

INTEGRATED PEST MANAGEMENT IN RICE IN INDONESIA

A SUCCESS STORY

J. Soejitno



ASIA-PACIFIC ASSOCIATION OF AGRICULTURAL RESEARCH INSTITUTIONS
FAO REGIONAL OFFICE FOR ASIA & THE PACIFIC
BANGKOK

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FOREWORD

APAARI publishes success stories of significant agricultural breakthroughs in the Asia-Pacific region to share the results of agricultural research and development among the member NARS and other partners. These success stories have been developed on specific topics and written by national experts in scientific/semi-technical style so that the research findings serve the need of a wide range of stakeholders, including the extension and other grassroot level workers and the farmers.

The subject treatment of these success stories published has particularly laid emphasis on popularization of improved agricultural technologies relating to farming systems and have stressed specially on technology adoption and sharing of knowledge among NARS, so as to enhance food security and rural development in the Asia-Pacific region.

This success story on 'Integrated Pest Management in Rice in Indonesia', is the fifteenth in this series and provides an interesting case study on research and development in this field, well planned and executed by the national programme, and well coordinated with all concerned partners through a participatory approach. The successes and achievements thus, are the results of cooperative venture by scientists, extension workers, farmers and other frontline workers in developing and implementing IPM Programme on a large scale and its adoption by farming communities. The IPM programme with greater emphasis on human resource development has brought about tremendous changes in farmers' behaviour and their field practices. The IPM

programme in Indonesia, thus, presents a cost-effective model, wherein complex methodologies have been institutionalized at the farmer's field level, and crop production benefits achieved at the national level.

It is strongly felt that the publication of this success story will serve well the member NARS and other stakeholders, by suitably adopting the methods/technology advocated on IPM in Indonesia curbing heavy losses in rice crop caused by several diseases and pests, through good field management practices, which helps in increasing crop production, boosting national economy and above all reduces dependance on use of chemical pesticides.

New Delhi
20 October 1999



(R.S. PARODA)

INTRODUCTION

For most Indonesians, rice is the major staple food, which supplies most of the carbohydrates and protein for their lives. Because of its importance in providing national food security and generating employment and income for the low income people, rice is regarded as a strategic commodity. Therefore, the government has kept rice in the food production programme as the top priority since the beginning of the series of Five Year Development Plan started in 1968. Strong commitment of the national leaders and the political stability supported by the hard work of people involved have led the country to self sufficiency in rice since 1984.

Rice production in modern times, while benefitting greatly from application of the green revolution technologies to meet the need, has been plagued with other problems. Implementation of the green revolution technologies, particularly using high yielding varieties, fertilizers and pesticides have contributed to the increase of rice production in Indonesia. Apparently the high rate of agrochemical use have also created some negative impact on the environment. Drawbacks due to pesticide application encouraged us to initiate better control measures for pests and diseases. The measure was primarily a blend of biological and chemical control and later has acquired a wider meaning known as Integrated Pest Management (IPM). IPM is implemented by utilizing a sound ecological approach, which is aimed at optimizing control measures rather than maximizing them.

IPM has been launched since 1979 and has become officially a government policy in plant protection in Indonesia. It has been realized that there are still many problems in implementing IPM, since it is a dynamic process. Since 1989, the government of Indonesia has been undertaking a large-scale IPM programme that works directly with frontline agricultural extension workers and a large number of farmer's groups across the country. IPM programme's emphasis on developing human resources brings about tremendous changes in behaviour and field practice, enabling farmers to escape from previous habits and threatening advertisements of persuasive chemical companies. IPM in Indonesia has evolved concepts by honing the skills of fieldworkers and farmers in ecology-based methods where decision making and field management are based upon agro-ecosystem analysis and hands-on fieldwork. In review and evaluations to date, the programme has been judged to be successful at getting complex methodologies "institutionalized" at the farmer's level.



A vast area is covered under irrigated rice in West Java, Indonesia

AGRICULTURAL RESOURCES

Indonesia is an archipelago consisting of more than 13,000 tropical islands which stretch along the equator between the mainland of Southeast Asia and northern part of Australia. The country extends 5,000 km from east to west. Indonesia consists of the world's largest islands: Kalimantan, Sumatra, Sulawesi, Irian Jaya, and Java as well as the world famous island of Bali. Indonesia is the fourth most populous country in the world with an estimated population of around 200 million in 1998. The island of Java, which covers only 7 per cent of Indonesia's total area supports about 60 per cent of the population (Fig. 1). Java has the most fertile soil and

