IICA

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ABC OF VEGETABLE FARMING

A DRAFT HIGH SCHOOL TEXTBOOK

VOLUME IV a

A.B.C. OF VEGETABLE FARMING.

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Ministry of Agriculture
Jamaica.

PART 4.

"AGRICULTURE IN JAMAICA"

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1977 - 1978

No. I - 1.	Fritz Andrew Sibbles, "Basic Agricultural Information on Jamaica", Internal Document of Work, January, 1977.
No. I - 2.	Yvonne Lake, "Agricultural Planning in Jamaica", June, 1977.
No. I - 3.	Aston S. Wood, Ph.D. "Agricultural Education in Jamaica", September - October, 1977.
No. I - 4.	Uli Locher, "The Marketing of Agricultural Produce in Jamaica", November, 1977.
No. I - 5.	G. Barker, A. Wahab, L.A. Bell, "Agricultural Research in Jamaica" November, 1977.
No. I - 6.	Irving Johnson, Marie Strachan , Joseph Johnson, "Land Settlement in Jamaica", December, 1977.
No. I - 7.	Government of Jamaica, "Agricultural Government Policy Papers", February, 1978.
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No. I - 9.	IICA and MoAJ "Hillside Farming Technology - Intensive Short Course", Vols. I and II, March, 1978.
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No. I - 12.	D.D. Henry, "Brief Overall Diagnosis of Hillside Farming in Jamaica", May, 1978.
No. I - 13.	Neville Farquharson, "Production and Marketing of Yams in Allsides and Christiana", May, 1978.
No. I - 14.	R.C. Harrison, E.McDonald, A.H. Wahab, "Fertility Assessment of Newly Terraced Hillside Soils using the Microplot Technique, the Allsides Case Study", May, 1978.
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II - 1 O. Arboldea-Sepulveda (IICA-CIDIA),"Agricultural Documentation and Information Network in Jamaica (Elements for a Proposal)

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II - 3. Joseph S. Johnson "A Review on Land Reform in Jamaica for the Period 1972-1978" September 1978.

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FOREWORD

IICA - Jamaica - who recognised the need - with financial assistance from the Canadian High Commission and the Royal Netherlands Embassy, spearheaded the preparation of "ABC of Vegetable Farming" - a high school textbook to teach Agriculture.

"ABC of Vegetable Farming" is a revolutionary step in Caribbean secondary education, in that it seeks to provide that much talked about agricultural textbook information which was hitherto conspicously absent.

This most important break-through and the information provided therein are in line with the philosophy of Caribbean Governments and the Jamaican Ministry of Agriculture which clearly indicates that children at primary and secondary stages of education should be exposed to agricultural education.

While no praise can be too high for IICA, the Canadian High Commission, the Royal Netherlands Embassy and Jamaica (Ministry of Agriculture) for their sterling contribution, special tribute should be paid to two members of the staff of the Ministry of Agriculture, Jamaica:- Mr. Neville Farquharson who prepared the original document in 4 volumes and Garnet Malcolm who read and assisted in editing the document.

It is my wish that "ABC of Vegetable Farming" will not only find pride of place in school and home libraries, but will be used to the extent it will assist in guiding teachers to impart, and students to become eminent fellows in their fields of endeavour. For the youth to whom this textbook is dedicated, I am sure it will become a guiding influence.

Derrick Stone
Permanent Secretary
Ministry of Agriculture of Jamaica.

PROLOGUE

The office of IICA/Jamaica is extremely pleased that the proposed book titled "ABC pf Vegetable Farming" has reached this draft stage of preparation.

The fact that this activity became possible once IICA had thought of the idea was due in large measure to the financial assistance provided by the Canadian High Commission and the Royal Netherlands Embassy, to both of whom we are profoundly grateful.

There is little doubt that the proposed text-book will fill an important gap in the education of the youth of the English speaking Caribbean countries. The existing high dependence on agriculture; the low status of agriculture in most of these countries and the associated low incomes of rural dwellers, most of whom rely on agriculture for a living; the high degree of rural/urban migration and the social costs associated therewith, are factors which make it necessary to take early steps to inculcate into our youth knowledge concerning agriculture. This book is a contribution to that effort.

While expressing my pleasure with the outcome of this venture and the catalytic role which IICA/Jamaica has been able to play. I also record my fervent hope that this book will be only the first in a series of such publications.

In the above context I must also express our pride in having been able to work with Mr. Neville Farquharson of the Ministry of Agriculture, Jamaica on this activity.

This draft preparation is being presented to a number of key personnel in the English speaking member countries of the Caribbean for suggestions for modification where appropriate. These suggestions will then be made available to IICA's Central Office in San Jose for the attention of Carlos Molestina, Director of Public Information and Publication. The book in final form is expected to be the result of action to be taken by IICA's Headquarters at San Jose.

Percy Aitken-Soux PhD.
Director, IICA Office, Jamaica.

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VEGETABLE TRIALS AND OTHER FIELD WORK FOR STUDENTS

Section 6.

The practical work dealt with in this section is intended to introduce students to a scientific approach to vegetable production. The importance of making tests and using these results as a guide to improve production must always be considered by the student. Before growing vegetables on a large scale, it is always best to do trials and use the results for the large scale farming. On a school farm which has a section for commercial farming, there should be an area where trials and demonstrations are done and used on a large scale operation.

What are trials and demonstrations?

Trials in this book refers to experiments done in the field. In other words, a trial is a field experiment. There are other types of experiments eg. growing plants in plant nutrient solutions which are done in the laboratory but these are not called trials. The general aim of trials are to carry out the experiment under different conditions and see how these affect the growth and production of the crop. These results are then used to draw conclusions and make recommendations to farmers and other vegetable growers. Experts in this work use statistical methods to set up trials and to analyse these results before drawing their conclusions and making recommendations. But such statistical tests are very complex and can only be done by those with special training in statistics (statistician).

Like all trials, those in this section are to compare different treatments of the crop, but are simple and aimed at introducing students to field experiments. The method suggested for studying the results are not as sound as the methods used by the experts. The experts do some trials once and draw sound conclusion from this. Sometimes they have to repeat the trial. We will have to depend more on repeating trials, at least doing an experiment 3 times and more where it is necessary, before conclusions and recommendations can be made. Such results can be used to help those farmers who are not using their work on any kind of results from trials.

Demonstrations are a simple kind of field work. Although there is no clear line between demonstrations and trials, the demonstrations are usually to teach a person how to grow a crop, or how to use a certain practice correctly. The experiments are more concerned with comparing crops practiced etc. While the demonstrations are more for the learners at different stages, the trials are more for those who already can grow the crop or carry out the cultivation practices and has now moved to the stage of comparing results from these field works to draw conclusions and make recommendations.

Planning the trial

What to do?

1. Decide on the aim of the trial
2. Decide on the treatments
3. Decide on number of plots.
4. Decide on plot size
5. Draw a plan of the area.

Aim of trial

The first point that should be made clear to the student growing vegetables , is the main aim of the trial being done. In other words, before we begin an experiment, we must be clear about the factor or factors affecting production to be tested. Examples:-

Yield from different varieties of a crop
Effect of different fertilizer rates on yields of a crop.

Number of aims in a trial - One aim for each experiment is most desirable. But sometimes, a maximum of two major aims per trial is quite in order. When more than one factor to be tested should be closely related to each other. Example - A single test may aim to look how different fertilizer rates affect production - both the quantity as well as the quality of the produce. A single trial might be aimed at observing insects and diseases control methods on a crop. But aiming to test fertilizer rates and grades on production (quantity and quality) and effects of insects and disease control methods in one trial might be confusing to both students and teacher (although the teacher might not admit this). The results might not show clearly what factor was being tested, hence the aim of the experiment.

Expressing aims of trial - The simplest and most effective way of expressing the aim of the exercise is on a label or sign board in the field. These act as a constant remainder. They can be designed by both teacher and students and should not be crammed with information. Labels should be kept simple.

Notes whether as charts or tables should clearly express the aims of each practical work. Unlike labels they can easily be removed from the field for further study in class discussions.

Deciding what are the treatments

Treatments here refer to the different conditions under which a crop is grown during a trial. When 4 different types of mulch are used in an experiment, we say the crop is grown with 4 different treatments. In one trial, a single crop might be grown under different treatments while in another trial different crops might be grown under the same treatments.

Treatments used in a single trial will depend largely on the aim of the experiment. For instance, the trial is to determine the effects of N,P and K on a crop, then the treatments N, P and K applied at the same rate on a crop. In a more complex experiment, the same N,P and K fertilizer might be used to treat different crops. While the crops would be different, the treatments would still be 3 + 1.

The 1 refers to the treatment that should be included in all such experiments. It is the treatment for the control plots. The control treatment usually mean that those plots either get none or a combination of the factors being tested. For example, in the N,P and K trial, the control plots would get no fertilizer or it might get a balance application of N,P and K. We might have 1 or 2 control treatments depending on whether or not the student thinks that a second control will help his results. So that in the example above, we might end up with 4 or 5 treatments. No fertilizer, N,P and K fertilizer and a balanced N-P-K at the same rates.

Deciding number of plots

Generally, if an experiment is properly designed and field work properly done, the more the number of plots per treatment, the more accurate the results of the trial are likely to be. The number of plots per treatment are called the replicates.

For vegetable test on small plots, up to 10 replicates can be used depending on available land and the degree of accuracy required. A minimum of 3 plots per treatment should be suitable and these should be used with large plot sizes or 1/10 sq. chn. or 440 sq. ft.

Why minimum of 3 plots?

In a trial with N,P and K treatments on a crop, there were 2 plots per treatment. One plot of treatment N produced 20 lbs. while the other plot produced 5 lbs. Which plot indicates more accurately how much the treatment can produce?

Take a minute and try to answer this question. If the question seems difficult, consider if the experiment had 3 plots to each treatment and the third plot produced 18 lbs. or 8 lbs. Do you see the reason for having a third plot?

Note - For large plots (over 1/10 sq. chn.) in which crops are grown for general observation and introducing students to vegetable growing, one or two plots of a crop will be adequate.

Although the minimum number of plots per treatment (replicates) should be 3, it is best to use about 5 replicates on these experiments, that will not be subjected to statistical tests. The 5 results from each treatment will help the student to draw a more accurate conclusion.

Total number of plots - The total number of plots in a trial is decided by simple arithmetic.

Example:-

No. of treatments = 4
No. of plots/treatments = 5
Total number of plots = 4 x 5 = 20

Deciding plot size

Plot size here means the size of each plot in the trial, i.e. expressed as area or length and width. The size of each plot in the trial will depend partly on the amount of land available for the trial. Another important fact is the area required for the experiment. For most experiments it is not the entire plot or all the plants in the plot which will be reaped. Data from an area around the edge of each plot (guard rows) is not recorded, to reduce the effect of the treatment from the adjacent plot (edge-effect). For most experiments, the plot size should allow space for at least 2 guard rows of the crop.

As long as the trial is properly designed and done, the larger the plot size, hence number of plants reaped the more accurate the conclusions are likely to be.

The plot should be able to hold a minimum of 25 plants to be reaped, planted at visual planting distance (except for population trials). The number of plants and plot size can be increased if more land is available. For most vegetable crops, a plot size of about 150 sq. ft. can give good results. But crops of the cucumber family (cucumbits) would need more land to hold the 25 plants, plus the plants in the guard rows. All would have the same planting distance.

Plot size may also be influenced by the type of equipment available to do planting, spraying etc. and the amount of material available for the experiment.

Draw plan of trial

The plan of the trial puts the other 3 points together and expresses them on paper, so that the plan is the blue-print of what is to be set up in the field. As the builder uses his plan as the guide in making a house or a bridge, so will the students need to use his plan later in setting up his vegetable trial. After setting up the trial, he will need the plan to tell him where treatments are located, where paths are to be and the size of paths etc. In addition, plans are very important for class discussions. They are important in all field work. But for drawing the plan of a trial, a key point is to position the treatments on the plan. How do we do this?

<u>How to position treatments</u> - Design of the trial

There are 3 common methods that are used in arranging the treatments on a trial. These designs are:-

1. Complete random method
2. Random in blocks (or randomized blocks)
3. Latin square method.

To illustrate each method, let us assume:-

No.	of treatments	5 (A, B, C, D, E).
No.	of plots/treatments	4
	Total no. of plots	20

The treatments can be referred to as:-

T_1 meaning treatment No. 1, T_2, T_3, T_4, T_5.
In this book, we will use mostly A, B, C, etc. to avoid a mistake between the number of treatment and the plot number, but students should feel free to use T_1, T_2 etc.

<u>Complete random</u>

In this method the treatments are placed at random over the entire area for the trial.

How?

The simplest way to do this is to draw numbers as is done in raffles of lotteries.

<u>Steps</u>.

1. Write the numbers 1 to 20 on strips of paper with one number on each strip.
2. Fold up the strips (into little balls) and put them in a smaller empty container. (An empty drinking glass, mug or box will do.
3. Shake the strips in the container making sure that they are free of each other.

4. List the treatments as going down or across the page.

5. Draw one strip at a time, listing 4 consecutive numbers (ie. 4 numbers following each other) under each treatment.

Example

Step 4	A	B	C	D	E
Step 5	5	3	6	1	2
	8	4	9	7	10
	12	11	17	14	13
	16	20	18	19	15

Write the treatments on the plots with the corresponding numbers listed as done in the model below:-

Plot No.
Treatment

(1) D	(2) E	(3) B	(4) B	(5) A
(6) C	(7) D	(8) A	(9) C	(10) E
(11) B	(12) A	(13) E	(14) D	(15) E
(16) A	(17) C	(18) C	(19) D	(20) B

Complete Random Design

Note:- There is no reason why two or even three treatments cannot be drawn to be placed in plots beside each other. Look at plots (3) and (4) (10) and (15) (17) and (18) (14) (19) and (20). People who buy lottery, will know that very often the same number might be drawn, two or 3 or even more consecutive times

Random in Block - (Randomized blocks)

In the randomized blocks design, the area for the trial is divided in blocks depending on the number of replications of the treatment. e.g. for 4 plots/treatments there would be 4 blocks. The total number of plots will be same as if the complete method is used. One plot for each treatment will be assigned in each block. This can also be done by drawing numbers.

Blocks					
	(1)	(2)	(3)	(4)	(5)
I	B	C	A	D	E
II	(1)	(2)	(3)	(4)	(5)
	B	C	A	D	E
III	(1)	(2)	(3)	(4)	(5)
	A	E	C	D	B
IV	(1)	(2)	(3)	(4)	(5)
	C	B	D	E	A

Randomized Blocks

Steps.

1. Write the numbers 1 to 5 on strips of paper with one number on each strip.

2. Fold up the paper and put them in a small empty container

3. Shake the strips in the container making sure they are free of each other.

4. List the treatments prefably across the page

5. Draw a strip at a time, listing the number drawn under each treatment in the order of treatments. Repeat this according to the number of blocks (i.e. 4 times in this case).

