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HOW TO WRITE A SCIENTIFIC PAPER FOR PUBLICATION

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Introduction

A Scientific paper in fact is a report which describes original research carried out on any particular subject. It is written to be published in a Journal and therefore must be presented in a special manner. The broad concepts of how to write for publication have been developed over the years. In addition to these basic requirements, which are similar for all scientific Journals, each of them usually has its own "house style" which it favours, eg. in the presentation of the abstract, summary and references. Therefore, it is necessary to keep to the format required

It is generally accepted that a scientific paper should satisfy three essential requirements: it should contain sufficient information for a reader to (a) assess observations, (b) repeat the methods used, and (c) evaluate the thinking process that has gone into the study and the discussion resulting from it. DeBakey (1976) has put this very succinctly: "the contents of an article should be how true, important and comprehensible".

The art of presenting a scientific paper is now well developed, and each paper should have in proper sequence the following sections:

(a) Title,
(b) Abstract or Summary,
(c) Introduction,
(d) Materials and Methods,
(e) Results,
(f) Discussion,
(g) Acknowledgements, and
(h) References.

This order of presentation is now so well developed that it is accepted by a great majority of Journals publishing scientific papers, and all new journals

generally adopt the same sequence as it is quite logical, and can be adopted for any discipline in science, whether it be biology, chemistry, economics or medicine.

Day (1979) states that this method of reporting becomes simple and logical when you answer four questions in order:

(a) What was the problem? Your answer is the Introduction.

(b) How did you study the problem? Your answer is the Materials and Methods.

(c) What were your findings? Your answer is the Results.

(d) How do you interpret your results? Your answer is the Discussion.

Then follows the Acknowledgements, which is a matter of courtesy and the Literature Cited.

The paper must be written in good, clear and easily understood language. This is most important, as good scientific work is often rejected by journals, as the reports on the subject are not written clearly so that they can be easily understood, even by the layman.

The Title

It is important to accept that you write to be read; therefore, from the beginning you must try to woo your reader. Remember that a great number of people will read the title of your paper; but only a few will read the full paper, and that only if the reader's interest is aroused by the title. So it is essential to write a good title, which can be defined as "the fewest possible words that describe the contents of the paper".

The title should give sufficient detail for a person scanning the contents page to know whether the paper will be of interest to him, eg. if the paper deals with a fungus, it should give the name of the organism, what aspect is being studied, and if it is a pathogen, what crop was affected. However, the title should never be too long and should not have redundant words such as "Studies on ..." or "Investigations on ..." obviously the report is

on a study. Abbreviations, chemical formulae, proprietory names of drugs and coined words should not be used in titles. Finally the series title eg. "Studies on head injuries - I ..." is definitely taboo in current journals.

The abstract should not exceed 300 words, and should be a good summary of the paper presented, so that the busy reader can decide whether he should read the whole paper. Ray (1979) has described the ideal abstract as one that: "(a) states the principal objectives and scope of the investigation, (b) describes the methodology employed, (c) summarizes the results, and (d) states the principle conclusions".

The abstract as far as possible should be one paragraph, contain no information that is not in the text and should not have any literature references.

Writing the Introduction

The title and the abstract of a paper are best prepared after the full paper is written; but you should have a provisional title in mind, while writing.

The introduction is the first part of your paper and introduces the subject to the reader by stating the problem that you have set out to study. Then you should describe the available information on the subject, by reviewing the relevant literature, which should be brief and to the point. This is followed by an equally brief reference to the methods used, bearing in mind that a detailed description of the methods is to follow immediately after the introduction. There must then be a clear statement, usually in one sentence, to explain why you did the work described. Finally, you give the principal results of the investigation as concisely as possible.

You can see that everything you have referred to in the introduction and the sequence of presentation is logical, and this is important in reporting. You start by defining the problem; then you state what is already known about it in

the literature survey; next, you say how you carried out the study, and finally your results and observations on them. The essence of good scientific writing is simplicity and a natural sequence of events, described in that way.

Description of Materials and Methods

Materials

This section must give a full description of the materials you used and the methods you adopted in the study. The most important requirement you must keep in mind when writing this section is that it should provide enough detail for any competent worker to repeat your study.

The materials used should be described in detail, eg. if you carried out a study on coconut sap, where, at what time of the day, and how you collected the material - how you carried it to the laboratory; in a refrigerated can or thermos flask or in a test tube, after treatment with a preservative - what you did with the sap when you brought it to the laboratory - did you leave it on a lab table or in a refrigerator? If any chemicals were used, their grade and quality must be given. These details are essential for someone who wishes to repeat your studies; as each treatment will alter the conditions of the experiment.

Methods

The methods are best described in chronological order, as they were carried out in the laboratory. If you used a new method, describe it fully; but if you used a modified method, already described by someone else, give the reference to the earlier work and describe only the modification fully. Remember the important requirement, to give enough detail to enable someone else to repeat your study.

Presentation of Results

Handling data

This is essentially a matter of presenting data, that you have obtained, in the best possible manner, so as to be meaningful to the reader and enables you to present your own point of view to best effect.

You should avoid the common error of starting the results section, by describing the methods you may have left out by error, from the previous section. The results section must present only the data you recorded; but never any interpretation of those results, which will follow.

One of the most important factors to remember here is that, your paper should present only some of the data that you recorded, not an endless succession of the results of hundreds of experiments that you repeated. Therefore, the data should be representative of the whole and never the whole. Thus selection and preparation of the selected data, for presentation to best effect, becomes all important.

Handling numbers

A large series of numbers can be handled in several ways; in Tables, Graphs or Histograms. In the great majority of cases, one of these methods should be selected and the presentation of the same data in both a table and a graph should be avoided, unless a series of numbers have to be presented to make a very important point, the table to show exact values and the graph to show trends. Generally, unrelated numbers are best presented in tables, and it is important to ensure that each table does not contain such a large number of figures that it becomes difficult for the most interested reader to follow. Therefore, only sufficient data to make the point that you wish to make, without tiring out the reader should be presented.

If the data show pronounced trends, which can be made into an interesting picture, clearly showing the trends, then such data are best presented in a graph. A reader can very easily grasp the significance of trends and relationships between lines presented in a graph; the visual effect always has a greater and more immediate impact on the reader. However, the cost of preparation and printing of graphs is much higher than for tables. Therefore, the decision to present data as a graph should be carefully considered.

Histograms too have a high visual impact and can be used to show similarities and differences between figures that do not show clear trend lines. However, like graphs, histograms are costly to produce, and should be used only when they are essential to make an important point.

The results should be presented as such, short and sweet, without any fanfare. If statistics are used to qualify the results, they must be meaningful, and not used merely to make the results look more profound. The simpler the results and their message, the clearer their impact: always strive for clarity and avoid making any interpretation of the results in this section.

Writing the Discussion

A lot of people can carry out high quality research work, especially if they are guided and supervised by a competent scientist. However, it takes a good research worker to interpret the significance of the results recorded. Therefore, the writer always considers the Discussion as the most important part of a research paper, and the hardest to write. Many papers are rejected by the editors of journals because of faulty discussions, even though the data presented in the paper may be both valid and interesting. The true meaning of the data in a paper may be completely misinterpreted in the discussion, and this will again result in rejection of the paper.

This section is so important that I should like to quote from Day (1979) the essential components of a good discussion, which he states should:

"1. Try to present the principles, relationships and generalization shown by the results. In a good Discussion, you discuss; but not recapitulate the results.

2. Point out any exceptions or any lack of correlation and define unsettled points.

3. Show how your results and interpretations agree (or contrast) with previously published work.

4. Discuss the theoretical implications of your work, as well as any possible practical applications.

5. State your conclusions as clearly as possible.

6. Summarize your evidence for each conclusion."

Briefly stated, the purpose of the discussion is to inform the reader how you interpret the results, and what you think of their significance. To do this successfully, the writer must be widely read on the subject on which he has worked, and have a nimble mind that recognizes the relationship of different pieces of information. The discussions should end with a summary giving the significance of the full study.

Acknowledgements

The main text of the paper is now over, all that remains is to acknowledge the help or assistance you received from your colleagues, assistants or supervisors and thank those that provided financial aid for the work. Finally, if you worked part or full time in someone else's laboratory, this is the place to record your appreciation for the facilities provided. It is important to remember that the acknowledgements are a simple matter of courtesy, and the more sincerely you express your thanks the better it will read.

Literature Cited

It is necessary and correct to list only published references, which have a significant bearing on your work. References to unpublished data, personal communications and other material need not be listed in this section.

There are several methods of writing the list of references; all Journals have their own style and it is essential to adhere to the requirements given. The most favoured style of listing references is the harvard system, where the name of the author is given first, followed by his

initials, then the year of publications, in brackets; next comes the full title of the paper, the name of the Journal in which the paper is published, its volume number and the number of the first and last page on which the paper is published. Many journals use the abbreviations provided by the World List of Abbreviations for Journals, but a few have recently started publishing the full title of the Journal.

The preference of various Journals for a particular style of presenting the literature cited, makes it essential for the writer to refer to a recent issue of the Journal he wishes to write for, not only for the "house style" for references; but for general information on the style of presenting the full paper. All Journals almost invariably publish a note on: "Instructions for Contributors" at least once a year in their Journal, giving clear, detailed advice on how they require their papers to be prepared for publication.

Useful Points

1. It is always advisable to start writing the paper quite early. This will not only enable you to write when the material is still fresh in your mind, but allow you time to repeat experiments where the data are not up to the required standard for writing up.

2. Write in very simple English, so that everybody will understand what you wish to say. Therefore write "find out" instead of "ascertain": "do" instead of "perform"; and make everything else equally simple.

3. Write in the past tense, after all you are reporting work that has been completed.

4. Do not strive hard and write in the passive voice, it is not a crime to say:"we did this and we found that". More and more journals are encouraging the method of direct reporting, instead of the old style of:"it was found that". The same goes for writing in the abstract.

5. Put your manuscript aside for 2 - 3 weeks after writing it, then read it again. You will be amazed at the corrections you have to make.

6. It is very useful to request a colleague to read your manuscript, and discuss his suggestions with him. If this is done it is important to remember that nothing your colleague says or suggests should ever be misinterpreted as destructive criticism.

7. Check and re-check that the verbs agree with the subjects in your writing. Disagreement in this is a common error and it can easily happen.

8. Write the Abstract and Title after writing the full text; but do have a tentative title in mind while writing the paper.

References

1. Day, R.A. (1979) How to write and publish a scientific paper. ISI Press, Philadelphia, U.S.A.

2. DeBakey, L. (1976) The Scientific Journal. Editorial policies and practices. Guidelines for editors, reviewers and authors. The C.V.Mosby Co., St.Louis.

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SUCCESSFUL COMMUNICATIONS

A good communicator,

KNOWS -

1. His objectives - has them specifically defined
   His audience - needs, interests, abilities, predispositions.
   His message - content, validity, usefulness, importance.
   Channels that will reach audience and their usefulness.
   How to organize and treat his message.
   His professional abilities and limitations.

2. IS INTERESTED in -

   His audience and its welfare.
   His message and h ow it can help people.
   Results of communication and their evaluation.
   Communication process (factors essential for success).
   Communication channels. Their proper use and limitations.
   How to improve his communication skill.

3. PREPARES -

   A plan for communication - teaching plan.
   Communication materials and equipment.
   A plan for evaluation of results.

4. HAS SKILL in -

   Selecting messages.
   Treating messages
   Expressing messages - verbal and written.
   Selection and use of channels.
   Understanding his audience.
   Collecting evidence of results.

POOR COMMUNICATIORS -

- Fail to have ideas to present that are really useful to the audience
- Fail to give the complete story and show its relation-ship to peoples problems.
- Forget that time and energy are needed to absorb the material presented.
- Feel they are always clearly understood.
- Refuse to adjust to 'closed' minds.
- Talk while others are not listening.
- Get too far ahead of audience understanding.
- Fail to recognise other view points - and develop presentation accordingly.
- Fail to recognise that communication is a 2 way process.
- Let their own biases over-influence the presentation.
- Fail to provide a permissive atmosphere.
- Disregard the values, customs, prejudices and habits of people with whom they attempt to communicate.
- Fail to start where people <u>are</u> with respect to knowledge, skill, interest and need.

