PIIAAP 902

REPORT OF A MEETING OF ASIAN RICE-BASED CROPPING SYSTEMS ENTOMOLOGISTS

15-16 MAY 1981
BOGOR, INDONESIA

ELEVENTH CROPPING SYSTEMS WORKING GROUP MEETING
18-22 MAY 1981

HOSTED BY THE CROPPING SYSTEMS PROGRAMS, BOGOR RESEARCH INSTITUTE FOR FOOD CROPS (BORIF), BOGOR, INDONESIA

SPONSORED BY THE PARTICIPANT ASIAN NATIONAL CROPPING SYSTEMS PROGRAMS, ASIAN CROPPING SYSTEMS WORKING GROUP, AND THE INTERNATIONAL RICE RESEARCH INSTITUTE

PREFACE

Rice-based cropping systems research in Asia is coordinated by the Cropping Systems Working Group composed of the leaders of national programs active in cropping systems research and the Multiple Cropping Department, International Rice Research Institute. Eleven meetings of the Working Group have been held since 1975 -- the locations are rotated among the participant countries. The product of each meeting is a published report which is circulated among the participants, sponsoring agencies, and others active in cropping systems research worldwide.

Each report includes the results of research from the participant cropping systems programs within the Asian Network of cropping systems sites as well as special topics of mutual interest.

At the tenth Cropping Systems Working Group Meeting held in Korea, it was decided that a special meeting of entomologists active in cropping systems research be held preceding the eleventh session to discuss issues of mutual interest. Invitations were sent to the member country programs and the meeting was hosted by the Indonesian Cropping Systems Program in Bogor, 15-16 May 1981.

This report includes a summary of the issues discussed at that meeting, mainly methodological, plus reports submitted by several of the national programs. The meeting was attended by the following scientists:

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A METHODOLOGY FOR ENTOMOLOGICAL RESEARCH IN CROPPING SYSTEMS PROGRAMS

Committee Report

Twenty one participants from six Asian countries -- Indonesia (11), Thailand (3), Bangladesh (1), Philippines (1), Sri Lanka (1), India (1) -- and IRRI (3) met for the two-day discussions on contemporary issues relevant to entomologists working in cropping systems programs.

It was pointed out that under Asian conditions, insect pests are major constraints to food production in rice-based cropping systems and chemical control with insecticides represents a major expenditure to farmers, second to fertilizer. Entomology applied research carried out in several cropping systems target sites which have reached the phase of production programs has already demonstrated that site-determined insect control practices are superior to national recommendations. The development of insect control recommendations under local conditions offers the following benefits which justify the budgeting of cropping systems entomological positions in national programs:

1. Assurance that the insect control recommendations are technically sound.
2. The recommended practices, having been evaluated by criteria scaled to the resources and abilities of the local farmer population, will have the greatest probability of being adopted by those farmers.
3. The simplification of insect control technology that will result from local testing helps the extension service focus their effort, making them more effective.

4. Economic evaluation of insect control practices ensures that farmers, if they follow the recommended technology, will earn the greatest optimal economic benefits thereby increasing their welfare and ability to repay loans.
5. National governments benefit because - a) insecticide loans will be based on locally-derived calculations, thus more accurate, b) more farmers will repay their loans, and c) local production will increase.

These benefits to the nation should more than repay the cost of the entomological input at cropping systems sites and is a sound investment. In spite of these potential benefits, the participants pointed out that the number of entomologists active in cropping systems sites is insufficient to meet the needs of all national programs. Institutionalization of the entomologists into cropping systems programs is a major constraint at present, but there are positive signs from most national programs that this deficiency is being addressed.

The dynamic nature of insect pests in time and space demands that entomologists spend from 3-5 years at each site in order to develop reliable insect control recommendations. The time required at sites will decrease in the long run for each national program as more experience is gained. Insect control is further complicated by the nature of cropping systems research which often tests crops where little pre-existing information is available. New cropping patterns may also significantly influence the local dynamics of pest populations to cause new pest problems to appear.

After a brief introduction from each country program, the meeting focused on three general topics:

1. Methodology development
2. Insect control technology
3. Working in cropping systems programs

Methodology Development

The objective of entomologists working in cropping systems programs is clear -- to develop, for each crop in the cropping patterns, profitable insect control recommendations that will have the greatest probability of being adopted by farmers at cropping systems sites.

A procedure has been developed to ensure that insect control recommendations are developed quickly and objectively following sound scientific principles. The method can be carried out by staff who possess the following minimal skills:

- o Ability to recognize the potential insect pest species in the field for each crop,
- o Ability to effectively sample insect pest populations,
- o Knowledge of economic injury levels for each potential pest, and
- o Knowledge of insecticide efficacies against potential pests.

It is also imperative that such staff live near the site.

The procedure for developing insect control recommendations follows the overall cropping systems methodology of description, design, testing and evaluation.

Description

There are four descriptive aspects:

1. Understanding farmers' current insect control practices and resources available for insect control

2. Determination of yield losses for each crop growth stage

3. Matching key pests to measured yield losses

4. Enumeration of insecticides recommended nationally for each crop and calculation of the cost of application for each chemical using local prices.

Understanding farmers' current practices. At the beginning of cropping systems research for each site the entomologist will interview local extension agents or other reliable sources to find out as much as possible about the key pests, local recommendations, and farmers' practices.

The site entomologist should interview local farmers first casually in groups and then intensively through a formal survey to focus on obtaining information that is not possible to gather from groups.

The following minimal information is considered essential from the farmers at each site.

- Cash value of insecticides applied per crop
- Presence of government program to provide credit (% farmers in that program)
- Source of cash to purchase insecticides
- Local interest rates
- Availability of sprayers
- Availability of water for sprayers
- Farmer preference for insecticide formulations

- List of commonly used insecticides
- Local prices for government supplied or retail insecticides.

The following additional information from local farmers is also useful but not essential:

- Number of insecticide applications per crop
- Timing of applications
- Dosages applied
- Labor usage (considered if water or chemicals are far away)
- Spray volume
- Size of sprayers
- Recognition of key pests
- Ranking of key pests
- Knowledge of insect resistant varieties and what pests are suppressed by each variety
- Use of cultural control practices
- Use of traditional methods of insect control
- Knowledge of natural enemies
- Constraints to insect control

Examples of farmer surveys and their evaluation in the context of cropping systems research objectives can be found in Litsinger et al 1978, Canapi et al 1980 and Prasadja and Ruhendi 1981.

Yield loss determination. Quantification of yield loss caused by insect pests will form a basis for insect control decision making. Appropriate treatments which minimize insect damage can be designed and tested to quantify yield losses in each growth stage of the crop (Litsinger et al, 1980). Insecticide usage, which will form the basis of insect control recommendations can be appropriately timed to growth stages where significant yield losses occur. This procedure ensures that insect control recommendations will be objectively based and reduces guesswork. Such a procedure acts as an internal check in each experiment and asides in evaluation of results.

Key pest determination. Insect pests responsible for yield losses need to be determined. Therefore in each experiment, insect pests will be sampled using the most practical methods designed to be as rapid and accurate as can be carried out with available staff. Knowing the key pests will aide in selecting the most appropriate insecticides.

Enumeration of insecticides. For each crop a list can be drawn up of insecticides based on national recommendations. Insecticide costs are calculated from local prices, either government or retail prices whichever is relevant. Cost per application based on recommended dosages and toxicity data (LD_{50}) are also listed beside each chemical (Litsinger et al, 1980).

Design

Insect control treatments are then designed for testing on each crop from the descriptive information gathered. It is realized that not all crops in the cropping patterns under evaluation by the team can be studied. The entomologist should choose crops which have proven agronomic adaptation and which the greatest insect problems are expected. The number of crops per year which can be tested depends on site staffing.

In each experiment the entomologist must design two types of treatments: 1) yield loss and 2) potential recommendations for farmers.

Yield loss treatments are designed to eliminate insect pests for which insecticide cost is not a factor. The treatments will call for frequent applications (at least every 10 days) using broad spectrum insecticides at dosages which will ensure the greatest killing power against expected pests. Here it is possible to use insecticides which are not locally available. Use the best insecticides. The insecticides should be neither phytotoxic or phytotonic. Avoid using carbofuran on rice as it stimulates plant growth (Venugopal and Litsinger, 1980).

Divide each crop into growth stages for which yield loss are expected to occur from insects. The following examples were given:

Transplanted or dry seeded rice

- o Seedbed or seed/seedling
- o Vegetative (transplanting to panicle initiation)
- o Reproductive (panicle initiation to flowering)
- o Ripening (flowering to hard dough)

Wet seeded (pregerminated rice)

- o Vegetative
- o Reproductive
- o Ripening

Soybean

- o Seed (ants)
- o Preflowering (beanfly, leaf feeders, thrips)
- o Postflowering (pod borers, aphid)
- o Pod filling (seed bugs)

Maize

- o Seed/seedling (ants, seedling maggot)
- o Pretasseling (corn borer)
- o Posttasseling (corn borer, earworm, aphid)

One treatment will control insects in all growth stages and successive treatments will omit control for each growth, one treatment per growth stage. The last treatment is an untreated control (Litsinger et al, 1980).

The following examples from the Philippines illustrate complete control treatments:

Transplanted rice

- o Seedbed - 0.75 kg ai monocrotophos EC/ha weekly until 1 week before transplanting
- o Vegetative - 1 kg ai monocrotophos EC/ha 5, 15, 25 DT, etc. until panicle initiation
- o Reproductive - 1 kg ai chlorpyrifos EC/ha at 10-day intervals until flowering

- o Ripening - 1 kg ai monocrotophos EC/ha at 10-day intervals until hard dough

Dry seeded rice

- o Seed/seedling 4 g ai bendiocarb WP/kg seed (seed treatment)
- o Vegetative, reproductive and ripening stages as in transplanted rice

Wet seeded rice

- o Vegetative, reproductive and ripening stages as in transplanted rice

Mungbean/cowpea

- o Preflowering - 0.5 kg ai monocrotophos EC/ha 2, 9, 16 DE
- o Postflowering - 0.03 kg ai decamethrin EC/ha 25, 35, 45 DE

Soybean

- o Preflowering and postflowering as in mung bean
- o Pod filling - 0.03 kg ai decamethrin EC/ha 55, 65 DE

(Note: Dryland plantings of legumes need a seed treatment - 4 g ai diazinon WP/kg seed to control ants and other soil pests)

Maize/sorghum

- o Seed/seedling - 4 g ai bendiocarb WP/kg seed
- o Pretasseling - 0.05 kg ai decamethrin EC/ha at 10-day intervals until tasseling
- o Posttasseling - 0.05 kg ai decamethrin EC/ha at 10-day intervals

Each experiment will include the current recommended practice plus one or two alternative practices designed as possible insect control recommendations.

Cost is a major factor in designing potential insect control treatments. As a rule of thumb, at least in the initial stages of a site, make the cost of the recommended practice within upper one third percentile of the range of the values of insecticide applied by farmers living in the area (determined from the farmer survey) but less than 10% of the value of the crop. You may wish to increase the value somewhat if you expect credit will be available later on. However it cannot be more strongly emphasized that the practices to be tested should be within the expected reach of farmers' resource levels at each site. After the first year you can use the yield loss calculations as a basis for determining the value of insecticide to be applied. The value of insecticide applied per growth stage should not exceed half the value of the crop loss.

Design alternative practices which provide a range of application times compared to the recommended practice. Use the following guidelines in order of priority:

First - test time of application

Second - test different insecticides

Third - test lower dosages

Two examples for rice:

1. Cash scarce farmers (currently insecticide usage is low or none)

   - o Practice 1 (recommended) = economic threshold
   - o Practice 2 = one prophylactic application in one growth stage plus economic thresholds for other growth stages

2. Cash-rich farmers (current insecticide usage averages three application)

   - o Practice 1 (recommended) = one prophylactic application in one growth stage plus economic thresholds for other growth stages.

- o Practice 2 = prophylactic insecticide applications in two growth stages plus economic thresholds for other growth stages

- o Practice 3 = economic thresholds for all growth stages

Transplanted rice

1. Practice 1 = economic thresholds

   - o Caseworm, 15% cut leaves: 0.75 kg ai malathion EC/ha

   - o Whorl maggot, grade of 5: 0.75 kg ai monocrotophos EC/ha

   - o Stem borer deadhearts, vegetative (15%), reproductive (5%): 0.75 kg ai chlorpyrifos EC/ha

   - o Leaffolder, % damaged leaves, vegetative (15%), reproductive (10%): 0.75 kg ai BPMC/ha

   - o Rice bug, $8/m^2$: 0.75 kg ai BPMC/ha

   - o Brown planthopper, adults and nymphs/tiller, vegetative (10), reproductive (5): 0.75 kg ai BPMC/ha

   - o Defoliators, % defoliation seedbed (50%), vegetative (25%), reproductive (15%): 1 kg ai carbaryl WP/ha

2. Practice 2 = 1 kg ai carbofuran G/ha soil incorporated before transplanting plus economic thresholds for other growth stages

3. Practice 3 = 1 kg ai carbofuran G/ha soil incorporated before transplanting, 0.75 kg ai chlorpyrifos EC/ha 35, 45 DT plus economic thresholds for other growth stages

Legumes

1. Practice 1

   - o Preflowering - 0.25 kg ai monocrotophos EC/ha 5 DE

   - o Postflowering - 0.75 kg ai endosulfan EC/ha 35 DE

2. Practice 2

   - o Preflowering - 0.25 kg ai monocrotophos EC/ha 2, 12 DE

- o Postflowering - 0.75 kg ai monocrotophos EC/ha 30, 40 DE

3. Practice 3

- o Preflowering - 0.75 kg ai monocrotophos EC/ha 2, 12 DE
- o Postflowering - 0.75 kg ai endosulfan EC/ha 25, 35, 45 DE

Maize

1. Practice 1

- o Seed treatment (diazinon)
- o Economic thresholds for other growth stages
  - Seedling maggot: 0.75 kg ai monoctorophos EC/ha
  - Corn borer: 1.25 kg ai carbaryl WP/ha

2. Practice 2

- o Seed treatment
- o 1.25 kg ai carbaryl WP/ha at tasseling and 7 days later
- o Economic thresholds for other growth stages

3. Practice 3

- o Seed treatment
- o Pretasseling - 1.25 kg ai carbaryl WP/ha 30, 40 DE
- o Posttasseling - 1.25 kg ai carbaryl WP/ha 50, 60 DE

Possible abbreviated designs if resources are not available to carry out the number of treatments outlined in the above examples:

Transplanted rice

1. Complete control
2. Omit vegetative protection
3. Omit reproductive protection

4. Untreated check

5. Practice 1

6. Practice 2

7. Practice 3 (optional)

(Notice: We omitted two yield loss treatments for the seedbed and ripening stages. This can be done if you do not expect yield losses during these stages - and generally you will not. However it would be best to do the complete trial the first year to verify this assumption.)

Transplanted rice

1. Complete control

2. Untreated

3. Practice 1

4. Practice 2

5. Practice 3 (optional)

By this design you will not know the yield loss in each growth stage, therefore would have limited power of interpretation. However, we realize that in some situations manpower is limited for carrying out trials.

As a general guide, use information gathered in the farmer surveys and your common sense. If you are in a dryland area where water for sprayers is scarce, test granular insecticides or seed treatments. If labor is an anticipated problem or sprayers are not available, choose granulars over sprays. The best guidelines is to place yourself in the position of local farmers and decide what you would do in their situation.

You can choose from insecticides available in your country even though they may not be locally available. They can be made available at your site in most cases. If you have a choice, however, prefer locally available insecticides.

Testing

Once treatments have been designed, then they will be tested in the field at the time the crop is grown in a cropping pattern. Trials can be superimposed on cropping pattern trials supervised by agronomists or researcher managed where you find you own cooperators. Superimposed trials are less costly but they will be small in area (few treatments) and you must communicate often with other people using the field. Researcher managed trials can be large, up to 9-10 treatments.

Avoid paying money to farmers for land rental, however if you want seed you can pay the farmer. The normal arrangements that apply for cropping pattern trials apply to your farmer cooperators. Be sure you check with other team members at your site to ensure your arrangements with farmers are consistent. Check with the site coordinator.

If through sampling for insects you remove or destroy the farmer's crop, you may want to make compensation in cash or kind. If farmers complain that they are losing yield from untreated plots, you can compensate each farmer by the difference between the average of all plots compared to the yield in the recommended practice. No compensation is given for losses due to factors beyond the control of the researcher such as floods, drought, or cattle entering the field. Communicate with your

farmer cooperators before the crop is grown to explain your sampling procedures. Be consistent among all your farmer cooperators.

Field trials should be randomized complete blocks, each block (replicate) is a different farm. Treatments are not replicated on each farm, as large plots are desired (50 m^2 minimum, 80-100 m^2 preferred). You will need larger plots for maize or sorghum because plant stand is low compared to legumes or rice.

Avoid performing your trial on one block of land as you would at an experiment station. Replication in different farmers fields representing the average range of field variability and planting dates that exists in your site is highly desirable. Remember, the recommended practice that will be developed will be extrapolated over a large region, not one village or small field.

Four replications are a minimum for reliable statistical analysis for each trial. Three years' data per crop in each cropping pattern is minimal for deriving a sound recommended practice. You may choose to remain at a site after the agronomists have left in order to fulfill this requirement.

Each year sample only those insect pests which exceed economic injury levels. This will save valuable research time and allow you to perform more trials at a site. The only reasons to sample insect pests are to explain yield losses and test the performance of insect control treatments.

Several examples from the Philippines illustrates these points.

Wetland rice

- o Seedbed - % defoliation, 21 DE (per plot estimate)
- o Whorl maggot - grade 1-9 30 DT (per plot)
- o Caseworm - % cut leaves seedbed (50 plants) 30 DT (20 hills)
- o Stem borers - % deadhearts 40-45 DT (5 m^2), % whiteheads (5 m^2)
- o Leaffolder - % damaged leaves (10 hills)
- o Rice bug - no./m^2, 5 m^2

Dryland rice

- o Plant stand - no. plants/m-row, 10-14 DE (3 x 5-m row)
- o Seedling maggot - % deadhearts, % infested plants (3 x 5 m-row)

Legumes

- o Beanfly - % infested plants, 25 DE (35 plants)
- o Flea beetle - no. feeding holes/plant, 14 DE (35 plants)
- o Thrips - no./plant (50 leaf bud tips)
- o Leafhopper, leaffolders, leaf miner - no./plant, 35-45 DE (35 plants) (only if abundant)
- o Aphid - grade 1-9 45 DE
- o Pod borers
  - Maruca % damaged flowers, 35 DE (50 flowers)
  - Heliothis no. larvae/plant, 55 DE (35 plants)
  - Etiella % damaged seeds (at harvest) 50 pods

Maize

- o Plant stand - no. plants/m-row (3 x 5 m-row) 10-14 DE
- o Seedling maggot - % deadhearts or % infested plants, 14 DE (3 x 5 m-row)

o Corn borer - no. tunnels/plant at harvest (25 plants)

The objective of these trials is not ecological studies therefore sampling is limited to insect pests only (not natural enemies) and to only those which are causing yield losses. Avoid sampling the same insect pest twice during one growth stage and sample pests only on those growth stages in which yield loss is expected. The entomologist should help the farmers performing cropping pattern trials to monitor insect pest populations to determine economic thresholds as a basis for insect control. It is expected that once such recommendations are made for production programs that extension workers would perform this function.

Evaluation

Perform statistical analyses on pest populations that exceeded economic injury levels or for pests that can explain yield losses. Compare pest populations between treatments using Duncan's Multiple Range or a similar statistical test. Yields are similarly compared.

Using the prevailing price of crops to farmers in the locality (not the national price) convert yield losses to monetary values. Determine benefit cost ratios and net returns. Perform statistical analyses for net returns but not benefit cost ratios. By determining the profit (net returns) and rate of return (benefit cost ratio) between treatments, by comparing insecticide application timing to the measured yield losses for each growth stage, and by comparing insect control efficacy, one can determine which insect control practice is most appropriate.

Repeat this process over at least three years, making adjustments as necessary each year in the yield loss treatments and potential recommended treatments.

One may receive forehand information about potential adoption from the farmers at the site -- farmer cooperators or their neighbors -- who may spontaneously adopt insect control practices. These are also useful guidelines for adoption, even though there has been no attempt at this stage to provide extension services.

Often introduced cropping patterns being tested at a site are out of phase with existing cropping patterns. These may attract artificially high populations of rats, birds, and some insect pests such as rice bug (those pests which are less sedantary). Because it is expected that if the introduced pattern were widely grown in the area that the damage from these pests would be diluted, it is considered appropriate to perform additional pest control methods to control them -- which cost would not be included in an economic evaluation. Experience however has shown this to be an uncommon occurrence.

Extension involvement

Extension personnel should be involved at cropping systems sites from the inception of the program. Extension workers will eventually become directly involved during the pilot production phase but extension technicians will understand the technology better if they become involved early in the testing phase. The site entomologist should seek out local extension workers and take them to the site to show them ongoing trials as frequently as practical.

Multilocational testing phase

In order to verify the performance of the recommended insect control practice at the multilocational testing stage it is desirable to include several treatments in at least four of the fields. One treatments would be a complete control and a second treatment would include comparable insecticides than those recommended.

The inclusion of a complete control treatment will tell if the recommended practice is achieving yields within the expected range. Inclusion of a treatment with comparable insecticides is designed to provide flexibility in a recommended practice to lessen the likelihood of insect resistance from developing.

These trials would be designed by the site entomologist but would be performed by the multilocation testing personnel. Only yield data is taken.

Adjustments in the recommended insect practice therefore can be made at this stage but it is anticipated that the adjustments would be minor (fine tuning).

Integrated pest control

Cropping systems site research precedes integrated pest control (IPC) programs in time. IPC programs are extension programs and are active at the final production stage. Cropping systems researchers utilize IPC principles in developing insect control recommendations but the two are complementary. Cropping systems research has a major objective of changing existing cropping patterns and is a research function. IPC programs do

not change cropping patterns and are oriented to teach farmers to monitor insect pests and apply the most stable insect control technology.

Cropping systems research has these same goals and therefore helps IPC programs focus their effort.

Insect Control Technology

Cropping systems researchers are the principal consumers of the insect control technology generated at experiment station, therefore it is imperative that we keep informed of the results coming from research stations. The following are areas of most concern to cropping systems entomologists.

Sampling

By the nature of cropping systems work -- limited time frame and many patterns being tested -- the cropping systems entomologist has to perform many trials each crop year. We cannot sample insect pests extensively or intensively as one would do at a research station. However reliable estimates of insect pest populations are essential for evaluation of insect control practices.

The following sampling units and number of samples are guidelines to entomologists with little experience and can act as starting points. It is encouraged that coefficients of variability will be calculated during statistical analysis and that if these values exceed 25%, more samples should be taken in the future.

	Pest	Character	Sample unit
Rice	o Defoliation	% defoliation	20 hills
	o Caseworm	% cut leaves	20 hills
	o Whorl maggot	1-9 scale	Per plot
	o Stem borer	% deadheart or whiteheads	5 m^2
	o Leaffolder	% damaged leaves or % damaged flag leaves	10 hills
	o Brown planthopper	Number adults and nymphs/tiller	20 hills
	o Rice bug	No./square meter	5 m^2
	o Gall midge	% infested tillers	20 hills
	o Seedling maggot	% damaged plants or or % deadhearts	15-m row
Legumes	o Beanfly	% infested plants (cowpea, mungbean)	30 plants
		% infested cotyledons (soybean)	
	o Flea beetle	No. holes/plant	30 plants
	o Leafhopper	No. nymphs/plant	30 plants
	o Aphid	1-9 scale	Per plot
	o Leaffolders,rollers	No./plant	30 plants
	o Leaf miner	No./plant	30 plants
	o Thrips	No./leaf bud, no./ flower	50 leaf buds 50 flowers
	o *Maruca*	% damaged flowers	50 flowers
	o *Heliothis*	No./plant	30 plants
	o *Etiella*	% damaged seeds	50 pods
	o Defoliation	% defoliation	30 plants
Maize/sorghum	o Ants	No. plants/m-row	15-m row
	o Seedling maggot	% damaged plants or % deadhearts	15-m row
	o Corn borer	No. tunnels/plant	30 plants
	o Aphid	1-9 scale	Per plot
	o Earworm	% damaged ears (maize)	50 ears
		No./head (sorghum)	25 heads
	o Defoliation	% defoliation	30 plants

Economic Thresholds

As prophylactic insecticide treatments can only be justified if consistent yield losses occur over years in a growth stage, economic thresholds will form the basis of insect control recommendations otherwise. Experience has shown however that economic thresholds are highly dynamic and vary by site. Therefore economic thresholds as guidelines to insect control recommendations must be developed at each site. This realization runs contrary to current opinion held by most entomologists, that thresholds once determined are immutable.

Therefore we do not list thresholds for each pest as we believe these figures should be derived locally under local yield potentials, pest populations, and costs of insecticides.

Chemical Control

Insecticides are the only insect control tactic to be tested at the sites due to several factors. Cropping systems research is dependent on technology generated elsewhere and current national recommendations call for little else than chemical control or varietal resistance.

There is little scope for the cropping systems entomologist to test varieties at the sites as an insect control tactic. The entomologist should verify the level of resistance in variety trials because biotypes may be different at the site. However the choice of variety is based on a team decision and at that meeting if the entomologist feels that an insect pest resistant variety should be recommended, he makes his case at that time.

There is scope for some cultural control tactics to be tested such as fertilizer levels (eg. corn borer in Pangasinan, IRRI, 1980), and tillage method (eg. mungbean in Pangasinan, IRRI, 1981). Planting time is an integral component of a pattern, therefore testing planting time is testing different patterns. Intercropping trials using combinations not currently being evaluated should only be done if trials on the crops in the test patterns have been amply studied by the entomologist. Normally site staff cannot afford to look for new pest stable patterns, as time and manpower resources are limiting to undertake such basic research. Cropping systems is not only intercropping, one crop of rice is a cropping system.

Supportive Technology

Often a cropping systems site will present research opportunities to undertake basic research - ecology, insect control and bionomics - on insects or environments which are not present at existing research stations. In the Philippines, for example, the Batangas dryland rice site has been used to study population dynamics and food webs by the IRRI Cropping Systems entomologists. Iloilo, Pangasinan and Cagayan sites which represent rainfed wetland rice environments are utilized by IRRI for the same reasons. However additional manpower is needed to do this.

Another arrangement could be made to allow basic research to be carried out by contacting research institutions such as nearby universities to have students do their thesis research at cropping systems sites.

The most common technology that might be tested at a site would be insecticide screening, for insect pests where little information is available. It would be desirable if the research station personnel actually did the trials but often this is not possible. Cropping systems entomologists may, out of necessity, enter into this realm. However it is important that the research entomologist at the experiment station responsible for this activity be contacted beforehand to communicate the reasons for doing this and to seek his help in designing the experiment. Otherwise professional jealousies may arise. Cropping systems researchers by the nature of their work need to maintain good relationships with basic research and extension personnel.

