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Technical report: Findings and recommendations*

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

Based on the work of Kawal Dhari
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United Nations Industrial Development Organization
Vienna

* This document has not been edited.

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PURPOSE OF THE PROJECT

To provide technical assistance to member countries in Asia and the Pacific in the safe development and use of pesticides. The consultant in association with the counterparts of Central Agricultural Research Institute, Gannoruwa, Peradeniya was expected to :

- evaluate methods used for testing of pesticides, particularl organophosphates, carbamates, pyrethriods etc.
- advise on conducting field trials to establish efficacy of standard formulation.
- advise to up-grade small, medium and large-scale testing to be undertaken under, available facilities with insecticide in crops of economic importance.
- advise in collection of data, interpretation and standards that are to be used.
- advise on pest pressure and thresh hold levels before taking decision on application of insecticides and also in observing harvesting time after application.
- advise on methodologies to stop development of resistance to pesticides.

and after completion to submit a typed draft report on his findings and recommendations.

RECOMMENDATIONS

Having considered Sri Lanka immediate needs and priorities after discussion with scientist and visit to some research stations and keeping in view the resources and scientific manpower available at present, it is recommended :

1. Scientists available for insecticide efficacy testings are thinly distributed over different research stations throughout the country. Scientists who are qualified for undertaking such type of research work should be based at Central Agricultural Research Institute (CARI) so that need based phase-wise research work-laboratory, insectary and field may be initiated on a continous basis for required number of years/ crop seasons.

2. There is no need for field testings, at present, in all agro-ecological regions. First, important agro-ecological regions on priority should be selected keeping in view the insecticides used and crops cultivated. Later field trials may be undertaken in all the regions.

3. Complete information on insecticides efficacy, phytotoxicity, compatability, assessment of crop losses, pre-harvest intervals, maximum residue limits (MRLs) and acceptable daily intake (ADI) from countries, preferably similar to Sri Lanka, should be collected so that working protocols for Sri Lanka on different aspects may be drawn up after few pilot experiments. For this purpose national plant protection priorities and resources are to

be kept in mind. Some basic informations are given in annexure 2 to 8 to facilitate decision making. For collecting such type of information/ data, UNIDO may be requested for sponsorship and while finalising the guidelines for Sri Lanka, the help of UNIDO Consultant may be sought, if required. Training of scientists/ research workers is also essential and International Rice Res. Institute (IRRI) will be ideal. UNIDO sponsored Pesticide Development Centre (PDC) in India can also be utilized.

4. After a judicious exercise on recommendation No. 3, phase-wise testings-insectary, laboratory and field should be started. This will cut-down the expenses on efficacy testings as all insecticides may not be found suitable for field testings.

5. As efficacy aspects are also linked with residue and quality control ; analysis and residue laboratory of CARI should be strengthened so that maximum residue limits (MRLs) and pre-harvest intervals(PHI) are worked out. Scientists are tobe trained and these laboratories should be headed by a Ph.D. in the relevant field.

6. For tackling the problem of insect resistance, insecticides with complicated multiplicate resistance like diazinon should be avoided. Avoid or delay the use of dimethoate which acts as effective selector of resistance for pyrethroids. Sub-lethal doses should not be used in the field. Some chemical strategies to alleviate resistance in future are (a) Use of insecticides with multiple sites of action (b) Use of mixtures of insecticides with dissimilar modes of action that lack cross-resistance potential. (c) alternations and rotations of such dissimilar insecticides. (d) use of additives that antagonize the adaptive value of the resistance mechanism (e) use of insecticides that display negatively-correlated cross-resistance.

7. Efficacy is always linked with safety, therefore, FAO code of conduct for using the pesticides should be practiced by effectively implementing monitoring and regulatory activities.

8. There is a need for strengthening the work on application methods/ technology as it will reduce the load of insecticides in the environment as proper application will reduce the dose per unit area.

9. More effective linkage should be established between Entomology, Plant Pathology and Agronomy Deptt. of CARI, so that entire plant protection problems are tackled more efficiently. This step will also help in insecticide efficacy testings. Efficacy research work may be assigned to the candidates enrolled for Ph.D. degrees as it would gear up the research work, at least, at laboratory and insectary level. University of Peradeniya can collaborate such research work with CARI.

10. Division of Entomology, CARI has skeleton facilities and for proper research work more facilities and manpower are to be provided.

I. INTRODUCTION

Agriculture is the main source of income in Sri Lanka, supplying the basic domestic food requirements and accounting for ca 58% of the country's exports. Rice is the staple food. Other cultivated crops are maize, onion, chillies, kurakkan, cowpea, green gram, soyabean, black gram, groundnut, sesame, potato, ginger, turmeric, bushbeans, polebeans, capsicum, tomato, cabbage, beet-root, carrot, radish, knolkhol, leeks, cauliflower, longbeans, bushitavo, okra, luffa, snakegourd, cucumber, pumpkins, brinjal, winged beans, and sugarcane. Rubber, coconut, cocoa, coffee, cloves, nutmeg cinnamon, caramum, citronella, pepper are the export crops. Pineapple, banana, mango, passion fruit, lime and oranges are the main fruit crops. The elevation varies from sea level up to 183 meters above sea level and the annual rain-fall varies from 75 cms. to 500 cms. while the temper-ature varies between 16 to 33°C. Though, small country, Sri Lanka has 22 agro-climatic zones. There are 63 recommended varieties for 23 locally grown field crops and 79 for 23 locally grown vegetables.

The expanded use of insecticides resulting from targets of increased yields through improved production led to Government imposed import restrictions. When these controls were lifted in 1977, the use of insecti-cides increased dramatically. The Government enacted legislation regulating pesticides and their use increased steadily from 2309 MT in 1980 to 4193 MT in 1983 and in 1988, 256 MT technical insecticides valued US $ 2.14 million and 531 MT formulated insecticides worth US $ 2.34 million were imported. Same year, insecticide sale was 605 MT. Major formulated insecticides imported in 1988 were monocrotophos and methamidophos and the major tech..

nical insecticides imported in the same year were methamidophos, carbafuron and BPMC. Insecticides used in agriculture are given in Annexure 1. In health programme, for mosquito control, malathion 50 WP, permethrin 25 WP and fenthion 85 EC are mainly used. In grain storage phoxim 50 EC and premiphos methyl 20 DP are used. Household insecticides are propoxur , propoxur + dichlorvos, permethrin + PBO, allethrin, d-allethrin, propoxur + dichlorvos + cyfluthrin, propoxur + dichlorvos + tetramethrin and natural pyrethrin.

All type of available pesticidal formulations are being used in Sri Lanka but, so far, there is no indigenous manufacture of technical grade pesticides. Pests of economic importance are given below :

Rice	brown planthopper, rice bug, leaf folder, stem borers, gall midge, rice blast, weeds;
Maize	stalk borer, earworm, cutworm, leaf blight, root rot;
Pulses	bean fly, pod borers, caterpillar, leaf folder, dry rot, collar rot;
Root-Crops	potato weevil, potato moth, cutworm, potato beetle, nematodes;
Chilies	thrips, cutworm, whitefly, aphids;
Coconut	caterpillar, scale rhinoceros beetle;
Tea	weeds

The Department of Agriculture estimates that 20 to 30 per cent of the rice crop is destroyed annually by pest infestations. While pesticides are the most common and practical means of pest control in the country, integrated pest management (IPM) is also practiced. IPM extension services are jointly operated in 13 districts by the Department of Agriculture through its Plant Protection Service and FAO to educate farmers in IPM techniques, emphasizing judicious and efficient pest control methods in case of paddy.

Pesticides are mainly used in food and cash crops such as rice, vegetables, cotton tobacco and chillies, and less often used in plantation crops such as tea, rubber, coconut, sugar-cane and spices. Rice is the heaviest consumer, particularly of insecticides, while herbicides are most extensively used in tea and rubber, and fungicides in vegetables.

Public and private companies compete in Sri Lanka's pesticide market. Imports of formulated products and technical grade materials as well as local formulation of products are conducted by both the private sector and the Ceylon Petroleum Corporation (CPC) - a Government Institution engaged in importation, formulation and distribution of pesticides in addition to petroleum products, Nine major firms market pesticides in Sri Lanka. Haylays Ltd., Harrison & Crossfield Ltd., Lankem Ltd., and CPC have the highest sales level.

II. EVALUATION OF METHODS USED FOR TESTING OF INSECTICIDES

The product performance data are required for registering the insecticides and only those provided by Government Institutions are accepted by the Registration Authority. The largest number of insecticides are used in domestic agriculture for which the Deptt. of Agriculture is responsible. Efficacy testing are conducted by Department of Entomology, Central Agricultural Research Institute (CARI) and different research stations of CARI. Department of Entomology at CARI has limited scientific staff and still some sections are tobe established and Scientists recruited. Minimum facilities of efficacy testing of insecticide at lab. and insectary level are available but maintenance of the proper temperature and humidity conditions are tobe improved. Available manpower for efficacy investigations are thinly distributed over different research stations of Deptt. of Agriculture, thus, no continuous and concentrated efforts are possible for phase wise studies like laboratory, insectary and field testing.

There is lack of continuity of the field trials and no efficacy protocols have been prescribed by the Department of Agriculture. There are also no protocols of efficacy testings in the areas where insecticides are used for non-agricultural purposes. Much work has been done on the rice crop but only a few systematic studies have been made for the assessment of the crop losses due to insects and cost benefit ratio given by the use of insecticides.

Much improvement is required in case of training the users for proper application. Work on insect resistance to insecticides and screening of resistant varieties of the crop plants against insects is satisfactory. Statistical treatment of the data and documentation is generally poor.