A GOOD MESSAGE MUST BE,

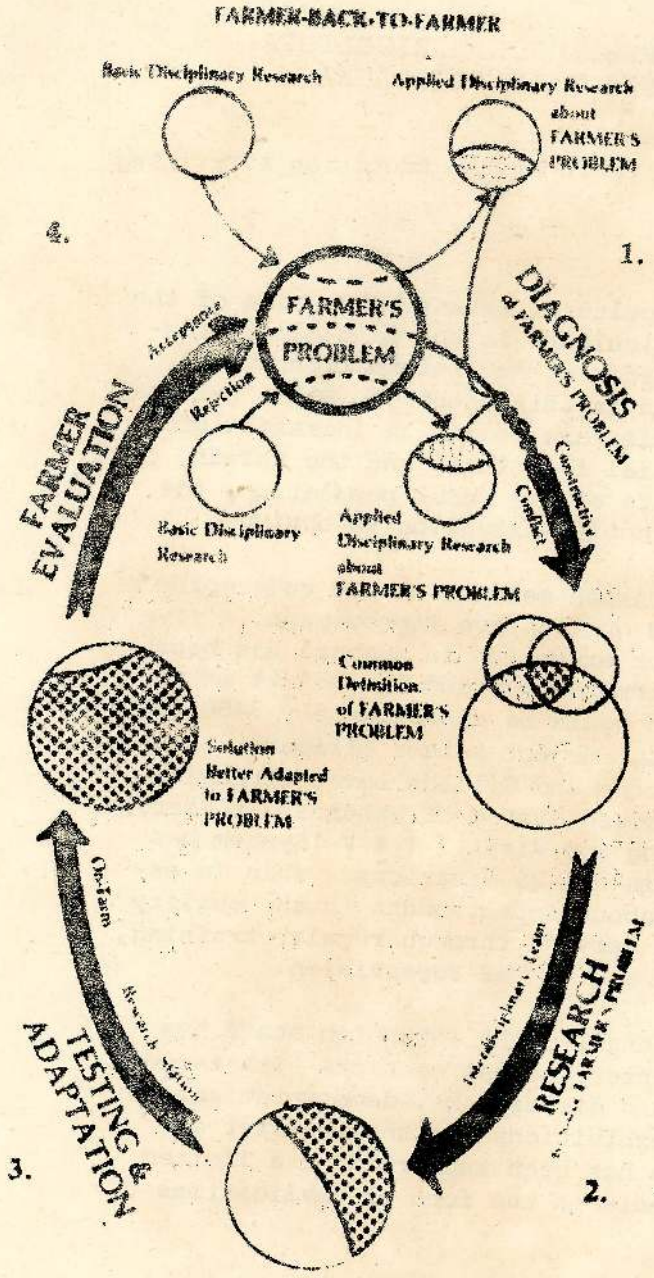
- In line with the objective to be attained.
- Clear-understandable by the audience.
- In line with the mental, social, economic and physical capabilities of the audience.
- Significant-economically, socially or aesthetically to the needs, interests and values of audience.
- Specific - no irrelevent material.
- Simply stated - covers only one point at a time.
- Accurate - scientifically sound, factual and current.
- Timely - specially when seasonal factors are important and issues are current.
- Supported by factual material covering both sides of the argument.
- Appropriate to the channel selected.
- Appealing and attractive to the audience has utility and immediate use.
- Applicable-audience can apply recommendation.
- Adequate - combines principle and practice in effective proportion.
- Manageable - communicator can handle with high professional skill and within the limits imposed by time.

"FARMER-BACK-TO FARMER" FOR SUITABLE TECHNOLOGY

An interdisciplinary research team from the International Potato Center in Peru sought improved and acceptable technology for consumer potato storage, building on previous experience in the design of household and village-level potato processing equipment. In looking at success and failure, they devised a model called "Farmer-Back-to-Farmer," representing the continuity from where to begin to where to end in applied agricultural research and extension.* Its graphic presentation is shown elsewhere on this page.

The beginning is the farmer's perception of the problem, and the end is his acceptance or rejection of the solution. "Starting with the philosophy that the farmer's circumstance is the spring board of research, the model then logically consists of a series of task-oriented goals aimed towards achieving acceptable technological solutions to specific farmers' problems." Goals are linked by activities numbered as followed: (1) arrival at a common definition with the farmer; (2) identification and development of a potential solution through interdisciplinary research ("which rejects the fragmented, staggered roles of several specialists in favour of ongoing, dialoguing, and totally involved research teams working together"); (3) testing and adaptation to make the proposed solution better fit the farmer's needs; and (4) completion of the circle by the farmer's all-important judgment as to acceptance or rejection.

The model is presened by its authors as an effective means of designing, generating, and transferring technology appropriate and acceptable to farmers, with economy of time and money and with the easy pinpointing of both progress and hurdles remaining, since the circle must be "closed back-to-the-farmer" for success.



* Robert E. Rhoades and Robert H.Booth, "Farmer-Back-to-Farmer: A Model for Generating Acceptable Agricultural Technology," Agricultural Administration October, 1982. pp.127-137.

MEDIA SUPPORT FOR AGRICULTURAL EXTENSION IN SRI LANKA

Extract from a report of the Education & Training Division

1. Introduction:

The Agricultural Extension Service of the Department of Agriculture is the main agency responsible for transfer of new information to the farming population in this country. Since national agricultural policies are geared to increased production of essential food items and the raising of the quality of life of the rural population, the importance of effective extension is obvious.

The extension service is now undergoing a quantitiative and qualitative improvement. A five year programme for expansion in numbers has been accepted for implementation and by 1984 it is expected that there would be approximately 3480 Agricultural Officers, Subject Matter Officers, Agricultural Instructors and Village Level Extension Workers. An improved system of extension referred to as the Training and Visit (T & V)System has been introduced in all 25 districts. This is expected to bring about improvements in the quality of the extension service through regular training, scheduled visits and better supervision.

Traditionally, the extension staff has relied more on interpersonal contacts with farmers group meetings and discussions, demonstrations, field days and exhibitions for the transfer of knowledge. This has been supported on a limited scale by mass media in the form of publications and radio.

Experience has shown that interpersonal contact, group meetings and discussions, demonstrations and field days are more effective than mass media. There are limitations in the acceptablity of mass media by the people owing to the different cultural, social and religious background. Furthermore, in skills training, individual and group methods have been found to be more successful particularly when supported by relevant communication aids and materials.

To make the extension services more effective there is a need for a strong training and media support. The staff should receive regular training not only in technical subject matter but also in communication skills and be supported by media and materials. The need for such a regular and continuous training has been recognised by the Government and action has been taken to establish Training Centres at regional level (R.T.C.s) - one in each agroecological region in close proximity to the Regional Centres. Eight R.T.Cs are already functioning, they are at Peradeniya, Maha Illuppallama, Bindunuwewa, Kilinochchi, Karadian Aru, Angunukolapelessa, Bombuwela and Makandura.

The major function of these R.T.Cs is to bring about a close link between research and extension, and improve the capabilities of the field workers within each region by means of short duration (usually one week) inservice training courses before the beginning of the season, and thereafter during the season. These courses are based on training needs and field problems identified by the extension service. The trainers are Research Officers at the regional Research Centres and Subject Matter Specialists at the R.T.Cs. This mechanism has been found to be an effective method of transferring technology to the field workers.

While training in technical subject matter is reasonably adequate and is supported by the expanding research organisation, the training in communications and the use of different supporting media and materials is virtually a new field and needs strengthening. The use of appropriate media and materials as for instance, posters, flip charts, wall charts, phtographs, slides, film strips , tapes, etc.would enhance the effectiveness of the extension worker.

Department of Agriculture is keen on strengthening this activity further owing to its scope and importance. The most logical way would be to develop the media resources at the eight Regional Training Centres so that each of these Institutions

could thereafter continue to train the local extension staff and also support them further by producing some of the more complex media/materials.

When fully functional, each R.T.C. will have a media resources centre with a trained S.M.S, a Photographer, an Artist and a minimum of facilities and equipment for training and production purposes. Most of this staff has already been recruited but what is lacking is the expert guidance and continued training and a minimum of equipment to get these off the ground.

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HOW TO MAKE BANANA VINEGAR

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Peel the ripe bananas and place them in a jar or large vessel. Pour off the juice each day as it accumulates; until there is only the coarse spongy debris left. Strain the juice through a thick bit of brown calico (the calico must be washed first), and let it stand until turned to vinegar. The vessel that holds the juice should not be corked, but have a piece of thin muslin tied over its mouth, to let the air in and to keep insects out etc. The time for the juice to become good vinegar depends on the condition of the bananas used. Indifferent fruit makes poor vinegar. A common way to make banana or mango vinegar is to fill a corn bag with the ripe fruit and hang it over a wooden tub to collect the juice but the flavour of the vinegar is not so good as if a jar or enamelled vessel were used.
- JAMAICA AGRIC. SOCIETY JOURNAL.

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RICE WEEDS IN MINOR TANK PADDY FIELDS AND THEIR EFFECT ON CROP YIELDS

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Maha Illuppallama

Introduction:

Rice is best adapted to grow on hydromorphic soils. Yet it is grown under diverse soil moisture conditions ranging from well drained uplands to poorly drained lowlands where the soil is continuously submerged. As such, rice fields may be colonized by terrestrial, semi aquatic or aquatic plants depending on the moisture regime of the soil. Paddy soils under minor tanks in Dry Zone of Sri Lanka are characterized by a series of different soil drainage classes. Information regarding the abandance, distribution and floristic composition of weeds inthese different soil drainage classes are very megre, but such information is of immense importance in evolving efficient weed control methods, as weeds have become a major constraint to rice cultivation under minor tanks. This becomes more obvious, particularly, regarding chemical weed control since different weeds have shown a differential response to various herbicides.

This paper summarises the results of weed survey carried out in typical minor tank paddy fields during 1979/80 Maha and 1980 Yala seasons.

Materials & Methods:

Paddy fields under the three typical minor tank villages, Walagambahuwa, Mawathawewa and Panidikulama in Anuradhapura district were selected for the investigation. Paddy extents under the three villages ranged from 30 to 80 acres. During 1979/80 Maha season weeds were sampled from 1 x 1 m stands selected systematically at fifty metre intervals along three line transects, running from higher end to the lower end of the catenary sequence, under each minor tank. All the samples were taken when the weeds were at flowering stage, from fields where any measure of weed control had not been adapted

for the standing crop. In 1980 Yala season, another forty two 1x1 m samples were taken from fourteeen fields, selected randomly from the three drainage classes namely well drained, moderately drained and poorly drained from Walagambauwa to obtain floristic data. Crop yields were also estimated from the same fields by harvesting three 1x1 m quadrates from each field. Information on the use of herbicides by farmers in the selected fields were also collected.

Results & Discussion:

Rice fields under the three minor tank paddy fields were colonized by a fairly rich weed flora comprising of about thirty different species (Table 1). Except for Marselia minuta other cryptogamic weeds have deliberately neglected during the survey because of their minor importance. It was revealed from the results that the composition of the weed flora under the three tanks showed not much of a difference suggesting that a typical set of weeds could be found under minor tank paddy fields. The entire weed flora was comprised of grasses, sedges and broadleaves and each of these category had contributed a more or less similar number of species to build up the whole weed spectrum (Table 1), However, bulk of the weed biomass was shared by grasses and sedges- broad leaves were of minor significance. Of the predominant two categories of weeds, grasses were co-dominant by both annuals and prennials while cyperous population was primerily of annuals.

The abundance of weeds along the catenary sequence in all the three locations have shown a similar trend. Weed growth was gradually decreased from crest tothe bottom of each catena Fig.1) It has been demonstrated that moving down the topo sequence from crest towards the valley bottom in minor tank paddy fields soils can be distinguished into three land classes namely well drained upper slope, moderately drained middle slopes and poorly drained bottom lands.Usually, poorly drained soils experience a very high soil moisture regime than does the well or imperfectly drained soils. Moreover, due to low percolation rates, standing water is retained for an extended period of time in poorly drained soils than does

on well drained soils. Thus there is a clear cut variation in the soil moisture regime and the duration of standing water retained from crest to the bottom of the catena. The characeristic reduction in weed growth observed from crest to the bottom of the catenary sequence, could be related to the moisture gradient present across the catena as emergence and subsequent growth of weeds are severely handicapped by high moisture regimes and and standing water.