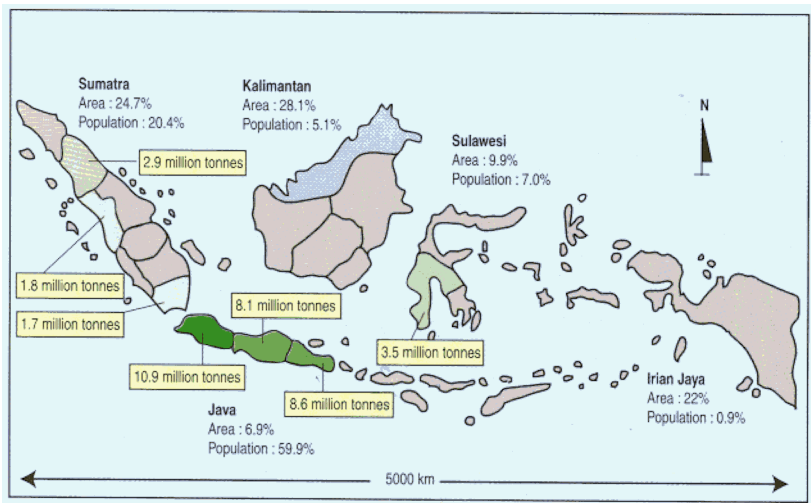


Fig. 1: Area, population, and rice production of five major islands of Indonesia, 1992

accounts for most of the country's agricultural and industrial output.

Of Indonesia's total land area of about 202 million hectares, forest land occupies 112 million hectares. Approximately 52 million hectares are devoted to various agricultural activities, of which, around 8 million hectares are wetland suitable for rice cultivation. More than 50 per cent of the wetland receives irrigation water, which makes it possible to grow two or more crops per year. Most land holdings in Indonesia are very small. In 1993, more than half of the 21 million total farm households owned or cultivated less than 0.50 hectare. Nevertheless, these small farms are the source of income for the majority of farm households in Indonesia. Therefore, the efforts to increase food production, especially rice, have been focused on small farms instead of rice estates.

AGRICULTURAL SHARE IN NATIONAL DEVELOPMENT

During the last two decades, Indonesia has shown significant progress in national development with the agricultural sector playing an important role. During the fifth and sixth Five Year Development (1988-1998), the role of agriculture was integrated further into the objectives: (1) to sustain and improve food self-sufficiency; (2) to increase agricultural production which provides raw materials for industry and export; (3) to increase farm productivity and added value of agricultural products; and (4) to increase farmers' income as well as to improve their welfare.

The agricultural sector has contributed significantly to the nations' gross domestic product (GDP). In 1991, more than 19 per cent of GDP came from agriculture and forestry. In providing food for the nation, agriculture has also shown a significant achievement. Rice production, for example increased by more than 70 per cent during the last two decades, from 26 million tonnes in 1973 to 48 million tonnes in 1992. In the same period, the production of other food crops (corn and soybean) also increased almost double and triple, respectively (Table 1). The production increase has provided a positive impact on the improvement of food consumption by the people.

Table 1: *Production of food crops in Indonesia: 1973, 1983, and 1992*

Commodity	Production ('000 tonnes)		
	1973	1983	1992
Rice (dry grain)	25,902	35,303	48,240
Corn	3,690	5,086	7,996
Soybean	541	536	1,870
Groundnut	290	460	739
Cassava	11,186	12,102	16,516
Sweet potato	2,220	2,210	2,171

INCREASING FOOD PRODUCTION

The programme of increasing food production is aimed at providing sufficient food for domestic consumption through increasing farm productivity, stability, sustainability, and equity. The government's policy in food crop production, especially the rice production programme includes: (1) development and adoption of modern technology; (2) motivation of farmers' active participation; (3) provision of farm inputs at proper times, location, quantity, type and price; and (4) establishment of floor and ceiling price.

Indonesia has experienced a long struggle to reach the stage of rice self-sufficiency. It was started with the Kasimo Plan during the revolution in 1948-1950, followed by the BIMAS (Mass Guidance) scheme in 1963/1964. Then the plan was shifted to BIMAS Gotong Royong (Mutual Cooperation BIMAS), INSUS (Special Intensification), and SUPRA INSUS (Modified INSUS). The development of BIMAS concept has induced changes and progress in farm society and its farming system. Key factors behind the success in achieving rice self-sufficiency include political will, systems approach, continuous generation of technology, progressive rural structure, mass guidance, socio-economic engineering, and a well coordinated programme.

Information and technologies have been generated in relation to production, economic, and social aspects. Improved varieties can be perceived as one of the most salient technologies which play a significant role in the rice production programme. These varieties

provide a higher yield of 5-8 tonnes per hectare within 110-135 days. Early maturing varieties allow farmers to increase their cropping intensity from one to two or three crops of rice per year. Since the introduction of IR5 and IR8 in 1967, more than 100 improved varieties have been released in Indonesia. During 1978-1998, the government released 43 rice varieties, mostly suitable for wetlands at low elevation environment (Table 2).

Further, contribution of researchers can also be seen in other programmes such as the IPM system, efficient use of fertilizers, and farming system. IPM encouraged integrated use of resistant varieties, appropriate use of natural enemies, and monitoring. The policy and strategy in the implementation of this system has contributed significantly to the success of the rice production programme (Fig. 2).