Insecticides efficacy is linked also with other parameter like quality control and testing. This area too is in a very primary stage. With Department of Chemistry, CARI, there are two laboratories one for formulation and analysis and another for residues. At present there is no any work in the formulation and analytical lab. as the concerned scientist has gone abroad for training and in the residue lab. the following studies are being undertaken :

1) Determination of residue of diazion, malathion, fernthion, dimethoate, chlorpyrofos, carbophenthion and chlorfenvinphos in some vegetables. 2) Determination of pirimiphosmethyl and malathion in market samples of greengram and cowpea. Out of five gas chromatographs available with residue lab. only two are functional and there is acute shortage of spare parts and even solvents. In such a situation, investigations on maximum residue limits (MRLS) to work out PHI (Pre Harvest Intervals) are difficult.

Another area where efficacy data are required is the registration of insecticides by Registrar Pesticides. All organochlorine insecticides are banned for agricultural use. List of registered insecticides for agriculture is given in Annexure 1. Highly restricted and prohibited insecticides are :

Highly restricted : aldrin, BHC/Lindane, Chlordane, dieldrin (used for construction purposed).
Prohibited : DDT, endrin, heptachlor, leptophos, organo mercurial compounds, parathion, 2,4,5-T, camphochlor, TDE, toxaphene, strychnine and TEPP (not been used or registered in Sri Lanka).

Provisional permits are subject to such restrictions as distribution for a limited duration, regional distribution, quantity restrictions or the condition specified in relation to use and/or application. Further modification of the registration procedure has been made recently to expedite the registration of WHO class II and III products as alternates for three class 1b insecticides currently recommended for general case (monocrotophos, methamidophos and omethoate). Pesticides Registration Scheme has the provision either to totally ban the pesticides, restrict its use to trained applicators are issue to specific target applications. For example 1a group of fumigrants (almuninium phosphide, methyl bromide and hydrogen cyanide) are allowed only for trained applicators and 1b allowed only for special projects until such time a suitable alternative is found.

Sri Lanka is a member nation of the UN Body and has agreed to support the FAO Code of Conduct which outline the overall responsibility of member governments to allocate high priority and adequate resources for Pesticide Management, but trained manpower, support facilites and financial resources in the Department of Agriculture, are very limited consequently progress in slow.

Quality testing facilities are not in place in the country. The Registration Authority is therefore unable to check imports with any sample tendered at registration and has to depend on Quality Certificates submitted by basic manufacturers or formulators for exported Commodity Products.

There have been instances where such Certificates have been found to be unreliable. In the case of certain products from doubtful sources, as a means of cross checking their Quality Certificates, the services of Independent Analysts such as Caleb Brett and S.G.S have been employed, but this service too will soon be out of reach of Registrar Pesticides as insepection fee currently at US $ 0.5 per kg. of consignment will continue to rise and the importing companies will farm these additional costs down to the user, resulting in increased cost of production of crop produce.

III. FIELD TRIALS TO ESTABLISH EFFICACY OF STANDARD FORMULATIONS

Field efficacy testing of insecticides is a complex area and subject to variations by a number of factors. The users, proprietors and regulatory authorities have prime interest in such testings.

Many ecological factors affect the quality of field testing of insecticides. These factors include plot size, cultivar, site of field, choice of standard check insecticides, application methods, evaluation methods, and level of insect pressure. Methods for increasing insect pressure include planting time, fertilization, plant spacing, artificial lighting, insecticide induced resurgence on neighbouring plants, and artificial release of caging of insects in the field. Recommendations about insecticides should only be made after a review committee has evaluated the data collected under standard conditions. Standard conditions should be specified to include the number of sites and seasons data are to be collected, the untreated level of insect pressure that represents a valid test, the rates and volumes tobe tested, and the application methods to be used, giving special importance to farmers methods. Virus vectors require high levels of control. Effects on non-target mammals and fish, persistence, and resurgence activity must also be examined. A model field evaluation scheme of granular insecticides for the control of yellow stem borer of rice is given in annexure-5. A field testing protocols of planthopper, lepidopterous, stem borers, leafhoppers in case of rice and cabbage caterpillar in cabbage crops are given in annexure - 2, , which are applicable to all formulations and applied in the field.

Research workers adopt various methods of recording phyto-toxic effects. Under visual method low, slight, moderate, severe injury symptoms etc., on the plants are recorded. Symptoms like oil blotches on the leaves and leaf drop have been recorded of citrusplants. In wheat, severe buring effects accompanied twisting of leaves have been recorded. The organo - phosphatic insecticides such as malathion employed to control the pests may result in yellowing, curling and dropping of leaves although it is comparatively a safe material to handle and shows little phytotoxicity to most plants. Dinitro compounds are highly phytotoxic, therefore, their use has been restricted to dormant sprays on orchard trees.

High temperature enhances the phytotoxicity. The phytotoxic effects are characterised by acute necrosis but no chronic injury. The lethal action on plants may be due to increased oxidative catabolism to a level beyond the restoring power of phyto-synthetic anabolism. Chlorinated insecticides, in most cases, have been found to be associated in particular with BHC, especially in respect of cucurbitaceous plants. A general phytotoxicity protocol is given in annexure 3.

For its essential role in crop pollination, beekeeping, is an essential component of agriculture today. Pesticides are evidently another. With either of the two, global food production would be seriously impaired. Yet beekeeping has been sustaining heavy losses through pesticide use since the advent of synthetic pesticides several decades ago. Pesticides, and especially herbicides, reduce the foraging areas available to the bees; the application of toxic insecticide on farmlands and in forests often makes it impossible for the bees to utilize potential forages; and worst of all, the insecticides frequently kill bees, reduce colony strength and contaminate hive products.

While beekeepers have no direct way of controlling the application of pesticides near their apiaries or within the flight range of their bees, some lines of action are still available to them to prevent damages : they can ask for help from extension agents, for understanding and cooperation on the part of the growers. At the same time, they must be fully alert to the potential damage that certain toxic insecticides can inflict on their colonies.

When bees are kept in or near areas where such insecticides are occasionally used, the beekeeper must be in a position to know in advance the insecticides used and their residual effect, what damaged they can cause to the bees, and the time of application. Moving the colonies out of range of insecticide application temporarily is often one approach available to the b-eekeeper; in some circumstances he can prevent the bees from flying for several days, until the residual effect of the insecticide has subsided.

The recent development of new "micro-encapsulated" insecticide formulations, specifically designed for the controlled release of the product overtime, has created a new bee poisoning problem. When such insecticides have been dusted on blooming crops, worker bees collect the particles, return them to the hive and store them in pollen cells, The consequence is the poisoning of the entire colony. Honeybees react differently to different pesticides, and most herbicides and fungicides are less toxic to bees than are insecticides. To the beekeeper, the most obvious sign of pesticide poisoning is the presence of an exceptional number of dead bees in-front of the hives. The followingfigures have been established as guidelines for assessing the extent of pesticide poisoning: 100 dead bees per day is the colony's normal death rate: 200-400 dead bees indicate a low level of pesticide poisoning; 500-1000 dead bees indicated a medium level of pesticide poisoning; over 1000 dead bees indicated a high level of pesticide poisoning.

IV. UPGRADATION OF SMALL, MEDIUM AND LARGE SCALE TESTING

LAB TESTING

Proper planning is essential to ensure success in conducting laboratory, insectary and field insecticides studies. Rearing of test insects is a major input for insecticides evaluation studies in a laboratory or in insectary. Proper rearing technique will ensure low insect mortality in untreated control and decrease variation in successive tests. An efficient insect-rearing program is also available in field studies of insecticides. Field populations of insects are often not sufficiently large to provide valid data and cultured insects can be used to artificially infest plants when field populations are low.

Methods of rearing the stripped stem borer(Chilo suppressalis), yellow stem borer (Tryporyza incertulas), brown planthopper (Nilaparvata lugens), whitebacked planthopper (Sogatella furcifera), green leafhopper (Nephotettix, virescens), leaf folder (Cnaphalocrocis medinalis), caseworm (Nymphula depunctalis) and ricebug (Leptocorisa oratorius) have been developed at IRRI, where CARI staff can be trained and information obtained.

Insecticide screening identifies commercially useable chemicals according to biological effectiveness and environmental impact. Screening techniques are becoming standardized as governments and international bodies exert their influence. Initial laboratory screening is a compromise to reduce the number of potential candidates before more expensive field screening. The methods should be fast, cheap & related to field conditions, but less rigorous without missing any important compound. Laboratory techniques and guidelines on complicating factors exist to test chemicals acting as stomach or contact poisons, fumigants, chemosterilants, microbial agents, juvenile hormones and mimics, chitin inhibitors, phermones, and systemic poisons. Criteria for promotion of candidates to field testing should include comparable performance on standard targets, safety, rapid metabolism, low toxicity to beneficials, and economic feasibility.

Insectary Testing

The initial screening of new insecticides and test for resistance to insecticides are done in the laboratory and insectary. Field trials require expensive work and land and are subject to many variables. Insectary studies will narrow the number of chemicals to a few promising ones which can then be tested in the field. For this purpose, the methodology for determing LD_{50} values of insecticides as given in Chapter 3 of the Manual for Testing Insecticides on Rice published by International Rice Research Institute (IRRI) which can be used in Sri Lanka as the agro-climatic conditions are more or less similar. Insecticides found promising in the laboratory should be further tested in the insectary for contact toxicity studies with precision spraying, foliar sprays, broadcast application of granules, root zone application, antifeedant activity, ovicidal activity, fumigation activity and resurgence activity. Chapter 4 of Manual for Testing Insecticides on Rice published by IRRI should be consulted for such trials. It should be kept in mind that methyl parathion, diazinon and deltamethron cause resurgence of whitebacked planthopper. Phorate and carbofuron granules cause resurgence of rice leaf folder and sublethal doses cause resurgence of the armyworm, *Spodoptera litura* in the laboratory.