Apart from the total weed density, an individual species variation was also observed along the soil catena. Grasses and broadleaves were more prominant in well drained soils than on the other soil classes (Table 1). However, certain grass species have deviated from this trend. For example, Panicum repens was commonly found throughout the soil catena while Isachnae globosa confined mainly to poorly drained soils. Echinocloa species were usually more common on well drained and imperfectly drained soils except for E. glabrasancewhich was more abundant in poorly drained soils. Leaving Leersia hexandra and Eragrostis uniloides aside, other reported grasses were found to be major weeds inthe rice fields.

Majority of the cyperacious weeds observed were comprised of Fimbrystylis miliaceae, Cyperus iria, C.difformia and C.tenuispica. All these were annuals and were concentrated more cowards the imperfectly drained and poorly drained soils.(Table I)

The weed incidence and the grain yield showed a significant negative correlation and the relationship holds true for all the three drainage classes. This suggests that heavy weed incidences would reduce the grain yield tremendously (Table 2)

It was evident fromthe results that about 75% of the farmers used herbicides. More than 90% of them have restricted to MCPA while only very few few farmers used both 3-4 DPA and MCPA. Except for these two, no other herbicide were used by the farmers. Rate of application of herbicides by the farmers were found to be varied and most of them did not apply the optimum dosage. Nevertheless, application of herbicides have resulted a signi-

ficant degree of weed control (Table 2). In well drained soils, application of MCPA alone has resulted a 50% increase in the grain yield over the control while both MCPA and 3-4 DPA has increased the yields over 150% . On the other hand application of MCPA alone on poorly drained soils resulted over a 100% increase compared to unsprayed fields. The difference in yield increase due to application of MCPA on different drainage classes is clearly explained by the differential weed flora in the two drainage classes.

In general,resu lts of the survey suggests that weeds under minor rank paddy fields cause a considerable crop loss. The types, distribution and abundance of weeds on different soil drainage classes are different. The weed control measures adopted should therefore, vary depending on the drainage class. Control of grassy weeds seems to be more important on well drained soils, while more emphasis has to be given on sedges on imperfectly and poorly drained soils.

Table I. Composition of Weed Flora and Its Occurence in Different Drainage Classes.

Species	Frequency of Occurance in Different Soil Drainage Classes.		
	W.D.	I.D.	P.D.
Grasses			
1. Cynadon dactylon (L) Pers (Kukul Atora)	+		
2. Echinocloa colona (L) Link (Heen maruk)	+++	++	+
3. Echinocloa cruss-galli ssp. hispidula (Retz) Honda. (Kendi maruk)	+++	++	+
4. Echinocloa glabrasance Munro (Maha maruk)		+	+++

Table I. Composition of Weed Flora and Its Occurence in Different Drainage Classes.

Species	Frequency of Occurance in Different Soil Drainage Classes.		
	W.D.	I.D.	P.D.
5. Eragrostis uniloides Nees (Bata della)	+	+	
6. Ischeamum rugosum Salish. (Gojaravalu)	+++	+++	+
7. Isachne globosa R.Br. (Batadella)		++	+++
8. Leersia hexandra Sw.		+	+
9. Leptochloa Chinensis (L) Nees		+	+
10. Panicum repens L (Atora)	+	+	+
11. Paspalum distichum L		+	+++
Sedges:			
1. Cyperus brevifolius	+	+	+
2. difformis L		++	+++
3. iria L (Thunassa)	+	++	+++
4. Cyperus puncticulatus		+	+++
5. " rotundus L (Kalanduru)	++	+	+
6. Cyperus tenuispica Steud.		++	+++
7. Fimbristylis dichotams		+	+
8. Fimbristylis miliaces Vahl (Kudumatta)	+	+++	+++
9. Fimbristylis littorales Gaud.		+	+

Table I. Composition of Weed Flora and Its Occurence in Different Drainage Classes.

Species	Frequency of Occurance in Different Soil Drainage Classes.		
	W.D.	I.D.	P.D.
Broadleaves			
1. Aeschynomena indica L. (Diyasiyambala)	+	+	
2. Ammania baccifera L	+	+	+
3. Commelina benghalensis L (Girapala)	++	+	+
4. Eclipta prostrata L	++	+	
5. Hydrolea zeylanica Vahl.	+		
6. Ludwigia octavalis (Jacq) Raven	+		
7. Marsilia minuta L (Hatharapethi)		+	++
8. Monochoria vaginalis (Burm.f) Prese (Diyahabarala)			+
9. Moschosma polystachyum Benth	+		
10. Sphenoclea zelanica Gaertn.			+

\+ rare ++ frequent +++ Abudnant.

W.D. - Well drained. I.D. - Imperfectly drained.

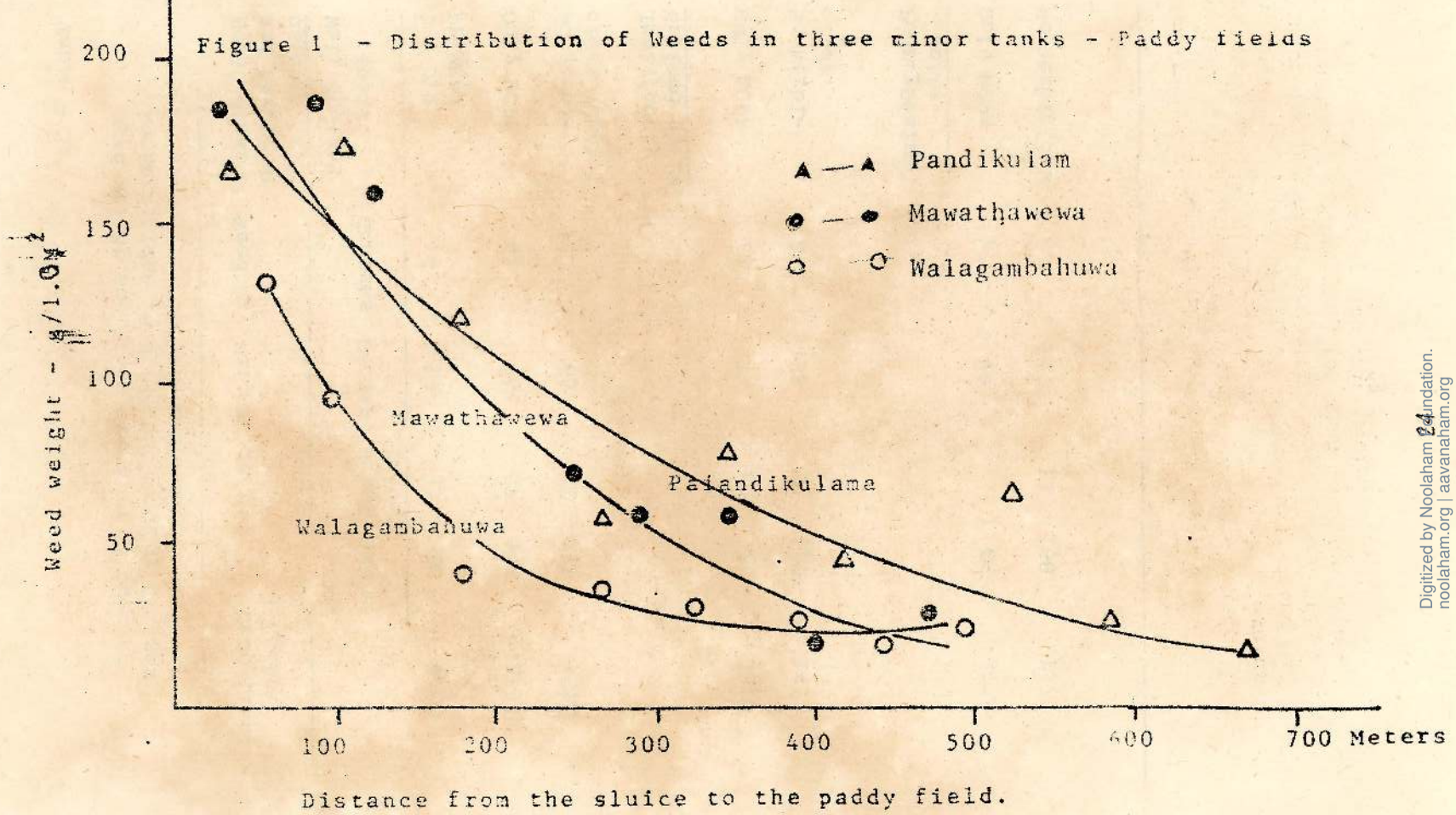
P.D. Poorly drained.

Table - 2.

Weed weight and Grain Yield as Influenced by Herbicides in Different Dranage Classes in Walagambahuwa.

Soil Class and herbicide usage.	Weed Dry Weight gm/m^2				Crop Yield kg/ha.
Well drained soils.	Grasses	Sedges	Broad leaved.	Total	
3-4 DPA FB.MCPA	16	19	23	58	4100
Only MCPA	43	76	57	176	2375
No herbicides (Cont.)	142	65	31	238	1570
Imperfectly drained soils.					
ONly MCPA	12	14	18	74	3810
No herbicides.	24	131	14	169	1420
PoorlyDrained Soils.					
Only MCPA	27	39	-	66	3770
No herbicides	21	144	13	168	1375

Figure 1 - Distribution of Weeds in three minor tanks - Paddy fields



GUIDE LINES FOR DRAINAGE DESIGNS OF UPLAND FARMS

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The practice of the art of drainage is probably as old as the art of agriculture. "Drainage" in this context may refer to the physical network of streams and surface water ways in an area, by which water is being carried away. The safe disposal of rain water from an agricultural land maintains the level of fertility and the soil moisture status within a suitable range for crop production. Inadequate drainage leads to water logging problems and a poorly planned drainage system may reduce the productivity of the land by eroding top soil layer and forming gullies.

A proper drainage system of a land will remove water without causing any damage to the soil at desirable rate. Therefore, drainage should be designed by taking following factors into consideration which affect the rate of removal.

i. Soil condition.
ii. Land slope (length and percentage)
iii. Rainfall (amount and intensity)
iv. Vegetation.

The design of drains should indicate shape, dimension, roughness and gradient. The drainage network for upland comprises of four types of surface drains.

a. Storm water drain.
b. Field drain
c. Grass Water way.
d. Intercepting drain or Diverting drain.

The layout showing the various types of drains, roads, lots and the cross section of drains are shown in Fig.1. These different types of drains and their locations can be shown in the Blocking Out Plan of the proposed farm settlement. But detail designs should be prepared for each location on the basis of micro topographic information.

Design of Storm Water Drain.

Storm water drain diverts runoff water which would other wise flow down from higher ground on the arable land in which dry farming activities and the settlement take place. The step by step procedure for the storm water drain is described below.

1. Determine the extent of land from which the rain water flows to the concerned point of the storm water drain.

In this determination, extents should be reported seperately with respect to the existing vegetation.

2. Four types of vegetation are identified and different values for runoff coefficient of each type of vegetation are suggested as follows :

Type of vegetation.		Runoff coefficient(C)	Area.
i.	Matured jungle(M)	0.2	Am
ii.	Intermediate jungle (I)	0.25	Ai
iii.	Shrub jungle (S)	0.27	As
iv.	Cultivated lands (C)	0.3	Ac

An average value for C can be calculated as follows :

$$C = \frac{0.2\ Am + 0.25\ Ai + 0.27\ As + 0.3\ Ac}{\text{Total extent.}}$$

3. Estimate the rate of runoff by using Rational Formula.

$Q = C\ I\ A$ Where Q = Rate of runoff in cusec

C = Runoff coefficient

I = Rainfall intensity in inches/hour

A = Area in acres.

In case of Anuradhapura District, maximum rainfall intensity for 10 year return period has been used as 4 inches/hour.

4. Gradient of the channel should not exceed 1.0% as to prevent any scouring action. Higher gradients can be reduced below this level by placing drop structures.

Table - 1. Discharge values for storm water drains in cusec per foot width of channel.