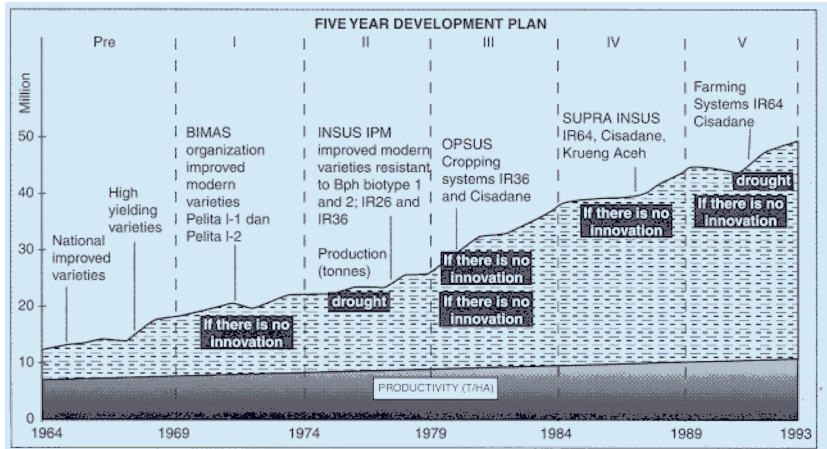


Fig. 2: Successful planning for self-sufficiency in rice in Indonesia

Table 2: *Modern high yielding rice varieties released in 1978-1998*

No.	Variety	Year	Duration (days)	Yield (t/ha)
1.	Citarum	1978	125-130	4.0-4.5
2.	Semeru	1980	122-132	4.5-5.5
3.	Cisadane	1980	135-145	4.5-5.5
4.	Cimandiri	1980	135-145	3.5-4.5
5.	Ayung	1980	135-145	4.5-5.5
6.	PB 42	1980	135-145	4.5-5.5
7.	Atomita 4	1981	110-120	5.0-7.0
8.	Cipunegara	1981	130-135	4.5-5.0
9.	Krueng Aceh	1981	125-135	4.5-5.5
10.	IR64	1982	110-115	4.5-6.0
11.	Atomita 1	1982	122-127	4.5-5.0
12.	Atomita 2	1983	120-125	4.5-5.5
13.	Sadang	1983	125	5.4-6.9
14.	Bahbolon	1983	120-125	4.0-5.0
15.	Kelara	1983	95-110	4.5
16.	Citanduy	1983	113-120	4.5-5.0
17.	Porong	1983	110-115	4.5-5.0
18.	Bogowonto	1983	115-120	4.5-5.0
19.	Cikapundung	1984	110-122	4.5-5.0
20.	Cisokan	1985	110-120	4.5-5.0
21.	Progo	1985	125	4.5-5.0
22.	Cimanuk	1985	117	4.5-6.0
23.	Bahbutong	1985	115-125	4.0-5.0
24.	Tuntang	1985	115-125	4.5-5.0
25.	Batang Pane	1985	115-125	4.5-5.0
26.	Tajum	1985	120-130	4.0
27.	Cisanggarung	1985	125-135	5.0-6.0
28.	Dodokan	1987	100-105	5.1
29.	Jangkok	1987	95	4.7
30.	Ciliwung	1988	121	4.8
31.	Walanai	1989	120-125	5.0
32.	Lusi	1989	135	4.0-5.0
33.	Way Seputih	1989	125	5.0
34.	Barumun	1991	125-130	5.0-6.0
35.	Bengawan Solo	1993	117	4.5-6.0
36.	Cibodas	1995	110	6.9
37.	Memberamo	1995	115-120	6.5
38.	Cilosari	1996	110-125	5.0-6.5
39.	Batang Anai	1996	115	6.4
40.	Digul	1996	115-125	5.0-7.0
41.	Maros	1996	110-115	6.3
42.	Cilamaya Muncul	1996	125-130	5.0-6.0
43.	Way Apo Buru	1998	115-125	5.0-8.0

RICE PRODUCTION AND PESTS

Rice production in recent times, has benefitted greatly from application of green revolution technologies, including the impact of various guidance (BIMAS) programmes to meet its increasing demand. However, it has been plagued by several other problems. Primary among these problems are frequent outbreaks of pests and diseases. Rats (*Rattus rattus argentiventer*), brown planthopper (*Nilaparvata lugens* (Stal.)), rice stemborers (*Scirpophaga innotata* (Walker) & *S. incertulas* (Walker)), and rice tungro disease were considered as the most important pests of rice in Indonesia.

Estimates of damage and yield losses due to rice pests vary widely according to pest species, varietal reactions, growth stage of plant, and health conditions of the plants (Fig. 3).

As an example, the following is a chronological description of the major pest outbreaks that occurred during the implementation of the green revolution technology of rice production in Indonesia.