Actually cropping systems sites offer an opportunity to do such basic research activities as insecticide screening and evaluation of insect resistant varieties. Research costs are lower than at research stations because crop maintenance is done by the farmer and the researcher can utilize the site office as a base of operations as well as the team's vehicles to get around. Arrangements however need to cleared with the site coordinator before such research is initiated.

Working in a Cropping Systems Program

Cropping systems research involves the efforts of many disciplines and institutions in national programs. Aspects of organization, communication, and institutions are involved and are relevant to entomologists. Cropping systems research is new in many countries and the linkages to existing entities need to be formulated. This occurs at many levels.

Cropping Systems Teams

Entomologists who staff sites are drawn from many existing or newly created agencies. Often entomologists come from commodity-based institutions such as rice research stations. Each cropping systems program will test many different crops, therefore entomologists may be drawn to one site from several different agencies.

However, research institutions have been reorganized to handle this by creating cropping systems teams which include entomologists who can work on all crops (eg. Indonesia and Thailand). However, this requires the creation of additional positions in institutions and in the short run these often are shortages of entomologists working at sites, particularly if the number of sites is large, Indonesia with 20 sites has met this problem. Some of these sites are no longer active but newly assigned entomologists can still perform trials after the site is officially closed. Experimental design is streamlined to fewer treatments (elimination of the full yield loss component) so that more sites and crops can be studied. The Indonesian entomologists test four treatments -- untreated control. complete control, and two insect control practices.

The minimal staff requirement per site would be one worker living at the site - preferably an entomology graduate but could be a high school graduate trained to perform the operations. One or two laborers should be assigned to the entomology staff member.

The reason why a staff member should reside at the site is to respond to economic threshold treatments which require frequent field visitation to perform. The entomology staff should be provided with his own transport, preferably a motorcycle with a side attachment (tricycle).

The entomology graduate should be supervised by a Ph. D or a senior entomologist with experience to provide guidance in experimental design and interpretation of results.

Communication between team members is essential particularly regarding choice of variety as the entomologist who does researcher-managed trials will need to acquire seed ahead of scheduled crop planting, and as airline regulations do not permit the shipment of liquid pesticides, the chemicals will need to be carried overland or sea to the site -- this takes planning.

An annual meeting should be held for the team members of each site to review the progress of each crop year. Management recommendations should be written down so that all team members know them. Entomologists from basic research as well as extention representatives should be at that meeting.

National Cropping Systems Program

Often cropping systems research is carried out by several different institutions within each country. In order to promote communication between the various programs, a national meeting should be held (as in Thailand) in which site entomologists would also attend. Research results will be shared and entomologists can learn from each other.

International Linkages

IRRI acts as a liaison between national cropping systems programs as does the Cropping Systems Working Group. Both are involved in methodology development. The meeting held at the request of the Working Group shows the benefits that can accrue by discussions of contemporary issues relevant to entomology between the national cropping systems programs. These meetings are encouraged because the IRRI entomologist cannot get to each country but every few years.

Other ways to communicate between programs include:

- o Sending research reports to IRRI for distribution to entomologists in the network
- o Publishing results in the International Rice Research Newsletter
- o Publishing in the Proceedings of the Cropping Systems Symposium held at IRRI every two years
- o Contributing reports to the Report of Working Group Meeting

Recommendations

1. A collaborative project be established to evaluate the performance of economic thresholds as a basis for insecticide applications. Cropping systems research by its methodology and the number of crops and sites in Asia make this a unique opportunity.

   The objective would be to test if the use of economic thresholds can be made to work for rice and maize, two crops commonly tested at most cropping systems sites. The importance of this study to cropping systems programs is that a recommendation based on economic thresholds represents the lowest cost for an insect control practice. This fact

is particularly relevant because cropping systems research focuses on small-scale farmers, those who cannot apply insecticides as insurance to protect yield. The dynamic nature of insect pest populations on rice and maize takes this collaborative study particularly relevant to small-scale farmers.

The use of economic thresholds is an unproven technology in rice and maize. One of the reasons perhaps is the belief held by many entomologists that the thresholds that have been developed at experiment stations are immutable. Our premise is that the thresholds are conditioned by site variables such as yield potential, environment, pest complexes and economic factors.

Cropping systems methodology for evaluation of insect control practices includes the measurement of yield loss by growth stage as well as rigorous economic analysis of control measures. These factors form a unique opportunity to critically evaluate an insect control practice such as economic thresholds.

The project will apply the following economic thresholds as a starting point and over the years at each site change them as needed.

Pest	Threshold
Rice defoliation	% defoliation - seedbed (50%), vegetative (25%), reproductive (10%)
Caseworm	15% cut leaves
Whorl maggot	Grade of 5 (on 1-9 scale)
Gall midge	5% infested tillers
Stem borer	15% deadhearts (vegetative stage) 5% deadhearts (reproductive stage)

Leaffolder	15% damaged leaves (vegetative stage) 10% damaged flag leaves
Rice bug	8 bugs/m^2
Brown planthopper	10 adults and nymphs/tiller (vegetative) 5 adults and nymphs/tiller (reproductive)
<u>Maize</u>	
Seedling maggot	10% damaged plants
Corn borer	10% damaged plants (leaf damage) (pretasseling) 2 larvae/tassel (posttasseling)
Aphid	Grade of 5 (on 1-9 scale)
Defoliation	% defoliation - pretasseling (25%), posttasseling (15%)

Insecticide applied will be the least costly recommended one for each country.

A standard format for reporting results will be drawn up and distributed to all entomologists working at cropping systems sites. Each year a report will be circulated to all concerned.

2. Monitoring tour of entomologists to cropping systems sites in Thailand, Indonesia, and the Philippines should be held in the future to foster communication of research techniques and results among entomologists in the Asian cropping Systems Network.
3. A meeting of cropping systems entomologists be held in two years before a working group meeting such as this.

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REVIEW OF ENTOMOLOGICAL RESEARCH ON CROPPING SYSTEMS IN THAILAND

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Although cropping systems have been practiced in certain areas in Thailand for many years, as of 1980 only 7 sites (Kampang Phet, Chiang Mai, Phrae, Khon Kaen, Ubon, Pimai and Bangpae) were active in cropping systems research. At the beginning, most of the research was focused on finding the most suitable cropping pattern each site. Little attention has been paid to crop protection research. The role of crop protection was started in early 1978. Therefore, little entomological information is available. Data are scattered and hard to find. This report is basically a review of personal communication, supplemented by available information from each cropping systems site in Thailand. Perhaps this review will provide the broad background which will facilitate and stimulate further study.

At each site, the cropping patterns are designed by the team members. The insect control recommendations are made for each cropping pattern or each crop. In general most of the recommendations from entomologists at each site were reviewed and changed each year. At some sites, integrated pest management concepts were included in insect control recommendations.

The basic pattern of the Department of Agriculture cropping systems site at Kampang Phet North Thailand site is rice-rice. Potential pest control recommendations for rice-rice pattern were tested for each crop. On the first year (1979) carbofuran 3 G at 5 kg formulated product/rai was recommended to use in the rice field at the seedling stage. This insecticide was used for control sucking insect pests such as brown planthopper. On the second year (1980), a more objective process of determining insect control recommendation was developed based on the first year's work at this site. Yield losses were quantified for each crop in the rice-rice pattern by applying high levels of insecticide to each growth stage of a recommended variety such as RD 11 in a series of treatments replicated across at least four farms. For example in transplanted rice there are four growth stages which can suffer economic loss from insects to possibly warrant control. The objective in the yield loss assessment is to evaluate the potential need to control insect pests in each of the four growth stages and identify the target insect pests responsible for yield loss so that appropriate insecticides can be tested. At the same time, population dynamics of insect pests and natural enemies were also measured.

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If the recommended practice is suboptimal then changes are in order. However, because of the yield loss assessment they know what growth stage (s) to focus on, and they can be quite accurate, eliminating much of the guess work which might occur. If the recommended practice gave as high a yield as the complete control, then we may look for ways of reducing it.

The result of the yield loss assessment trials for the second year's research on rice at Kampang Phet site has not been evaluated yet. However, the goals at this site are to determine the need for pest control, to select the most appropriate technology, to verify if it works, and to evaluate the economic implications.

At the nearby Phrae site, also of the Department of Agriculture, there are four cropping patterns:

1. Mungbean-rice-soybean
2. Mungbean-rice-tobacco
3. Corn-rice-peanut
4. Rice-rice

The insect control program started only in 1980. Most of the recommendations were suggested by the same entomologist team at Kampang Phet site. Therefore, yield loss assessment on rice was also tested at this site. The insect damage on each crop was evaluated every week. Only monocrotophos was recommended to use for control of flea beetle (*Longitarsus manilensis*) and leaf roller (*Archips* sp.) on mungbean. The insect damage on the remaining crops did not exceed the economic threshold. In this case the entomologists feel confident that the recommendation for applying chemical control in these remaining crops is not necessary.

Cropping patterns were tested from 1977 up to 1980 at the Department of Agriculture sites in Northeast (Ubon) and Northcentral (Pimai) Thailand. Cropping patterns for these site are:

1. Rice (RD7)-rice (RD 6)
2. Mungbean-rice
3. Peanut-rice
4. Cowpea-rice
5. Corn-rice

The crop protection program has started at Upon and Pimai in 1978 by the entomologists Dr. Weerawooth Katanyukul and Mr. Narong Chantaraprapha.

In 1978, entomological research was studied on rice only. Six treatments were used to compare the effectiveness of controlling rice insect pests. The treatments were:

1. Carbofuran 3 G 1 kg ai/ha (at planting) and monocrotophos 56 EC 1 kg ai/ha (30 days after emergence)

2. Carbofuran 3 G 2 kg ai/ha (at planting) and endosulfan 35 EC 1 kg ai/ha

3. Aldicarb 10 G 1 kg ai/ha (at planting) and monocrotophos 56 EC 2 kg ai/ha (30 days after emergence)

4. Aldicarb 20 G 2 kg ai/ha (at planting) and endosulfan 35 EC 2 kg ai/ha (30 days after emergence)

5. Check

6. Spray monocrotophos 56 EC 2 kg ai/ha based on economic threshold

The result from this experiment showed that the cost of treatments with insecticide on rice was higher than benefit return (or the net return was negative). Therefore, the treatment with insecticide on rice field at Ubon and Pimai was not recommended because the cost of insecticide was more than the return. The insecticidal experiment on rice field was tested again in 1979. The carbofuran (3 G) was applied at the rate of 5 kg/rai on rice during seedling stage. The result in 1979 confirmed the 1978 result that insecticidal treatment on rice was not profitable.

Insecticide has not been used on corn because pest incidence was low in both 1978 and 1979 at Ubon and Pimai sites.

In general most farmers sprayed insecticide (monocrotophos) 3 times on mungbean and 2 times on peanut. Insecticidal control on mungbean was necessary because the pest damage was high. The key pests on seedling, preflowering and postflowering stages were beanfly, leaf roller, leaf miner, aphid and pod borer. On the peanut plots to which fertilizer was applied, monocrotophos (1 kg ai/ha) should be used to control leaf miner when the damage reached 50% leaf damage. On the peanut field which the fertilizer was not used, the peanut could tolerate the damage up to 35% leaf damage. At this stage of peanut growth, insecticide should be applied.

In the future the researchers at Ubon and Pimai site suggested that the threshold damage from each pest in cropping patterns should be evaluated. The profit and rate of return from using insecticide should be the main criteria. The study of economic threshold is one of the most important things which the researchers mentioned for study in 1981.

At Khon Kaen University (KKU) cropping systems research, started in 1975 included an entomologist as a team member. The promising cropping patterns are:

<u>Upland area</u>

1. Cassava - peanut: intercropping
2. Cassava - mungbean: intercropping

3. Peanut - mungbean: double cropping
4. Mungbean - peanut: double cropping

Upper paddy area

1. Peanut-rice
2. Mungbean-rice

Lowland paddy area

1. Mungbean-rice

Most of the crop protection studies focused on insect pests of legume crops (mungbean, soybean, cowpea and peanut). Seasonal distribution on legume insect pests was studied for two years. Beanfly (*Ophiomyia phaseoli*) was the key pest; leaf miner (*Biloba subsecivella*) and leaf roller (*Archips* sp.) were the secondary pests on the legume crops. Subterranean ant (*Dorylus orientalis*) was the key pest on the peanut.

Chumpol Kuntha and Tasanee Jampanya are the entomologists responsible for all of the entomological research at KKU sites. The results from 1977 and 1978 showed that the population of beanfly had tendency to increase from year to year. The population peak of beanfly still varied depending on many factors such as temperate, amount of rainfall, beneficial insects and the application of insecticides from the adjacent field.

The population of leaf roller and leaf miner tended to decrease from year to year.

Insecticide screening trials against the main insect pests of cowpea began in 1977. The results showed that high cowpea yields without the insecticide application was impossible. Cowpea is highly susceptible to beanfly, aphids, thrips and pod borers. During the preflowering stage, dimethoate was more economically attractive for the control of sucking insects. At flowering and pod forming stage, fenvalerate 15 EC (10 cc/20 liters of water) and monocrotophos 24 EC (80 cc/20 liters of water) are most suitable for the control of pod borers and other cowpea insect pests.

It should be realized that it is not easy to kill the larvae of pod borer that may be present inside flowers or pods. Timing can influence the success of spraying. Usually spraying should start at flowering stage, the time of application should be during the cooler conditions of early morning because the cowpea flowers are open.

At Chiang Mai University, plant protection research started from 1977 in cooperation with the Department of Plant Protection and Entomology. At the beginning, Mrs. Jariya Visitpanite and Mr. Manut had studied seed bugs and pod borers on legumes and aphids on lettuce and potato. Most of

the earlier experiments were insecticide trials and lately distribution of key pests has been emphasized.

Insect management studies have begun at Bangpae site near Bangkok. The pattern of mungbean-rice-mungbean had been used as a model for insect management program. The entomologists (Dr. Neungpanich Sinchaisri, Dr. Surachate Jamornmarn and Mr. Intawar Burekam) from the Department of Entomology, Kasetsart University reside in the area year round and have responsibility for hiring and training research assistants to inspect farmers' mungbean and rice on a weekly basis for the occurrence of pest species and damage, the incidence of beneficial insects, the stage of crop, field moisture conditions, etc.

Because of the lack of data for an ecological basis of insect pest management, chemical control formed the basis of most recommendations until the late of 1978's. The general review of controlling insect pests on mungbean is shown that insect control relied to a large extent on the wide-spread, prophylactic use of synthetic organic insecticides. Fortunately, recent work has refined and improved the earlier recommendations.

Better timing of insecticides to minimize the development of secondary pest problems and delay the build-up of resistance are recommended. This purpose can be achieved through knowledge of the economic threshold for each pest. It is, roughly, the value of the loss expressed in monetary terms occurring from the insect organism which is in balance with the costs resulting from action taken to prevent this loss.

The economic threshold may change from one year to another, especially in consideration of the variability of the commodity prices. It clearly reflects the cornerstone of any crop protection action which also include ecological considerations. Without threshold values, crop protection remains guesswork. Even temporary and rough evaluations of these values may considerably change the protection pattern.

It has been stressed that the various parameters which are basic for any crop production optimization are needed for the implementation of insect management. Since data collection which is essential for effective decision-making processes, is secured through real time pest control information net works, sampling technique is necessary in pest evaluation.

The result from the sampling method on mungbean at Bangpae showed that the key pests were thrips (*Thrips palmi*) and flea beetle (*Longitarsus manilensis* Weise): the secondary pests were armyworm (*Spodoptera litura* (F.)), red spider mite (*Oligonychus biharensis*), aphid (*Aphis craccivora* (Koch)) and beanfly (*Ophiomyia phaseoli* (Tryon)). The beneficial insects of mungbean pests were braconid parasite (*Apanteles* spp.) and the coreid bug (*Cantheconidea furcellata* (Wolff)), coccinelid beetle (*Menochilus sexmaculatus* (F.)) and reduviid bug predators.

Damage on mungbean grown after rice was solely depended on thrips population. Dimethoate 40% EC 10 ml/25 m^2 was used to control this key pest. The timing of spraying was carried out at three levels -- no spray, spray at economic threshold (average number of thrips approximately 3 per plant and the stage of mungbean not over 40 days after emergence) and spray after economic threshold level. The height, numbers of pods per plant, weight per plot and weight per rai were measured and evaluated for each treatment. Results showed that greatest yield occurred when the economic threshold level was followed (Table 1).

The pest damage situation on mungbean was changed when this crop was grown before rice. At this time, both thrips and flea beetle were the key pests. Therefore, the threshold level was changed from one pest to the economic threshold for both pests or pest complex. At first when we sprayed insecticide (dimethoate) at the economic threshold of one key pest (3 thrips per plant) we got the yield only 14 kg/rai (Table 2). This yield was lower (202 kg/rai) than last years' experiment because the damage did not come from one key pest but from two key pests (thrips and flea beetle).

Thus the economic threshold must be changed to account for the insect complex. From Table 3 when we sprayed insecticide at 2 thrips/ plant and the leaf damage from flea beetle a rating of 3 we got a yield of only 58 kg/rai. In this case the best prediction of the economic threshold for insect complex should be at 2 thrips per plant plus a rating of 2 from flea beetle.

Our sampling method in the rice field at Bangpae showed that the number of pests and damage were very low. In this case, the usage of insecticide on the rice field at Bangpae was not recommended.

As we have discussed previously, it is not the role of the cropping system entomologists to develop new technology. This is best done at experiment stations by basic researchers. Our job at each site is to determine the need for pest control, select the most appropriate technology, verify it if works, and evaluate the economic implications.

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Table 1. Effect of time of insecticide application on yield of mungbean after rice. Bangpae, 1980.

Timing of spray	Plant height (cm)	Pods/plant (no.)	Yield (kg/rai)[2]
Untreated	48 ± 41.8	8.3 ± 5.1	50 b
Spray at ET[1]	71 ± 55.5	8.9 ± 2.9	202 a
Spray after ET[1]	64 ± 8.9	8.2 ± 1.8	50 b

[1]ET = economic threshold.

[2]Numbers followed by the same letter are not significantly different (P = 0.05) according to the Newman-Keul's sequential range test.

Table 2. Effect of time of insecticide application on yield of mungbean before rice. Bangpae, 1981.

Time of spray	Plant height (cm)	Pods/plant (no.)	Yield (kg/rai)[2]
Untreated	54 ± 10.8	8.2 ± 1.7	61.6 b
Spray before ET[1]	50 ± 7.1	7.6 ± 1.8	58.9 b
Spray at ET[1]	64 ± 8.9	9.4 ± 7.1	140.8 a
Spray after ET[1]	63 ± 2.7	8.4 ± 2.5	90.4 b

[1]ET = economic threshold.

[2]Numbers followed by the same letter are not significantly different (P = 0.05) according to the Newman-Keul's sequential range test.

Table 3. Comparison of thrips and leaf damage from flea beetle on mungbean grown before rice at different ages of mungbean and at different time of spraying.

Days after crop emergence	Untreated		Spray before ET[1]		Spray at ET[1]		Spray after ET[1]	
	T[2]	F[3]	T[2]	F[3]	T[2]	F[3]	T[2]	F[3]
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.2	1.0	1.0	0.8	0.2	1.0	1.0	0.8
42	2.9	3.0	2.0	3.0	0.4	3.4	8.3	3.0
49	6.0	2.0	0.0	0.0	2.0	2.0	4.4	2.2
56	3.6	1.8	4.2	1.0	6.6	1.4	0.8	0.0
63	6.2	1.8	5.2	1.2	3.0	1.4	8.8	0.4
70	0.6	3.2	3.2	1.2	0.6	0.8	5.4	1.2
77	3.0	1.0	0.0	0.2	0.0	0.6	0.2	0.4

[1]ET = economic threshold for thrips only (3 thrips/plant).

[2]T = number of thrips per plant.

[3]F = leaf damage rating (0 to 4) by flea beetle adults where: 0 = no damage, 1 = low damage, 2 = moderate damage, 3 = heavy damage, 4 = severe damage. = The time where insecticide (dimethoate) were used.

STATUS OF PEST CONTROL RESEARCH IN CROPPING SYSTEMS IN BANGLADESH

Shamsul Alam, A.N.M. Rezaul Karim, C.M. Nurullah and Mainul Haq[1]

Introduction

A crop field is a contiguous area of land planted in more or less a homogenous manner during a particular season or a period. Crop cultivation or production therefore follows a system called cropping system, based on specific environmental conditions. The main objective of a cropping systems program is to increase food production per crop as well as per year. In order to achieve this goal, cropping systems researchers test improved cropping patterns which, if adopted, would change farmers existing cropping patterns and may change pest incidence creating possibly new pest problems (Litsinger and Moody, 1977). Favorable effects of cropping patterns on plant damage and crop loss depend on whether insect pests are repelled or less attracted to a particular crop. Successful planning of cropping patterns may thus become a powerful cultural component of pest control (Perrin, 1977).

In Bangladesh, rice-based cropping systems research was initiated by BRRI in 1974. Preliminary surveys conducted in 186 tanas of Bangladesh in 1980 showed 14 rainfed and 17 irrigated cropping patterns (Hoque et al, 1980). Incidence of insect pests is expected to vary or change in response to the inputs associated with these different cropping patterns. Crop loss due to insect damage has been identified by BRRI cropping systems researchers as one of the major constraints to higher yields at cropping systems research sites (Hoque and Hobbs, 1977).

But pest control is complicated, because a wide array of pests is present in each cropping pattern (Anonymous, 1977). Since pest incidence varies from region to region and from one cropping pattern to another, pest control methods should suit the specific problems of each region and cropping pattern. It is therefore necessary to study pest problems over the entire cropping period so that the effects of cropping pattern on pest populations can be understood and appropriate control measures, if

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required, can be properly employed. Based on these major objectives, entomologists became associated with the BRRI cropping systems research in 1978. This paper briefly describes the progress of entomological research carried out at cropping systems sites up to 1980.

Current status of entomological research in cropping systems sites

Entomological research in the context of cropping systems is just beginning in Bangladesh. We have conducted two types of studies since 1978: 1) survey of insect pests on various crops, and 2) superimposed trials to determine insect pest control recommendations at cropping systems sites.

1. Survey of insect pests in cropping systems sites. We have concentrated insect pest surveys in different seasons at the rice-based cropping systems sites of: a) BRRI farm, b) Salna, and c) Bhogra. The sites represent rainfed as well as irrigated environments. Rice is the most important crop in these sites. A new agroforestry environment was however included at Salna in 1980. The sites have the following major cropping patterns:

Site	Cropping season and major crops			Predominant cropping pattern
	Boro	Aus	Transplanted Aman	
Bhogra (rainfed)	Fallow	Rice	Rice crop	Double crop
BRRI farm (irrigated)	Rice, corn, millet, beans	Rice, corn, beans, jute	Rice, beans	Triple crop
Salna (irrigated + rainfed)	Rice, wheat	Rice	Rice	Triple crop
Salna forest (rainfed)	Timber plantation (permanent)	Cowpea, pigeon pea, rice (direct seeded)	Timber plant (permanent)	Triple crop

Except rice insects, we have so far identified 16 important insect pests on 17 different crops in cropping systems research sites (Table 1). Several of these insects (jute hairy caterpillar, aphid, thrips, stink bug, beanfly, pod borer, leaffolder and *Empoasca* leafhopper) are polyphagous and caused moderate to severe damage to several crops. These insects are mostly abundant in multiple cropping patterns rather than in rice- rice patterns. Out of 159 insect species recorded on rice in Bangladesh so far, only a few were found to be important in the croppping systems sites and their incidence varied according to seasons or rainfed and irrigated conditions. In direct seeded rice (rainfed), thrips. leafhoppers and grasshoppers were important: but under irrigated or wetland situations in different seasons, stem borers, gall midge, case worm, leaf roller and mealy bug were important. More intensive surveys are required to fully understand the pest problems of these sites.

2. Superimposed trials for insect control. Seven superimposed trials have been carried out on rice crops since 1978. Two more experiments are now going on in farmers' fields. A trial on crops other than rice at BRRI has been conducted during 1980-81 Boro season. Recommended practices of insect control by insecticides were compared with different treatments.

   Insect infestations in the superimposed trials conducted so far were below economic threshold levels. Distinct differences in insect populations or damage and grain yields were not obtained between treatments. As a result, no economic benefit from insecticide use was obtained. The results, in general, strongly indicated that prophylactic applications, as recommended by plant protection authorities, are not profitable. In one experiment (Boro, 1979-80), however, 2 to 3.7 times economic return was obtained by insecticide applications (Diazinon 60 EC) although the yields between the treatments were statistically insignificant (Table 2). More trials are therefore necessary to understand the pest activities and to draw conclusions on such results.

Future research needs

In future we have plans to undertake the following research projects to obtain important information for the pest management component of cropping systems research:

1. Review of relevant literature in cropping systems research.

2. Development of a comprehensive methodology for pest management research based on a cropping systems approach.

3. Preparation of a questionaire for bench mark survey of current insect control practices use by the farmers.

4. Superimposed trials to evaluate current pest control recommendations.

5. Key pest survey in single and multiple cropping systems.

6. Monitoring of some important insect pests (brown planthopper, hispa, mealy bug, etc.) in endemic areas having characteristic cropping patterns.

Intensity and frequency of insect infestations, even in endemic or outbreak areas, vary by weather, cropping patterns, crop varieties, crop stage, and the various inputs associated or used for them. A cropping systems approach is an important way to interrelate the differences in pest management aspects. Information obtained through this approach would enrich the knowledge of the researchers and narrow the gap between research and its application for the ultimate benefit of farmers.

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Table 1. Incidence of important insect pests at cropping systems research sites, 1978-80. BRRI.

Insect	Crops attacked	Predominant cropping pattern	Insect population	Insect damage
Aphid	Corn	Multiple cropping pattern	High	Moderate
	Potato	"	Moderate	Low
	Safflower	"	High	Low
	Peanut	"	Moderate	Low
	Gram	"	Moderate	Low
	Wheat	"	Moderate	Low
Beanfly	Potato	"	Moderate	Low
	Safflower	"	Moderate	Low
	Gram	"	High	Moderate
	Wheat	"	High	Low
Caseworm	Rice (rainfed wetland)	Rice-rice pattern	High-moderate	Severe-moderate
Corn borer	Corn	Multiple cropping	Moderate	Moderate
Corn earworm	Corn	"	Low	Low
Epilachna beetle	Broad bean	"	Moderate	Moderate
Flea beetle	Onion	"	High	Low
	Mungbean	"	Low	Low
	Cowpea	"	Low	Low
Fruit fly	Watermelon	"	Moderate	Moderate
Grasshoppers	Rice (irrigated)	Multiple cropping pattern	High-moderate	Low

Table 1 contd.