Depth ft.	1.0	0.66	0.50	0.40	0.33	0.25	0.20	0.17
	Percent gradient of channel							
0.25	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3
0.50	2.2	1.8	1.6	1.4	1.3	1.1	1.0	0.9
0.75	4.3	3.5	3.0	2.7	2.5	2.2	2.0	1.8
1.00		5.6	4.8	4.3	3.9	3.4	3.0	2.8
1.25		8.0	7.0	6.3	5.7	5.0	4.4	4.0
1.50			9.5	8.5	7.7	6.7	6.0	5.5
1.75				11.0	10.0	8.6	7.7	7.0
2.00					13.0	11.0	10.0	9.0
2.25						13.0	12.0	11.0
2.50						16.0	14.0	13.0
2.75							16.0	15.0
3.00								18.0

5. Select depth and width of the drain in such a manner so that the depth would not exceed 20% of the width. By using Table - 1 the dimension can be determined for a channel with parabolic cross section.

Limitation of the depth also will call for change in the gradient by using drop structures.

Once the dimentions at each outlet are calculated, drop structures have to be fixed at least 3 meters away from the point of conjuction. Gradual change in dimension from one outlet to the other is more smart than sudden distortion.

Note: In these calculations, maximum permissiable velocity was assumed as 1.5 m/sec. or 4.5 ft/sec. and channel factor was taken accordingly.

$X = V/S$ Where X - channel factor
V - velocity
1 in S - gradient of the channel.

Design of Grass Water Ways:

Grass water way is the common drain or a collector drain of runoff water flowing from field laterals. The water diverted from storm water drains is also carried by grass water ways. In this case soil is excavated to form a shallow dished drain and the excavated soil is either carted away or used to form low banks on either side.

In addition to the runoff water coming from storm water drain, parcels of cultivated land will contribute water at different points. Therefore, dimension of the grass water way may go on changing as it moves down wards.

Following values have been fixed to design grass water ways for upland farms in Anuradhapura District.

Maximum intensity of rainfall with a ten year. return period = 4"/hour.

Catchment coefficient = 0.3

Maximum permissiable velocity of the flow = 6 ft./sec.

Roughness coefficient = 0.035

Using Rational Formula,

$Q = C I A$

$C = 0.3$ and $I = 4$"/hour

$Q = 1.2$ A cusec.

This means that an addition of one acre land may contribute additional 1.2 cusec to the drain. The width and the depth of channel may be determined by using Table 2. It is desirable to keep the depth below 20% of the top width.

Field Laterals:

Field drain or field lateral is aligned just above the conservation bund to collect water flowing downward from the field and moves at a gradient of 0.4 - 0.5 toward the grass water way. Parabolic shape of small drain is desirable to serve the purpose. A general range of dimension can be given for these laterals as mentioned below.

Top width = 1.5 - 2.0 ft.

Depth = 4 - 6 inches

The drain should be free of cultivation and thick growth of weed is undesirable.

Table - 2:

Discharge values for Grass Water Ways in cusec per foot width of channel.

Depth of flow ft.	1.0%	0.66%	0.5%	0.4%	0.33%	0.25%
	Percent slope					
0.25	0.2	0.2	0.2	0.1	0.1	0.1
0.50	0.7	0.6	0.5	0.4	0.4	0.3
0.75	1.4	1.1	1.0	0.9	0.8	0.7
1.00	2.2	1.8	1.6	1.4	1.3	1.1
1.25	3.1	2.5	2.2	2.0	1.8	1.6
1.50	4.3	3.5	3.0	2.7	2.5	2.2
1.75	5.5	4.5	3.9	3.5	3.2	2.8
2.00	6.8	5.6	4.8	4.3	3.9	3.4
2.50	10.0	8.0	7.0	6.3	5.7	5.0
3.00	12.0	11.0	9.5	8.5	7.7	6.7

Intercepting Drains (Diverting Drains

This drain is used to intercept runoff water flowing along grass water ways and divert out side the paddy field. Design procedure is similar to the storm water drain.

Spot heights may be required to produce a survey line along the teritory of upland and paddy area most probably parallel to the irrigation main supply channel. Longitudinal section of the intercepting drain has to be designed on the basis of this survey.

ACKNOWLEDGEMENT:

I am greatly indebted to Dr.S.D. Khaper, Consultant - Water Management (ADZAP), for giving his valuable time to review this manuscript.

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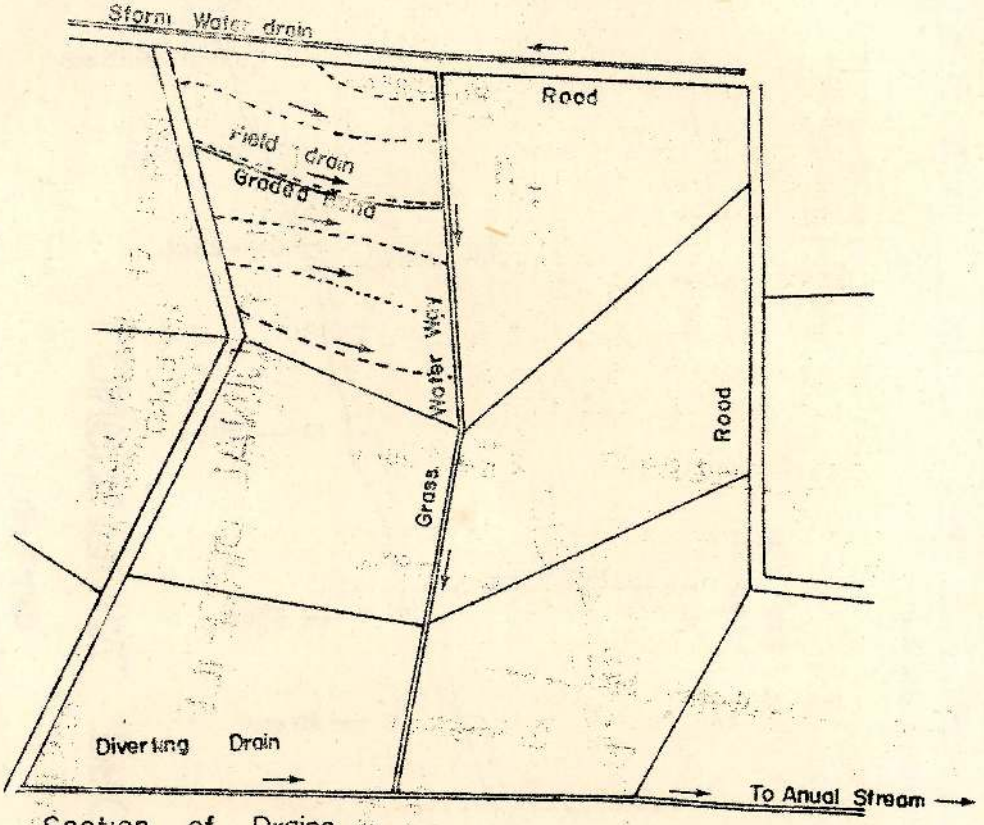
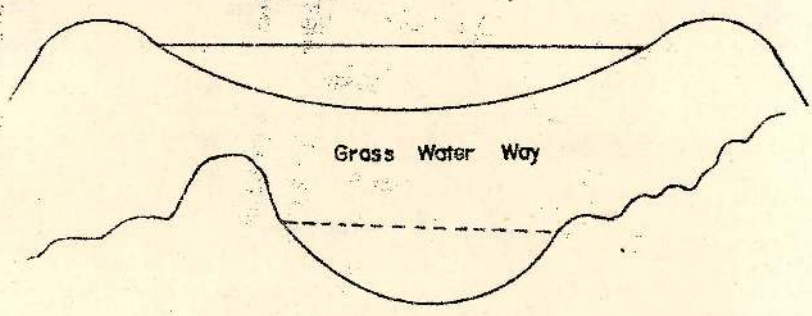
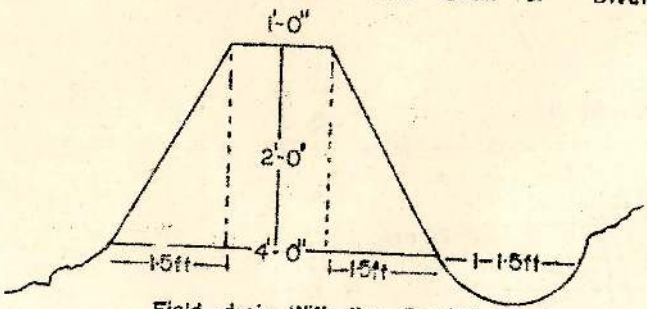
Fig. LAYOUT OF DRAINAGE SYSTEM AND CROSS SECTIONS OF DRAINS



Section of Drains



Storm Water Drain or Diverting Drain

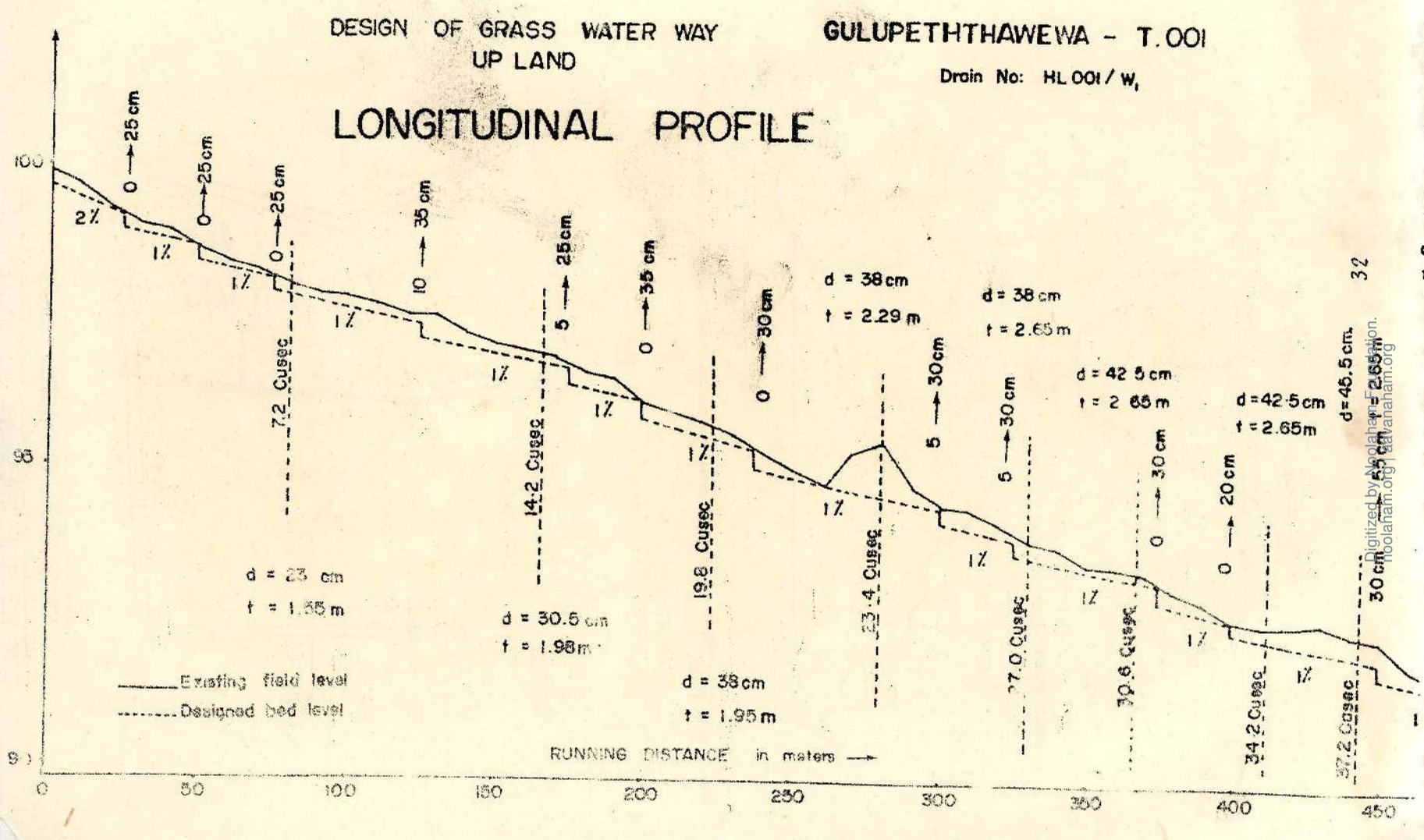


Field drain With the Graded Bund

DESIGN OF GRASS WATER WAY
UP LAND

GULUPETHTHAWEWA - T.001

Drain No: HL 001 / W_1



A METHOD TO REDUCE MORTALITY RATE IN RAMBUTAN GOOTEE LAYERS

M.E.R. Pinto, Addl. D.D. (Hort)
H.M.S. Heenkenda, R.O.
C.A.R.I., Gannoruwa.