Rice tungro virus

In 1972/73 crop season, the rice tungro virus (RTV), transmitted by the green leafhopper (*Nephotettix virescens* (Distant)) became a major disease particularly in the province of South Sulawesi causing yield reductions of 50-87 per cent on over 40,000 hectares of rice.

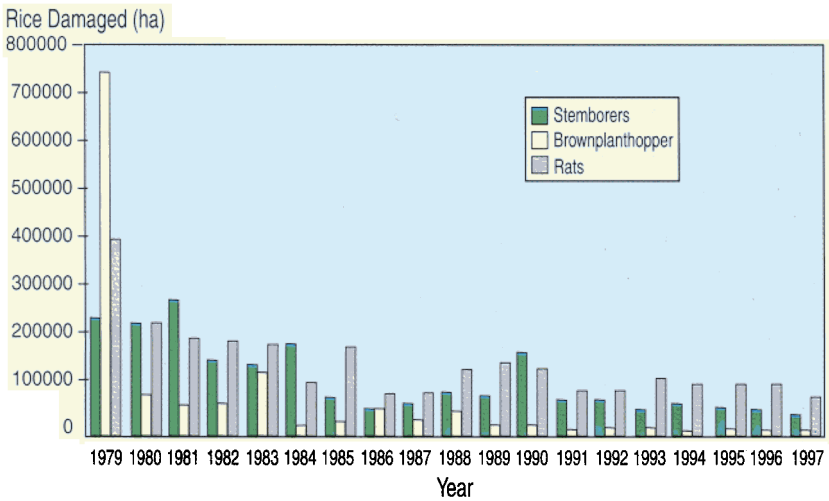


Fig. 3 : Total area damaged by major rice pests



Damage caused by rice tungro virus

In 1980/81 crop season, more than 4,000 of the 12,000 hectares of infected rice in the province of Bali were destroyed by the RTV.

Brown planthopper

In 1976/77 crop season, the brown planthopper (BPH), evolved in status from a minor to a major rice pest. When the insect is present in large numbers, it directly damages the plants, which is called "hopperburn". Resurgence of the pest is found to be induced by a number of insecticide formulations frequently applied in rice. In addition, the insect is an effective vector of both the grassy stunt virus (GSV) and the ragged stunt virus (RSV) diseases. An average of about 30 per cent of the 450,000 hectares of rice infested was totally damaged by these pests in this crop year. The loss was estimated at over \$100 million with enough rice being destroyed to feed more than three million people for a year.

In 1986 crop season, a massive outbreak of BPH in parts of Central Java destroyed about 75,000 hectares of rice fields and provided proof that most of the organophosphorus insecticide formulations in use at that time, caused BPH populations to resurge.



Hopperburn in rice caused by BPH

Rice stemborers

In 1989/90 crop season, the white rice stemborer epidemics took place along the north coast of West Java which is the major rice bowl for that province. More than 75,000 hectares were heavily damaged by the pest causing yield losses of around 250,000 tonnes of rice.



Damage caused by stemborer

Rats

Rats always pose a threat to many food crops. The average area damaged by rats annually in Indonesia is estimated between 150,000 and 250,000 hectares with crop losses in these areas estimated at 17 per cent.



Damage caused by rats

PESTS-PESTICIDES-ENVIRONMENT

During the early years of the BIMAS scheme, pesticides were relied on to protect the rice crop from pest attacks. It was entirely a pesticide-based pest control system. The goal was to keep the crop clean from any unknown organisms that may do harm to the plant. The prevailing belief in those days (still existing today) was that pesticides were a mighty weapon to guard and protect the rice plants from any and all pests. Pesticides were incorrectly regarded as highly effective medicines to heal plants suffering from pest attacks. This belief led the government to subsidize the pesticides used in the BIMAS programme up to even 80 per cent of the total cost of the pesticides.

Under the BIMAS programme, time of application of the pesticides to the rice crop was fixed following a calendar schedule, usually 4 times during the growing season, regardless of the presence or absence of the pests. In case of pest attacks, the frequencies of pesticidal sprays were increased. Aerial sprays were also carried out for the first time in 1968-69 in attempts to control the yellow rice stemborer (*Scirpophaga incertulas*) in the northern plains of West Java province. Aerial sprays using ULVs were also conducted to control BPH, throughout the main rice centres of Java, North Sumatra and Bali, covering an area of not less than one million hectares. The pesticides used were of broad

