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Technical report: Efficacy Evaluation for the Purposes of Pesticides Registration in the Republic of the Philippines*

Prepared for the Government of the Philippines
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Brian B. Watts,
consultant on pesticides

United Nations Industrial Development Organization
Vienna

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REPORT TO UNIDO ON EFFICACY EVALUATION FOR THE PURPOSES OF PESTICIDES REGISTRATION IN THE REPUBLIC OF THE PHILIPPINES

BASED ON THE WORK OF BRIAN B. WATTS, UNIDO CONSULTANT

ABSTRACT

The Consultant visited the Republic of the Philippines from 28 January 1985 - 10 February 1985 to evaluate the procedures used for developing data on efficacy in support of pesticide registration in that country.

A number of research stations were visited where discussions were held with scientists who conducted trials. Also data evaluators were visited. Industry met with the Consultant and some useful discussions took place. Some recommendations are made to modify the procedures.

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INTRODUCTION

Mr Brian B. Watts of the New Zealand Ministry of Agriculture and Fisheries and Registrar of the New Zealand Pesticides Board visited the Philippines from 16 - 19 December 1984 and from 28 January - 10 February 1985 as a UNIDO consultant. His terms of reference were to:

1. Assist authorities in amending guidelines, registration requirements and labelling to conform with the agreements on harmonization.

2. Assist the regional co-ordination unit in organising regional data on registration.

3. Assist the Regional Coordinator in preparation of an Aide Memoire for the second harmonization meeting planned to be held in September 1985.

With regard to terms of reference 1 this was after agreement with the respective authority, the Fertilizer and Pesticide Agency (FPA) restricted mainly to efficacy data. An Aide Memoire for the proposed meeting at Seoul in September was prepared and other aspects of pesticide registration were discussed with ADB Consultants working at FPA.

ACKNOWLEDGEMENTS: Grateful thanks are due to Mrs C. Gaston and her staff for their help given to assist the Consultant in his task and for arranging appointments to visit various organisations. Professor Sanchez, and officers of the University of the Philippines, Los Banos are also to be thanked, as are staff of the Bureau of Plant Industry both in Manila and at Maligaya. Acknowledgement is given to the help provided by the Agricultural Pesticide Institute of the Philippines, and particular thanks are due to Mr L . Villa-Real and the two ADB consultants Mr E. Johnson, and Mr Roy Pavey for help given.

1. EFFICACY EVALUATION

1.1 Introduction

Although considerable progress has been made in the use of other than chemical methods to control pests, diseases and weeds, nevertheless in many cases pesticides offer the only satisfactory means of limiting losses. It is necessary for regulatory authorities to assess the efficacy of the particular pesticide for which registration is sought, and in making this assessment to satisfy themselves that the efficacy data provided support the proposed label claim. In this report efficacy evaluation is a term used to cover the evaluation of pesticides for both efficacy and safety to the crop.

1.2 Factors In Efficacy Evaluation

- the Draft FAO Guidelines on developing Efficacy Data for Registration list the following factors which should be taken into account when evaluating efficacy.

a. The effect of the pest organism.

b. The reliability, duration, and consistency of protection or other intended effects, appropriate to the desired crop protection objective at the various stages of the pest and/or of the crop.

c. The effects on quantity or quality of the yield of treated plants or plant products.

d. Safety considerations, to the crop (including different cultivars), to animals or to the substrate to be treated.

e. Comparison with a reference product or normally accepted practice.

f. The compatibility with different cultural practices and other crop protection measures under the conditions of use envisaged.

g. The effect of variables, such as climate, temperature, humidity, soil etc, and in the case of baits, acceptability by the pest organism.

h. Advantages of the product or its manner of use which may compensate for any deficiencies in level, duration or consistency of protection or other intended effects.

i. Undesirable or unintended side effects, e.g. on beneficial and other non-target organisms, on succeeding crops, other plants or parts of treated plants used for propagating purposes.

1.3 Role Of Efficacy Testing In Registration

The role of efficacy testing in the registration process is to enable the registration authority to assess the benefits of the pesticide. In order to do this it is necessary to carry out field trials under practical conditions of use. The test procedures, the design of the experiment and the reference product should be discussed with the registration authority, or should follow guidelines set and agreed by that authority. The efficacy evaluation should primarily be based on the data in the dossier submitted by the applicant. Not only data in the country in which registration is sought is required but also relevant data obtained in other countries could be taken into account and accepted as a part of the efficacy evaluation, provided these data were obtained by internationally recognised, and harmonized evaluation methods.

1.4 Transportability of data

In 1977, the Ad Hoc Consultation on Harmonization of Pesticide Registration Procedures arrived at the following conclusions:

(a) Fewer efficacy trial tests should be required for pesticides already registered in another country for the same uses in similar agricultural and ecological conditions.

(b) Fewer efficacy tests should also be necessary for pesticides already registered for use against a particular pest or type of pest of some main crops in a country when registration is required for similar uses on additional crops.

(c) Fewer efficacy tests, if any, should be required for pesticides already registered for which there are minor changes in formulation, and in these instances laboratory bio-assay tests in comparision with the standard material may be sufficient.

(d) Registration authorities should be prepared to consider data obtained under comparable condition from field trials in any country provided that these data are generated, using recognised test methods and provided that reasonable scientific standards are met.

The second Harmonization meeting held in 1982 supported the above concepts as well as recommending to FAO that encouragement be given to appropriate regional organizations and institutes to establish programmes for the preparation of guidelines for efficacy evaluation of pesticides for the control of pests, diseases and weeds of the major crops in tropical and sub-tropical regions.

1.5 Standard Test Protocols

A number of organizations both international and national have developed guidelines for efficacy evaluation. Possibly the best known is that of the European and Mediterranean Plant Protection Organization (EPPO). In addition a number of countries have published their own methods or have developed methods for use within the country for the development of efficacy data.

It was reported at a recent (December 1984) meeting of the Expert Group on Pesticide Registration Requirements that FAO will be considering entering into a contractural arrangement with EPPO to develop some efficacy tests protocols for some of the major pest on crops in tropical areas.

The above meeting finalised FAO Guidelines on Efficacy Data for the Registration of Pesticides for Plant Protection. Some of the general requirements for design and reporting on trials are quoted in Annex I.

2. SITUATION REGARDING EFFICACY TESTING/REQUIREMENTS IN THE PHILIPPINES

2.1 Requirements for Efficacy Data

This requirement is a major input into the registration process. For herbicides, replicated trials have to carried out in the Philippines for two seasons in two locations while for insecticides replicated trials have to be carried out for one season in two locations.

Data developed by members of the Pesticides Industry is not acceptable by itself for the purposes of registration. It may be used to a limited extent as support data for trials carried out by research institutes. Data developed by the International Rice Research Institute (IRRI) are also not acceptable for registration purposes.

2.2. Test Protocol Guidelines

The FPA has developed Guidelines for Pesticide Biological Efficacy Evaluation. These guidelines cover the major subjects of experimentation, experimental design, methods of assessment for insects, nematodes, weeds, diseases, reporting of data plus a number of tabular appendixes containing forms and arithmetical tables. (See Annex II). The crops covered include rice, corn, cabbage, tomatoes, cotton, sweet potatoes, mango, field legumes, tobacco and potatoes.

A revision of the guidelines (Annex III) for rice, corn, and vegetables, (those foods included in Government

supported food programmes) has been proposed by the National Food and Agricultural Council Integrated Pesticide Technical Committee (IPTC) and will shortly be submitted to the Pesticide Technical Advisory Committee (PTAC) and Industry for comments. Agreement has not yet been reached on standard methods of assessment, but it would seem that agreement could be close to hand. No protocols appear to be available or at least were not sighted by the Consultant for testing efficacy on plantation crops such as bananas, and pineapples but it is understood that the plantations concerned have their own procedures.

2.3 Organizations Carrying Out Research

2.3.1 Industry

In the view of the Consultant some companies have research and development personnel of sufficient expertise, and in sufficient numbers to carry out efficacy trials and a number of them are doing that. However, as previously stated such data is not acceptable by itself for registration purposes.

2.3.2 Government/Semi-Government Institution

There are a number of research stations operated by the Bureau of Plant Industry (BPI) throughout the Philippines. Many if not all of these stations have research personnel who are capable of and who do carry out trial on behalf of Industry. In addition there are a number of other research institutions such as the Tobacco Research Station, the Cotton Research Institute who may do specific tests on a specific crop or a particular problem. Scientists at the University of the Philippines also carry out efficacy evaluations.

In the case of BPI the usual procedure is for the company to enter into a memorandum of agreement with the Head Office and then to approach an individual researcher to have the work done. Where BPI is not involved it seems that the initial approach would be direct to an individual researcher after which a contract may be drawn up.

The fees charged are dependent on the size of the trial, the number of treatments, the number of replications, and could range between 5000 and 25000 pesos (approximately $250.00 - $1250.00 US) per trial per crop.

2.4 Efficacy Waiver Procedures

In July 1978 that is one year after the registration scheme commenced a list of crops was prepared by FPA for which it was possible to waive the requirements for effi-

cacy data. The original list showed pesticides and crops only and was intended to facilitate registration of those pesticides for which there was a known effective control spectrum. This list is still in operation and to be eligible for inclusion on the efficacy waiver list the registrant must show the formulation for which registration is sought is identical or has very similar specifications to a product already on the list. The registration sub-committee determines eligibility of the request for inclusion on the list following the evaluators comments.

The waiver list is being refined to specify individual pests on individual crops and particular pesticides eligible for the waiver. The revised list has been completed for herbicides and fungicides but is still to be finalised for insecticides. Until this is finalised there are many labels which cannot be approved. (See para 4.1).

There is a complete waiver on efficacy data requirements, in force for household pesticides both proprietary (those on patents) and commodity products.

Because the pesticides on the waiver list are generally older materials they are therefore mainly commodity products.

2.5 Commodity and Proprietary Status

Although not strictly within the terms of reference of the Consultant, nevertheless because classification into a commodity or proprietary product has such a major effect on the data requirements the subject is addressed. At the moment the decision as to whether or not a pesticide is a proprietary or a commodity product it is made when the application comes into FPA. Various publications (Hubert Martin, Farm Chemical News) are consulted and if it is found that 17 years have elapsed since the pesticide was recorded as being first available it is then determined that the product is a commodity one.

If a product is classified by FPA as a commodity one the company can challenge the decision on the production of the appropriate patent papers.

Confidentiality of data is respected. Data owned by the first registrant is not used in support of the second applicant apart from specifications to see whether it qualifies for the efficacy waiver. Fewer data are however required for commodity than proprietary product.

2.6 Evaluation of Data/Trial Protocols

There are four types of experimental use permits in operation in the Philippines and the same initial evaluation process is applicable to the all. See Annex IV for the Data Requirements for Experimental Use Permits.

The type of experimental use permit are:

Type IA Coded compounds in the initial stages of development to be tested within the company premises.

Type IB Is required for coded pesticides tested outside the company premises whose active ingredient has an acute oral LD50 value greater than 50 mg/kg.

Type II Includes those pesticides whose efficacy data generated may be used for registration purposes.

Type III Is required for all fully registered pesticides to be tested for additional uses.

The research outline format is submitted to FPA in all cases (see Annex IV). These details are sent to an evaluator for comment not withstanding that fact the trial layout required to be followed is the FPA trial guidelines (See Annex II). The evaluation of the application for an EUP is discussed at the Registration Subcommittee of PTAC and the company is informed of the result. The process seems to take up to 45 days provided there are regular meetings of the Registration Subcommittee but if they do not meet then no decision can be made until they do. This may cause a delay and thus the loss of a seasons trials. Toxicological data are summarised by the efficacy evaluator at this stage and no detailed evaluation of this is done because the main emphasis of the evaluation at this stage is on efficacy. However the summary is discussed at the Registration Sub-committee meeting.

There is no requirement for the company to submit efficacy results from any EUP trials to FPA. Products do not go through the EUP process as far as efficacy is concerned if they qualify for waiving of efficacy requirements.

Data developed at the EUP II stage, by institutions or plantations are sent to FPA who then send the data to the appropriate evaluator. It should be noted that if the applicant deviates from the trial outline proposed and agreed to by the Registration Subcommittee the trial results could be declared invalid. Toxicological data are sent to the health evaluators. The draft label is now also submitted with the application, this being a new requirement since September 1982. The label is also evaluated at the same time as other data supplied in support of registration.

The Registration Subcommittee submits its recommendation for registration to PTAC who advise FPA according.

2.7 Proposals for Accredited Researchers

It is understood that there have been problems with the quality of some efficacy data due to the possibility that a researcher may be carrying out trials outside his particular discipline, for example an entomologist may be doing fungicide trials. Proposals have been put forward by PTAC to accredit researchers in accordance with the guidelines attached (see Annex V). A final decision has not yet been made on this proposal.

2.8 Registration of Other Chemicals

The law requires surfactants, plant regulation, synergists and wood preservatives to be registered and guidelines have been developed relating to the data requirements (see Annex VI).

2.9 Industry Discussions

In discussions with Industry the view was expressed that some companies have resources which would enable them to carry out efficacy trials which could be used for the purposes of registration or to obtain an extension to allow a new label claim. Some companies however prefer to have plantations and research institutes do the testing as is the case at the present.

3. PROPOSALS FOR EFFICACY TESTING AND OR REQUIREMENT IN THE PHILIPPINES

Apart from one major proposal relating to a modification of the clearances most of the proposals relate to changes in procedures to simplify and speed up consideration of efficacy submissions.

3.1 Types of Clearance

It is recommended that the classification of EUP's be reviewed. It is the Consultants view that the number and type of EUP's could be restricted to cover two main situations.

Trial clearances (not for sale)
Limited clearance (for limited sale)

Proposed guidelines are attached (Annex VII) listing the suggested requirements for these two types of clearances.

3.2 Proprietary/Commodity Products

It is a view of the Consultant that consideration about the patent status of a particular pesticide should not be part of the registration process. Patent considerations should be left to the industry to resolve and take action as appropriate in the event of a the breach of same. The following proposals are put forward, to remove patent consideration as a parameter, in the registration process.

Commodity Product

This would be defined as a product the active ingredient of which was commercially available either in the Philippines or another country 15 years prior to the current year i.e 1970 in the case of year ending 1985, 1971 in the case of 1986 and so on.

Proprietary Product

This would be defined as a product the active ingredient of which was commercially available in the Philippines or in another country from 1970 onwards, this date to shift forward by one year each year.

For registration of commodity products fewer data are required than for proprietary products unless there is some known concern (usually of a toxicological nature) while for proprietary products the full registration package is required.

3.3 Waiving Of The Need To Develop Efficacy Data

As a general rule efficacy data requirements could be waived for all commodity products (as defined above) provided the label claims are the same as those included on the waiver list. Some proprietary products may also be eligible for waiving of efficacy data depending on what is available in the published literature about efficacy. The present waiver list should be redefined and rewritten on the basis of accepted label claims for particular formulations. If the list contains a waiver for a specific crop/pest combination the second product should also be eligible for such a waiver. e.g. If product A has a waiver for brownleaf hopper on rice, and product B (same formulation as A) is granted registration for leaf borer on rice, then both A and B should be allowed identical label claims. It is also proposed that similar formulations be eligible for inclusion on the list, not necessarily only identical ones - for example wettable powders, "flowables" and possibly water soluble powders could be considered to be similar in most cases but emulsifiable concentrate or granules would not be and would therefore not qualify for a waiver of the efficacy data.

A change in concentration of the same formulation for example from a 300 g/l EC to a 600 g/l EC should not require new efficacy data provided the end use concentration is the same. In some cases claims for control of the same pest on different crops should be eligible for efficacy data waiver but this would need to be decided on

an individual crop basis. There may be need to test on different varieties and cultivars. Generally however it could be assumed that there would be little difference shown by different varieties to the same formulation of the same pesticide.

3.4 Industry role in efficacy testing

As there appears to be considerable expertise in industry and as there is a reported high workload on institutional researchers it is recommended that data generated by industry should be eligible for use by itself for registration purposes. For those companies in industry without the resources to do trials, institutional testing could still be used. Testing by either industry or institutions must of course follow the prescribed test protocols, and if these are not followed the data would be invalid.

3.5 Accredited researchers

This concept is not new, it was first discussed in 1977. It is the Consultants view that as trials must be carried out in accordance with specified procedures it should not be necessary to accredit individual researchers. It is entirely reasonable that a person with considerable trials experience would be able to carry out trials on herbicides, fungicides or insecticides and indeed this is what is currently happening in a number of countries. If faulty data are presented then the evaluators should be able to detect this and therefore the results would not be able to be eligible for use for registration purposes. Most emphasis should be placed on data, not on the qualifications of the researcher and therefore the Consultant could not support the concept of accrediting individual researchers.

3.6 Clearance of Experimental Use Permits Trials Protocols by FPA Evaluators

(a) EUP (Type I, Type II). It is the view of the Consultant that there should be no need for trial proposals to be even referred to evaluators for consideration at this stage. The summary of the toxicological data (see para 2.6) should be sent to the Health Authorities for reference but consideration of these data should not delay the issue of the EUP. A number should be assigned by FPA to the EUP which should be recorded in numerical order.

(b) EUP Type III.

There should be no need for evaluators to clear these as once again the trials must be laid down in accordance with FPA guidelines and if the individual com-

pany does not do this then the data would not be eligible for use.

3.7 Consideration of Applications for Registration by FPA Evaluators

This is the most important aspect of the registration process and could either be done as is now by a meeting of the Registration Subcommittee, or possibly as a better alternative sending in written comments for collation and action by the FPA Secretariat. The Secretariat would collate the comments from the evaluators and present these in a schedule to PTAC or some other advisory committee. It is not necessary in the Consultants view for evaluators to be members of PTAC. The Consultant considers it desirable that at least two evaluators consider trial data for herbicides, insecticides and fungicides.

3.8 Private Testing Companies

The concept of a private testing company consisting of trained researchers should be explored. It was understood that there can be considerable pressure on research workers employed by institutions due to the limited number of people that may be available. Private testing companies would need to follow guidelines and any other procedures laid down by FPA otherwise data generated by them on behalf of their industry clients would not be acceptable for consideration.

3.9 Test Protocols

The present FPA guidelines on efficacy testing are excellent but are now being revised for rice, corn and vegetables (crops on the government food programme). It is suggested that this revision be further expanded to include other crops at the earliest opportunity. The FPA guidelines will be drawn to the attention of EPPO for use by them in the production of their Guidelines for efficacy testing in tropical areas (see para 1.5).

It is also suggested that consideration should be given to developing guidelines for efficacy testing in plantation crops.

3.10 Inclusion of Registered Pesticide in Government Food Programmes

As the purpose of registration is to provide the registration authority with information that the product will do what the label says it will when label directions are followed then it is strongly recommended that all registered products should be included in a list of pesticides eligible for use in a particular food programme. If

there are any advantages such as cost, availability of any particular pesticide it should be left to extension workers to point out the costs/benefits of that pesticide to the individual farmers.

3.11 Testing of Other Chemicals

In the Consultants view the registration of wood preservatives and plant regulators should be treated in the same way as other pesticides. In the case of surfactants however the situation is somewhat more complex. Surfactants which form part of the formulation do not need to be registered but where they are added separately to the ready to use formulation then registration of this use is required. Efficacy, tests to demonstrate effectiveness and lack of phytotoxicity for each use recocommended on the label must be provided to FPA. Trial protocols as laid down must be followed, and only when satisfactory trial results have been submitted would label claims, both on the pesticide container and the surfactant container be accepted.

4. LABELS

4.1 Situation

A number of labels were studied from the point of view of use directions. The labelling guidelines covering directions for use are as follows:

2.a Directions for use must be in English or Filipino and must state the names of the crops to be protected, pests and weeds to be controlled, amount recommended and frequency of application. Only registered crops must be stated.

2.b Re-entry period (for insecticides unless deemed necessary for other groups).

2.c Pre-harvest interval.

2.d Restrictions and limitations if there are any.

The labels are now being cleared with the application for registration but this is only a relatively new procedure (see para 2.6). There was considerable variation in the few labels that have now been approved which points to a more uniform approach being needed.

4.2 Proposals for amendment to Labelling Guidelines

4.2.1 General Statement

This should appear on the front panel. A statement of the nature "For Control of Insect Pests in Rice Cotton and

Bananas" should be used. This draws to the users attention the crops on which the pesticide is registered and therefore can be used. It is not required that the individual pests be specified in this general statement but in some instances it may be useful to say "For Control of Grass and Broad Leafed Weeds in Rice" as some herbicides do not have activity against a particular class of weed.

The general statement should only include crops for which registration has been granted and not include any reference to crops not registered.

4.2.2 Use of Tables

A tabular format for use directions is usually easier to read.

However any phrases or limiting comments must be short, clear and concise.

4.2.3 Crops to be Specified

Each crop should be specified and each specific pest listed unless there is some data to show that a more general statement could be used such as caterpillars on crucifers. However in most cases crop and pest specificity will be called for.

4.2.4 Measuring devices

In the absence of a commonly available measuring device it is the Consultants view that the tablespoon should be considered as the preferred standard. While proposals have been put forward to use the cap of a bottle as a measuring device difficulties in avoiding skin contact with the concentrate when pouring from the container and the disfiguring of the label by drips when the container lid is replaced are two of the main reasons why this proposal is not supported. It is however recommended that emphasis be placed in extension programmes on safe use to keep a special tablespoon for the purpose of measuring pesticides. This special spoon could be identified by a hole in the handle or even by bending the handle and could be tied or fixed to the sprayer. The standard abbreviation should be TBSP and each label should have the metric capacity spelt out, e.g.

Liquids: 1 TBSP = 15 ml

Solids: 1 TBSP = xg

x would vary depending on the bulk density of the solid but the company would advise of the weight in one tablespoon with a liquid capacity of 15 ml as part of the registration requirement.

4.2.5 Use of common names for pests

Common names of pests should be used to completely replace scientific names. The Consultant feels that FPA should adopt standard common names for insects and weeds after these have been agreed by the relevant professional societies, if they do not already exist. Standard common names for diseases may pose some problem but it is probable that these already exist in individual situations. The practice of showing scientific names only for weeds as has been noted on some of the labels is in the Consultants view virtually meaningless to the end user.