Rambutan (Nephelium lappaceum.L.) is one of the most delicious fruits in Sri Lanka. Rambutan can be propagated by seed, layering, budding and grafting. Propagation by seeds, unless for stock plants, is not recommended since it creates several disadvantages such as (1) seedling trees have longer vegetative phase prior to reproductive phase, (ii) uncertainity of genetic uniformity due to open pollination, (iii) the possibility of increasing the proportion of male trees and (iv) decrease in the number of trees per unit area due to wider spacing between trees. Hence vegetative methods of propagation are used to overcome these disadvantages.

Stock plant production by seed is restricted due to seasonal availability of seed and inability to handle large quantities of seed which have a very short viability period. Hence the method of air-layering can be adopted.

Method of Air Layering:

Air layering or marcotage or gootee layering is one of the ancient propagation techniques used to propagate rambutan. The method of layering does not demand any specialized skill.

10 to 18 months old terminal branches, 1-3 cms. in diameter and 60-80 cms. in length are suitable. Two horizontal circular cuts 2-3 cms. apart are made around the branch in the region of semi-hardwood. The strip of cortex between these two cuts is removed by a vertical cut joining the horizontal cuts and the cambium is scraped To make these horizontal circular cuts, a partly split whole piece of bamboo can be used. In th is method the twig is inserted between the split bamboo and the bamboo is twisted from side to side to make the cuts and then remove the ring of bark (Figure 1)

Once the bark is removed, the wound is allowed to dry and callus for 2-3 weeks. Subsequently the callused wound is covered with moistened coirdust made into a ball around the part where the ring of bark is removed. (Figure 2).

To keep the ball of coir dust in position around the wound, wrap the ball with a piece of 300 gauge polythene sheet. This must be bound tight by using metal binding wire.

After layering, 3-4 weeks are needed to produce a good ball of roots. September, October, November and December are the best months to induce rooting. When gooteeing is done during these months, maximum rooting can be obtained.

The rooted twig is notched below the gootee to reduce shock and mortality. Then the twig is separated from the parent tree at 2 weeks after notching. These are potted in 1:1:1 normal potting mixture of top soil, compost and sand. Care should be taken when these gootees are handled at potting. Damaging of roots must be avoided. After potting, these plants must be thoroughly watered and kept in shade for a few weeks.

Eventhough a good ball of roots is formed, bud break after potting, is very low or in many cases completely absent. If bud break does not occur within 2 weeks after potting, leaf senescence progresses resulting in the die back of the potted gootees. This results in high percentage failure. A few of these potted plants would survive for more than 1½ years in the pots without producing new shoots and then gradually die. Due to this, the adoption of the technique of gootee layering for large scale production of plants was severely restricted. Hence a method to reduce casualties had to be developed.

Method of Inducing Bud break and reducing casualties.

Inducing bud break is a possible remedy to prevent failures. A large number of studies in several aspects were done at Fruit Research Farm, Eraminigolla. These studies included leaf pruning, time of gooteeing, time of potting, potting mixtures etc.

These techniques did not give significant results in reducing the mortality rate of these plants. Therefore a simple technique of inducing bud break was evolved. This method is as follows:-

It is very essential to select an undamaged, healthy bud as close as possible to the base of the layering twig. Make a shallow notch about 1/4 depth of the diameter of the twig, 1-2 cms. above the selected plump bud. Then the gootees can be potted as mentioned earlier. If the twig is large then it can be topped to half of its size, usually about 30 cms. in height, but to include a few leaves. Depending on the status of the bud, the bud just below the notch will break and produce a new vigorous shoot within a very short time. If the selected bud is not in a proper development stage or unhealthy, it will take a longer period for bud break. Once the bud grows, it is tied to the upper portion of the plant to train it and prevent damage. The layer is topped at the point of notch after hardening. A suitable wound dressing is used at the cut end to prevent die back. (Figure 3).

When gooteeing is done during the period September to December, it would take around 3 months to produce a salable plant.

The success of this notching technique shows that the normal leaf senescence after potting is completely stopped and that the twig tries to depend on its own root system for sustenance. Success in producing healthy plants by this method has been in the range of 70-75%.

Hence gootee layering, adopting this technique is recommended for production of rambutan plants. This technique which does not involve special skill and is quite economical with regard to labour and time is ideal for mass production of rambutan.

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STEPS IN AIR LAYERING RAMBUTAN

1. Select an erect twig about 2-3 cms. diameter, bearing a few leaves.

2. Ring bark in the region of semi hardwood, removing a ring of bark about 2-3 cms.

3. Allow the ring barked area to callus for 2-3 weeks.

4. After 2-3 weeks, the injured area is covered with moist coir dust formed into a ball and held in position with 300 gauge polythene sheet and bound tightly.

5. After 2-3 weeks a notch is made 1-2 cms. below the gootee to a depth of about 1/4 the diameter of the twig. Support the twig to avoid breakage.

6. The twig should be severed from the parent two weeks after notching.

7. Before potting the layer, a healthy, undamaged bud should be selected as close to the base of the layer as possible and a notch made about 1 cms. above the selected bud.

8. The layer is now potted after topping any excess length of twig to about 30 cms.

9. Water the potted layers and place them in shade.

10. Pests should be controlled when necessary.

11. Bud break occurs 2-3 weeks after potting.

12. Train the new shoot to grow erect.

13. When the shoot reaches semi hard wood stage of maturity, harden the layer progressively.

14. The layer is ready for planting in the field in 10-12 weeks from ring barking.

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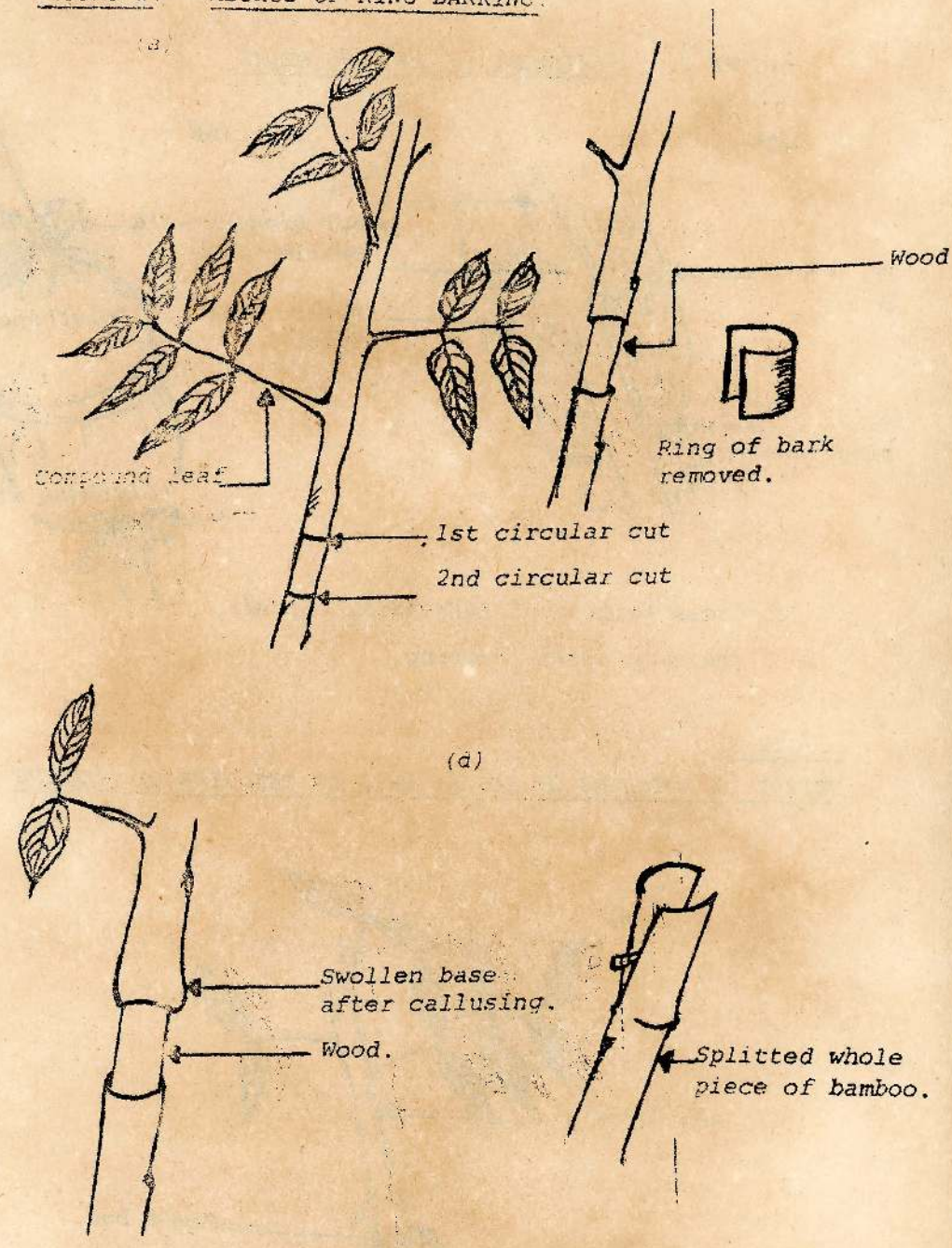
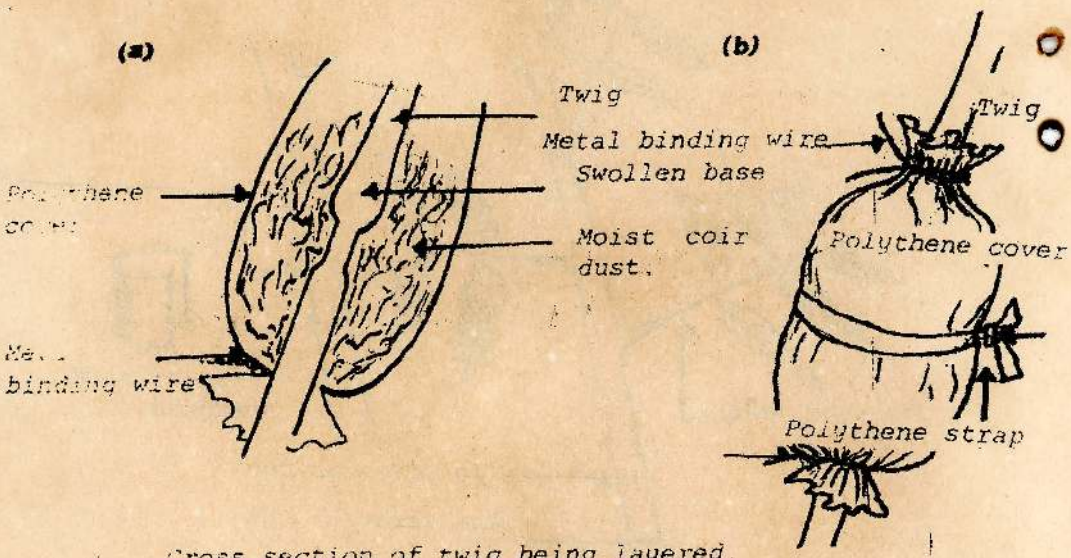
FIGURE 1. METHOD OF RING BARKING



a) Selected twig showing place of ring barking.
b) Twig after ring barking.
c) Appearance of twig at 3 weeks after ring barking.
d) Splitted whole piece of bamboo.

FIGURE 2. PLACEMENT OF ROOTING MEDIA.