Field testing

Field testing compares candidates with standard products and controls under close to realistic conditions. The parameters investigated should include spectrum of activity, residual activity, crop tolerance dosage, formulation, application, waiting periods and cost performance. Establishing good field trials is a matter of experience, and influential factors include environment, local standard check treatments, untreated controls, volume applied. The distribution of insect populations should be uniform and precounts help in the proper allocation of plots through randomization. Data collection is also a compromise between statistical purity and cost consideration. The criteria of assessment for primary trials are degree of infestation and damage, but later trials must include data on yield and economic costs and returns.

Farmers compare the value of yield loss prevented with expenditure made. High cost treatments, if ever economically attractice seldom give complete protection. Low cost treatments may be attractive if insects occuring frequently are fully controlled. Therefore, recommended treatment should have reasonable cost (considering average cultivator/ consumers resources) and give return in excess of its cost. Following treatments should be included, in rice crop for the beginning in Sri Lanka, and field experiments designed for making recommendations.

a	zero insecticide treatment				
a	treatment equal to value of			200kg.	paddy
a	treatment	"	"	400kg.	"
a	treatment	"	"	600kg.	"

Above monitary values should be determined first in different agro-ecological regions and by proper assessment of rice crop losses due to insects in natural conditions, cost-benefits ratio may be worked out. This will be a more convencing and practical approach. Later on, criteria can be developed for other crops also. Sometimes a term avoidable loss is preferred which is computed as :

$$\text{Avoidable loss \%} = \frac{\text{Yield in intensively protected plot} - \text{Yield in particular treatment}}{\text{Yield in intensively protected plot}} \times 100$$

Criteria for the economic evaluation of alternative pest management strategies for developing countries as proposed by Waibel and Engelheardt (1988) may also be applied in Sri Lanka at later stages by the extension entomologists. A brief summary of criteria is given in annexure 4.

Various techniques to measure the efficacy of insecticides by measuring the insect population and amount of plant damaged caused by the insects are available and can be suitably used. A high natural infestation of insect is desirable but sometimes the insects population are too low for reliable field testing of insecticides. In such a situation artificial infestation can be made. Different techniques for the artificial infestation are given in above referred manual of IRRI. Field testing protocols for representative insects in case of paddy and cabbage crops are given in annexure 2.

Application Techniques

The major problem with hydraulic spraying is the large range of droplet sizes, which increase loss through sedimentation and evaporation. Correct choice of nozzle and uniform pressure can greatly improve existing application through knapsack sprayers.

Controlled droplet application (CDA) can reduce dosage requirements by 30-40%, compared with knapsack spraying, by narrowing the spectrum of droplet size. It will thus not only reduce waste but also save time and labour. Its major drawbacks are the recurrent costs of batteries and special formulations. Researchers are attempting to reduce the energy required. Small droplets allow a reduction in the total volume of spray, but narrow swath widths are necessary to allow for change in wind speed and direction.

Electrostatic spraying reduces drift while retaining a small droplet size and a narrow spectrum of sizes. It also eliminates moving parts (i.e. the spinning disc of CDA) but requires special semiconducting formulations. Coverage of upper crop canopies is excellent but penetration is poor because the charged particles stick to the first grounded surface they strike. This is a source of ecological selectivity : if pests live on the upper canopy while natural enemies live below, the distribution of spray favours the natural enemies. Rice leaf-folder and GLH are thus potential targets, but BPH seems less susceptible. Precise timing of spraying and accurate information on the migration of BPH and its natural enemies, however, may make adequate control possible. Applications must be made when the natural enemies are below the canopy and BPH is still in the canopy tops after immigration.

The simplicity and ecologically precise control possible with electrostatic sprayers are exciting, but further research is required. In addition, special formulations must be made available in their packaged form at the farm level.

Physico Chemical properties and efficacy

The relationship between physico-chemical properties of formulations and insecticidal activity is complex. To optimise activity, the formulator must know precisely where the active material must be located to exert the biological effect. For contact action, some generalisations can be made. For example, on non-porous surfaces, insecticide deposits which are in the form of a solution are often more accessible to insect pick up than are particulate forms. The incorporation of low volatile liquid components into formulations such as ULVs can therefore enhance biological activity. However, on porous surfaces, solutions are readily absorbed. As a result, the active ingredient becomes less available for pick-up and contact action is reduced. For this reason, WPs and SCs are widely used for treatment of porous surfaces. Lipophilic solutions enhance penetration into many insects.

Increasing viscosity of such solutions can decrease the rate of spread on leaves and in somecases lead to reduced penetration into insects. By analogy, highly viscous solutions and materials in particulate form are less readily absorbed by plant surfaces than solutions of low viscosity. Formulation techniques such as encapsulation can be used to minimise uptake of liquid pesticides by substrates.

For solid deposits, insecticidal activity is dependent upon particle size. Deposits of 5 to 15 µm have been claimed tobe most suitable for many substrates because they are relatively easily picked up and retained by insects. However, resistance of deposits to wash-off at least for essentially insoluble materials, has been found to decrease with increasing particle size. Thus deposits from SC formulations have been shown to be more persistent than from WPs.

V. COLLECTION OF DATA, INTERPRETATION AND STANDARDS

It is essential that the presentation of the results should be standardised in order to facilitate understanding of the trials. Therefore, the data should preferably include the following points :

1. Name of the experimenter and organisation responsible for the trial
2. Objective and location of the trial
3. Chemical name and formulation
4. Pest, disease or weed against which tested
5. Crops and cultivars
6. Plant growth stage
7. Soil type
8. Experimental design, size and number of plots treated
9. Application method and equipment
10. Application dates and rates
11. Volume of spray liquid or other carrier (types)
12. Weather conditions during and after treatment
13. Treatment of the plots with other crop protecting materials, fertilizers and other products
14. Application dates
15. Dates of assessment
16. Size and frequency of sampling
17. Quantity and quality of the yield of the harvested crop
18. Any results on crop safety including intervals tobe observed in order to avoid phytotoxic effects
19. Data assessment including significance
20. Interpretation and discussion on the results of the experiment in comparison with similar trials

Always an outline of an experiment should be prepared to avoid the omissions of any valuable information. Therefore, a model outlined of an experiment on rice yellow stem borer is given in annexure 5. FAO guidelines on efficacy data for the registration of pesticides for plant protection should also be utilised for general guidelines.

Statistical procedure should fit the specific problems and needs of a given experiment. It should not be applied ritualistically. Entomologists and statisticians working together must consider the following problems unique to entomological trials to achieve the most appropriate statistical procedure.

While grain yield data must be collected along with data on insect incidence, two sources of variation, soil heterogeneity and nonuniform insect distribution, must be handled simultaneously. In addition, unlike soil heterogeneity, which can be effectively handled by proper blocking, insect direction and distribution are unpredictable. The primary types of data collected in an entomological trial are percentage and count data, neither of which can be expected to follow the normal distribution. Thus, appropriate modifications of standard statistical procedures, such as data transformation (arc sine or logarithmic) and probit analysis, are generally needed for application to percentage and count data. Most insecticide treatments produce large border effects, and generally require the use of plot sizes that are much larger than those normally required for accurate yield determination. In a field trial, if the level of insect infestation is not high enough for a valid evaluation of insect control methods, the resulting data would not be meaningful and should be discarded.

With the increased importance of IPM, the use of factorial experiments - rather than the traditional single factor experiments, is expected to increase. Experimental designs suitable for factorial experiments, such as split-plot designs, should be considered.

VI. PEST PRESSURES, THRESHHOLD AND PHI

Department of Entomolcgy of CARI has recommended threshold limit for some insects in certain crops but mostly this information has been collected from the neighbouring countries having the same agro-ecological conditions. A tentative threshold limit and sampling procedure is given in annexure 6 in case of insects of rice which should be verified and further improved after suitable experimentation at different levels. Pre-Harvest Interval. (PHI) have been recommended in some crops in relation to specific insecticides but this has not been linked with residue data in relation to Maximum Residue Limits (MRL). PHI & MRL in case of some insecticides and crops are given in annexure-7 as per Sri Lanka notification No. 433/9 Dec' 24, 1986. A brief summary of the monitoring activities in relation to post registration activities of pesticides are given below which give the idea about the studies on this aspect :

Post Registration Monitoring Activities

Product quality at packing	Inactive - lack of facilities & trained manpower.
On retail	Inactive - " "
Residue in food	Inactive - " "
Resticide use in accordance with label	Inactive - lack of full time staff
Environmental impacts	Inactive - lack of expertise & manpower
Accidental poisoning	No organisational network for follow up.

Pre-harvest intervals are linked with residue levels, but only residue laboratory with CARI has very meagre facilities.

In Sri Lanka only three laboratories are available for pesticide work, Ceylon Institute for Scientific and Industrial Research (CISIR), Community Medicine Section of University of Colombo, and Central Agricultural Research Institute (CARI) of Department of Agriculture. The laboratories of CARI has Formulation Analysis Laboratory and Residue Analysis Laboratory, which are responsible for providing information for the implementation of the pesticide control Act.

I. Formulation Analysis Laboratory

Quality control of pesticide is done in this laboratory. It concentrates on determining the chemical and physical properties such as active ingredient content, particle size, acidity, alkalinity, emulsion stability, flash point, wettability etc. of pesticide available in the market. Services offered are : 1) Analysis of pesticide formulations submitted by the registrar of pesticides. 2. Survey on the quality of mosquito coils in Sri Lanka. 3. Degradation studies of pesticide formulations under different climatic conditions. 4. Help in the implementation of the Pesticide Act.