4.2.6 Pre-Harvest Intervals Restrictions and Limitations

These, if required, must be close to the directions for use panel. Pre-harvest intervals may need to be shown only in special circumstances.

These cases will need to be considered on a case by case basis. A proposed amendment to the labelling guidelines relating to directions for use is attached as Annex VIII.

5. PROPOSALS FOR THE REGION

The above proposals would generally be applicable both to those countries who are members of RENPAF and to other countries who operate a registration scheme. It is suggested that the proposals in this report could be put forward as a working paper on efficacy for discussion at the proposed Harmonization Conference planned to be held in Korea in September 1985. Of all the data packages, that relating to efficacy is probably the most difficult to reconcile as far as transportability is concerned. Thus a considerable amount of effort and use of resources, which could, perhaps be better used for more rewarding research, is often expended in countries to develop efficacy data. Every effort should be made to develop as quickly as practicable test protocols applicable for tropical areas and which when followed could be used in countries other than those in which the results were developed to permit the transportability of efficacy data. The work of FAO and negotiations with EPPO in the development of these standard protocols should be strongly encouraged.

ANNEX I

PORTION OF DRAFT FAO GUIDELINES ON EFFICACY DATA FOR THE REGISTRATION OF PESTICIDES

General Requirement for the design of the Efficacy Trial Programme

Only basic requirements of a general nature can be given. The design of any experiment, the required plot size and the methods for the evaluation have to be adapted to the specific pest/crop combination and the agricultural practices concerned. More detailed information on this can be found in specific internationally or nationally accepted guidelines.

Trials are in principle carried out in the field. However, if the test product is to be used on a glasshouse crop, the trials are carried out under glasshouse conditions close to those of practical use.

The test programme and the documentation should be sufficiently comprehensive to allow a thorough evaluation of the efficacy of a plant protection product under study. The trials in this programme should be designed in such a manner, the pesticide concerned applied and results evaluated in such a way that a reliable judgement can be made on the efficacy of the pesticide under the conditions prevailing in these experiments.

The test programme should not only include the application of the pesticide in a typical or an "average" condition prevailing in regions in which the use is intended, but the performance of the pesticide should be studied in a range of conditions prevailing in these regions during the periods of the year the pesticide will be used.

Such programmes including a range of conditions will enable the evaluation of possible differences in performance of the pesticide applied under various conditions. These differences can arise from differences in climate, agricultural practices, crops and cultivars of crops grown or pests and strains of pests that occur. The test programme for a pesticide under study should always include supervised trials on main cultivars currently grown in regions where the use of the product is intended. Where relevant, the crop safety should be investigated at rates of application higher than recommended, as well as at the recommended rates.

The number of sites in which supervised trials should be carried out with a pesticide used on a specific pest/crop combination for which an authorization is requested is dependent on

the extent of variations as mentioned above (which should be covered) and on the predictability of the occurrence of the pest or disease.

As a general rule, replicated trials on annual crops should be carried out at at least eight-ten sites in any one season. In large perennial crops such as fruits, owing to the difficulty of acquiring adequate sites, the number of sites may have to be confined to three-five.

Where a pest is not generally abundant or the distribution of the pest population is rather uneven, a larger number of sites may be advantageous. With soil-applied chemicals, it is essential to spread the experiments over a range of soil types. This is particularly important if the pesticide may be used on rather "extreme" soil types, e.g. soils with a high organic matter content such as peat soils or very light sandy soil types. If there is any likelihood of use on such soils they should be included in the test programme.

In order to cover to some extent the variation in climatic conditions in different years, the test programme should normally be carried out in at least two successive seasons.

1. Guidance for designing and reporting individual efficacy trials

1.1 Background and design of individual trials

1.1.1 The selection of trial sites

1.1.1.1. Field trials

Great care is needed in the selection of test sites. The sites should be as level and uniform as possible and representative of the conditions where commercial use is anticipated. Sites with irregular soil conditions should be avoided. The pest, disease or weed which forms the object of the efficacy test should occur in a uniform pattern over the site or should be expected to become uniformly present during the trial period. With soil insects or nematodes in particular, estimates of numbers present and uniformity should be made before the start of the trial. Special conditions may favour the development of particular target pests or diseases.

When selecting a site, the preceding crop situation should be known and taken into account: A single preceding crop, on which only uniform treatments were applied, should have been grown over the whole area of the site.

Sites at field edges, or near ditches, trees, hedges or other obstacles should in general be avoided, as they are subject to interfering "edge" effects from those obstacles. Edge effects may however sometimes be exploited especially when

the pest organism concerned prefers the field-edges rather than the middle of the field, but the trial lay-out should then be specially designed for this situation.

It is usually desirable to site the experiment towards the centre of a normal commercial crop. If this crop has to be treated with a pesticide which may interfere with those under study in the experiment, then a sufficient margin of untreated crop should be left in the immediate vicinity of the experiment. If the trial consists of repeated blocks which follow each other in the direction of drilling, spraying or other treatment of the crop, it may be helpful to have a gap between the blocks to allow for turning the supply of the pesticide on and off and for lining the apparatus up with the next plot or sub-plot.

1.1.1.2 Trials on glasshouse crops

In the glasshouse, the same general principles apply. If products with high vapour pressure, fumigants, aerosols or fogs are tested, separate glasshouses or glasshouse compartments should be used for each treatment.

1.1.2 Biology of pests, diseases and weeds

Experiments for efficacy testing of pesticide products should be designed and treated, taking into account adequate knowledge of the life history and behaviour of the pest, disease or weeds to be controlled. The timings and the mode of application of the plant protection chemical should be determined by the behaviour of the organism in question. Also the mode of action of the pesticide may influence the timing and methods of application. The evaluation methods may need to be adapted to the mode of action of the pesticide under study. Especially when a pesticide may show "delayed" effects, the observations and assessments should be designed to reveal such effects. It is also important that the experimental crop should be sown and treated similarly to a commercially grown crop, e.g. late sowings or excessively sheltered sites should be avoided since such conditions may be quite atypical and not representative for prevailing growing conditions.

1.1.3 Lay-out of individual trials

The design of a trial intended for efficacy evaluation should permit a statistical evaluation. The design, however, should not be made any more complicated than is compatible with the immediate object of the test. Multi-factorial designs should in general be avoided.

Usually a randomized block design is adequate, comprising in each block the pest control chemical(s) to be evaluated, the reference product(s) and in general a non-treated plot, distributed at random in the block,

the blocks being repeated as many times as there are replications (in most cases 4-5).

If it is necessary to introduce in to the experiment other factors in addition to the treatments of the pesticide(s) under study at the recommended dosage rate, e.g. various times of application or other dosage rates, this can be accomplished by splitting the main plots into sub-plots, provided that the size of the sub-plots is still sufficient to allow a reliable evaluation.

Although in many cases the inclusion of non-treated control plots is essential, it has to be recognized that in some particular situations the lay-out of non-treated plots within the randomized blocks may give rise to disadvantages due to extensive interference between non-treated and treated plots. Examples are efficacy trials for fungicides with a so-called "preventive" action on susceptible cultivars of potatoes or apples aiming to control late blight and apple scab respectively.

It may sometimes be necessary, in order to avoid heavy loss in crop growth on the trial plots or in the next year's crop, to discard the non-treated plots from the experiment shortly after the occurrence of the pest or the disease becomes obvious. The initial non-treated plots are then sprayed taking due care to avoid drift onto treated plots.

In the case of herbicide trials, efficacy tests (on weed control) and selectivity tests (for crop safety) should be considered on a separate but equal footing. In particular, for selectivity evaluation, it is desirable to test at least one dosage rate higher than the recommended rate, and to use land which is as free from weeds as possible.

1.1.4 Choice of reference product

Wherever feasible the reference product chosen should be one which has shown satisfactory results in practice; its mode of action should be the same as or similar to that of the test product.

1.1.5 Plot size and shape

No general rules can be given on the most suitable plot size, which depends on the particular combination of crop, pest or disease situation.

In orchard trials or trials on similar tree crops, it is desirable to have 4-6 trees per net plot to allow for variability between trees. In agricultural crops the minimum plot size will probably be between $10m^2$ (e.g. 5 x 2m) and $100m^2$ (e.g. 10 x 10m). The minimum plot

size in very uniform vegetable or flower crops may be smaller but only in cases where internal interferences can be avoided.

The mobility of pests and lateral spread of treatments may considerably influence the plot size. Also the available apparatus for spraying or other mode of treatment and for harvesting may require an increased plot size.

Since guard rows often have to be included, the plot size should be sufficiently large to allow for net plots on which periodic sampling and evaluation of the crop yield at harvest can be carried out.

1.1.6 Number of replications

The number of replications to be included in one trial is dependent on the following factors:

(1) The likely magnitude of experimental variance.

(2) The number of treatments. The fewer the treatments, the more replications are needed to give an acceptable estimate of variance.

In most cases 4-5 replications should be sufficient to give a reasonable estimate of the variation, but in special circumstances 3 may be acceptable. An erratic distribution of the pests, diseases or weeds over the experimental area will call for a greater number of replications. In trials on glasshouse crops, if separate glasshouse or compartments have to be used (cf. section 5.1.1.2), replications may be reduced to three or replaced by replications in time.

When crop yields are to be evaluated, replications should be sufficient in number and the plot size large enough to offset the variability in crop yield due to variation of soil or other environmental factors over the test area.

In the development stage of a pesticide, manufacturers often carry out a considerable number of trials with a simpler design for demonstration purposes (often unreplicated and without, or with only a small, non-treated control area). Data obtained in such trials may provide valuable additional information for the authorizing agency, but these trials cannot replace specific efficacy evaluation trials.

1.1.7 Application of the pesticides

The equipment used should give an even distribution of the pesticide product over the plot. The type of equipment used, which should where possible be similar to that currently used in practice, should be recorded; when relevant, information should also be provided on operating conditions (e.g. type of

nozzles, operating pressure in kP), as well as any deviations in dosage of more than 10%.

The type, time and dosage of the pesticide application will generally be as proposed by the applicant. Precautions should be taken to ensure a minimum of interference with other pestticide applications.

1.1.8 Meteorological data

In the field, weather conditions around the time of application, precipitation (type and daily amount in mm), temperature (daily average, maximum and minimum in ^{o}C) should be recorded on the trial site or obtained from a nearby meteorological station. Extreme weather conditions such as severe and prolonged drought, storms, hail, etc., which are likely to influence the effect of the product(s) to be tested should also be recorded. For trials on glasshouse crops, temperature and humidity should be recorded throughout the trial period.

1.1.9 Assessment of efficacy

Observations should be scored using convenient quantifying methods such as the quantity and quality of yield, percent of control and extent of remaining pest populations, according to the pesticide and pest concerned.

For many pests and diseases, guidelines already exist specifying the type and times of assessments, the minimum sample sizes, sampling methods and the most suitable scoring systems. In any case the mode of assessment should be clearly stated.

1.1.10 Assessment of phytotoxicity and other side-effects

The type and extent of phytotoxicity should be described and, where appropriate, recorded according to a recognized scale. Any detrimental effects on wildlife and/or beneficial organisms should also be recorded.

1.1.11 Statistical analysis of data

The raw data should be supplied (or held by the applicant for submission on request) and statistically analysed where appropriate. The statistical method(s) used should be indicated.

1.2 Report of the experiment

1.2.1 General remarks

The report section of the efficacy evaluation dossier is a very important but other rather neglected part of the presentation. This may be due to the circumstance that efficacy

trials are often designed and carried out within the manufacturer's organization by skilled experts on a routine basis. A presentation of assessment data in a summarized form without explanation or clarification of specific methods of assessment will often suffice for the team of experimenters and others within the firm concerned with the efficacy evaluation. For their purposes headings of table may be left incomplete, since assessments are often carried out in a standard manner.

It should be recognized however that such presentation of data is not suitable when these have to be provided to the authorizing agency or other interested parties. Although in many cases efficacy trials are carried out and assessments made according to high standards, the presentation of data without sufficient details or clarification may give rise to loss of essential or valuable information for the expert(s) in the authorizing agency engaged with the evaluation of efficacy data of the pesticide for which a marketing authorization is sought. Therefore, the importance of a suitable and sufficiently detailed presentation of data should be stressed.

In essence this means that all data obtained from the analysis of single samples should be recorded and not merely a summary or an average figure. If necessary, explanatory notes for erratic results should be provided. It should always be clearly stated how samples were taken and in which manner assessments were made. It is also essential that the evaluation method used to establish the effectiveness is described together with the way in which the results are interpreted.

1.2.2 Lay-out of the report

It is essential that the presentation of the results should be standardized in order to facilitate understanding of the trial results. Therefore, the data should preferably be presented in the following way:

name of the experimenter and organization responsible for the trial;

objective and location of the trial;

chemical name and formulation;

pest, disease or weed, against which tested;

crops and cultivars;

plant growth stage;

soil type;

experimental design, size and number of plots treated;

application dates and rates;

application method and equipment;

volume of spray liquid or other carrier (types);

weather conditions during and after treatment;

treatment of the plots with other crop protecting materials, fertilizers and other products;

application dates;

dates of assessment;

size and frequency of sampling;

quantity and quality of the yield of the harvested crop;

any results on crop safety including intervals to be observed in order to avoid phytotoxic effects;

data assessment including significance;

interpretation and discussion on the results of the experiment in comparison with similar trials.

ANNEX II

GUIDELINES FOR PESTICIDE BIOLOGICAL EFFICACY EVALUATION

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For the

Fertilizer and Pesticide Authority
(FPA Publication No. P-01)

GUIDELINES FOR PESTICIDE BIOLOGICAL EFFICACY EVALUATION

In order for a pesticide to be given full registration in the Philippines, there must be adequate proof of effectiveness against selected pest species. This proof is obtained by conducting a series of valid experiments in the appropriate areas. This guideline on testing for biological efficacy is thus important in terms of 1) helping the researcher conduct the testing program in accordance with acceptable standards, 2) providing a uniform, simplifying format with its built-in advantages in record keeping, reporting of results to, and examination of the data by the Authority and 3) assurance that under most conditions, the efficacy of a pesticide, or lack of it, can be demonstrated. It should also be observed that the data obtained through biological efficacy testing will form the basis for label recommendations; no positive recommendations are allowed in the label unless the claims are supported by experimental facts.

On the other hand, it is not the intention of the Authority to destroy experimental innovativeness nor to propose this guideline as a rigid requirement that must be adhered to at all costs. Rather, it should be looked at as a guide and adherence should be to the principles of validity, randomness and lack of experimental bias rather than to any rigid set of requirements. The importance of a systematic approach to a complex problem cannot be overemphasized, however, so that this guideline should be followed except for justifiable circumstances which in turn have to be considered by the Authority on a case-to-case basis.

EXPERIMENTATION

A. Number of Trials

A candidate pesticide should always be tested in at least two seasons (wet and dry season) if practicable

B. Choice of Experimental Site

The Authority should be consulted when choosing the experimental site in order to pinpoint the most appropriate areas. If possible, the experiment should be conducted in a major growing area for specific crops, with due consideration of the availability of an expertise pool to conduct the trial as well as variations in the pest species composition with area. As a general guide, the areas acceptable to the Authority for the different major crops are shown in Table I. However, field trials may also be conducted outside these designated areas especially for other crops but the choice should be justified to the Authority. For rice, the test should be done in any three places with Iloilo being a requirement because of the presence of Tryporyza innotata in the area. For other crops, two areas will suffice.

C. Reference Plots (Controls and Reference Pesticides)

The use of control plots and reference pesticide is very important. Control plots are used to evaluate the effectiveness of the treatment and as bases for statistical analysis of results. For herbicides, an unweeded control is required. Handweeded controls are desirable but not required since this practice may damage the crop. On the other hand, it has been observed that in several instances, statistical significance between controls and treatments cannot be obtained, e.g., in cases of

low infestation levels. This is where reference pesticides become important. Reference pesticides allow for a quantitative comparison of efficacy between the test material and one of proven efficacy. The choice of reference pesticide should be cleared with the Authority because some of the commercialized pesticides may have already lost their effectiveness due to resistance; in this event, their use as reference standard could give misleading results.

D. Border Plots

Border plots between treatments are necessary to minimize the effects of pesticide drift. If one has a row of crops, the most practical approach is to make one row as the common border of two adjacent plots (Figure 1a). If space is available, individual boundaries between plots are advisable (Figure 1 b). In direct-seeded crops, borders are also necessary. This is accomplished by spraying the entire plot, but assessments/harvesting should only be done at the central portions (Figure 1 c).

E. Plot Sizes

This is very difficult to standardize since it depends on the crop as well as the method of application. However, for a regular experiment requiring the use only of a knapsack sprayer, it is preferable to maintain a plot size of 10 to 20 sq m. Too small a plot size results in greater variability in the extrapolation of the data to, say yield on a per hectare basis and only a limited number of observations may be possible before overlaps occur. On the other hand, it may not be economical nor feasible to have a very large plot size. While the degree of variability also becomes smaller as plot size is increased, a point will be reached

wherein a further increase in plot size will no longer result in significant variability. It is also worth noting that as block size increases, within block variability also increases.

F. Replicates

There should be a minimum of three replicates; four would be preferable. Nothing significant can be gained by increasing replications beyond four. As a rule of thumb, there should be at least 10 degrees of freedom (d.f.) for error in an experiment. An experiment in RCB with five treatments (treatment d.f. = 4) requires four replications (block d.f. = 3) to get an error d.f. of 12 (4 x 3 = 12). A similar experiment with only three replications has an error d.f. of only eight (4 x 2) and thus not acceptable.

G. Researcher responsibility

Because of the importance of the biological efficacy testing in the registration of a pesticide, the role of a pesticide researcher assumes new dimensions and several added responsibilities. The first requirement for an acceptable biological efficacy data is that it must have been done by a researcher not in the employ of the pesticide industry; it is therefore expected that the researcher would be full-time employees of the Bureau of Plant Industry and similar government institutions performing research functions, as well as academic and research institutions. Researchers are expected to keep updated records of their work which may be spot-checked by FPA staff.

The FPA has a list of researchers in the different parts of the country and industry is advised to have prior consultation with the

Authority regarding their choice of researchers.

EXPERIMENTAL DESIGN

A. Preferred design

Among the more important considerations in a pesticide efficacy experiment is the experimental design. For a single factor experiment as in efficacy evaluations, one can choose from a number of standard experimental designs, e.g., Completely Randomized Design (CRD), Randomized Complete Block (RCB), Incomplete Block Designs, and Latin Square (LS). The general rule is to choose the simplest design suited to the objectives of the experiment.

The adoption of a single experimental design has its merits for purposes of comparison at the national level. In terms of flexibility, simplicity, data analysis, and error control, the RCB design is recommanded. In the RCB, the heterogenous area is subdivided into blocks such that plots within each block are uniform although the blocks differ from each other. The treatments, preferably limited to a maximum of 10, are then randomly assigned to the plots within the blocks. A sample field layout for an RCB experiment is given in Figure 2.

In the experimental design, the effects of gradients of any kind should be avoided or compensated for. Soil fertility is a very good example. When a unidirectional fertility gradient is known to exist, the block should be placed across the gradient and oriented in such a way that the length of plots is parallel to the gradient (Figure 3). This orientation minimizes variability within blocks while

variability among blocks is maximized.

All plots within each block should be treated as uniformly as possible. This means that any cultural operation, management practice, etc., should be evenly applied to each block at the same time. If the harvesting of field plots is spread over a period of several days, all plots in a block should be harvested on the same day. It may also be preferable if only one person should make the observations within each block in order to minimize the effects of individual differences in data gathering.

B. Analysis of Variance

The step-by-step statistical analysis of variance using the data in Table 2 for illustrative purposes are as follows:

Step 1. Group the data by treatments and blocks. Compute for treatment totals, treatment means, block totals and block means (Table 2).

Step 2. Construct an analysis of variance (ANOVA) table (Table 3) and calculate the number of degrees of freedom (d.f.) associated with each source of variation. Degrees of freedom are one less than the number of observations. Therefore d.f. for the 10 treatments is nine and that for the four blocks is three. The total d.f. is $(4 \times 10)-1 = 39$. Error d.f. can be obtained by subtracting: $39 - 9 - 3 = 28$.

Step 3. Compute for sum of squares (SS) and mean squares (MS) for each source of variation. Computations are preferably carried out to two or three extra figures more than the data, especially

when using calculating machines. Thus, if the data are presented up to two decimal places the computations may be carried up to at least four decimal places. In final reporting, results may be rounded off to the original number of decimal places.

3.1. Sum of Squares

3.1.a.) Correction Factor (CF) $= \frac{(\text{Grand Total})^2}{\text{No. of Observations}} = \frac{(\Sigma X)^2}{bt}$

$= \frac{(153.8)^2}{40}$

$= 591.3610$

3.1.b.) Total SS = TSS $= \Sigma X^2 - CF$

$= (6.6)^2 + \ldots + (0.4)^2 - CF$

$= 775.2000 - 591.3610$

$= 183.8390$

3.1.c.) Block SS = BSS $= \frac{\Sigma(B)^2}{t} - CF$

$= \frac{(40.4)^2 + \ldots + (37)^2 - CF}{10}$

$= 591.9960 - 591.3610$

$= -.6350$

3.1.d.) Treatment SS $= TrtSS = \frac{\Sigma(Tt)^2}{b} - CF$

$= \frac{(21.9)^2 + (20.1)^2 + \ldots + (2.)^2 - CF}{4}$

$= 766.1950 - 591.3610$

$= 174.8340$

3.1.e.) Error SS = ESS $= TSS - BSS - TrtSS$

$= 183.8390 - 0.6350 - 174.8340$

$= 8.3700$

3.2. Mean of Squares (MS)

3.2.a.) Block MS = MSB = $\frac{\text{BSS}}{\text{Block d.f.}}$

$= \frac{0.635}{3}$

$= 0.2112$

3.2.b.) Treatment MS = MSTrt = $\frac{\text{TrtSS}}{\text{Treatment d.f.}}$

$= \frac{174.8340}{9}$

$= 19.4260$

3.2.c.) Error MS = MSE = $\frac{\text{ESS}}{\text{Error d.f.}}$

$= \frac{8.370}{27}$

$= 0.310$

Step 4. Compute the F value for testing treatment effects by dividing treatment MS with error MS. To compare block effects, obtain block F value by dividing block MS with error MS.