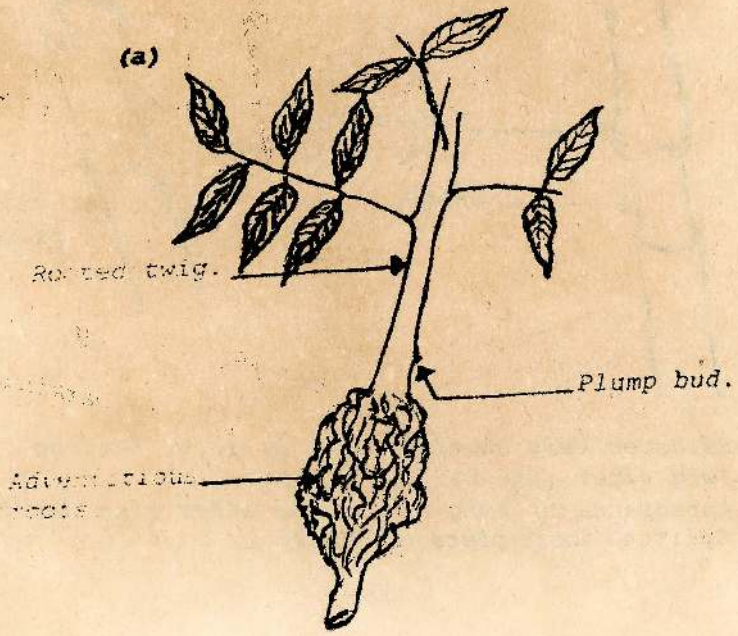


a Cross section of twig being layered.

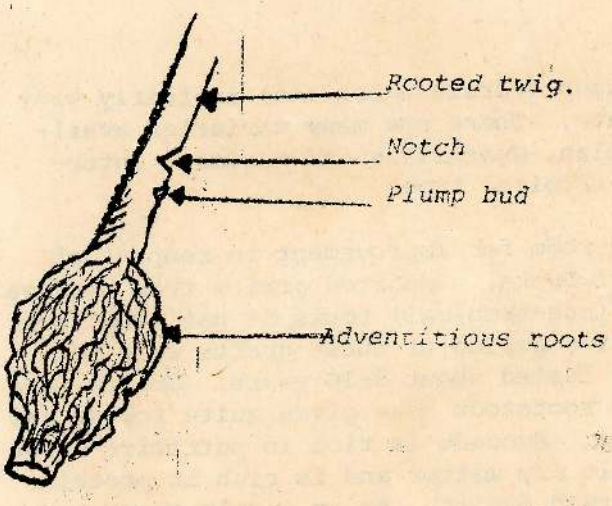
b The twig after layering.

FIGURE 3.

METHOD OF NOTCHING OF ROOTED TWIG AT THE TIME OF POTTING



(b)



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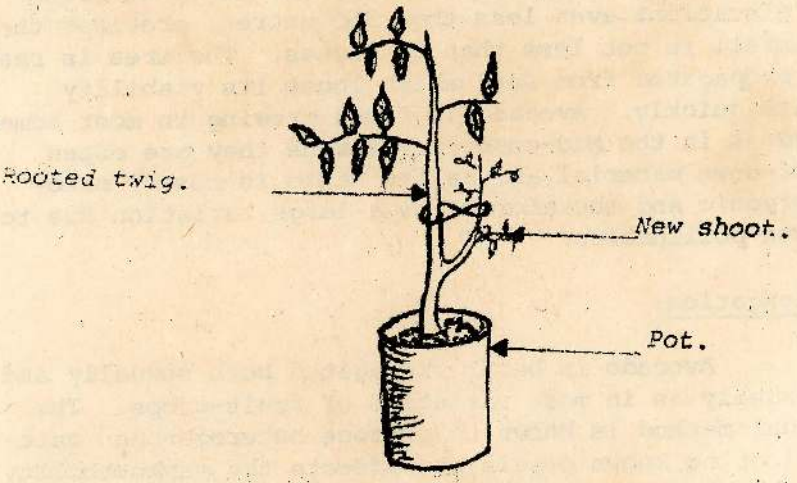

(a) Rooted twig.

(b) Method and place of notching at the time of potting.

(c) Training of the new shoot.

SEEDLING GRAFTING TECHNIQUE OF AVOCADO

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Introduction:

The Avocado (Persia americana) is fairly easy plant to cultivate. There are many varieties available as West-Indian, Guatemalan and Mexican, Intermediate and sub-tropical types.

There is room for improvement in respect of this fruit in Sri Lanka. Imported grafts from America were on Mexican (sub-tropical) roots, it has been found that the productive period of these grafts were not long-lived, they lasted about 8-10 years. Grafts made on local Avocado rootstock have given quite robust and long-lived plants. Avocado is rich in nutritive value and has 30% edible dry matter and is rich in protein than any other fresh fruits. As an easily grown crop it should be cultivated more extensively, not only for export but also to supplement the dietary needs of the Sri Lankans. Avocado is essentially a wet-zone crop it grows best in the mid-country and could be grown at elevations even less than 350 metres, provided the rainfall is not less than 60 inches. The tree is readily propagated from seed which loose its viability quite quickly. Avocado is found growing in most home-gardens in the Mid-country wet-zone they are often self-sown material and unlike Mango is mostly mono-embryonic and therefore show a large variation due to cross-pollination.

Propagation:

Avocado is being propagated both sexually and asexually as in most varieties of fruit-crops. The sexual method is known to produce heterogenous material of no known origin and affects the marketability of the produce and hence commercial Orchards prefer asexually propagated plants. Avocado can be asexually propagated by cuttings and grafts. The most widely used methods of grafting are Side-wedge graft- Whip-graft and Bud-graft. However, the production of a graft by the above gechniques has been found to be time consuming, expensive and requires large Nursery acreage.

Seedling grafting technique:

This technique has been developed in order to produce saleable grafts within a very short period of 5-6 months incorporating a technique developed in Hawaii (1) which has now been modified for easy handling and better results.

This technique has been successfully tried out at the Horticultural Farm, Gannoruwa, Peradeniya, using Avocado seedlings 4-6 weeks old having a stem girth of about 1/2 cm. It has also been found that germinated seed planted singly in suitably sized polythene bags is convenient to handle and enhances the success of the technique almost to 100% apart from the limited space required for such bags (about 9 seedling bagas/sq.ft or about 100 seedling bags/sq.metre) and the time and expense saved is almost 50-75%

Method: (1) Raising of Root-stock plants:

Sprouted Avocado seed are deposited singly in 300 gauge 15 oms x 30 cm. bags in a media mixture of 1:1:2 ratio of sand,coir-dust and top-soil respectively. The seed is buried in the media leaving about 2 cms. uncovered by the media mexture. Seived River-sand is then placed over the media mixture to cover the balance part of the seed left uncovered by the media. (Fig.1). This is essential in applying the original technique, to prevent infection of the scion-union by soil organisms. The seedling bags are watered and allowed to stand in shade. The seedlings will be ready for grafting in 4-6 weeks after planting when the stem of the seedling has attained a diameter of about 1/2 cm.

(2) Selection of Scion-wood.

Two types of scion material can be selected which have a primary difference of age and maturity.

(i) Tender shoots of new flush (3-4 weeks old) at the point of turning green having a dormant apical bud are selected from a selected Mother-tree.

(ii) Twigs of past season's growth (2-3 months old) having dormant apical buds are selected in this instance.

In the collection of scion material care should be taken to prevent dessication of the twigs by exposure and should therefore be well protected during collection.

Techniques of Grafting.

Two methods are possile viz:

(A) Grafting at cotyledon level.

(B) Grafting at a height of 6-10 cms. length on main stem.

(A). Grafting at cotyledon level:

The tender stem (plumule) is cut horizontally at the level of the cotyledons and the base portion is split vertically downwards between the cotyledone to a depth of about 1½ - 2 cms. (Fig.3).

A piece of scion wood of equal thickness as the plumule is selected and trimmed-off its leaves to a length of 12-15 cms. from its apex and the stem cut-off horizontally at the selected length. The base of the scion is now shaped in the form of a wedge about 1½ cms. in length. The scion is now forced into the cleft in the plumule of the cut-back plumule of the seedling. (Fig.3 & 4).

No binding is possible but the scion will be held in place by the pressing cotyledons.

Aftercare:

Watering of the grafted seedling should be carefully done so as not to allow any water to seep into the graft union. The graft should be regularly watered and protected against dessication and also to conserve humidity of the environment. This is done by slipping a polythene bag of sufficient length over the seedling-bag. This cover should be removed occasionally to provide necessary aeration to the plant. The cover should be replaced after drying-out the vapour.

Scion union takes place in 4-6 weeks and thereafter the buds commence sprouting. When the scion has put-forth 5-6 leaves the plant should be

progressively hardened for about 3-4 weeks and is then ready for planting. The percentage of the technique is dependent on the post-grafting care and handling and varies from 40-75%.

(B). Grafting at 6-10 cms. above cotyledons (modified method).

This method is the same as the above, except that the stock is prepared at a height of 6-10 cms. above cotyledon level and bound after insertion of the scion. In this technique the tender stem of the seedling is cut-off about 6-10 cms. above the cotyledons Fig.5) and a cleft made at a depth of about 1½ - 2 cms. downwards in the centre of the stem. The scion prepared in likewise fashion as for cotyledon level grafting is then inserted in the cleft of the stock and bound with polythene strip. Graft union is established in 3-4 weeks and bud-break in scion commences 6-8 weeks later. When the scion has thrown-out 6 - 8 leaves the plant should be progressively hardened and is ready for planting in 20-24 weeks from initial sprouting of the seed.

Aftercare of the graft is as for (A) above.

This technique produces almost 100% successful grafts.

Advantage of Modified technique over basic technique:

1. Easy to handle the grafting process.

2. Eliminates danger of water seepage to graft union.

3. Eliminates the possible infection of graft-union by soil micro-organisms.

4. The higher percentage of sucess is mainly due to the perfect cohesion of the cambial tissue of both scion and stock affected by binding.

Table 1 Comparison of time taken for producing grafts by different techniques:

Method.	Raising of stock plant.	Nursery period of graft.	Root pruning potting, hardening.	Total. Time
Bud grafts	8-10 mths	8-10 mths.	1½-2 mths.	18-22 mths
Grafts	8-10 "	6-8 "	1½-2 "	16-20 "
Seedling graft.	4-6 weeks (1-1½ mths)	2½-3 "	1-1½ "	4½-6 "