Example

		A	B	C	D	E
Step 4						
Step 5 block	I	3	1	2	4	5
	II	1	5	3	4	2
	III	3	5	4	2	1
	IV	4	2	1	3	4

or the numbers 1 to 5 might be listed and the treatments written on the strip.

6. Write the treatment on the plots with the corresponding numbers listed as done in the model 2.

Steps 4 and 5 can be omitted without the chance of mistake as in using the complete random method.

Note:- Two plots with the same treatment might also be positioned beside each other, but only in one direction i.e. only in separate block. There cannot be more than one of each treatment in each blocks.

While plots in a block should be adjacent to each other, the blocks for an experiment do not have to be beside one another. The blocks can be arranged to suit the shape of the land for the trial.

How do we position treatments this way?

The random methods (complete or blocks) of positioning the treatments are used to make the results more accurate. The treatments are spread over a larger area and gives a more accurate picture of what would happen when the treatment is applied on a larger scale. For instance, in an acre of land, there would be difference in the amount of nutrients at different areas in the field. Now the area on which the trial is done has this difference although it might not be as great. By randomizing the plots, the different treatments are given a better chance under the different conditions on the farm.

Let us look at an illustration:-

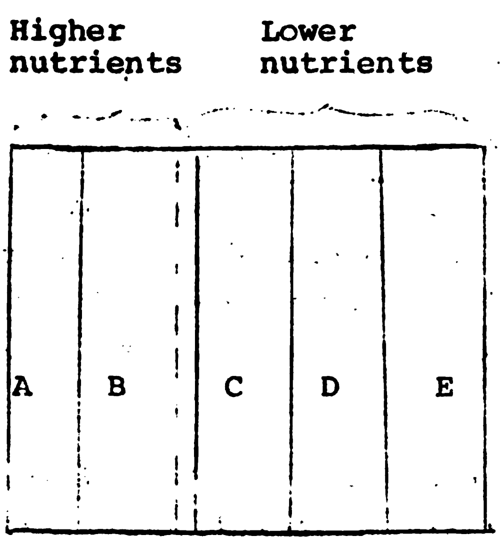
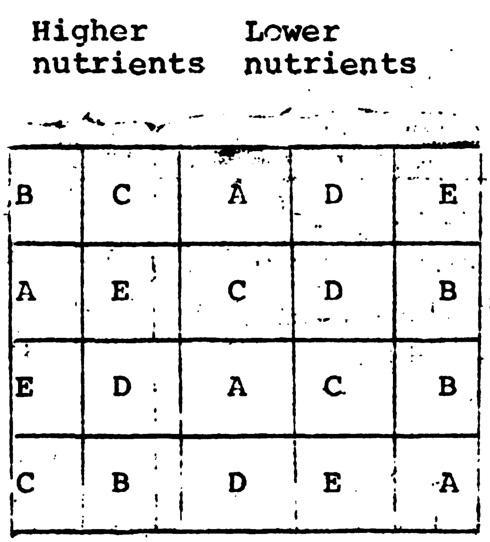


Fig (a) the treatments are not given a fair chance



(b) the treatments are given a fairer chance.

If the treatments are not located on the land in such a way as to expose all treatments as equal as possible to other factors apart from the factor tested in the trial, the results will be misleading (i.e. treatments should be so positioned as to eliminate the effect of factors other than the one tested in the trial).

Example:

If figs/refers A & B to a fertilizer trial in which A = no fertilizer B = fertilizer, C = P fertilizer, D = K fertilizer, E = N-P-K fertilizers Look at Fig. (A)

If the factors are located as in Fig/(A) because of the higher nutrient status on which A and B are located (dotted lines show difference) from the start and throughout the trial, A and B are at an advantage. The results might well indicate that A for example given higher yields than C,D, or E. Now look at Fig. (B)

If the factors are located as in Fig/(B) we see that this difference from the start and throughout the experiment is almost completely eliminated. We see - higher nutrients vs. lower nutrients.

1	plot	A	3	plots	A
2	plots	B	2	plots	B
3	plots	C	2	plots	C
1	plot	D	3	plots	D
2	plots	E	2	plots	E

Can you explain how this difference is almost totally eliminated?

Checking the site of experiment - It is good to check the area to be used to find out if difference in soil conditions, wind movements, shading from trees exist which might bias the experiment. In the previous example, if the difference in soil fertility is known before starting the experiment, the best thing would be to change the layout of the experiment.

Here, the blocks should be layed down on either side of the different fertility level and not across the (broken) line. In this case, 2 complete blocks would fall in the area of higher nutrients and 3 blocks under lower fertility level, or the Latin-Square design could be used.

<u>Lattin-Square Method</u>

In this method, each treatment occurs once in every row (horizontal) and column(vertical) of the design.

<u>Example 1</u>

There are 3 treatments
A, B, C

A	B	C
B	C	A
C	A	B

(25:4)
This is a 3 x 3 Latin Square.

<u>Example 2</u>

There are 5 treatments
A, B, C, D, E

A	B	C	D	E
B	C	D	E	A
C	D	E	A	B
D	E	A	B	C
E	A	B	C	D

(25:4)
This is a 5 x 5 Latin Square

Note that the number of replicates and the number of plots is determined by the number of treatments. 3 treatments need 9 plots and 5 need 25 plots. Sometimes, where land or material for the experiment is limited, it is not practical to use this method. The student may need to use the 5 treatments but only 3 replicates.

With experience, the student will choose the design best suited for the type of trial, the conditions existing on the farm.

Another way of arranging treatments - <u>the single block method</u>. This method is not suited for detailed research work, but can be used by students for simple comparisons of 2 or 3 treatments. It should be used on large plots (i.e. plot size 1/10 sq. chn.) and 3 plots per treatment make good demonstrations.

A	B	A	B	A	B

(c) the single block method

The treatments are positioned alternatively in the block.

For students being introduced to experimental work, using either of the two other methods, might require the type of explanation that should be avoided at this stage. Most of the work would be simple comparisons to illustrate certain points of the random methods are necessary. As in all practices in experimental vegetable growing, the student should use his initiative in choosing his method of positioning treatments.

Setting up field-work

Stick closely to the plan. The first rule about setting up a trial or a general work in the field is that one should stick as much as possib to the plan on paper. The plan is the guide plotted for the work and almost anything other than what is designed will make the exercise inaccurate and the results misleading.

Preparing the plots

1. Measuring plots - For accurately measuring plot size, a tape measure (25' to 100' metal tape most suited) should be used. Wooden pegs and a line (cord) will be helpful both in marking off each plot and keeping the plots in line. Keeping the plots in line is the first necessary step for getting plots of equal sizes without wasting land space. Try to keep the corners of the plot at right angle. This makes it easier to get plots of equal sizes.

2. Marking off plots - Each plot should be separate and distinct from another plot. The distance between two plots will vary with the crop and the type of experiment. For instance, the difference in a trial with upright crops might be less than with trailing crops to make it more difficult for stems to cross plots. Although these stems would have to be lifted and put on their plots, the fact is that the nearer the plots are, the more difficult it is to prevent the stems crossing.

As for difference in type of trial, the distance between plots in a fertilizer experiment, might be greater than that of say a variety test. In the latter, the movement of fertilizer in water from one plot to another will not affect the results as seriously as in the fertilizer test. Generally the type of experiment to be done, would be more important in deciding on the space to be left between plots. Sometimes, the width of a furrow cut by a tractor will provide sufficient distance between one plot and another. In this case, the plot might be the width of a bank or two banks side by side, thrown together. However, a small tractor aided by manual labour is the most suitable means of marking off small plots.

In most cases, a path of 2 feet between plots will be sufficient to reduce edge-effects. However, for fertilizer experiments, and pest control trials, wider spacing and additional steps may have to be taken to reduce edge-effects.

(a) Measuring and lining up prepared land for a vegetable trial.

(b) Marking off plots with small tractors and manual labour.

(c) Prepared plots ready for planting

GROWING THE CROPS

Planting

Planting of the crop or crops and its maintenance will also be determined by the design of the field work. Here, the treatments planned in the design will be the determining factor. If for example, a test is a population trial, not only will there be a difference in planting distance, but might also be variations in the number of seeds per hole for different plots. If the experiment is on different planting methods, some seeds might be planted directly in the field, while others in a seed bed for later transplant. For where planting is not the factor tested, crops should be planted following general recommendation for normally growing the crops.

Maintenance

What is true for planting is true for maintenance. Because, if the trial is on disease and insect control, we might find some plot being sprayed regularly while others once in a month or none at all. Its the same with weed control or any other practice in growing the crops.

Reaping

As for reaping, most crops will be reaped in the same way and their yields recorded for each plot. It is only if a work is testing some point in harvesting that there might be a difference in this practice.

But except where the exercise demands a difference, the same general practice in growing vegetables hold good for growing the crops in field tests.

Guard rows

The guard rows are usually the two outer rows of the crop on each plot in a trial. For most trials particularly those where edge-effect can occur, the growth and production from the guard rows should be recorded. This is done to make results more accurate, as in some cases, because of water and nutrient movement (whether in soil or due to washing across plots) the performance of the guard rows might be markely different from that of other rows on the same plot.

Application of treatments in trials

How the treatments are applied to the plots will depend largely on the type of trial. The plan or design of the experiment will have to determine this. Example - A trial on how planting methods (direct vs transplant) affect time to maturity and production of a crop. Then, it means that some plots will have to be seeded directly while others will be planted with transplants at a later time.

When the treatments are applied similarly will depend on the type of trial. Example, in a test on effects of different weed-killers, the pre-emergent spray would have to be applied at or before planting, while the post-emergent spray after weeds have grown.

Labelling the trials

Labels play a very important part in all cases of growing vegetables on an experimental basis. They may vary from a small strip of metal or plastic bearing only a name or a number to a fairly broad bit of metal or bearing enough information to tell an observer what the work is about.

For the student, both the small label and the larger ones are of importance. Because where it is necessary, he should have a small label on each plot and always have the larger labels giving more information in the area of work. Labels should be simple, clearly written and placed where they can be easily seen.

Example.

For the fertilizer trial often use as illustration in this section here are 2 models.

Labels for single plot:-

(1) B	(2) C	(3) A	(4) D	(5) E

Each label would be placed on a plot. The number is the plot number with the letter referring to the treatment on the plot.

Labels for the trial.

Fertilizer Trial
Contender (Beans)
Area 1,000 sq. ft.
Planted - 1/3

Treatments
A - No fert.
B - Nitrogen (N)
C - Phosphorous (P)

Treatments
D- Pottasium (K)
E- N.P.K.
Rate - 50 lbs/ sq. chn.

The number of labels bearing information on the whole trial, will firstly depend on the total amount of information that is to be expressed. Secondly, it will depend on how much information each label can hold. The teacher and students will have to decide this. For different exercises, the type of material on the label will be different. However, for all work, only information that explains the most to be observed should be put up, and remember, do not cram too much information on labels.

RECORDING DETAILS OF FIELD WORK

The students in a class working on a particular vegetable practical should be familiar with the details of the whole exercise, but must know that relating to the plots to which each is assigned. It is only by at least being familiar with the details of the whole trial that the student will be able to understand the results and conclusions drawn from the work. The details should be recorded in the form of notes and tables.

Notes - The notes of the details of a fertilizer test might look like this:-

Trial - fertilizer (grade) on yields.

Crop - String beans
Variety - Contender

No. of plots - 20
Plot size - (10x5) sq. ft.
planted 1/3
final reap - 30/6

Fertilizer		(grade)
A	-	None
B	-	N only
C	-	P only
D	-	K only
E	-	N P K

Fertilizer (rate)

Additional notes

eg. on rainfall, disease control, other problems and observations.

Tables

A table is the simplest means of expressing the details of more than 2 field exercises at a time. Notes can be used as supplement to the tables.

A table for expressing details of a trial might look like the model on p (Table), The model like all others is a guide for teacher and students in designing their own.

Collecting data - What is data?

What is observed is usually recorded as data. Data is information collected from experimental work. In vegetable trials, it is the data that is collected that will be used to find the results of the tests.

All observations and collecting of data should be carefully done. If this is not done, the results will be inaccurate. The student will therefore, draw wrong conclusions from the exercise. Most data is collected in written form on what are called data sheets. We will look at some models soon.

Students observing and collecting data on corn trial.

How often should we observe and collect data?

Observations should be made daily by the teacher and more advanced students, but data might not have to be recorded as frequently. The regularity will depend on the type of work and the stage of the crops. An experiment in which growth is under study might have to be observed weekly, while one dealing with the effectiveness of different insect control methods might have to be studied daily. Exercises in which the effects of the factors on production only is studied, might be observed at regular intervals, but the only data recorded is that of the yields from the different plots.

Because we observe the field and collect data to compare the performance of the different treatments, it is important each time an observation is made, to try and collect data from all plots within one to two days. A difference of more than this, might give misleading information. For example, a whole field of a crop might be without flowers when the observation is started, but if the process is done slowly and delayed 3 or 4 days later, plots in various sections of the field might be flowering.

If observations are made from the front of the section to the back, the data for the plots at the back will show flowering while those at the front will show none. When it comes to interpreting the data when the trials are completed, this might be misleading. If say, one trial is

Trial (Name & No.)	Crops	Varieties	Dates	Position on Farm	Total Area
eg Fertilizer (grade) on yields	String beans	Contender	1/3/ (planted) ? (final reap)	Section I	2000 sq.ft (app. 2/3 sq. chn)
Variety on yields	Cucumber	A - Ashley B - Polmar C - Straight 8 D - Pionesett	7/3/ (planted ? (final reap)	Section II	1 sq. chn

Contd.

Trial (Name & no.)	No. of plots	Plot size	Fertilizer		Add notes
			Grade	Rate	
eg Fertilizer (grade) on yields	20	(10x10) sq. ft.	A - None B - N only C - P only D - K only E - N-P-K	50 lbs/ sq. chn (recomm.)	
Variety on yields	16	(25x10) sq. ft.	N_{10} P_{10} K_{10} (recomm)	40 lbs /sq. chn (recomm)	Make intervals between plots not less than 2 ft. to avoid plants crossing over.

(25:6)

1. This table can express the details for 5 different trials.
2. The table allows for a convenient look at all the trials to be set up or trials in progress.

on different varieties, and the time taken for each variety to flower and fruit, then if a single observation is not done in 1-2 days, the data will be sure to produce the wrong conclusions.

<u>What types of data?</u>

The type of observations made and data collected are determined by the aim of the work. If the aim is to see how a factor affects growth and production as in most fertilizer trials, then sample plants will be measured at the given intervals. In addition, production figures will have to be taken from the different plots when they are reaped. Notes on for example, type of insects attacking crop will not be very important.

If an experiment is on the effectiveness of different insect control methods, then observation will have to be made on both types of insects and effects of the control methods of each type. Records of growth and production might not be important.

In another trial, with types of fertilizers, signs of deficiency of elements will be recorded and no notes made of weeds. However, in a weed control trial, the tables will be turned in the opposite direction.