Insect	Crops attacked	Predominant cropping pattern	Insect population	Insect damage
	Peanut	Multiple cropping pattern	Moderate-low	Low
Gall midge	Rice (irrigated)	"	Moderate	Moderate
Hoppers (*Nephotettix* sp.)	Rice (direct seeded)	"	Low	Not visible
Hopper (*Thaia oryzivora*)	Rice (irrigated)	"	Low	Low
Hoppers (*T. spectra*, *K. mimica*)	Rice (direct seeded)	"	Low	Not visible
Hoppers (*Empoasca* sp.)	Peanut	"	High-moderate	Moderate-low
	Mungbean	"	High	Moderate
	Cowpea	"	High	Moderate
	Potato	"	High	Low
Jute hairy caterpillar	Jute	"	High-moderate	Moderate
	Soybean	"	High	Severe
	Peanut	"	High-moderate	Severe-moderate
	Mungbean	"	High-moderate	Severe-moderate
	Cowpea	"	Low	Low
Leaffolder	Soybean	"	Moderate	Moderate
	Peanut	"	Moderate	Moderate
	Corn	"	Low	Moderate-low
Leaf roller	Rice (rainfed wetland)	"	Low	Low

Table 1 contd.

Insect	Crops attacked	Predominant cropping pattern	Insect population	Insect damage
Mealy bug	Rice (rainfed wetland)	Rice-rice pattern	High-moderate	Moderate
Pumpkin beetle	Water melon	Multiple cropping pattern	Moderate	Low
Por borer	Gram	"	High	Severe
	Mungbean	"	High-moderate	Severe
	String bean	"	Moderate	Moderate
Spittle bug	Jute	"	High	Severe-moderate
	Dhaincha (green manuring plant)	"	Moderate	Moderate
Stem borer	Rice	Rice-rice pattern	High-moderate	Moderate
Stink bug	Millet	Multiple cropping pattern	High-moderate	Moderate
	Soybean	"	Moderate	Moderate-low
Thrips	Rice (direct seeded)	"	High-moderate	Severe-moderate
	Peanut	"	High	Low
	Onion	"	Moderate	Low
	Potato	"	High	Low
	Safflower	"	High	Low
Termite	Mehgani (timber plant)	"	Low	Low

Table 2. Effect of different insect protection levles on yield of rice in rice-rice-rice cropping pattern during Boro season, 1979-80. Salna, BRRI (Variety BR3).

Treatment[a/]	No. of applications	Per 5 sweeps (no.)			Yield (t/ha)	Yield loss (%)	Cost benefit ratio
		T. oryzivora	Green leafhopper	Grasshopper			
Protection at vegetative, reproductive and ripening stage	5	12	7.0 a	1.0 b	4.74 a	--	1:2.6
Protection at reproductive and ripening stage	3	8	6.5 a	5.5 ab	3.68 a	22	1:0.4
Protection at vegetative and ripening stage	3	20	4.5 a	1.5 b	4.50 a	3	1:3.7
Protection at vegetative and reproductive stage	4	14	4.0 a	2.0 ab	4.30 a	9	1:2
No protection	0	11	7.0 a	8.0 a	3.58 a	24	

[a/] Protected by applying Diazinon 60 EC at 0.75 lbs a.i./acre. Price of paddy: Tk. 100/md. Price of Diazinon 60 EC: Tk. 79.90/lb.

CROPPING SYSTEMS ENTOMOLOGY RESEARCH IN INDONESIA

Imam Prasadja and Ruhendi[1]

ABSTRACT

The cropping systems entomology research in Indonesia was initiated in 1975, but has been intensified since 1979-1980.

Research now focuses on the process of developing pest control recommendations suitable to farmers' conditions.

In order to achieve this goal, the key pests in the target areas must first be determined. Specific problems occurring in the target area should also be solved as well. Results can then be adapted to the farmers' existing technology to develop pest control recommendations.

INTRODUCTION

Cropping systems, defined as a mix of crops and production enterprises used by farmers to derive benefits from a given resource base and specific environmental conditions (Morris, 1979), have an ancient history and have been practised by farmers a long time (Soehardjan and Partoatmodjo, 1978). This has been attributed to climates favorable for year-round cultivation (Suryatna, 1976). Small-scale farmers generally have diversified farm enterprises with different resource requirements, that may involve various cropping patterns, tree crops grown in fence rows and homested areas, and animal production (Garrity et al, 1979).

Over the years, farmers have practised various types of diversified cropping methods, such as intercropping, relay-cropping, and mixed intercropping, particularly in home gardens. Home gardens play a unique and important role in the agricultural production pattern in Indonesia, and play a variable but important role in the farm family economy (Yogyakarta Rural Development Project, 1979).

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Perrin (1977) mentions that where agriculture is capital-scarce and labor-intensive, and where pest and disease incidence is usually high, diversified cropping systems give higher and more dependable returns than monocropping. Extreme population pressure can also enforce and encourage intercropping, so that the overall stability of production is maintained. The loss of crop stand by damage to one crop can be compensated by another crop. Also the manipulation of sowing dates, the use of susceptible and resistant varieties, early and late maturing crops, and different plant densities, are subtle adjusting measures open to the farmers.

The need of more food production to meet the population increase in developing countries has encouraged the development of cropping systems programs. Vast areas under upland crops have the potential to give good returns with the introduction of improved varieties, fertilizer practices and other cultural methods.

The development of more intensive cropping patterns could change pest problems by creating a more or less favorable environment for pest survival. As a consequence, a new cropping pattern may increase or decrease pest problems (Litsinger and Moody, 1976).

The cropping systems program focusses research on specific sites. Pest and disease incidence varies from place to place, therefore, pest control methods should relate and be suited to the specific problems existing in each site (Litsinger, 1979b).

If pest and/or disease incidence is the main constraint for successful crop production, control efforts should follow the concept of integrated pest management. This means that the control methods must be sound in terms of economics, ecology and sociology (Soehardjan and Partoatmodjo, 1978).

The ultimate goal of the entomologist working on cropping systems research is to provide appropriate pest control technology suitable to the farmers in the target areas. To first meet these goals, we should determine the key pests occurring in the target area. Then, to solve specific problems occurring in the target area (e.g. to find out the time of pod borer infestation as well as the proper time of insecticide application), we may conduct supporting component technology trials in the location. Results can then be merged with the farmers' existing technology to develop pest control recommendations that do not greatly differ from their current practices. All these activities are carried out simultaneously in the target area.

The strategy for cropping systems entomology research in Indonesia is shown in Figure 1.

Key Pest Determination

During the growth of a crop it is continually subjected to numerous hazards. Pest and disease incidence play a vital role among the biological hazards. The type and extent of damage caused by insect pests, diseases and wild animals varies greatly from place to place.

At present, farmers are getting more and more conscious of the need to protect plants to secure their crop yield. To eliminate these hazards, there is a tendency to rely mainly on the use of pesticides (Table 3 and 5). As a consequence, the use of agricultural chemicals has risen vastly. Pesticide application in a calendar system without recognizing the presence or absence of the pest will be dangerous and unsound economically and ecologically. Furthermore, since cropping systems are generally expected to create more environmental diversity than monocropping, they have the potential to reduce the dependence on pesticides (Soehardjan and Partoatmodjo, 1978).

In order to minimize the use of pesticides in cropping systems research, it is important to first determine the key pests for each crop included in the pattern. Since cropping systems research is site specific this key pest determination will also be true only for a specific site.

A method for determining key pests particularly for a crop grown alone, has been developed by Litsinger (1979b). This method enables us to pinpoint key pests which cause considerable yield loss for each crop growth stage. Pesticide application in a growth stage which has no important pest can then be avoided.

However, since most farmers' cropping patterns, as well as introduced cropping patterns in Indonesia, are highly diversified (e.g. intercropping and relay cropping), the situation is rather complex. Key pest determination by crop growth stage becomes more difficult, and so it has to be carried out more carefully. Eacy crop in an intercropping has its own growth stages. Yet, similar crop growth stages of two crops may not occur simultaneously if the crops are planted at different times.

For instance, corn and soybean maturing in about 90 days have a somewhat similar division of growth stages. Intercropping of these two crops simultaneously is recommended. Problems arise if intercropping is done at one or two week intervals.

As a further example, in the main cropping pattern developed in Lampung, S. Sumatra for upland areas, cropping is as follows: upland rice (125 days mature) followed by corn (120 days mature) two weeks later and then followed by cassava (6-8 months). The growth stages of rice and corn will be staggered. To avoid this, it is advisable to use an earlier maturing corn variety (90 days mature) for key pest determination trials so that the intercropping can be established simultaneously.

The reason we do not carry out key pest determination trials in sole cropping rather than in intercropping is to maintain similar conditions to the environment in the actual cropping pattern. Reports from IRRI (1974) have clearly shown that corn borer is more abundant in a sole crop than when intercropped with peanut. Ruhendi et al (1976) report that rice gall midge incidence is more severe in rice monocropping than in rice planted is sorjan (alternating ditches and beds) systems.

Farmers often spray their crop mixture simultaneously, regardless of the crop age. They spray heavily-infested more than lightly-infested plants. Therefore, crops planted in the intercropping will not receive equal frequency and amount of insecticide application (Prasadja and Ruhendi, 1981). Results from a survey conducted in Yogyakarta clearly show that in a rice and corn intercrop, rice was sprayed by 80% farmers and corn by only 12% (Table 3).

Farmers' Existing Technology

Before designing the component technology and cropping pattern trials in target areas, basic data must first be collected so that existing agro-climatic and socio-economic conditions can be considered. The data collected should provide information that will be of value in designing furure research (Bernsten, 1980). Moreover, to make pest control recommendations that farmers will adopt, the human element in farming as well as the biological element should be taken into consideration (Perrin et al, 1976).

Bernsten (1980) mentions that in order for a farmer to adopt recommendations, first he should be aware of the technology itself. Then the technology being introduced must be available and beneficial, and should be compatible with farmers' environment, personal characteristics and farming situation. That is why trial results must be evaluated using the same frame of reference as the farmer. Generally, such information is gathered by the agro-economists of cropping systems teams through a "baseline" survey and/or and "agro-economic profile".

However, such surveys would not answer all aspects as thoroughly as a specialist may require. They can only provide general information for each discipline. The same situation is also true for indepth studies on the insect pests and diseases. Therefore, it is highly desirable to investigate these factors in more detail through a special survey focusing on pest and disease occurrence (Litsinger, 1979a).

Information gathered in a survey of insect pest and disease problems will enable us to understand more thoroughly the nature of problems relating to pest incidence, farmers' ability to recognize pests, existing pest control practices, the extent of damage, and environmental-pest damage interactions.

Conducting such an in-depth survey is time consuming. For this reason, the questionaire should be carefully designed to avoid complexity and to collect only data relevant for planning further research. These efforts should not only enable the entomologist to describe the farmers' existing conditions in relation to pest and disease occurrence, but also to understand the systems well enough to make research recommendations (Bernsten et al, 1980). A questionaire survey designed by Litsinger (1979c) of farmers' insect and rodent control practices in irrigated rice can be used as a standard pattern. Modification for corn and grain legumes can be made.

Since entomological terminology will be used during the survey, it is advisable that it should be performed by the entomologist. Interviewing individual farmers will be time consuming and need many enumerators familiar with entomological terminology. For this reason, if there is a shortage of entomology staff, it will be better to question groups of 5-10 farmers instead of individual farmers. The interview will take about 2.5 hours for each group. Three to five groups per site will provide sufficient data.

Litsinger (1979c) suggests the survey should cover the following points of interests:

1. Constraints in food crop production (Prasadja and Ruhendi, 1981)

2. Farmers' pest recognition

3. Farmers' resources

4. Local market (availability of pesticide, fertilizers, etc.)

5. Traditional beliefs

6. Existing pest control practices:

   a. Cultural control
   b. Traditional control
   c. Varietal resistance
   d. Natural enemy conservation
   e. Physical/mechanical control

7. General pesticide usage

   a. Source of pesticide use information
   b. Constraints in implementing chemical control
   c. Source of cash to purchase pesticide
   d. Method of pesticide application
   e. Time of pesticide application
   f. Spray volume
   g. Formulation preference

h. Awareness on the mode of action of pesticide
i. Safety considerations
j. Rat bait placement

8. Field observation (conducted by the entomologist at the survey time) (Prasadja and Ruhendi, 1981)

Results from surveys in three farming systems sites in Yogyakarta (Prasadja and Ruhendi, 1981) and three sorjan areas in Central Java (Prasadja, 1981) revealed some interesting points, as follows:

1. Farmers' pest recognition is rather low, especially for very small insects and insects living inside the plants. Likewise, the occurrence of many diseases is unrecognized by farmers. However, some damage symptoms caused by an unrecognized insect (such as beanfly on legumes) is well known.

2. The concept of integrated pest management (IPM) has been partially adopted and executed by some farmers, although still in a simple way. To combat a typical pest, they do not rely mainly on one control method, but use two or more pest control methods simultaneously for instance, a combination of pesticide, cultural practices, traditional control and physical/mechanical control.

3. Farmers seldom achieve adequate control of pests through the use of pesticide, because of the lack of pest recognition resulting in improper time of insecticide application, the use of very low insecticide dosage and spray volume, and lack sprayer ownership. For instance, farmers' dosage for diazinon is only one tenth up to one half of the recommended dosage (Table 4). Similar situations occur in the "Bimas" government production program. Here, the amount of insecticide applied by farmers was 0.55 kg or liter commercial formulation/ha in the 1978-79, and was raised slightly in 1979-1980 to 0.78 kg or liter/ha (Table 6). Most farmers apply insecticide on rice one to three times per season (Table 7). If we divide these figure into the total applications in 1979-80 (Table 6), we find that the amount of insecticide used per application per hectare is approximately 0.26 kg or liter commercial formulation. Likewise, the spray volume per hectare used by farmers under upland conditions was mostly less than 200 liters water/ha (Prasadja and Ruhendi, 1981). Different situations can be found under irrigated rice fields. Here, many farmers are able to apply a spray volume up to 500 liters/ha or more. Farmers sprayed irrigated rice fields 1.26 times more frequently in the wet season than in the dry season (Table 8).

Developing Pest Control Recommendations

The ultimate goal of cropping systems entomology research in the target areas is to provide information to production programs where farmers will be educated as well as pest control recommendations suitable to farmers' conditions. The development of pest control recommendations for cropping systems should take into account the resources of the farmers. Litsinger and Moody (1976) mentioned that pest control tactics will differ for large-scale and small-scale farmers, as each has a different resources base of capital, labor, power, land and management capability.

This situation is particularly true for most cropping systems target areas in transmigration areas of Indonesia. A family of transmigrants consisting of five persons (parents and three children) is only able to cultivate an average of 0.7 hectares of land by using conventional equipment, whereas the land given by the government through this project is two hectares or more. This is why Barlow et al (1979) stated that this information and technology should emphasize small-scale rather than large-scale farmers.

Spraying scheduled in a calendar system will be beyond the resources of small-scale farmers. Most farmers apply insecticide in response to the presence of pests and pest-damaged plants rather than for prophylactic purposes. This was attributed to the conception that prophylactic treatment is often useless and a waste of money (Prasadja and Ruhendi, 1981).

Litsinger and Moody (1976) recommended that research should concentrate on the development of the optimal use of pesticides, ie. to find out the lowest dosage and the most profitable time of insecticide application. Moreover, small-scale farmers would probably prefer an economical and broad-spectrum-type of insecticide that could be used on several crops against a wide array of pests.

Guidelines for pesticide usage in pest control recommendations being developed at cropping systems sites show preferences for the use of moderately effective insecticides, but cheaply relatively safe to non-target organisms, and broad-spectrum in action, rather than insecticides, highly effective but expensive, toxic and specific in action.

Moreover, many traditional control methods employed by farmers have a wide flexibility that lessen or partially combat pest incidence. Earlier maturing rice varieties escape from late rice bug incidence (Prasadja, 1981). Fresh crabs or frogs are used as attractants for rice bugs, and are either mixed with poison or burnt to attract bugs. Scattering wood, ash on the soil is primarily used to control ants and other soil insects, and on leaves to control aphids as well as *Phaedonia* (Prasadja and Ruhendi, 1981). Modern pest control technology being tested is highly compatible with these existing traditional pest control practices.

Pest control recommendations being developed will thus include the following:

1. Pesticide: recommended pesticide should be:

   - Broad-spectrum in action
   - Moderately effective (most profitable)
   - Low priced
   - Available in the local market
   - Still effective in low dosages
   - Safe to mammals, fish and other non-target organisms

2. Method of application. It is preferable to treat seed with pesticide for early crop protection, followed by one to three pesticide sprayings. The existing key pests in the target area should be taken into consideration when deciding the time and frequency of pesticide application. Since few farmers, especially in upland areas are able to apply the recommended spray volume or 500 - 1,000 liter water/ha, it is extremely important to find a new type of sprayer and its method of use that needs a smaller amount of water (eg. controlled droplet application).

3. Other control measures. The chosen pesticide and its methods of application will be more effective if combined with other control measures, so that crops will continue to have protection. These control measures are:

   - Varietal resistance (local/national resistant varieties)
   - Cultural practices (fertilizer level, tillage method)
   - Traditional controls (ash/salt scattering, fresh crab/frog attractants, other beliefs for farmers' reassurance
   - Physical/mechanical control (insect handpicking, rat traps, etc.)

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Table 1. Key pests in Way Abung, North Lampung, 1979-80.[a]

	Cropping pattern (main)	Key pest[b]	Cropping pattern (alternative)	Key pest[b]
First crops				
October planting 1979-1980 wet season	1. Upland rice +	- shoot fly - rice blast - rice bug	1. Soybean +	- defoliators - pod borer - pod sucker
	2. Corn (≠)	- shoot fly - downy mildew	2. Corn -	- shoot fly - downy mildew
	3. Cassava	- bacterial wilt disease		
Second crops				
February planting 1980 dry season	4. Peanut	- pod borer ("gapong")	3. Mungbean +	- beanfly - aphids - thrips - pod borer
			4. Corn -	- shoot fly
Third crops				
June planting 1980 dry season	5. Rice bean[c]	- beanfly - pod borer	5. Cowpea[c]	- beanfly - aphids - pod borer

[a]First year results.

[b]Shoot fly *Atherigona exigua*; Rice blast *Pyricularia oryzae*; rice bug *Leptocorisa* spp.; cassava bacterial wilt disease *Pseudomonas solanacearum*; pod borer *Etiella zinckenella*; beanfly *Ophiomyia phaseoli*; pod sucker *Nezara* spp. and *Riptortus linearis*; defoliators *Chrysodexis chalcites* and *Prodenia litura*; thrips *Thrips* spp.; aphids *Aphis* spp. Symbols: (+) = intercropping; (≠) = relay cropping; (-) = sequential.

[c]Data derived from field observation.

Table 2. Key pests and incremental gains in yield due to different methods of insecticide application at Bandarsari, Central Lampung, 1975-1976.[a]

	Cropping pattern	Key pests[b]	Yield (in kg/ha)		
			Insecticide spraying[e]		
			None	Incidentally	Biweekly[c]
First crops					
December planting 1975-1976	1. Upland rice +	- shoot fly - neck blast	164	861 (697)[c]	710 (546)[c]
	2. Corn +	- shoot fly - downy mildew	601	1,330 (729)	975 (374)
	3. Cassava	- tuber rot	---	---	---
Second crops					
May planting 1976 dry season	4. Peanut -	- pod borer - Cercospora - Mozaic virus	0[d]	526 (526)	512 (512)
Third crops					
September planting 1976 dry season	5. Rice bean	- beanfly - pod borer	154	508 (354)	620 (466)

[a]Data for key pests derived from actual field observation (not from the key pest determination trial).
[b]Shoot fly *Atherigona exigua*; pod borer *Etiella zinckenella*; beanfly *Ophiomyia phaseoli*; neck blast *Pyricularia oryzae*; tuber rot
[c]Numbers within parentheses indicate the increment in yield due to the method of insecticide application compared to no protection.
[d]Heavily damaged by pod borer ("gapong").
[e]Spraying was done with cyanophenphos 25 EC (0.5 kg ai/ha). Spray volume used was 400 liter/ha. (-) = data not available.

Table 3. Percentage of farmers using pesticides and fertilizers.

Site[1]	Cropping pattern	Farmers (% using)	
		Pesticide	Fertilizers
Central Lampung[1]			
Bandarjaya 1976-1977	Lowland rice	47	80
	Corn + upland rice - corn	33	100
	Corn + upland rice ≠ cassava	20	40
West Java[2]			
Indramayu 1976-1977	Wet seeded rice	69	100
	Dry seeded rice	53	100
Yogyakarta[3]			
Gunung Kidul and Kulon Progo 1980	Rice + corn ≠ cassava	12/80/0	100/20/20
	Soybean	78	n.a.
	Peanut	17	n.a.
	Yardlong bean	22	n.a.
	Sweet potato	7	n.a.

[a]Source: Wayan Sudana (1978). Farm record keeping studies in Central Lampung 1976-1977.

[b]Source: A. Saefuddin, S. Tadjuddin and Anwar Hidayat (1978). Farm record data. Cropping Systems Research Indramayu, 1976-1977.

[c]Source: I. Prasadja and Ruhendi (1981). Farmers' existing technology and pest control practices in Yogyakarta. n.a. - data not available, (+) - intercropping, (≠) - relay cropping, (-) - sequential.

Table 4. Farmers' insecticide dosages.[1]

Insecticide (common name)	Dosage (kg ai/ha)	
	Farmers	Recommended
Diazinon	0.06 - 0.25	0.6 - 1.0
Carbaryl	0.07 - 0.37	0.5 - 1.0
Chlorpyrifos	0.03 - 0.14	0.3 - 0.5
MIPC	0.03 - 0.25	0.5 - 1.0

[1]Data derived from problem-focussed survey conducted at three sorjan areas (Sukoharjo, Demak and Wates), and three farming systems areas (Kedung Poh, Banjar Oyo, and Hargo Tirto), all in Central Java.

Source: I. Prasadja and Ruhendi (1981). Farmers' existing technology and pest control practices in Yogyakarta.

I. Prasadja (1981). Farmers' existing technology and pest control practices in sorjan areas.

Table 5. Amount of insecticide applied by farmers.[1]

Farmers' cropping pattern	Kg or liter formulation/ha		
	1st-rice	2nd-rice	Total
With constraint[2]	3.5	3.6	7.1
Without constraint[3]	9.9	4.2	14.1

[1]Data was averaged from three categories of irrigation system. Insecticide: Cyanophenphos, Diazinon and carbofuran.

[2]With constraint: managed under farmers' management capability, limited resources.

[3]Without constraint: supplied by pests and technically supervision.

Source: A. Saefuddin, Tadjuddin S, and Anwar Hidayat (1978). Cropping systems research, Indramayu, 1976-1977.

Table 6. Total amount of insecticide applied by farmers in the "Bimas" and "Inmas" program (mass intensification).[1]

Region	Kg or liter formulation/ha	
	1978/79	1979/80
Java	0.70	0.73
Sumatera	0.82	0.80
Sulawesi	0.51	0.82
Kalimantan	0.16	0.06
Bali	0.80	1.20
Nusa Tenggara Barat	0.28	0.95
Nusa Tenggara Timur	n.a.	0.90
Average	0.55	0.78

[1]Source: Bimas Programme. Cit. D. Soekarna (1980). Pesticide management in rice insect control in Indonesia. n.a. - data not available.

Table 7. Percentage farmers applying certain frequency of insecticide application on rice, 1972-1973.[1]

Province	Season	Insecticide frequency/season (no. times)					
		One	Two	Three	Four	Five	Total
		% farmers					
West Java	Dry	16	23	27	9	1	76
	Wet	7	17	26	24	1	75
Central Java	Dry	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Wet	17	24	25	8	2	76
East Java	Dry	13	18	4	3	0	38
	Wet	18	29	15	9	1	72
Lampung	Dry	19	16	16	9	0	60
	Wet	38	6	6	6	0	56
Average	Dry	16	19	16	7	0	58
	Wet	20	19	18	12	1	70
Ratio: wet/dry							1.21x

[1]Data derived from average over Kabupaten (districts) in each province.

Source: Directorate Agricultural Technics (1974). Pests and diseases observation report during 1972 dry season and 1972/73 wet season. n.a.-data not available.

Table 8. Percentage of farmers applying certain amount of spray volume on rice, 1972-1973.[1]

Province	Season	Spray volume/application (l/ha)			
		250	250-500	500-1,000	Total
		% farmers			
West Java	Dry	6	15	55	76
	Wet	9	21	45	75
Central Java	Dry	n.a.	n.a.	n.a.	n.a.
	Wet	22	22	38	82
East Java	Dry	8	7	23	38
	Wet	19	15	40	74
Lampung	Dry	22	28	9	59
	Wet	13	25	19	57
Average	Dry	12	17	29	58
	Wet	16	21	36	73
Ratio: dry/wet					1.26x

[1]Data derived from average over Kabupaten (districts) in each province.

Source: Directorate of Agricultural Technics (1974). Pests and diseases observation rerpot during 1972 dry season and 1972-73 wet season.

n.a. - data not available.