Diagrams showing steps in Avocado Seedling Grafting tecniques

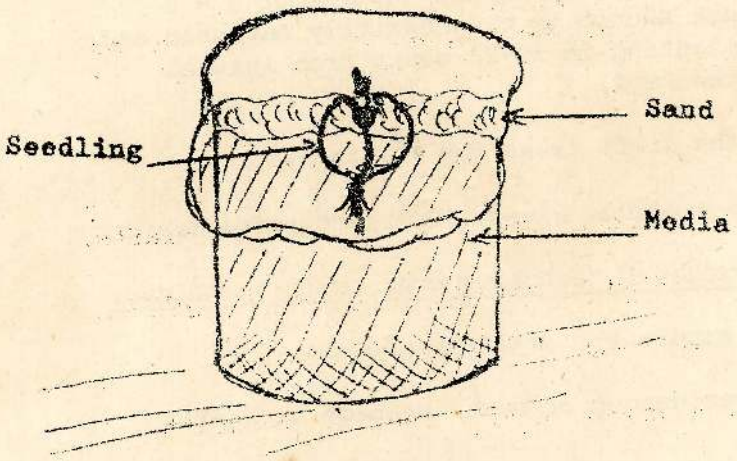

Fig. 1. Method of planting Seedling

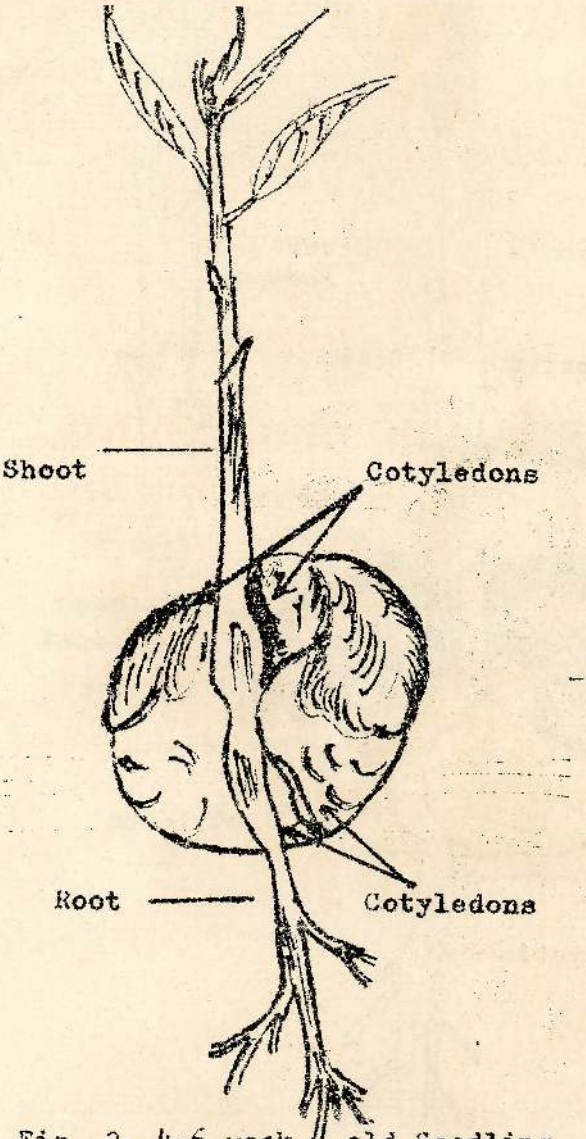

Fig. 2. 4-6 week old Seedling

Avocado Seedling

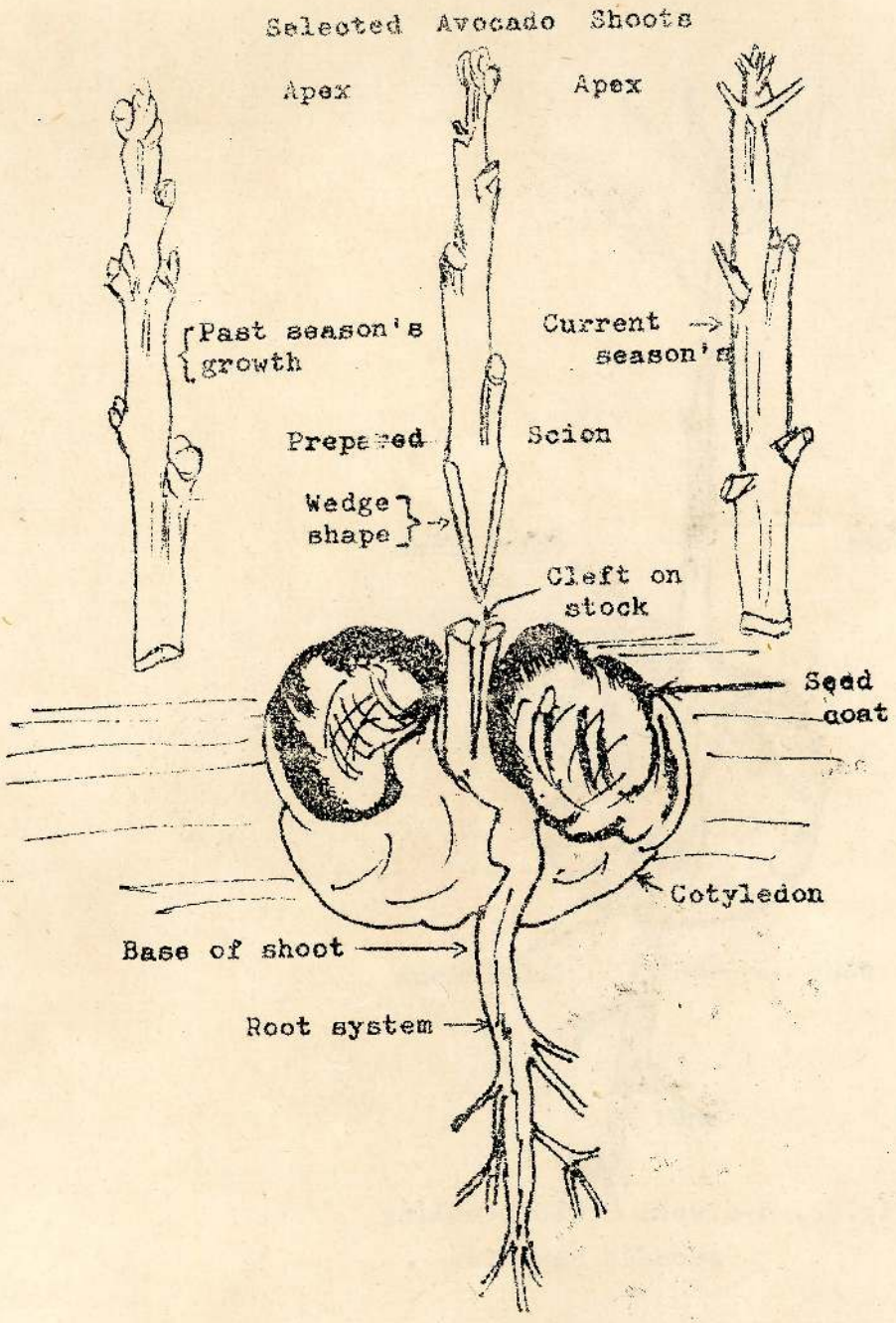

Fig.3 Avocado seedling ready for grafting

Avocado Seedling Grafts

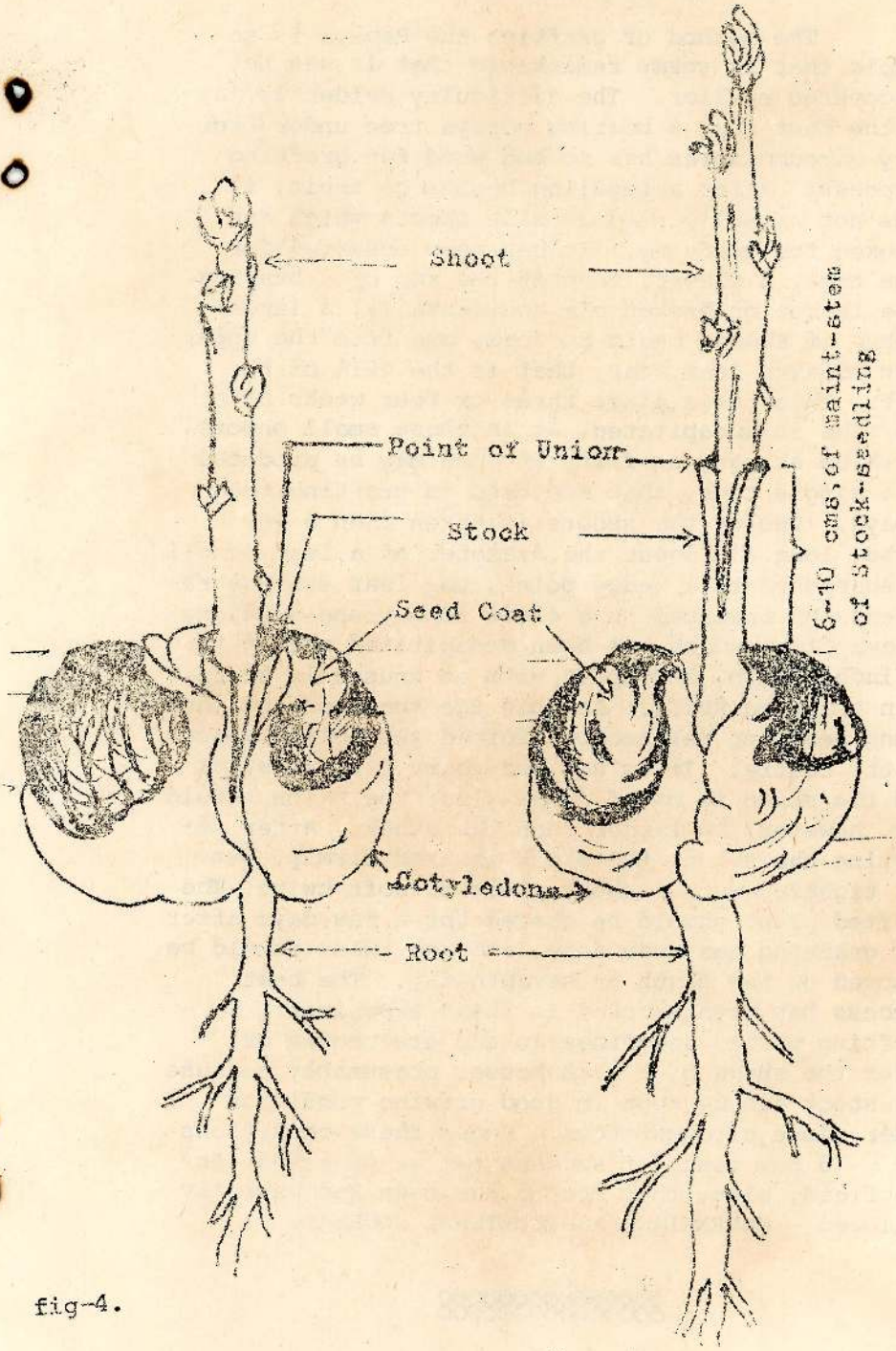

fig-4.

Fig. 5

GRAFTING THE PAPAW

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The method of grafting the Papaya is so simple that it seems remarkable that it was not discovered earlier. The difficulty evidently lay in the fact that a bearing papaya tree under ordinary circumstances has no bud wood for grafting purposes. After a seedling begins to fruit, it does not normally produce side shoots which can be used for grafting. It has been observed for some time, h owever, that if the top of a bearing tree is cut or broken off accidentally, a large number of shoots begin to form, one from the upper part of each leaf scar, that is the axil of the leaf. This takes place three or four weeks after the tree is decapitated. It is these small shoots, of which as many as fifty or more may be produced by a single tree, that are used in grafting the papaya. One of the shoots is taken when a few inches long and about the diameter of a lead pencil is sharpened to a wedge point, the leaf surface reduced, and inserted in a cleft in a young seedling papaya plant which has been decapitated when 6 to 10 inches high, and split with an unusually sharp, thin grafting knife. At this age the trunk of the young seedling has not yet formed the hollow space in the centre. It is not necessary for the stock and the scion to be of equal size; the scion should not, however, be larger than the stock. After inserting the scion, the stock is tied firmly, but not tightly, with a short piece of soft twine. The grafted plant should be shaded for a few days after the grafting has been done, and the twine should be removed on the sixth or seventh day. The best success has been secured in these experiments by grafting potted seedlings in the greenhouse or under the shade of a lath house, presumably because the stock can be kept in good growing condition under these circumstances. Under these conditions 75 per cent, of success can be expected. In the field, also, this method has been successfully followed - QUEENSLAND AGRICULTURAL JOURNAL.

MAJOR BEE PLANTS OF SRI LANKA

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G.A. Lanerolle, A.O. Bee-Keeping Unit Bandarawela.

The bee keeping division has been able to identify more than 250 bee plants in Sri Lanka. It is not possible to list out all those plants in this paper The division hopes to publish a separate booklet for this purpose.

The plants listed out herein are some of the major bee plants found under different Agro Climatic zones of the Country.