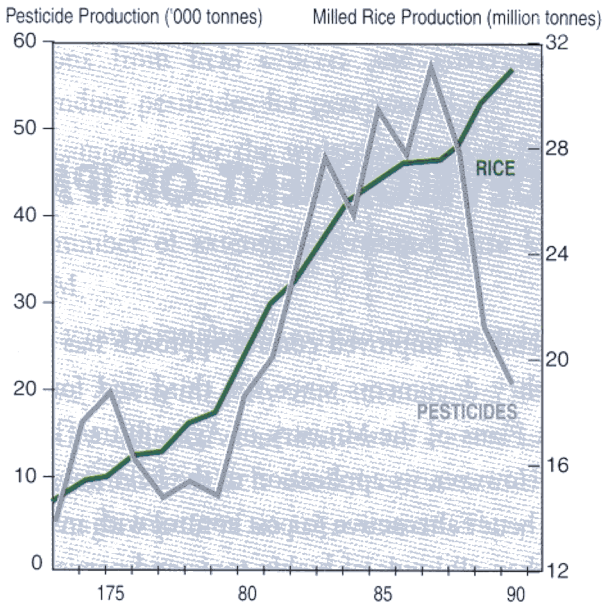


Fig. 4: Pesticide usage and rice production in Indonesia (1973-1990)

spectrum and mainly those belonging to the organophosphorus group of insecticides. The use of pesticides increased until 1986 and further decreased after that year (Fig. 4).

DEVELOPMENT OF IPM

IPM as a potentially improved control approach has been included in official policy documents since the third and fourth Five Year Development Plans of the Ministry of Agriculture (1979-1984 and 1984-1989). However, its application in the field was limited. It was not seen as a better alternative to pest control with insecticides until the 1970's, when all kinds of highly toxic and persistent pesticides were widely applied. The first large scale implementation of IPM on rice pests was against the BPH, in the 1979/1980 crop season. The control tactics applied included: (1) cultural control (synchronized planting and crop rotation over wide areas with a defined cropping pattern involving two crops of rice and a non-rice crop or fallow, with selective sanitation aimed at destroying stubble and ratooning after harvest); (2) utilizing high yielding resistant varieties; and (3) judicious use of pesticides, depending on pest numbers based on (4) surveillance data. This provided a better chance for the natural enemies (predators and parasitoids) to function as control agents. Although pest outbreaks became less frequent and less severe, the rice crop continued to be threatened due to several constraints:

- pesticide subsidies encouraged their overuse by farmers because they were easy to obtain at low cost,

- the farmers were almost entirely dependent on guidance or instructions from field officers and government agencies recommending pesticides for pest control,
- massive campaigns for the widespread use of pesticides were conducted by the pesticide industry,
- limited number of extension personnel were knowledgeable about IPM,
- external factors continued to exist to promote and sell pesticides.

In addition, during the early implementation of IPM programme for the BPH, RTV and rats, some associated economic and political problems were surfaced which needed organizational/institutional innovation through inputs of social scientists. These included:

- Convincing farmers to understand the advantages of IPM.
- To mobilise and educate a large number of farmers to make it possible to carry out synchronized planting and crop rotations over wide areas. In order to implement synchronized planting, irrigation water distribution had to be regularized so that water was made available to groups of farmers with land in designated large areas in a timely manner.
- To facilitate synchronized planting and crop rotation, the farmers need to be organized into production units, today known as “kelompok tani” (farmers groups).
- Very low prices for crops other than rice made farmers reluctant to adopt synchronized planting and crop rotation even though they understood the benefits. Equally important is that, because the piece of land cultivated by each farmer is very small, they were compelled to look for a job other than farming. This situation makes it difficult to implement large scale synchronized planting and crop rotation.

- The low acceptance by consumers (ca 20-25 per cent) of the existing, high yielding, resistant varieties due to poor cooking quality with resultant lower market prices, induced farmers to simultaneously grow susceptible varieties with desired cooking quality. In many cases, farmers returned to growing susceptible varieties after a few successful cropping seasons despite the risks of BPH and disease epidemics.
- Limiting the number of pesticide formulations permitted for use in rice and allowing only pesticides of narrow spectrum.
- Close cooperation among local government authorities, extension specialists, field technicians, and researchers for effective implementation of IPM programmes. Annual meetings at the national level and periodic meetings at the provincial level are assisting mechanisms.
- More intensive review and evaluation of the programme by cooperating agencies so that there is better implementation.

IPM FOR DEVELOPING HUMAN RESOURCES

The extensive BPH outbreaks in parts of Central Java in July-August 1986 covering an area of about 75,000 hectares, caused concern at the highest level of government because past experiences showed that the pest could spread further and would affect the rice bowl areas in the neighbouring provinces. The BPH epidemics became a real threat to the rice self-sufficiency that had been achieved with great difficulty. This situation was the basis for promulgating the Presidential Decree No. 3/1986, which support the following objectives:

- IPM should be utilized as the strategy for pest control on rice and it should be based on a farmer-ecological approach rather than a pesticide-based pest control,
- IPM should be viewed as a means for developing human resources at the farmer's level. The farmers, IPM field officers, and extension workers in IPM practices, and higher echelons and local governments, should guarantee support to IPM,
- increased efficiency of inputs, particularly reduced pesticide use,
- maintaining and improving the quality of the environment and protecting both producers (farmers) and consumers.