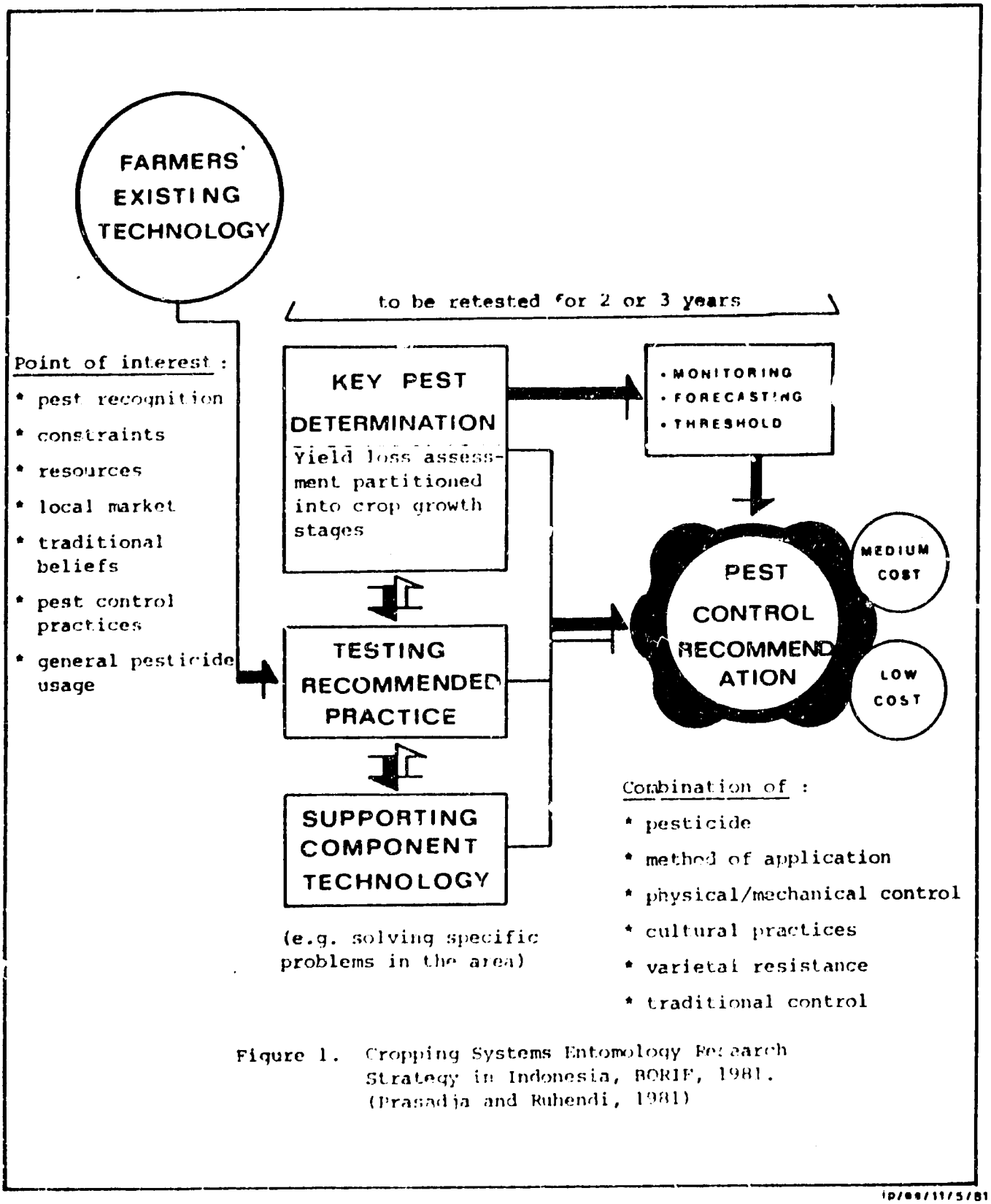

Figure 1. Cropping Systems Entomology Research Strategy in Indonesia, BORIF, 1981. (Prasadja and Ruhendi, 1981)

FARMERS' EXISTING TECHNOLOGY AND PEST CONTROL PRACTICES FOR FOOD CROPS AT THREE LOCATIONS IN YOGYAKARTA PROVINCE

Imam Prasadja and Ruhendi[1)]

ABSTRACT

The process of developing packages of insect control recommendations suitable to farmers conditions, is not a simple thing.
In order to achieve this goal, a preliminary study on farmers' existing technology and pest control practices, as well as their management capability, is described.
Data was obtained by conducting a survey focussing on insect and disease problems in the target area. The result is then combined with the key pest study, which is stated in a research-managed trial.

INTRODUCTION

Three sites for farming system research financed by the Rural Development (RDP) were selected in the Province of Yogyakarta. These pilot areas were Hargo Tirto and Banjar Oyo, both in Kulon Progo district, and Kedung Poh in Gunung Kidul district.

The purpose of establishing these pilot sub-watershed hillside farming areas was to address the development problems presented by verious stages of land degradation. Furthermore, these pilot project areas are representative of a much larger area having similar soil type, climate, topography, and production problems. A considerable area, upwards of 400,000 ha in central and east Java, has conditions similar to the dry-land and hill areas of Gunung Kidul and Kulon Progo districts (Yogyakarta Rural Development Project, 1979).

Program planning and trials implementation will start with the existing crops and crop-systems as a point of departure.

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In order to achieve this program, preliminary data on the physical, biological and socio-economic aspects of the area should be identified and collected from all available sources (Zandstra, 1977).

This data was then strengthened by a base-line survey to quantivy as much as possible agro-socio-economic factors in relation to production practices. Such information is necessary for planning research priorities (Carangal, 1977). This information was supplemented by using a problem-focussed survey, by which it was aimed to throughly understand farmers' existing pest control management practices. Likewise an analysis was carried out as to what pests farmers recognize, what insect control tactics they execute, how well they execute insect control technology, and what kind and levels of technology they will be likely to adopt (Litsinger, 1977).

The data gathered will provide information that will be of value in designing future biological research (Bernsten, 1980). Through an understanding of farmers' current pest control practices, their capability in dealing with pest problems can be estimated (Litsinger, 1977).

METHODOLOGY

This survey was conducted from 14 to 28 May 1980. Data for the study were derived from personal interviews with both individual farmers and groups of farmers. Farmers were selected by a systematic random sampling method.

A sample of 9 respondents in each of three project sites and two additional groups of farmers in Kedung Poh were interviewed, using a questionnaire which included color photographs (13 x 9 cm) of insects and diseases, as well as damaged plants or symptoms. The questionnaire used was based on the Litsinger Method with some modification (Litsinger,1979 & 1979 b). Actual specimens collected prior to interview from surrounding fields were also used as alternatives.

Field observations and diagnoses were also made, in order to find out the degree of pest infestation and disease severity at a location.

RESULTS AND DISCUSSION

All discussion is based on information provided by the farmers from the three locations.

Constraint in food crops production.

The number of food crops grown among the three villages varied greatly. The variety is greatest in Kedung Poh with an average of 5.3

types crop, and least in Hargo Tirto with an average only 1.8 types of crop. This difference may replect farmers' awareness and capability to cope with problems arising from each crop.

More than 80% of farmers mentioned that there were constraints which can affect their crop growth and production. Forty five percent of these are caused by pests or diseases (Table 1).

Furthermore, farmers were also asked to mention constraints on a crop basis. It was revaled that more then 70% of rice and legumes both in Kedung Poh and Banjar Oyo endured pest and disease infestation. Likewise was cassava grown in Banjar Oyo (Table 2).

Farmers ranking of pests.

Farmers were asked to rank in order of importance all commonly found pests and diseases of cassava, corn, grain legumes, and rice.

Cassava. Most farmers stated bacterial wilt diseases caused by Pseudomonas solanacearum as the major disease of cassava. According to them, this disease can attack both the young and matured crop. Infestation occuring at the early growth stage may cause a wilting of leaves leading to the failure of plant growth, whereas in infestation at the late grown stage may influence tuber formation.

Leaf wilting starts from the middle portion upwards, while the lower part leaves wilt and fall latest. Attacked internodes can not be used as cassava sticks for the next growing season. However, the adjacent healthy internodes can still be used. Farmers refer to the mites as the causal agent.

Farmers are quite aware that a local variety, namely Mentega, which is sweet, yellowish and good testing, is very susceptible to this disease. Other less preferred cassava varieties are resistant. For this reason, this disease is quite easy to combat.

Rats are considered as the most serious pests of cassava in Banjar Oyo. It damage the tubers by digging out the soil.

Scale insect is considered of minor importance. Some farmers consider it as walking white fungus. According to them, this pests only attacks during the early growth stage, and even an infested plant may still produced tubers. As for the previous disease, infested internodes are excluded from cutting (Table 3).

Corn. Rat, seedling maggot, and downy mildew were considered as the most serious pests. White grub also ranked high because it can attack any crop. No crop can grow well under its attack. This pest may be attributed to the use of dung manure.

Only a small number of farmers recognized that downy mildew is a disease. That is why other often used insecticide to control the disease. Ants were also cited as pests, even thougt of minor importance. They are considered as pests because of their attempts to carry away the seed as soon as they are put into the ground.

No serious pest or disease was mentioned in Hargo Tirto. The severe spotty infestation of downy mildew was considered of minor importance due to the lack knowledge of the diseased plant symptoms.

Grain legumes. Farmers rated pests differently in the most commonly-planted legumes, namely yardlong bean and jackbean. Aphid, which is considered as a disease, was cited as the most serious pest in Banjar Oyo. Other frequently cited pests are Riptortus linearis, flea beetle, and bean fly.

Bean fly probably did not rank high with farmers because no farmer had even seen its adult, but nevertheless, their damage symptoms are recognized. Grasshopper was also considered of minor importance, though it ranked as the second in importance in Banjar Oyo.

Flea beetle is considered as a serious pest because it damages the leaves. Its damage is commonly called "complong-corplong" (defoliation) in the local dialect.

Aphid and Phaedonia inclusa are considered as the most serious pests of soybean. Most farmers know exactly the characteristics and damage symptoms related to these two important pests. It is of interest, that farmers consider both Aphid and Phaedonia as belonging to the same species. Aphid is considered as the early growth stage of Phaedonia. On the other hand, Phaedonia infestation occurs earlier than Aphid. According to farmers, attacked plants can not be harvested, since this pest attacks all important parts of the plant, such as leaves, flowers, and pods. These insect are abundant during the rainy season.

Pod borer is believed to be more severe on soybean than other legumes, whereas green stink bug is more abundant on mungbean. Likewise, the semi-looper is considered only to attack soybean.

Riptortus linearis rated high on mungbean, while rat is considered to be most serious pest of peanut. Cercospora leaf-spot is also recognized by the farmers. Its attack usually occurs after flowering until maturity, resulting in a woody-peg formation.

Rice. Brown planthopper is cited as the most serious pest, especially because of the wide spread use of local varieties. Some farmers were able to combat this insect successfully by using a high yielding variety which is resistant to this insect. However, grassy stunt, which is related to this insect, was considered to be a result of drought stress or nutricient deficiency.

White grub is quoted as second in importance in upland rice (gogo). It is considered of minor importance in flooded rice (sawah). In contrast, mole cricket only occurs if the soil is wet or under flooded conditions.

Some farmers believe that rice bug is only a flower eater, and never attacks the panicle. Birds are also considered a flooded rice pest, but are less severe in upland areas. This may be attributed to a synchronous planting throughout upland areas. Consequently, their infestation will be spread over a large area, resulting in fewer fallen panicles.

Physical and mechanical control.

A wide array of physical and mechanical control methods is employed by farmers. Of these, many practices are only partially adopted (Table 5).

The most commonly-used method is insect handpicking from plants, which is practised by 62% of farmers. A hundred percent of farmers in Kedung Poh employ this method on legumes. Furthermore, if the insect is abundant, they will employ this method both in the morning and afternoon.

Several methods of rat and bird control are also quoted, such as digging out rat burrows, which is practised by 39% of farmers, rat trap (10%), bird-scarecrows (46%), flags (41%), and bamboo-sticks sounded by clapping them together (43%). Digging out rat burrows might be preceded by smoking using dry leaves to scare the rat inside.

Cultural control.

A series of cultural practices to control pests is employed by farmers. Removing infested plants is practised by 58% of farmers. Other frequently mentioned were adjusting date of planting (18%), synchronizing planting with neighbors (20%), flooding or draining field (19%), and crop rotation (24%).

Farmers are quite aware of the benefits derived from synchronous planting, especially in upland rice, since it will minimize bird infestation. Bird infestation will be spread over a large area.

Crop rotation in Kedung Poh is practised only on soybean, while in Banjar Oyo only on rice (Table 6).

Traditional control.

The most commonly belief obeyed by farmers (58%) is a prohibition of planting any kind of plant on the death-date of their parents and/or parents-in-law. Dating is based on the name of day within a week, combined

with the name of the day within the Javanese five-day week namely legi, pahing, pon, wage, and kliwon. Consequently, any one day may fall on any day in the Javanese week. For example, Monday-legi, Monday-pahing, Monday-pon, and so on.

Growing this prohibition will be disastrous a farmers crop, either by pest infestation or for other reasons. Activities other than planting are allowed, such as weeding, spraying, and so on. This prohibition order is called "sirikan" or"sangaran" in local dialect.

Another tradition commonly practised is placing food in the field (15%) for general purposes. Results expected to derive from this are prosperity, a good harvest, and escape from pest infestation. The term for this custom in the local dialect is "sesajen". The food is placed in the field after rice or corn harvesting, also on a holyday in the month of "Rewah" (an Islamic month).

In another custom a mixture of spiced-rice and safforn (Curcuma domestica) together with boiled legumes is eaten, after this has been placed in the field for a certain time. Another kind of food used for this is rice with boiled egg.

Ash is applied after the crop emergence, practised by 25% of farmers. This used for two purpose : for insect control and to increase soil fertility. Scattering ash on the soil may control ants, while on leaves it may control Phaedonia inclusa as well as Aphid.

Likewise, scattering salt on to the soil is also used both for insect control (17%), and to keep the soil in a cold condition. The insects it is expected to control are mainly caterpillars, such as white grub.

Other methods practised are the use of either frogs or crabs (17%), and the use of plant parts in the field (4%). Fresh frogs or crabs, acting as attractants, are intended to control rice bugs. Some farmers may mix it with endrin. This material is placed in high places among the rice hills.

The use of plant parts in the field for "prosperity" is practised by 10% of farmers. The most common materials used in Kedung Poh are four pieces of palm leaves (Zalacca edulis), which are placed in the corners of the field. Sugarcane leaves (Saccharum officinarum) may be used instead. Farmers in Banjar Oyo often use Erythrina leaves or ginger-root (Alpinia galanga), which are placed at the beginning of rivers every Tuesday-kliwon.

Farmers in Bargo Tirto often used four pieces of areca-palm (Areca-catechu), which are put in the ditch (Table 7).

Varietal resistance.

Only 20% of farmers are aware of plant resistance to pests in rice, corn and cassava. The numbers of varieties resistant to each pest are as follows : brown planthopper (5 varieties), rice stemborer (3 varieties), rice gall-midge (1 varieties), downy mildew of corn (4 varieties), and bacterial wilt disease of cassava (all local varieties, except Mentega).

Resistant varieties included modern and local varieties. No varietal resistance of corn was recognized by farmers in Hargo Tirto (Table 8).

Natural enemy.

No farmer recognized natural enemies which prey or parasitize on insect pests. The most commonly known are rather large predators, such as cat (100%), snake (39%), bird (28%), dog (14%), fowl (13%), and caterpillar (8%) (Table 9).

Furthermore, there were discrepancies among farmers on the role of natural enemy in controlling pests. Most farmers (72%) believe that pests, particularly rat, can be controlled by the predators mentioned above (Table 10).

Farmers who disbelieve this may argue that the pest population can not be diminished by natural enemies, Pests are only frightened and driven away by them. Likewise, a small number of fowl may to control numerous ants.

General pesticide usage.

Farmers in Kedung Poh spray four type of crops (rice, soybean, corn, and peanut), two crops (rice and corn) are sprayed in Banjar Oyo, and two crops (sweet potato and yardlong bean) in Hargo Tirto.

Taking into account cropping patterns in the three location (Figure 1) insecticides are sprayed on rice by 80% of farmers, soybean (78%), yardlong bean (22%), peanut (17%), corn (12%), and sweet potato (7%) (Table 11 a).

No farmer had ever used any fungicide, and only a few number ever used a single brand of rodenticide. As a consequence, they use insecticide to combat rat and disease problems. For example, one farmer in Kedung Poh sprays Sevin or Diazinon to control downy mildew of corn.

Most farmers (41%) apply insecticide two times on rice. The first spray is applied at 4 weeks after planting (WAP), and the second at 9 WAP. Soybean is sprayed twice by 50% of the farmers. The first spray is employed at 3 WAP and second at 7 WAP. Detailed information on each location is presented in Table 11.

Source of pesticide use information.

More than 50% of farmers gained information on the use of insecticide and on pest-control strategy from field extension workers and the School on the Air (a radio extension programme).

Other commonly-mentioned sources are neighbors (32%), pesticide distributors (30%), leaflets (3%), and extension films (7%) (Table 12).

Methods of insecticide application.

Most farmers apply insecticide in response to the presence of pests (37%), damaged plants (34%), and for prophylactic purposes (14%). Farmers who adhere to the prophylactic system may repeat the spraying even within an interval of one or two days to overcome subsequent pest infestation.

It seemed that farmers disagree among themselves on the importance of synchronous spraying in adjacent fields. Some farmers recognized its importance, since it may prevent the spread of the pest over a large area. Delay may allow the pest population to build up.

Farmers who disagree may argue either that their neighbors never spray or that sprayer ownership is low, so that a sprayer has to be used alternately. Furthermore, they usually wait for each others result from the preceding spraying. Unless it showed effective control, they will not take part in the subsequent spraying. Normally, two weeks is needed to demonstrate the preceding spraying result (Table 13).

Constraint in implementing chemical control.

Three most commonly-cited constraints in implementing chemical control are the unavailability of an intended insecticide in the local market (42%), lack of sprayer (40%), and lack of money (37%) (Table 14).

As a matter of fact, only one or two insecticide brands are available in the local market in each growing season. It seemed that certain brands monopolize the distribution of insecticide in each location. Therefore, farmers have no other choice other than using the seasonally available brand for all crops planted.

Likewise, sprayer ownership is also a limiting factor in each location. A group of 12 to 20 farmers organize the usage of a sprayer. The most popular types of sprayer are a 10-litre hand sprayer, and a 15-litre knapsack sprayer. Each farmer undertakes to pay Rp. 250.000 in monthly instalments, allowing payment to be settled within three years. The sprayer then can be used by farmers within the group or in many cases outside farmer related to members of the group. For this reason, synchronous spraying throughout the area is almost imposible.

Farmer outside a group or hairing no convenient relatives, may use a bamboo-operated sprayer. This home-made tool, which is 45 cm in length and 3 cm in diameter and has a capacity of 0.25 liters, can only be used once. A new one is needed for subsequent sprayings.

In some cases farmers may use a bundle of rice straws as a substitute for a sprayer or bamboo sprayer in applying liquid insecticide. The rice straw bundle is first immersed in the solution and is then shaken over the top of the plant.

Source of cash.

Cash to purchase insecticide comes from their own savings (78%), borrowed from neighbors (23%), and "BIMAS" credit (15%) (Table 15).

All farmers interviewed consider that the price of insecticide is reasonable. They distrust lower priced brands since these may be less effective or not effective at all.

Time of insecticide spraying.

Time of spraying depends upon many factors. Most farmers (60%) spray early in the morning, while others (34%) always spray in the afternoon (Table 16).

Reasons for this discrepancy are either the farmers' consideration of many technical factors, or the availability of free time or distance to the field.

According to them, good control will be achieved by spraying early in the morning. This may be attributed to the low wind velocity, dew availability on leaves, less hazard to flowers and fruit, and that the insects are easily visible.

Farmers who prefer spraying in the afternoon intend to avoid the inactivation or destructive processes of light on the insecticide structure. Smaller wind velocities and no dew on leaves are also believed to be favorable conditions.

Furthermore, regardless of all reason mentioned above, the distance of fields from the farmer's house may influence the decision. A distant place is usually sprayed in the morning.

Opinion on the use of under-doses.

Farmers were asked about their opinion of using one-half of the normal dose. The aim was to reveal information on what a proper dose of insecticide means to farmers.

Four different answers which are equally distributed were given, namely no control at all (29%), no difference from the normal dose (26%). and kill only one-half the number of pests (18%). Another 27% had no opinion (Table 17).

However, farmers who were convinced that the use of a half dose is useless appeared to derive this from their understanding of the insecicide host relationship. According to them, the same result would probably be achieved if one half of the normal dose is diluted in one half of the recommended amount of-water, and then used in a 50% reduced area.

Mode of action of pesticide.

As a general statement, it may be said that farmers have a very superficial knowledge on the mode of action of pesticide. The most commonly-cited actions are stomach poison (30%), fumigant (17%), and contact action (17%) (Table 18).

As a matter of fact, chemical properties of a pesticide, are not considered in the mode of action, but nature of the target pest is. For example, fumigant action must be true for caterpillars, since they can not fly. Stomach poison was associated with rat, whereas contact action and repellent are thought to be true for rice bug.

Safety consideration.

For a number of years farmers have realized the hazard coming from insecticide, and 61% of them feared certain insecticides, such as endrin (Table 19).

In orede to minimize insecticide hazard during spraying, 56% of farmers use a mask to avoid inhaling the insecticide spray during application. Most farmers are aware that endrin vapour is very strong and dangerous. It irritates the skin, and therefore any long expsure to such a formulation should be avoid.

If one does the insecticide application for the first time, one may feel dizzy afterwards. Some farmers may associate certain brands such as Diazinon with responsibility for this phenomenon.

Spray volume.

The amount of water used for spraying is of great importance, since it will determine the insecticide dosage. Unfortunately, it has been proven that farmers always use a low spray volume. Spray volumes of less than 100 litres per hectare are employed by 36% of farmers, whereas only 26% of them used 200 to 250 litres per hectare (Table 20).

Low spray volume may be attributed to a scarcity of sprayer ownership and their capability of completing the application. A farmer working from 07:00 to 13:00 pm is only able to complete a maximum number of 5 loads.

Most farmers usually increase the number of loads in response to higher pest infestation.

Insecticide dosage.

Farmers determine dosage either through the guidance of field extension workers or by guessing. No farmer can follow the directions written on the package label, since the units used are mililiters per liter.

A great number of farmers use very low dosages, ranging from 0.02 to 0.24 kg active ingridient per hectare. This may be attributed to a smaller spray volume used per hectare, whereas the recommended dosage as written on the label is based on a spray volume of 500 to 1,000 liters per hectare.

Furthermore, farmers are quite ignorant of the active ingridient contained in each brand. Therefore, the same number of tablespoons will be used for all kinds of insecticides.

One indication of the poor understanding of farmers of proper doses is that they will use a tablespoonful of wettable powder formulated if there is still enough stock. A smaller amount is often used when stock is limited (Table 21).

Formulation preference.

Only 48% of farmers are aware both of the liquid and powder formulated insecticides. The powder formulated is preferred by 23% of farmers, liquid by 21% (Table 22).

Powder is more preferred because it is more effective than liquid, easy to carry and handle, does not cause dizziness, and is harmless if it comes in contact with the skin. Furthermore, the color of most liquids is similar to soya ketchup, so it is particulary dangerous to children.

Other farmers consider that liquid is superior to powder, since it possesses a strong smell, resulting in more effective control, is easy to apply and dissolve. No farmer had about granular.

Rat-bait placement.

Several years ago some rice-grower farmers used to employ a baiting method to control rat. Zinc phosphide, an acute rodenticide, was the only brand used by farmers.

At the present time, only a few farmers are still practising this method, because of the scarcity of zinc phosphide in the local market.

Numerous chronic action rodenticides now available and recommended are less preferred, due to the slow killing action.

Coconut slices mixed with the poison is used as bait, and placed in a banana leaf as a bait holder. Each bait-holder catches half of a coconut fruit. No set amount of zinc phosphide is poured in the mixture. A rather dark color is used as the criteria that the measure of poison in the mixture is sufficient. A few farmers may use rice instead of coconut.

The bait is usually set from afternoon until morning. A range of 5 to 20 bait holders is required to cover a hectare, depening upon rat infestation.

Bit-holders are placed inside field, about 0.5 meter away from the dike. The presence of a "rat-way" and/or burrows are the prerequisite for putting a bait-holder nearby. Placement in the middle of the plot is seldom practised due to the difficulty of ascertaining and collecting the victims.

However, most farmers recognize that rat infestation usually occurs only from the booting stage up to the ripening stage. For that reason, baiting often starts after the flowering stage.

Field observation.

Field observation and diagnosis of major insects and diseases problem were made by the two entomologists on a crop basis. Data derived from actual observation, as well as from interviews should be taken into consideration for planning future research.

Kedung Poh. Most of the crops grown in this village were already harvested about 3 weeks before this problem-focussed survey was launched. Therefore, only a little data could be gathered.

Bean fly, Empoasca, Thrips, and defoliators, which were observed on just-planted soybean, seemed to have the potential to built up if not properly managed (Table 23 a).

Banjar Oyo. Rice bug seemed to be a major pest of rice during the ripening stage. Its population had exceeded the economic threshold, and therefore it should be taken into consideration. Likewise, should the green stink-bug, even though there was a lesser number of these then the previous insect.

The use of any insecticide to combat these pests should be carefully implemented, otherwise, it will adversely affect non-target organisms, such as spiders.

Thrips of legume, which attaccks either flower or buds, was also of major importance. Its degree of infestation on split pea (Cajanus cajan) reached 3.3 insects/flower, and on chilli reached 1.6 insects/bud (Table 23 b). However, yield losses due to this insect have not yet been determined.

Bargo Tirto. Among grain legumes pests, thrips, bean-fly, Empoasca, and flea beetle should be taken into consideration, as should aphid on peanut.

Observations made on yardlong bean revealed that thrips reached 1.3 insects/bud, bean fly infestation on leaves was 55%, and flea beetle defoliation was 18%.

Bacterial wilt disease of cassava is of major importance and is widely distributed throughout the area. Downy mildew of corn, which is not ranked high by the farmers, was extremely important. More than 30% of corn plants were infested by this disease (Table 23c).

CONCLUSION

Most farmers still fear brown planthopper because of attacks on their rice crop several years ago. In fact, infestation by this insect has now already diminished through the use of resistant varieties and careful pest population monitoring.

Many rice diseases, such as grassy stunt, bacterial blight, etc. were unrecognized by farmers. Rice bug and green stink bug are very serious in Kedung Poh but were not ranked highly by farmers.

The situation was rather different for legume pests. Most farmers are aware of the key pests attacking their crops. The importance of flea beetle as defoliators, and bean fly and insects attacking the pod, were well recognized. Our field observation in Kedung Poh has shown to built up above the economic threshold if not carefully controlled, but unfortunately thrips and Empoasca were not mentioned by farmers.

The concept of integrated pest management (IPM) has been partially adopted and executed by some farmers, although still in a simple way. To combat a typical pest, they do not rely mainly on one control method, but use two or more pest control methods simultaneously, varietal resistance and insecticide spraying. Nevertheless, the implementation of the IPM concept by farmers needs to be improved to achieve better control.

The existing traditional pest control practised by many farmers will not hinder the introduction of modern pest control practices. In some cases existing non-chemical pest control was partially effective in diminishing the pest infestation.

Farmers seldom achieve adequate control of pests through the use of pesticide, because of the lack of pest recognition, the use of very low insecticide dosage, and lack of sprayer ownership.

The use of very low insecticide dosages arises from insufficient spray volume per hectare. Generally, farmers cannot follow the directions written on the package label, since the units used are mililiters per liter. For this reason, they use a standard tablespoon for measuring the amount of insecticide. One to two tablespoons of insecticide per a-10 to 15 liters sprayer capacity was used. Most farmers use a spray volume of less than 200 liters/ha, whereas the recommended dosages are based on spray volumes of 500 to 1.000 liters/ha. As a consequence, farmers use insecticide dosages of about one fifth of the recommended level (e.g. the recommended dosage for diazinon is 0.6 - 1.0 kg a.i./ha).

RECOMMENDATIONS

(1) Education of farmers through extension programs is badly needed, since many farmers still do not recognize and are unaware of insect pests and diseases attacking their food crops.

(2) The widespread use of existing technology, such as cultural, physical/mechanical, and traditional pest control methods, are not a hindrance to the introduction and adoption of better pest control practices.