F for treatment = $\frac{\text{MStrt}}{\text{MSE}}$

$= \frac{19.4260}{0.3100} = 62.6645$

F for blocks = $\frac{\text{MSB}}{\text{MSE}} = \frac{0.212}{0.310} = 0.684$

Step 5. Enter all values obtained from Step 3.1b through Step 4, rounded off to two decimal places, in the analysis of variance table (Table 4).

Step 6. The F values used to test for statistical significance can be found in Appendix IV. The following data are obtained using the block and treatment d,f. (3 and 9, respectively) as numerator and the error d.f. as denominator.

Block

10% - 2.29

5% - 2.96

1% - 4.60

Treatment

10% - 1.87

5% - 2.25

1% - 3.14

Since the observed F value for treatment exceeded that required for significance at the one percent level, the chances are less than one in 100 that the treatment effects are due to chance alone. Thus, there are real treatment differences. On the other hand, since the F values for block is lower than that required for significance even at the 10 percent level, there are no significant differences between the values observed among the blocks.

C. Test on Means

After ANOVA comes the test for specific difference between any pair of treatment means. One of the most widely used test, the Duncan's Multiple Range Test, is illustrated as follows:

Step 1. Rank the treatment means. Using our example:

Treatment No.	Rank	Mean
9	1	6.30
5	2	6.28
1	3	5.48
2	4	5.02
3	5	4.76
6	6	4.62
4	7	3.22
7	8	1.50
8	9	0.80
10	10	0.50

Step 2. Compute the standard error of a treatment mean

$$SS_{\bar{x}} = \frac{\text{Error mean square}}{\text{Number of replications}}$$

$$= \frac{0.3100}{4}$$

$$= 0.2783$$

Step 3. Enter Duncan's table of significant ranges (SSR) (Appendix V) at the desired level of significance using n_2 error d.f. and $p = 1, 2, \ldots t$ treatment means and list the $t-1$ ranges. Multiply these ranges by $S_{\bar{x}}$ to form a group of $t-1$ least significant ranges (LSR).

	2	3	4	5[p]	6	7	8	9	10
Error d.f. = 27									
SSR[a/]	2.90	3.05	3.14	3.20	2.26	3.30	3.34	3.36	3.38
LSR[b/]	0.81	0.85	0.87	0.89	0.91	0.92	0.93	0.94	0.94

a/ mean of SSR for 26 and 28 d.f. rounded to two decimal places

at = 0.05

b/ $LSR_1 = 2.90\ (0.2783) = 0.8070$

$LSR_2 = 3.05\ (0.2783) = 0.8488$

.
.
.

$LSR_{10} = 3.38\ (0.2783) = 0.9406$

Step 4. Test the observed ranges between means, beginning with the largest versus the smallest and compare this with the LSR for p = t; then test the largest versus smallest with LSR for p = t-1 etc. until all possible pairs of means have been tested. No significant difference between two means may be declared significant if the two means are both contained in a subset with a nonsignificant range.

6.30 - 0.50 = 5.80	0.94, significant
6.30 - 0.80 = 0.50	0.94, significant
6.30 - 5.48 = 0.82	0.85, not significant
6.30 - 6.28 = 0.02	0.81, not significant
6.28 - 0.50 = 5.78	0.94, significant
6.28 - 0.80 = 5.48	0.93, significant

.
.
.
etc.

Step 5. Summarize:

Treatment No.	Mean
9	6.30 a
5	6.28 a
1	5.48 ab
2	5.02 bc
3	4.72 c
6	4.62 c
4	3.22 d
7	1.50 e
8	0.80 ef
10	0.50 f

Treatment means followed by a common letter are not significantly different at the five percent level.

We can now conclude that treatments nos. 9, 5, 1 gave the best yield while treatment 8 and 10 gave the lowest.

D. Transformations

In the above example using yield data, a straightforward method of statistical analysis is given. However, there are cases wherein the data obtained cannot be analyzed in this manner. Insect count data made from net sweepings, percent of damaged hills, no yield or 100% damage in controls, and no or only slight damage in treatments, are just among the examples of data sets that cannot be analyzed directly. These data have to be transformed into a set of numbers that will allow for the analysis. Once the data are transformed, they are then analyzed in the same manner as above. Note however that transformation is not resorted to in order to get data to our liking but in order to obtain valid analysis and correct conclusions.

Two commonly used transformations are the square root and the arcsine transformations.

1. Square root transformation

This is used mainly for counts of rare events. By a rare event, we mean one which has a very low probability of occuring in any individual e.g., insect counts per definite number of sweeping.

Data of this kind can be made more nearly normal by transforming them into square root, or better yet, transform the data into Y by using the formula:

$$Y = \sqrt{X + 0.5}$$

An example of this type of data together with its transformation is given in Tables 5 and 6 while the summarized ANOVA is given in Table 7.

2. Arcsine or Angular Transformation

This transformation is used for data based on counts expressed as percentages or proportions of the total sample. The transformed data is obtained by finding the angle whose sine is the square root of the proportion or percentage.

$$Y = \text{arcsine } \sqrt{X}$$

The table used for this transformation is given in Appendix VI. It should be pointed out however that although this transformation is generally used with percentages data, such transformation is not necessary for ranges below 40 percent.

METHODS OF ASSESSMENT

A. INSECTS

Rice

1. Rice Whorl maggot (Hydrellia philippina Ferino)

a. Field symptoms: The larvae feed on the unopened central whorl of the leaves. Damaged leaves show small, chewed-up, discolored areas on the innermost margin of the central whorl. Heavily infested plants are stunted in growth.

b. Procedure: The damage caused by the whorl maggot is assessed at the early vegetative stage, usually 15 to 30 days after transplanting (DAT), preferably the latter. The simplest method of maggot damage assessment is visual grading of all leaves per hill based on the IRRI Standard Evaluation System as shown in Table 8. On the other hand, this evaluation system may be too laborious so that the damage could be based on the two youngest leaves per plant and then expressed in terms of percent leaf damage per hill.

2. Leafhoppers and planthoppers (Nephotettix spp., Nilaparvata lugens, and Sogatella furcifera)

a. Field symptoms: They suck the sap of stems and leaves. They frequently occur in large numbers to cause complete drying of the crop, commonly referred to as "Hopper burn". Aside from direct damage, leafhoppers and plant hoppers are vectors of most virus diseases in rice, such as tungro, grassy stunt, etc. For tungro, the leaves turn yellow to orange-yellow, plant growth is stunted, and the infected plant has fewer tillers. These symptoms usually appear at the start of stem elongation (about 20 DAT). For grassy stunt, the leaves are pale green, erect, and

sometimes with yellow blotches. Growth is stunted and excessive tillering is observed.

b. Procedure:

1. Estimation of damage. All hills from 10 m^2 area at the middle of the plots are assessed visually for virus damage. Damaged and undamaged hills are counted. Damage is then expressed as percent virus infested plants per plot using the formula given below.

$$\text{\% virus infected} = \frac{\text{No. of damaged hills in sample area}}{\text{Total no. of hills in sample area}} \times 100$$

Percentage of virus-infected plants are assessed twice, at 40 DAT and after the milking stage. The virus should be identified.

2. Estimation of insect population. Another method of evaluating the presence of green and brown hoppers is through actual counting of the nymphs and adults. For the green leafhopper, sampling is done by net sweeping which cover the front 180° of the operator. The number of hoppers caught per 10 to 20 sweeps in each plot is then counted. For the brown planthopper, visual counting per hill may be done by "slapping" the hill and estimating the number of hoppers falling in the water. Alternately, plastic cages are placed over two hills and the plants are then slapped. This is an accurate method at the early stage of plant growth. In older plants, the hill may be "slapped" using a piece of wood with graphing ink or motor oil where the insects will stick.

3. Stem borers (Striped-Chilo suppressalis: Yellow-Typoryza incertula: White-T. innotata; and Pink-Sesamia inferens)

a. Field symptoms: The rice stemborers infest plants from the seedling stage to maturity. At the vegetative phase, the central whorl turns brownish and dies off as a result of larval feeding at the base of the plant. Such condition is known as "dead heart"."White head" appears after panicle initiation. Infested tillers remain straight, whitish and contain empty panicles.

b. Procedure:

1) Estimation of damage - An area of at least 10 m² situated at the center is sampled and the formula below used to calculate percent dead heart or white head.

$$\% \text{ dead heart or white head} = \frac{A \times 100}{(B) \cdot (Y/10 \times D)}$$

Where: A = Number of damaged tillers (or panicles) in sample area.

B = Total number of tillers (panicles) in all damaged hills in sample area.

Y = Total number of tillers (panicles) in five pairs of undamaged hills.

D = Total number of undamaged hills in sample area (minus missing and virus hills).

Dead heart is assessed twice at 35 and 50 DAT while percent white head is evaluated about 10 days before harvest. Use only virus-infected hills and omit healthy hills for observation if majority of hills are infested by a virus disease.

2) Estimation of insect population - For a more rigorous procedure, the larvae are counted in randomly selected damaged hills, preferably at the reproductive stage. Damaged tillers are removed completely and dissected; live larvae are counted and the number of borers per 100 tillers is calculated below.

$$\text{No. of borer/100 tillers} = \frac{\text{No. of infested hills}}{\text{Total no. hills examined while collecting sample of 25 infested hills}} \times \frac{\text{No. of live borers obtained by dissecting sample hill}}{\text{Total no. of tillers in sample of 25 hills}}$$

This is the basis for statistical evaluation especially if borer density is high. Normally, however, damage estimation is good enough.

Corn

1. Corn borer (Ostrinia furnacalis Guenie)

a. Field Symptoms: On the stalks, the presence of bore holes usually at the nodal part are observed with granular excretions coming out of the hole and the stalk breaks. Leaves are damaged by the feeding of the larvae on the epidermis of the tender leaf blades. Corn plants are susceptible during whorl stage (3-4 weeks after planting). Sometimes the larvae feed on the ears resulting to the fall of corn ears.

b. Procedure: Get 20 to 25 random sample plants per treatment at 115 days after planting. Sample the basal half of the corn plant for borer number and tunnel count after removing the ear. The data should include (1) total borer number (larvae, pupae, and pupal cases) and (2) number of borer tunnels in the stalk. For early infestation, count the number of larval holes/stem in the sampled plant.

Grain yield is measured by getting the weight of clean kernel per plant after drying for two days and dehumidification to 14 percent moisture content.

2. Corn earworm (Heliocverpa armigera (Hubner))

a. Field Symptoms: Newly-hatched larvae feed on the silk of the corn ears. Older larvae heavily damage the corn ear and cobs thus reducing the quality and quantity of the yield.

b. Procedure: Select 25 corn ears at random. To estimate population density of earworm larvae, unhusk the sample ears (25 corn ears) and count total larvae present per ear. Get the average number of larvae per plot.

3. Corn Aphid (Rhopalosiphum maidis (Fitch))

a. Field Symptoms: Aphids cause considerable loss to corn plant by sucking a large amount of sap from young leaves, tassels, or corn ears and transmitting disease organisms to cause the corn plant to wilt and prevent the corn ears from maturing.

b. Procedure: Heavy infestation occurs during tasseling stage. At this stage, evaluation of aphids should be conducted using the index system in table 9.

Aphid population count is another method used during the whorl stage. This is done by estimating aphid population just before spraying and three and 12 days after spraying.

Cabbage

1. Diamondback moth (Plutella xylostella) (Linnaeus)

a. Field Symptom: Presence of chewed cavities and holes on the leaves caused by the feeding of the larvae. In severe infestation, leaves look like "laces" with its transparent leaf areas.

b. Procedure: Sampling is done on 20 random plants per treatment. Population count is based on the number of larvae and pupae. Another method is to use the index of degree of damage as shown in Table 10.

2. Cabbage moth: (Crocidolomia binotalis Zeller)

a. Field Symptoms: Non-formation of heads due to the feeding of the larvae at the growing point of the plants. At head formation, holes are present while for non-head-forming crucifers, perforation of the leaves is observed.

b. Procedure: Larval and pupal counts are taken from 20 randomly selected plants per treatment. Data gathering is done at three-week intervals from transplanting until harvest for cabbage.

Prior to harvest 20 plant samples are indexed as to the degree of damage using Table 11. The cabbage yield data is based on total weight of marketable heads taken from the 20 randomly selected plants.

Tomato

1. Tomato fruitworm: (Helicoverpa armigera (Hubner)

a. Field Symptoms: Presence of holes on the fruits caused by the voracious feeding of the larvae which results in the drying up of the tomato fruits.

b. Procedure: Randomly select 10 or more plant samples per plot Estimate the percentage of fruits damaged. Yield data is taken by weighing fresh marketable fruits from the 10-plant samples.

Cotton

1. Leafhopper (Empoasca spp.)

a. Field Symptoms: Both the nymphs and adults are found under the leaves. The insect suck the sap of the leaves and make the infected leaves curl or bend downwards, become wrinkled, and fall down. Bud development is abnormal.

b. Procedure : Nymphs are counted on the leaflet of 20 randomly selected plants per plot. Insect counts are taken at 10 days interval.

2. Bollworm: (Helicoverpa armigera (Hubner)

a. Field Symptoms: Young larvae feed on the flower buds. Older larvae bore through the bolls and cause their premature falling.

b. Procedure : The number of larvae per plot is counted on 20 plants selected at random. The number of eggs per boll is also determined on the same sampled plants. Sampling is taken twice a week from the 4th leaf stage to boll opening.

Additional observations on percentage boll damage during harvest is done on 20 plants selected randomly at the center rows.

3. Boll weevil: (Amorphoidea Lata Motschulsky.)

a. Field Symptoms: The adults feed on the flowers causing early falling or rotting of the flower parts. Young bolls are also

destroyed by the adults causing them to drop prematurely. The larvae eat the young cotton bolls.

b. Procedure: Boll weevil adults are estimated by counting the number of weevils per flower of 20 randomly selected plants in each plot. Population counts are determined before insecticides application and one or two times a week thereafter.

The percentage of punctured bolls from the sample plants is determined before boll opening. Yield data sampling is the same as in the bollworm.

Sweet Potato

1. Sweet potato weevil: Cylas formicarius formicarius (Fabr.)

a. Field symptoms: Presence of pinholes in the main stem and tuber as a result of adult oviposition. The larvae bore and tunnel into the tuber and cause odor and bitter taste which make the tuber unfit for human and animal consumption.

b. Procedure:

1) Sample three kg. of tuber, cut into 2.5 mm slices and count the number of larvae, pupae and adults.

2) Count the number of larvae, pupae and adults in dissected stems taken at random from each plant.

3) Compute percentage damage of tuber by weight.

$$\% \text{ damaged tuber} = \frac{\text{Wt. of damaged tuber/plot}}{\text{Total weight of tuber/plot}} \times 100$$

4. Obtain the weight of total marketable tubers from 20 plants samples.

1. Mango leafhoppers (Idioscopus clypealis (leth) and Chunrocerus niveosparsus

a. Field Symptoms: Nymphs and adults deprive the flowers and fruits of their sap, causing them to wither and drop. The oviposition of adults in the flower buds and small fruits arrests their development. At the same time, their feeding and oviposition punctures give an additional means of entry for a fungus, Gloesporium mangiferea, which develops in all the attached parts of the plants. In addition, the honey dew secreted by the hoppers kill the flowers.

b. Procedures: Before treatment, ten panicles per tree will be randomly picked to estimate the number of insects. The inflorescences will be enclosed in plastic bags, detached, sealed and brought to the laboratory for counting. Three days after spraying, the insects in each treatment will be counted. The same procedure will be done in subsequent sprayings.

When the fruits are already ripe, 10 panicles will be randomly picked from each tree. The number of panicles per square meter will be determined per tree based on 5 samples. The total fruit production will be computed based on the total area of the crown and number of panicles per meter square.

Field Legumes

1. Bean Fly (Melanogromyza phaseoli)

a. Field Symptoms: The young plants are especially exposed to attack by this pest. The leaves have dark spots scattered all over its surface. The stem above the roots is thickened.

b. Procedure: Assessment of beanfly damage is based on samples of 20-30 seedlings per replication or direct field reading using the damage index in Table 12.

Insect samples are taken a day or two before the succeeding spray is applied or if the plants are not due for spraying, then two weekly samples are taken.

The impact of th treatments is evaluated against beanfly using damage index, defoliation (leaf area damage), actual counts (number of lepidopterous larvae), pod damaged at pod formation and maturity (percentage seed damage, number of pod borer per plant,) and yield. Insect population density is surveyed by actual count per linear meter of row or by sweep net twice weekly.

Tobacco

1. Tobacco budworm: Helicoverpa armigera (hubner)

a. Field Symptom: The larvae bore through the growing points and young leaves have large irregular holes due to larval feeding.

b. Procedure: Damage and budworm population assessments start a week after recovery of the transplanted seedlings up to harvesting stage. These are done by randomly sampling 75 plants from the center of each plot. Leaf injury measurements are taken from every third leaf of each sample plant starting from the top. Leaf injury is determined by measuring the leaf area consumed (cm^2) during the first sampling and by visually examining each leaf of infested plants and recording the portions of the leaves consumed to the nearest 1/10th, starting from the middle vegetative up to harvesting stage.

Actual counting of budworm is alsc done.

Pre-sampling for insect pests and damage level are done before the application of insecticides.

B. NEMATODES

Many nematode species are destructive to the crops, namely Meloidogyne incognita, Pratylenchus spp., and Trichlodorus christei.

1. Field symptoms: Nematodes feed on the roots of the crop. The infested plant shows galling on the roots and stunted growth thus reducing crop yield.

2. Procedure:

1) Population count of nematodes.

Soil samples are taken from three sites of each plot prior to nematocidal application. Two samplings are done of two to three months after applications. Nematodes are identified and determined by processing

the soil samples using the sieving and Baermann funnel methods in the laboratory.

2) Index rating of root galls

Degree of nematode infection is evaluated after harvest by using the following index rating; 1 for no galling; 2 for trace; 3 for slight; 4 for moderate; 5 for severe root galling formation.

3) Yield data

Yield is taken from representative plants selected randomly; 20 plants are preferred.

4) Plant height

The height of the plant is taken at weekly intervals for seven weeks especially in vegetables. Height is measured based on the growth stages.

C. WEEDS

In any herbicide evaluation test, the performance of different herbicides under consideration could be gauged from their effects on both crops and weeds. Although crop yield is the ultimate basis for the assessment of the efficiency of a herbicide, supplementary data are also necessary in lending support for the final analysis of such results. The most common data obtained in any herbicide screening test are crop injury rating, weed control rating, weed counts, weed weights, and crop yield.

1. Crop Injury Rating or Phytotoxicity Rating

There are several parameters by which the effects of a herbicide on a crop could be measured. The most important are the visual phytotoxic symptoms exhibited by treated crops. The nature of such symptoms will depend upon the properties of the herbicide. In order that a phytotoxic symptom could be quantitatively evaluated, one has to establish an index or scale in which a certain degree of phytotoxicity corresponds to a numerical value. An example of such rating scale is the European Weed Research Council scale which is shown in Table 13.

With this type of rating scale, however, it is very hard to determine whether the symptoms exhibited by a crop are slight, moderate, or otherwise. In these situations, the exactness of every rating depends upon the oberver's keen sense of appraisal. Thus, it is required that the observer exercise complete impartiality in his rating.

Another parameter by which an injury of a certain herbicide on a crop could be evaluated is tiller count or tiller number. This is only applicable to crops which produce tillers. Tiller number can be expressed as the number of tillers per unit area or the number of tillers per plant when single-plant hills are used. It is accepted that herbicides usually applied in cereals (e.g. rice) exhibit phytotoxicity by reducing the number of tillers.

In general, the more toxic the chemical, the less the number of tillers produced. In taking representative samples, a two-hill x two-hill sampling unit taken at random is advisable.

In cases where the herbicides in question give discernible phytotoxic symptoms like stunting, plant height measurement is the most appropriate. Plant height is the distance from ground level to the tip of the longest leaf. For plant height measurement, a single-hill sampling unit taken at random within the plot is advisable.

In broadcast or direct-seeded crops herbicide injury can be measured in percentage germination or stand count per one linear meter or per 25 x 50 cm.

2. Weed Count and Weed Weight

Two supplementary data in evaluating the efficacy of a herbicide are the weed counts and weed weights. Weed count are taken at least twice, the first one, two to three weeks after herbicide treatment and the second, six weeks after, the latter to determine any regrowth. Weed weights are taken during the second weed counting and at harvest. This reflects more or less the extent of regrowth of a given weed species despite the application of a herbicide. Although weed counts for any two treatment may be the same, the weed weights may differ due to differences in growth.

The most common method of weed counting is by the quadrat method. In here, a quadrat, usually measuring 25 cm x 50 cm is laid out at random in a plot and all weeds within the quadrat are counted. Since there are some weeds that are dominant over the others, it is advisable to have the weed count by species. Weed counting by species shows the predominant weed in an area and the spectrum of control of any particular herbicide.

In general, the more toxic a herbicide is, the less the number of weeds per unit area, consequently, the less weed weight also. When weed samples are obtained, these are dried under sunlight or in the oven to obtain dry weight. Again, dry weight by species is preferred over the collective weight of all weeds per quadrat, as some weed species are more dominant than the others.

3. Weed Control Rating

Weed control rating gives the overall assessment of control. Like toxicity rating, this kind of appraisal requires comparison with the handweeded plot. The accuracy of the data depends so much on the impartial judgment of the observer. Coding of treatment labels may help decrease subjectivity. An example of such rating scale is the European Weed Research Council Scale shown in Table 14.

Data Collection

Collect data on:

a. Crop Injury Rating (use format in Table 15) within two to three weeks after treatment (Rating Scale in Table 13)

b. Weed Control Rating (use format in Table 16) at the same time (Rating Scale in Table 14)

c. Weed counts and weed weights (use format in Table 17 and 18) are to be taken within four to six weeks after treatment, (earlier if weed growth is heavy) using a 25 x 50 cm quadrat. Individual weed species should be counted and weighed separately for each treatment/replication.

d. Data on grain yield at harvest from 2 x 5 meters (10 sq. meters) area expressed as kg/ha (use format in Table 19).