Following the Decree No. 3/1986, the government banned 57 broad-spectrum insecticide formulations used for rice production. Only a few narrow spectrum insecticide formulations were permitted

to be used on rice. However, in the field many farmers, primarily those not yet trained in IPM, were still applying the banned insecticides on rice, because of ignorance or lack of information from their field officers. This might be the reason why some rice pests, like the BPH are still a threat in some areas. This resulted in banning the re-registration of 28 active ingredients of insecticides out of the 57 broad-spectrum formulations by the Ministry of Agriculture in July 1996 (Table 3). This policy has become essential to the farmer-ecological-based IPM implementation.

In addition, the government's subsidies on insecticides for rice were gradually reduced from 80 per cent before the Presidential Decree to 40-45 per cent in 1987 and in January 1989 the subsidies were totally withdrawn, which saved the government between US \$ 100-150 million per year (Fig. 5). These are the important policy supports for the successful implementation of IPM.

Table 3: Active ingredients of pesticide banned from re-registration

1. Acephate	15. Fenthion
2. Azinphos-methyl	16. Isazophos
3. Carbaryl	17. Malathion
4. Carbophenthion	18. Mephosfolan
5. Cartap hydrochloride	19. Methamidophos
6. Chlorpyrifos methyl	20. Methomyl
7. Chlorpyrifos	21. Monocrotophos
8. Cyanophenphos	22. Omethoate
9. Diazinon	23. Phenthoate
10. Dichlorvos	24. Piridafenthion
11. Endosulfan	25. Phosphamidon
12. Etrinfos	26. Quinalphos
13. Fenitrothion	27. Triazophos
14. Fonophos	28. Trichlorfon

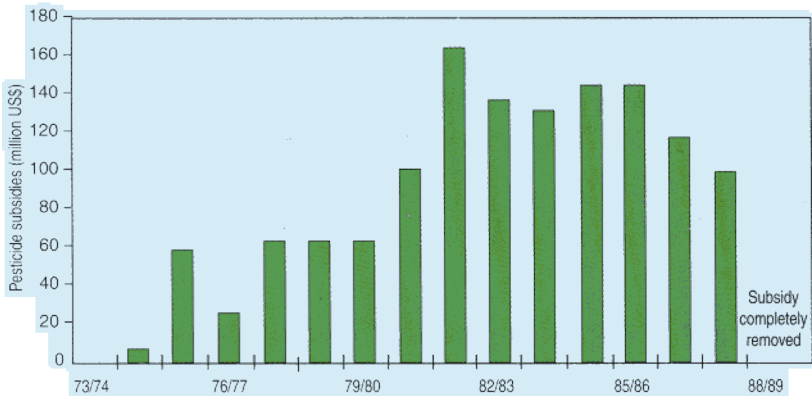


Fig. 5 : Pesticide subsidies in Indonesia, 1973-1989

The government's decisive action provided not only major institutional credibility for IPM but also brought awesome responsibilities for its continued implementation. The following resource and action areas are chosen to exemplify the essential components for successful IPM implementation:

- Developing human resources at the farmer's level. This includes educating farmers on IPM principles. They should be capable of implementing IPM programmes in their own fields. Key to this capacity is decision making by the farmers themselves on how to cope with pest problems based on IPM principles. The farmers themselves should master IPM technology - they should become experts in IPM themselves - IPM by farmers not IPM for farmers. Human resource development is a continuing priority in both the public and private sectors of Indonesia's economy.
- Strengthening institutional capabilities for the collaboration was necessary to effectively implement and sustain the IPM programme. Institutions which both provide and facilitate the useful management of knowledge required for IPM application

span both the public and private sectors. Human resources provide the needed innovations, and in the case of IPM, the essential continued monitoring and evaluation of the many processes involved.

To assure the continuity of food (rice) supply at levels that meet the consumption demand in which IPM is also expected to play its role.

By both its name and nature, IPM integrates knowledge from a number of biological sciences (entomology, plant pathology, weed sciences, resistance plant breeding, agronomy, plant physiology), economic and social sciences in relation to pest control. To make it work in the fields as part of the farmers' practices, it requires the close cooperation of the scientists of the various disciplines with field practitioners, and of course with the farmers themselves.

To take up the challenges, the National IPM Programme should be designed not only based on ecological principles - a technology which is environmentally friendly and very much concerned with the health of both consumers and producers, but also by giving equal importance to the socio-economic environment and the educational aspects suited for the farmers. It follows that IPM is not a package of technology that should be implemented in the same manner all over. Moreover, as pest problems may vary due to various ecological factors, IPM is a totality of measures to grow a healthy crop, which starts from selecting good and viable seeds to postharvest and storage practices.

IPM by farmers, means that the farmers should understand the why (the reasons for doing this and not that) in coping with the pest problems, and they should be motivated to practice it in their fields. This requires careful planning on how to convey the IPM message

to millions of farmers. Contrary to past experiences, it is not enough to provide them with the various technical know how on how to control pests, because they were still incapable of making decisions by themselves to control pests. They were almost entirely dependent on recommendations issued by the field pest observers through field extension workers who were mostly recommending the use of pesticides.