This laboratory is essential for the enforcement of the law on pesticides. The analytical methods are based on CIPAC (Collaborative International Pesticide Analytical Council) hand books.

II. Residue Analysis Laboratory

The analysis of insecticides residues in various commodities is being carried out in this lab. Activities are confined to service rendered 1. Analysis of samples submitted from time to time by the Department of Agriculture and various other sources. 2. Participating in the ring analysis organised by the Pesticide Residue Project, GTZ in Darmstadt, West Germany. 3. An all island survey on organochlorine insecticide residues in vegetables and fruits.

4. Survey on organo-chlorine residues in breast-milk.
5. Survey of chlinesterase levels in the blood of farmers who had recently been spraying insecticides. (this survey was only small and suffered few set-backs). 6. Survey of organo-chlorine residues in drinking water. 7. Survey on pesticides usage by vegetable farm rs.

Now the attention is shifted to the use of organo-phosphate and carbamate pesticides in agriculture. The work of these labor-tories are severely handicapped by the lack of : (a) trained personnel (b) high quality reagents (c) literature and information, and (d) equipments and spares.

It should be kept in mind that MRL's are trade standards. Insecticides residues found significantly over MRL indicate the misuse of product. The concept of MRL should be treated as quite different from an ADI (Acceptable Daily Intake). MRL is applicable in trade and ADI at the point of consumption. Registrar of Pesticides while permitting a proposed use, should judge whether resulting residue intakes by consumers will in practice fall within the ADI and if necessary, proposed use patterns should be modified.

Post registration monitoring activities are inactive due to lack of facilities and trained manpower. Quality Control and residue analysis facilities are to be strengthened immediately, to avoid misuse and abuse of pesticides. A number of poisoning cases, though many of them need verifications, have been reported in Sri Lanka.

VII. METHODOLOGIES TO STOP DEVELOPMENT OF RESISTANCE

During the past 40 years insecticide resistance pests have been controlled largely by the simplistic process of changing to newer type of insecticide to which the insect is still susceptible. The widening patterns of multiple resistance indicates that this is an increasingly dubious longterm solution. The discovery and development of new types of insecticides have become increasingly more regorous and costly and insecticide resistance has steadily eroded the marketable lifetime of new insecticides. Cross and multiple resistance prejudice the effectiveness of new products even before they are marketed.

There are no conclusive proofs of insect resistance to insecticides in case of agriculture in Sri Lanka, however, in case of health programmes, some cases have been reported but the resistance was not determined as per the FAO Plant production and production paper. Choices for a resistance management programmes will always have some uncertainties associated with them. Countermeasures that relate specifically to the proper choice and use of insecticides can be decisive factors in coping with insect resistance or more realistically in preserving pests susceptibility.

To overcome this problem

1. Monitor insect pest populations so that primitive susceptibility levels are understood and early detection of specific resistance becomes possible. Following steps should be taken to establish appropriate warning systems for insecticides resistance :

a) Early detection of resistance through precise dosage mortality data to monitor the position (LD_{50}) and slope of dosage-mortality response.

b) Establish the levels of primitive susceptibility to a variety of insecticides of the insect from areas where insecticides have not been used extensively, or if this is impracticable, study of closely related species that are not of economic importance.

c) Discontinue the use of specific insecticides whenever the above parameters indicated that a change in susceptibility has started.

2. Avoid the use of insecticide mixtures as they generally result in the simultaneously development of resistance, (each compound seems to develop the residual inheritance of the supporting genome for resistance in the other). Mixtures may be effective in delaying resistance if (a) initial frequencies of resistance are slow. (b) the fraction escaping treatment is high relative to dominance and linkage and (c) the insecticide mixtures are ca 100% effective against treated susceptible homozygotes and nearly equal in persistance. If anyone of (a), (b) and (c) fails to hold, the mixtures loose much of their effectivenss and alternation becomes the more attractive option. The last two factors, equal persistance and complete effectiveness against treated susceptible homozygotes, are especially crucial to the success of mixtures.

3. Choose a sequence of suitable alternative insecticides based on genetic considerations of cross resistance and multiple resistance. A remedial insecticide choosen from cross resistance studies should always be available for example, methyl chlorpyrifos for tempephos in WHO vector control programms of Simulium, vector of onchocerciases; chlorphyrifos for fenthion in larval control of Culex fatigans, the vector of filariasis; carbaryl + piperonyl butaxide for malathion in the control of Pediculus humunus, the vector of endemic typhous. In agriculture azinophos methyl for DDT in codling moth control, diazinon for aldrin in corn rootworm control and permethrin and fenvalerate for methyl parathion for Heliothis control are the examples. Incorrect choice of alternatives may be most damaging for future control, therefore, first use insecticides with simple one factor resistance and limited cross resistance e.g. malathion. Avoid insecticides with complicated multiplicate resistance, e.g. diazinon, Avoid or delay use of insecticides that act as effective selectors of resistance for other insecticides e.g. dimethoate for pyrethroids. Exploit alternative treatments with insecticides without common major factors and

change insecticides before resistance develops. This latter point is particularly important when following DDT resistance due to the kdr mechanism with synthetic pyrethroids.

4. Extend the useful life of a satisfactory insecticide as long possible, but monitor susceptibility and replace the insecticide before the control fails.

5. The use of slow release formulations should be discouraged because continous release of insecticide during the entire cropping season may lead to more rapid development of resistance and is tasteful at growth stages when no pests occur.

Management strategies, that will extend the lifetime of the insecticides now available, should be incorporated in IPM programmes. Strategies for delaying resistance involve the rotation or the joint use of insecticides. In Chinese fruit orchards, for example, three to five different insecticides are carefully rotated to delay the onset or resistance. Such strategies will need biological wisdom, social cooperation, and economic constraints that can be achieved in large public health programs but that will be much more difficult to implement in agriculture.

References for further reading and planning of good efficacy testings are given in Annexure 8.

In addition to the assigned job as per UNIDO job description, counterparts of CARI suggested that the consultant should deliver some lectures for the benfit of the Scientists of different Agriculture Research Stations and a short course on Insecticide Efficacy Testings and Evaluation was conducted on 17-18 Sept.'90 and the details are given in Annexure-9.

Annexure - 1

Common and Trade Names of Insecticides used in Agriculture

Name of active ingredient % and amount of a.i./l	Trade Names
Acephate 30EC	Orthene 300EC
Bacillur thuringiences 16,000 IU/mg	Thuricide HP, Bactospeine
Benfuracarb 3GR	Oncol 3G
BPMC (50%EC) 500g/1	Bassa 50, BPMC, Hopcin 50EC, Moricarb, Red star BPMC 50EC, Strike BPMC 50EC, Mackarb Baycarb, Harcros BPMC,
Carbaryl 85% WP	Sevin XLR, Carbaryl 85% dicarbam, Sevin 85S
Carbofuran 3%G	Curaterr 3G, Carbofuran, Furadon 3G
Carbosulphan 20ST	Marshal
Carbosulphan (20EC)200g/l	Marshal 20EC
Chlorpyriphos (20%EC) 200g/l	Makfos, Lorsban, Pyrinex 20EC
Chlorfluazuron (5EC) 50g/l	Atabron
Coumorin	
Cyfluthrin (5EC) 50g/l	Baythroid 050 EC
Deltamethrin (25EC) 25g/l	Decis
Diazinon 5GR	Basudin 5G
Diazinon 50EC (500g/l)	Basudin 50EC, Diazinon 50EC
Dicofol (42%EC) 420g/l	Kelthane MF42
Dimethoate (40%EC) 400g/l	Roxion Harcross Demoro, Perfekthion EC, Red star Dimitex Rogor 40, Dimethoate 40,
Endosulphan (35EC) 350g/l	Thiodan 35EC, Endosulphan 35EC
Fenthion 50EC (500g/l)	Baytex 50EC, Laybaycid 50EC
Fenvalerate (7.5EC) 75g/l	Sumicidin super 7.5% EC

Methamidophos (60EC) 600g/l	Methamidophos 60 WSC, Monitor 600
	Morithion, Pillaron, Methion
	Red star Aloran,
	Tamaron LC 60, Methedrin 60
Methomyl (18%EC) 180g/l	Lannate L
Monocrotophos 60 SL	Marcros Nuvacron
	Monocrotophos 60 WSC
	Red star Monocrotophos
	Monocron, Nuvacron
Omethoate (50%EC) 500g/l	Folimat LC50
Oxydemoton methyl 50 EC	Metasystox R, EC
Phenthoate (50%EC) 500g/l	Elsan 50, Cidial
Pirimiphos methyl 50EC	Actellic 50EC
Pirimiphos methyly 2%DP	Acetellic 2% dust
Permithrin (25EC) 250g/l	Ambush 25% EC
Profenophos 500g/l	Selecron
Propoxur (20EC) 200g/l	Unden 200EC
Prothipphos (50EC) 500g/l	Tokuthion EC
Quinalphos (25EC) 250g/l	Bayrusil 25%EC
	Ekalux 25EC
Sulphur 80% WP	Thiovit, Sulphur 80WP
	Sofril 81, Morisal, Red star
	Sulphur,
	Unisal
Thiodicarb 75WP	Larvin 75WP
Thiodicarb 34EC	Larvin
Trichlorofon 50EC	Dipterex LC 50%
Buprofezin 25 WP	Applaud

Annexure 2

EFFICACY TEST PROTOCOLS

I. Planthoppers in Rice

1. EXPERIMENTAL CONDITIONS

1.1 Selection of Crop and Cultivar, Test Organisms

These test protocols are concerned with the efficacy evaluation of insecticides for the control of *Nilaparvata lugens*, *Sogatella furcifera*, *Laodelphax striatella* and other delphacids in lowland rice, either wet-sown or transplanted. Use a susceptible cultivar, preferably a heavy tillering semi-dwarf cultivar.