D. DISEASES

Fungicides are applied to the soil, seed and propagating material, growing plants, and produce. The method of application and choice of fungicide depends upon the crop, the pathogen and the surface to be protected.

Application to Standing Crops

To demonstrate the protective and therapeutic action of a chemical against plant diseases, healthy seedlings of, say, rice, corn, and vegetables are grown under greenhouse or field conditions. Then half of the leaves of some healthy and some previously inoculated seedlings are sprayed with a therapeutant fungicide. The other halves of each set are unsprayed. Some healthy plants are allowed to dry up, then their leaves are inoculated with a spore suspension of the pathogen. The protective and therapeutic actions of fungicides are evaluated by recording the percentage of diseased plants, organs or tissues or by comparing with descriptive scales and diagrams of disease intensity. Appendix I may be used with the damage index rating scale, percent germination, or percent infection (to be discussed subsequently), being used in the tabulation.

Seed Treatment

Chemical seed treatment is aimed at destroying pathogens borne on the seed surface, those beneath the seed coat, and those soil-borne pathogens adjacent to seeds in seedbeds. Seed treatment is also used to protect the seedlings from pre and post-emergence damping-off and seedling blight pathogens like Pythium, Phytophthora, Sclerotium, Rhizotonia, and Fusarium. Propagation materials other than seeds are often treated with fungicides before planting. Fleshy bulbs and potato seedpieces are dipped or immersed in aqueous formulations of various fungicides to get rid of seed-borne pathogens. Appendix I is used for reporting.

Soil Treatment

Generally, fungicides are introduced into a point source and are dispersed by various means to the pathogens. Fumigants and nonvolatile fungicides are mixed with soil to get rid of pathogens. Application of fumigants to soil is by drench and multiple point methods and the toxicant attacks the pathogen in a vapor state. The liquid fumigant is deposited to a depth of six to eight in. and spaces of six to nine in. The soil surface is closed immediately after treatment. Due to their phytotoxicity, the liquid fumigants are used at a time prior to planting which is sufficient for the residual vapors to dissipate from the soil.

The fumigant methyl bromide can be used on small plots if a plastic cover is sealed over the soil. The covering is held above the soil

surface to permit circulation of vapor from evaporating pans. Just like formaldehyde, methyl bromide is commonly used for treating bulk soil for potting and bed use.

Nonvolatile fungicides like pentachloronitrobenzene, captan, dexon, thiram, nabam and 8-hydroxyquinoline sulfate are drilled or sprayed to the soil surface. Then they are mixed in soil to a prescribed depth with use of disc or cultivator. Broadcast method or drench application of aqueous suspensions and solutions of fungicides can be effective in controlling Rhizoctonia and Streptomyces on potato and damping-off disease in the nursery and greenhouse.

Application to Plant Products

Losses among fresh produce are minimized by preventing infection before, during, and after harvest. The chances for fungal attack after harvest are reduced if bruising and wounding of produce are avoided during harvest. Postharvest fungicide treatment minimize the inoculum of pathogens and protects produce from subsequent inoculations. The treatment is incorporated into the processing scheme and little residue remains shortly thereafter. The produce may be treated during processing, in storage, or in transport to the retail market. The fungicides preferred are those that can concentrate at the infection sites or wounds on the produce. The chief means of treating the produce is by fumigation with polar fumigants like sulfar dioxide, ammonia, and low molecular weight amines. The pathogens controlled by fumigating highly perishable

fruits and berries include Rhizopus, Botrytis, Penicillium, and Monilinia.

Disease Assessment

In studies with plant diseases, fungitoxicity may be measured by the reduction in the amount or in the rate of disease development. This should take into consideration the percentage of plants infected as well as the severity of infection.

a. Recording the percentage of diseased plants, organs or tissues - This is particularly applicable to diseases which kill plants rather quickly or which cause about the same amount of damage to all infected plants. The amount of disease in the harvested product is sometimes a useful indication of its prevalence in the crop, and the number of surviving plants in relation to the number of seeds sown gives a measure of fatal seedling disease, germination percentage of the seed being taken into account.

If a disease is very prevalent, it may be quicker to record the percentage of uninfected plants whereas if it is sparse, various special methods of assessment can be used, including counting the number of infected plants observed on walking for a known time or distance through the field. Approximate percentage infection can then be calculated from the density of plants using the formula:

$$\% \text{ infected plants} = \frac{\text{No. of infected plants/A}}{\text{Total plants counted/A}} \times 100$$

Where A = unit area

Whenever applicable, the direct counts of infected plants are reasonably accurate and objective, but they are not applied to diseases in which different plants show markedly different amounts of infection. If disease incidence varies greatly on different plants, it may be useful to record the number of plants or organs falling into known percentage disease groups. The Horsfall-Barratt system (1945) is based upon the ability of the eye to distinguish logarithmic differences accurately. Their 12 grades ranging from 0 to 11 represent percentages of disease: 0, 0 to 3, 3 to 6, 6 to 12, 12 to 25, 25 to 50, 50 to 75, 75 to 87, 87 to 93, 93 to 96, 96 to 100, and 100, respectively.

b. Descriptive Scales and diagrams of disease intensity - These are widely used and are of many different types ranging from disease ratings on a numerical scale (often 0-7) to subjective estimates such as "moderate", "severe" and so on. Such scales describe in detail the various grades of disease and may take into account the stage of development of the plants. Examples are the scales for assessment of potato late blight developed by the British Mycological Society and for the rice blast disease which are given below:

A. Potato late blight

0 - Not seen in field

0.1% - Only a few plants affected here and there. Up to one or two spots in 10.8 m radius

1% - Up to ten spots per plant or general light spotting

5% - About fifty spots per plant, or up to one leaflet in ten attacked.

25% - Nearly every plant with lesions; plants still retaining normal form, fields may smell of blight but look green although every plant is affected.

50% - Every plant affected and about half of the leaf area destroyed by blight; field looks green flecked with brown.

75% - About three-quarters of the leaf area destroyed by blight; field looks neither predominantly brown nor green. In some varieties, the youngest leaves escape infection so that the green is more conspicuous than in varieties like King Edward which commonly shows severe shoot infection.

95% - Only a few leaves left green, but stems are green.

100 % - All leaves dead, stems dead or dying.

B. Rice Blast

Methods of Classifying Disease Reaction

Scale Unit 1: Only small brown specks of pinhead size are produced on leaves, few or many, sometimes unrecognizable, no necrotic (collapsed cell) spots.

Scale Unit 2: Slightly large brown specks, about 1/2 mm in diameter, no necrotic spots.

Scale Unit 3: Small, roundish, necrotic, gray spots, about 1-2 mm in diameter, surrounded by brown roundish margin which tends to be elliptical. lesions may be numerous, but leaves are seldom killed from infection.

Scale Unit 4: Typical blast lesion, elliptical 1-2 mm long, usually confined to the space of two main veins, with large necrotic, gray center and brown or reddish brown margin usually relatively few on a leaf; less than 5 per cent of leaf area is damaged.

Scale Unit 5: Many large blast lesions, as in scale unit 4, or even larger and broader; the upper portion of one or two of the leaves of seedling of 4-to-5 leaf stage may be killed by coalescence of lesions; the total area killed, however, does not exceed 25 per cent.

Scale Unit 6: Lesions as in scale unit 5, but more numerous; a few leaf blades may be completely withered; the total area killed may reach 50 per cent; the margin of the lesions often shows less brown color but more yellowish or grayish brown.

Scale Unit 7: Large, quickly expanding lesions, the margin of which is mostly gray color with brown tinge, most of the expanded leaves are killed but young ones remain. Leaf kill ranges from over 50 per cent to complete death.

The scale units correspond to the following:

1,2 = R - resistant

3 = MR - moderately resistant

4 = MS - moderately susceptible

5,6,7 = S - susceptible

Grades of disease incidence can likewise be assessed comparison with standardized diagrams, photographs, or even preserved specimens. They are frequently used for leaf spotting, blight, rusts, fruit spotting, mosaics and other diseases. They should be simple to use, with different grades of disease clearly distinct. An example of a disease assessment diagram aimed at providing standard method of assessing the percentage of plant organs affected by pathogens is given in Figure 4.

It is sometimes desirable to summarize the disease severity by estimates carried out on a population of plants in the form of a single figure called an infection index, severity index, coefficient of infection, average infection, disease intensity and others. A widely used way of doing this is that devised by McKinney (1927) which is

$$\frac{\text{Sum of all disease ratings} \times 100}{\text{Total number of ratings} \times \text{maximum disease grade}}$$

The maximum disease grade is the highest rating on the severity scale for instance in the case of 0-7 scale. This method gives infection indexes ranging from 0 (no disease) to 100 (maximum disease possible).

c. Measuring crop losses by comparing infected plants with those treated with chemicals - In these experiments, one tries to obtain gradients of diseased to disease-free plants by applying different dosages of protective or eradicative chemicals to the plants, planting materials or soil. The yield of such plants is then compared with that of the untreated plants and the % control is calculated as shown below.

$$\% \text{ control} = \frac{(\% \text{ diseased plants, organs or tissues/unit area in untreated} - \% \text{ diseased plants, organs or tissues/unit area in treated}}{(\% \text{ diseased plants/unit area in untreated plants, organs or tissues})} \times 100$$

The experiments can be carried out in fairly small replicated plots or over comparable fields, a properly designed lay-out being used so that statistical analysis can be applied. This method is widely used and is generally considered to be one of the most accurate method of showing decrease in crop losses due to chemical treatments.

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McKinney, H. H. 1923. Influence of soil temperature and moisture on infection of wheat seedlings by Helminthosporium sativum. J. Agric. Res. 26: 195-218.

Tarr, S. A. J. 1972. Principles of plant pathology. Winchester Press. New York. 632 p.

REPORTING OF DATA

A. General

In submitting any report to the FPA, it is important that the data are presented in tabular form. The report must be brief yet descriptive so as not to confuse the evaluator. Photographs and graphs presenting results are acceptable as additional information to the usual tables. The following must be included in the report.

1. Abstract - Discuss the procedures used and important findings of the experiments. The abstract should not exceed two pages of 8½ x 11½" papers, typewritten double space.

2. Materials and Methods - State briefly the equipment, materials used, cultural practices, experimental design and illustrated field layout.

3. Tabulated data of treatment averages - This refers to observations for each plot which may be useful for future references. Report the data as gathered.

4. Summary Tables - This refers to the transformed or summarized raw data which will be used for statistical analysis.

5. Climatic conditions - This is important to give future workers an idea of the conditions upon which the experiment was done.

6. Capsule summary for compilation - It is the intention to compile all the effectiveness evaluation data for future reference. Six copies of the attached capsule summaries (or summaries similar to the ones given for other crops) should be submitted.

7. Proposed Pest - that the compound can control.

Table 1. Preferred Areas For Testing Pesticides In Specific Crops

Major Crop	Provinces
Bananas	Cotabato, Davao
Corn	Batangas, Bukidnon, Cebu, Cotabato, Laguna, Cagayan Valley
Cotton	Cagayan, Laguna, Nueva Ecija, Pangasinan
Cruciferous Vegetables	Benguet, Cebu, Davao, Iloilo, Kanlaon City, Laguna, Mt. Province
Legumes	Cotabato, Iloilo, Laguna, Nueva Ecija
Mango	Bulacan, Cavite, Cebu, Iloilo, Bataan, Pangasinan, Zambales, Batangas
Rice	Camarines Sur, Davao, Iloilo, Laguna, Nueva Ecija, Bulacan
Tobacco	Cagayan Valley, Ilocos Norte, La Union, Pangasinan, Ilocos Sur
Tomato	Batangas, Cavite, Laguna, Misamis Occidental, Mt. Province, Nueva Ecija, Pangasinan

Table 2. Yield data in kilograms for a rice experiment.

Treatment	I	II	III	IV	Treatment Total (TI)	Treatment Mean (Tx)
1	6.6	4.4	5.9	5.0	21.9	5.48
2	5.2	6.1	4.9	3.9	20.1	5.02
3	5.4	4.5	4.0	5.0	18.9	4.72
4	3.5	2.9	3.4	3.1	12.9	3.22
5	6.0	6.8	6.4	5.9	25.1	6.28
6	4.9	5.0	4.5	4.1	18.5	4.62
7	1.0	1.2	1.8	2.0	6.0	1.50
8	0.8	1.0	0.5	0.9	3.2	0.80
9	6.5	5.9	6.1	6.7	25.2	6.30
10	0.5	0.8	0.3	0.4	2.0	0.50
Block Total (Bt)	40.4	38.6	37.8	37	157.8	
Block Mean (Bx)	4.4	3.86	3.78	3.7	Grand Mean	3.84 (Gx)

Table 3. Analysis of Variance (ANOVA)

Source of variation	d.f.	ss	MS	Computed F 5%	Tabulated F 1%
Blocks	3				
Treatment	9				
Error	27				
TOTAL	39				

Table 4. Analysis of Variance Table

SV	d.f.	SS	MS	Computed F	Tabular F 5%	Tabular F 1%
Block	3	0.645	0.21	0.68	2.96	4.60
Treatment	9	174.834	19.43	62.661	2.25	3.14
Error	27	8.37	0.31			
TOTAL	39	183.84				

Table 5. Stemborer Larva Per Hill

Treatment	Replication				Total
	I	II	III	IV	
1	2	4	3	2	11
2	1	7	2	1	11
3	1	6	3	1	11
4	2	6	2	2	12
5	1	4	1	1	7
6	2	6	7	1	16
7	0	1	0	0	1
8	1	9	3	2	15
9	2	2	2	2	8
10	5	9	11	1	26

Table 6. Square root transformation ($y = \sqrt{x + .5}$) of Table 4

Treatment	Replication				Total	Mean
	I	II	III	IV		
1	1.58	2.12	1.87	1.58	1.15	1.79
2	1.22	2.74	1.58	1.22	6.76	1.69
3	1.22	2.55	1.87	1.22	6.86	1.72
4	1.55	2.55	1.58	1.58	7.26	1.82
5	1.22	2.12	1.22	1.22	5.78	1.45
6	1.58	2.55	2.74	1.22	8.09	2.02
7	.71	1.22	0.71	0.71	3.35	0.84
8	1.22	3.08	1.87	1.58	7.75	1.94
9	1.58	1.58	1.58	1.58	6.32	1.58
10	2.34	3.00	3.39	1.22	10.03	2.51

Table 7. Analysis of Variance for data in Table 5

SV	d.f.	SS	MS	Computed F	Tabular 5%	Tabular 1%
Block	3	6.77	2.25	15.00		
Treatment	9	6.58	0.73	4.81		
Error	27	4.10	0.15			
TOTAL	39	17.45				

Table 8. IRRI Standard Evaluation System for Whorl Maggot Damage

Grading Number	Scale (% Damage)
1	Less than 1%: feeding lesion, small, pin head in size
3	1-5%: feeding lesions about a centimeter in length
5	5-25%: feeding lesions about a centimer in length
7	25-50%: feeding lesions occupying up to one-half of the total leaf area but with no leaf breaking
9	50-100%: feeding lesions severe causing leaf curling and breaking in all leaves

Table 9. Damage Index Rating for Corn Aphids

Rating	Description
0	Sound (no aphid)
3	Light infestation; no visible effect, but size of corn ear is reduced (50-100 aphids/plant)
5	Moderate infestation; smaller ears, and reduced corn ear size and weight (100-1,000 aphids/plant)
7	Severe infestation, very small ears or no ears at all (more than 1,000 aphids/plant)

Table 10. Damage Index Rating for the Diamondback Moth in Cabbage

Rating	Description
0	Sound : No damage
1	Slight: 1-3 leaves with holes
2	Moderate: 4-6 leaves with holes
3	Heavy: Most leaves with holes
4	Severe: No heads produced

Table 11. Damage Index Rating for the Cabbage Moth.

Rating	Description
0	Sound: Heads undamaged
1	Slightly damaged: Heads with few holes and required slight trimming
2	Heavily damaged: Heads with many holes and required extensive trimming
3	Severe: No heads produced.

a/ mean of SSR for 26 and 28 d.f. rounded to two decimal places at $\rho = 0.05$

b/ $LSR_1 = 2.90\ (0.2783) = 0.8070$

$LSR_2 = 3.05\ (0.2783) = 0.8488$

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$LSR_{10} = 3.38\ (0.2783) = 0.9406$

Step 4. Test the observed ranges between means, beginning with the largest versus the smallest and compare this with the LSR for p = t; then test the largest versus smallest with LSR for p = t -1 etc. until all posible pairs of means have been tested. No significant difference between two means may be declared

significant if the two means are both contained in a subset with a nonsignificant range.

6.30 - 0.50 = 5.80	0.94, significant
6.30 - 0.80 = 0.50	0.94, significant
6.30 - 5.48 = 0.82	0.85, not significant
6.30 - 6.28 = 0.02	0.81, not significant
6.28 - 0.50 = 5.78	0.94, significant
6.28 - 0.80 = 5.48	0.93, significant

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•

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etc

Step 5. Summarize:

Treatment No.	Mean
9	6.30 a
5	6.28 a
1	5.48 ab
2	5.02 bc
3	4.72 c
6	4.62 c
4	3.22 d
7	1.50 e
8	0.80 ef
10	0.50 f

Table 12. Damage Index for Bean Fly in Field Legumes

Rating	Description
0	No feeding damage
1	2-3 holes present/leaf
2	2 leaves damaged
3	2-4 leaves damaged
4	Heavy or all leaves damaged

Table 13. Crop Injury Rating Scale

Scale of Rating	Symptoms of phytotoxicity on the crop
1	None
2	Very slight symptoms
3	Slight symptoms
4	Heavy symptoms (not necessarily affecting yield)
5	Doubtful
6	Evident damage
7	Heavy damage
8	Very heavy damage
9	Complete kill

Table 14. Weed Control Rating Scale

Scale of Rating	% Weed Control	Weed Infestation	General Appraisal
1	100	None	Excellent
2	98	Extremely weak, 1%	Very good
3	95	Very weak, 2%	Good
4	90	Weak, 5%	Satisfactory
5	82	Moderate, 10%	Uncertain
6	70	Heavy, 20%	Unsatisfactory
7	55	Very heavy, 40%	Bad
8	30	Extremely heavy, 80%	Very bad
9	0	100%	Absolutely useless

Table 15. Crop Injury Rating Form

TREATMENTS :	NUMBERS :	:R_1	:R_2	:R_3	:R_4	:R_5	: M :
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						

Table 16. Weed Control Rating Form

TREATMENTS	NUMBER		R_1	R_2	R_3	R_4	$\bar{X}$
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Table 17. Weed Count Data Form

Weed counts (no./25 x 50 cm) Date Taken:

REPLICATION

TREATMENT	NUMBER	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								

Table 18. Weed Weight Data Form

REPLICATION

TREATMENT NUMBER		S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								

Table 19. Yield Data Form

TREATMENT	NUMBER		R_1	R_2	R_3	R_4			2B*	2C*
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

* Averages of Weed Weight and Crop injury rating.

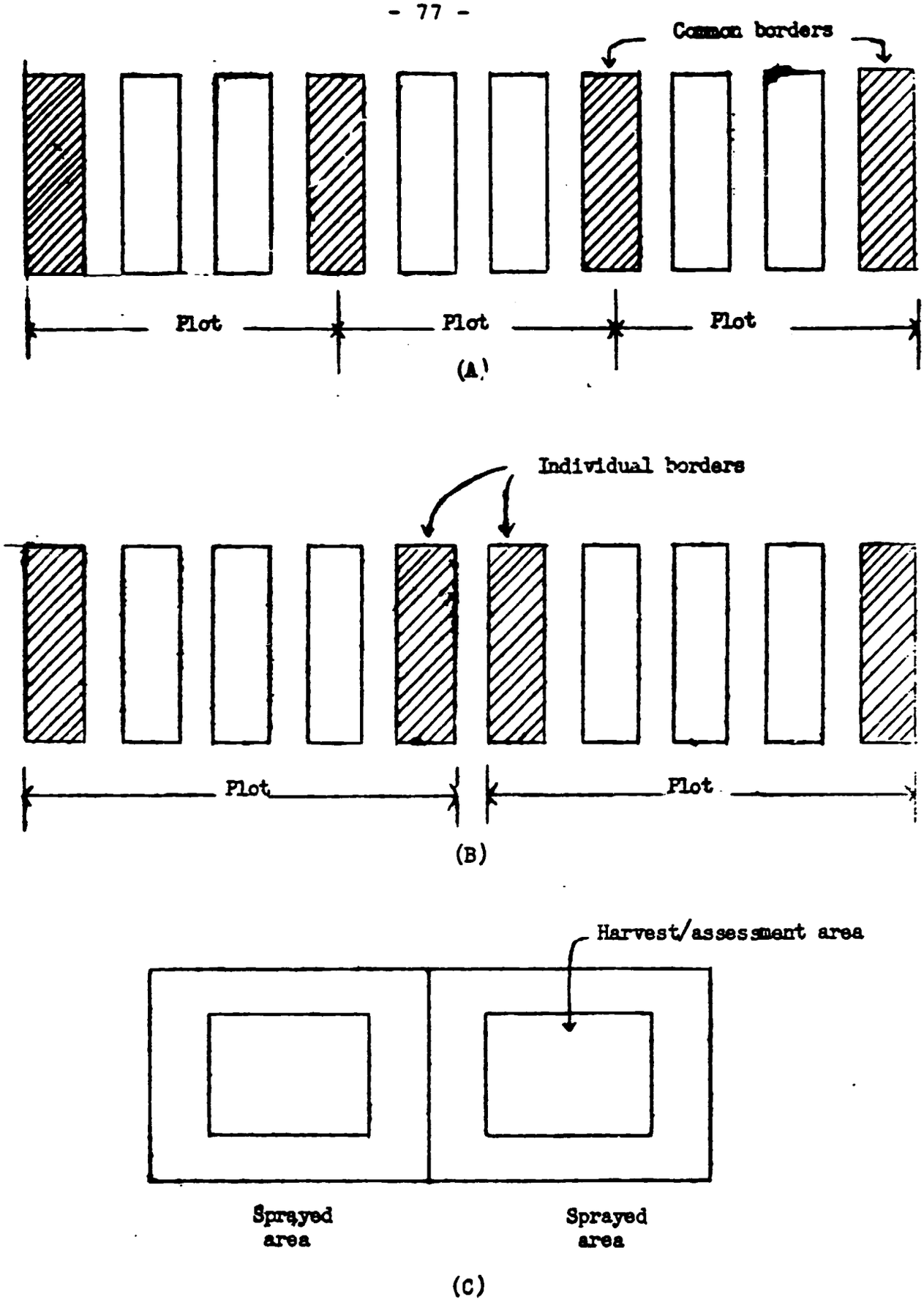

Figure I. Placement of border rows. (A) Border rows as common border, (B) Individual border rows, and (C) Border arrangements with direct seeded crop.