THE NATIONAL IPM PROGRAMME

Organization

To implement IPM in rice, the National IPM Programme was established in 1989, coordinated by the National Planning and Development Agency (BAPPENAS) of the Republic of Indonesia. The programme was managed by a Steering Committee (SC) consisting of members appointed from the Ministries of Agriculture, Home Affairs, Environment, leading Universities and the Statistical Bureau. The SC was assisted by a Working Group (WG) composed of a limited number of IPM experts and administrators, who were also members of the SC, and the FAO. The SC is responsible for outlining the policy guidelines while the task of the WG is to see to it that the daily programme of IPM training is carried out properly according to schedule.

From 1989 to 1992, the implementation of the IPM programme included curriculum development, training methodologies, and some relevant field studies to strengthen the implementation of IPM. During 1993-1994 fiscal year, transfer of the programme was processed from the BAPPENAS to the Ministry of Agriculture. A new set up of organization and personnel were established to manage the programme, but the long term goals of IPM remained unchanged (Fig. 6).

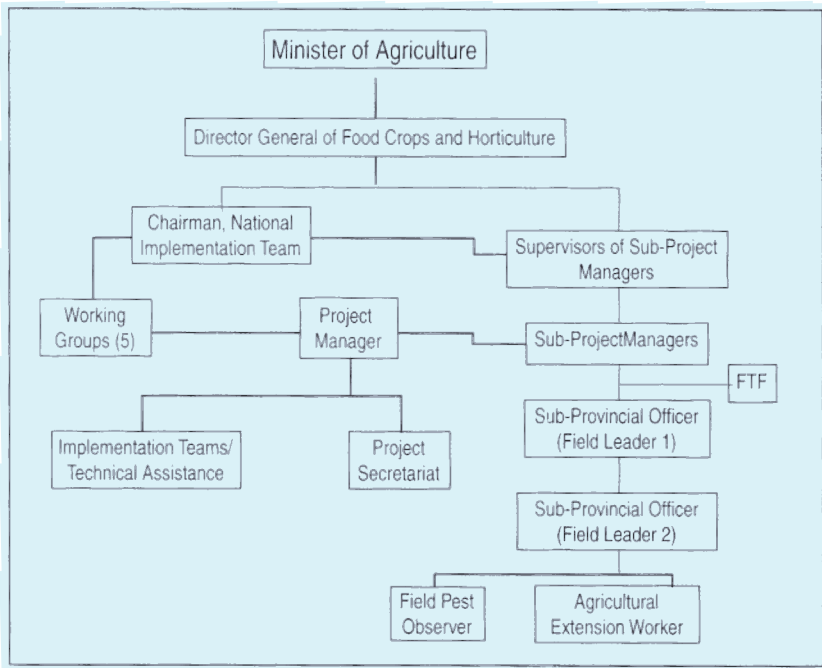


Fig. 6 : Organization of National IPM Programme in Indonesia

Since the beginning of the programme, both the provincial and the district (*kabupaten*) governments, including the resident representatives of the Ministry of Agriculture in each province, the heads of the agricultural services, training, and plant protection are supporting fully the National IPM Programme, in terms of finance (partly) as well as active participation for smooth running of the programme.

Programme scope and priorities

During the first two years of the programme (1989-1991) only six provinces were covered (West - Central - East Java - Yogyakarta - North Sumatra - South Sulawesi), which produce about 70 per cent of the national rice supplies. Later on, as other provinces began to see the

benefits of the programme, they also requested for the same IPM to be carried out in their provinces. The central government agreed to extend the programme in the other six provinces (Bali, West Sumatra, South Sumatra, Lampung, Aceh, and West Nusa Tenggara), where also rice cultivation is very important (Fig. 7).



Fig. 7 : The major rice production provinces covered by IPM programme in Indonesia

Human resource development: farmers first

The plan aspired to train 100,000 farmers during the first two years (1989-1991) from the six main rice growing provinces mentioned earlier. Initially, 22 selected field pest observers (FPOs) were given rice IPM training for an entire rice growing season. This was followed by an extension activity where these FPOs were sent to rice fields to train rice farmers in IPM for one season. Thereafter, they went back to the training centre to receive training in non-rice IPM (soybean, corn, and low altitude vegetable crops) for another four months. At the end of the programme, they were given the title Field Leader 1 (FL 1). Another 90 selected FPOs were given a two-week rice IPM training, who were then given the title Field Leader 2 (FL 2). One FL 1 assisted by two FL 2, are the key trainers in the

Field Training Facilities (FTFs) located in the provinces to train the other FPOs and Field Extension Workers (FEWs) and of course the farmers. These FPOs also receive a one year full training in IPM (rice IPM - extension - non-rice IPM), after which they are enrolled for one semester at a collaborating University for a D1 diploma on pest control. They are called IPM trainers. The FEWs receive a two-week rice IPM training at the FTFs. After completion of their training at the FTFs, they are sent to their respective original places to train the farmers. This phase of the programme was called the dissemination period. Each FPO was assisted by two FEWs to train four farmer's groups of 25 persons each. The training of each group was conducted once a week, for five to six hours a day, for 12 weeks. Thus one FPO spent four days a week to train the four groups of farmers. On the fifth day the FPO, led by FL 1 or FL 2, held a meeting to share each other's experience and discuss the programme for the following week.