1.2 Trial Conditions

Field trials :- The trials should be set up in a lowland rice area where paddies are likely to be infested. Heavy tillering cultivars, the use of nitrogen fertilizers and the use of a broad-spectrum insecticide earlier in the season stimulate the development of planthopper populations.

Since planthoppers tend to crowd, some disturbance by hitting hills before the experiment starts may be useful. The site of the experiment should not be at the edge of a field. The trial should start well before hopperburn develops.

Cultural conditions (e.g. soil type, fertilization, tillage, row spacing, water depth) should be uniform for all plots of the trial and should conform with local agricultural practice. Trials should be carried out in different regions with distinct environmental conditions and preferably in different seasons.

1.3 Design and Lay-out of the Trial

1.3.1 Treatments

Test product(s), reference product(s) and untreated control, arranged in a randomized block or any other statistically suitable design. There may be additional remarks in specific cases. Each plot should be surrounded by a small ridge to prevent the insecticides from contaminating neighbouring plots through possible water movements.

1.3.2 Plot Size and Replication

Net plot size : at least 15 sq.m., but according to the formulation (e.g. dust) or application equipment, it may be necessary to use a larger plot size. Replicates : at least 4.

2. APPLICATION OF TREATMENTS

2.1 Test Product(s)

The named formulated product under investigation.

2.2 Reference Product(s)

The reference product should be a registered product currently recommended for the control of planthoppers in rice. In general, formulation type and mode of action should be close to those of the test product, but this will depend on the aim of the particular trial.

2.3 Mode of Application

2.3.1 Type of Application

Application should comply with good agricultural practice. The type of application will normally be specified on the label.

2.3.2 Type of Equipment Used

The equipment should be of a type in current use. It should provide an even distribution of product on all plants in the plot or parts of the plot, as appropriate. Any deviations in dosage of more than 10% should be reported. Give full information on the type of equipment and operating conditions (e.g. operating pressure) used.

2.3.3 Time and Frequency of Application

The time and frequency of application will normally be specified on the (proposed) label. The number of applications and the date of each application should be recorded. Normally the product is applied when the population of plant-hoppers rises, but before the development of yellowing or hopperburn. This may be during the tillering stage (Sogatodes orizicola) or towards maturity of the rice plants (Nilaparvata lugens).

2.3.4 Doses and Volumes

The product should normally be applied at the dosage(s) recommended on the (proposed) label. This will normally be expressed in kg (or ℓ) of formulated product per ha. For sprays, data on concentration (%) and volume (ℓ/ha) should also be given.

2.3.5 Data on chemicals Used Against Other Pests

If other chemicals have to be used, they should be applied uniformly to all plots, separately from the test product and reference product. Possible interference with these should be kept to a minimum. Precise data on the applications should be given.

3. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

3.1 Meteorological and Edaphic Data

3.1.1 Meteorological Data

Data on precipitation (type and daily amount in mm) and temperature (daily average, maxima and minima in °C) should be obtained from the nearest meteorological station or preferably recorded on the trial site. Additional data may be needed in specific cases.

Throughout the trial period, extreme weather conditions, such as severe or prolonged drought, heavy rain, late frosts, hail, etc., which are likely to influence the results, should also be reported.

The standard meteorological data should be recorded around the time of application.

3.1.2 Edaphic Data

Depth of water layer, overflowing water, excessive algal growth or excessive organic matter content of water or soil should be recorded.

3.2 Type, Time and Frequency of Assessment

3.2.1 Type

The number of planthoppers, nymphs and adults, is counted or assessed. A fast and reliable method is to strike or hit 4 rice hills vigorously and to assess or count the number of hoppers floating and jumping on the water surface between the 4 hills. Ten such places are observed at random within each plot.

Scales such as the following may be used :

Number of planthoppers on the water surface between 4 hills :	or, on direct seeded rice, per plant:
0 = 0	1 = 0 - 5
1 = 1 to 10	3 = 6 - 10
3 = 10 to 25	5 = 11 - 25
5 = 25 to 100	7 = 26 - 50
7 = 100 to 1000	9 = over 50
9 = Over to 1000	

For this purpose a sticky board (e.g. 15 x 15 cm) held close to the shaken hills can also be used. The above methods are faster and more convenient than net sweeping or suction pump, especially in a wet crop. If net sweeping or suction pump are preferred, they may be/the case if several hopper species or other insects are involved./ used. This may be

The degree of wilting, yellowing or hopperburn should also be recorded using a rating scale or assessing percentages.

3.2.2 Time and Frequency of Assessment

A preliminary assessment should be made immediately before treatment. Further assessments should be made 1-3 days and 1 week after treatment and then weekly if necessary.

3.3 Direct Effects on the Crop

The crop should be examined for presence or absence of phytotoxic effects. The type and extent of these should be recorded. In addition, any positive effects should be noted (accelerated ripening, increased vigour, etc.).

Phytotoxicity is recorded as follows :

a) If the effect can be counted or measured, it may be expressed in absolute figures, e.g. plant height;

b) in other cases, the frequency and intensity of damage may be estimated. This may be done in either of two ways: each plot is scored for phytotoxicity by reference to a scale which should be recorded;
each treated plot is compared with an untreated plot and % phytotoxicity estimated.

In all cases, symptoms of damage to the crop should be accurately described (stunting, chlorosis, deformation, etc). For further details, refer to the Guideline on Phytotoxicity Assessment which also contains sections on individual crops.

3.4 Effects on Other Organisms

3.4.1 Effects on Other Pests

Any effects, positive or negative, on the incidence or other pests or diseases should be noted. Planthoppers are often associated with virus diseases. Virus infestation should be recorded using a suitable rating scale or essessing infestation percentages.

3.4.2 Effects on Other Non-target Organisms

Any observed effects on wildlife and/ or beneficial arthropods should also be recorded.

3.5 Qualitative and/ or Quantitative Recording of Yield

Yield data adjusted to 14% moisture content should be recorded and provided.

4. Results

The results should be analyzed by appropriate statistical methods and the statistical conclusions reported. Raw data should, however, also be available and the statistical method should always be indicated. The report should be presented in a systematic form and should include an interpretation of the results. See in particular the relevant section of FAC Guidelines on Efficacy Data.

II. Lepidopterous Stemborers in Rice

1. EXPERIMENTAL CONDITIONS

1.1 Selection of Crop and Cultivar, Test Organisms

These test protocols are concerned with the efficacy evaluation of insecticides for the control of :

Scirpophaga(Tryporyza) innotata	White rice borer
S.(T.) incertulas	Yellow rice borer
Chilo suppressalis	striped rice borer
C. polychrysus	dark-headed rice borer
Sesamia inferens	pink borer

and other leipdopterous stemborers on lowland rice, either wetsown or transplanted. Use cultivar, preferably a moderately tillering, semi-dwarf cultivar.

1.2 Trial Conditions

Field trials : The trials should be set up in a lowland rice area where paddies are likely to be infested and preferably during the main (= rainy) season.

Cultural conditions (e.g. soil type, fertilization, tillage, row spacing, water depth) should be uniform for all plots of the trial and should conform with local agricultural practice. Trials should be carried out in different regions with distinct environmental conditions and preferably in different seasons.

1.3 Design and Lay-out of the Trial

1.3.1 Treatments

Test products(s), reference product(s) and untreated control, arranged in a randomized block or any other statistically suitable design. There may be additional remarks in specific cases. When systemic insecticides are involved, each plot should be surrounded by a small ridge to prevent the insecticides from contaminating neighbouring plots through possible water movements.

1.3.2 Plot Size and Replication

Net plot size : 15 m^2 but according to the formulation (e.g. dust) or application equipment, it may be necessary to use a larger plot size. Replicates : at least 4.

2. APPLICATION OF TREATMENTS

2.1 Test Product(s)

The named formulated product under investigation.

2.2 Reference Product(s)

The reference product should be a registered product currently recommended for the control of lepidopterous stemborers in rice. In general, formulation type and mode of action should be close to those of the test product, but this will depend on the aim of the particular trial.

2.3 Mode of Application

2.3.1 Type of Application

Applications should comply with good agricultural practice. The type of application will normally be specified on the label.

2.3.2 Type of Equipment Used

The equipment should be of a type in current use. It should provide an even distribution of product on all plants in the plot or parts of the plot, as appropriate. Any deviations in dosage of more than 10% should be reported. Give full information on the type of equipment and operating conditions (e.g. operating pressure) used.

2.3.3 Time and Frequency

The time and frequency of application will normally be specified on the proposed label. The number of applications and the date of each application should be recorded. The time and frequency depend on the pest species and local environmental conditions and circumstances. The young larvae hatch and penetrate the leafsheath or stem. Larval attacks are not visible until dead hearts or white heads appear. The presence of a light trap may help in predicting a pending outbreak.

2.3.4 Doses and Volumes

The product should normally be applied at the dosage(s) recommended on the (proposed) label. This will normally be expressed in kg (or l) of formulated product per ha. It may also be useful to record the dose in g of active ingredient per ha. For sprays, data on concentration (%) and volume (l/ha) should also be given.

2.3.5 Data on Chemicals used Against Other Pests

If other chemicals have to be used, they should be applied uniformly to all plots, separately from the test product and reference product. Possible interference with these should be kept to a minimum. Precise data on the applications should be given.

3. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

3.1 Meteorological and Edaphic Data

3.1.1 Meteorological Data

Data on precipitation (type and daily amount in mm) and temperature (daily average, maxima and minima in °C) should be obtained from the nearest meteorological station or preferably recorded on the trial site. Addition may be needed in specific cases.

Throughout the trial period, extreme weather conditions, such as severe or prolonged drought, heavy rain etc., which are likely to influence the results, should also be reported.

The standard meteorological data should be recorded around the time of application.

3.1.2 Edaphic Data

Depth of water layer, overflowing water, excessive algal growth or excessive organic matter content of water or soil should be recorded.

3.2 Type, Time and Frequency of Assessment

3.2.1 Type

Percentage dead heart and white head are calculated after examining 20 to 50 hills per plot. These hills may be in 2 or 3 rows or randomly selected. If Stemborer infestation is high, dead heart and white head percentage can also be visually assessed, however only by experienced personnel.

3.2.2 Time and Frequency

A preliminary assessment should be made immediately before treatment. Counts or assessments are done when symptoms are abundant; for instance, 2 and 4 weeks after treatment in directseeded rice, or 5 and 7 weeks after transplanting for dead heart, and 10 days before harvest for white head.

3.3. Direct Effects on the Crop

The crop should be examined for presence or absence of phytotoxic effects. The type and extent of these should be recorded. In addition, any positive effects should be noted (accelerated ripening, increased vigour, etc.).

Phytotoxicity is recorded as follows :

a) if the effect can be counted or measured, it may be expressed in absolute figures, e.g. plant height;

b) in other cases, the frequency and intensity of damage may be estimated. This may be done in either of two ways : each plot is scored for phytotoxicity by reference to a scale which should be recorded; each treated plot is compared with an untreated plot an % phytotoxicity estimated.

In all cases, symptoms of damage to the crop should be accurately described (stunting, chlorosis, deformation, etc.). For further details, refer to the Guideline on Phytotoxicity Assessment (EPPO) which also contains sections on individual crops.

3.4 Effects on Other Organisms

3.4.1 Effects on Other Pests

Any effects, positive or negative, on the incidence of other pests or diseases should be noted.

3.4.2 Effects on other Non-target Organisms

Any observed effects on wildlife, and/or beneficial arthropods should also be recorded.

3.5 Qualitative and/or Quantitative Recording of Yield

For each plot record yield in kg/ha adjusted to 14% moisture content. If ditches have been made or paths have been cut earlier in the experiment, the 2 border rows or some 30 to 40 cm of each plot are not included (net plot).

4. RESULTS

The results should be analyzed by appropriate statistical methods and the statistical conclusions reported. Raw data should, however, also be available and the statistical method should always be indicated. The report should be presented in a systematic form and should include an interpretation of the results. See in particular the relevant section of FAO Guidelines on Efficacy Data.

2.3.3 Time and Frequency of Application

The time and frequency of application will normally be specified on the (proposed) label. The number of applications and the date of each application should be recorded. Normally, the product is applied when the population of leafhoppers rises, but before the development of wilting or yellowing. This is normally during the tillering stages.

2.3.4 Doses and Volumes

The product should normally be applied at the dosage(s) recommended on the (proposed) label. This will normally be expressed in Kg. (or l) of formulated product per ha. It may also be useful to record the dose in g of active ingredient per ha. For sprays, data on concentration (%) and volume (l/ha) should also be given.

2.3.5 Data on Chemicals Used Against Other Pests

If other chemicals have to be used, they should be applied uniformly to all plots, separately from the test product and reference product. Possible interference with these should be kept to a minimum. Precise data on the applications should be given.

3. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

3.1. Meteorological and Edaphic Data

3.1.1 Meteorological Data

Data on precipitation (type and daily amount in mm) and temperature (daily average, maxima and minima in °C) should be obtained from the nearest meteorological station or preferably recorded on the trial site. Additional data may be needed in specific cases.

Throughout the trial period, extreme weather conditions, such as severe or prolonged drought, heavy rain, etc., which are likely to influence the results, should also be reported.

The standard meteorological data should be recorded around the time of application. Humidity may also be recorded. During full moon, after heavy rainfall, and often for no obvious reasons, leafhoppers swarm at night time. This may interfere with the trial. A light trap at some distance of the experimental site will record such events.

3.1.2 Edaphic Data

Depth of water layer, overflowing water, excessive algal growth or excessive organic matter content of water or soil should be recorded.

3.2 Type, Time and Frequency of Assessment

3.2.1 Type

The number of leafhoppers, nymphs and adults is counted or assessed. A fast and reliable method is to shake or hit 2 or 4 rice hills vigorously and to assess or count the number of hoppers floating and jumping on the water surface between these hills. Ten such places are observed at random within each plot.

Scales suchas the following may be used :

Number of leafhoppers on the water surface between the hit hills, or on the sticky board, or per board.

	(per hill)
0 = 0	1 = 0 - 1
1 = 1 to 5	3 = 2 - 5
3 = 5 to 10	5 = 6 -10
5 = 10 to 25	7 = 11-25
7 = 25 to 100	9 = over 25
9 = over 100	

For this purpose a sticky board (e.g. 15x15 cm) held close to the shaken hills can also be used. In a dry crop the number of leafhoppers can also reliably be assessed by net sweeping or suction pump.

Leafhopper numbers are rarely high enough to cause yellowing. If that happens, however, the degree should be recorded using a rating scale or assessing percentages.

3.2.2 Time and Frequency

A preliminary assessment should be made immediately before treatment. Further assessments should be made 1 - 3 days and 1 week after treatment and then weekly if necessary.

3.3 Direct Effects on the Crop.

The crop should be examined for presence or absence of phytotoxic effects. The type and extent of these should be recorded. In addition, any positive effects should be noted (accelerated ripening, increased vigour, etc.)

Phytotoxicity is recorded as follows:

a) if the effect can be counted or measured, it may be expressed in absolute figures, e.g. plant height.

b) in other cases, the frequency and intensity of damagemay be estimated. This may be done in either of two ways:
each plot is scored for phytotoxicity by reference to a scale which should be recorded;
each treated plot is compared with an untreated plot and % phytotoxicity estimated.

In all cases, symptoms of damage to the crop should be accurately described (stunting, chlorosis, deformation, etc.) For furtherdetails, refer to the Guideline on Phytotoxicity Assessment which also contains sections on individual crops.

3.4 Effects on other Organisms

3.4.1 Effects on other Pests.

Any effects, positive or negative, on the incidence of other pests or diseases should be noted. Planthoppers are often associated with virus diseases. Virus infestation should be recorded using a suitable rating scale or assessing infestation percentages.

3.4.2 Effects on other Non-target Organisms.

Any observed effects on wildlife, and/or beneficial arthropods should also be recorded.

3.5 Qualitative and/or Quantitative Recording of Yield.

Not required.

4. Results.

The results should be analyzed by appropriate statistical methods and the statistical conclusions reported. Raw data however, also be available and the statistical method should always be indicated. The report should be presented in a systematic form and should include an interpretation of the results. See in particular the relevant section of FAO Guidelines on Efficacy Data.

PLUTELLA XYLOSTELLA

1. EXPERIMENTAL CONDITIONS

1.1 Selection of Crop and Cultivar, Test Organisms.

These test protocols are concerned with the efficacy evaluation of insecticides for the control of caterprillars of *Plutella xylostella* (*plutella maculipennis*) on cabbage (*Brassica oleracea* and *B. chinensis*)

1.2 Trial Conditions

Field trials on crops with a uniform high infestation with the pest.

Cultural conditions (e.g. soil type, fertilization, tillage, row spacing) should be uniform for all plots of the trial and should conform with local agricultural practice. The timing, amount and method of irrigation, if applied, should be recorded. Trials should be carried out in different regions with distinct enironmental conditions and preferably in different seasons.

1.3 Design and Lay-out of the trial.

1.3.1 Treatments

Test product(s), reference product(s) and untreated control, arranged in a randomized block or any other statistically suitable design. There may be additional remarks in specific cases.

1.3.2. Plot Size and Replication

Net plot size: at least 25 plants. Replicates: at least 4. Sometimes the beds are only 2-3rows wide and may even be surrounded by water. Under these and similar conditions the "border" rows are included in the trial, and the entire width of a bed may be used as a plot.

2. APPLICATION OF TREATMENTS

2.1 Test Product(s)

The named formulated product under investigation.

2.2 Reference Product (s)

The reference product should be a registered product currently recommended for the control of *Plutella xylostella*. In general, formulation type and mode of action should be close to those of the test product, but this will depend on the aim of the parti-cular trial.

2.3 Mode of Application

2.3.1 Type of Application

Applications should comply with good agricultural practice. The type of applications will normally be specified on the label.

2.3.2 Type of Equipment Used

The equipment should be of a type in current use. It should provide an even distribution of product on all plants in the plot or parts of the plot, as appropriate. Any deviations in dosage of more than 10% should be reported. Give full information on the type of equipment and operating conditions (e.g. operating pressure) used.

2.3.3 Time and Frequency of Application

The time and frequency of application will normally be specified on the (proposed) label. The number of applications and the date of each application should be recorded. Normally a first application will be made when young caterpillars are present in sufficient numbers (e.g. 1-3 young stage caterpillars per plant). A second application follows as required. Note the growth stage of the crop at treatment.

2.3.4 Doses and Volumes Used

The product should normally be applied at the dsoage (s) recommended on the (proposed) label. This will normally be expressed in kg. (or l) of formulated product per ha. It may also be useful to record the dose in g of active ingredient per ha. For sprays, data on concentration (%) and volume (l/ha) should also be given.

