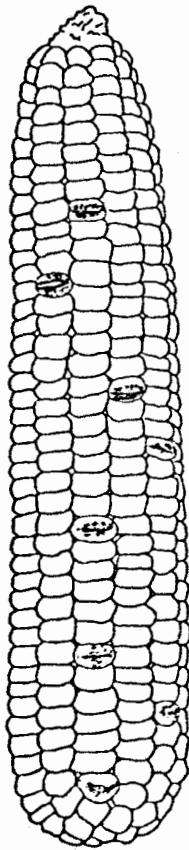
5

RATING SCALE FOR *Diplodia* EAR ROT

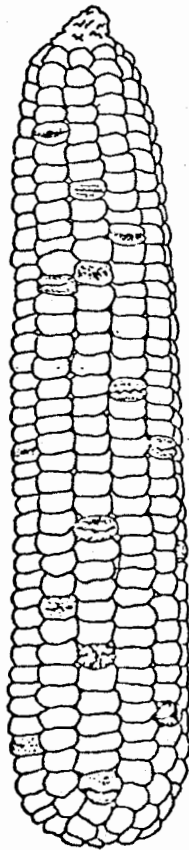
Escala de calificación de Pudrición de la mazorca por *Diplodia*.



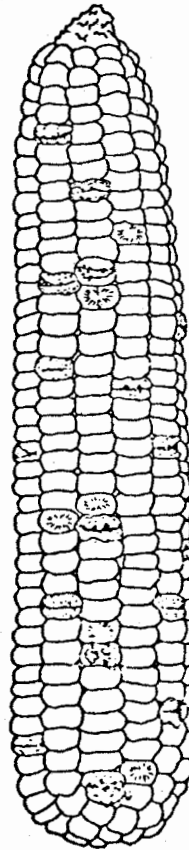
1



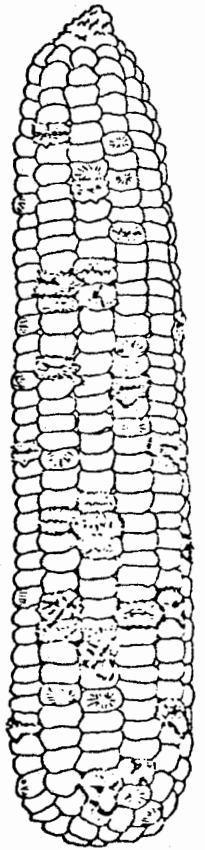
2



3

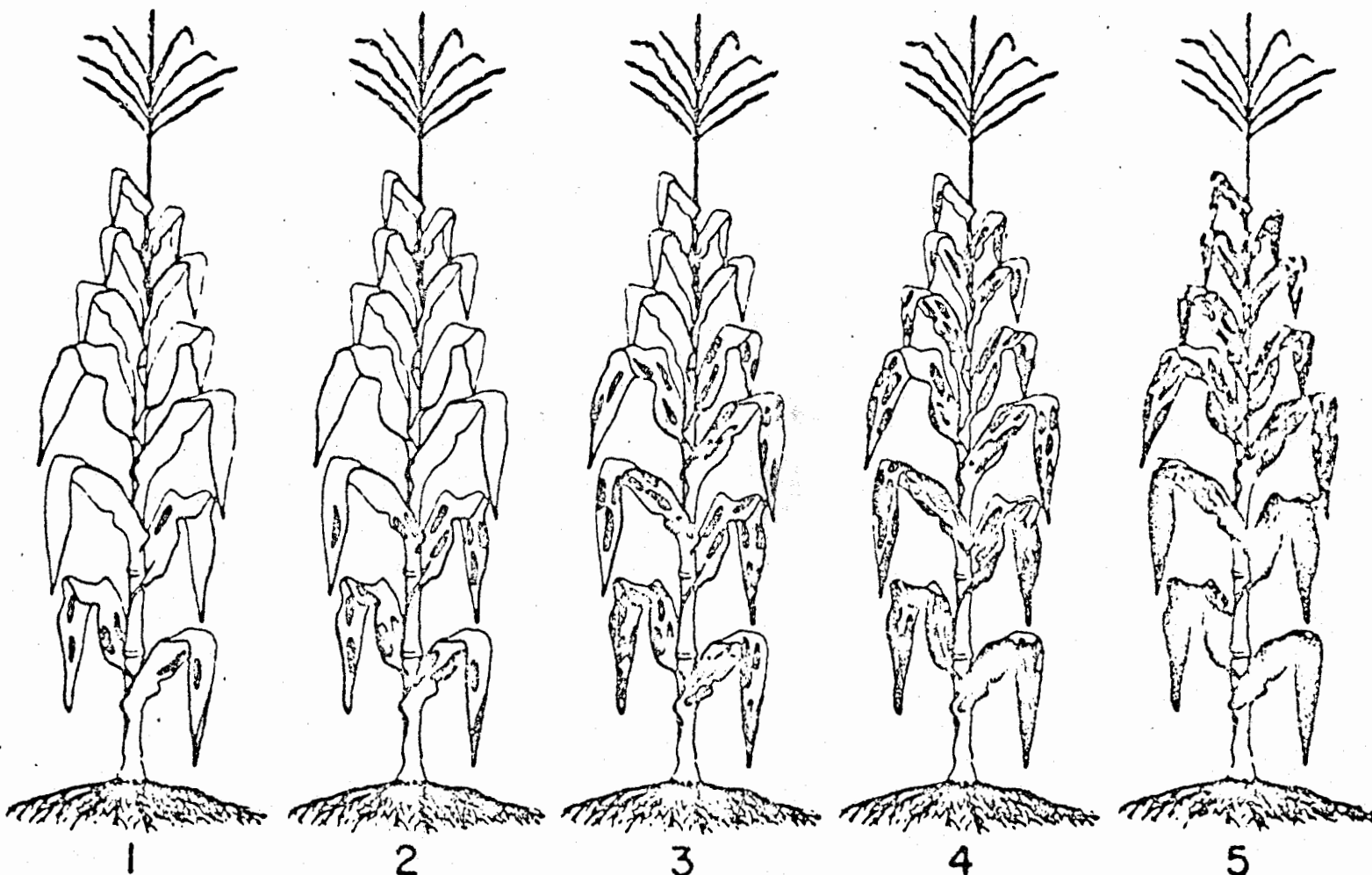


4



5

RATING SCALE FOR *Fusarium* EAR ROT



1

2

3

4

5

RATING SCALE FOR FOLIAR DISEASES
Escala de calificación de Enfermedades foliares