(3) The problem of using very low dosages of insecticide can be solved as follows :

a. Chemical companies need to revise the directions written on the package label, for instance : measurement is based on number of tablespoonfuls of chemical per 10-liters. Mention must also be made of the number of loads needed to treat one hectare.

b. Field extension workers need to address and emphasize this problem in their extension program.

c. It has to be proven in the research station that the use of low spray-volume per hectare in conjunction with higher chemical concentrate in the water, will not be hazardous to crops if applied with conventional equipment.

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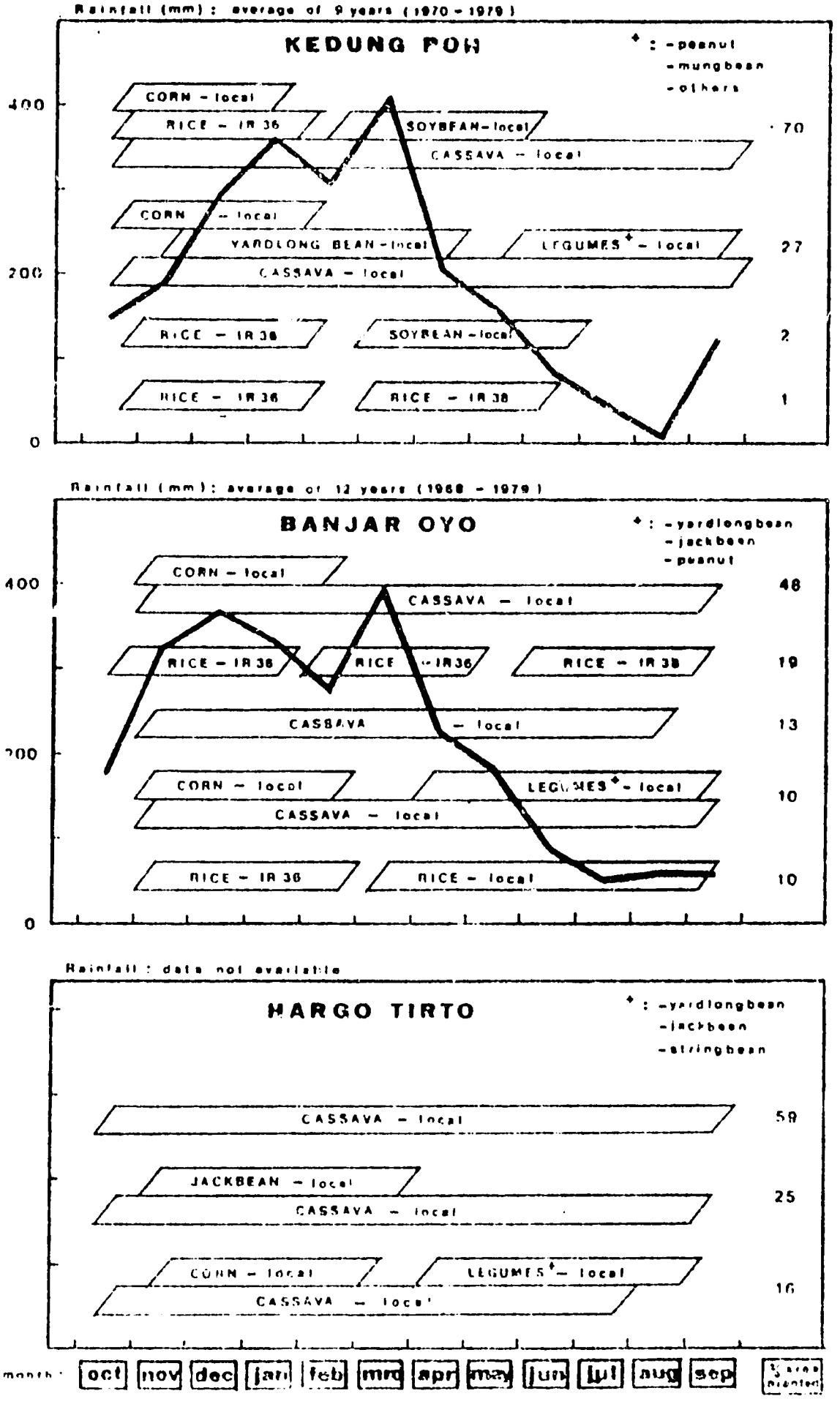


igure 1. Farmers cropping Pattern, Yogyakarta, CRIA 1980

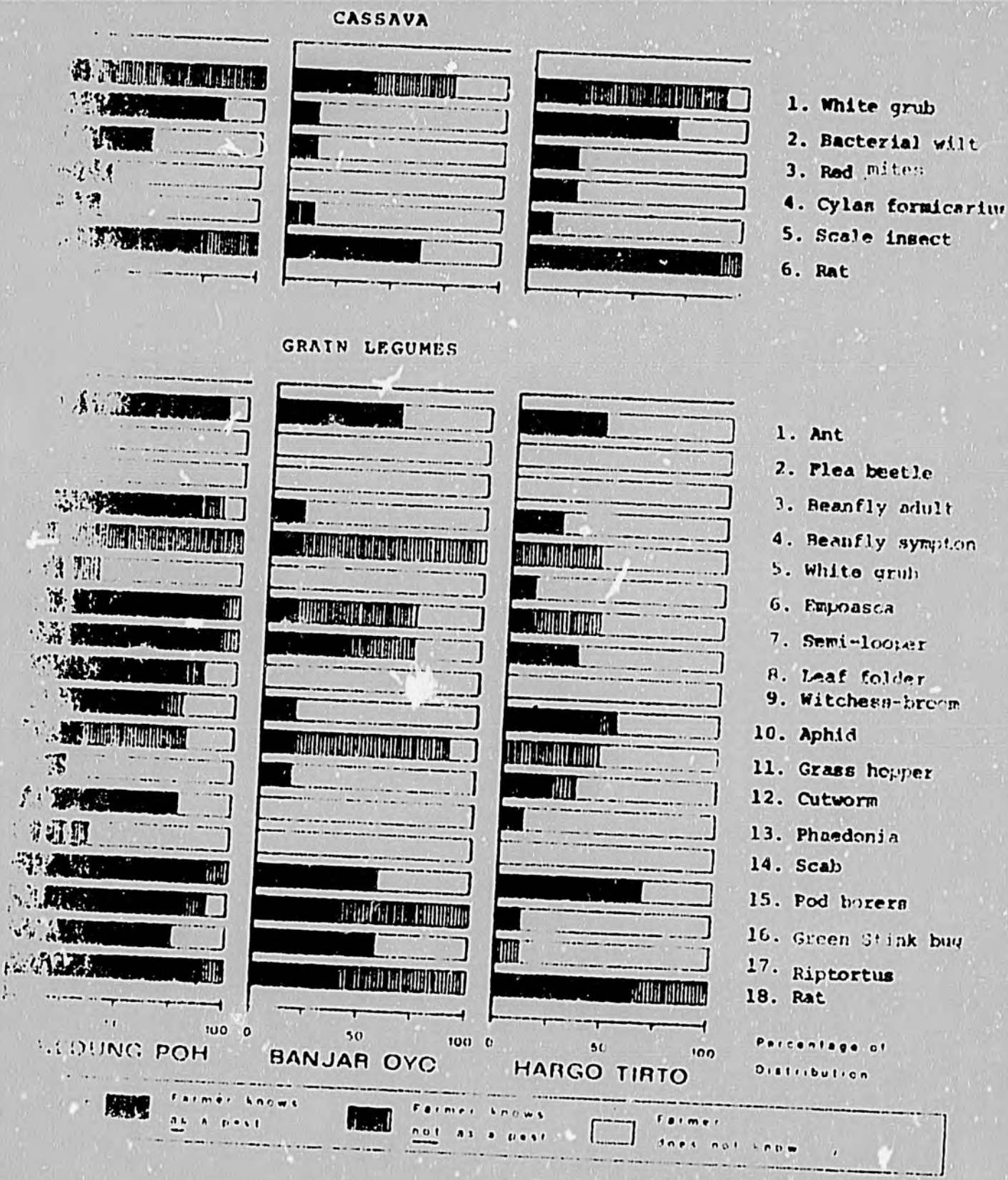
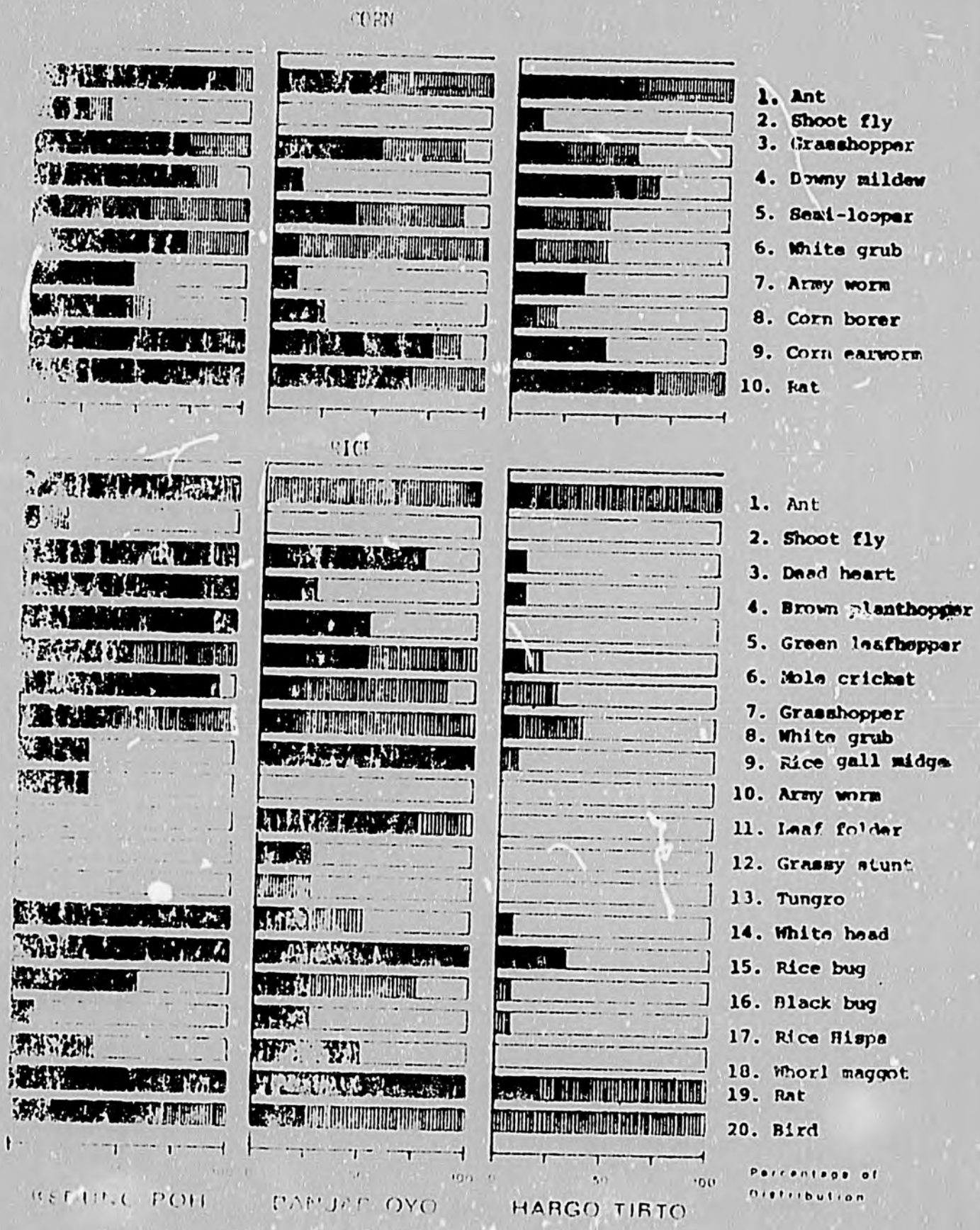


Figure 2a. Farmers Pests Recognition, Yogyakarta, CRIA 1980.



Farmers Pests , CRIA 1980

Table 1. Farmers' Constraint in Food Crops Production, Yogyakarta, CMIA 1980 [a]

	Gunung Kidul		Kulon Progo[b]				
	Kedung Poh		Banjar Cyo		Hrgo Tirto[c]		Mean
	Average	Range	Average	Range	Average	Range	(%)
Food crops planted	5.3	(3-6)	3.2	(2-6)	1.8	(1-4)	-
Constraints :	4.4	-	2.6	-	1.4	-	81
Pest or diseases	3.0	(1-6)	1.9	(0-5)	0.3	(0-2)	45
Other factors	1.4	(0-5)	0.7	(0-2)	1.1	(0-3)	36
No Constraint :	0.9	(0-4)	0.6	(0-3)	0.4	(0-4)	19

[a]Data based on interviews with 23 farmers in Kedung Poh, and 24 farmers each in Banjar Cyo and Hargo Tirto. [b]Kabupaten (district). [c]Desa (village). [d]Food crops namely : cereal crops (rice, corn), tuber-crops (cassava, sweet potato), and grain legumes (yardlong bean, jackbean, soybean, mungbean, peanut).

Table 2a. Farmers' First Rank Constraint in Food Crops Production Yogyakarta, CRIA, 1980

Crop	Kedung Poh (n_1 = 23)				Banjar Oyo (n_1 = 24)				Hargo Tirto (n_1 = 24)			
	n_2	Constraint (%)			n_2	Constraint (%)			n_2	Constraint (%)		
		Pests[a]	Not Pests	None		Pests[a]	Not Pests	None		Pests[a]	Not Pests	None
Cassava	23	57	30	13	24	71	12	17	24	12	67	21
Corn	23	48	30	22	24	46	37	17	4	25	50	25
Rice	22	82	14	4	14	79	21	-	-	-	-	-
Soybean	23	69	22	9	-	-	-	-	-	-	-	-
Peanut	18q	39	33	28	4	50	25	25	-	-	-	-
Sorghum	7	14	14	72	-	-	-	-	-	-	-	-
Yard long bean	-	-	-	-	3	67	-	33	6	17	66	17
Jackbean	3	67	33	-	5	20	-	80	3	-	33	67
Sweet potato	-	-	-	-	-	-	-	-	5	20	30	-
Mungbean	3	33	67	-	-	-	-	-	-	-	-	-

n_1 = total number of farmers interviewed in each village, n_2 = Number of respondent growing the corresponding crops.

[a]Pests including insects, diseases, rodents, and birds, but not weeds.

Table 3. Farmers' Panking of the Most Important Pests of Food Crops, Yogyakarta, CRIA,1980[a].

Rank	Kedung Poh (n = 6+2)[b]		Banjar Oyo (n = 8)		Hargo Tirto (n = 9)	
			CASSAVA			
1.	Bacterial Wilt	(1.3)[c]	Rats	(2.5)	Bacterial Wilt	(1.8)
2.	Scale-insects	(2.5)	Bacterial Wilt	(4.0)	Termitesi	(9.0)
3.	Red Mites	(4.5)	Scale-insects	(16.0)	Ants	(9.0)
4 .	Rats	(9.4)			Red Mites	(18.0)
					Scale-insects	(18.0)
			CORN			
1	Rat	(1.9)	Seedling maggot	(1.2)	Downy mildew	(6.3)
2	White Crub	(2.7)	Downy mildew	(1.4)	Cricket	(6.8)
3	Downy mildew	(4.0)	Corn earworm	(3.5)	Corn earworm	(8.0)
4	Corn earworm	(4.7)	Wild pig	(7.0)	Aphid	(9.0)
5	Crazzy corn	(5.3)	Rat	(14.0)	Giant snail	(9.0)
6	Bird	(9.1)	Ant	(14.3)	Armyworm	(18.0)
7	Termites	(13.7)	Rust	(30.0)	Ant	(18.0)
8	Ant	(16.0)			Seedling maggot	(18.0)
9	Semi-looper	(18.2)			Grasshopper	(36.0)
10					Rat	(45.0)
11					Semi-looper	(45.0)
12					Crazzy corn	(54.0)

Table 3. (continued)

Rank	Kedung Poh (n=6+2)		Banjar Oyo (n=8)		Hrgo Tirto (n=9)	
			YARDLONG BEAN/JACKBEAN			
1	Riptortus linearis	(4.5)	Aphid	(1.2)	Flea beetle	(4.5)
2	Bean fly	(6.0)	Grasshopper	(4.7)	Aphid	(5.1)
3	Rat	(6.0)	Green stink bug	(7.0)	Bean fly	(6.0)
4	Aphid	(6.0)	Riptortus linearis	(7.0)	Pod borer	(9.0)
5	Pod borer	(12.0)	Defoliators	(7.0)	Ant	(9.0)
6	Lady beetle	(12.0)	Ant	(8.7)	Armyworm	(22.5)
7	Green stink bug	(18.0)	Pod borer	(10.5)	Green stink bug	(36.0)
8					Leaf folder	(54.0)
9					Semi-looper	(72.0)
			SOYBEAN			
1	Phaedonia inclusa	(1.4)	Not planted		Not planted	
2	Aphid	(2.0)				
3	Green stink bug	(3.4)				
4	Semi-looper	(5.2)				
5	Pod borers	(7.1)				
6	Rat	(7.3)				
7	Riptortus linearis	(10.2)				
8	Leaf folder	(10.5)				
9	Fowl	(13.7)				

Table 3. (continued)

Rank	Kedung Poh (n=6+2)		Banjar Oyo (n=8)	Hargo Tirto (n=9)
			PEANUT	
1	Rat	(1.5)	Not planted	Not planted
2	Witchess broom	(2.9)		
3	Termites	(6.8)		
4	Damping-off	(7.2)		
5	Ant	(11.4)		
6	Cercospora leaf spot	(12.0)		
7	Fowl	(13.7)		
8	White grub	(17.3)		
9	Green stink bug	(18.0)		
			MUNGBEAN	
1	*Riptortus linearis*	(2.3)	Not planted	Not planted
2	Rat	(4.6)		
3	Green stink bug	(6.8)		
4	Black bean Aphid	(9.1)		
5	Scab	(13.7)		

Table 3. (continued)

Rank	Kedung Poh (n=6+2)		Banjar Oyo (n=8)		Hargo Tirto (n=9)
			RICE		
1	Brown planthopper	(1.4)	Brown planthopper	(1.4)	Not planted
2	White grub	(2.9)	Rat	(3.1)	
3	Rat	(4.7)	Rice bug	(3.8)	
4	Rice bug	(5.4)	Fowl	(4.0)	
5	Green stink bug	(8.5)	Case worm	(5.0)	
6	White head	(10.6)	Whorl maggot	(6.0)	
7	Mole cricket	(12.0)	Leaf folder	(6.0)	
8	Green leafhopper	(12.0)	Stemborer	(6.7)	
9	Bird	(13.2)	Green stink bug	(8.8)	
10	Dead heart	(14.0)			
11	Grasshopper	(22.8)			
12	Semi-looper	(27.3)			
13	Ant	(30.0)			
14	Fowl	(31.2)			

[a]Data based on interview in the three pilot-project villages.
[b]n = number of farmers.
Six individual farmers and two farmers' groups were interviewed in Kedung Poh.
[c]Based on their experience, farmers were asked to rank the importance of the pest (1,2,3,4,.... etc.). Number within parentheses indicated the index of importance Lower number denotes greater importance (Litsinger, et al. 1978).

Table 4. Farmers' Control Methods for Each Pest, Yogyakarta, CRIA 1980[a]

Name of pests	Control Method		
	Kedung Poh (n=6+2)	Banjar Oyo (n=7)	Hargo Tirto (n=9)
	CASSAVA		
Bacterial wilt	- pruning - none	- none	- removing then burning infested plants.
Scale-insects	- limestone or hand rubbing-off - wash with water	- none	- none
Rat	- none	- none	
Red-mites	- none		- none
Termites			- none
	CORN		
Rat	- baiting - digging out burrows - sulphur fuming - mass round up	- none	- none
White grub	- insecticide spray		- none
Grasshopper		- removing-infested plants	removing infested plants
Seedling maggot			

...ued)

Control Method		
Kedung Poh (n=6+2)	Banjar Cyo (n=7)	Hargo Tirto (n=9)
- insecticide spray to the soil	- none	- none
- insecticide spray - removing infested plants	- removing infested plants	- removing infested plants
- insecticide spray to the soil		
		- insecticide spray - collecting
- killing the larvae (during processing)	- none	- killing the larvae (during processing)
- drowning infested ear at harvest		- none
- dispeling		
- insecticide spray		- none
	none	
	none	

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Table 4. (continued)

Name of pests	Control Method		
	Kedung Poh (n=6+2)	Banjar Oyo (n=7)	Hargo Tirto (n=9)
		GRAIN LEGUMES	
Phaedonia inclusa	- insecticide spray - ash scattering[c]		
Piptortus linearis	- insecticide spray	- insecticide spray	
Bean fly	- none		- none
Aphid	- insecticide spray - ash scattering on leaves	- none	- insecticide spray
Rat	- insecticide spray - zinc phosphide baits		
Green stink bug	- insecticide spray	- insecticide spray	- none
Pod borer	- killing the larvae (during processing)	- insecticide spray	- killing the larvae (during processing)
Semi-looper	- insecticide spray - handpicking	- insecticide spray	- none
Leaf folder	- insecticide spray - handpicking		- removing infested leaves
Grasshopper		- none	
Flea beetle			insecticide spray

Table 4. (continued)

Name of pests	Control Method		
	Kedung Poh (n=6+2)	Banjar Oyo (n=7)	Hargo Tirto (n=3)
White grub	- Seed dressing[d] - handpicking - use salt		
Termites	- insecticide spray to the soil		
Witchess brom	- removing infested plants		
Damping-off	- insecticide spray - removing infested plants		
Cercospora leafspot	- leaves cutting		
Ant	- insecticide spray to the soil - use kerosene, ratio 1 : 8	- none	- ash scattering on the soil
Fowl	- shout dispel - use bamboo fence		
Armyworm			- handpicking
		RICE	
Brown planthopper	- insecticide spray	- insecticide spray	- not planted
Caseworm		- none	

Table 4. (continued)

Name of pests	Control Method		
	Kedung Poh (n=6+2)	Banjar Oyo (n=7)	Hargo Tirto (n=9)
White grub	- seed treatment with a kerosene and DDT mixture - handpicking - scattering of salt[f] - flooding		Not planted
Rat	- baiting - digging out burrows - sulphur fuming - mass round up	- baiting	
Mole cricket	- insecticide spray		
Green leafhopper	- none		
Dead heart	- insecticide spray	- insecticide spray - ash scattering	
Grasshopper	- insecticide spray		
Semi-looper	- insecticide spray		
Ant	- insecticide spray to the soil - burning the ant-hill - seed dressing[e]		
Leaf folder		- none	
White head	- insecticide spray - removing infested tillers	- insecticide spray	

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Table 4. (continued)

Name of pests	Control Method		
	Kedung Poh (n=6+2)	Banjar Oyo (n=7)	Hargo Tirto (n=9)
Rice bug	- insecticide spray - use fresh crab or frog as attractant	- insecticide spray	
Green stink bug	- insecticide spray - use fresh crab or frog as attractant	- insecticide spray	
Bird[g]	- use net-string - sound dispel with bamboo-sticks		
Fowl	- dispeling - use bamboo-fence	- none	

[a]Data based on interview in the three pilot-project villages

[b]Insecticides were used in every spraying. Brand name used depends upon the availability in the local market. Frequently used insecticides were : Sevin, Diazinon, Endrin, Mipcin, DDT, Nogos, Dieldrin, and a rodenticide, Zinc Phosphide.

[c]Ash is used for dual purposes, insect control and increase the soil fertility. The amount used is 1,500 kg/ha, with a total cost of Rp. 12,500.00 (US$20.00).

[d]Mixture of dieldrin, kerosene and water is used for seed dressing.

[e]Used only for upland rice, 1 kg seed + 1 teaspoon Sevin or DDT mixed waterless.

[f]Salt was applied when rice is two month old. The amount used is 100 kg/ha, a total cost of Rp. [illegible] 000.00 (US$[illegible] 0).

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Table 5. A Mechanical and Physical Methods of Pest Control Practised by Farmers, Yogyakarta, CRIA, 1980.

Method	Kedung Poh (n=6+2)				Banjar Oyo (n=9)				Hargo Tirto (n=9)			Mean (%)
	% - Farmers											
	Rice	Corn	Legume	Tuber crops	Rice	Corn	Legume	Tuber	Corn	Legume	Tuber crops	
Insect handpicking	42	92	100	42	22	56	44	33	78	78	78	62
Cutting rice seedlings	25	-	-	-	-	-	-	-	-	-	-	13
Sticker-board[a]	9	9	9	9	-	-	-	-	-	-	-	3
Rat-trap	9	9	31	-	22	11	11	11	-	-	-	10
Digging out rat burrows	84	59	92	25	22	33	33	33	22	-	22	39
Mass round-up	84	25	25	25	22	-	-	-	-	-	-	21
Bird scare-crows	70	-	-	-	22	-	-	-	-	-	-	46
Flags for birds	70	-	-	-	11	-	-	-	-	-	-	41
Bamboo- sticks sound[b]	75	-	-	-	11	-	-	-	-	-	-	43
Dipping[c]	-	-	-	-	11	-	-	-	-	-	-	6

[a]Made of natural glue

[b]Used for birds, local name : Koplok

[c]Use insecticide.

Table 6. Cultural Methods of Pest Control Practised by Farmers, Yogyakarta, CRIA, 1980.

Method	Kedung Poh (n=6+2)				Banjar Oyo (n=9)				Hargo Tirto (n=9)			Mean (%)
	%-Farmers											
	Rice	Corn	Legume	Tuber crops	Rice	Corn	Legume	Tuber crops	Corn	Legume	Tuber crops	
Removing infested plants	84	92	92	75	11	67	44	33	44	44	56	58
Adjusting date of planting time	25	25	25	25	33	22	-	11	-	-	-	18
Synchronizing planting with neighbors	50	34	34	34	22	22	-	11	-	-	-	20
Crop rotation	-	-	62	-	11	-	-	-	-	-	-	24
Flooding/draining field	25	-	-	-	22	-	-	-	-	11	-	19

Table 7. Traditional Methods of Pest Control Practised by Farmers, Yogyakarta, CRIA, 1980.

Method	Kedung Poh (n=6+2)				Banjar Oyo (n=9)				Hargo Tirto (n=9)			Mean (%)
	%-Farmers											
	Rice	Corn	Legume	Tuber crops	Rice	Corn	Legume	Tuber crops	Corn	Legume	Tuber crops	
Place food in the field[a]	31	22	22	22	11	11	-	11	-	-	11	15
Unl ucky planting date[b]	67	67	67	67	56	67	67	67	44	44	44	58
Use of kerosene	45	45	45	17	-	-	-	-	-	-	-	13
Use of salt	37	9	-	9	11	-	-	-	22	22	22	17
Use of ash	17	17	75	17	22	-	-	-	22	22	22	25
Recite prayers	-	-	-	-	11	-	-	-	33	33	33	15
Use of fresh frog or crab[b]	-	-	-	-	33	-	-	-	-	-	-	17
Use plant parts in field[c]	-	-	-	-	-	-	-	-	11	-	-	10

[a]A mixture of spiced-rice with safforn (Curcuma domestica) and legumes. Other kind is place rice with boiled eggs at harvest time.