Replicates

TREATMENTS	I	II	III	IV
	1	2	4	3
	3	1	2	5
	5	4	5	4
	4	5	3	2
	2	3	1	4

Figure 2
A Randomized Complete Block Design

Replicates

I	II	III	IV
4	1	4	3
1	4	3	2
2	4	2	1
3	2	1	4

Low Fertility ⟶ High Fertility

Figure 3. Experimental layout to minimize the effects of a fertility gradient.

Appendix I

SUMMARY TABLE FOR TREATMENT AVERAGES

Crop: _____ Design: _____

Crop Age: _____ Plot Size: _____

Date of Evaluation: _____ Remarks: _____

Date Planted/Transplanted: _____

TITLE: _____

TREATMENT	RATE	REPLICATION				TOTAL	MEAN

ANOVA

SV.	D.F.	SS	MS	F-COMPUTED	F-TABULATED	CONCLUSION
BLOCK						
TREATMENT						
ERROR						
TOTAL						

Appendix II

TABULATION FORM FOR TREATMENT AVERAGES

Title _____

Crop _____ Researcher(s) _____

Location _____ _____

Treatment : Rate : EVALUATION DETAILS

General Information

Soil Type _____ Equipment Used _____
Irrigation Type _____
Method of Application _____

Appendix I

Correction factor, A, for adjustment of grain weight at a given moisture content to grain weight at 14% moisture content (After Gomez, 1972).

Moisture (%)	A	Moisture (%)	A	Moisture (%)	A	Moisture (%)	A
10.00	1.0465	12.40	1.0186	14.80	0.9907	17.20	0.9628
10.04	1.0460	12.44	1.0181	14.84	.9902	17.24	.9623
10.08	1.0456	12.48	1.0177	14.88	.9898	17.28	.9619
10.12	1.0451	12.52	1.0172	14.92	.9893	17.32	.9614
10.16	1.0447	12.56	1.0167	14.96	.9888	17.36	.9609
10.20	1.0442	12.60	1.0163	15.00	.9884	17.40	.9605
10.24	1.0447	12.64	1.0158	15.04	.9879	17.44	.9600
10.28	1.0433	12.68	1.0153	15.08	.9874	17.48	.9595
10.32	1.0428	12.72	1.0149	15.12	.9870	17.52	.9591
10.36	1.0423	12.76	1.0144	15.16	.9865	17.56	.9586
10.40	1.0419	12.80	1.0140	15.20	.9860	17.60	.9581
10.44	1.0414	12.84	1.0135	15.24	.9856	17.64	.9577
10.48	1.0409	12.88	1.0130	15.28	.9851	17.68	.9572
10.52	1.0405	12.92	1.0125	15.32	.9847	17.72	.9567
10.56	1.0400	12.96	1.0121	15.36	.9842	17.76	.9563
10.60	1.0395	13.00	1.0116	15.40	.9837	17.80	.9558
10.64	1.0391	13.04	1.0112	15.44	.9833	17.84	.9553
10.68	1.0386	13.08	1.0107	15.48	.9828	17.88	.9549
10.72	1.0381	13.12	1.0102	15.52	.9823	17.92	.9544
10.76	1.0377	13.16	1.0098	15.56	.9819	17.96	.9540
10.80	1.0372	13.20	1.0093	15.60	.9814	18.00	.9535
10.84	1.0367	13.24	1.0089	15.64	.9809	18.04	.9530
10.92	1.0363	13.28	1.0084	15.68	.9805	18.08	.9526
10.96	1.0358	13.32	1.0079	15.72	.9800	18.12	.9521
11.00	1.0353	13.36	1.0074	15.76	.9795	18.16	.9516
11.04	1.0349	13.40	1.0070	15.80	.9791	18.20	.9512
11.08	1.0344	13.44	1.0065	15.84	.9786	18.24	.9507
11.12	1.0340	13.48	1.0060	15.88	.9782	18.28	.9502
11.16	1.0335	13.52	1.0056	15.92	.9777	18.32	.9498
11.20	1.0330	13.56	1.0051	15.96	.9772	18.36	.9493
11.24	1.0326	13.60	1.0047	16.00	.9767	18.40	.9488
11.28	1.0321	13.64	1.0042	16.04	.9763	18.44	.9484
11.32	1.0316	13.68	1.0037	16.08	.9758	18.48	.9479
11.36	1.0312	13.72	1.0033	16.12	.9749	18.52	.9474
11.40	1.0307	13.76	1.0028	16.16	.9744	18.56	.9470
11.44	1.0302	13.80	1.0023	16.20	.9740	18.60	.9465
11.48	1.0298	13.84	1.0019	16.24	.9735	18.64	.9460
11.52	1.0293	13.88	1.0014	16.28	.9730	18.68	.9456
11.56	1.0288	13.92	1.0009	16.32	.9726	18.72	.9451
11.60	1.0284	13.96	1.0005	16.36	.9721	18.76	.9447
11.64	1.0279	14.00	1.0000	16.40	.9716	18.80	.9442
11.68	1.0274	14.04	0.9995	16.44	.9716	18.84	.9437

Correction factor, A, for adjustment of grain weight at a given moisture content to grain weight at 14% moisture content (after Gomez, 1972).

Moisture (%)	A	Moisture (%)	A	Moisture (%)	A	Moisture (%)	A
11.72	1.0270	14.08	0.9991	16.48	.9712	18.88	.9433
11.76	1.0260	14.16	0.9981	16.56	.9702	18.96	.9423
11.80	1.0256	14.20	0.9977	16.60	.9698	19.00	.9419
11.84	1.0251	14.24	0.9972	16.64	.9693	19.04	.9414
11.88	1.0247	14.28	0.9967	16.68	.9688	19.08	.9409
11.92	1.0242	14.32	0.9963	16.72	.9684	19.12	.9405
11.96	1.0237	14.36	0.9958	16.76	.9679	19.16	.9400
12.00	1.0232	14.40	0.9953	16.80	.9674	19.20	.9395
12.04	1.0228	14.44	0.9949	16.84	.9670	19.24	.9391
12.08	1.0223	14.48	0.9944	16.88	.9665	19.28	.9386
12.12	1.0219	14.52	0.9940	16.92	.9660	19.32	.9381
12.16	1.0214	14.56	0.9935	16.96	.9656	19.36	.9377
12.20	1.0209	14.60	0.9930	17.00	.9651	19.40	.9372
12.24	1.0205	14.64	0.9926	17.04	.9647	19.44	.9367
12.28	1.0200	14.68	0.9921	17.08	.9642	19.48	.9363
12.32	1.0195	14.72	0.9916	17.12	.9637	19.52	.9358
12.36	1.0191	14.76	0.9912	17.16	.9633	19.56	.9353

Appendix II

ABRIDGED TABLE OF 5% AND 1% POINTS FOR THE DISTRIBUTION OF F

Denominator d.f. (Error d.f.)		Numerator d.f. (Treatment d.f.)															
		1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24
5	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.78	4.74	4.70	4.68	4.64	4.60	4.56	4.53
	.01	16.26	13.27	12.06	11.39	10.97	10.67	10.45	10.27	10.15	10.05	9.96	9.89	9.77	9.68	9.55	9.47
6	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.03	4.00	3.96	3.92	3.87	3.82
	.01	13.74	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.79	7.72	7.60	7.52	7.39	7.31
7	.05	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.63	3.60	3.57	3.52	3.49	3.44	3.41
	.01	12.25	9.55	8.45	7.85	7.46	7.19	7.00	6.84	6.71	6.62	6.54	6.47	6.35	6.27	6.15	6.07
8	.05	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.34	3.31	3.28	3.23	3.20	3.15	3.12
	.01	11.26	8.65	7.59	7.01	6.63	6.37	6.19	6.03	5.91	5.82	5.74	5.67	5.56	5.48	5.36	5.28
9	.05	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.13	3.10	3.07	3.02	2.98	2.93	2.90
	.01	10.56	8.02	6.99	6.42	6.06	5.80	5.62	5.47	5.35	5.26	5.18	5.11	5.00	4.92	4.80	4.73
10	.05	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.97	2.94	2.91	2.86	2.82	2.77	2.74
	.01	10.04	7.56	6.55	5.99	5.64	5.39	5.21	5.06	4.95	4.85	4.78	4.71	4.60	4.52	4.41	4.33
11	.05	4.96	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.86	2.82	2.79	2.74	2.70	2.65	2.61
	.01	9.65	7.20	6.22	5.67	5.32	5.07	4.88	4.74	4.63	4.54	4.46	4.40	4.29	4.11	4.10	4.02
12	.05	4.75	3.88	3.49	3.26	3.11	3.00	2.92	2.85	2.80	2.76	2.72	2.69	2.64	2.60	2.54	2.50
	.01	9.33	6.93	5.95	5.41	5.06	4.82	4.65	4.50	4.39	4.30	4.22	4.16	4.05	3.98	3.86	3.78
13	.05	4.67	3.80	3.41	3.18	3.02	2.92	2.84	2.77	2.72	2.67	2.63	2.60	2.55	2.51	2.46	2.46 (?)
	.01	9.07	6.70	5.74	5.20	4.86	4.62	4.44	4.30	4.19	4.10	4.02	3.96	3.85	3.78	3.67	3.59
14	.05	4.60	3.74	3.34	3.11	2.96	2.85	2.77	2.70	2.65	2.60	2.56	2.53	2.48	2.44	2.39	2.35
	.01	8.86	6.51	5.56	5.03	4.69	4.46	4.28	4.14	4.03	3.94	3.86	3.80	3.70	3.62	3.51	3.43
15	.05	4.54	3.68	3.29	3.06	2.90	2.79	2.70	2.64	2.59	2.55	2.51	2.48	2.43	2.39	2.33	2.29
	.01	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.73	3.67	3.56	3.48	3.36	3.29
16.	.05	4.49	3.62	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.45	2.42	2.37	2.33	2.28	2.24
	.01	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.61	3.55	3.45	3.37	3.25	3.18
17	.05	4.45	3.59	3.20	2.96	2.81	2.70	2.62	2.55	2.50	2.45	2.41	2.38	2.33	2.29	2.23	2.19
	.01	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.52	3.45	3.35	3.27	3.16	3.08
18	.05	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.37	2.34	2.29	2.25	2.19	2.15
	.01	8.28	6.01	5.09	4.58	4.25	4.01	3.85	3.71	3.60	3.51	3.44	3.37	3.27	3.19	3.07	3.00

ABRIDGED TABLE OF 5% AND 1% POINTS FOR THE DISTRIBUTION OF F

Denominator d.f. (Error d.f.)		Numerator d.f. (Treatment d.f.)															
		1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24
19	.05	4.38	3.52	3.13	2.90	2.74	2.63	2.55	2.48	2.43	2.38	2.34	2.31	2.26	2.21	2.15	2.11
	.01	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.42	3.36	3.30	3.19	3.12	3.00	2.92
20	.05	4.35	3.49	3.10	2.87	2.71	2.60	2.52	2.45	2.40	2.35	2.31	2.28	2.23	2.18	2.12	2.08
	.01	8.10	5.85	4.94	4.43	4.10	3.87	3.71	3.56	3.45	3.37	3.30	3.23	3.13	3.05	2.94	2.86
21	.05	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.28	2.25	2.20	2.15	2.09	2.05
	.01	8.02	5.78	4.87	4.37	4.04	3.81	3.65	3.51	3.40	3.31	3.24	3.17	3.07	2.99	2.88	2.80
22	.05	4.30	3.44	3.05	2.82	2.66	2.55	2.47	2.40	2.35	2.30	2.26	2.23	2.18	2.13	2.07	2.03
	.01	7.94	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.18	3.12	3.02	2.94	2.83	2.75
23	.05	4.28	3.42	3.03	2.80	2.64	2.53	2.45	2.38	2.32	2.28	2.24	2.20	2.14	2.10	2.04	2.00
	.01	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.14	3.07	2.97	2.89	2.78	2.70
24	.05	4.26	3.40	3.01	2.78	2.62	2.51	2.43	2.36	2.30	2.26	2.22	2.18	2.13	2.09	2.02	1.98
	.01	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.25	3.17	3.09	3.03	2.93	2.85	2.74	2.66
25	.05	4.24	3.38	2.99	2.76	2.60	2.49	2.41	2.34	2.28	2.24	2.20	2.16	2.11	2.06	2.00	1.96
	.01	7.77	5.57	4.68	4.18	3.86	3.63	3.46	3.32	3.21	3.13	3.05	2.99	2.89	2.81	2.70	2.62
26	.05	4.22	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15	2.10	2.05	1.99	1.95
	.01	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.17	3.09	3.02	2.96	2.77	2.66	2.58	2.50
27	.05	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.30	2.25	2.20	2.16	2.13	2.08	2.03	1.97	1.93
	.01	7.68	5.49	4.60	4.11	3.79	3.56	3.39	3.26	3.14	3.06	2.98	2.93	2.83	2.74	2.63	2.55
28	.05	4.20	3.34	2.95	2.71	2.56	2.44	2.36	2.29	2.24	2.19	2.15	2.12	2.06	2.02	1.96	1.91
	.01	7.64	5.45	4.57	4.07	3.76	3.53	3.36	3.23	3.11	3.03	2.95	2.90	2.80	2.71	2.60	2.52
29	.05	4.18	3.33	2.93	2.70	2.54	2.43	2.35	2.28	2.22	2.18	2.14	2.10	2.05	2.00	1.94	1.90
	.01	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.08	3.00	2.92	2.87	2.77	2.68	2.57	2.49
30	.05	4.17	3.32	2.92	2.69	2.53	2.42	2.34	2.27	2.21	2.16	2.12	2.09	2.04	1.99	1.93	1.89
	.01	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.06	2.98	2.90	2.84	2.74	2.66	2.55	2.47
32	.05	4.15	3.30	2.90	2.67	2.51	2.40	2.32	2.25	2.19	2.14	2.10	2.07	2.02	1.97	1.91	1.86
	.01	7.50	5.34	4.46	3.97	3.66	3.42	3.25	3.12	3.01	2.94	2.86	2.80	2.70	2.62	2.51	2.42
34	.05	4.13	3.28	2.88	2.65	2.49	2.38	2.30	2.23	2.17	2.12	2.08	2.05	2.00	1.95	1.89	1.84
	.01	7.44	5.29	4.42	3.95	3.61	3.38	3.21	3.08	2.97	2.89	2.82	2.76	2.66	2.58	2.47	2.38
36	.05	4.11	3.26	2.86	2.63	2.48	2.36	2.28	2.21	2.15	2.10	2.06	2.03	1.98	1.93	1.87	1.82
	.01	7.39	5.25	4.38	3.89	3.58	3.35	3.18	3.04	2.94	2.86	2.78	2.72	2.62	2.54	2.43	2.35

ABRIDGED TABLE OF 5% AND 1% POINTS FOR THE DISTRIBUTION OF F

Denominator d.f. (Error d.f.)		Numerator d.f. (Treatment d.f.)															
		1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24
38	.05	4.10	3.25	2.85	2.62	2.46	2.35	2.26	2.19	2.14	2.09	2.05	2.02	1.96	1.92	1.85	1.80
	.01	7.35	5.21	4.34	3.86	3.54	3.32	3.15	3.02	2.91	2.82	2.75	2.69	2.59	2.51	2.40	2.32
40	.05	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.07	2.04	2.00	1.95	1.90	1.84	1.79
	.01	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.88	2.80	2.73	2.66	2.56	2.49	2.37	2.29
42	.05	4.07	3.22	2.83	2.59	2.44	2.32	2.24	2.17	2.11	2.06	2.02	1.99	1.94	1.89	1.82	1.78
	.01	7.27	5.15	4.29	3.80	3.49	3.26	3.10	2.96	2.86	2.77	2.70	2.64	2.54	2.46	2.35	2.26
44	.05	4.06	3.21	2.83	2.56	2.43	2.31	2.23	2.16	2.10	2.05	2.01	1.98	1.92	1.88	1.81	1.76
	.01	7.24	5.12	4.26	3.78	3.46	3.24	3.07	2.94	2.84	2.75	2.68	2.62	2.52	2.44	2.32	2.24
46	.05	4.05	3.20	2.81	2.57	2.42	2.30	2.22	2.14	2.09	2.04	2.00	1.97	1.91	1.87	1.80	1.75
	.01	7.21	5.10	4.24	3.76	3.44	3.22	3.05	2.92	2.82	2.73	2.66	2.60	2.50	2.42	2.30	2.22
48	.05	4.04	3.19	2.80	2.56	2.41	2.30	2.21	2.14	2.08	2.03	1.99	1.96	1.90	1.86	1.79	1.74
	.01	7.19	5.08	4.22	3.74	3.42	3.20	3.04	2.90	2.80	2.71	2.64	2.58	2.48	2.40	2.28	2.20
50	.05	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.02	1.98	1.95	1.90	1.85	1.78	1.74
	.01	7.17	5.06	4.20	3.72	3.41	3.18	3.02	2.88	2.78	2.70	2.62	2.56	2.46	2.39	2.26	2.18
55	.05	4.02	3.17	2.78	2.54	2.38	2.27	2.18	2.11	2.05	2.00	1.97	1.93	1.88	1.83	1.76	1.72
	.01	7.12	5.01	4.16	3.68	3.37	3.15	2.98	2.85	2.75	2.66	2.59	2.53	2.43	2.35	2.23	2.15
60	.05	4.00	3.15	2.76	2.52	2.37	2.25	2.17	2.10	2.04	1.99	1.95	1.92	1.86	1.81	1.75	1.70
	.01	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.56	2.50	2.40	2.32	2.20	2.12

Appendix III
SIGNIFICANT STUDENTIZED RANGES FOR 5% AND 1% LEVEL NEW MULTIPLE-RANGE TEST

Error d.f.	Protection Level	2	3	4	5	6	7	8	9	10	12	14	16	18	20
1	.05	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	.01	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
2	.05	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
	.01	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
3	.05	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
	.01	8.26	8.5	8.6	8.7	8.8	8.9	8.9	9.0	9.0	9.0	9.1	9.2	9.3	9.3
4	.05	3.93	4.01	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02
	.01	6.51	6.8	6.9	7.0	7.1	7.1	7.2	7.2	7.3	7.3	7.4	7.4	7.5	7.5
5	.05	3.64	3.74	3.79	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
	.01	5.70	5.96	6.11	6.18	6.26	6.33	6.40	6.44	6.5	6.6	6.6	6.7	6.7	6.8
6	.05	3.46	3.58	3.64	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68
	.01	5.24	5.51	5.65	5.73	5.81	5.88	5.95	6.0	6.0	6.1	6.2	6.2	6.3	6.3
7	.05	3.35	3.47	3.54	3.58	3.60	3.61	3.61	3.61	3.61	3.61	3.61	3.61	3.61	3.61
	.01	4.95	5.22	5.37	5.45	5.53	5.61	5.69	5.73	5.8	5.8	5.9	5.9	6.0	6.0
8	.05	3.26	3.39	3.47	3.52	3.55	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
	.01	4.74	5.00	5.14	5.23	5.32	5.40	5.47	5.51	5.5	5.6	5.7	5.7	5.8	5.8
9	.05	3.20	3.34	3.41	3.47	3.50	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
	.01	4.60	4.86	4.99	5.08	5.17	5.25	5.32	5.36	5.4	5.5	5.5	5.6	5.7	5.7
10	.05	3.15	3.30	3.37	3.43	3.46	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
	.01	4.48	4.73	4.88	4.96	5.06	5.13	5.209	5.24	5.28	5.36	5.42	5.48	5.54	5.55

SIGNIFICANT STUDENTIZED RANGES FOR 5% AND 1% LEVEL NEW MULTIPLE-RANGE TEST

Error d.f.	Protection Level	p = number of means for range being tested													
		2	3	4	5	6	7	8	9	10	12	14	16	18	20
11	.05	3.11	3.27	3.35	3.39	3.43	3.44	3.45	3.46	3.46	3.46	3.46	3.46	3.47	3.48
	.01	4.39	4.63	4.77	4.86	4.94	5.01	5.06	5.12	5.15	5.24	5.28	5.34	5.38	5.39
12	.05	3.08	3.23	3.33	3.36	3.40	3.42	3.44	3.44	3.46	3.46	3.46	3.46	3.47	3.48
	.01	4.32	4.55	4.68	4.76	4.84	4.92	4.96	5.02	5.07	5.13	5.17	5.22	5.24	5.26
13	.05	3.06	3.21	3.30	3.35	3.38	3.41	3.42	3.44	3.45	3.45	3.46	3.46	3.47	3.47
	.01	4.26	4.48	4.62	4.69	4.74	4.84	4.88	4.94	4.98	5.04	5.08	5.13	5.14	5.15
14	.05	3.08	3.18	3.27	3.33	3.37	3.39	3.41	3.42	3.44	3.45	3.46	3.46	3.47	3.47
	.01	4.21	4.42	4.55	4.63	4.70	4.78	4.83	4.87	4.91	4.96	5.00	5.04	5.06	5.07
15	.05	3.01	3.16	3.25	3.31	3.36	3.38	3.40	3.42	3.43	3.44	3.45	3.46	3.47	3.47
	.01	4.17	4.37	4.50	4.58	4.64	4.72	4.77	4.81	4.84	4.90	4.94	4.97	4.99	5.00
16	.05	3.00	3.15	3.23	3.30	3.34	3.37	3.39	3.41	3.43	3.44	3.45	3.46	3.47	3.47
	.01	4.13	4.34	4.45	4.54	4.60	4.67	4.72	4.76	4.79	4.84	4.88	4.91	4.93	4.94
17	.05	2.98	3.13	3.22	3.28	3.33	3.36	3.38	3.40	3.42	3.44	3.45	3.46	3.47	3.47
	.01	4.10	4.30	4.41	4.50	4.56	4.63	4.68	4.72	4.75	4.80	4.83	4.86	4.88	4.89
18	.05	2.97	3.12	3.21	3.27	3.32	3.35	3.37	3.39	3.41	3.43	3.45	3.46	3.47	3.47
	.01	4.07	4.27	4.38	4.46	4.53	4.59	4.61	4.68	4.71	4.76	4.79	4.82	4.84	4.85
19	.05	2.96	3.11	3.19	3.26	3.31	3.35	3.36	3.39	3.41	3.43	3.44	3.46	3.47	3.47
	.01	4.05	4.24	4.35	4.43	4.50	4.56	4.58	4.64	4.67	4.72	4.76	4.79	4.81	4.82
20	.05	2.95	3.10	3.18	3.25	3.30	3.34	3.35	3.38	3.40	3.43	3.44	3.46	3.46	3.47
	.01	4.02	4.22	4.33	4.40	4.47	4.53	4.53	4.61	4.65	4.69	4.73	4.76	4.78	4.79