<u>For all field work, notes should be made of the seasonal conditions existing for the duration of the crop</u>. eg. periods of limited and heavy rain, marked changes in temperature and other seasonal conditions should be recorded on the data sheet. This will later be helpful in understanding the data at the end of the work.

For experiments in which the general growth and production of a crop is studied, the data collected will be on a wide range of factors eg. height of plant at set intervals (weekly etc.) pests, signs of nutrient deficiency, time to first and final reap. In the next chapter, suggestions are made under each exercise, as to the type of data that would generally be needed for that specific work. Students should try to add and subtract from these suggestions to suit his location.

How to collect data

The question of how to collect data is a tricky one, as it requires experience more than anything else. However, the way the data is collected, is also determined by the aim of the work, hence the type of data required.

Growth and production data

Generally speaking, production by itself or with growth is the most common type of data.

Growth - For growth what is usually needed is an expression of the growth habit of the crop and its foliage description.

1. Measurements of plant - i.e height only for some crops and height and diameter for mostly leaf crops. Because most of the plants of any one crop grow to almost the same height, diameter has to be used to indicate the difference. Diameter can be measured across the width of the whorls of leaves that are not resting on the ground. Generally it is best to exclude the 2 lowest whorls since they tend to be out of line with overall growth of the crop.

   The height of the plant is usually the height of the main stem. This is measured from the ground level to the base of the terminal bud. In some cases, e.g. okra, the main stem of the plant will indicate how it is growing. For other crops it is the point at which most of the upper leaves form a level. This is true in plants that have their growing tips below the level of most of their upper leaves. (eg. turnip, pepper, some legumes).

This measurement from the ground level to the level of the upper leaves (or the crown,) should be taken in the morning or at anytime that leaves are fresh and not "droopy". The idea is to make sure that the data is not affected by anything but actual growth of the plants.

For some crops (eg. some legumes) one has to record both the measurement from ground to the base of the bud, and also the level of the uppermost leaves to really show how the crop is growing. The base of the bud or the point at which leaflets begin to form a whorl on the main stem, is choosen since in the later stage of some crops, the terminal bud develops and grows at a rate which is no-where near the overall growth of the plant.

In other crop, eg tomato and cucurbits, the height or length of the stem can be taken from the ground level to the tip of the terminal bud because:-

(a) - base of terminal bud is not easily defined so that measurements can always be taken from this point;

(b) - the tip of the terminal bud remains in basically the same relation or position to the rest of the plant as far as its growth is concerned.

Where the crop or samples have a number of well developed branches making a main stem hard to distinguish, one has to take the average of 3 to 5 branches. Some crops are very difficult to measure,and one has to design other ways of taking the measurements. But whatever standards are used, these must be clearly defined and stated in the records.

The average measurement from the base of the root to the base of the terminal buds can be recorded as its length. In some cases, measurements of roots are also taken. This is done by rooting up samples at different stages of growth and measuring the length of the main root or the average of longest rootlets. In collecting data, observations recorded for the whole plot is not made for mono-cots from all the plants on a plot, but from samples on a weekly, 2-weekly, monthly or other set intervals depending on the type of data required.

What are samples?

The word 'sample' seems to have a close sound to 'example' and if we think of a sample as being an example, we would not be too wrong. A sample is supposed to be a representative of the group from which it is taken, ie. more or less like the entire plot. (Remember soil samples?).

Data form a set number of samples (say 5-10 plants) should be taken from each plot at random. The data sheet should be designed to record the information for the number of samples which will be taken. These required information should be recorded: care should be taken in working with a sample to prevent damage to it. This is most important in collecting samples of roots from plots. As many secondary roots as is possible should be left intact.

Average maximum and average minimum data

Average maximum and average minimum figures might not be necessary for all trials. For trials in . growth and production (except total production) it is not very important. The student should not take these figures neither for the plant nor the fruit.

But for general trials (crop and variety trials in particular) average maximum and average minimum readings should be taken.

Why? - Maximum and minimum figures are important to show how well or how poor a crop can grow and produce ie. (by knowing expected maximum and minimum growth at different times after planting. A vegetable grower can spot slow or stunted growth, and if he knows expected average maxim and minimum production, ie. production from each plant, he can know when he is getting less than maximum production. This is however, not always a practical type of data to use. The average from the samples is recorded as data for the whole plot from which it is taken.

Data collected this way will not be very accurate for each plot, but with the same person taking it from the same plots and the large number of samples taken, the results will represent fairly well the growth of the plot. As the student improves his methods of taking observations, so will the accuracy of his data on growth.

2. Growth description - This description can be recorded at the time that growth measurements are taken. Notes on:-

   1. time to germination
   2. time when trailing starts for about 50% of the plot.
   3. time to flowering
   4. time to 1st and final reaping.

   Both measurements and description of growth are taken from samples on each plot.

3. Foliage appearance ie. good, fair, poor.

This is largely comparison of what the stem and leaf growth looks like to the observer. It will be difficult at times especially for the beginner to make this observation, but with practice, this becomes easier. It is a rather useful bit of information. It supplements measurements of the plant, for example, two plants might have the same height, but one has poor and the other good vegetative growth. The foliage appearance is recorded for the whole plot, and not individual plants.

For this type of data, the student needs to define the standards that are being used. By doing this, the information will be more useful since it will not depend on the judgement of the person collecting the data.

Production - This is usually the most important data from most experiments and for some, the only information collected. The data on yields for each plot is much more easily collected than for growth. This is so as far as the weight of the produce goes, because this requires only correct recording for the weight on the scale or in the volume measure. Adjustments must be made for the yield from plants removed in sampling before reaping the crop. One way to do this is to find an average yield per plant from the plot and multiply this figure by the number of plants removed before reaping. Add this production figure to the amount reaped to get the total for the plot. For the quality of yield, this will be more difficult and will involve again, the taking of samples and the individual judgment again has importance.

In some cases, the length and diameter of produce (at its widest point) is recorded for certain trials.

Produce reaped from each plot must be properly labelled and kept separate or their weights recorded as soon as each plot is reaped to avoid mistakes.

Other type of data

For some trials, other type of data has to be recorded. How these are recorded will be dealt with under the experiments for which they are needed. Students need to use initiative here. Set standards which wil make the data more objective.

Setting the standards used in weighing data

Setting standards or defining the terms used when recording informatio on a trial is very important. As we have said before, for collecting information like foliage description, where weights and measurements cannot be readily used, standards have to be set to guide anyone collec ing or studying the information.

A plot that looks 'good' to one person, may look 'fair' or even 'poor' to another. But where we define these terms, the chance of this differ ence become less as the whole exercise now depends less on the judgemen of the person.

Example 1. For a trial with harvester beans, foliage appearance is d fine as:-

good - When 2/3 or more of the mature leaves are dark green, flat, not less than 2 ins. from base to a pex by 1½ ins. across, firm and have a lush appe ance.

fair - When between 2/3 and ½ meet the above standards.

poor - When less than ½ meet the above standards.

Example 2. For a weed control trial, effectiveness of control is de-fined as:-

good - Where less than 3/4 of the area weeded, has re-growth of weeds less than 2 inches up to 4 weeks after weeding.

fair - When a half to 3/4 of the area weeded meets the above condition.

poor - When less than a half meets the above condition.

SUGGESTED DATA SHEETS

1. Each sheet can be used to collect general information for one plot in a trial.

The production sheet of the model can be used for most field work. For those in which general fruit descrip tion is not registered. Use the production section only.

Note the close resemblance in organization between sheets for general (model) and for specific observations. When stencilling material is limited, prepare a blank sheet (without writing) of model 1 (production). By filling in the appropriate type of data, the sheet can be used during growth and production for all tests.

SUGGESTED DATA SHEETS

Model 1 - For general data (GROWTH)

Plot No.	
Date	
Plant Ht.	NOTES
Av.	
Max.	
Min.	
Plant diameter	
Av.	
Max.	
Min.	
Foliage and early fruits	*Some measure of the % of plants bearing flowers and fruits may be kept. The stage of development of the fruits might be indicated by taking measurement, length and diameter of samples plus notes.
Appear.	
Disease	
Deficy.	
Insect	
Flower*	
Fruit*	
Root	
Growth	
Disease	
Insect	

Model 1. For general data (PRODUCTION)

Plot No.	
Date planted	
Fruit description (Wts.)	NOTES
Av.	
Max.	
Min.	
Develop.	
Disease	
Defray	
Insect	

Production			
Date	Wt.	Date	Wt.
Total			

* L x D means the length by the diameter of the fruit or any other plant part reaped. These measurements should be taken in the same way for all samples. eg. length of fruits cut in half from base to apex (longitudinally) and diameter at widest point.

Suggested data sheet.

Model 2.

1. Model recommended for general observation of a number of plots in a trial. When the field work is complete, it is easier to compare the data since there are less data sheets to deal with.

2. Depending on the aim of the work or the type of data collected will be determined.

Model can be used by advanced students or teacher.

Model 3. - For specific data

1. This model provides a guide as to what data sheets for specific trials (mulching, weed control, irrigation) can look like. For each trial, the appropriate type of data would be written in the columns. For example, in an weed control experiment 'weed growth' good, fair, poor, would be in a place of 'mulch' on the model. (Remember to define the measurements - 'good', fair, poor).

2. Models for recording data for more than one plot on the same sheet, can be prepared in a fashion similar to model 2.

Model 3. For specific data (e.g. mulch trial)

Plot No.		Trial -
Date		Crop -
		Soil Type -
Plant Description		NOTES
Av. Ht.		
Foliage		
Disease		
Insects		
Plant		
Mulch		
Mulch		
Dry		
Moist		
Wet		
Soil Surface		
Dry		
Moist		
Wet		
Other Data		

* Feel of soil can be used to give some knowledge of the % moisture for the soil type being used. Standards would have to be set e.g.

Dry

Moist

Wet

COMPARING THE RESULTS

To understand the data and interpret it, is the last stage of the field work. It is a practice that requires a great deal of skill and as such experience in experimenting will be necessary. This skill can be acquired by student and teacher if they apply themselves fully to the vegetable tests.

The two vital practices here, are first, to get the results in a form where they can be easily compared and secondly to study these results for a conclusion. The conclusion should be based on the interpretation of the results.

The sheets should be studied and the average of the data for the 4 plots would express the results for that treatment.

Put the results for the different treatments together. The average for the different treatments should be put together in a way that will make them easily compared.

Expressing results of trials

Tables - The production results in a field work is best expressed in a table form with the factors listed with their corresponding production. If the treatments in a trial are of varying qualities, (e.g. fertilizer rates of application) then they should be listed with the lowest quantity and its first and the highest quantity and its yield last.

Expressing the results in this way is helpful in comparing the treatments for drawing conclusions.

Example (Production results) expressed in a table.

In a fertilizer trial, the aim is to determine how different rates of application affect production in a particular crop. The results might be expressed like this:-

Treatments (lbs./sq. chn.	Results (prod.)
A - OR (0 lbs.)	400 lbs.
B - ½R (20 lbs.)	600 lbs.
C - R (40 lbs.)	950 lbs.
D - 1½R (60 lbs.)	1,100 lbs.
E - 2R (80 lbs.)	1,150 lbs.

R = recommended rate of application.

OR

N-P-K Fertilizer	0 lbs.	20 lbs	40 lbs	60 lbs	80 lbs.
Production	400 lbs	650 lbs	950 lbs	1,110 lbs	1,150 lbs.

Notes which bring out important points observed during the trial or will help a person to better understand the table should accompany the table. This is particularly important where the difference in the results are not clearly brought out in the figures shown in the table. For example, although 2 different fertilizer treatments may give almost the same yields, the quality of their yields might be greatly different. In such a case, a note would have to be used to point this out.

Results other than figures on production can be expressed in note form or also in a table (description below).

Example

The aim is to see how effectively different weedicides applied at a set interval throughout the crop, can control weeds. The results might be expressed in a table like this:-

Treatments	Results
A - Manual Control	Poor
B - Mechanical Control	Fair
C - Chemical	Good

In this case, notes would have to be used to show the standards used to define 'poor','fair' and 'good' control. Also, if there are special problems or special advantages observed in using the different methods of control, this would have to be mentioned.

Graphs

A graph is a type of diagram that gives a picture of the relation between two or more sets of data. In the case of our vegetable trials, the sets of data would be the treatments (input) on one hand and the production (output) on the other. This is for trials in which the aim is to see the effects of the treatments on production. For other types of trials, it is more difficult to express the results on a graph. The student of vegetable growing should be familiar with graphs - Why?

Importance of graphs

A graph can give important information on the trial that the figures (results) do not tell. When we look at the examples later, we will see how a graph can tell what the production for a particular treatment is likely to be, although the treatment was not used in the trial. We shall also see how the graph can help us to work out the treatment that is likely to give the greatest returns although that specific treatment was not included in the experiment.

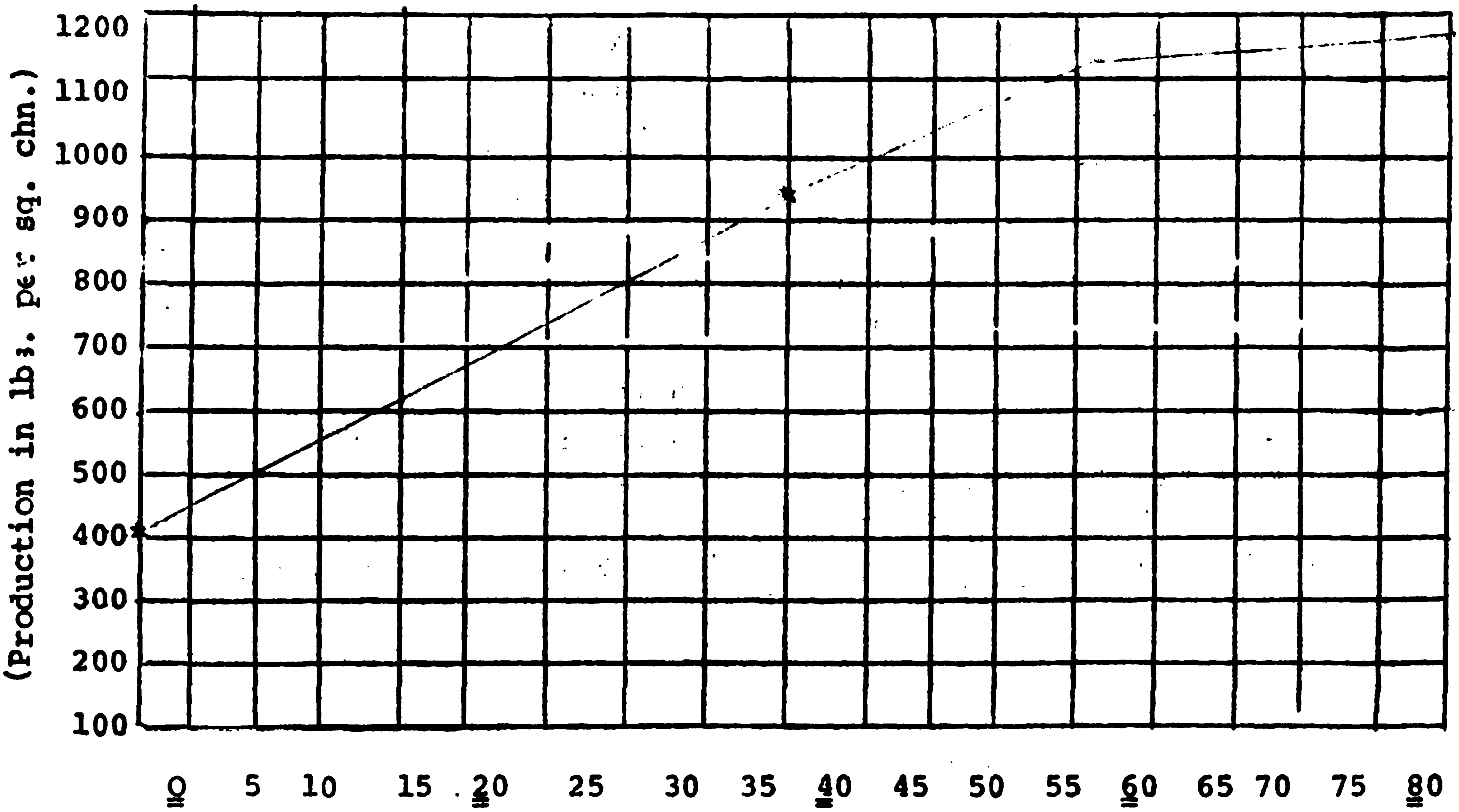
Example 1. (Production)

Let us reproduce the table expressing production results on p. 32 and see how we can express these on a graph.