[b]Most commonly they refer to the dead-date of their parents and/or parent-in-law.

[c]Place four pieces of palm leaves (Salacca edulis) in the corner.

Table 8. Varieties Resistant to each Pest listed by Farmers, Yogyakarta, CRIA, 1980a

Village	Brown planthopper		Rice stemborers		Rice gallmidge		Downy mildew		Mean (%)
	%-Farmer know	Variety	%-Farmer know	Variety	%-Farmer know	Variety	%-Farmer know	Variety	
Kedung Poh (n=6+2)	80	IR 28 IR 32 IR 36 IR 38	0	-	0	-	22	Perta Antang	26
Banjar Oyo (n=9)	22	IR 36 IR 38	22	Krentul Andel-abang Rojolele	11	IR 5	11	Jagung-kuning Genjah-Kertas	
Hrgo Tirto (n=9)	0	-	0	-	0	-	0	-	
Mean (%)	51		11		6		11		

[a]Almost all farmers know the cassava varieties which are resistant to Bacterial wilt disease (Pseudomonas solanacearum). According to them, all local varieties they familiarized are resistant to this disease, except the yellowish, sweet and good-tasting : Mentega variety.

Table 9. Farmers' Recognition of Natural Enemies, Yogyakarta, CRIA 1980.

Natural Enemy	%-Farmers Know										Mean (%)
	Kedung Poh (n=6+2)					Banjar Oyo (n=8)		Hargo Tirto (n=9)			
	Ant	Rat	Bug	Grass-hopper	Cater-pillar	Rat	Cater pillar	Rat	Ant	Cater pillar	
Cat	-	100	-	-	-	100	-	100	-	-	100
Snake	-	59	-	-	-	25	-	33	-	-	39
Dog	-	42	-	-	-	25	-	-	-	-	14
Bird	25		25	9	42	-	38	-	-	22	28
Fowl	25	-	25	9	25	-	-	-	22	11	13
Caterpillar	25	-	-	-	-	-	-	-	-	-	-

Table 10. Role of Natural Enemies in Controlling Pests, Yogyakarta, CRIA 1980.

Opinion	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=8)	Hargo Tirto (n=9)	
Believe	73	58	50	72
Do not believe	32	17	50	28

Table 11a. Mean pesticide usage on a crop basis, Yogyakarta, CRIA 1980.

	Rice	Soybean	Corn	Peanut	Sweet potato	Yardlong bean
General pesticide usage						
%-farmers use	80	78	12	17	7	22
Usage pattern						
irregularly (%)	14	11	8	20	0	0
regularly (%)	86	89	92	80	100	100
Frequency and time of spray						
one-application (%)	25	28	59	40	100	none
time of spraying: (I) (WAP) - (range)	7 (2-11)	4 (2-6)	3 (-)	3 (2-4)	2 (-)	
two-application (%)	41	50	25	40	none	50
time of spraying: (I) (WAP) - (range)	4 (3-6)	3 (2-6)	3 (3-4)	3 (3-4)		1 (-)
(II)	9 (5-11)	7 (3-10)	6 (5-9)	6 (5-9)		6 (-)
three-application (%)	20	11	8	none	none	50
time of spraying: (I) (WAP) - (range)	3 (1-4)	2 (1-3)	1 (-)			2 (-)
(II)	5 (3-9)	4 (3-6)	3 (-)			4 (-)
(III)	9 (6-11)	6 (4-9)	6 (-)			6 (-)

WAP = week after planting

Table 11a. Mean pesticide usage on a crop basis, Yogyakarta, CRIA, 1980.

	Rice	Soybean	Corn	Peanut	Sweet potato	Yardlong bean
General pesticide usage						
%-farmers use	80	78	12	17	7	22
Usage pattern						
irregularly (%)	14	11	8	20	0	0
regularly (%)	86	89	92	80	100	100
Frequency and time of spray						
one-application (%)	25	28	59	40	100	none
time of spraying: (I) (WAP) - (range)	7 (2-11)	4 (2-6)	3 (-)	3 (2-4)	2 (-)	
two-application (%)	41	50	25	40	none	50
time of spraying: (I) (WAP) - (range)	4 (3-6)	3 (2-6)	3 (3-4)	3 (3-4)		1 (-)
(II)	9 (5-11)	7 (3-10)	6 (5-9)	6 (5-9)		6 (-)
three-application %)	20	11	8	none	none	50
time os spraying: (I) (WAP) - range)	3 (1-4)	2 (1-3)	1 (-)			2 (-)
(II)	5 (3-9)	4 (3 6)	3 (-)			4 (-)
(III)	9 (6-11)	6 (4-9)	6 (-)			6 (-)

WAP = week after planting

Table 12. Source of Pesticide Use Information, Yogyakarta, CRIA, 1980.

Source	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Field extension worker	100 (1.6)	44 (4.5)	11 (27.0)	52
School on the air (radio programme)	100 (2.0)	44 (4.5)	11 (9.0)	52
Pesticide Distributor	56 (6.8)	22 (6.8)	11 (9.0)	30
Neigbors	42 (5.8)	33 (8.2)	22 (4.5)	32
Self-learning	47 (9.6)	22 (11.4)	22 (6.8)	30
Leaflets/booklets	9 (24.0)	-	-	3
Extension film and slides	9 (48.0)	-	11 (18.0)	.7)

Number within parentheses indicated the index of importance. Lower number denotes greater importance (Litsinger, et al., 1978).

Table 13. Farmers' Decision in Method of Insecticide Application, Yogyakarta, CRIA, 1980

	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Calandar system (prophylactic)	31	11	-	14
Observe the pest	23	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Table 14. Constraints in Implementing Chemical Control, Yogyakarta, CRIA, 1980.

	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Lack of money	67 (3.0)	33 (3.9)	11 (9.0)	37
Lack of sprayer	75 (3.1)	33 (7.0)	11 (9.0)	40
Pesticide intended not available in the local market	59 (3.8)	22 (9.1)	44 (2.8)	42
Pesticide not effective	17 (24.0)	-	-	6
Lack of technology	-	11 (45.4)	-	4
Others	-	11 (27.0)	-	4

Number within parentheses indicated the index of importance. Lower number denotes greater importance (Litsinger, et al., 1978).

Table 15. Source of Cash to Purchase Pesticide, Yogyakarta, CRIA, 1980.

	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Own cash	50 (2.4)	100 (1.0)	83	78
"Bimas" credit	30 (4.4)	16 (2.5)	-	15
Borrowed from neighbors	20 (15.0)	32 (7.8)	17	23
Family saving	-	16 (25.0)	-	5

Number within parentheses indicates the index of importance. Lower number denotes greater importance (Litsinger, et al., 1978).

Table 16. Time of Insecticide Spraying, Yogyakarta, CRIA, 1980[a].

	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Morning	54	84	44	60
Noon	6	-	11	6
Afternoon	40	16	45	34

[a]Depends upon many factors, often on the technical factors (i.e. wind velocity, dew, avoid sunshine hazard, drift, etc.) [illegible]

Table 17. Farmers' Opinion on the Use of One-half of Normal Dose in Spraying, Yogyakarta. CRIA, 1980.

Result	% Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
No difference from lethal dose	2	33	44	26
Kills only one half the number	27	17	11	18
No control	42	33	11	29
Do not know	29	17	34	27

Table 18. Mode of Action of Pesticide According to Farmers, Yogyakarta, CRIA, 1980.

	% Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=9)	Hargo Tirto (n=9)	
Fumigant	32	11	8	17
Stomach poison	14	22	54	30
Contact poison	15	22	15	17
Repellent	5	11	15	10
Do not know	34	33	8	26

Table 19. Precautionary in Using Pesticide, Yogyakarta, CRIA, 1980.

	%-Farmers			Mean (%)
	Kedung Poh (n=6+2)	Banjar Oyo (n=6)	Hargo Tirto (n=9)	
Use mask during spraying	84	33	50	56
Feel dizzy after spraying	15	-	17	11
Fear on certain pesticide	51	50	83	61

Table 20. Spray volume, Yogyakarta, CRIA, 1980.

	%-Farmers	Volume liter/ha	Range (liters)	Categorizing
Kedung Poh (n=6+2)	37	50	40 - 70	Spray volume:
	63	100	90 - 135	/ 100 : 33%
Banjar Oyo (n=8)	11	60	-	100 - 200 : 33%
	44	220	200 - 250	200 - 250 : 26%
Hargo Tirto (n=9)	11	40	30 - 70	
Mean		96	30 - 250	

Table 21. Insecticide Dosage

Brand	Dose in kg a.i./ha			
	Kedung Poh	Banjar Oyo	Hargo Tirto	Mean Dosage
Endrin 19.2 EC	0.01 - 0.08	0.01 - 0.14	0.01 - 0.02	0.02
DDT 50 WP	0.02 - 0.17	0.03 - 0.32	0.02 - 0.04	0.07
Sevin 85 SP	0.04 - 0.29	0.05 - 0.54	n.a.	0.24
Diazinon 60 EC	0.03 - 0.24	0.04 0.44	0.02 - 0.05	0.13
Nogos 50 EC	0.02 - 0.20	0.04 - 0.36	n.a.	0.15
Mipcin 50 WP	0.02 - 0.17	0.03 - 0.32	n.a.	0.14

n.a. - not available in the village.

Table 22. Farmers Preference for Insecticide Formulation, Yogyakarta, CRIA, 1980.

Formulation	Kedung Poh (n=6+2)		Banjar Oyo (n=9)		Hargo Tirto (n=9)		Mean (%)	
	%-Farmers							
	Know	Prefer	Know	Prefer	Know	Prefer	Know	Prefer
Liquid	100	53	22	11	22	0	45	21
Wetatble powder	100	47	22	0	22	22	43	23
Granule	0	-	0	-	0	-	0	-

Table 23a. Field Observation of Insect Pests and Diseases in Kedung Poh Village.

Crop	Name of Pests and Diseases Existed	Severity
Soybean	Bean fly	1.5 adults/100 plants at 2 DE
	Defoliation	10% (at 6 DE)
	Empoasca	abundant
	Thrips	abundant
Peanut	Pod-borer	0% (from 107 pegs)
Cassava	*Tetranychus bimaculatus*	few
Corn (earvested)		
Rice (harvested)		

[a]Most of crops grown in this village were already harvested about 3 weeks before this problem-focussed survey was launched.

Table 23b. Field Observation of Insect Pests and Diseases in Banjar Oyo Village.

Crop	Name of pests and diseases existed	Severity
Lowland rice (Ripening stage) (IR 36)		
	Rice bug	6.7 bugs/sq.m. (range 2-16)
	Green Stink Bug	1.4 bugs/sq.m. (range 0-2)
	Spider	abundant
Yardlong Bean	White Head (T. incertulas)	/ 1%
	Riptortus linearis	few
Kecipir Split-pea (Cajanis cajan)	Thrips	100 adults/30 flowers (range 0-14/flower)
Chili	Thrips	47 adults/30 buds (range 0-5/bud)
Corn	Semi-looper	/ 1%
	Mantidae	few
	Grasshopper	/ 1%
	Coccinella sp	/ one beetle/25 plants
	Sheath Blight	/ 1%
	Spide	few
	Corn-borer infestation	/ 1%
	Corn-earworm infestation	/ 1%
	Downy Mildew	/ 1%
	Melamphaus faber	few

Table 23c. Field Observation of Insect Pests and Diseases in Hargo Tirto Vilaage.

Crop	Name of Pest and Diseases Existed	Severity
Yardlong Bean		
	Thrips palmi	40 adults/30 buds (range 0-7/bud)
	Bean fly : Infested plants	90%
	Infested leaves	55%
	Black Bean Aphid	Rating 5.4 (range 1-9)
	Empoasca	abundant
	Chilomenes sexmaculata	4 beetle/10 plants
	Flea-beetle defoliation	18%
	Leaf-miners	9 tunnels/19 plants
	Riptortus linearis	few
	Nezara sp	few
Peanut		
	Leaf-miners	few
	Aphid	abundant
Cassava		
	Termites	few
	Jamur upas	few
	Tetranychus bimaculatus	few
	Phytopthires	abundant
Sweet-potato	*Cylas formicarius*	few
Corn		
	Downy mildew infestation	32%
	Aphid	Rating 3
	Coccinella sp	$\angle$ 1/25 plants
	Corn-borer infestation	$\angle$ 1%
	Crazzy-corn	$\angle$ 1%
	Semi-looper	$\angle$ 1%
	Army-worm	$\angle$ 1%

Table 24. Pest Associated Terminology in the Local Dialect, Yogyakarta, CRIA, 1980.

Common/Scientific name	Indonesian name	Local name
Armyworm/cutworm	Ulat grayak	ular geni
Mole cricket	Anjing tanah	orong-orong
Termites	Rayap	rayap kuning
White grub	Uret	uret
Brown planthopper	Wereng coklat	rengit
Dead heart	Sundep	sundep, ingser
Rice bug	Walang sangit	uyuh
Phyton	Ular sawah	uwi
White head	Beluk	sundep
Bamboo-fence for fowl	Pagar bambu	gripik
Empty panicles	Malai hampa	gabuk
Aphid	Kutu daun	remis
Phaedonia inclusa	Wereng kedelai	ndulun
Riptortus linearis		ayang-ayang
Pod borer	Penggerek polong	krewek
Green stink bug	Kepik hijau	lembing hijau/biru
Semi-looper	Ulat jengkal	ular centing
Witches-broom	Sapu setan	daun berintik
Defoliation	Kerusakan daun	complong-complong
Downy mildew of corn	Bulai	mentek
Scale insects		banci
Bacterial wilt disease of cassava	Penyakit layu	plek

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DEVELOPING INSECT CONTROL RECOMMENDATIONS FOR IMPROVED CROPPING PATTERNS AT THE PHILIPPINE GOVERNMENT SECOND RURAL DEVELOPMENT-LAND SETTLEMENT CROPPING SYSTEMS SITES IN AGUSAN DEL SUR, BUKIDNON AND CAPIZ PROVINCES, 1978-80

The Second Rural Development-Land Settlement Cropping Systems sites of the Philippine government formed their research teams in 1977-78. The three sites, known as the ABC sites, are located in 1) Del Monte, Talacogon, Agusan del Sur province, 2) Pangantucan, Bukidnon province, and 3) Astorga, Dumarao, Capiz province. The first two sites are in Eastern and Central Mindanao and the third site is in North Central Panay island, Visayas Central Philippines.

The cropping systems teams work in management units called Agricultural Service Centers (ASC) under the leadership of an experienced agriculturist - the ASC director. The ASC has both research and extension functions.

The research team leader is a site coordinator usually an agronomist with experience who has responsibility for cropping pattern trials. The teams are composed of researchers for varietal testing, fertilizer, weed control, insect control,economics, and a horticulturalist or plantation crop agronomist.

The research team shares one jeep and several motorcycles. They are mostly recent graduates from regional agricultural schools who are attracted by the salary bonuses which are incentives for living in these rural locations.

The Philippine government National Food and Agricultural Council (NFAC) coordinates the agricultural research at the sites through its office in Quezon City, Metro Manila. A liaison scientist from IRRI

(International Rice Research Institute) through monthly visitations to the sites also supervises research direction.

Each year the ASC teams from three sites meet together to review research results and to plan experiments for the coming year.

The following data set - a compilation of tables - was taken from the working papers presented at the meetings for 1978-80. The tables show the progress made over the first three years (due to funding problems very little research was done the first year). The five year projects have two more years of research before the final recommendations will be made.

This data set is of interest in that it shows what a dedicated team, working under adverse conditions (funding problems and remoteness) most of the time, can do on their own with little supervision from outside.

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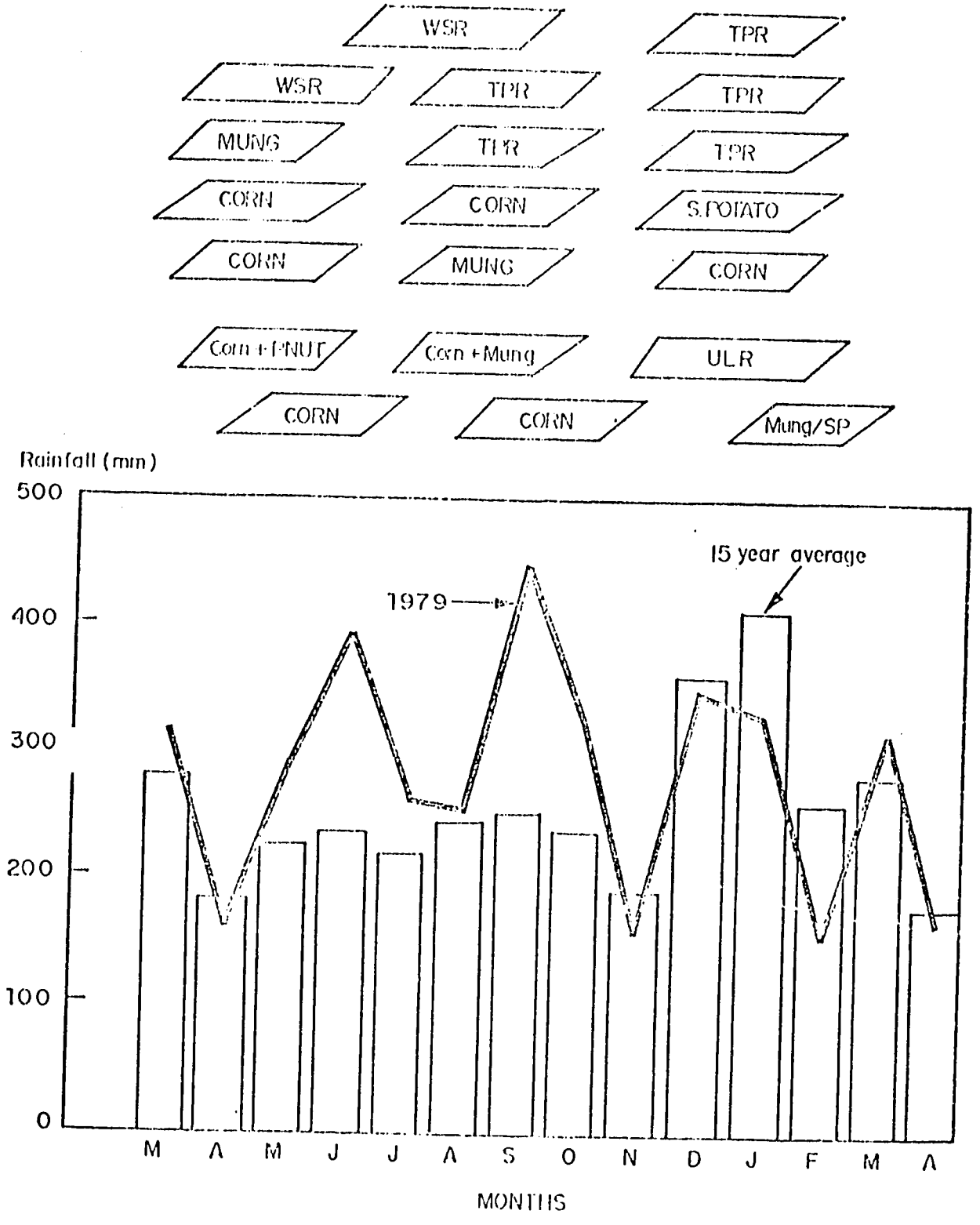

Fig. 1. Alternative cropping patterns to be tested graphed against the 15-year average monthly rainfall and 1979 monthly rainfall distribution, Agusan del Sur Settlement Project, 1979.

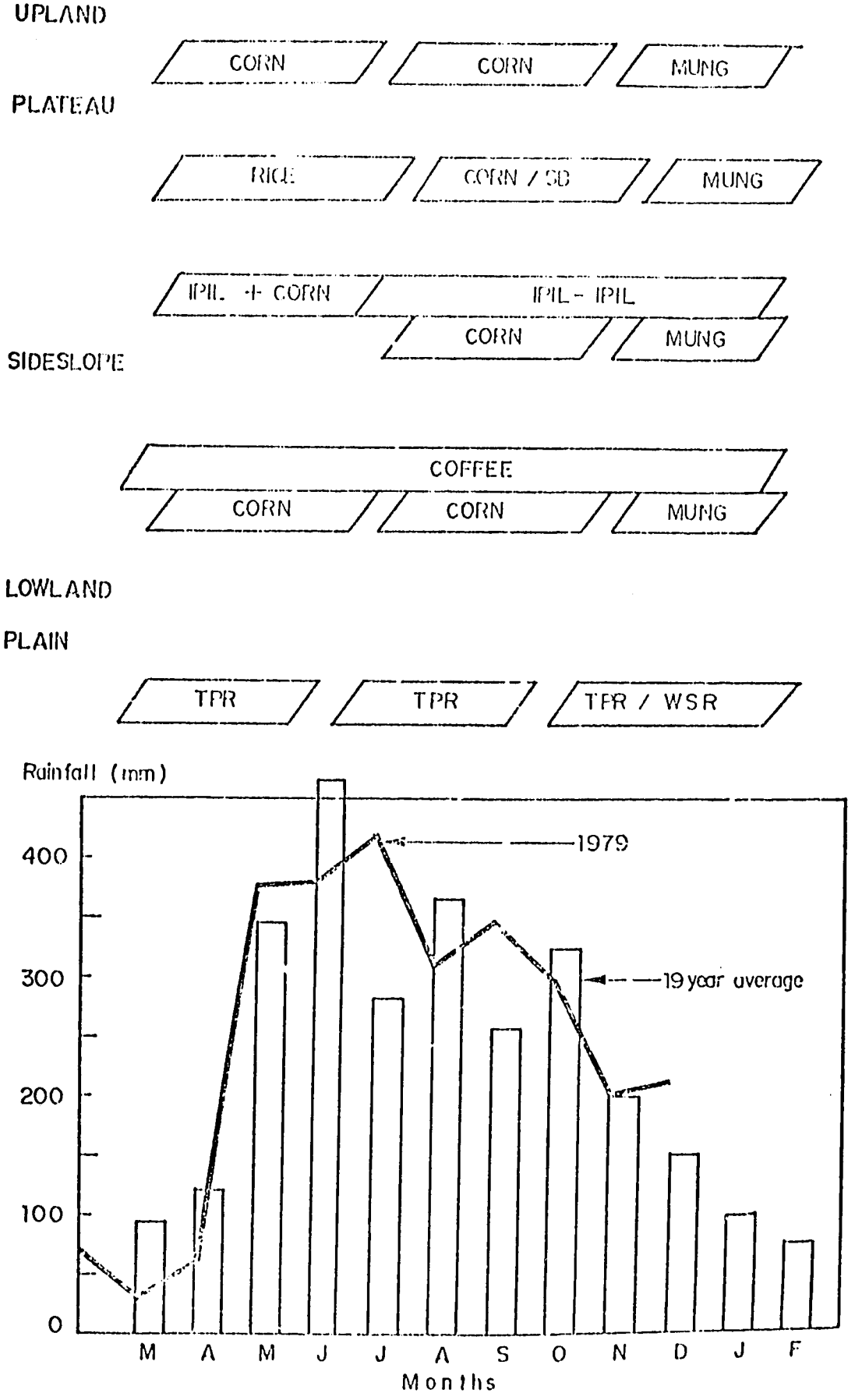

Fig. 2. Alternative cropping patterns to be tested graphed against the average monthly rainfall distribution. Bukidnon Settlement.

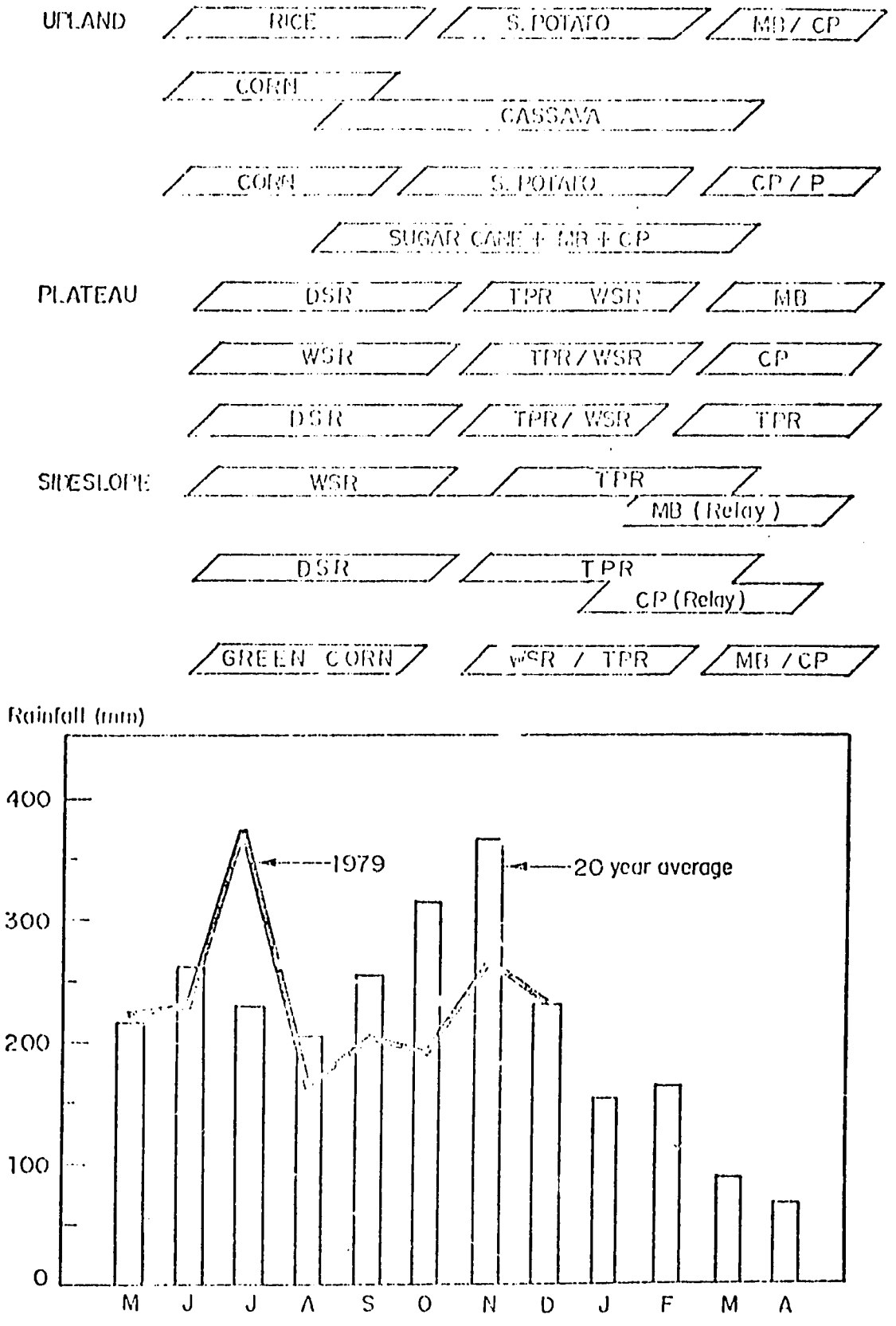

Fig. 3. Alternative cropping patterns to be tested graphed against the 20 years average monthly rainfall and 1979 monthly rainfall distribution, Capiz Settlement Project.