SIGNIFICANT STUDENTIZED RANGES FOR 5% AND 1% LEVEL NEW MULTIPLE-RANGE TEST

Error d.f.	Protection Level	p = number of means for range being tested													
		2	3	4	5	6	7	8	9	10	12	14	16	18	20
21	.05	2.93	3.08	3.17	3.24	3.29	3.32	3.35	3.37	3.39	3.42	3.44	3.45	3.46	3.47
	.01	3.99	4.17	4.28	4.36	4.42	4.48	4.53	4.57	4.60	4.65	4.68	4.71	4.74	4.75
22	.05	2.92	3.07	3.15	3.22	3.28	3.31	3.34	3.37	3.38	3.41	3.44	3.45	3.46	3.47
	.01	3.96	4.14	4.24	4.33	4.39	4.44	4.49	4.53	4.57	4.62	4.64	4.67	4.70	4.72
26	.05	2.91	3.06	3.14	3.21	3.27	3.30	3.34	3.36	3.38	3.41	3.43	3.45	3.46	3.47
	.01	3.93	4.11	4.21	4.30	4.36	4.41	4.46	4.50	4.53	4.58	4.62	4.65	4.67	4.69
28	.05	2.90	3.04	3.13	3.20	3.26	3.30	3.33	3.35	3.37	3.40	3.43	3.45	3.46	3.47
	.01	3.91	4.06	4.18	4.23	4.34	4.39	4.43	4.47	4.51	4.56	4.60	4.62	4.65	4.67
30	.05	2.89	3.04	3.12	3.20	3.25	3.29	3.32	3.35	3.37	3.40	3.43	3.44	3.46	3.47
	.01	3.89	4.06	4.16	4.22	4.32	4.36	4.41	4.45	4.48	4.54	4.58	4.61	4.63	4.65
40	.05	2.86	3.01	3.10	3.17	3.22	3.27	3.30	3.33	3.35	3.39	3.42	3.44	3.46	3.47
	.01	3.82	3.99	4.10	4.17	4.24	4.30	4.34	4.37	4.41	4.46	4.51	4.54	4.57	4.59
60	.05	2.83	2.98	3.08	3.14	3.20	3.24	3.28	3.31	[illegible]	3.37	3.40	3.43	3.45	3.47
	.01	3.76	3.92	4.03	4.12	4.17	4.23	4.27	4.31	[illegible]4	4.39	4.44	4.47	4.50	4.53
100	.05	2.80	2.95	3.05	3.12	3.18	3.22	3.26	3.29	3.32	3.36	3.40	3.42	3.45	3.47
	.01	3.71	3.86	3.98	4.06	4.11	4.17	4.21	4.25	4.29	4.35	4.38	4.42	4.45	4.48
00	.05	2.77	2.92	3.02	3.09	3.15	3.19	3.23	3.26	3.29	3.34	3.38	3.41	3.44	3.47
	.01	3.64	3.80	3.90	3.98	4.04	4.09	4.14	4.17	4.20	4.26	4.31	4.34	4.38	4.41

Appendix IV

The Arcsin $\sqrt{\text{Percentage}}$ Transformation

%	0	1	2	3	4	5	6	7	8	9
0.0	0	0.57	0.81	0.99	1.15-	1.28	1.40	1.52	1.62	1.72
0.1	1.81	1.90	1.99	2.07	2.14	2.22	2.29	2.36	2.43	2.50
0.2	2.56	2.63	2.69	2.75-	2.81	2.87	2.92	2.98	3.03	3.09
0.3	3.14	3.19	3.24	3.29	3.34	3.39	3.44	3.49	3.53	3.58
0.4	3.63	3.67	3.72	3.76	3.80	3.85-	3.89	3.93	3.97	4.01
0.5	4.05+	4.09	4.13	4.17	4.21	4.25+	4.29	4.33	4.37	4.40
0.6	4.44	4.48	4.52	4.55+	4.59	4.62	4.66	4.69	4.73	4.76
0.7	4.80	4.83	4.87	4.90	4.93	4.97	5.00	5.03	5.07	5.10
0.8	5.13	5.16	5.20	5.23	5.26	5.29	5.32	5.35+	5.38	5.41
0.9	5.44	5.47	5.50	5.53	5.56	5.59	5.62	5.65+	5.68	5.71
1	5.74	6.02	6.29	6.55-	6.80	7.04	7.27	7.49	7.71	7.92
2	8.13	8.33	8.53	8.72	8.91	9.10	9.28	9.46	9.63	9,81
3	9.98	10.14	10.31	10.47	10.63	10.78	10.94	11.09	11.24	11.39
4	11.54	11.68	11.83	11.97	12.11	12.25-	12.39	12.52	12.66	12.79
5	12.92	13.05+	13.18	13.31	13.44	13.56	13.69	13.81	13.94	14.06
6	14.18	14.30	14.42	14.54	14.65+	14.77	14.89	15.00	15.12	15.23
7	15.34	15.45+	15.56	15.68	15.79	15.89	16.00	16.11	16.22	16.32
8	16.43	16.54	16.64	16.74	16.85-	16.95+	17.05+	17.16	17.26	17.36
9	17.46	17.56	17.66	17.76	17.85+	17.95+	18.05-	18.15-	18.24	18.34
10	18.44	18.53	18.63	18.72	18.81	18.91	19.00	19.09	19.19	19.28
11	19.37	19.46	19.55+	19.64	19.73	19.82	19.91	20.00	20.09	20.18
12	20.27	20.36	20.44	20.53	20.62	20.70	20.79	20.88	20.96	21.05-
13	21.13	21.22	21.30	21.39	21.47	21.56	21.64	21.72	21.81	21.89
14	21.97	22.06	22.14	22.22	22.30	22.38	22.46	22.55-	22.63	22.71
15	22.79	22.87	22.95-	23.03	23.11	23.19	23.26	23.34	23.42	23.50
16	23.58	23.66	23.73	23.81	23.89	23.97	24.04	24.12	24.20	24.27
17	24.35+	24.43	24.50	24.58	24.65+	24.73	24.80	24.88	24.95+	25.03
18	25.10	25.18	25.25+	25.33	25.40	25.48	25.55-	25.62	25.70	25.77
19	25.84	25.92	25.99	26.06	26.13	26.21	26.28	26.35-	26.42	26.49
20	26.56	26.64	26.71	26.78	26.85+	26.92	26.99	27.06	27.13	27.20
21	27.28	27.35-	27.42	27.49	27.56	27.63	27.69	27.76	27.83	27.90
22	27.97	28.04	28.11	28.18	28.25-	28.32	28.38	28.45+	28.52	28.59
23	28.66	28.73	28.79	28.86	28.93	29.00	29.06	29.13	29.20	29.27
24	29.33	29.40	29.47	29.53	29.60	29.67	29.73	29.80	29.87	29.93

%	0	1	2	3	4	5	6	7	8	9
25	30.00	30.07	30.13	30.20	30.26	30.33	30.40	30.46	30.53	30.59
26	30.66	30.72	30.79	30.85+	30.92	30.98	31.05-	31.11	31.18	31.24
27	31.31	31.37	31.44	31.50	31.56	31.63	31.69	31.76	31.82	31.88
28	31.95-	32.01	32.08	32.14	32.20	32.27	32.33	32.39	32.46	32.52
29	32.58	32.65-	32.71	32.77	32.83	32.90	32.96	33.02	33.09	33.15
30	33.21	33.27	33.34	33.40	33.46	33.52	33.58	33.65-	33.71	33.77
31	33.83	33.89	33.96	34.02	34.08	34.14	34.20	34.27	34.33	34.39
32	34.45-	34.51	34.57	34.63	34.70	34.76	34.82	34.88	34.94	35.00
33	35.06	35.12	35.18	35.24	35.30	35.37	35.43	35.49	35.55-	35.61
34	35.67	35.73	35.79	35.85-	35.91	35.97	36.03	36.09	36.15+	36.21
35	36.27	36.33	36.39	36.45+	36.51	36.57	36.63	36.69	36.75+	36.81
36	36.87	36.93	36.99	37.05-	37.11	37.17	37.23	37.29	37.35-	37.41
37	37.47	37.52	37.58	37.64	37.70	37.76	37.82	37.88	37.94	38.00
38	38.06	38.12	38.17	38.23	38.29	38.35+	38.41	38.47	38.53	38.59
39	38.65-	38.70	38.76	38.82	38.88	38.94	39.00	39.06	39.11	39.17
40	39.23	39.29	39.35-	39.41	39.47	39.52	39.56	39.64	39.70	39.76
41	39.82	39.87	39.93	39.99	40.05-	40.11	40.16	40.22	40.28	40.34
42	40.40	40.46	40.51	40.57	40.63	40.69	40.74	40.80	40.86	40.92
43	40.98	41.03	41.09	41.15-	41.21	41.27	41.32	41.38	41.44	41.50
44	41.55+	41.61	41.67	41.73	41.78	41.84	41.90	41.96	42.02	42.07
45	42.13	42.19	42.25-	42.30	42.36	42.42	42.48	42.53	42.59	42.65-
46	42.71	42.76	42.82	42.88	42.94	42.99	43.05-	43.11	43.17	43.22
47	43.28	43.34	43.39	43.45+	43.51	43.57	43.62	43.68	43.74	43.80
48	43.85+	43.91	43.97	44.03	44.08	44.14	44.20	44.25+	44.31	44.37
49	44.43	44.48	44.54	44.60	44.66	44.71	44.77	44.83	44.89	44.94
50	45.00	45.06	45.11	45.17	45.23	45.29	45.34	45.40	45.46	45.52
51	45.57	45.63	45.69	45.75-	45.80	45.86	45.92	45.97	46.03	46.09
52	46.15-	46.20	46.26	46.32	46.38	46.43	46.49	46.55-	46.61	46.66
53	46.72	46.78	46.83	46.89	46.95+	47.01	47.06	47.12	47.18	47.24
54	47.29	47.35+	47.41	47.47	47.52	47.58	47.64	47.70	47.75+	47.81
55	47.87	47.93	47.98	48.04	48.10	48.16	48.22	48.27	48.33	48.39
56	48.45-	48.50	48.56	48.62	48.68	48.73	48.79	48.85+	48.91	48.97
57	49.02	49.08	49.14	49.20	49.26	49.31	49.37	49.43	49.49	49.54
58	49.60	49.66	49.72	49.78	49.84	49.89	49.95+	50.01	50.07	50.13
59	50.18	50.24	50.30	50.36	50.42	50.48	50.53	50.59	50.65+	50.71
60	50.77	50.83	50.89	50.94	51.00	51.06	51.12	51.18	51.24	51.30

%	0	1	2	3	4	5	6	7	8	9
61	51.35+	51.41	51.47	51.53	51.59	51.65-	51.71	51.77	51.83	51.88
62	51.94	52.00	52.06	52.12	52.18	52.24	52.30	52.36	52.42	52.48
63	52.53	52.59	52.65+	52.71	52.77	52.83	52.89	52.95+	53.01	53.07
64	53.13	53.19	53.25-	53.31	53.37	53.43	53.49	53.55-	53.61	53.67
65	53.73	53.79	53.85-	53.91	53.97	54.03	54.09	54.15+	54.21	54.27
66	54.33	54.39	54.45+	54.51	54.57	54.63	54.70	54.76	54.82	54.88
67	54.94	55.00	55.06	55.12	55.18	55.24	55.30	55.37	55.43	55.49
68	55.55+	55.61	55.67	55.73	55.80	55.86	55.92	55.98	56.04	56.11
69	56.17	56.23	56.29	56.35+	56.42	56.48	56.54	56.60	56.66	56.73
70	56.79	56.85+	56.91	56.98	57.04	57.10	57.17	57.23	57.29	57.35+
71	57.42	57.48	57.54	57.61	57.67	57.73	57.80	57.86	57.92	57.99
72	58.05+	58.12	58.18	58.24	58.31	58.37	58.44	58.50	58.56	58.63
73	58.69	58.76	58.82	58.89	58.95+	59.02	59.08	59.15-	59.21	59.28
74	59.34	59.41	59.47	59.54	59.60	59.67	59.74	59.80	59.87	59.93
75	60.00	60.07	60.13	60.20	60.27	60.33	60.40	60.47	60.53	60.60
76	60.67	60.73	60.80	60.87	60.94	61.00	61.07	61.14	61.21	61.27
77	61.34	61.41	61.48	61.55-	61.62	61.68	61.75+	61.82	61.89	61.96
78	62.03	62.10	62.17	62.24	62.31	62.37	62.44	62.51	62.58	62.65+
79	62.72	62.80	62.87	62.94	63.01	63.08	63.15-	63.22	63.29	63.36
80	63.44	63.51	63.58	63.65+	63.72	63.79	63.87	63.94	64.01	64.08
81	64.16	64.23	64.30	64.38	64.45+	64.52	64.60	64.67	64.75-	64.82
82	64.90	64.97	65.05-	65.12	65.20	65.27	65.35-	65.42	65.50	65.57
83	65.65	65.73	65.80	65.88	65.96	66.03	66.11	66.19	66.27	66.34
84	66.42	66.50	66.58	66.66	66.74	66.81	66.89	66.97	67.05+	67.13
85	67.21	67.29	67.37	67.45+	67.54	67.62	67.70	67.78	67.86	67.94
86	68.03	68.11	68.19	68.28	68.36	68.44	68.53	68.61	68.70	68.78
87	68.87	68.95+	69.04	69.12	69.21	69.30	69.38	69.47	69.56	69.64
88	69,73	69.82	69.91	70.00	70.09	70.18	70.27	70.36	70.45-	70.54
89	70.63	70.72	70.81	70.91	71.00	71.09	71.19	71.28	71.37	71.47
90	71.56	71.66	71.76	71.85+	71.95+	72.05-	72.15-	72.24	72.34	72.44
91	72.54	72.64	72.74	72.84	72.95-	73.05-	73.15+	73.26	73.36	73.46
92	73.57	73.68	73.78	73.89	74.00	74.11	74.21	74.32	74.44	74.55-
93	74.66	74.77	74.88	75.00	75.11	75.23	75.35-	75.46	75.58	75.70
94	75.82	75.94	76.06	76.19	76.31	76.44	76.56	76.69	76.82	76.95-

%	0	1	2	3	4	5	6	7	8	9
95	77.08	77.21	77.34	77.48	77.61	77.75+	77.89	78.03	78.17	78.32
96	78.46	78.61	78.76	78.91	79.06	79.22	79.37	79.53	79.69	79.86
97	80.02	80.19	80.37	80.54	80.72	80.90	81.09	81.28	81.47	81.67
98	81.87	82.08	82.29	82.51	82.73	82.96	83.20	83.45+	83.71	83.98
99.0	84.26	84.29	84.32	84.35-	84.38	84.41	84.44	84.47	84.50	84.53
99.1	84.56	84.59	84.62	84.65-	84.68	84.71	84.74	84.77	84.80	84.84
99.2	84.87	84.90	84.93	84.97	85.00	85.03	85.07	85.10	85.13	85.17
99.3	85.20	85.24	85.27	85.31	85.34	85.38	85.41	85.45-	85.48	85.52
99.4	85.56	85.60	85.63	85.67	85.71	85.75-	85.79	85.83	85.87	85.91
99.5	85.95-	85.99	86.03	86.07	86.11	86.15-	86.20	86.24	86.28	86.33
99.6	86.37	86.42	86.47	86.51	86.56	86.61	86.66	86.71	86.76	86.81
99.7	86.86	86.91	86.97	87.02	87.08	87.13	87.19	87.25+	87.31	87.37
99,8	87.44	87.50	87.57	87.64	87.71	87.78	87.86	87.93	88.01	88.10
99,9	88,19	88,28	88,38	88,48	88,60	88,72	88.85+	89.01	89.19	89.43
100.0	90.00									

Appendix V

RANDOM NUMBERS

Line/Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
151	38128	51178	75096	13609	16110	73533	42564	59870	29399	67834	91055	89917	51096	89011
152	60950	00455	73254	96067	50717	13878	03216	78274	65863	37011	91283	33914	91303	49326
153	90524	17320	29832	96118	75792	25326	22940	24904	80523	38929	91374	55597	97567	38914
154	49897	18278	67160	39408	97056	43517	84426	59650	20247	19293	02019	14790	02852	05819
155	18494	99209	81060	19488	65596	59787	47939	91225	98768	43688	00438	05548	09443	82897
156	65373	72984	30171	37741	70203	94094	87261	30056	58124	70138	18936	02138	59372	09075
157	40653	12843	04213	70925	95360	55774	76439	61768	52817	81151	52188	31940	54273	49032
158	51638	22238	56344	44587	83231	50317	74541	07719	25472	41602	77318	15145	57515	07633
159	69742	99303	62578	83575	30337	07488	51941	84316	42067	49692	28616	29101	03013	73449
160	58012	74072	67488	74580	47992	69482	58624	17106	47538	13452	22620	24260	40155	74716
161	18348	19855	42887	08279	43206	47077	42637	45606	00011	20662	14642	49984	94509	56300
162	59614	09193	58064	29086	44385	45740	70752	05663	49081	26960	57454	99264	24142	74648
163	75688	28630	39310	52897	62748	72658	98059	67202	72789	01869	13496	14663	87645	89713
164	13941	77802	69101	70061	35460	34576	15412	81304	58757	35498	94830	75521	00603	97701
165	96656	86420	96475	86458	54463	96419	55417	41375	76886	19008	66877	35934	59301	00497
166	03363	82042	15942	14549	38324	87094	19069	67590	11087	68517	22591	65232	85915	91499
167	70366	08390	69155	25496	13240	57407	91407	49160	07379	34444	94567	66035	38918	65708
168	47870	36605	12927	16043	53257	93796	52721	73120	48025	76074	95605	67422	41646	14557
169	79504	77606	22761	30518	28373	73898	30550	76684	77366	32276	04690	61667	64798	66276
170	46967	74841	50923	15339	37755	98995	40162	89561	69199	41257	11647	47603	48779	97907
171	14558	50769	35444	59030	87516	48193	02945	00922	48189	04724	21263	20892	92955	90251
172	12440	25057	01132	38611	28135	68089	10954	10097	54243	06460	50856	65435	79377	53890
173	32293	29938	68653	10497	98919	46587	77701	99119	93165	67788	17638	23097	21468	36992
174	10640	21875	72462	77981	56550	55999	87310	69643	45124	00349	25748	00844	96831	30651
175	47615	23169	39571	56972	20628	21788	51736	33133	72696	32605	41569	76148	91544	21121

ANNEX III

DISCUSSION DOCUMENT ON DRAFT REVISED

GUIDELINES FOR PESTICIDE BIOEFFICACY EVALUATION

General Requirements:

A) Experimental designs (any of the following)

1. Completely Randomized Design (CRD)
2. Randomized Complete Block Design (RCBD)
3. Latin Square (LS)
4. Split-plot design
5. Factorial (for rodenticides)

B) Experimental data not older than three (3) years

C) Statistical analysis and appropriate tests of means

D) Economic analysis (requirement for inclusion in NFAC food programs

E) Additional information - amount (a.i. per hectare) and timing of application of other pesticides.