The table -

Treatments (x)	Production (y)
A - OR (0 lbs.)	400 lbs.
B - ½R (20 lbs.)	600 lbs.
C - R (40 lbs.)	950 lbs.
D - 1½R (60 lbs.)	1,100 lbs.
E - 2R (80 lbs.)	1,150 lbs.

The graph



(26:5) (Rates of fertilizer application in lbs. per sq. chn.)

The horizontal line at the base of the graph is called the X - axis
The vertical line at the extreme left of the graph is the Y - axis.

The student will see later that it is not only treatments that can be put on the x - axis and only production that can be put on y - axis. Generally, whatever factors are put into growing the crop i.e. inputs (expressed as quantity or money value) can be put on the x - axis and whatever the results are expressed as quality or money value) can be put on the y - axis.

What does the graph show?

1. The graph shows us the production (lbs.) for the different rates of application.

2. The graph also shows the production for rates not tested, but within that range of rates, (i.e. between 0 and 100 lbs.)

   For example, at 10 lbs. according to the graph the expected production would be approximately 500 lbs. At 50 lbs. it would be approximately 1,050 lbs.

<u>Note</u> - that these are expected values i.e. if for example, 10 lbs. fertilizer was applied to the crop in the same way as say 40 lbs. or any other treatment and the crop grown under the same general conditions, then he could <u>expect</u> the production to be 500 lbs.

What would be the expected yield at 35 lbs. of fertilizer per square chain.

How to plot the graph.

1. Find the required rates one at a time (starting from the lowest to the highest on the a x axis.

2. As each rate is found, find the corresponding production on the y - axis.

3. Mark the point (X) where the vertical line from the value on the x - axis meets the horizontal line from the value on the y - axis (i.e. the rate on the x - axis and its corresponding value on the y - axis).

4. <u>Carefully join the points marked with a smooth curve</u>.

Example 2.

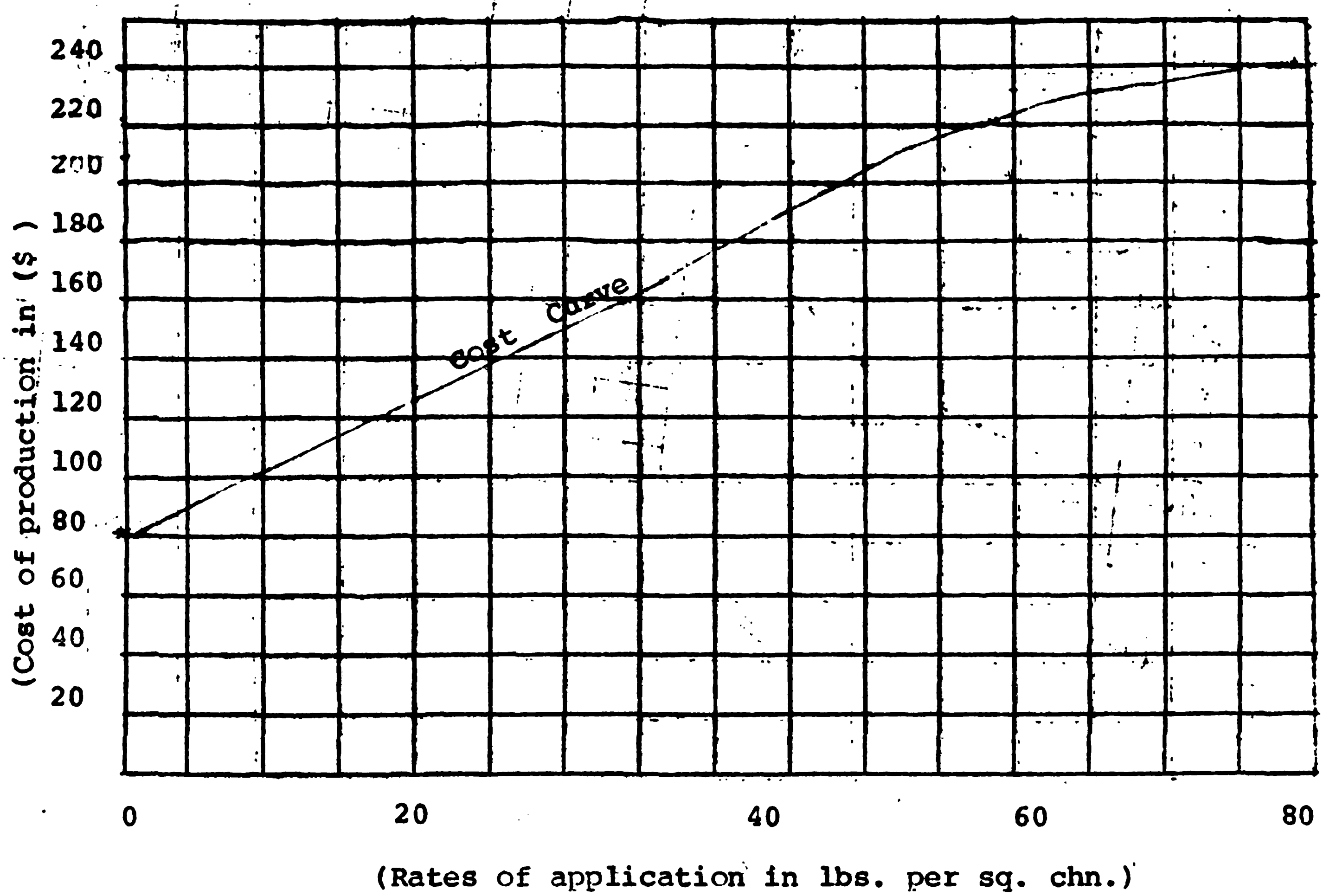
Now let us see how graphs can help us to work out the treatment or treatments that are likely to give greatest profits.

Here is a table showing (a) the treatments (rates in lbs/sq. chn.) (b) corresponding calculated costs (also for a sq. chn.)

Treatments			Cost of Production
A	- OR	(0 lbs.)	$ 70
B	- ½R	(20 lbs.)	$100
C	- R	(40 lbs.)	$140
D	- 1½R	(60 lbs.)	$180
E	- 2R	(80 lbs.)	$220

Here is a graph drawn from the results shown on the table.

(26:6)



* To convert rates of application and yields to lbs./acre, multiply figures for lbs/sq. chn by 10. To find sales, the crop is calculated to sell at 20¢ per lb.

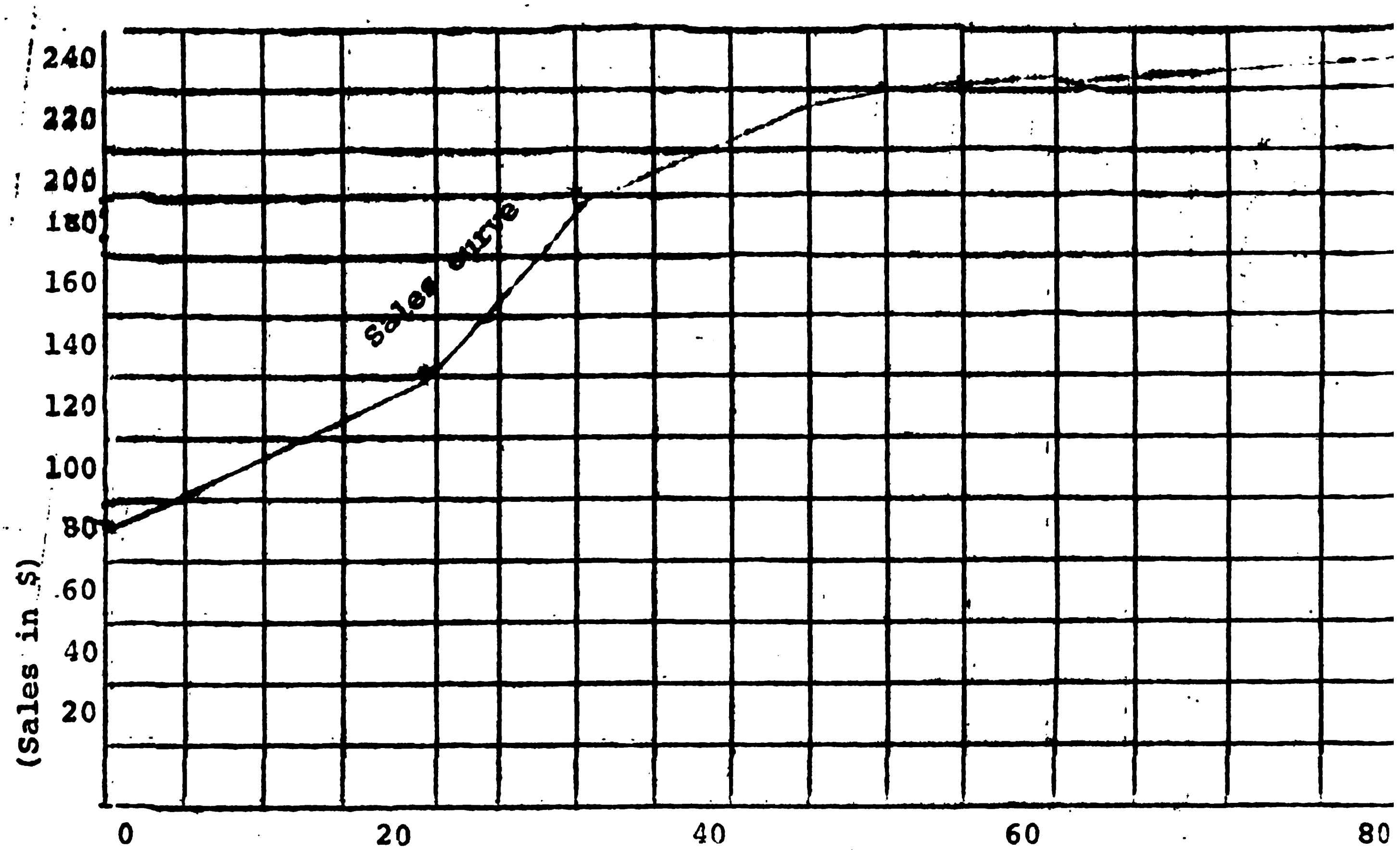
Example 3.

Here is a table showing (a) the treatment (rates in lbs). (b) the corresponding calculated sales assuming a price of 20¢ per lb.

(26:7)

Treatments	Sales
A - OR (0 lbs.)	$ 80
B - ½R (20 lbs.)	$120
C - R (40 lbs.)	$190
D - 1½R (60 lbs.)	$220
E - 2R (80 lbs.)	$230

Here is a graph drawn from the results shown on the table.



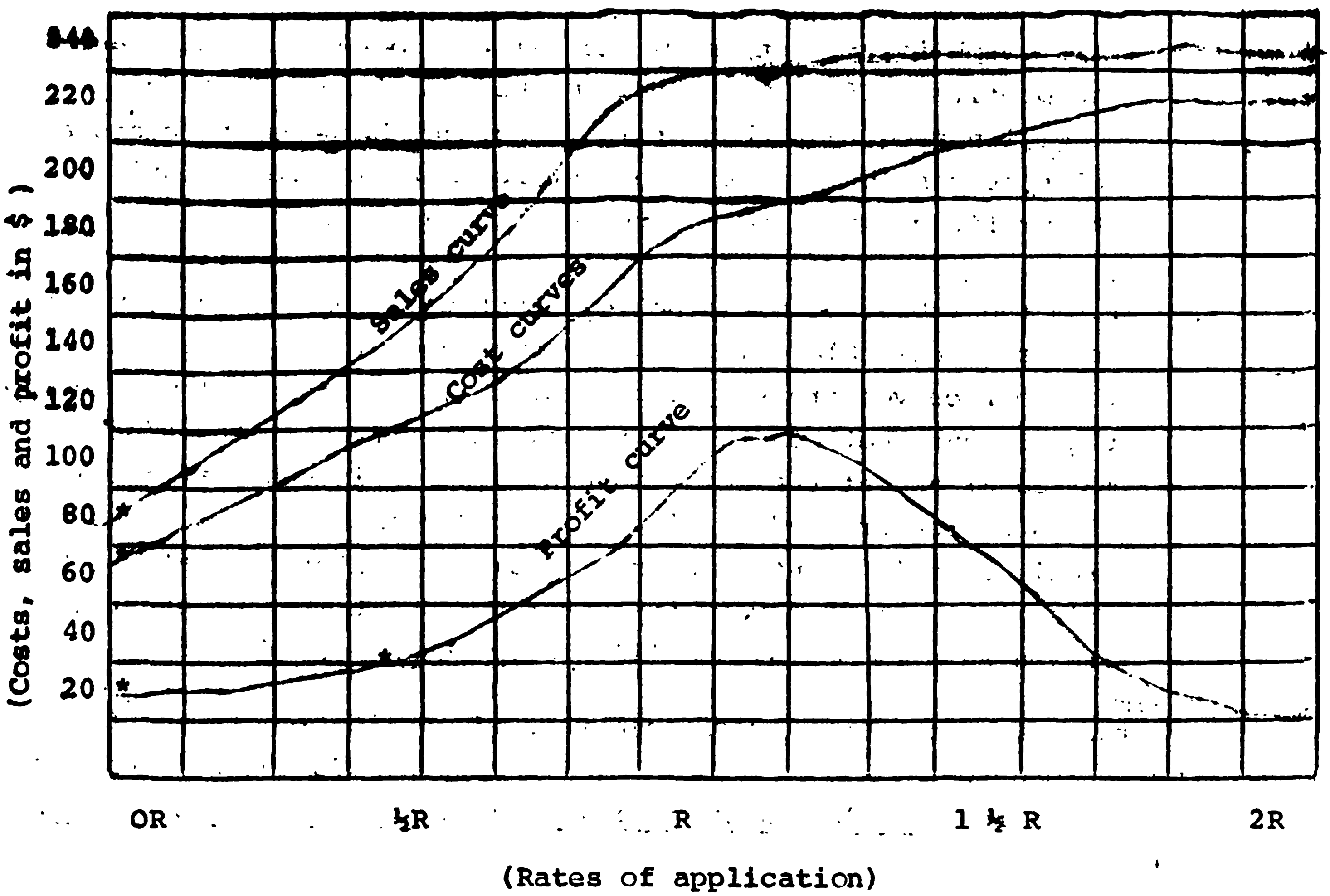
(26:8) Rates of application in lbs per sq. chn.