Table 1. Determination of an optimal chemical insect control recommendation for first crop irrigated transplanted IR36 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Del Monte, Talacogon, Agusan del Sur province, Mindanao, Philippines. January - April 1980.

Whorl maggot (grade)[b] 30-35 DT	Caseworm[c] (% cut leaves) 30 DT	Stem borer (%)[d] Deadhearts 45-55 DT	Stem borer (%)[d] Whiteheads	Yield[e] (t/ha)
Complete protection: seedbed - 1.5 kg ai carbaryl WP/ha 7, 14 DE; vegetative - 1 kg ai carbofuran G/ha before transplanting; reproductive- 1.5 kg ai Brodan EC/ha 35, 45 DT; ripening - 1.5 kg ai carbaryl WP/ha milky stage				
3.8 a	1.0 ab	0.7 a	0.8 a	6.40 ab
Omit seedbed protection				
4.2 a	1.0 ab	0.7 a	0.8 a	6.41 ab
Omit vegetative protection				
5.1 a	1.6 c	0.7 a	0.8 a	5.76 bc
Omit reproductive protection				
4.7 a	1.0 ab	0.7 a	0.7 a	5.80 bc
Omit ripening protection				
4.1 a	1.1 ab	0.7 a	0.7 a	5.88 bc
Untreated control				
5.4 a	1.4 bc	0.8 a	1.1 a	4.87 c
Recommended practice: 1.5 kg ai carbaryl WP/ha 7, 14 DE (seedbed), 1 kg ai carbofuran G/ha before transplanting, 1.5 kg ai Brodan EC/ha 35, 45 DT				
3.4 a	1.0 ab	0.7 a	0.7 a	7.46 a
Alternative practice: 1 kg ai diazinon G/ha broadcast 5 DT plus economic threshold				
4.0 a	0.8 a	0.7 a	0.7 a	6:01 b

[a]Av. of 3 fields (replications). DE = days after crop emergence. DT = days after transplanting. In a column, means followed by a common letter are not significantly different by DMRT. Carbaryl (Sevin 85 WP), carbofuran (Furadan 3 G) soil incorporated, Brodan 31.5 EC (20% chlorpyrifos + 11.5% BPMC), diazinon (Basudin 10 G).

[b]*Hydrellia sasakii*: 1-9 scale per-plot estimate on damaged leaves - 1 <1%, 3 = 2-5%, 5 = 6-25%, 7 = 26-50%, 9 = 51-100%.

[c]*Nymphula depunctalis*: 20-hill sample. DMRT $P < 0.01$.

[d]*Scirpophaga incertulas*: 5-m^2 sample.

[e]DMRT. $P < .05$

Table 2. Determination of an optimal insect control recommendation for second crop irrigated wet-seeded IR36 rice using the partitioned growth yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program, Del Monte, Talacogon, Agusan del Sur province, Mindanao, Philippines, July - November, 1979.

Whorl maggot[b] (grade) 35 DE	Yield (t/ha)
Complete protection: vegetative - 1.5 kg ai carbofuran G/ha before sowing; reproductive - 0.75 kg ai monocrotophos EC/ha 35, 45 DE; ripening - 1.5 kg ai carbaryl WP/ha 65 DE	
2.0	5.2 a
Omit vegetative protection	
3.3	5.2 a
Omit reproductive protection	
2.4	4.8 a
Omit ripening protection	
2.2	5.3 a
Untreated control	
3.5	4.5 a
Recommended practice: 1 kg ai carbofuran G/ha before transplanting plus economic threshold	
2.1	5.0 a

[a]Av. of 4 fields. DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G) soil incorporated, monocrotophos (Azodrin 202 R 30% EC), carbaryl (Sevin 85 WP).

[b]*Hydrellia sasakii*: 1-9 scale per plot estimate.

Table 3. Determination of an optimal chemical insect control recommendation for second crop irrigated transplanted IR36 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Del Monte, Talacogon, Agusan del Sur, Mindanao, Philippines, July-October 1979.

Whorl maggot[b] (grade) 30 DT	Stem borer white head[c] (%)	Yield (t/ha)
Complete protection: seedbed - 1.5 kg ai carbaryl WP/ha 7, 14 DE; vegetative - 1.5 kg ai carbofuran G/ha before transplanting; reproductive - 0.75 kg ai monocrotophos EC/ha 35, 45 DT; ripening - 1.5 kg ai carbaryl WP/ha 65 DT		
2.0	0.6 a	7.9 a
Omit seedbed protection		
3.2	0.6 a	7.9 a
Omit vegetative protection		
2.5	0.7 a	7.2 a
Omit reproductive protection		
2.2	1.0 a	7.4 a
Untreated control		
3.6	1.2 a	7.3 a
Recommended practice: 1 kg ai carbofuran G/ha before transplanting plus economic threshold		
1.8	0.7 a	7.8 a
Alternative practice: 1.5 kg ai diazinon G/ha 7 DT; 0.75 kg ai monocrotophos EC/ha 35, 45 DT plus economic threshold		
2.3	0.7 a	7.0 a

[a]Av. of 4 fields (replications). DE = days after seedling emergence. DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G) soil incorporated, carbaryl (Sevin 85 WP), monocrotophos (Azodrin 202 R 30% EC), diazinon (Basudin 10 G) paddy water broadcast.

[b]*Hydrellia sasakii*: 1-9 scale per plot.

[c]*Scirpophaga incertulas*: 5-m^2 sample.

Table 4. Determination of an optimal chemical insect control recommendation for second crop irrigated transplanted IR50 rice using the partitioned growth stage yield loss method.[a] Philippine Government - Land Settlement Cropping Systems Program, Del Monte, Talacogon, Agusan del Sur province, Mindanao, Philippines. July-October 1980.

Whorl maggot[b] (grade) 30-35 DT	Caseworm[c] (% cut leaves) 30 DT	Stem borer (%)[d] Deadhearts 45-55 DT	Stem borer (%)[d] Whiteheads	Yield[e] (t/ha)
Complete protection: seedbed - 0.75 kg ai monocrotophos EC/ha 7, 14 DE; vegetative - 1 kg ai monocrotophos EC/ha 5, 15, 25 DT; reproductive - 1 kg ai Brodan EC/ha 35, 45, 55 DT; ripening - 1 kg ai monocrotophos EC/ha sprays from postflowering to hard dough				
3.2 a	0.7 a	0.3 a	0.3 a	5.75 a
Omit seedbed protection				
3.6 a	0.7 a	0.6 a	0.4 a	5.59 a
Omit vegetative protection				
4.1 a	0.7 a	0.5 a	0.5 a	5.65 a
Omit reproductive protection				
3.8 c	0.7 a	0.8 ab	0.5 a	5.36 a
Omit ripening protection				
4.2 a	0.7 a	0.3 a	0.4 a	5.24 a
Untreated control				
5.1 a	0.7 a	1.5 b	0.9 b	4.88 a
Recommended practice: economic thresholds				
4.0 a	0.7 a	0.6 a	0.6 ab	5.44 a
Alternative practice: 1 kg ai carbofuran G/ha before transplanting plus economic thresholds				
3.0 a	0.7 a	0.6 a	0.5 a	5.38 a

[a]Av. of 3 fields (replications). DE = days after crop emergence. DT = days after transplanting. In a column, means followed by a common letter are not significantly different by DMRT. Monocrotophos (Azodrin 202 R 30% EC), Brodan 31.5 EC (20% chlorpyrifos + 11.5% BPMC), carbofuran (Furadan 3 G) soil incorporated.

[b]*Hydrellia sasakii*: 1-9 scale per plot estimate on damaged leaves - 1 < 1%, 3 = 2-5%, 5 = 6-25%, 7 = 26-50%, 9 = 51-100%. $P < .05$ by DMRT.

[c]*Nymphula depunctalis*: 20-hill sample. $P < .01$ by DMRT.

[d]*Scirpophaga incertulas*: 5-m^2 sample. $P < .05$ by DMRT.

[e]$P < .05$ by DMRT.

Table 5. Determination of an optimal chemical insect control recommendation for dryland maize using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Del Monte, Talacogon, Agusan del Sur Province, Mindanao, Philippines, April - July 1980.

Corn seedling[b] maggot (grade)	Corn borer[c]			Yield (t/ha)
	Tunnels below ears (no./plant)	Tunnels above ears no./plant)	Infested plants(%)	
Complete protection control: seed/seeding - bendiocarb WP seed treatment; pretasseling - 0.05 kg ai decamethrin EC/ha 21, 31, 41 DE; posttasseling - 0.05 kg ai decamethrin/ha 51, 61, 81 DE				
1.0 a	0.8 a	1.2 a	77 a	3.35 a
Omit seed/seedling protection				
2.3 a	0.9 a	1.7 a	91 a	2.57 a
Omit pretasseling protection				
1.0 a	0.8 a	1.4 a	91 a	3.25 a
Omit posttasseling protection				
1.0 a	0.8 a	1.4 a	80 a	2.82 a
Untreated control				
2.3 a	1.0 a	1.4 a	87 a	2.27 a
Recommended practice: kerosene seed treatment; 1.25 kg ai carbaryl WP/ha for corn borer				
1.7 a	0.8 a	1.8 a	95 a	2.73 a
Alternative practice: 0.5 kg ai carbofuran G/ha in seed furrow, 1 kg ai carbofuran G/ha in whorl for corn borer				
1.0 a	0.8 a	1.5 a	92 a	2.72 a
Alternative practice: kerosene seed treatment; 0.75 kg ai carbaryl WP/ha 30, 45, 60, 70 DE				
1.3 a	0.8 a	1.5 a	88 a	3.10 a

[a]Av. of 3 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Bendiocarb 80 WP 10 g ai/kg seed, decamethrin (Decis 2.5 EC); carbaryl (Sevin 85 WP), carbofuran (Furadan 3 G)

[b]*Atherigona oryzae*: 0-3 grade; 0 = no infestation, 1 = slight infestation, 2 = moderate infestation, 3 = high infestation.

[c]*Ostrinia furnacalis*: 25 plants dissected at harvest.

Table 6. Determination of an optimal chemical insect control recommendation for dryland CES ID-21 mungbean using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development-Land Settlement Cropping Systems Program. Del Monte, Talacogon, Agusan del Sur Province, Mindanao, Philippines. July - November 1979.

Defoliation[b] (grade)	Pod borer (% damaged pods)	Yield (t/ha)
Complete protection - preflowering - 0.5 kg ai monocrotophos EC/ha 2, 15 DE; postflowering - 0.05 kg ai fenvalerate EC/ha 35, 45 DE.		
2.2 a	0.7 a	0.65 a
0.5 kg ai monocrotophos EC/ha 15 DE, 0.05 kg ai fenvalerate EC/ha 35, 45 DE		
3.2 ab	1.4 abc	0.22 b
Untreated control		
7.2 c	2.5 d	0.06 c
Recommended practice: 0.75 kg ai carbofuran G/ha basal; 0.5 kg ai monocrotophos EC/ha 35, 45 DE		
3.0 ab	0.8 ab	0.26 b
Alternative practice: 1 kg ai carbaryl WP/ha 2, 15 DE		
4.8 b	2.0 cd	0.50 a
Alternative practice: 0.25 kg ai monocrotophos EC/ha 2, 15 DE; 1 kg ai carbaryl WP/ha 35, 45 DE		
3.4 b	1.6 abc	0.27 b

[a]Av. of 4 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G) in seed furrow, monocrotophos (Azodrin 16.8 EC), fenvalerate (Sumicidin 20 EC), carbaryl (Sevin 85 WP).

[b]1-9 Scale on percentage leaf area was 1 = <1%, 3 = 1-5%, 5 = 6-25%, 7 = 26-50%, 9 = 51-100%.

Table 7. Determination of an optimal chemical insect control recommendation for dryland CES ID-21 mungbean using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development-Land Settlement Cropping Systems Program. Del Monte, Talacogon, Agusan del Sur Province, Mindanao, Philippines, September-November 1980.

Beanfly[b] (% infested plants) 21 DE)	Flee[b] beetle feeding holes (no./25 plants) 17 DE	Thrips[d] (no./25 plants) 21 DE	Defoliation (grade) 35-45 DE	Yield[e] (t/ha)
Complete control: preflowering - 1 kg ai carbofuran G/ha in seed furrow; postflowering 0.05 kg ai decamethrin EC/ha 25, 35, 45 DE				
8 a	17 a	0.8 a	1.0	0.44 a
Omit preflowering protection				
13 a	22 a	0.9 a	1.0	0.40 a
Omit postflowering protection				
12 a	28 a	0.9 a	2.3	0.35 a
Untreated				
12 a	26 a	0.9 a	4.3	0.39 a
Recommended practice: economic threshold				
14 a	26 a	0.9 a	2.3	0.49 a
Alternative practice: 0.25 kg ai monocrotophos EC/ha 2, 12 DE; 0.75 kg ai methyl-parathion EC/ha 25, 35 DE				
9 a	16 a	0.9 a	1.0	0.43 a
Alternative practice: 0.75 kg ai methyl-parathion EC/ha 25, 35 DE				
13 a	30 a	0.9 a	2.3	0.34 a
Alternative practice: 0.25 kg ai monocrotophos EC/ha 2, 12 DE				
10 a	14 a	0.8 a	3.0	0.52 a

[a]Av. of 3 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G), decamethrin (Decis 2.5 EC), monocrotophos (Azodrin 202 R 30% EC), methyl-parathion (Folidol 50 EC).

[b]*Ophiomyia phaseoli*: 25 plants dissected.

[c]*Medythia nitidula*: 25 plant sample.

[d]*Thrips palmi*: 25 leaf bud tips/sample.

[e]Heavy frequent rains reduced yield.

Table 8. Determination of an optimal chemical insect control recommendation for dryland C171-136 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development-Land Settlement Cropping Systems Program, Pangantucan, Bukidnon Province, Mindanao, Philippines, February-May, 1979.

Seedling maggot[b] (% infested plants) 12 DE	Stem borer[c] (%) Deadhearts 35 DE	Stem borer[c] (%) Whiteheads	Yield (t/ha)
Complete protection: vegetative - 1 kg ai carbofuran G/ha basal; reproductive - 1 kg ai monocrotophos EC/ha 35, 45 DE; ripening - 1 kg ai carbaryl WP/ha pre-milky and 10 days later			
0.3	2	4	4.22 a
Omit vegetative protection			
0.5	3	4	3.87 b
Omit reproductive protection			
0.8	3	5	4.04 a
Omit ripening protection			
0.5	3	3	3.89 b
Untreated control = recommended practice			
1.8	3	6	2.25 c

[a]Av. of 4 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD, carbofuran (Furadan 3 G) in seed furrow, monocrotophos (Azodrin 202 R 30% EC), carbaryl (Sevin 85 WP).

[b]*Atherigona oryzae:* 15-m row sample.

[c]*Scirpophaga incertulas:* 15-m row sample.

Table 9. Determination of an optimal chemical insect control recommendation for dryland C171-136 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Pangatucan, Bukidnon province, Mindanao, Philippines, February-May 1980.

Root[b] aphid (% infested plants)	Stem borer (%)[c]		Leaf-folder[d] (% damaged leaves)	Rice bug[e] (no./15 m row)	Yield (t/ha)	Insecticide cost (₱/ha)	Marginal return[f] (₱/ha)	Benefit[g] cost ratio
	Dead-hearts	White-heads						
Complete control: seed/seedling - bendiocarb WP seed treatment; vegetative - 1 kg ai monocrotophos EC/ha 15, 25, 35 DE; reproductive - 1 kg ai Brodan EC/ha 45, 55, 65, 75 DE; ripening-1 kg ai monocrotophos EC/ha 3 sprays from postflowering to hard dough								
0.3	1	0	2	2	4.67 a	---	----	---
Omit seed/seedling protection								
5	3	1	3	2	4.60 a	---	----	---
Omit vegetative protection								
2	3	2	4	3	4.53 a	---	----	---
Omit reproductive protection								
7	1	2	1	2	4.20 a	---	----	---
Omit ripening protection								
13	1	1	3	2	4.23 a	---	----	---
Untreated control								
10	8	6	4	4	3.55 a			
Recommended practice: 1 kg ai carbofuran G/ha basal; 0.75 kg ai carbaryl WP/ha at pre-milky and 7 days later								
1	1	2	1	3	4.61 a	354	1024	3.9
Alternative practice: 0.5 kg ai carbofuran G/ha basal; 0.75 kg ai carbaryl WP/ha at pre-milky stage and 7 days later								
2	2	2	3	3	4.26 a	224	699	4.1

[a]Av. of 3 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT.

[b]*Tetranuera myria dominales*.

[c]*Scirpophaga incertulas*: 15-m row sample.

[d]*Cnaphalocrocis medinalis*: 15-m row sample.

[e]*Leptocorisa oratorius*: 15-m row sample.

[f]Returns from insecticide treatment less insecticide cost. 1 kg rice = ₱1.30.

[g]Insecticide usage.

Table 10. Determination of an optimal chemical insect control recommendation for first crop irrigated transplanted IR36 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Kalilangan Bukidnon province, Mindanao, Philippines. March-June 1979.

Caseworm[b] (% defoliation) 35 DT	Stem borer (%)[c] Deadhearts	Stem borer (%)[c] Whiteheads	Rice bug[d] (no./m^2)	Yield (t/ha)	Insecticide cost (₱/ha)	Marginal return[e] (₱/ha)
Complete control: seedbed - 0.5 kg ai carbofuran G/ha; vegetative - 1.5 kg ai carbofuran G/ha before transplanting; reproductive - 0.75 kg ai monocrotophos EC/ha 35, 45 DT; ripening - 0.75 kg ai endosulfan EC/ha pre-milky stage and 10 days later						
2	0.1	0.6	0	6.32 a	---	----
Omit seedbed protection						
8	1.2	0.7	0	5.73 bc	---	----
Omit vegetative protection						
4	1.7	1.0	0	5.38 bc	---	----
Omit reproductive protection						
5	0.9	0.9	0	5.34 bc	---	----
Omit ripening protection						
7	0.1	0.7	0	5.46 bc	---	----
Untreated control						
10	2.5	2.3	1	4.12 d	---	----
Recommended practice: 1 kg ai carbofuran G/ha before transplanting plus economic threshold						
6	0.9	1.0	0.1	5.29 bc	280	1007
Alternative practice: 1.5 kg ai diazinon G/ha 5 DT plus economic threshold						
7	0.4	0.4	-	5.13 c	350	761
Alternative practice: 0.75 kg ai monocrotophos EC/ha 5, 15 DT plus economic threshold						
6	0.4	0.6	0.3	5.44 bc	542	910

[a]Av. of 3 fields (replications). DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD. Carbofuran (Furadan 3 G) soil incorporated, monocrotophos (Azodrin 202 R 30%), endosulfan (Thiodan 35 EC), diazinon (Basudin 10 G) paddy water broadcast.

[b]*Nymphula depunctalis*: per-plot estimate.

[c]*Scirpophaga incertulas*: 5-m^2 sample.

[d]*Leptocorisa oratorius*: 5-m^2 sample.

[e]Returns from treatment less insecticide cost. 1 kg rice= ₱1.10

Table 11. Determination of an optimal chemical insect control recommendation for first crop irrigated transplanted IR36 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Kalilangan, Bukidnon province, Mindanao, Philippines, March-June, 1980.

Defoliation[b] (%) seedbed 18 DE	Whorl maggot[c] (% infested tillers) 30 DT	Caseworm (% defoliation) 30 DT	Stem borer[e] (%) Dead-hearts 45 DT	Stem borer[e] (%) White-heads	Leaffolder[f] (% damaged leaves)	Rice bug[g] (no./15 m^2)	Yield[h] (t/ha)	Insecticide cost (₱/ha)	Marginal return[i] (₱/ha)	Benefit cost[j] ratio
Complete protection: seedbed - 0.75 kg ai monocrotophos EC/ha 7, 14 DE; vegetative - 1 kg ai monocrotophos EC/ha 5, 15, 25 DT; reproductive - 1 kg ai Brodan EC/ha 35, 45, 55 DT; ripening - 1 kg ai monocrotophos EC/ha 3 sprays from postflowering to hard dough										
1	3	4	6	1	0.4	6	3.40 a	---	---	---
Omit seedbed protection										
3	5	8	8	2	1	5	3.10 ab	---	---	---
Omit vegetative protection										
1	7	14	7	2	1	6	3.00 ab	---	---	---
Omit reproductive protection										
2	5	5	9	2	5	5	2.60 b	---	---	---
Omit ripening protection										
1	10	13	8	2	1	7	3.00 ab	---	---	---
Untreated										
5	13	36	65	14	17	9	1.60 c	---	---	---
Recommended practice: carbofuran G before sowing seedbed (0.5 kg ai/ha) and before transplanting (1 kg ai/ha) plus economic thresholds										
0	4	8	5	1	2	5	3.30 ab	628	1610	3.6
Alternative practice: carbofuran G before sowing seedbed (0.5 kg ai/ha) and before transplanting (1 kg ai/ha); 0.75 kg ai Brodan EC/ha 35, 45 DT; 0.75 kg ai endosulfan EC/ha premilky stage and 7 days later										
0	7	6	7	2	6	6	3.20 ab	677	1450	3.1
Alternative practice: 0.5 kg ai carbofuran G/ha before transplanting plus economic threshold										
0	10	8	15	2	4	8	2.60 b	498	810	2.6

[a] Av. of 3 fields (replications). DE = days after crop emergence. DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Monocrotophos (Azodrin 202 R 30% EC), Brodan 31.5 EC (20% chlorpyrifos + 11.5% BPMC), carbofuran (Furadan 3 G) soil incorporated, endosulfan (Thiodan 35 EC).

[b] 25-plant sample.

[c] *Hydrellia sasakii*.

[d] *Nymphula depunctalis*.

[e] *Sesamia inferens*: 5-m^2 sample.

[f] *Cnaphalocrocis medinalis*: 15-m^2 sample.

[g] *Leptocorisa oratorius*: 15-m^2 sample.

[h] Crop infested with tungro.

[i] Returns from insecticide treatments less insecticide cost. 1 kg rice = ₱1.30

[j] Insecticide usage.

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Table 12. Determination of an optimal chemical insect control recommendation for second crop irrigated transplanted IR50 rice using the partitioned growth stage yield loss method.[a] Philippine Government, Second Rural Development - Land Settlement Cropping Systems Program, Kalilangan, Bukidnon Province, Mindanao, Philippines, July - October, 1980.

Defoliation[b] (%) seedbed 18 DE	Whorl[c] maggot (% infested tillers) 30 DT	Caseworm[d] (% defoliation) 30 DT	Stem borer[e] (%) Deadhearts 45 DT	Stem borer[e] (%) Whiteheads	Leaf folder[f] (% damaged leaves)	Rice[g] bug (no./15 m^2)	Yield (t/ha)	Insecticide cost (₱/ha)	Marginal return (₱/ha)	Benefit cost ratio
Complete protection: seedbed - 0.75 kg ai monocrotophos EC/ha 7, 14 DE; vegetative - 1 kg ai monocrotophos EC/ha 5, 15, 25 DT; reproductive - 1 kg ai Brodan EC/ha 35, 45, 55 DT; ripening - 1 kg ai monocrotophos EC/ha 3 sprays from postflowering to hard dough										
0	2	2	0.3	0.7	0	4	6.70 a	-	-	-
Omit seedbed protection										
3	3	6	5	1.7	1	3	6.60 a	-	-	-
Omit vegetative protection										
1	6	9	4	1.3	1	5	6.00 a	-	-	-
Omit reproductive protection										
2	2	3	6	1.7	1	3	5.90 a	-	-	-
Omit ripening protection										
1	7	8	3	0.7	0.3	5	6.30 a	-	-	-
Untreated										
5	10	21	18	2.0	11	8	4.60 a	-	-	-
Recommended practice: carbofuran G before sowing seedbed (0.5 kg ai/ha) and before transplanting (1 kg ai/ha) plus economic thresholds										
0	4	6	1	0.8	0.3	5	6.50 a	510	1920	4.4
Alternative practice: carbofuran G before sowing seedbed (0.5 kg ai/ha) and before transplanting (1 kg ai/ha); 0.75 kg ai Brodan EC/ha 35, 45 DT; 0.75 kg ai endosulfan EC/ha premilky stage and 7 days later.										
0	4	4	3	0.7	4	3	6.30 a	504	1730	4.4
Alternative practice: 0.5 kg ai carbofuran G/ha before transplanting plus economic threshold										
0	4	11	10	0.9	3	4	5.00 a	364	117	1.3

[a] Av. of 3 fields (replications). DE = days after crop emergence; DT = days after transplanting. In a column, means followed by a common letter are not significantly different (P < .05) by DMRT. Monocrotophos (Azodrin 202R 30% EC), Brodan 31.5 EC (20% chlorpyrifos + 11.5 % BPMC), carbofuran (Furadan 3 G) soil incorporated, endosulfan (Thiodan 35 EC).

[b] 25 plant sample.

[c] *Hydrellia sasakii*.

[d] *Nymphula depunctalis*.

[e] *Scirpophaga incertulas*: 5 m^2 sample

[f] *Cnaphalocrocis medinalis*: 15 m^2 sample.

[g] *Leptocorisa oratorius*: 15 m^2 sample.

[h] Net returns from insecticide treatments less insecticide cost. 1 kg rice = ₱ 1.30

[i] Insecticide usage.

Table 13. Determination of an optimal chemical insect control recommendation for first crop dryland Philippine DMR Comp. 2 maize using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Pangantucan, Bukidnon province, Mindanao, Philippines. June-August 1979.

Seedling maggot[b] (% infested plants)	Corn borer[c] (no. tunnels/ 25 plants)	Yield (t/ha)	Insecticide cost (₱/ha)	Marginal[d] return (₱/ha)
Complete protection: 1 kg ai carbofuran G/ha basal; 1 kg ai endosulfan EC/ha 45, 85 DE				
10	17	3.61 a	---	---
1 kg ai carbofuran G/ha basal				
15	14	3.25 b	---	---
0.75 kg ai methomyl EC/ha 30 DE				
15	21	3.20 b	---	---
0.75 kg ai methomyl EC/ha 60 DE; 0.75 kg ai endosulfan EC/ha 85 DE				
25	25	3.07 b	---	---
Untreated control				
40	32	2.10 c	---	---
Recommended practice: 0.5 kg ai carbofuran G/ha basal; 0.75 kg ai monocrotophos EC/ha 30, 45, 65, 85 DE				
14	14	3.35 b	780	345

[a]Av. of 4 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD. Carbofuran (Furadan 3 G) in seed furrow, endosulfan (Thiodan 35 EC), methomyl (Lannate 40 EC).