2.3.5 Data on Chemicals Used Against Other Pests.

If other chemicals have to be used, they should be applied uniformly to all plots, separately from the test product and reference product. Possible interference with these should be kept to a minimum. Precise data on the applications should be given.

3. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

3.1 Meteorological and Edaphic Data

3.1.1 Meteorological Data

Data on precipitation (type and daily amount in mm) and temperature (daily average maxima and minima in °C) should be obtained from the nearest meteorological station or preferably recorded on the trial site. Additional data may be needed in specific cases.

Throughout the trial period, extreme weather conditions, such as severe or p-rolonged drought, heavy rain, hail, etc., which are likely to influence the results, should also be reported

The standard meteorological data should be recorded around the time of application.

3.1.2 Edaphic Data

Not applicable.

3.2 Type, Time and Frequency of Assessment.

3.2.1 Type

Count numbers of live caterpillars of different ages on all 20 plants in each plot. If other species than *P. xylostella* are present, record the species separately; ex[illegible] whole plants.

3.2.2 Time and Frequency

Preliminary assessment : Immediately before treatment.

1st assessment : 1-3 days after treatment.

2nd assessment : 7-14 days after treatment.

Addtional assessments may be useful, particularly for slow acting products.

3.3 Direct Effects on the Crop.

The crop should be examined for presence or absence of phytotoxic effects. The type and extent of these should be recorded. In addition, any positive effects should be noted (accelerated head formation, increases vigour, leaf coloration etc.).

Phytotoxicity is recorded as follows:

a) if the effect can be counted or measured, it may be expressed in absolute figures, e.g. plant height;

b) In other cases, the frequency and itensity of damage may be estimated. This may be done in either of two ways:
each plot is scored for phytotoxicity by reference to a scale which should be recorded ;
each treated plot is compared with an untreated plot and phytotoxicity estimated.

In all cases, symptoms of damage to the crop should be accuratel described (stunting, chlorosis, deformation, etc.). For further details, refer to the EPPO Guideline on Phytotoxicity Assessment which also contains sections on individual crops.

3.4 Effects on Other Organisms

3.4.1 Effects on Other Pests

Any effects, positive or negative, on the incidence of other pests or diseases should be noted.

3.4.2 Effects on other Non-target Organisms

Any observed effects on wildlife and/or beneficial arthropods should also be recorded.

3.5 Qualitative and/or Quantitative Recording of Yield.

Quantitative yield recording is not required, but any effects on the quality of the product should be noted (e.g. market- -ability of produce).

4. RESULTS

The results should be analysed by appropriate statistical methods and the statistical conclusions reported. Raw data should, however, also be available and the statistical method should always be indicated. The report should be presented in a systematic form and should include an interpretation of the results. See in particular the relevant section of FAO guide- lines of efficacy data.

Annexure - 3

Protocols for evaluation of Phytotoxicity of Insecticides and fungicides - technical and formulation.

1. Trials should be conducted in two different agro-climatic zones. These zones are - Arid, Semi-Arid, Tropical, Coastal and Temperate/hilly.

2. Trials should be conducted in scientific manner using standard statistical experimental designs. Number of treatment (T) and Replication (R) should be such that the total degree of freedom (R&T) should not be less than 12.

3. Recommended and 2-4 times higher than recommended dose should be used.

4. In case of seed soil treatment following observations should be recorded :

   (i) Germination percentage
   (ii) Plumule and Radical growth

5. In case of foliar spray, observations should be recorded as :

   (i) Leaf injury on tips and leaf surface, wilting, vein clearing, necrosis, epinasty and Hyponasty.

   (ii) Leaf injury should be considered on visual rating from 1-10 such as :

   (0-10% = 1, 11-20% = 2, 21-30% = 3, 31-40% = 4
   41-50% = 5, 51-60% = 6, 61-70% = 7, 71-80% = 8
   81-90% = 9, &91-100%-10).

6. Test plants should be selected from each group of crops, i.e. cereals -maize and paddy; vegetables - cucurbits (Tinda) and potato; Legumes(Pulses); fruits - grapes, apples and citrus; oilseeds - groundnut and mustard; plantation crops - coffee and tea, and fibre crop - cotton.

7. Recovery of plants from damage and time required for recovery should be noted.

8. The phytotoxic studies of insecticides/fungicides can be undertaken either separately or while evaluating their bio-effectiveness against pests/diseases of the agricultural crops mentioned above. However, active ingredient in the technical or formulated material

should invariably be determined as the case may be and appropriate allowance should be made while preparing pesticide dilutions of required strength. Type of plant protection equipment employed should also be mentioned.

9. In case of technical grade pesticides, a suitable formulation is required to be made and diluted to the desired strength. Similar control samples of the formulation of various pesticides should also be prepared for comparison purposes.

Annexure. - 4

EMPIRICAL RESULTS FOR CRITERIA IN EVALUATING A PEST MANAGEMENT STRATEGY

No.	Criterion	Formula	Empirical value %
1.	Potential loss	$\frac{a_2z_2-a_2z_1}{a_2z_2}$	780
2.	Residual loss	$\frac{a_1z_2-a_1z_2}{a_1z_2}$	4.98
3.	Control Efficiency	$\frac{\text{residual loss}}{\text{potential loss}}$	30.80
4.	Reduction in loss (AT not reached)	$\frac{a_1z_2 - a_2z_2}{a_1 z_1}$	1.10
5.	Production increase (AT reached)	$\frac{a_1z_1 - a_2z_2}{a_1z_1}$	1.93
6.	Actual benefit	increase in production + reduction in cost*	1.35
7.	Potential benefit (AT reached)	$\frac{a_2z_2 - a_1z_1}{a_1z_1}$	6.38

*The probability of state of nature-action threshold reached — is 0.1; however, 70% offarmers apply pesticides in any case.

The pay-off matrix in its simplest case consists of four sections and describes the economic result of the actions "treat" (a_1) and "do not treat" (a_2) given the extension service forecasts "threshold reached" (z_1) and "threshold not reached" (z_2) The pay_off(a_1z_1) of the action (a_1) in the case of the forecast "action threshold reached" (z_1) is the average net return for a production method geared to the action threshold. The same applies to the pay-off (a_2z_2) which covers the cases in which no treatment is carried out because the action threshold is not reached.

In the event that the action threshold . is reached (z_1) but nevertheless no treatment is carried out (a_2), the pay-off value (a_2z_1) corresponds to the average of the net returns for the untreated plots. If, contrary to the extension service forecast "action threshold not reached" (z_2) treatment is nevertheless still carried out (a_1), the pay-off value (a_1z_2) corresponds to the average net returns achieved by the farmers who treat their crops.

Field evaluation of granular insecticides for rice yellow stem borer control

Background information : The yellow stem borer, *Tryporyza incertulas*, is a pest that frequently causes deadheart damage above the economic injury level. Because varietal resistance is only of a moderate level, insecticides are commonly used for control. The effectiveness of currently recommended insecticides must be verified before revising current recommendations. Also new insecticides need to be tested to find additional effective insecticides.

Objectives : To determine which of the currently recommended insecticides should be delisted and whether any new chemicals should be added.

Site : Central Agricultural Research Institute, Peradeniya, Sri Lanka.

Research Staff :

Experimental Procedure : Nine insecticides will be applied 5 times, in a field experiment, 10, 25, 45, 60 and 75 DT as a paddy water granular broadcast at 1.0kg a.i./ha. Deadheart counts will be made twice and whiteheads will be counted at harvest. Data on additional insects will be recorded. Yields will be recorded.

Treatments :

1. Carbofuran 3 GR
2. Diazinon 10 GR
3. Gamma BHC 6 GR
4. Endosulfan 5 GR
5. Gamma BHC + Carbaryl 6+4GR
6. Bendiocarb 5 GR
7. Gamma BHC + MIPC 6 + 4 GR
8. Gamma BHC + MTMC 6 + 3 GR
9. Isazophos 10 GR
10. Untreated check

Experimental design and layout :

Randomized complete block with 4 replication (see field layout) Plot size = 4X9m

Agronomic practices :

Variety	-IR 29
Planting	-Plant 14-day-old dapog-grown seedlings at 2 seedlings/hill on 15 November 1980
Spacing	-25 X 25cm
Fertilizer/ha	-Basal = 14 KgN+14KgP+14KgK
	-25-30 days after transplanting (DT) = 23 KgN
	-Panicle initiation = 23 KgN
Weeding	-Hand weed when necessary

Field Layout

Block - I		Block - II	
4	7	9	3
1	6	5	2
9	2	1	6
10	8	10	4
3	5	7	8

1	6	4	8
5	8	3	2
9	2	1	9
3	7	5	7
10	4	10	6
Block-III		Block-IV	

Special instructions :

1. Use insecticides not more than 1 year from date of manufacture. 2. Before the first insecticide application, make leaves to separate each plot and then throughout the experiment. 3. Maintain 2-4cm of water in plots at all times. 4. Do not apply insecticide during heavy rains or winds. 5. Control rats as per recommended method. 6. Control birds.

Equipment, supplies, and personnel needed :

Equipment and Supplies : Power tiller, Meter tape, Seedlings, Abaca twine, Fertilizer, Insecticides, Balance (50 g sensitivity), Sweep nets, Data sheets, Bamboo stakes.

Personnel : Plot preparation - 5 labour days, Transplanting- 10 persons for 2ha, Plot maintenance - 1 person for week, Observations - 3 persons on sar.

Observations and sampling dates :

1. Whorl maggot damage rating at 20 and 30 DT.
2. Deadheart counts at 20 and 40 DT. Check 20 randomly selected hills per plot, to determine percentage of each borer species present.