Example 4.

Here is a table showing (a) the treatments, (b) the costs (c) the sales and (d) the profits.

Treatments		Costs	Sales	Profit.
A - OR	(0 lbs.)	$ 70	$ 80	$ 10
B - ½R	(20 lbs.)	$100	$120	$ 20
C - R	(40 lbs.)	$140	$190	$ 50
D - 1½R	(60 lbs.)	$180	$220	$ 40
E - 2 R	(80 lbs.)	$220	$230	$ 25

Here is a graph drawn from the results shown on the table (26:8)



Note - Increase in expenses would be mainly to increase in cost of transport and labour cost to apply additional fertilizer and to reap the increase in yield from that fertilizer application.

What do graphs show -
Examples 2 and 3.

1. The graphs show costs and sales for the different rates of application in the trial.

2. The graphs also show the expected costs and sales at rates of application not tested but falling in the range of rates tested (0 to 2R).

Example 4

1. This graph is drawn to show the relation between costs, sales and profits. If we use a rule marked off in centimetres (cm), we will notice that the vertical distance between the costs and sales curves is equal to the distance between the x - axis and the profit curve. Look at the point ½ R.

2. From the table, we would believe that the application R, would be most profitable. The graph shows otherwise. (Bear in mind that our curves are supposed to be drawn smooth). If we measure the distance between the costs and sale curves at the R(point marked X) and at the point marked X, we would see that the latter gives a greater reading (i.e 2.5 vs. 2.7 cms.). This means that profit at this point X (approx. $55) is greater than at R ($50). This might not seem very important here, but when we start thinking on an acre basis, we will easily see the difference.

From the graph, the most profitable rate of application is not R, but some where between 1 1/8 R and 1¼ R. i.e approx. 47½ lbs./sq/chn. or 4 3/4 lbs/acre <u>would be the most profitable rate of fertilizer application</u>.

CONCLUSIONS AND RECOMMENDATIONS

It is important to understand the results to draw conclusions from the work. The conclusions must be the answer to the question asked in the aim of the exercise. Example:- The aim of the trial is to determine how the 4 grades of fertilizer (N,P,K and N-P-K) affects yields for growing corn on the school farm. Then the conclusion should be for example that for growing corn:-

- N-P-K gives the highest yield
- P " " 2nd highest yield
- K " " 3rd " "
- N " " lowest yield.

The conclusion of an exercise is most important, because it is to get this information that the field work has been carried out. For simple demonstrations, from one experiment, simple conclusions can be drawn, but these will not be very accurate, since the conclusion may only hold for that particular trial. The teacher should try to organize work in such a way (i.e planting time) that students are present when the results are collected and conclusions made.

For trials designed to give accurate findings, the test should be carried out at least 3 times. If the second test shows a different trend from the first, or sometimes, even when they are not different to be more certain, the trial should be done a third time. Determining the average results for each treatment, and compare these results to draw a conclusion. Recommendations can be made based mainly on these conclusions.

As we mentioned before, agricultural experts can do complicated trials mostly once and the results analysed with various statistical methods. Students who do not have such advanced techniques, will have to depend more on repeating the trials to see if a definite pattern occurs with the treatments used. These can be use ful as a guide for making recommendations in the absence of the advanced techniques. How do we do this? We will first have to compare the average of the results and then look at the trend shown by the results.

1. The average yield (or, other results) from each treatment.

These averages can be compared to rate (or rank) the treatments. In example 1, the ratings were N-P-K fertilizer gives the highest yield, K the 2nd highest etc.

By calculating the percentage difference between the yields from one treatment with another. We can get some idea how significant* is the difference between the results from the treatments.

A difference of less than 5% between results of two treatments is not significant. Both results from these treatments are likely to rate in the same order in future field work as long as the the conditions under which the treatments are applied are similar to those under which the experiment was done.

A difference of 5% or more is significant. A difference of 10% or more is very significant. When 2 treatments are markely (or significantly) different, they are likely to give the same rating of results under conditions similar to those used in the trial.

2. The trend or pattern of production given from these results

This will show how consistent* the results from each treatment was and this with the averages, will indicate the amount of confidence* one can have of how likely the treatment is to perform in a particular way, whenever the crop is grown under similar conditions.

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* Statistician also use these terms in more or less the same sense but they have some complex ways of working out these things more precisely.

To check how consistent the results from a treatment is, we can compare the rating of the results from each trial (rating per trial) with the rating of the average yield. (average rating of results)

How do we compare the rating per treatment results with the average rating for a particular treatment.

Sometimes one can just look at the rating of the results and see that the trend is consistent. If a treatment in all the trials gives the lowest yields, it is clear that it is consistently the lowest producer.

But where the same treatment ranks differently in different trials, an easy way to determine its consistency is as follows:-

1. Make a table showing the results from each treatment in the different trials and the average for each treatment in the experiment.

2. Rate the results in each trial and then rate the averages with the best result ranking. 1st best, rank 2nd etc.

3. To be consistent, the majority of the ratings per trial for treatment must be the same as the average rating, and not more than 1 out of 4 (¼) results for that treatment.

When the majority* of the ratings are the same as the average and the remaining* ratings are only 1 rank above or below the average, we can say that the pattern is very consistent. *(for 3 trials or when we have only 3 treatments in an experiment all the ratings must be the same for results for a treatment to be very consistent.)

Example 1. Averaging rating = 1st
Ratings of results for a treatment from 3 trials

1st, 1st, 1st	Av.	1st	(very consistent)
or 1st, 1st, 2nd	Av.	1st	(consistent)
or 1st, 1st, 3rd	Av.	1st	(not consistent)
or 1st, 1st, 4th	Av.	1st	(not consistent)

The equivalent sign can be used to show consistency. The not consistent equivalent sign shows 'not consistent'. The order in which the ratings per trial for the treatment occurs is not important.

Ratings	1st,	1st,	2nd,	Av.	1st.
	1st,	(2nd)	1st,	Av.	1st.
	(2nd),	1st,	1st,	Av.	1st.

Remember that the number of ranks is determined by the number of treatments. If we have 5 different treatments, which must include the <u>control</u> treatment), we can have results rating 1st to 5th. We could not have any 6th.

Sample 2. Av. rating = 2nd
Ratings for a treatment from 4 trials

	2nd,	2nd,	2nd,	2nd	Av,	2nd	(very consistent)
or	2nd,	1st,	2nd,	2nd	Av.	2nd	(very consistent)
or	3rd,	2nd,	2nd,	2nd	Av.	2nd	(very consistent)

The majority ratings per trial (3 out of 4) are the same as the average rating (2nd) and the remaining (one) is one rank above (3rd) or below (1st) the average.

Ratings	2nd,	2nd,	2nd,	4th	Av.	2nd	(consistent)
	2nd,	2nd,	2nd,	5th	Av.	2nd	(consistent)

In this case 1 out of 4 results (¼) is more than 1 rank (4th is 2 ranks, 5th is 3 ranks) above the average.

	2nd,	2nd,	3rd,	3rd	Av.	2nd	(not consistent)
or	2nd,	2nd,	1st,	4th	Av.	2nd	(not consistent)
or	1st,	1st,	1st,	2nd	Av.	2nd	(not consistent)

The majority of ratings per trial are not the same as the average.
Results from 5 <u>trials</u> with 6 treatments, results from a treatment are:-

	2nd,	1st,	2nd,	2nd,	3rd	Av.	2nd	(very consistent)
or	2nd,	1st,	2nd,	2nd,	6th	Av.	2nd	(consistent)

Less than ½ of the ratings per trial are within one rank of the average. Only 1/5 rate more than 1 rank (6th) above average.

	2nd,	2nd,	1st,	3rd,	3rd	Av. 2nd	(not consistent)
or	2nd,	2nd,	4th,	5th,	2nd	Av.	(not consistent)

In the last set of ratings, although the majority 3/5 are 2nd, 2/5 which is more than ½, ranks too high. In the one before, although, all the ratings per plot are just between 1st and 3rd, only 2 out of the 5, rate 2nd.

Although in practice, one could rarely do the same trial for more than 3, 4 or 5 times at most, this method of checking consistency in the results from a treatment can be used for larger number of trials.

Take results for a treatment after 8 trials.

2nd, 2nd, 2nd, 5th, 2nd, 3rd, 2nd, 6th   Av. 2nd

These results are consistently 2nd because:-

1. 5 out of 8 results (5/8) rate 2nd
2. only about 2 out of 8 (½) rate more than 3rd.

Significance and consistence - Where the difference in the results from a treatment is significant, compared to results from another treatment, and these results are consistent, the vegetable grower can be confident that the treatments are likely to rank in the same order under similar conditions to those in the trial.

If a N.P.K. fertilizer used to grow corn gives significantly better results than the same quantity of P -fertilizer on a certain soil type, and if the results from the NPK fertilizer is consistent, then we can be confident that in the majority of cases that ½ crop is grown with these same fertilizers at the same rate, the NPK will give better yields than P- fertilizer in most cases on that soil type.

Where the difference is significant and the results consistent, we can be sure that more than a half of the times used (75%) confident) a treatment will rank in the same order in later crops under similar conditions. The more significant and consistent the results, the greater the confidence one can have. Very significant difference and very consistent results mean that we can be at least 75% confident (3 out of 4 times) how the treatment will perform. Where the results is inconsistent, even if it is significantly different, we cannot be more than 50% confident, that is, we cannot be sure that the result from the treatment will rank against another treatment in the same order for more than half the number of times that the crop is grown under similar conditions to that of the trial.

The same holds for results with no significant differences. For while the differences are not likely to be great, if results are consistent, it can be expected that with least 3 out of every 4 crops, there will be little difference. But where the results from a treatment is inconsistent they may be different for at least 2 out of 4 times.

Finally, if the difference in the results from two treatments is very significant (over 10%) then the treatment with the better average should be used even if its results are not consistent.

Example 3

Here are the results from the 3 trials using 4 fertilizer grades (at the same rate of application) to grow corn on a green valley clay loam. Ratings of the production from each trial are given in the brackets.

Treatments	R E S U L T S			
	Trial 1	Trial 2	Trial 3	Averages
No. Fert.	30 (5th)	35 (5th)	40 (5th)	35 (5th)
15% N "	48 (2nd)	45 (4th)	44 (4th)	46 (4th)
15% P "	40 (4th)	66 (1st)	56 (3rd)	54 (2nd)
15% K "	45 (3rd)	53 (3rd)	59 (2nd)	52 (3rd)
NPK/5-5-5	52 (1st)	60 (2nd)	62 (1st)	58 (1st)

(a) NPK fertilizer gives the highest yield.
(Difference compared with yields from P = $\frac{(58-54)}{58} \times 100$ 7%

The results using the NPK on corn is significantly better than results from the P - fertilizer (app. 7% diff.) and very significantly different from K(app10% diff.), N (app. 20% diff.) and when no fertilizer is applied (app. 40% diff.) (Rating 1st, 2nd, 1st = Av. 1st) The results are also consistent.

(b) P-fertilizer gives the 2nd highest yields. These are not markely different from use of K- fertilizer (app. 3%) but very significantly better than use of N - and where no fertilizer is used. But P - results are not consistent.

(c) K fertilizer gives the 3rd best yields, very significantly better than yields from N and when no fertilizer is used. These results show a consistent pattern.

(d) N gives the lowest yield among fertilizers but is very markely better than using no fertilizer. Its results are also consistent.

Recommendations -

1. Use of NPK/5-5-5 to grow corn on Green Valley Clay Loam is likely to give markely better results than using single fertilizers with the same total nutrients.

2. Use of P and K results are likely to give the same yields but K may be better since it is likely to give more consistent results.

3. Generally, balanced NPK fertilizers can be expected to give better results on corn than single fertilizers with the same leave of total nutrients when used on the green valley clay loam and other in areas with the similar soil and moisture conditions.

3 Manure - Do not apply any manure or fertilizers in any form throu
out the crop.

4. Label all plots

Observation and records -

Students should observe and keep records of the following:-

1. Weekly records of measurements of growth (i.e. ht, diam.of main stem) and plant description.
(Notes of disease, deficiency, insects should also be kept, but much detail may not be essential.)

2. Record weekly and total production of each crop.

Notes should also be made of climate conditions throughout the trial. These might be helpful in interpreting the results. (General data sheet model 1 can be used as a guide to design a data sheet for collect ing growth and production data).

Comparing results -

To compare the results, the general steps recommended for all vegetable trials should be followed.

1. The student should compare the time from planting seeds to final reaping in the different crops and try to see how this difference is important to the vegetable farmer.

2. The period of most rapid growth for each crop should be calculate This is very important information for determining when to apply fertilizer to different crops. Discuss the results and try to draw conclusions.

Conclusion and recommendations.

If the information is to be later given to farmers, repeat the trial. This is particularly important if there was a marked change in climate at any time during the experiment. This goes for all trials.

Observation and records.

Students should observe and make notes of the following in different crops:-

(1) Certain features of the growth habit eg. time to germination for about 50% of first reaping, seeds planted, flowering for approx. 50% of population, duration of reaping.

(2) Insect, disease and other pests attacking each crop.

(3) The production of each crop i.e. difference in total production for each plot the average maximum, average minimum size and or, weight of the part reaped. Discuss the points observed when the work is complete.

FW. 3. (Trial)

Growth habits in different vegetable crops

Aim - To compare the growth habits of different vegetable crops.

Planning.

1. Choose about 10 crops of different types (i.e. fruit, leafy and root vegetable) for this trial.

2. Use either the completely random or random in block method to position the crops. Make a plan of the area to be used to show where each crop will be located in the trial (see crop symbols on p). Choose a well-recommended easily grown variety of each crop.

Setting up the trials

1. Set up the trial as shown in the plan.

2. Grow each crop according to the general recommendation and fertilizer for that crop on soil and other conditions present on the farm.

FW. 5. (Trial)

Growth habits in different varieties

Aim - To compare certain features in different varieties of a crop.

Planning -

The planning will be the same as in the demonstration no. 4, but vars. should be randomized within the area for each crop. Use 4 to 6 varieties of each crop and not more than 2 or 3 crops.