[b]*Atherigona oryzae*: 15-m row sample.

[c]*Ostrinia furnacalis*: 25-plant sample dissected at harvest.

[d]Returns from treatment less insecticide cost. 1 kg maize = ₱ 0.90/kg

Table 14. Determination of an optimal chemical insect control recommendation for second crop dryland Philippine DMR Composite 2 maize using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program, Pangantucan, Bukidnon province, Mindanao, Philippines, August-December 1979.

Plant stand (no. plants/ 30 m-row)	Seedling maggot[b] (% infested plants) 21 DE	Corn borer[c] (no. tunnels/ 25 plants)	Yield (t/ha)	Insecticide cost[d] (₱/ha)	Marginal return[e] (₱/ha)	Benefit cost ratio[f]
Complete control: 1 kg ai carbofuran G/ha basal; 0.75 kg ai methomyl EC/ha 30, 65 DE; 0.75 kg ai endosulfan EC/ha 45, 75 DE						
157 a	5	3	2.85 a	---	---	---
Omit seed/seedling protection: 0.75 kg ai methomyl EC/ha 30, 65 DE; 0.75 kg ai endosulfan EC/ha 45, 75 DE						
147 b	11	9	2.63 ab	---	---	---
Omit pretasseling protection: 1 kg ai carbofuran G/ha basal; 0.75 kg ai methomyl EC/ha 65, DE; 0.75 kg ai endosulfan EC/ha 75 DE						
147 b	7	15	2.47 ab	---	---	---
Omit posttasseling protection: 1 kg ai carbofuran G/ha basal; 0.75 kg ai methomyl EC/ha 30 DE; 0.75 kg ai endosulfan EC/ha 45 DE						
152 ab	9	19	2.20 b	---	---	---
Untreated						
125 c	17	24	1.82 c	---	---	---
Recommended practice: 0.5 kg ai carbofuran G/ha basal; 0.75 kg ai carbaryl WP/ha 30, 45, 65, 85 DE						
145 b	10	8	2.73 a	455	546	2.2

[a]Av. of 4 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G), methomyl (Lannate 40 EC), endosulfan (Thiodan 35 EC), carbaryl (Sevin 85 WP).

[b]*Atherigona oryzae*.

[c]*Ostrinia furnacalis*: 25-plant sample dissected.

[d]Furadan 3 G ₱ 0.07/g, Lannate 40 EC ₱ 0.0073/ml, Thiodan 35 EC ₱0.065/ml, Sevin 85 WP ₱ 0.076/g.

[e]Returns from insecticide treatments less insecticide cost. 1 kg maize = ₱1.10

[f]Insecticide usage.

Table 15. Determination of an optimal insect control recommendation for second crop dryland Philippines DMR Composite 2 maize using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Pangatucan, Bukidnon province, Mindanao, Philippines, March-July, 1980.

Plant stand (no. plants/ 50-m row)	Seedling maggot[b] (% infested plants) 21 DE	Corn[c] thrips (no./25 plants) 28 DE	Corn borer[d] (no. tunnels/ 25 plants)	Yield (t/ha)	Insecticide[e] cost (₱/ha)	Marginal return[f] (₱/ha)	Benefit cost ratio[g]
Complete control: seed/seedling - bendiocarb WP seed treatment; pretasseling - 0.05 kg ai decamethrin EC/ha 21, 31, 41 DE; posttasseling - 0.05 kg ai decamethrin EC/ha 51, 61, 71, 81 DE							
144	1	1.3	1	4.12	---	---	---
Omit seed/seedling protection							
152	8	1.7	11	3.97	---	---	---
Omit pretasseling protection							
142	3	1.3	11	3.29	---	---	---
Omit posttasseling protection							
139	2	1.9	12	3.62	---	---	---
Untreated							
149	14	7.0	23	3.10	---	---	---
Recommended practice: 0.5 kg ai carbofuran G/ha basal; 0.75 kg ai carbaryl WP/ha 30, 45, 65, 85 WP							
132	3	3.0	2	4.10	215	884	5.1
Alternative practice: kerosene seed treatment plus economic threshold							
147	3	3.8	10	3.77	117	619	6.3
Alternative practice: 0.5 kg ai carbofuran G/ha basal plus economic threshold							
135	5	2.6	9	3.68	145	493	4.5

[a]Av. of 3 fields (replications). DE = days after crop emergence. Carbofuran (Furadan 3 G), bendiocarb 80 WP 10 g ai/kg seed, carbaryl (Sevin 85 WP), kerosene - 2 tablespoons/kg seed.

[b]*Atherigona oryzae*.

[c]*Frankiniella williamsi*.

[d]*Ostrinia furnacalis*: 25-plant sample dissected.

[e]Furadan ₱145/16.7 kg, Sevin WP ₱40/kg.

[f]Returns from insecticide treatments less insecticide cost.

[g]Insecticide usage.

Table 16. Determination of an optimal chemical insect control recommendation for dryland CES-14 mungbean using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Pangantucan, Bukidnon province, Mindanao, Philippines, November 1979-January 1980.

Beanfly[b] (no. larvae + pupae /25 plants)		Defoliation[c] (%)	Aphid[d] infestation (grade)	Leaf miner[e] 30 DE (no. tunnels /25 plants)	Yield (t/ha)	Insecticide cost (₱/ha)[f]	Marginal return[g] (₱/ha)	Benefit cost[h] (₱/ha)
12 DE	21 DE	35 DE	35 DE					
Complete control: 0.5 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35, 45 DE								
1.7	0.5	3	1.0	5	0.50 a	---	----	---
0.05 kg ai fenvalerate EC/ha 25, 35, 45 DE								
2.2	2.0	4	1.0	7	0.21 b	---	----	---
0.5 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 35, 45 DE								
2.1	1.8	4	1.5	3	0.27 b	---	----	---
0.05 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35 DE								
3.0	2.5	4	1.0	6	0.13 c	---	----	---
Untreated control								
3.4	3.0	7	3.9	15	0.09 d	---	----	---
Recommended practice: 0.5 kg ai carbofuran G/ha basal; 0.75 kg ai monocrotophos EC/ha 25, 35 DE								
1.9	0.8	3	1.3	6	0.45 a	454	1346	3.4

[a]Av. of 4 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G) in seed furrow, fenvalerate (Sumicidin 3 EC), monocrotophos (Azodrin 202 %).

[b]*Ophiomyia phaseoli*: 25-plant sample dissected.

[c]Per-plot estimation.

[d]*Aphis craccivora*: 1-9 scale.

[e]*Stomopteryx subsecivella*: 25-plant sample.

[f]Furadan 3 G ₱0.13/g, Sumicidin 3 EC ₱0.097/ml, Azodrin 202 R ₱0.082/ml.

[g]Returns from insecticide treatments less insecticide cost. 1 kg mungbean = ₱3.00

[h]Insecticide usage.

Table 17. Chemical insect pest control and yield response of dryland Pellunga cowpea using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. ASC farm, Pangantucan, Bukidnon province, Mindanao, Philippines. October 1979 - January 1980.

Beanfly[b] (no. larvae + pupae /25 plants)		Defoliation (%) 21 DE	Aphid[c] infestation (grade) 35 DE	Leaf miner[d] (no. tunnels /25 plants) 35 DE	Pod borer[e] (% damaged dry pods)	Yield (t/ha)	Insecticide cost (₱/ha)[f]	Marginal returns[g] (₱/ha)	Benefit cost[f] ratio
10 DE	21 DE								
Complete protection: 0.5 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35, 45 DE									
3	2	3	1.0	4	10	1.20 a	---	---	---
0.05 kg ai fenvalerate EC/ha 25, 35, 45 DE									
6	5	4	1.5	8	13	0.56 c	---	---	---
0.5 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 35, 45 DE									
8	6	4	1.2	6	16	0.53 b	---	---	---
0.5 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35 DE									
10	9	6	1.6	9	20	0.32 d	---	---	---
Untreated control									
12	13	10	5.0	13	34	0.30 d	---	---	---
Recommended practice: 0.25 kg ai monocrotophos EC/ha 2, 12 DE; 0.75 kg ai azinphos-ethyl EC/ha 25, 35, 45 DE									
5	4	3	1.5	6	11	0.82 b	499	541	2.1

[a] Av. of 4 replications in 1 field. DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3G) in seed furrow, fenvalerate (Sumicidin 3 EC), monocrotophos (Azodrin 202 R), azinphos-ethyl (Gusathion 40 EC).
[b] *Ophiomyia phaseoli*: 25-plant sample.
[c] *Aphis craccivora*: 1-9 scale per plot.
[d] *Stomopteryx subsecivella*: 25-plant sample.
[e] *Maruca testulalis*: 100-pod sample.
[f] Sumicidin 3 EC ₱0.091/ml, Furadan 3 G ₱0.13/g, Azodrin 202 R ₱0.082/cc, Gusathion 40 EC ₱0.065/ml.
[g] Returns from insecticide treatment less insecticide cost. 1 kg cowpea = ₱2.00
[h] Insecticide usage.

Table 18. Chemical insect control and yield loss on dryland Clark 63 soybean using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Agricultural Service Center farm, Pangantucan, Bukidnon Province, Mindanao, Philippines, 1979 Wet Season.

Beanfly[b] (No. larvae + pupae/ 25 plants	Pod borers[c] (no./100 pods)	Yield (t/ha)	Insecticide cost (₱/ha)	Marginal[d] return (₱/ha)
Complete protection: preflowering protection - 1 kg ai carbofuran G/ha basal; postflowering protection - 0.05 kg ai fenvalerate EC/ha 25, 35, 45; post pod forming - 0.05 kg ai fenvalerate EC/ha 55, 65 DE.				
0	1	0.90 a	-	-
Omit preflowering protection				
1	2	0.87 a	-	-
Omit postflowering protection				
2	2	0.76 a	-	-
Omit post pod forming protection				
1	1	0.89 a	-	-
Untreated control				
1	3	0.65 a	-	-
Recommended practice: 0.25 kg ai monocrotophos EC/ha 2, 12 DE; 0.75 kg ai azinphos-ethyl EC/ha 25, 35, 45 DE				
0	1	0.88 a	840	-150

[a]Av. of 4 replications in field. DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD, carbofuran (Furadan 3 G) in seed furrow, fenvalerate (Sumicidin 20 EC) monocrotophos (Azodrin 202R 30% EC), azinphos-ethyl (Gusathion 40 EC).

[b]*Ophiomyia phaseoli*: 25 plant sample dissected.

[c]*Etiella zinckenella*: 100 pod sample

[d]Returns from treatment less insecticide cost. 1 kg soybean = ₱3.00.

Table 19. Chemical insect pest control and yield response of dryland Clark 63 soybean using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. ASC farm, Pangantucan, Bukidnon province, Mindanao, Philippines, October 1979 - February 1980.

Beanfly[b] (no. larvae + pupae /25 plants) 10 DE	21 DE	Defoliation (%) 21 DE	Aphid[c] infestation (grade) 35 DE	Leaf miner[d] (no. tunnels /25 plants) 35 DE	Pod borer[e] (% damaged dry pods)	Yield (t/ha)	Insecticide cost (₱/ha)[f]	Marginal returns[g] (₱/ha)	Benefit cost[h] ratio
Complete control: 1 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35, 45 DE									
0	1	1	1.0	4	1	0.83 a	---	---	---
0.05 kg ai azinphos-ethyl EC/ha 25, 35, 45 DE									
2	3	8	1.0	6	2	0.71 a	---	---	---
1 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 35, 45 DE									
0	1	6	1.7	5	1	0.74 a	---	---	---
1 kg ai carbofuran G/ha basal; 0.05 kg ai fenvalerate EC/ha 25, 35 DE									
1	1	3	1.0	7	1	0.65 a	---	---	---
Untreated									
9	7	8	5.0	14	10	0.44 a	---	---	---
Recommended practice: 0.25 kg ai monocrotophos EC/ha 2, 12 DE; 0.75 kg ai azinphos-ethyl EC/ha 25, 35, 45 DE									
5	5	5	1.0	5	1	0.78 a	449	571	2.3

[a] Av. of 4 replicates in 1 field. DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Carbofuran (Furadan 3 G) in seed furrow, fenvalerate (Sumicidin 3 EC), azinphos-ethyl (Gusathion 40 EC), monocrotophos (Azodrin 202 R 30 EC).

[b] *Melanagromyza phaseoli*: 25-plant sample.

[c] *Aphis glycines*: 1-9 scale per plot.

[d] *Stomopteryx subsecivella*: 25-plant sample.

[e] *Heliothis armigera, Etiella zinckenella*: 100-pod sample.

[f] Sumicidin 3 EC ₱0.097/ml, Furadan 3 G ₱0.13/kg, Azodrin 202 R ₱0.082/ml, Gusathion 40 EC ₱0.065/ml.

[g] Net returns from insecticide treatment less insecticide cost. 1 kg soybean = ₱3.00

[h] Insecticide usage.

Table 20. Development of an optimal chemical insect control recommendation on dryland C171-135 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program, Astorga, Dumarao, Capiz province, Panay, Philippines, July-November 1979.

Stem borer[b] (%)		Yield (t/ha)
Deadhearts 35 DE	Whiteheads	
Complete control: vegetative - 0.75 kg ai monocrotophos EC/ha 5, 18, 25 DE; reproductive - 0.75 kg ai monocrotophos EC/ha 35, 45, 55 DE; ripening - 0.75 kg ai malathion EC/ha pre-milky and 10 days later		
0.3	0.4	2.46 b
Omit vegetative protection		
1.2	0.8	1.94 b
Omit reproductive protection		
0.8	0.6	2.30 b
Omit ripening protection		
0.6	0.3	2.29 b
Untreated control = recommended practice		
3.6	2.3	1.11 c
Alternative practice: 0.5 kg ai carbofuran G/ha basal, 0.75 kg ai monocrotophos EC/ha 35, 45, 55 DE; 0.75 kg ai malathion EC/ha premilky and 10 days later		
0.4	0.3	3.46 a

[a]Av. of 3 replications (fields). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD. Monocrotophos (Azodrin 16.8 EC), carbofuran (Furadan 3 G) in seed furrow, malathion (Malathion 57 EC).

[b]*Scirpophaga innotata*: 15-m row sample.

Table 21. Chemical insect control and yield response on first crop rainfed transplanted IR36 rice.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Astorga, Dumarao, Capiz province, Panay, Philippines. July-November 1978.

Caseworm[b] (% defoliation) 20 DT	Stem borer[c] (%) Deadhearts 35 DT	Stem borer[c] (%) Whiteheads	Yield (t/ha)
1 kg ai carbofuran G/ha paddy water broadcast 5 DT			
1	5.5	4.3	5.4 a
1 kg ai carbofuran G/ha soil incorporated before transplanting			
1	2.8	2.6	5.1 a
Seedlings soaked 24 h in carbofuran G before transplanting			
1	4.2	3.2	5.0 a
0.75 kg ai monocrotophos EC/ha 3, 17, 31 DT			
1	3.5	3.2	5.0 a
Untreated control			
3	6.6	5.9	4.0 b

[a]Av. of 3 fields (replications). DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD. Carbofuran (Furadan 3 G), monocrotophos (Azodrin 16.8 EC).

[b]*Nymphula depunctalis*: per plot estimate.
[c]*Scirpophaga innotata*: 5-m^2 sample.

Table 22. Determination of an optimal chemical insect control recommendation for first crop rainfed wet-season transplanted IR36 rice using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program, Astorga, Dumarao, Capiz province, Panay, Philippines. August-December 1980.

Stem borer[b] (%)		Leaf folder[c] (% damaged leaves)	Rice bug[d] (no./5 m^2)	Yield (t/ha)	Insecticide cost (₱/ha)	Net return[e] from insecticide (₱/ha)
Deadhearts 35 DT	Whiteheads					
Complete control: seedbed - 0.75 kg ai monocrotophos EC/ha 7, 14 DE; vegetative - 0.75 kg ai monocrotophos EC/ha 5, 18, 25 DT; reproductive - 0.75 kg ai Brodan EC/ha 35, 45, 55 DT; ripening - 0.75 kg ai malathion EC/ha 3 sprays from postflowering to hard dough						
0.5	0.4	0.3	1.6	4.94 a	---	----
Omit seedbed protection						
0.2	0.9	0.4	2.0	3.96 b	---	----
Omit vegetative protection						
0.9	0.8	0.5	2.3	4.42 a	---	----
Omit reproductive protection						
0.6	0.8	0.7	2.6	4.29 ab	---	----
Omit ripening protection						
0.5	0.3	0.3	3.0	4.79 a	---	----
Untreated control						
2.6	1.8	1.8	5.0	2.50 c	---	----
Recommended practice: 1 kg ai carbofuran G/ha before transplanting plus economic threshold						
0.5	0.6	1.1	2.5	4.58 a	392	3276
Alternative practice: 1 kg ai carbofuran G/ha before transplanting; 0.75 kg ai Brodan/ha 35, 45, 55 DT, 0.75 kg ai malathion EC/ha 3 sprays from postflowering to hard dough						
0.4	0.2	0.6	2.0	5.00 a	409	3869

[a]Av. of 3 fields (replications). DE = days after crop emergence. DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Monocrotophos (Azodrin 16.8 EC), Brodan 31.5 EC (20% chlorpyrifos + 11.5% BPMC), malathion (Malathion 57% EC), carbofuran (Furadan 3 G) soil incorporated.

[b]*Scirpophaga innotata* : 5-m^2 sample.

[c]*Cnaphalocrocis medinalis*: 100-leaf sample.

[d]*Leptocorisa oratorius*: 5-m^2 sample.

[e]Based on total gross returns less total variable costs. Total variable cost for the untreated control was ₱1346/ha.

Table 23. Chemical insect control and yield response on second crop rainfed transplanted IR36 rice.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Astorga, Dumarao, Capiz province, Panay, Philippines, December 1978-March 1979.

Caseworm[b] (% defoliation) 20 DT	Stem borer (%)[c] Deadhearts 35 DT	Stem borer (%)[c] Whiteheads	Yield (t/ha)
1 kg ai carbofuran G/ha paddy water broadcast 5 DT			
1.7	0.1	1.6	5.6 a
1 kg ai carbofuran G/ha soil incorporated before transplanting			
1.3	0.1	1.2	5.5 a
Seedlings soaked 24 h in carbofuran G before transplanting			
2.7	1.7	1.7	5.3 ab
0.75 kg ai monocrotophos EC/ha 3, 17, 31 DT			
1.3	1.7	1.1	5.5 a
Untreated control			
4.0	3.5	2.2	4.9 b

[a]Av. of 3 fields (replications). DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P < .05$) by LSD. Carbofuran (Furadan 3 G), monocrotophos (Azodrin 16.8 EC).

[b]*Nymphula depunctalis*: per-plot estimate.

[c]*Scirpophaga innotata*: 5-m^2 sample.

Table 24. Determination of an optimal insect control recommendation for dryland Improved Tiniguib-maize using the partitioned growth stage yield loss method.[a] Philippine Government Second Rural Development - Land Settlement Cropping Systems Program. Astorga, Dumarao, Capiz province, Panay, Philippines. August-December 1980.

Corn borer/25 plants[b]		Yield (t/ha)	Insecticide cost (₱/ha)	Net return from insecticide[c] (₱/ha)
Tunnels (no.)	Larvae (no.)			
Complete control: seed/seedling - bendiocarb seed treatment; pretasseling - 0.05 kg ai decamethrin/ha 21, 31, 41, 51 DE; posttasseling - 0.05 kg ai decamethrin/ha 61, 71, 81, 91 DE				
11	6	4.19 a	---	---
Omit seed/seedling protection				
19	5	3.37 ab	---	---
Omit pretasseling protection				
24	7	3.39 a	---	---
Omit posttasseling protection				
18	5	3.97 a	---	---
Untreated control				
43	12	2.29 c	---	---
Recommended practice: kerosene seed treatment plus economic threshold				
29	6	3.59 b	520	910

[a]Av. of 3 fields (replications). DE = days after crop emergence. In a column, means followed by a common letter are not significantly different ($P < .05$) by DMRT. Bendiocarb 80 WP seed treatment 10 g ai/kg seed, decamethrin (Decis 2.5 EC) kerosene seed treatment 2 tablespoons/kg seed.

[b]*Ostrinia furnacalis*: 25 plants dissected at harvest.

[c]Based on total gross returns less total variable costs. Total variable cost for the untreated control was ₱750/ha.

Table 25. Recommedned agronomic practices for cropping pattern, Agusan del Sur Settlement, CY 1980-81.

Crop	Variety	Spacing (cm)	Seeding Rate	Fertilizer Rate	Insect Control Chemical	Insect Control Rate	Weed Control
Wet Seeded Rice (WSR)	IR-36	Broadcast	120	45-0-0	Furadan 3G Azodrin ET	1.0 0.75	Butachlor 5G + 1.0 kg ai/ha Spot Weeding
Transplanted Rice (First Crop) (TPR)	IR-36	25 x 25	60	45-0-0	Furadan 3G Azodrin ET	1.0 0.75	Butachlor 5G 1.5 kg ai/ha Rotary Weeding
Transplanted Rice (Second Crop)	IR-36	25 x 25	60	45-0-0	Azodrin ET	1.0	
Upland Rice (ULR)	C171-136	Drilled	120	60-30-0	Furadan 3G + Azodrin ET	1.0 .75	Butachlor EC 2.0 kg ai/ha
Corn	Improved Tinidguit	75 x 40	18	45-40-0	Furadan 3G + Sevin	0.5 0.75	Interrow Cultivation
Mungbean	CES-ID-21	Drilled	30	10-40-40	Azodrin 2 & 12 DE		Interrow Cultivation
Sweet Potato	C-35-1	50 x 30	2-3 seed piece/hill	40-40-0	Sevin		Interrow Cultivation
Peanut	CES 101	50 x 20	2-3 seed per hill 100 kg/ha	20-30-0	No Spraying Recommended		One Interrow Cultivation

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Table 26. Recommended agronomic practices for cropping pattern, Capiz Settlement Crop Year 1980-81.

Crop	Variety	Spacing (cm)	Seedling rate (kg/ha)	Fertilizer rate	Insect Control Chemical (rate a.i./ha)	Weed control rate (a.i./ha)
Transplanted Rice (TPR)	IR-36	20 x 20	80	60-30-0	Furadan 3G at the rate of 0.75 incorporated during the final harrowing plus foliar spray EC	Apply Butachlor at the rate of 1.5 3-4 DAT + b spot weeding
Wetseeded Rice (WSR)	IR-36	Broadcast	80	60-30-0	Furadan 3G at the rate of 0.5 incorporated during the final harrowing plus foliar spray EC	Apply Butachlor at the rate of 1.5 7 DAS + b spot weeding 4 DAE
Upland Rice	UPL Ri-5	25 cm between rows (drilled)	120	60-30-30	Furadan 3G at the rate of 0.5 mixed with fertilizer applied in furrows before weeding plus foliar spray EC	Apply Butachlor at the rate of 1.5 8-4 DAS + b spot weeding 4 WAS
Corn (Dry)	Phil DMR Comp #1	75 x 25	2 seeds/hill 18 kg/ha	60-60-0	Treat seeds with kerosene 2 tablespoonfuls/1 kg of seeds spray Sevin 85 WP at the rate of 1.25 a.i./ha.	Hill of 25 DAE + b spot weeding
Corn (Green)	Los Baños Lagkitan	75 x 25	2 seeds/hill 18 kg/ha	50-60-0	- do -	- do -
Cowpea	EG# 2 EG# 3	HT 50x10 cm ZT Relay with lowland rice	1 living plant/ hill 50 kg/ha	20-40-0	Spray Azodrin 16.8 EC at the rate of 0.25 at pre flowering stage plus Sevin 85 WP at the rate of 1.25 at post flowering stage	HT Hill of 21 DAE + b spot weeding ZT Spot weeding
Mungbean	CES 10-21	HT-50 cm between rows ZT Relay with lowland	23 living plants/linear meter 50 kg/ha	20-40-0	- do -	- do -
Peanut	Dyxie Giant	HT 50 x 20	3 living plants/hill	20-40-0	Foliar spray of recommended insecticide (Sevin & Azodrin)	Hill of 21 DAT + b spot weeding
Sweet Potato	C 35-1	HT 50 x 20	1 cutting/hill 44,333 cutting/ha	30-30-60	- do -	Hill-Up 3 WAT + b spot weeding
Cassava	Indonesian #17	HT 100x75	1 seedpiece/hill 8,000 seedpieces/ha	50-50-50	None	None

Note: HT - High Tillage ZT - Zero Tillage

Table 27. Recommended agronomic practices used for cropping pattern trials, Bukidnon Settlement, CY 1980-81.

Crop/ Variety	Spacing (cm.)	Seeding Rate	FERTILIZER Rate kg./ha.	FERTILIZER Time of Application	INSECT CONTROL Chemical	INSECT CONTROL Rate (kg. a.i. per ha.	INSECT CONTROL Time of Application	WEED CONTROL
LOWLAND RICE								
IR36	20 x 20 (wet)	60 kg/ha	40-30-0	20-30-0 Basal	Furadan 3G	0.5 1.0	Seedbed Soil Inc.	Butachlor at 1.0 kg a.i./ha. (Granule at 4 DAT+spot weeding at 4 WAT
IR50	15 x 18 (dry)	90 kg/ha	40-30-0	20- 0-0 Topdress at 45 DAS	Azodrin 202	0.75	Pre-milking	
					Thiodan 35 EC	0.75	Eco. threshold	
UPLAND RICE								
UPLRI-5	25 cm. Furrows by lithao	100 kg/ha	60-30-30	30-30-30 Basal	Furadan 3G	1.0	Soil Inc.	Butachlor at 2.0 kg. a.i./Ha+Handweeding at 4 WAE
				30- 0-0 Topdress at 55 DAE	Sevin 85 wp	1.0	Pre-milking	
CORN								
Early DMR Comp #2	75 x 20	3 seeds/ hill or 15 kg/ha	60-30-30	30-30-30 Basal	Furadan 3G	0.5	Soil Inc.	Plateau off baring at 14 DAE & hilling at 28 DAE
				30- 0-0 Sidedress at 25 DAE	Sevin 85 wp	0.75	Eco. threshold	Sideslope hilling-up at 21 DAE
MUNGBEAN								
CES ID-2	50 cm. Furrows drilled	18-20 seeds/ 1 m.	20-30-30	Basal	Furadan 3G	0.5	Soil Inc.	Hilling-up at 14 DAE
					Azodrin 202	0.75	Eco. threshold	Spot weeding at 21 DAE if needed
					Dithane M45	2.0	Eco. threshold	
SOYBEANS								
Clark 63	50 x 20	3-4 plants/ hill	20-30-30	Same as mungbean	(Same as mung)			
PEANUT								
CES 10	50 x 20	3-4 plants/ hill	20-30-30	Same as mungbean	(Same as mung)			