3. Whitehead counts at harvest. Check 20 randomly selected hills per plot.

4. Other insects. If populations of other insects or insect damage warrant, record : Green leaf-hoppers - Make 10 sweeps/ plot. Planthoppers-shake insects off the plants by tapping 10 plants/plot a insects that fall. Leaf folder and caseworm-Estimate percentage of damaged leaves on 10.

5. Yield data. Take sample from a 3X4 m area in the centre of each plot.

Annexure - 6

Suggested Sampling and Thresh-Hold - Rice Insects

Insects	Sampling	Thresh-hold
Mole Cricket	Pull up 20 plants at rondom within a field and record % of infested hills.	10% hills infested (25-40 DAS)
Root aphids	Dig at the base of the plants symptoms of aphid attack and look for sign of aphids % of infested hills.	10% hill infested (30-90 DAS)
Seedling maggots	Cross the field and remove 5 leaves from each plant in 20 random location or a total of 100 leaves.	15% damage leaves (1-15 DAS)
Rice whorl maggot	Randomally select 20 hills and record number of eggs/ hill.	2 eggs/hill (0-20 DAS)
Rice case-warm	Look at the number of insect damaged & undamaged leaves on 5 leaves from each of 20 hills chosen at random. Combine the damage caused by other leaf feeders with that caused by case warm.	50% damaged leaves (0-20DAS) 15% leaves damaged (20-50 DAS)
Rice green semilooper	-do-	-do-
Rice beetles	Randomally choose 20 hills to record the number of beetles	2 beetles/ 20 hills. (20-50 DAS)
Rice-thrips	Pick 5 leaves from each of 20 randomally selected hills across the field and record the number of damaged leaves.	15% damaged leaves(0-10DAS)
Rice gall midge	Field sampling is based on plant damage as a percentage of either damaged leaves or cut panicles. Randomally select 5 leaves or panicles in each 20 hills across the field.	50% damaged leaves or cut panicles (0-10DAS)

Grass hoppers	Visit the field each week, picking 5 leaves from each of 20 randomally selected hills, across the field determine the percentage of damaged leaves or panicles. Leaf damages from grass hoppers and other defloating insects should be combined to form the thresh-hold value.	50% damaged leaves/hill (0-20DAS)
Rice leaf folders	Randomally pick-up 5 leaves each of 2 hills across the field. Take note of leaf folder moths while walking across the field.	15% damaged leaves(20-50 DAS) 5% damaged leave (50-90 DAS)
Rice stem-borers	Record the number of dead hearts and healthy tillers in 20 randomally choosen hills across the field. Take note of moths while crossing the field.	10% dead hearts (0-50 DAS) 5% dead hearts (50-90 DAS)
Rice black-bug	Randomally select 20 hills across the field and count the numbers of adults and nymphs.	5 black-bug/hills (10-155 DAS)
Rice hispa	Weekly from transplanting to panicle initiation, count the number of adults and larval mines in each of 20 randomally choosen hills across the field.	4 adults/hill (0-80 DAS) 15 larval mines/leaf(30-80DAS)
Mealy bug	Visit the field each week and look at the base of 20 hills across the field.	20% hills with mealy bug colonies (20-120 DAS)
Rice green horned cater-piller	Randomally pick 5 leaves from each of 20 hills across the field. Yield loss in related to the degree of defoliation; therefore, there is no need to distinguish the leaves damaged by the insect from leaves damaged by other pests, e.g. armyworms, cutworms, grass-hoppers and rice skippers.	15% damaged leaves (30-70 DAS)

Rice brown plant hopper	Pick 20 hills at random across the paddy. Hit each hill several times with the hand and count the number of mature nymphs that fall on the water. Mature nymphs are brown and immature nymphs are white.	115 mature nymphs/ tiller(0-115 DAS)
Rice white backed plant hoppers	Hoppers from 20 randomally selected hills or parts across the field.	115 mature nymphs/ tiller(0-100DAS)
Rice green leaf hoppers	A)Swing the Sweep net in a "brush-stroke"(following are of a pendulum) for each sweep. The bottom of the net should penetrate the rice canopy during the sweep. Make 10 sweeps (a sweep is one bass of the net across the plants, either to or from while following a diagonal line across the paddy. Take sweep net samples twice a week, from seedling stage to panicle initiation count the nymphs and adults B) Each week randomally pick 20 hills across the paddy. Slap the plants with force several times with the palm of the hand. Count both nymphs and adults that fall on the water. Calculate the average green leaf hopper number per hill.	2 leaf hoppers/ sweep(0-60DAS)
Rice seed bug	Sampling early in the morning or late in the afternoon from 20 randomally choosen hills across the paddy.	10 bugs/20 hills

DAS : Days after sowing

Annexure- 7

PHI AND MRL -SRI LANKA

INSECTICIDE	CROP	PHI	MRL
Carbofuran	Gourds	14	1.0
	Banana	14	0.2
	Brinjal	14	0.2
	Onion	14	0.1
	Any other vegetable	14	0.2
Carbaryl	Gourds	7	3.0
	Onion	7	2.0
	Brinjal	7	5.0
	Potato	7	0.2
	Sweet Potato	7	1.0
	Any other vegetable	7	5.0
Dimethoate	Mung	14	0.5
	Soya Bean	14	0.5
	Bean	14	0.5
	Chillie	14	1.0
	Tomato	14	1.0
	Any other vegetable	14	1.0
Fenthion	Gourd	14	1.0
	Onion	14	1.0
	Tea	14	0.5
	Any other vegetable	14	0.05
Methamidophos	Cabbage	14	1.0
	Beet	14	1.0
	Bean	14	1.0
	Bushitao	14	1.0
	Any other vegetable	14	0.5
	Potato	21	0.1
Methomyl	Bean	14	2.0
	Cowpea	14	2.0
	Any other vegetable	14	1.0
Monocrotophos	Cabbage	14	0.2
	Bean	14	0.2
	Cowpea	14	0.2
	Mung	14	0.5
	Soya Bean	14	0.05
	Ground Nut	14	0.05
	Chillie	14	1.0
	Brinjal	14	0.5
	Gourds	14	0.5
	Any other vegetable	14	0.2
	Potato	21	0.05

Oxydemeton Methyl	Beans	21	0.2
	Soya Bean	21	0.2
	Cowpea	21	0.2
	Mung	21	0.2
	Chillie	21	1.0
	Brinjal	21	0.2
	Any other vegetable	21	0.2
Phenthoate	Bean	14	1.0
	Chillie	14	1.0
	Any other vegetable	14	1.0
Profenophos	Cabbage	14	0.2
	Bean	14	0.2
	Potato	14	0.2
	Any other vegetables	14	0.2
Prothicphos	Cabbage	21	0.2
	Bean	21	0.1
	Potato	21	0.05
	Any other vegetable	21	0.1
Quinalphos	Cabbage	14	0.5
	Onion	14	0.1
	Tobacco	14	0.1
	Any other vegetable	14	0.1
Trichlorfon	Gourds	7	0.1
	Any other vegetable	7	0.1

PHI (Pre-Harvest Interval) MRL (Maximum Residue Limit)

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Annexure 9

My No: NCERG
Division of Entomology
Central Agricultural Research Institute
P O Box 11
Peradeniya

11th September, 1990.

DDR/ADA ISTI/Principal School of Agriculture
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A Short Course on Insecticide Efficacy Testing and Evaluation
17th to 18th September, 1990

Insecticide efficacy testing and evaluation is the beginning to frame the opinion for field recommendations and economical use of insecticides to protect crops. Recognising this fact, NCERG plans to organise a 2 day refresher course on above activity by availing the services of visiting UNIDO consultant to Dept. of Agriculture, Dr. Kamal Dhari. The venue is at the In-Service Training Institute, Gannoruwa. Accommodation and meals will be provided from the 16th night until the end of the programme.

Following topics will be dealt with:

17-09-90

9.30 - 12.30 pm	-	Evaluation of dosage mortality data
2.00 - 4.00 pm	-	Evaluating the toxicity of mixtures of Insecticides

18-09-90

9.00 - 12.00 noon	-	Field testing and analysing the data
2.00 - 4.00 pm	-	Calibration of sprayers and calculations of optimum required quantity of insecticides.

NCERG Co-ordinator

ic. D D Research } Ref. conversation with you please.
D D Ed. & Training }

ADA ISTI Gannoruwa - For your kind cooperation

UNIDO'S SUBSTANTIVE COMMENTS

DP/RAS/88/031

REGIONAL NETWORK ON PESTICIDES FOR ASIA AND THE PACIFIC (RENPAP)

Technical report of Mr. Kawal Dhari

Introduction

Under the activities of the regional project. UNIDO assigned a regional expert to visit Sri Lanka to look into the insecticide efficacy and how to avoid pesticides reaching non-target organisms.

Comments

The report mainly addresses to the protocol to be followed for carrying out bio-efficacy testing of pesticide formulations. The most important aspect is the data collection, interpretation of the results and the standards that are to be used for comparison. In a country like Sri Lanka where natural resources are vital to the economy and tourism being one of the major industries, it becomes a compelling necessity that hazardous chemicals, however essential, should be used in accordance with international protocol so that ecological damage is kept to the minimum.

The expert strongly recommends strategy for management of resistance to pesticides and also adherence to the Maximum Residue Levels in crops. The author's recommendation to strengthen the Central Agricultural Research Institute should be given a serious consideration so as to minimize the adverse effects in the misuse of pesticides. The regional network project has set up Pakistan as the Technical Coordinator for eco-toxicology related to pesticides and Sri Lanka through the Regional Coordinator Unit in New Delhi could make use of the facilities to be provided to Pakistan by UNIDO.