1.	*Antigonon leptopus*	- Antignon
2.	*Acacia Sps.*	- Acacia
3.	*Aporosa lyndleyana*	- Kebella
4.	*Azadirachta indica*	- Kohomba
5.	*Albizzia stipulata*	- Mara
6.	*Albizzia lebbek*	- Mara
7.	*Alseodaphne semi-carpifolia*	- Wewarana
8.	*Albizzia odoratissima*	- Suriya Mara
9.	*Acacia columnaris*	- Hinguruwel
10.	*Acacia pruinosa*	- Hingurugaha
11.	*Canthium coromandelicum*	- Kara
12.	*Cocus nucifera*	- Pol
13.	*Chloroxylon swietenia*	- Burutha
14.	*Cordia domestica*	- Lolu
15.	*Cassia siamea*	- Wa
16.	*Cedrella toona*	- Toona
17.	*Derris scandens*	- Kalawel
18.	*Dalbergia pseudosisoo*	- Bambarawel
19.	*Drypetes sepiaria*	- Weera
20.	*Elettara repens*	- Enasal
21.	*Eucaliptus robusta*	- Gamgasa
22.	*E. diglupta*	-do-
23.	*E. toruliana*	-do-
24.	*Elaecarpus serratus*	- Weralu
25.	*Feronia limonia*	- Juul
26.	*Grewia tillifolia*	- Damini
27.	*Gliricidia maculata*	- Makulatha
28.	*Hevea brassiliensis*	- Rubber
29.	*Hedyotis fruticosa*	- Weraniya
30.	*Ligustrum walkeri*	- Bora
31.	*Litsea glaberrima*	- Beeriya
32.	*Lagerstroemia speciosa*	- Murutha

33.	*Mangifera zylanica*	- Etamba
34.	*Morinda tinctoria*	- Ahu
35.	*Memecylon rostratum*	- Kuuratiya
36.	*Madhuca longifolia*	- Gam Mee
37.	*Mesna ferrea*	- Na
38.	*Meliosma arnottiana*	- Nikadawla
39.	*Manilkara hexandra*	- Palu
40.	*Melia dubia*	- Lunumidella
41.	*Mycroglossa zeylanica*	- Pupula
42.	*Neolitsea involucrata*	- Kududawla
43.	*Neolitsea cassia*	- Dawulkurundu
44.	*Nephelium longana*	- Mora
45.	*Nephelium lappaceum*	- Rambuttan
46.	*Ochna wightiana*	- Bokara
47.	*Persia gratissima*	- Alipera
48.	*Pometia tomentosa*	- Galmora
49.	*Pterocarpus marsupium*	- Gammalu
50.	*Pericopsis mooniana*	- Nedun
51.	*Psydium gujava*	- Pera
52.	*Pongamia pinnata*	- Karanda
53.	*Premna tomentosa*	- Seru
54.	*Phyllanthus emblica*	- Nelli
55.	*Ricinus communis*	- *Endaru*
56.	*Spondias pinnata*	- *Embarella*
57.	*Schleichera oleosa*	- *Kon*
58.	*Sapindus trifoliatus*	- *Kahapenela*
59.	*Sesamum indicum*	- *Thala*
60.	*Syzygium arromaticum*	- *Heendan*
61.	*S. cumini*	- *Madan*
62.	*S. zeylanicum*	- *Maranda*
63.	*Semecarpus obscura*	- *Badulla*
64.	*Symplocos spicata*	- *Bombu*
65.	*Santanum album*	- *Handun*
66.	*Strobilanthus Sps.*	- *Nelu*
67.	*Terminalia chebula*	- *Aralu*
68.	*T. belerica*	- *Bulu*
69.	*T. arju*	- *Kumbuk*
70.	*Toddalia asiatica*	- *Kudumiris*
71.	*Trema orientale*	- *Gadumba*
72.	*Tamarindus indica*	- *Siyambala*
73.	*Vitex nugundo*	- *Nikka*
74.	*Vitex pinnata*	- *Milla*
75.	*Ventilago maderaspatana*	- *Yakadawel*
76.	*Vateria copallifer*	- *Hal*
77.	*Walsura piscidia*	- *Kirikon*
78.	*Wendlandia bicuspidata*	- *Sawenidhala*
79.	*Zea mays*	- *Bada Iringu.*

MOLECULAR BASIS OF THE CHROMOSOME, THE GENE AND GENE EXPRESSION

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Cell is the basic structural and functional unit in all living organisms. All cells arise from the division of preexisting cells. However, the first cell or cells had a spontaneous origin and evolution. Nucleus is a normal constituent of all living cells. Chromosomes that are made up of chromatine are confined to the cell nucleus, the number of chromosomes depend on the kind of organism. Here ditary material of an organism is orderly arranged in one or more chromosomes so that the chromosome is a complex and highly ordered organelle Genetic transmission with the behaviour of the chromosomes in meiosis provides the physical basis for Mendelian inheretance where the transmission and continuity of traits from one generation to the next is followed by the determination of phenotypic ratios.

The DNA-histone complex or the nucleosome is the basic unit of structure of the chromosomes. These two components are present in roughly equal amount by weight. DNA or deoxyribonucleic acid is highly stable molecule conserved from one cell generation to the next. DNA is a polyanion with a continuous sequence of acidic phosphate and it is thought to be neutralized and stabilized by the histones with the basic nature that act as polycations.

The structure of DNA which is the molecule in which all precoded genetic information of an organism is stored , was discovered in 1953. Each molecule of DNA is a double helix with 2 strands that are identical to each other and are running in opposite direction. Each strand is a polymer of 4 nucleotide namely Adenine (A), Guanine(G), Thymine(T), and Cytocine (C). Two strands are attracted to each other and held together because there is specific H, bonding between A of one strand with T of the other and C of one strand with G of the other (Fig.1)

G C A T T G
C G T A A C Two strands

Fig. 1. Two strands of DNA.

As a matter of fact the base sequence of one strand is complementary to the base sequence of the other strand. Therefore, each strand has necessary information to determine the structure of the other. Different DNA molecules differ in their length and in sequence of base pairs.

Histones are a single class of proteins but 5 major types have been identified with each type having minor variants in structure but not necessarily so in function. It has been shown that the histones are nonspecific as to DNA nucleotide sequence or to species. Four of the five major histones that are involved in maintaining the structure of the chromosome are named as H_1, H_2, H_3, and H_4 Histones H_3 and H_4 are the most conservative and histone H_1 is the least conservative during the evolutionary process.

The basic unit of structure of chromosome is the nucleosome. The nucleosome consists of a core of eight histone molecules made up of two molecules each of H_2A_1, H_2B_1, H_3, and H_4 (Fig.2) DNA is wrapped arround this core of 8 histones with a stretch of linker DNA to which the histone H_1 is attached (Fig.3) So a nucleosome can be defined as a unit of about 200 nucleotide pairs of DNA organized into a globular structure by two moecules each of the four major histones. The histone H_1 links the nucleosomes with each other to make a chain (Fig.4) the nucleosome is the first stage of contraction above the level of the naked DNA double helix and its formation introduces a sixfold reduction in the length of the DNA strand. An additional reduction in length by fivefold or sixfold can be achieved by grouping of nucleosomes due to the binding action of histone H_1. Therefore, in chromosomes DNA molecules are kept in a tightly compact and organized state occupying only a few microns. On the other hand, it is reasonable to assume that only one double helix of DNA extends from one end of the chromosome to the other.

Existence of genes had been established with the discovery of Mendal's work since 1865. By means of wide variety of physical, chemical, and biological techniques, now it has been shown that relatively small regions of base pairs in the long DNA molecules which form chromosomos function as genes. Furthermore a gene has definite molecular boundaries, a beginning and an end, and a particular sequence of nucleotides in between and it can serve as a template for repli-

cation and transcription. Genes are functional entities of DNA which are not structurally distinguishable. Either the nucleotide sequence of one gene may entirely be included in the nucleotide sequence of another gene or the nucleotide sequence of two or more gnes may be overlapped or the nucleotide sequence of a gene may be independent.

Transcription and the translation are the first and second steps, respectively in a chain of biochemical events whereby a gene gains phenotypic expression through the formation of protein, Each specific protein of a cell is controlled by one or more genes unique for that protein. However, all the genes of an organism are not expressed all the time. Genes are expressed only when it is necessary. Different genes function in different cells at different times, and in different environmental conditions. Therefore, transcription which is the first step of gene expression is a highly selective process copying only certain portions of the genome at any one time.

Proteins are synthesised on ribosomes which are in the cytoplasm of the cell. The coded informations in DNA is sent to ribosome by messenger molecules made up of RNA (Ribonucleic acid) which is complementary to DNA. Therefore, mRNA(messenger RNA) should be synthesised on DNA by copying the necessary base sequence and this process is called transcription. Transcription involves only one of the two strands for any given gene or at any given region of the chromosome. But strand-switching can occur and mRNA for a different gene may be coppied from the other strand. The reaction of transcription is catalysed by the enzyme RNA polymerase When only a portion of a genome is being transcribed selectively, there must be a system to make it fully functional and responsive. A model that explains this selective transcription has been presented in terms of the 'operon' concept in micro organisms. According to this concept (1) there must be someway to repress those genes which are not been transcribed, (2) there must be a mechanism of derepression so that genes can be expressed when it is necessary ; (3) there must be a recognition site on DNA for the RNA polymerase to begin its transcriptional activities; and (4) there must be a termination signal for transcription to stop. The regions

of DNA that determines protein structure are called structural genes. Transcription of these structural genes are controlled by regulatory genes or controlling elements of DNA to which individual structural genes or groups of them are linked. Controlling elements are termed as operater, promoter, and terminater In a negative control system of the operon, the repressor must be removed from the operator region for RNA polymerase to bind with the promoter region to initiate transcription. In a positive control system, a specific protein should bind to the promotoer as a prerequisit for the proper binding of RNA polymerase to initiate transcription. Once the transcription is initiated the RNA polymerase travels along DNA and synthesise mRNA until the terminater sequence is found, which signals the enzyme to dissociate from DNA. The controlling system of selective transcription in micro organisms as described by the operon concept has not yet been found in higher organisms. However, there must,of course, be serveral kinds of recognition sites on DNA for the RNA polymerases, a system for selective transcription, and a termination point for the process in higher organisms too. It is believed that histones are the general repressors of DNA while the nonhistone chromosomal proteins are the derepressors that involve in the promotion of transcriptional process. It is shown that another molecule called heterogeneous RNA (HnRNA) is also involved between DNA and mRNA in the transcriptional process of higher organisms. In this system, first DNA to HnRNA and then HnRNA to mRNA are thought to be transcribed.

The process of protein synthesis on mRNA by converting the information to protein structure with the use of ribosomes is called translation. Proteins are linear polymers of aminoacids. The sequence of nucleotides in genes codes for the sequence of aminoacids in proteins. Each aminoacid in protein is coded by three adjoining nucleotides in DNA. This set of three bases is called a triplet. Front end,the leader and the tail end, the trailer of the mRNA are not translated during the translational process. Leader sequence is the binding site of ribosomes. Ribosomes bind at the leader sequence and travel along the mRNA passing triplets with addition of aminoacids in a sequence coded by the triplets until a nonsense

triplet is found which signals for termination. Thus the final product of a gene, the protein, is synthesized in order to carry out the gene expression.

The knowledge of gene, gene expression, and other related techniques open the door for genetic engineering, where genes are manipulated. In the near future, agriculture seems to be the one that is likely to be benifitted most due to the impact brought about by genetic engineering.

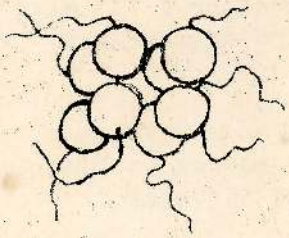

Fig. 2. The nucleosome without DNA

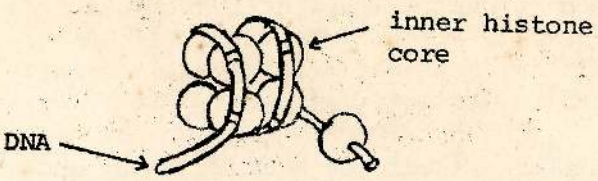

Fig.2. Single nucleosome.

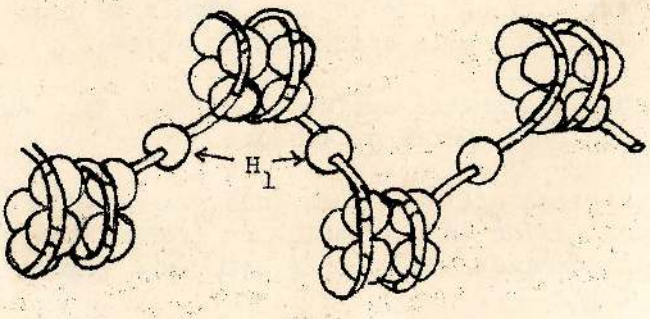

Fig.4. A chain of our nucleosomes.

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