Setting up the trial.

This will also be similar to setting up the demonstration.

Observation and records.

1. Observe and record the total growth (height, diameter) and general description of the growth habit on each plot. Length of time to 1st reap and to final reaping, size, shape, taste and any other important features of the plant part reaped for each plot, should be noted.

2. Record the total production on each plot.

Understanding results -

The features observed should be compared for the different varieties of the crop and to see which variety would be the one most likely choosen for farmers in the area.

Bear in mind that:-

1. The difference in the overall growth habit of a variety is a very important factor that farmers have to use to select varieties to be grown. For example, they will usually choose varieties of shorter duration unless there is a marked difference in quality or yields. Varieties that require less labour because of their growth habits (eg. pole vs bush beans) will also be prefered.

2. Ability of the variety to grow under the seasonal conditions of the area is also a very important factor.

3. Differences in quality of the reaped and total yields does not need much explanation for one to understand how these are important in selling varieties.

Conclusions and recommendations.

Remember that as far as production is concerned, results from a variety should be significant, (at least 5% difference) and consistent before making definate recommendations that one variety is better than another.

TESTING SEEDS

FW. 6. (Demonstration).
Determining %G

Aim - To calculate percentage germination (%G) of a given amount of seeds.

This work can be done either in the laboratory or in small plots in the field (See chapter 12)

Here is a formula to remember-

$$\%G = \frac{\text{no. of seeds germinated}}{\text{no. of seeds planted}} \times 100$$

FW. 7. (Trial)
Growing vegetables from bad seeds

Aim - To see the problems created by planting bad seeds and compare their products.

Planning -

1. Choose 1 or 2 crops with large seeds for the test.

2. Get some bad seeds of the crops and test them to ensure that %G app. 50%. (A legume or corn would be alright) Get enough bad seeds (over 75%) for planting another plot of the same size. Draw a plan to show the position of these plots.

Setting up the work.

Set up the trial as planned using the recommended population for plots with both good and bad seeds planted on them. Use a low population.

Observation and records.

1. Make general observations of the different plots during growth and try to see any marked differencies that would be of importance to the farmer.

2. Observe and note the difference in production between the different plots.

   Do the figures in any way indicate that the difference is directly related to the % G of the seeds planted. For example if 50% G and 90% G seeds were planted, is production from one plot nearly twice that of the other?

LAND PREPARATION

FW 8.
(Trial)

Growing vegetables on poorly prepared land

Aim - To see how land preparation affects vegetable growing.

Planning -

1. Choose two crops, one to be grown by direct seeding and another by transplanting. Each crop will be grown on well prepared vs poorly prepared land (use crops and a variety of each that is easily grown and of short duration).

2. Draw a plan of the area to be used. Position each crop in a separate area, and use the single block method to position the plots within each area.

Setting up the trial

1. Set up the trial following the plan. For the well prepared plots, the land should be ploughed, harrowed and plant beds made using hand-tools or small tractor if possible. For poorly prepared land, should only be cleared and holes dug for planting.

2. Use general recommendations of population, fertilizer application, weed control methods etc. for growing each crop.

Note - For all trials of this type where the factor tested is not the crop or varieties, try to use crops and varieties that are easily grown and of relatively short duration. The results are got more quickly and allows students to complete the experiment in a term.

Observations and records.

Observe and note the following for each plot.

1. Plant growth i.e. measurement of growth and foliage description.

2. Effectiveness of the method of weed control used on each plot. Remember that the same method should be used for all plots.

3. Water and fertilizer absorbtion on each plot i.e. use a convenient method to indicate absorbtion after irrigation (eg. Good, Fair or Poor) based on some objective standards.

4. Collect samples of roots from each plot say twice during the crop, to observe general root growth. Use a fork so that roots damage will be reduced to a minimum.

5. Note general problems that are directly related to the land preparation of each plot. eg. planting, drainage.

6. Production i.e. total quantity and fruit quality.

Comparing results.

Make a simple comparison of the observed features for well prepared vs poorly-prepared plots. Try to see how the conclusions from this trial is of importance to the vegetable farmer.

If you used two crops, was there any significant difference in the way the land preparation affected each crop?

CORRECTING SOIL pH.

FW. 9. (Trial.)

Growing vegetables with lime.

Aim - To see how application of lime affects vegetable production on the soil type existing on the farm. (If soil is alkaline, compare lime vs sulphur application.)

Planning -

1. Choose one or two crops for this trial.

2. Two treatment are to be used i.e. lime vs no lime. Determine the number of plots that will be in the trial and use equal numbers of each treatment.

3. Determine the size of each plot to be used in the trial and calculate the approx. amount of lime to be applied to each plot at the rate of 100 lbs/sq. chn. (This rate can be used despite the type of liming material to be used).

4. Draw a plan of the area and use one of the random methods to position the two treatments on the plots.

Setting-up trial

1. Set up the trial following the plan.

2. Fertilizer - Either avoid using fertilizer or use the same analysis and rate for the plots of each crop.

3. Use generally recommended practices in growing the crop.

Observations and records.

1. Observe and note important features for the overall growth of crop. (General data sheet model 1 can be used).

2. Record production i.e. total yield (wts) and fruit quality.

Comparing results

For comparing the results, a comparison of the two treatments for each crop should be made in the usual way. If two crops are used, make a comparison of the results from each crop. Try to draw conclusions on the trials after comparing the results. How is this test important to the vegetable farmer?

FW. 10. (Trial)

Growing vegetables with different amounts of lime.

Aim - To see the effects of adding lime at different rates for growing vegetable crops on acid soils. (or acid forming material eg. sulphur on alkaline soil.)

Planning -

1. Choose 1 or 2 crops that produce best on neutral to slightly acid soils

2. Find the recommended rate (R) of applying lime for each crop on that soil condition of the farm. (Note that this trial is only for ACID soils that need liming to raise the pH level for vegetable production. Use either recommendations from chemical soil tests or see general recommendations)

3. Choose about 4 rates of application for the test, so that there will be 5 treatments viz - T_1 = 0 R, T_2 = ½ R, T_3 = R, T_4 = 1½ R and T_5 = 2R.

4. Draw a plan to show the positioning of the treatments in the trial.

Setting up trial)
Observation) Similar to trial no. 9
Comparing)
Results.)

FW. 11. (Trial).

Growing vegetables with lime and fertilizer.

Aim - To see the effects of adding lime and fertilizer together in vegetable growing on acid soils. (or acid forming material eg. sulphur on alkaline soil.

Planning -

1. Choose one or two vegetable crops that produce best on neutral to slightly acid conditions.

2. Find the recommended rate of applying lime for growing each crop in the trial, on that soil type.

3. Find the generally recommended rate of fertilizer application for growing each crop using a medium population on that soil.

4. Treatments -

   A - Recomm. rates of fertilizer and lime.

   B - Recomm. rates of fertilizer only.

   C - No fertilizer and no lime

5. Draw a plan to show the plots and indicate the treatment on each.

Setting up) Similar to trial no. 9.
Observation) Note that the lime should be applied about 2 weeks
Comparing) before planting or if it is added a few days before

results) planting, apply the fertilizer (for all plots of A and B) about 2 weeks later.

For drawing sound conclusions, remember to repeat these trials and check results for significance and consistency.

APPLYING ORGANIC MANURE.

FW. 12. (Trial).

Growing vegetables with organic manure.

Aim - To see the problems and advantages in using an organic manure in growing vegetables.

Planning.

1. Choose 1 or 2 crops for the trial.

2. This trial is merely a comparison between two treatments i.e. adding an organic manure at a recommended rate vs. no manure. The manure should be partly decayed (Approx. 1 ton / sq. chn. 1000 kg/400 sq. m.) of slightly moist manure might be used. Find the approx. quantity a box or wheel-borrow can hold and use this container as a measure).

3. The single block method of randomizing treatments would be suitable.

Setting up the trial.

1. Follow the plan of the arrangement of the plots.

2. The manure can either be applied to the surface of the plots or worked into the soil for easy planting.

3. Do not use any fertilizer in these organic manure trials.

Observation and records

1. Observe and note the general difficulties in adding fertilizer.

2. Record production from each plot (i.e. yield in wt. and fruit quality).

Comparing results.

Compare the results and other observations from the two treatments and say whether or not you think that the difference in production justify using manure on a large scale. (Remember that to draw definite conclusions about large scale production, trial on plot size of 1 sq. chn. (400 sq. m) or more and cost and sales figures would be necessary).

FW. 13. (Trial)

Growing vegetables with organic manure on different soils.

Aim - To see how applying manure affect vegetable growing on a sandy soil or on a clay soil.

Planning.

1. Choose 1 or 2 crops for the test.

2. The treatments should be no manure vs recomm. manure.

3. A partly-decayed manure if easily available, should be used moist at approx. 1 ton/sq. chn.

Observations and records.

1. Observe and note how the manure affects the physical properties of the soil eg. drainage, cracking, crusting, moisture-holding capacity.

2. Record the yield and observe fruit quality.

Comparing results -

Discuss the results, compare them and try to draw conclusions.

FW. 14. (Trial).

Growing vegetables with different types of

Organic manure.

Aim - To see how application of different types of organic manure affect yields in a selected vegetable crop.

Planning -

1. Choose an easily grown crop for the test.

2. Plan to use 2 to 4 different manures, making sure that you use at least one animal and one plant manure. Only partly-decayed manures should be used.

3. Find the recommended rate for each manure and then calculate an average rate that can be applied in the trial (Approx. 1 ton / sq. chn. of slight moist material would be reasonable.)

4. Draw a plan of the area and position the treatments on their respective plots.

Setting up the trial - Similar to Trial no. 13.

Observation and records.

1. Observe and note the general growth of each plot. Pay special attention to deficiency symptoms.

2. Record the yields (wts) and fruit quality for each plot reaped.

Note - For more advanced students, 1 or 2 crops of each type of vegetable might be tested in the same trial. Plant each crop in a separate area.

Comparing results -

1. As in other trials, find the average production for each treatment. List them in the usual manner.

2. Now look at the chemical composition of each manure (Chap. 10) both total nutrients and individual major elements in the manure.

3. Do you see any relation between 1 and 2. Explain.

APPLYING FERTILIZERS

FW. 15. (Trial)

Growing vegetables with fertilizer.

Aim - To see how applying fertilizer affects vegetable growing.

Planning -

1. Choose one or two easily grown crops and a variety with short duration for each.

2. Find the recommended rate of fertilizer application and a balanced fertilizer for the trial. This would be the rate for growing a medium population on that soil nutrient level.

3. The treatments that should be used are - Recommended fertilizer vs No fertilizer.

   Draw a plan of the area and position the treatments on large plots using the single block method.

Setting up trial.

1. Follow the plan of the arrangement of the plots.

2. Apply the fertilizer in the generally recommended way for growing the crop. ie. using 2 or 3 applications. This also holds for other general practices.

Observations.

1. Observe and note the difficulties in applying fertilizer.

2. Production from each plot (i.e. yield in wt. and fruit quality).

Comparing results.

Compare the results and general observations from the two treatments. Say whether or not you think that the difference in production justify using fertilizer on a large scale.

FW. 16. (Trial).

Growing vegetables with different quantities of fertilizer

Aim - To see how applying different rates of fertilizer affect production in a crop.

Planning	)	Similar to trial using different amounts
Setting up trial	)	of lime (Trial 10.
Observation	)	
Comparing	)	
Results	)	

FW. 17. (Trial).

Growing vegetables with different grades of fertilizer

Aim - To see the effects of different fertilizers on a crop.

Planning -

1. Choose an easily grown crop for the trial.

2. Fertilizers used in the trial. (Use a medium population of the crop) Treatments. - Here are some possible treatments for 4 separate trials.

(1)	(2)	(3)	(4)
A-0 fert^{r}.	A-0 fert^{r}	A-0 fert^{r}	A-0 fert^{r}
B-N only	$B-N_H-P_L-K_L$	B-N only by %	$B-N_L-P_L-K_L$
C-P only	$C-N_L-P_H-K_L$	C-P only by %	$C-N_M-P_M-K_M$
D-K only	$D-N_L-P_L-K_H$	D-K only by %	$D-N_H-P_H-K_H$
E-N :P:K	$E-N_M-P_M-K_M$	E-N:P:K by %	

Use fertilizers with low % of the element. With fertilizers containing high % of elements, the quantities for each plot will be very small and difficult to apply evenly. If fertilizers with high nutrient levels are used, they should be diluted with dry soil from the same field to make sure that the % N: P: K is not changed.

Treatments explained-

(1) For using these treatments, use the same weights of each type of fertilizer.

(2) Using these treatments, first use the same weights for each type of fertilizer in addition to the same total nutrients. Example - Use the recommended rate (50 lbs/sq. chn. etc.) for all treatments and if 30 % total nutrients (30 lbs nutrients in 100 lbs fert.) is used, then the treatments would be -

A - O Fert^r.

B - NPK/00-5-5

C - /5-20-5

D - /5-5-20

E - NPK/10-10-10

(3) Using these treatments, find the % of the element found in each type of fertilizer so that approx. the same weight of nutrients can be used for each treatment.

Example.

Sulphate of ammonia (20%N), single super-phosphate (20%P) and potash (30%K) are to be used. The complete fertilizer (10-10-10) is to be applied at the rate (R) of 50 lbs / sq. chn.

(i) To find weight of total nutrients using the formula-

wt. of tot. nutrients = % E x R

ie. Fert. NPK_W $= \frac{30}{100} \times 50$

= 15 lbs

(ii) To find rate of application, when wt. of fert. NPK is known, the same formula can be used.

$$\text{ie. wt. of tot. nutrients} = \%E \times R$$

$$\frac{\text{wt. of tot. nutrients}}{\%E} = R$$

So that the rate to be used in the trial would be -

A - 0 fert.

B - $\frac{15}{20/100}$ = 75 lbs / sq. chn.

C - $\frac{15}{20/100}$ = 75 lbs/sq. chn.

D - $\frac{15}{30/100}$ = 50 lbs/sq. chn.

E - 50 lbs/ sq. chn from recomm.

If a 30% K fertilizer is not available, get a heap of sand and wet it throughly for a few days. Turn it before each wetting so that as much nutrients as possible are washed out. Add the dry sand as a fuller material to muriate of potash (60%K) in a 1:1 mixture. Use the required amount of this for D. OR use some dry soil from the field as mentioned before.

Setting up trials - Set each trial following its plan.

Observations -

1. Look for signs of deficiency and excess of plant elements on each plot.

2. Observe and note the overall growth per plot.

3. Record production i.e. yield (wts) and fruit description.

Comparing results.

Discuss the results, compare treatments and try to draw conclusions, What type of fertilizer analysis would you recommend to farmers in the community.

FW. (Trial)

Growing vegetables with different numbers of fertilizer applications.

Aim - To see the effects of different numbers of application on vegetable yields.

Planning -

1. Choose one or two crops for the trial.

2. Find the recommended grade and rate of application (R) for normal growing of the crop selected, at a medium population on that soil.