SPECIFIC REQUIREMENTS FOR RICE

REQUIREMENTS	R I C E		
	HERBICIDES	FUNGICIDES	INSECTICIDES
1. Number of trials a) No. of seasons b) No. of locations c) No. of replicates	2 (1 wet and 1 dry) 3 3-4	2 (1 wet and 1 dry) 3 at least 3	1 (preferably wet) 2 3-4
2. Plot size	20 sq. m. (4 m x 5 m)	20 sq. m. (4 m x 5 m)	20 sq. m. (4 m x 5 m)
3. Adequate infection/ infestation levels	Natural weed infestation of at least 25% ground cover in the unweeded plot at 15 DAT or DAP	Natural disease infection (at least 50% of the untreated control)	Adequate insect infestation levels that allow significant differences between insecticidal treatments. Cage data after field biological efficacy trial will be accepted in the absence of adequate infestation level.
4. Reference Plots	a) Control plots 1. Unweeded control 2. Handweeded control b) Reference treatments-any of the appropriate M99 Recommended Herbicides (optional)	a) Untreated control plots b) Reference treatments (optional) 1. benomyl/thiophanate methyl for rice blast and bakanae 2. Iprodione for sheath blight	a) Untreated control plots b) Reference treatment (optional) 1. Carbofuran (for testing granular insecticides) 2. Monocrotophos (for testing sprayables)
5. Method of assessment	a) Weed count & weed weight by species using the quadrat method (50 cm x 50 cm quadrat) within 4-6 weeks after treatment. b) Crop injury and weed control rating scale using the European Weed Research Council (EWRC) rating scale (Appendix I) within 2-3 weeks after treatment. c) Tiller count-number of tillers per unit at 45 DAT. d) Grain yield (kg/ha)	a) No. of infected plants (25% incidence and/or rating scale of at least 3) 15 days after spray application on untreated control plots. b) Rating scale of 0-9 where 0 indicates no disease & 9 represents 100% infection or International Evaluation scale for Rice (1981). c) Yield in kg/ha taken from 5 center rows. d) Phytotoxicity rating (if any) follow the scale adapted for herbicides on rice.	a) Rice whorl maggot: 1. Visual grading of all leaves per hill based on the IRRI Standard Evaluation System. 2. Percent leaf damage per hill based on the two youngest leaves per plant. b) Leafhoppers and planthoppers 1. Percent virus - infected plants per plot, using the formula to estimate damage.(1) 2. To estimate insect population the following methods may be done:

(1) Per cent virus - infected plants = $\frac{\text{No. of damaged hills in sample are}}{\text{total no. of hills in sample area}} \times 100$

REQUIREMENTS	R I C E		
	HERBICIDES	FUNGICIDES	INSECTICIDES
			a) for the green leafhopper, net sweeping covering the front 180° of the operator, counting the number of hoppers caught per 10 to 20 sweeps in each plot. b) for brown planthopper visual counting per hill may be done by "slapping" the hill and estimating the number of hoppers falling in the water. c) <u>Stemborers</u>: 1. Estimation of damages using a sample area of at least 10 m^2 situated at the center, and calculating for the percent dead heart or white head (2) Dead heart is assessed twice at 35 and 50 DAT while percent white head is evaluated about 10 days before harvest. - Phytotoxicity rating (if any)

(2) Per cent dead-heart or white-head $= \frac{A \times 100}{(B) + (Y/10 \times D)}$

Where A = number of damaged tillers (or panicles) in sample area
B = total number of tillers (or panicles) in all damaged hills in sample area
Y = total number of tillers (or panicles) in five pairs of undamaged hills
D = total number of undamaged hills in sample area (minus missing and virus-infected hills)

RD/JMD/mcgo.*

SPECIFIC REQUIREMENTS FOR VEGETABLES

REQUIREMENTS	V E G E T A B L E S		
	HERBICIDES	FUNGICIDES/NEMATICIDES	INSECTICIDES
1. Number of Trials a) No. of seasons b) No. of locations c) No. of replicates	At least 2 (wet and dry if practical) 2 4	At least 2 (wet and dry if practical) 2 4	2 (wet and dry if practical) 2 3-4
2. Plot size	.75 m x 5.0 m for non-vine crops 1.0 m x 5.0 m for vine 4 m x 5 m for green corn	.75 m x 5.0 m for non-vine crops 1.0 m x 5.0 m for vine 4 m x 5 m for green corn	.75 m x 5.0 m for non-vine crops 1.0 m x 5.0 m for vine 4 m x 5 m for green corn
3. Adequate infection/ infestation level	Natural weed infestation of at least 25% ground cover in the unweeded plot at 15 DAP or DAT.	Adequate level of natural disease infection: a) The untreated control should have at least 50% infection. b) Record the initial and final nematode population levels	Adequate infestation level - where significant differences between insecticidal treatments occur; moderate infestation for cabbage and tomato.
4. References plots	a) Control plots 1. Unweeded 2. Handweeded three times before close-in time b) Reference treatments (optional) - see list of Reference treatments for vegetables	See list of reference treatments for vegetables (optional)	a) Control plots b) Reference treatments (optional) See list of reference treatments for vegetables
5. Method of Assessment	a) Primary data 1. Crop injury and weed control rating 2 weeks after herbicide application using the EWRC rating scale. (Appendix I)	a) Data based on not less than 20 randomly sampled plants per replicate. b) Indicate leaf infection index (most acceptable or appropriate index.)	a) Not less than 20 plants per treatment per replicate. b) Leaf (or fruit) injury index. c) Larval counts or number of insects before and after application, or tunnel counts.

REQUIREMENTS	V E G E T A B L E S		
	HERBICIDES	FUNGICIDES/NEMATICIDES	INSECTICIDES
(Method of Assessment)	2. Weed counts and weed biomass (by species) using a 50 cm x 50 cm quadrat at 30 to 45 DAT or DAP b) Supplementary data 1. Grain or fruit yield per plot 2. Computed grain or fruit yield per hectare	c) Indicate root gall rating index (Appendix III) and qualitative and quantitative yield data (for nematodes)	d) Yield

ADDITIONAL REQUIREMENTS FOR VEGETABLES

A. Fungicide/nematicide evaluation:

1. Name of crop and variety

2. Identification of the disease and pathoger

   a) accepted common name of disease

   b) name of pathogen

3. Application timing and frequency

   a) Record actual dates of application, frequency and number of application

   b) Record stage of plant growth

4. Phytotoxicity - record any abnormal growth of the treated plants

5. Environmental conditions - record data on temperature, soil moisture, precipitation, soil type, and pH, if available

B. Insecticide evaluation

1. Frequency of application (maximum)

   a) Cabbage - 10

   b) Legumes - 4

   c) cucurbits (thrips) - 3

   d) tomato - 8

REFERENCE TREATMENTS FOR VEGETABLES

HERBICIDES:

1. Trifluralin (preemergence) against grasses for transplanted tomatoes, cabbage, and mungbeans

2. Oxyfluorfen (7 DAT, broad spectrum) for transplanted onions

3. Atrazine (preemergence) against annual grasses (except R. exaltata) and broadleaves for green corn

4. Pendimethalin (preemergence) against annual grasses including R. exaltata for green corn

5. 2,4-D or MCPA (15-20 DAP) against broadleaves and sedges) - green corn

FUNGICIDES:

1. Late blight (white potato, tomato) chlorothalonil
2. Downy mildew (cucurbits) - mancozeb
3. Anthracnose (beans, pepper) - maneb, zineb
4. Leaf mold (tomato, okra) - mancozeb
5. Downy mildew (green/sweet corn) metalaxyl
6. Root knot (white potato, etc.) - carbofuran

INSECTICIDES:

1. Beans (bean pyralid, tomato fruitworm) - monocrotophos (last day of application two weeks before harvest)

2. Tomato (tomato fruitworm) - methomyl, tetrachlovinphos

3. Crucifers (diamond black moth) - decamethrin

4. Bulb crops (thrips) - methiocarb, profenofos

5. Cucurbits (thrips) - methiocarb, profenofos
   (fruitflies) - eugenol + malathion

6. White potato (cutworm) - chlorpyrifos

7. Sweet potato (sweet potato weevil) -isoxathion

8. Green corn (corn borer and corn seedling maggot) - carbofuran (there should be pre-harvest interval between last treatment and harvest)

SPECIFIC REQUIREMENTS FOR CORN

REQUIREMENTS	C O R N		
	HERBICIDES	FUNGICIDES	INSECTICIDES
1. Number of trials a) No. of seasons b) No. of locations c) No. of replicates	2 (1 wet and 1 dry) 2 4	2 (1 wet and 1 dry) 2 at least 3	2 (one wet or one dry or 2 wet seasons) 2 at least 3
2. Experimental design	Preferably RCB or split plot	Split-plot or RCB	CRD, RCB or LS
3. Plot size	20 sq. m. (4 m x 5 m)	Minimum of 20 sq. m.	20 sq. m. (4 m x 5 m)
4. Adequate infection/infestation level	Natural weed infestation of at least 25% ground cover in unweeded plot at 15 DAT	Natural infection - at least 50% of the untreated control. Point source inoculations	Adequate infestation levels To ensure comparison of effectiveness between insecticides, at least 100 larvae per 100 plants or 1 larvae per plant at both the tasselling and whorl stages or 100% plants infested at late whorlstage
5. Reference plots	a) Control plots: 1. Hand-weeding 2. No weeding b) Reference treatments (optional) (See list of Reference treatments for corn)	a) Untreated control plots b) Reference treatment Seed dressing 1. Metalaxyl (for downy mildew) 2. Captan (as a general seed protectant)	a) Control plots b) Reference treatments (See list of reference treatments for corn)
6. Method of assessment	a) Weed control rating by species and crop injury rating 2-3 weeks after herbicide treatment using EWRC rating scale (Appendix I). b) Weed count and dry weight by species per quadrat (.5 x .5 m) at 4-6 weeks after planting. c) Yield by plot using 2 center rows (actual yield per area and computed yield per hectare)	a) not less than 40 plants for observation per plot. b) Rating Scale: 1. For downy mildew - % infected plants or disease incidence. 2. For other fungal diseases - rating scale c. 0-7 (see App.III) c) Actual and computed yield d) Phytotoxicity rating.	a) Based on not less than 20 plants per replicate, randomly sampled (See Appendix V, VI or VII) b) Deadhearts for corn seedling maggot. c) Larval number before and after insecticide application for corn borer and other lepidopterus species; number of entrance holes and tunnels/cavities for borers and other lepidopterus species.

REQUIREMENTS	C O R N		
	HERBICIDES	FUNGICIDES	INSECTICIDES
			d) Number of infested ears for corn earworm. e) Yield kg or ton/hectare; marketable ears for green corn f) Phytotoxicity rating (if any).

REFERENCE TI ATMENTS FOR CORN

Herbicides: (Optional)

1. Atrazine (for grasses)
2. Atrazine fa 2,4-D (for grasses and broadleaves)
3. MCPA or 2,4-D (for broadleaves)
4. Pendimethalin for Rottboellia exaltata (aguingay)

Insecticides:

1. Carbofuran (Basal) for corn seedling maggots and white grubs
2. Carbofuran at whorl - 75% detaselling at taselling stage for corn borer and spraying taselled plants with chlopyrifos + ethyl BPMC (Brodan) or methomyl
3. Carbofuran-methomyl - for corn borer or corn earworm

Appendix I

The European Weed Research Council Rating System

A. Weed Control Rating Scale

Rating	% Weed Control	Description
1	100	Completely destroyed
2	96.5-99.0	Very good control
3	93.0-96.5	Good control
4	87.5-93.0	Satisfactory
5	80.0-87.5	Just satisfactory
6	70.0-80.0	Unsatisfactory
7	50.0-70.0	Poor
8	1.0-50.0	Very poor
9	0	As untreated

B. Crop Injury Rating Scale

Rating	% Crop injury	Description
1	0	No reduction or injury
2	1.0-3.5	Very slight discoloration, etc.
3	3.5-7.0	More severe, but not lasting
4	7.0-12.5	Moderate and more lasting
5	12.5-20.0	Medium and lasting
6	20.0-30.0	Heavy
7	30.0-50.0	Very heavy
8	50.0-99.0	Nearly destroyed
9	100	Completely destroyed

Appendix II

Rating Scale for Assessing Other Fungal Diseases of Corn Aside from Downy Mildew

Rating	Description (% diseased area relative to total leaf area)
0	No disease
1	1-5%
2	6-15%
3	16-25%
4	26-50%
5	51-75%
6	76-85%
7	86-100%

Appendix III

Root Gall Rating Index

Rating	Description
0	No galls of root system of test plants
1	10% of total root system galled
2	20% of total root system galled
3	50% of total root system galled
4	80% of total root system galled
5	100% of total root system galled

Appendix IV

IRRI Standard Evaluation Scale for Rice Maggot Damaged

Rating	Description (% Damage)
1	Less than 17 feeding lesions, small, pin head in size
3	1-5% feeding lesions about a centimeter in length
5	5-25% feeding lesions about a centimeter in length
7	25-50% feeding lesions occupying up to one half of the total leaf area but with no leaf breaking
9	50-100% feeding lesions severe, causing leaf curling and breaking in all leaves

Appendix V

Corn Borer Damage Rating Based On Leaf Injury

(Dolinka et al., 1973)

Rating	Description
1	Plants with rare and sporadic pin-head holes
2	Intermediate amount of pin-head holes
3	Plants with a lot of pin-head holes
4	Plants with rare and sporadic match head-size holes
5	Intermediate amount of match-head holes
6	Plants with many match-head holes
7	Plants with rare and sporadic holes bigger than match-head holes
8	Intermediate amount of holes bigger than match-head holes
9	Plants with many holes bigger than match-head

Appendix VI

Rating Scale of Overall Plant Damage of Corn Borers

Rating	Description
1	Plants with slight leaf injury with little or no damage on stem
2	Plants with slight injury but broken or lost tassels
3	Plants with broken tassels and extensive leaf injury
4	Plants with stem broken above the ears
5	Plants broken above the ears and extensive leaf injury

Appendix VII

Rating Scale for Damage by Corn Aphids

Rating	Description
0	Sound (no aphids)
3	Light infestation; no visible effect, but size of corn ear is reduced (50-100 aphids/plant)
5	Moderate infestation; smaller ears, and reduced corn ear size and weight (100-1,000 aphids/plant)
7	Severe infestation, very small ears no ears at all (more than 1,000 aphids/ plant

Appendix VIII

Rating Scale Damage by Diamondback Moth in Cabbage

Rating		Description
0	Sound:	No damage
1	Slight:	1-3 leaves with holes
2	Moderate:	4-6 leaves with holes
3	Heavy:	Most leaves with holes
4	Severe:	No heads produced

Appendix IX

Rating Scale For Damage by Cabbage Moth

Rating	Description
0	Sound: Heads undamaged
1	Slightly damaged: Heads with few holes and required slight trimming
2	Heavily damaged: Heads with many holes & required extensive trimming
3	Severe: No heads produced

Appendix X

Damage Index Rating Scale for Bean Fly in Field Legumes

Rating	Description
0	No feeding damage
1	2-3 holes present/leaf/leaf
2	2 leaves damaged
3	2-4 leaves damaged
4	Heavy or all leaves damaged

Bio-efficacy Test for Rodenticides

LABORATORY TESTS

A. Screening for New Acute Poisons

1. LD50 Determinations

a) Dosage

(1) Upper dosage level

(2) Lower dosage level

b) Formulation of Poison

(1) Solution

c) Administration of Poison

(1) Oral intubation

d) No. of Animals

(1) 5 caged together

2. No-Choice Feeding Tests

a) Dosage

(1) High concentration of active ingredient

(2) Low concentration of active ingredient

b) Formulation of Poison

(1) Pre mix dispersed thoroughly in coarse-ground cereal and vegetable oil (if liquid, mixed with oil)

c) Administration of Poison

(1) Mixed with plain bait given in food containers

d) No. of Animals

(1) Singly caged 2 groups of 5 animals

e) No. of Days of Tests

(i) 4 to 5 days

3. Choice Tests on Singly-Caged Rodents

a) Dosage

(1) Concentrations that gave satisfactory results in no-choice test

(2) Any desired additional concentrations chosen by increasing or decreasing the former by a factor of 3

b) Formulation of Poison

(1) Premix dispersed thoroughly in coarse-ground cereal and vegetable oil

c) Administration of Poison

(1) Mixed with plain bait given in food containers

(2) Plain bait in which pre-mix has been replaced by whole meal flour

d) No. of Animals

(1) 5 animals per group singly caged

e) No. of Days of Test

(1) 3 or 4 days normal diet, 24 hours poison bait and plain bait equivalent, 1 day plain bait.

If the test substance shows further promise, it is desirable to proceed to more choice tests with more number of animals per group caged singly.

f) Possible Experimental Design

(1) Factorial

g) Statistical Analysis

(1) Chi-square or

(2) ANOVA

4. Choice Tests of Special Formulations of Acute Poisons

a) Dosage - Procedure as described above

(1) Candidate rodenticide

(2) Standard rodenticide chosen

b) Formulation

(1) Unpoisoned bait of 90% coarsely-cut cereal plus 5% maize oil plus 5% wholemeal flour

(2) Standard poison 5% plus maize oil 5% plus coarsely-cut cereal 90%

c) Administration

- Same as in Choice Tests singly caged rodents

d) No. of Animals

(1) Caged wild rodents in 2 groups of 20 (10 males and 10 females)

e) No. of Days of Test

- Same as in Choice Test on singly caged rodents but offer choice of poison and unpoisoned baits for 2 days

B. Testing Chronic Poisons

1. Acute Toxicity Tests

- Same as described for acute poisons

2. Chronic Toxicity Test

a) Dosage

(1) 4 daily doses at higher dosage level

(2) 4 daily doses at lower dosage level

b) Formulation of Poison

(1) Solution

c) Administration

(1) Oral Intubation

d) No. of Animals

(1) 5 animals per group caged singly

3. No-Choice Tests

a) Dosage

- 2 concentrations based on 4-day LD50 of poison obtained from chronic toxicity test

(1) Value of concentration of 4-day LD50

(2) 1/10 the value of concentration of 4-day LD50

b) Formulation

(1) Concentrations proportionately mixed with coarsely-cut cereal bait plus 5% maize oil

c) Administration

(1) Offered in experimental bait containers

d) No. of Animals

(1) 2 groups of 5 animals singly caged

e) No. of Days of Test

(1) 4 days poison bait; for normal lab, diet until mortality,

* For R. rattus, give poison for longer than 4 days, at least 6

4. Choice Tests on Singly-caged Rodents

- Same procedure as for acute poisons except that poison is offered for 4 days (or longer, if wished, in the case of R. rattus)

C. Testing Formulations of Existing Chronic Poisons

1. Toxicity Tests

i) No-choice tests with wild rats or mice with same procedure as above for poisons with sufficient data

ii) If there is insufficient data on the performance of the rodenticide the following are added to modified in the procedure

a) No. of Animals

(1) 20 animals (10 females and 10 males) per poison

(2) Control group of 20 animals (10 males and 10 females)

b) No. of Days Test

(1) 21 days poison or until mortality is complete

(2) 14 days normal diet for survivors

2. Palatability Tests with Singly-Caged Rodents

a) Dosage

(1) Concentration as required

b) Formulation

(1) 90% coarsely-cut cereal, 5% corn oil and 5% wholemeal flour

(2) Formulation or ingredient mixed with plain bait at required concentration

c) Administration

(1) Offered in experimental bait containers

d) No. of Animals

(1) 5 males and 5 females wild rodents

e) No. of Days Test

(1) Few days normal laboratory diet, 24 hours for 2 test baits; refill to original amount and offer for another 24 hours

f) Statistical Analysis

(1) Students t-test

FIELD TESTS

A. Type of Trial

1. Acute Rodenticides

a) method

b) percentage mortality

2. Chronic Rodenticide

a) method

b) percentage mortality

B. Type and Number of Infestations to be used

1. One Formulation

a) Infestation

(1) Variety of different types of rat infestation to assess versatility of poison

b) Treatments

(1) Between 6 and 10 infestations

2. Two or more Formulations/Concentrations

a) Infestation

(1) Infestation that appear to have stable populations, reasonably isolated from neighboring infestations, easy to gain access to where rodents are moving and feeding

b) Treatment

(1) Large number of infestations

Avoid if possible, sites which are very heavily or very slightly infested, where acute poisons have been used within previous 6 month

C. Trials with Acute Poison

Treatments

a) Dosage

(1) Concentration as required

(2) Plain bait

b) Formulation

(1) Poison dispersed in a suitable medium to coarsely-ground cereal with 5% maize oil or 5% mineral oil plus 5% sugar

(2) Plain bait of same bait-base as above

c) Treatment

(1) Lay Bait-trays

(2) Prebait

(3) Poison dispersal in same bait-base as in prebaiting

(4) Repeat Prebaiting

(a) Post treatment Index

D. Trials with Chronic Poisons

Prebaiting is not normally practiced. Dosage and formulation is same as trials with prebaiting

1. Treatment

a) Lay bait-trays

b) Poison dispersal

(1) Degree of control achieved

c) Baiting continued

ANNEX IV

DATA REQUIREMENTS FOR EXPERIMENTAL USE PERMITS

GENERAL GUIDELINES

1. All chemical companies, government or private agencies/institutions/ researchers should secure an approved EUP before conducting any pesticide biological efficacy trial.

2. An FPA license is required of all chemical companies which import/ use pesticides for testing purposes.

3. Every pesticide formulation to be tested must be covered by a separate EUP application with the detailed research outline for each crop to be tested, however for formulation tests, one EUP will suffice.

4. All crops used for trials with EUP IA & IB should be properly destroyed.

5. EUP applications should be submitted to FPA at least two (2) months before the proposed date of experiment.

6. An EUP will cover one trial program except for formulation tests.

SPECIFIC REQUIREMENTS FOR EUP TYPE IA

1. The applicant should accomplish FPA from P-001A and submit the research outline following the official format (Appendix I).

2. Testing should be done in the company's property or property leased for at least five (5) years on an area not to exceed 500 sq. m. at any time unless prior approval has been obtained.

3. The quantity of the experimental material is limited 200 g active ingredient equivalent.

4. A filing fee of One Hundred Pesos (₱ 100.00) will be charged per coded compound to be tested.

SPECIFIC REQUIREMENTS FOR EUP TYPE IB

1. The applicant should accomplish FPA Form P-00IB and submit the research outline following the official format (Appendix I).

2. Additional information should be provided by the applicant as cited in Appendix II.

3. Testing should be limited to two (2) traditional testing area, e.g. bonafide experiment stations.

4. The biological efficacy experiments should be conducted in accordance with FPA guidelines for Biological Efficacy Evaluation.

5. Trial should be done on a limited scale and a maximum of 2 kg active ingredient equivalent (except for bananas) is allowed for importation.

6. A filing fee of One Hundred Pesos (₱ 100.00) will be charged per EUP application per formulation for each crop to be tested.

SPECIFIC REQUIREMENTS FOR EUP II

1. The applicant should be guided by FPA Form P-002 and should submit the research outline following the official format (Appendix I).

2. The tests should be confined to traditional testing area, e.g., bonafide experiment stations, except for justificable cause.

3. The biological efficacy experiments should be conducted in accordance with FPA Guideline for Biological Efficacy Evaluation.

4. The data requirement depends on the type of pesticide to be tested:

   4.1 New Formulations

   The applicant should provide the information cited in either Appendix III or IV, whichever is applicable.

   4.2 Ready-to-use mixtures whose active ingredients have been fully registered at FPA.

   The EUP application submitted should include the following:

   a) full registration status report of each active ingredient

   b) detailed composition of the mixture

   c) a summary of toxicity values of each active ingredient.

   4.3 Tank-mix formulations involving fully registered products.

   The EUP application should include the following:

   a) full registration status report of the pesticide product.

   b) a summary of the toxicity values of the individual component.

   It is understood that the data generated from the tank-mix formulation may not be used to support registration of the mixture.

5. The allowable quantity of experimental material that can be imported is 50 kg active ingredient equivalent. Additional importation must be justified.

6. A filing fee of One Hundred Pesos (₱ 100.00) will be charged per EUP application per formulation for each crop to be tested.