3. The treatments should be:-

T_1	-	OR	i.e. apply no fert^r.
T_2	-	$R/_1$	i.e. apply R at planting.
T_3	-	$R/_2$	i.e. apply ½ R at planting and ½ R later.
T_4	-	$R/_3$	i.e. apply 1/3 R at planting and 1/3 R in two later applications at given intervals.
T_5	-	$R/_4$	i.e. apply ¼ R at planting and ¼ R in three later applications.

The time of application (wks) after planting) should be determined in planting the trial.

Setting up the trial -

Each crop should be planted in a separate area following the plan of the trial.

Observation -

1. Make general notes of points that seem to be important in discussing the results.

2. Record production.

Comparing results.

Compare the treatments in the usual way and try to draw conclusions. How many applications would you recommend to farmers for growing the crops tested.

The results from these fertilizer trials (no. 15-18) should be checked to see how consistent and how significant the differences are. Larger plot sizes and 2 or 3 of the best results can be combined (best grades and rates on a few crops) to compare how profitable treatments are.

FW. 19 (Demonstration)

Growing vegetables to observe nutrient deficiency

Aim - To try identify signs of element deficiencies in some vegetable crops.

Planning.

1. Choose between 6 and 10 crops making sure that there are at least 2 crops of each type i.e. fruit, leafy etc. (Include corn as deficiencies can be easily identified in it.)

2. Try to locate an area on the farm where manure has never been or applied in frequently in small amounts.

3. Draw a plan of the area, dividing into plots at not less than 4 plots per crop. Position the crops using either the completely random or random in blocks method.

Setting demonstration

Plant the crops as shown in the plan and grow them using the general recommended practices. No form of manure or fertilizers should be added . Make sure that plants get adequate supply of water throughout the trial. Many times what looks like a nutrient hunger sign, is really a sign that the plant needs water.

Observations.

1. Observe the plots weekly and note the symptoms and the element that is suspected to be in short supply. The symptoms should be described in details. Occasional samples of roots should also be taken from each plot.

2. Record the production paying particular attention to fruit description. Signs of deficiency on fruits should be described in details. Discuss the observations from different crops.

FW. 20. (Trial)

Growing vegetables to correct nutrient deficiencies

Aim - To try and identify and correct signs of deficiencies in some vegetable crops.

Planning	)	Similar to no. 19 except that the 4 plots for each crop should be put beside each other. Try to identify the nutrient in short supply for the whole crop (at least in 2 plots) and not for each plot.
Setting-up	)	
Observation	)	

Correcting deficiency.

1. After the suspected deficiency has been identified for the crop, decide on how you plan to correct it. (i.e. using solid fertilizer or foliar spray).

2. Apply the method planned to one plot showing the deficiency. Carefully mark the plot in addition to keeping your notes.

3. Whenever you have added the suspected deficient nutrient, observe the plot for one or two weeks. If there is no marked change in the appearance of the plant, then the nutrient applied was not the one in short supply.

4. With 2 or 3 suspected deficiencies, try to correct only one deficiency in each plot at a time. Leave one plot on which no nutrients have been applied throughout the trial. This will be the control plot needed for comparison.

PLANNING

Chapter 28.

FW. 21. (Trial)

Growing vegetables from different methods of planting (1)

Aim - To introduce students to different methods of planting vegetables

Planting.

1. Choose a crop that can be easily grown from direct planting or from transplanting. eg. tomato, lettuce, cabbage, pepper.

2. The methods to be used are direct planting, peat pot planting and transplanting. Find the size of the land to be used and buy enough seeds to plant this area. Divide the seeds into roughly 3 equal amounts. Also buy the required number of small peat pots (approx. 2x2x2 cubic ins.)

3. Prepare the area for the work and divide it into three large plots. Also prepare a small nursery. Draw a plan to show where the different methods will be used. Or set up the seeds in seed bed and peat pot and prepare land and plant all plots at the same time. This does not give as great a comparison as the first method.

Setting up the trial.

1. Plant 2 seeds directly in each peat pots, sow in the nursery and plant some directly in the field on the same day.

2. Grow the crop as generally recommended when using each method.

Observations and records.

1. Observe and note how each practice has to be applied for each method. Also the difficulties and advantages in using the method. Pay special attention to labour required for planting, watering and weeding needed.

2. Record production from each plot. Discuss the observations from the 3 methods. Which one would you recommend to the farmer in the area - Why?

FW. 21. (Trial)

Growing vegetables from different methods of planting (2)

Aim - To see the effects of different planting methods on yields.

Planning -)
Setting up trial)
Observations)

This trial is similar in most ways to the general work (No.21) except that 1 or 2 crops should be grown each in separate area. Plots should be positioned by complete randomizing or random in blocks. The only records needed are that of yields. Compare the results from the trial and try to draw conclusions.

FW. 22. (Trial)

Growing vegetables on banks and in furrows.

Aim - To compare planting on banks vs planting in furrows in vegetable growing.

Planning -

1. Choose 1 or 2 crops for the trial. Each crop can be grown either from direct seeding or from transplanting.

2. Choose 2 separate sections for this test.

3. Draw the plan of each section to be used, and, first position each crop in a separate area. Use the single block method to position the 2 treatments-(i.e. planting on banks vs in furrows) in each.

4. One section should be irrigated while the other should be grown with seasonal rainfall. This trial should be done in the dryer periods of the year.

Setting up trials.

1. Set up the trials as planned using the generally recommended practices in growing. No molding should be done to the plots as the crops should grow in the same positions as planted.

Observations and records.

1. Pay attention to labour requirements and difficulties with each method.

2. Observe the overall growth on each plot in each section. Pay special attention to root and other diseases. Also notice total growth for each plot.

3. Record production.

Comparing results -

1. Compare the two treatments for each crop in each section.

2. Compare the observations from the two sections. If you use two crops, do the results differ for each crop? Try to draw conclusions on the trial.
   What method would you recommend to the farmers in your area - Why?

FW. 23. (Trial).

Growing different crops using different planting methods.

Aim - To see how different crops respond to direct in seeding transplanting.

Planning.

1. Choose 6 to 10 vegetable crops with at least 2 of each type of vegetables. Make sure that some have fine seeds (smaller than okra seed) and about the same number have large seeds.

2. Draw a plan of the area, dividing the area for the trial according to the number of crops. Allow a separate area for each crop. Sub-divide each area into plots and use the single block method to lay out the two planting methods (Use small plots)

3. A half of the amount of seeds bought to plant each crop should be planted in a nursery.

Setting up trial.

1. About a week before the seeds in the nursery are ready for planting, prepare the section for each crop. (If weed control is by the pre-plant method, then the land preparation would be earlier).

2. Direct planting and transplanting to plots should be done at the same time in each crop. Count the number of seeds planted on each plot and note it.

3. Make sure that the crops are supplied with enough water especially at planting.

Observations and records.

1. Observe and note how successful the method of planting has been on each plot.

Using an index like this:-

$$\text{Plants growing} = \frac{\text{no. of seed/plants growing}}{\text{no. of seeds/plants planted.}} \times 100\ \%$$

Note that the above formula is similar to that for %G, but is not the same.

2. Record the time to 1st reap and to final reaping in addition to the total production from each plot.

Comparing results.

The results from the two methods of planting should be compared first for each crop, then for all crops.

Say which crops you would recommend for direct seeding and which ones for transplanting - Why?

FW. 24. (Demonstration)

Growing vegetables in containers.

Aim - To compare vegetable growing in containers with growing in the field.

Planning and setting up demonstration.

1. Choose about 10 vegetable crops, 3 fruit, 4 leafy and 3 root vegetables.

2. Plant about 20 seeds of each crop in separate plots at about a ½ of the recommended planting distance for each crop.

3. Plant the same amount of seeds for each crop in plastic bags, or other containers of not less than 6"x6"x6" . Plant one seed in each container and put the bags a few inches away from each other.

The idea is to get a population in almost the same area as planted in the field. If the containers are big, for example boxes or pans of more than 12"x12"x12" (or 30x30x30 cm) then the number of seeds planted in each containers can be increased and the population in the plots also stepped-up.

4. Put the containers in the open on a concreted or gravelly area.

5. The usual cultivation practices should be applied to the plots in the field. But those in the containers will have to be watered about 2 or 3 times each week, with one application of a balanced N-P-K fertilizer solution. (1 ounce per. plant per week can be used). Apply the same amount of fertilizer to the plots planted in the open.

Observation and records.

Try to keep a record of the total amount of fertilizer used and at the end of the experiment, calculate the amount applied per plant. Record growth, foliage and fruit description. Also record root growth of samples from the plots and from crops grown in the containers.

Record the production for each crop, time to first and final reaping from plots and containers. Observe and note any important features, advantages and problems especially in growing the crops in the containers.

Comparing results.

Calculate the average yield per plant for each crop and compare yields from open plots and containers.

Do you think that planting of vegetables in containers can be used successfully in town areas and other places where soil conditions and land space make it very difficult or impossible to plant in fields?

FW. 25. (Trial).

Growing vegetables from broadcasting seeds.

Aim - To introduce students to broadcasting seeds in different vegetable crops.

Planning

1. Choose 2 crops from each type of vegetable, making sure that one has small seeds and the other large seeds. These crops should be ones that are easily grown from direct planting. (Include beans, mustard, turnip).

2. Each crop should be grown from planting seeds in rows vs broadcasting. Draw a plan with each of the crops in a separate area. Use the single block method for positioning the treatments on small plots.

Setting up trial.

1. Follow the plan prepared using about the same amount of seeds for planting each plot of a crop. The general population for planting the crops in rows should be used to determine the amount of seeds to be used.

2. Apply the other general practices for growing the crop. Chemical weed control should not be used.

Observations and records.

1. Observe and indicate how successful each method of planting is in each plot (eg. Good, Fair, Poor) can be used as an index providing objective standards for each are set.

2. Pay attention to the problems and advantage in using each method- Suggest solutions to these problems.

3. Record production i.e. yields (wts) and fruit quality. Would you recommend any one of these crops to be grown from broadcasting. - Why?

FW. 26. (Demonstration)

Growing vegetables from vegetative parts.

Aim - To see if vegetables can be successfully grown by some methods of vegetative reproduction.

Planning -

1. Choose a variety of cucumber, egg plant, tomato, kohl-rabi, turnip and potato. Try to grow the first three crops from stem cuttings, budding and grafting, the other 3 from cutting of mature tubers. Grow the potatoes (sweet and non-sweet) from stem cuttings as well as tubers.

2. The number of crops tested at a time will depend on how advanced the class is. The work should not be set up unless the same crop in a later stage (over 4 weeks in field) is being grown on the farm. Use 4 small plots (not more than 50 sq. ft.) for the first set of crops.

Setting up the demonstration.

Cucumber, egg plant and tomato. Let us say that the varieties of each crop are V_1 and V_2.

1. Plant two plots of V_1 and one of V_2 with seeds. Later thin out to about 10 plants on each plot. Plant the other plot with about the same number of cuttings from the advanced plot in the other part of the field.

2. When suitable buds, scion (top 6"-8" of a branch) and stocks are available bud one plot of V_1 and graft the other plot with parts

from V_2. The stock is the part of the plant that will receive either a bud or a scion. Potato, Kohl-rabi and turnip.

3. Plant one plot of each crop from seeds and one plot from cutting of mature tubers and whole tubers.

Observation -

Observe the plants on each plot.
Do you think this work can benefit vegetable production in any way - How?

FW. 27. (Trial)

Growing vegetables from different populations

Aim - To see how different populations affects vegetable growing.

Planning -

1. Choose 1 or 2 crops that are easily grown from direct planting and having large seeds. (Use crops with pop^n. (5000 plants/ sq. chn. or 400 sq. m).

2. Find a medium recommended population for each crop. Let this be the recommended population (population R). Pop^n in each treatment.

ie. A	-	½ pop^n. R		C	-	1½ pop^n R
B	-	pop^n R		D	-	2 pop^n R.

3. Draw a plan of the area for each crop showing the position of the populations in the trial.

Setting- up the trial.

1. Set up the trial following the plan using suitable p. dist. for the required population. Grow each crop according to generally recomm. practices. Each crop should be grown with either a balanced fertilizer or a generally recomm. analysis at a suitable rate.

Observations and records.

1. Observe points of special interest in overall growth and the practices as they relate to each plot. Disease, insects, weed control and harvesting should be looked at carefully.

2. Record production from each plot ie. yields (wts) and fruit quality.

Comparing results.

Put the data from plots of the same treatment together and compare the treatments.

If more than one crop has been used, compare the results from both. What population would you recommend to the vegetable farmer in growing each crop with that rate of fertilizer? - Give reason

FW. 28. (Trial)

Growing vegetables with different populations at different rates of fertilizer application.

Aim - To see how different plant populations at different rates of fert application affect production.

Planning -

1. Choose 1 or 2 crops that are easily grown from direct planting. Find its recommended range of population. Use the lowest population as pop^n 1, the medium as pop^n 2, and the highest as pop^n 3.

2. Find the recommended grade and range of rates of fertilizer for that crop at that soil NPK. Use the lowest rate as R_1, the medium as R_2 and highest as R_3.

3. The treatments that can be used are:-

A - Pop^n1 with R_1	D - Pop^n 1 with R_2	G - Pop^n 1 with R_3
B - Pop^n2 with R_1	E - Pop^n 2 with R_2	H - Pop^n 2 with R_3
C - Pop^n 3 with R_1	F - Pop^n 3 with R_2	I - Pop^n 3 with R_3

(A group of students can be assigned to each set of treatments).

Note that for each range of population, and fertilizer rate, it is best to use a medium value for the experiment.

Draw a plan of the area showing the plots and position the treatments on it.

Setting up.)	Similar to Trial no. 27.
Observations and) records)	Suitable planting distances should be used for each population. Calculations for these planting distances can be made from table (12:4)

<u>Comparing results</u> -

Put the results together and try to decide which population and rate of application you would recommend to farmers in the area.

FW. 29 (Demonstration)

<u>Growing vegetables to increase number of reapings.</u>

<u>Aim</u> - To see how planting at different times can improve vegetable production on a farm. (Testing the multi-planting system)

<u>Planning</u> -

1. Choose 2 easily grown crops of short duration (approx 12 weeks). Short crops are choosen to complete the trial in a school year (8-9 mths.) The table on crops suited for different seasons (chap. 9.) should be checked to make sure that the crops choosen

will grow well in the period when the trial is done. It is best to choose crops that are not seriously affected by seasons.

2. A plan should be drawn of the section to be used, dividing it in 6 to 8 <u>large</u> plots depending on the length of time available for doing the trial.

<u>Example</u>.

Here is a model plan using string beans (C_1) and cucumber (C_2). Each crop is of approx. 12 weeks.

	1	2	3	4	5
	C_1	C_1	C_1	C_1	C_1
1st plant	1st wk Oct	3rd wk Oct	1st wk Nov	3rd wk Nov	1st wk Dec.
1st reap	1st wk Dec	3rd wk Dec	1st wk Jan	3rd wk Jan	1st wk Feb.
	C_2	C_2	C_2	C_2	C_2
2nd plant	3rd wk Dec	1st wk Jan	3rd wk Jan	1st wk Feb	3rd wk Feb.
2nd reap	3rd wk Mar	1st wk Apr	3rd wk Apr	1st wk May	3rd wk May

	6	7	8	9	10
	C_2	C_2	C_2	C_2	C_2
1st plant	2nd wk Oct	4th wk Oct	2nd wk Nov	4th wk Nov	2nd wk Dec.
1st reap	2nd wk Jan	4th wk Jan	2nd wk Feb	4th wk Feb	2nd wk Mar.
	C_1	C_1	C_1	C_1	C_1
2nd plant	4th wk Jan	2nd wk Feb	4th wk Feb	2nd wk Mar	4th wk Mar.
2nd reap	4th wk Mar	2nd wk Apr	4th wk Apr	2nd wk May	4th wk May.

* 1 st reap and 2nd reap refers <u>to the end of such reapings</u>.

Study the model carefully. The crop symbol in the bracket on each plot, is for the 1st crop that will be grown on the plot (top symbol) and for the 2nd crop (bottom symbol). Use this as a guide in making your own plans. Make sure to have one or more replicates in this work.

Setting up demonstration.

Set up the work according to your plans. The first half of the area (plots 1-4) can be set up while the area for plots 5-8 is still occupied by a crop in harvesting.

Observations -

No detailed observation of the crop is necessary. Try to think of how the trial can be applied to vegetable growing for farmers. Your notes and observations would be in this direction. Take special attention to problems and how you think they can be solved. Keep records of dates of reaping from each plot.

Comparing results.

Look at the notes you have collected and try to see how this trial can help to improve vegetable production on a large scale. Try to suggest ways of improving the technique where you observe room for improvement to meet the needs of your area.

In thinking of for example, the length of time between planting the different plots, bear in mind the following:-

1. The larger the scale of production if it is not highly mechanized, because each plot would be larger, it might take as much as one or two weeks for preparing and planting a plot.

2. For most of the time, the farmer also has to be reaping while planting. These might keep the grower so occupied that the difference of a week for planting each section is necessary.

Do you think that this technique will significantly increase total production, or it only distributes the product more evenly? How does this benefit the farmer?

IRRIGATION AND DRAINAGE

FW. 30. (Trial)

Growing vegetables with irrigation

Aim - To see how irrigation affects vegetable growing.

Planning -

1. Choose 1 or 2 fruit, leaf and root vegetables for this work. Try to include cucumber as it shows up certain important points in the trial.

2. The crops should be grown in large plots with a large plot for each treatment viz. - No irrigation vs Recomm. irrigation vs Daily irrigation. This trial should be located in an area not likely to be irrigated by mistake.

3. The plot size should be such that the sprinkler to be used can wet a single plot at a time. The plots should be located in level land and measures should ensure that the water applied to a plot does not run off the surface. At least 5 ft. (or about 1½m) should be left between plots. This work should be done in the dryer periods of the year.

4. The amount of water applied to the different plots can be controlled by using the same irrigation equipment - small sprinklers attached to a pipe or pipes with the same flow. The length of time a plot is watered should be the same but the regularity different.

Setting up the trial.

1. Set up the work as planned.

2. The plot with the recommended irrigation should be watered at intervals similar to the usual growing of the crop eg. 4 hours every 3 days. The plot to be irrigated daily should be watered each

day until the soil is saturated, eg 4 hours every day.

3. Grow each crop by its generally recommended practices.

Observation and records.

1. Look for difference in soil conditions of the plots and the effects of this on the crop.

2. Observe the overall growth on each plot (eg. total growth and foliage description). Pay a special attention to deficiencies, insects and disease control on both plants and fruits. Notes should be made of the climate during the work.

3. Record production.

What advice would you give to farmers on irrigation and drainage?

MULCHING

FW. 31. (Trial)

Growing vegetables with different types of mulch.

Aim - To see some types of mulch that can be used in vegetable production.

Planning.

1. Choose 6-10 easily grown crops of different types. Include a cucurbit and tomato for the work.

2. Collect the material to be used.ie. Grass, paper, plastic and wood-shaving would be some that can be used. Draw a plan to show the location of the crops and the different types of mulch. Use small plots and plant each crop in a separate block. Use the lowest population recommendation for each crop as heavy foliage growth might have misleading results.

3. A control plot to be irrigated can be included in the trial.

Setting up trial -

Set up the trial as planned during the dryer months of the year. Remember to have a plot without mulch for each crop. Plots are not to be irrigated, unless there is also a control plot which will be irrigated.

Observation.

1. Observe overall growth of each plot and record production.

2. Make note of the moisture condition of the soil at about weekly intervals. Also the presence of insects in the mulch and whether or not these insects attack the plant. Look for mulch damage to the crop. Objective estimation of the amount of moisture in the soil is required. (eg. % moisture above field capacity).

3. Observe the general difficulties in applying each particularly in laying down the mulch and planting the crop. Also note how the general practices have to be applied to the crop growth under the mulch.

Would you recommend mulching to farmers in your area? If so, which of these would you recommend? - Why?

FW. 33. (Trial)

Growing vegetables under mulch.

Aim - To see how mulching affects yields.

Planning.

1. Choose 1 or 2 easily grown crops.

2. Decide on 1 mulch that is available in the area and suited for vegetable production. This should be used for the mulch treatment vs no mulch in the trial. Draw a plan to show positioning of the treatments on small or large plots.

3. Use the lowest recommended population for the crop so that heavy foliage will not shade the plot and reduce evaporatoon. This might give misleading results.

Setting up trial.

This experiment is to be set up as planned and the recommended practices applied for growing the crop under mulch. The trial should be set up during dryier periods of the year and plots are not be irrigated.

Observations and records.

1. Observe and note the overall growth on each plot.

2. Record production per plot.

Comparing results

1. Discuss the results, compare two treatments and try to draw conclusions. Would you recommend mulching on a large scale your area - Why?

Conclusions and recommendations

If conclusions are to be used for further work on recommendations to be made to farmers, do the experiment at least 3 times and check the significance and consistence of these results before using them.

PEST CONTROL

FW. 33. (Trial)

Control insects in vegetables.

Aim - To identify and control insects in different vegetable crops.

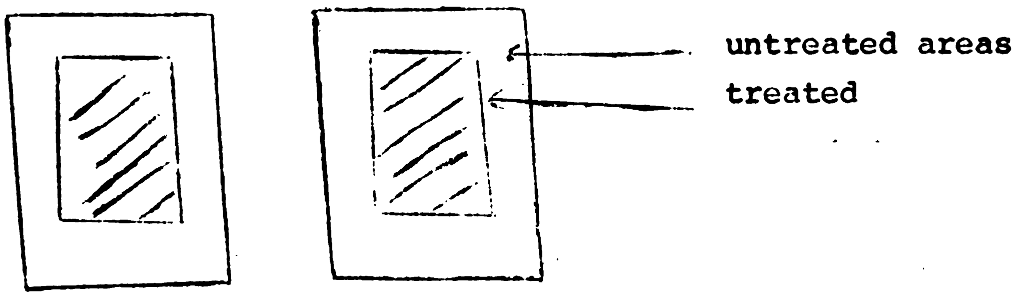
Planning-

1. Choose about 10 crops including at least two from each type of vegetables.

2. Divide the area to be used in small plots, allowing 4 plots beside each other for a crop. Assign a treatment to each plot in the following order:- (a) No control (b) Contact insecticide (c) Digestive insecticide (d) Systemic insecticide.

   Use the same order for each crop. Draw a plan to show the position of crops and treatments. Put each type of vegetables in a separate block.

3. Plots should be set up no less than 5 feet apart and surrounded by 6-10 guard rows. These rows should not be treated except on the control plots. Where practical, the plots may be surrounded with fine mesh, croous bags <u>or</u> dry coconut leaves to form a fence of 4 to 6 feet high.



The reason for taking these measures, is to prevent the movement of pests from one plot to another. If insects can move freely, then the contact insecticide for example might kill all the pests, and it will appear as if the other pesticides were also effective. Furthermore, how effective a spray is can be very clearly seen if there are no insects in the sprayed area of the plot, but insects are present in the guard rows around the plot.

<u>Setting up trial</u>

1. Set up the experiment as planned applying the other practices in the generally recommended way for growing each type of vegetable. Control diseases on all plots.

2. When insects attack a crop, students should try to identify the insect. Detailed description for each type insect should be made in addition to the approx length and measurement across the insect. Then apply the control method to the plot on which it is to be used. The same chemical should be applied to a plot, throughout the crop. Insecticides must be applied with a <u>sticker solution</u>. (eg. trial) at generally recommended number of days between applications.

3. Very good weed control is needed to prevent harbouring of pests.

Observations and records.

Try to see which method of control is most effective for controlling each type of insect. Different types present on different plots will indicate which insect a chemical can not control. The presence of the no control plots will be the test as to how effective a chemical is in its control.

Remember that standards have to be used in determing how effective the control is. Record and compare production - quantity and quality of the produce reaped.

FW. 34. (Trial)

Controlling diseases

Aim - To identify and control diseases in different vegetable crops.

Planning -	)	Similar to work on controlling insects (no.33
Setting up	)	except that 3 different chemicals recommended
work	)	for control of a wide range of diseases will be
Observations	)	used. Try to control insects on all plots.

The idea behind this trial, like the previous one is to demonstrate the need first to control diseases since these will affect quality and amount of the produce reaped. Use the fungicide which can control the disease on the crop grown.

Comparing results.

Compare the production figures and fruit quality from different treatments. Have the chemicals been able to rid the crops of all the diseases observed - Say why you think this is so.

WEED CONTROL

FW. 35. (Trial)

Testing weedicides

Aim - To see the effects of different types of weedicides used in various ways.

Planning

1. Choose each crop as is necessary for the particular test. Here are some simple ones.

   A - No weed control

   B - Using a pre-emergent weedicide before emergence of weeds vs use after emergence.

   C - Using a post-emergent weedicide before emergence of weeds vs after emergence.

   D - Using broad-leaf selective weedicide to control weeds in a grass family crop (eg. corn) vs control in a broad leaf crop. (eg. beans)

   E - Using grass selective weedicide to control weeds in a broad-leaf crop vs control in a grass family crop.

   F - Use of contact weedicide without the spray touching the crop vs allowing the spray to touch it.

In D and E spray the weedicide directly on weeds and crop.

2. Use only small plots not more than 50 sq. ft (or about 6 sq. m) for the work as in some cases the crop will be destroyed.

Observations and records

Observe and note the effect of the weedicide on each plot. Set standards to measure effectiveness of the weedicides .
Record and compare the production from each treatment. How is knowledge of types off weedicide and the use of each type important to the vegetable farmer.

FW. 36. (Trial)

Growing vegetables with different methods of controlling weeds.

Aim - To compare the effectiveness of different methods of weed-control and how weed control affect production of vegetables.

Planning.

1. Choose about 3 crops for the test including a cucurbit. Use crops to be grown from direct seeding.

2. Each crop is to be planted in a separate block with 1 or 2 plots for each treatment i.e. No control, vs mechanical control vs chemical control. Use a post-emergent spray suited for each crop. Draw the plan showing positioning of the method of control. Each method should be applied when necessary.

Setting up trial

Set up the work as outlined above.

Observations and records.

1. Observe the problems in applying the methods tested and note the effectiveness of each. A suitable index would be the regularity with which the method has to be applied.

2. Overall growth of plants in each plot and records of production. Compare the 3 treatments.

FW. 37. (Trial).

Aim - To compare effect of weed control on production.

The trial is to illustrate how the regularity of weeding affect production. 3 or 4 treatments are enough.

eg. A - No control

B - Weeded every week

C - Weed every 2 weeks

D - Weeded every 3 weeks

E - Weeded every 4 weeks

One method of control on one crop can be used. More than one method - manual, mechanical and chemical can be used on one or more than one crop.

Observation and records.

Keep a close check on the crop growth, also on weed growth each week. Standards used to assess weed growth, must be defined.

Compare results

Compare production figures for each treatment.

FW. 38. (Trial)

Inter-row cultivation.

Aim - To demonstrate the effect of inter-row tillage on the growth and production of a crop.

In this trial, we can have 1 or 2 crops grown with 1 or 2 treatments besides the control plots.

Example. Crop: Corn

Treatments: No inter-tillage
vs Inter-tillage at 4 weeks old
vs Inter-tillage at 4 and 8 weeks old.

Record production figures and compare them.

FW. 39. (Trial)

Reaping vegetables at the correct time.

Aim - To see the importance of reaping time in vegetable production

Planning and Setting up the work. - To this work, a large plot of cucumber and one of watermellon can either be grown for this work, or samples can be used from plots in a work in which production is not the main factor tested (eg. some mulching, disease, insects or weed control trials).

Observations and records

1. Mark certain flower as soon as they are observed to be fully open. A bit of plastic tape loosely tied with the data written on it, can be tied around the stalk of the flower. Knitting wool with different colours for different dates is better.

2. Reap about 5 fruits at daily intervals or 2 days intervals from about a week before the crop should reach its first reaping to about a week after. The fruits reaped on each occasion should be of the same number of days from flowering. The dates on the markets will be used here.

3. Find the average weight of the fruits and a number of students should eat portions of each fruit reaped. Quality of fruits according to their tastes, should be rated as -good, fair, poor. Look at seed maturity, sweetness, colour etc to define the quality of the fruits.

Does each crop show a given number of days or a range of days from flowering at which fruits are of good quality. What is the time period over which the quality is good? Is the quality best when the produce is heaviest?

Do you think this work is relevant to the vegetable farmer - How?

FW. 40. (Trial)

Growing vegetables on a large scale to determine economic returns

Aim - To introduce students to vegetable production on a large scale and the economics involved.

Planning -

1. Choose 1 or 2 vegetable crops on which numerous trials have been done using different factors to test production. The factors to be used are not those that necessarly give maximum production, but those that could economically give these results. Markets should also be available for these crops.

2. Select an area for the work allowing not less than 1 sq. chn (or 400 sq. m) per crop or preferably a bigger area for each crop.

3. Decide ways that will be used to estimate costs in growing the crop, eg. insecticide used should be taken from a separate pack so that estimate amount used can be made later. Time spent to fertilize, weed etc. should be recorded.

Setting up work-

1. Set up the work and apply the practices in the way that is likely to give maximum returns.

2. Use only a few students to work on each crop so that an estimate of labour can be made.

Observations

1. Make general notes of importance in understanding the figures at the end of the crop and for suggesting ways of improving the profits.

2. Cost, sales and production - records for crop should be kept. Try to make the calculation on a per. acre or per hectare basis.

Compare the records from each crop. What would you say is responsible for the difference in the cost and sales figures. Suggest ways of increasing the profits from each crop.
Which crop would you recommend to the farmers in the area - Why?

LIST OF MAIN REFERENCES

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FECHA DE DEVOLUCION