SPECIFIC REQUIREMENTS FOR EUP TYPE III

1. The applicant should accomplish FPA Form P-003 and attach the full registration status report including the research outline following the official format (Appendix I).

2. The biological efficacy experiments should be conducted in accordance with FPA Guidelines for Biological Efficacy Evaluation.

3. The test should be confined to traditional testing area, e.g., bonafide experiment stations, except for justifiable causes.

4. A filing fee of One Hundred Pesos (₱ 100.00) will be charged per EUP Application per formulation for each crop to be tested.

Appendix I

PESTICIDE EXPERIMENTAL USE PERMIT

Research Outline Format for Types IA, IB, II, and II

I. TITLE

II. PROPONENT/SPONSOR

III. RESEARCHER(S)

IV. OBJECTIVES

V. CROP(S)

VI. STARTING AND FINISHING DATE:
Target pest species

VII. TREATMENT:
(Including application time, interval frequency and methods of application)

VIII. EXPERIMENTAL DESIGN
(Attach layout)

IX. LOCATION(S) OF EXPERIMENT

Appendix II

DATA REQUIREMENT

FOR

TYPE I-B EUP

The following information should be provided by the applicant:

I. Pesticide Classification (Chemical Group)

II. Toxicological Data (Values only)

Acute Toxicity

1. Oral (mg/kg) - (rats & mice)
2. Dermal (mg/kg) - (rabbits)
3. Inhalation (mg/litre) - (rats or guinea pigs)
4. Other routes - (rodents)
5. Skin and eye irritancy - (rabbits)
6. Allergic sensitization - (rabbits)

III. Information on Diagnosis and Treatment

a. Diagnosis of poisoning, specific signs of poisoning, clinical tests.

b. Treatment of poisoning
   1. Antidote
   2. First Aid Treatment

Appendix III

DATA REQUIREMENT

FOR

TYPE II EUP INVOLVING PROPRIETARY PESTICIDES

I. Active Ingredient

- a. Chemical name
- b. Structural Formula
- c. Composition of the Technical Product

II. Method of Analysis

- a. Formulation
- b. Residues
- c. Metabolites

III. Toxicological Data

- a. Acute Toxicity
  1. Oral (mg/kg) - (rats or mice)
  2. Dermal (mg/kg) - (rabbits)
  3. Inhalation (mg/litre) - (rats or guinea pigs)
  4. Other routes - (rodents)
  5. Skin and eye irritancy - (rabbits)
- b. Short-term Toxicity
  1. Oral - (rats or mice)
  2. Other routes - (rodents)
  3. Allergic sensitization - (rabbits)
- c. Supplementary studies

  Long term feeding study (6 months results only) - (rats or mice)

IV. Information on Diagnosis and Treatment

- a. Diagnosis of poisoning, specific signs of poisonings, clinical tests
- b. Treatment of Poisoning
  1. Antidote
  2. First Aid treatments

V. Disposal of surplus pesticides and containers

Appendix IV

DATA REQUIREMENT

FOR

TYPE II EUP INVOLVING COMMODITY PESTICIDES

I. Active Ingredient

   a. Chemical Name
   b. Structural Formula
   c. Composition of the Technical Product

II. Toxicological Data

   a. Acute Toxicity
      1. Oral (mg/kg) - (rats or mice)
      2. Dermal (mg/kg) - (rabbits)
      3. Inhalation (mg/litre) - (rats or guinea pigs)
   b. Skin and eye irritancy - (rabbits)
   c. Short-term Toxicity
      1. Oral - (rats or mice)
      2. Dermal - (rabbits)

III. Observations on man

IV. Disposal of Surplus pesticides and containers

ANNEX V

DISCUSSION DOCUMENT ON ACCREDITED RESEARCHERS

Minimum Qualifications of an Accredited Researcher for Agricultural Pesticides

1. At least B. S. degree with major in entomology, plant pathology, weed science or crop protection.

If B. S. degree holder, he should have at least 3 years experience in field testing of pesticides and at least 2 technical publications on pesticide trials.

2. For M. S. degree holder, the applicant should have at least 2 years experience of actual field testing and 2 technical publications.

3. For Ph. D. degree holder, the applicant should have at least 1 year experience of actual field testing and 2 technical publications.

4. For B. S. degree holder, 5 years experience or an additional training on crop protection may be considered in lieu of technical publication.

APPLICATION FORM

Name: _____

Date and Place of Birth: _____

Agency: _____

Educational Background:

Degree	College/University	Title of Thesis/Dissertation

Additional Training:

Date	Nature	Agency/Sponsor

Employment Record:

Position/ Designation	Agency	Nature of Responsibility	Immediate Supervisor

Current Researches (Indicate co-workers if any):

Technical Publications:

Qualified to conduct trials on:

_____ Herbicides
_____ Fungicides
_____ Insecticides
_____ Others

APPROVED:

Remarks:

ANNEX VI

GUIDELINES FOR REGISTRATION OF "OTHER CHEMICALS"

I. Definition of Terms

a. Surfactants - shall refer to surface-active agents or materials which facilitate and accentuate emulsifying, dispersing, spreading, wetting and other surface-modifying properties of pesticide preparations.

Surfactants include but are not limited to activators, adjuvants, deflocculators, detergents, dispersants, drift control agents, emulsifiers, foam suppresants, spreaders, stickers wetting agents and others.

b. Plant Regulators - shall refer to compounds other than nutrients which in small amount promote, inhibit or otherwise modify any physiological process in plants. Among the plant regulators are the growth regulators, flowering regulators, flowering hormones, auxins and anti-auxins.

c. Synergists - shall refer to chemicals/materials which when united with other chemicals enhance potentiation or heightens efficiency of one or more components of the mixture such that the total effect is greater than the sum of the independent effects of the components of the mixture. These include, but shall not be limited to Piperonyl butoxide, Propylisome, Sulioxide and Sesamin.

d. Wood Preservatives - shall refer to compounds applied or injected to prolong the service life of structural timber as well as all wooden article and other cellulosic materials normally used in building construction. These include but shall not be limited to salts of heavy metals, copper naphthanate, pentachlorophenol, creosote, dinitrophenol, sodium pentachlorophenate, chlorinated hydrocarbons and others.

II. Guidelines for Registration

a. In the registration of a surfactant, biological efficacy data shall not be required if the product will be recommended as a tank mixed preparation with pesticide.

b. Registration requirements for plant regulators shall be for biological efficacy only unless the chemical has been shown to be toxic or has uses other than being a regulant, in which case, the compound shall be considered a pesticide.

c. Data requirements for registration of synergists shall follow that for surfactants.

d. Data requirements for registration of wood preservatives shall follow that for agricultural pesticides.

Surfactant and Synergist (Proprietary Name)

A. Chemical and Physical Properties

1. Chemical name of active ingredient
2. Chemical structure
3. Composition of the technical and commercial products; state impurities and inert ingredients
4. Manfuacturer of technical/commercial products
5. Flammability
6. Volatility
7. Stability

B. Biological Efficacy

1. Pesticides or growth substances with which the surfactant will be tank-mixed
2. Crops to be treated
3. Bio-efficacy results

Applicant and address:

Plant Regulator (Proprietary Name)

A. Product Properties

1. Chemical name of active ingredient
2. Chemical structure
3. Composition of the technical and commercial products; state impurities and inert ingredient
4. Manufacturer or technical/commercial products
5. Flammability
6. Volatility
7. Stability

B. Toxicological Requirements

- Acute oral, dermal toxicities

C. Biological Efficacy

1. Crops to be treated
2. Mode of action
3. Symptoms of overdosage
4. Precautions in use
5. Bioefficacy results

Applicant and address:

Wood Preservatives

Same as the requirement for proprietary or commodity agricultural pesticides as the case may be.

MIGUEL M. ZOSA
Administrator

2.25.81

ANNEX VII

EXTRACT FROM A DRAFT PREPARED BY B.B. WATTS ON PHASED REGISTRATION

Phased Registration

Phased, or as it sometimes may be called, stepwise registration procedures for pesticides have been in operation in a number of countries for some time. Such procedures have many advantages, both for the regulatory authority and for the manufacturer, in that they enable all parties to verify that the results of the laboratory or small scale trials are achieved in the field following wider use and thus allows any necessary modification to be made to the registration proposals before a full commercial registration is issued.

The development of a pesticide is a gradual but complex process. It is reasonable for the authority to allow the pesticide to be used in accordance with limitations or restrictions imposed by the regulatory authority during this development provided there is no undue risk to operators, the public or the environment.

During the phased registration stages, additional data that are required to enable both the authority and the manufacturer to evaluate the efficacy and possible side effects of the pesticide and to decide what additional testing, if any, may be necessary. It would be unrealistic to expect manufacturers to be able to provide the complete dossier to any registration authority before a submission could be considered.

In some instances, the chemical may be withdrawn by the manufacturer before registration is finalized due to difficulties which have come to light during the phased registration process. A phased registration system enables an evaluation of the performance of the product in the hands of farmers to be undertaken and observations on wildlife to be made from wide, but supervised, use.

By proceeding slowly there is a greater chance that all parties will be more fully aware of any problems arising from the application of the pesticide. However, there is no need for it to be a requirement that all chemicals must proceed through a phased registration system. For example, a product based on an active ingredient which has been in use for many years, may be granted registration immediately, subject, of course, to the provision of acceptable data.

However, as a general principle, it is suggested that all products based on new active ingredients should proceed through a phased system so that full evaluations of new pesticides are undertaken before registration is granted and unrestricted marketing commences.

1.1 Phases in the Registration Process

Provided an initial set of basic data is available then limited registration should be considered. There are three clearly identifiable stages in the development of a pesticide.

Trials (or experimental) Clearance: This would normally be granted for a period of one year. The trials would be supervised or monitored and the extent of such trials may be confined to a specific maximum. Generally the food or feed harvested from such trials would not be permitted to be used although in some instances permission to utilize it may be given. After the specified period of clearance, renewal could be granted, but before this the manufacturer would need to show that some more work has been done on the development of the product and that more is still required.

Provisional (or limited) Clearance: This type of clearance could be granted when most of the relevant registration data have been obtained. Some data, because of their very nature, can only be obtained when the scale of use of the pesticide is sufficient to demonstrate a measurable effect (or lack of one) on operators or on the ecology of the treated area. At this stage the product could be sold, but usually sales would be restricted to a certain quantity, perhaps over a specified period.

Commercial or Full Registration: This would be granted after a thorough evaluation of all data showed that the pesticide could be used without unacceptable risks. Registration authorities may, however, restrict the claims, place limitations on use, place a time limit on the tenure of the registration, or review any situation at any time in the light of new evidence. It should be emphasised that any registration is always subject to review in the light of new information coming to hand.

1.2 Data Required for Different Phases

It is not the intention to provide "check lists" for the various phases of registration as the check list concept should not be used in the registration process. Data supplied in support of registration must be able to be utilized and it is definitely not recommended that data be requested just for the sake of having it on the file. It is basic to the concept of phased

registration that a lesser amount of data would be required at the trials clearance stage than would be required at a more advanced stage in the process. The amount of data required at the various stages of clearances will vary depending on the nature of the pesticide and the proposed use. The following guidance is provided to assist in judging what would seem to be reasonable requirements for data. These data requirements are set out under five main headings, that is, chemical and physical properties, toxicology, environmental, residues and efficacy. Suggestions are made concerning use limitations and labelling which should be considered at each of the clearance stages.

1.3 Amount of Data Required and Suggested Limitations for Trials Clearance

The amount of data required at this stage of clearance will be quite minimal because of the limitations that the product will not normally be able to be sold, but will be for use only by bona fide research workers. Because the product is not for sale it will usually not be necessary for the regulatory authority to place a quantity limit on the amount to be used in trial. However, the manufacturer should specify the amount required for trials work so that the regulatory authority is aware of what is being used and can, if appropriate, suggest a reduction in the quantity permitted. At this stage minimal labelling requirements would be adequate.

1.3.1 Chemical and Physical Properties: Chemical name, common name and/or code number, formulation, simple physical and chemical properties (if available).

1.3.2 Toxicology: An indication of the toxicity, i.e. LD 50 figures plus first aid precautions to be followed in the event of accidental poisoning.

1.3.3 Environmental: Some data may be needed to indicate the possible effect on desirable species, depending on the proposed use regime. In most instances this may be predicted from the chemical and physical properties.

1.3.4 Residues: There will usually be no local data and thus it should be a general requirement that treated crops be not fed to animals or humans, and animals be not allowed to graze treated areas. From proposed use patterns, knowledge of the chemical and supplemented by any available

residue data it may be possible for authorities to be confident that residues of harvest or grazing will not pose a hazard and thus the general restriction against consumption could be waived.

1.3.5 Efficacy: No local data will be available, but there will be an indication from the manufacturer's screening tests of the likely effect on the pest spectrum. The application should define the pest(s) against which evaluation is intended and the amount of product to be used for trials.

1.3.6 Limitations: Limitations at this stage would be that the product will not be for sale, and will be for use only by research workers employed by government, universities or the manufacturer. The trials permit should be issued for a specific period of time, usually one year, which could be extended on request.

1.3.7 Labelling: At this stage a typewritten label will be acceptable, provided it contains information on the chemical type, precautions to take when handling the pesticide, together with an indication of the pests and situations where the product will be tested.

1.4 Amount of Data Required and Suggested Limitations for Provisional Clearance

This is an important stage in the phased registration process in that it will give the manufacturer and the regulatory authority the opportunity to see whether the results of the small scale tests carried out under the trials clearance phase are achieved under a wide range of conditions. A considerable amount of data is required for provisional clearance. At this clearance stage, the product can be sold and it is therefore important that residue data obtained during trials clearance be provided so that maximum residue limits can be established, if appropriate, where the product is used on food crops. Usually a limit would be placed on the amount of product which can be sold and also a time over which such clearance would be valid. Full labelling is required.

1.4.1 Chemical and Physical Properties: Chemical and physical properties of the technical grade active ingredients, and the formulated product should be provided. While there could be some situations where something less than the complete data could be sufficient, generally speaking as much as possible should be submitted.

1.4.2 Toxicology: The amount of toxicological data required for provisional clearance may vary markedly from country to country, with some countries requiring the full package and others a somewhat lesser amount. The final decisions on how much data to require must be left to the registration authority, but as a guide at least information from short term and subacute studies should be provided. Long term animal studies may not be required before provisional clearance is granted, provided it is made clear that such studies must be completed and submitted before full registration will be considered. The decision as to whether long term studies are required at provisional clearance level will also be influenced by the nature and proposed use of the chemical.

1.4.3 Environmental: The primary data needed for predicting environmental hazards are:

(1) the properties of the pesticide including chemical and physical properties, biological, metabolism and residue studies, and toxicological information, and;

(2) the influence of use patterns which takes into account formulation, methods of application, site, time and type of application, scale of use and the climatic and geographic locality.

The registration authority should be able to make a good prediction of the environmental hazards following assessment of the above data. Where such predictions indicate a possible hazard for specific components of the environment further specified data will need to be collected during the period of provisional clearance.

1.4.4 Residues: Residue data from tests conducted under trials clearance must be provided when the proposed use of the pesticide may lead to the creation of residues in food or feed. These data must have been obtained from supervised trials following use according to proposed label claims. Guidelines for the design and layout of residue trials have been developed by the Codex Committee on Pesticide Residues and the Commission on Pesticide Chemistry of the International Union of Pure and Applied Chemistry and published by FAO (4) IUPAC (5) and GIFAP (6) following a recommendation from the 1977 ad hoc Consultation. These guidelines discuss trial design, sampling techniques, packaging of samples and reporting of results. It may be necessary for the appropriate

authority to set a maximum residue limit either on a temporary or a firm basis to permit the sale of treated produce. Residue data developed in accordance with the above guidelines will be a necessary part of this evaluation.

1.4.5 Efficacy: Reports on trials carried out under trials clearance must be presented to show that the chemical will control the pest organism without adversely affecting the crops. Such trial results should demonstrate the effect on crop yields, and crop quality, selective varietal differences as well as compatibility with other chemicals and with agricultural practice. The results should:

(1) demonstrate the effect on the pest organism

(2) measure the reliability or consistency of control

(3) provide information on the duration of control

(4) define limitations including safety to crop, animal or substrate being treated

(5) show a comparison with the standard product or practice normally used

(6) determine, where applicable, the effect of variables such as temperature, moisture, and soil on effect of the pesticide on the pest organism.

Details of studies of efficacy and crop safety should be reported and submitted to the registration authority.

1.4.6 Limitations: It is normal for the regulatory authority to impose a restriction on the amount of pesticide which can be sold under provisional clearance. The authority should stipulate the period of time during which the clearance shall remain valid. The provisional clearance should lapse unless any additional data required to support full registration is provided.

1.4.7 Labelling: As the pesticide is to be sold full details as to identification, precautions, and directions for use and storage should be on the label which should generally comply with the FAO Guidelines on Labelling of Pesticides (3).

1.5 Amount of Data Required and Suggested Limitations for Full Registration

1.5.1 Chemical and Physical Properties: Any additional data - e.g., modification to formulations, should be provided. Also details on ways of disposal of unwanted material and containers should be provided plus any additional information as may be required by the authority.

1.5.2 Toxicology: Any outstanding tests - for example the results of any long term testing not available at time of provisional clearance must be made available.

1.5.3 Environmental: Reports of observations made during the wider use of the pesticide showing any effects on fish or other wildlife should be provided. If, for example, the primary data showed that the chemical has a high toxicity to birds, then special attention would be given to the possibility of adverse effects during use under provisional clearance and these data would be required before registration is granted. If a pesticide is intended to be used in or close to water or on rice toxicity tests on fish and fish food organisms should be carried out. Likewise, additional data on other possible environmental hazards such as leaching through the soil or effects on soil organisms following use under provisional clearance and in accordance with proposed use patterns may be required.

1.5.4 Residues: Generally little additional data would be required as maximum residue limits would have normally been set and/or acceptable waiting periods (withholding periods or pre-harvest intervals) established prior to provisional clearance having been given. Residue monitoring data should be provided if available.

1.5.5 Efficacy: Additional data will usually be of a qualitative rather than a quantitative nature with possibly major emphasis being placed on observations on phytotoxicity or fruit finish following wider field usage.

1.5.6 Limitations: Registration may be granted for a set period or for an undefined time depending on the requirements of the authority granting registration, but parties must be aware that in the event of new knowledge about the pesticide coming to hand it may be necessary to review registration at any time.

1.5.7 Labelling: Full labelling as for provisional clearance plus details on the disposal of containers, disposal of unwanted or contaminated product. The use of standard phrases for all precautionary labelling is recommended.

ANNEX VIII

PROPOSED DRAFT AMENDMENTS FOR LABELLING GUIDELINES

1. PRODUCT INFORMATION

1.1 The "descriptive name", (trade or commercial name of the product, together with a description of use) e.g. 'SMITHS HERBICIDE'

1.2 The names of all active ingredients in the product, using common names approved by the International Standards Organization or by a local standards association where no ISO name has been recommended together with the minimum guaranteed amount of each active constituent present expressed as follows:

a. Solids, Viscous liquids, Aerosols and Volatile liquids:

gram per kilogram (g/kg)

b. Other liquids:

gram per litre (g/L)

The amount of each active constituent present must be clearly described, e.g.

'400 g/L 2,4-D as sodium salt' NOT '400 g/L sodium salt 2,4-D'.

The active ingredient statement should be placed as near as possible to the descriptive name.

1.3 Solvent Statement:

Where a solvent is present the concentration must be stated. If the solvent significantly contributes either to user hazard, OR flammability of the product, appropriate standard symbols which indicate flammability and phrases which indicate user hazard must be included on the label.

1.4 A brief statement summarising the use of the product, e.g.

'FOR CONTROL OF POST-EMERGENT ANNUAL BROADLEAF WEEDS IN CEREALS'.

1.5 The net weight or volume (in metric units) of the product in the container.

1.6 Name and address of manufacturer, distributor or agent. The person or company responsible for registration of the product in the country concerned.

1.7 The FPA registration number.

2. DIRECTIONS FOR USE

2.1 Directions for Use

The directions for use on the label must clearly indicate how, when and where the product can be legally, effectively and safely used with maximum efficiency and minimum risk. This information may be repeated and expanded in separate technical or promotional literature or label leaflets. However, even if leaflets are used, the LABEL ON EVERY CONTAINER OR OUTER PACKAGE MUST ALWAYS SUPPLY THE ESSENTIAL INSTRUCTIONS LIKELY TO BE NEEDED AT THE TIME OF USE OR HIGHLIGHT THE NECESSITY TO READ AN ATTACHED LEAFLET BEFORE USE.

2.2 Information about the recommended uses of the product should be clear and specific, using names, terms or descriptions which will accurately inform the user, as to the pests, weeds and diseases controlled.

2.3 Directions for use must include information on:

a. Any warnings intended to provent incorrect or inappropriate use of the product, e.g.

'Do not use on sandy soils'
'Apply only at the 2-5 leaf stage'
'Do not apply when rain is imminent'

b. Crop or sitution, pests, weeds or diseases for which the product has been officially approved and registered.

c. Application rates and comments critical to the effective use of the product on each crop, situation, pest, weed or disease, including timing and method of application. A tabular format is often the clearest method of expressing these.

d. A statement, where required, of the period which should elapse between last application of the product AND:

harvest of plant products;
grazing of treated areas;
slaughter of treated animals for food;
feeding produce to domestic animals;
saving, offering for sale or using produce such

as milk, honey or eggs for human use;
seeding or planting of subsequent crops;

OR

the withdrawal period for treated feed to avoid unacceptability residues in animal products (1).

This is known as the 'withholding period' or pre-harvest interval.

2.4 GENERAL INSTRUCTIONS FOR USE

Included here is information essential to the proper use of the product in all the circumstances listed in the Directions For Use.

2.4.1 Practical Advice must be included on preparing, mixing and applying the product, storage and disposal of surplus or unwanted chemical and;

2.4.2 Compatability of the product with other products where this is appropriate.

2.4.3 Any special recommendations on storage conditions for the container and product.

2.4.4 Date of formulation (expiry date might be necessary in the case of products that may deteriorate under likely storage conditions).

2.4.5 Identification number of manufacturing lot or batch.