Farmers are chosen for IPM training through the help of the FEWs who have been closely working with the farmers in the area for a long time. During one farmers' gathering, it was explained to them that a special training will be conducted on how to cope with pest problems which is more reliable and more efficient, namely the IPM.

Both the older (age 50-70 years) and younger (15-35 years) farmers are encouraged to join. An average of about 25-30 per cent of the group consists of women. There is a wide variation on the level of education among the participating farmers, from uneducated (mostly older ones), to high school pass, and up to college graduates. In some areas, village heads and other non-farmer village personalities are also interested in joining the IPM training. This is important, because it gives a positive impact to the farmers' group.

Training methodology

The training method was designed with the understanding that the farmers to be trained, already had years of experience in growing rice. The emphasis of the training was to make the farmers understand more the cause and effect relationships of steps in the production process within the rice ecosystem, such as effects of too much dependence on pesticide applications for pests problems, environmental pollution and the unwanted side effects of pesticides, human hazards and the efficiency of production inputs. For this purpose, the trainees were requested to look at things for themselves to discover, to carry out simple experiments, to discuss with fellow participants, to analyze, and to finally decide alternative ways to solve the existing pest problems rather than depend on only using pesticides. Other problems such as the needs for more irrigation water, more fertilizer applications, weeding etc. in relation to pests were also given enough attention. This approach will lead farmers to look at pest problems as part of the management strategies of the total rice ecosystem.

In essence, the training methodology is an active participatory process of learning by doing. It might be more appropriate to call this farmer's education rather than farmer's training in IPM, because the aim is to educate farmers.

To expose the farmers to the reality of what is happening in the rice field, a 2,000 m² rice field was provided and it became the real blackboard to record what happens there and the findings are used as teaching materials. Written training materials were also provided to each of the participants. Coloured pictures on insect pests and diseases and their natural enemies were provided along with instructions for carrying out simple experiments, insect zoo construction, insect collection and others. The field was divided into two halves: on the one half farmers plant modern rice varieties

(IR 64 or others) using techniques they have usually practiced (such as mixing chemical fertilizers with granular insecticides as preventive measures, and applying insecticidal sprays at fixed intervals without regards to the presence or absence of pests); in the other half of the field they plant the same modern rice varieties, but follow IPM principles, as given below:

- **Grow a healthy crop:** encompassing varietal selection, seedbed management, plant nutrition and physiology, water and weed management.
- **Optimize natural enemies:** recognizing beneficials in the field, learning insect population dynamics, life cycles, and food webs; understanding the effects of pesticides on beneficial populations, promoting survivorship of predators through habitat management, and making local reference collections.
- **Observe fields weekly:** including recognition of damage symptoms, changes in insect populations, evaluation of plant growth and physiology, relationships between plant stages and insect populations, effects of weather conditions, and water and nutrient management.
- **Farmers as experts:** agro-ecosystem analysis and decision making based upon information directly observed and collected, train farmers to make sound crop management decisions across the season. Farmers learn to draw sound conclusions from observation of their fields during each stage of the crop.

Each farmers' group of 25 people was divided into 5 sub-groups each. Each sub-group has its own local name chosen by the participants themselves, usually adopting insect names, preferably beneficial ones, such as spider sub-group, butterfly sub-group, or lady beetle sub-group, etc. Others choose local flowers or a favoured village to name their sub-group. One participant is chosen by the sub-group as a spokesman for each session.

The training session usually starts at around 7.00-7.30 in the morning. After the trainers outline the programme of the day, the participants enter the muddy rice field. Each sub-group selects its own sample plants for observation. One participant of each sub-group is assigned to be the reporter. First they observe the weather condition (cloudy, rainy, or sunny); then they closely examine the plants (trying to distinguish between a healthy and a poor growing plant), the irrigation water level (either too much or too little water, stagnant or running water), and the weed situation. Further, they look for the presence of insect pests on the plant, which may be found at the base of the plants, the leaves, and the culm. Then they also look for the presence of predators (spiders, lady beetles, crickets, dragon flies, etc.). This field exercise lasts for about one to one and a half hours, after which each sub-group selects a shady place to describe their findings on a large piece of paper. With colour crayons they draw a full sized rice plant, sunny day or cloudy, water level, weeds, insect pests with their natural enemies complete with local names and their



FFS participants taking field observations



FFS participants conduct an analysis of field condition

respective numbers and in which parts of the plant they were found. After a short discussion they agree to write their comments and conclusions, for example: the plants look poor, need additional chemical N fertilizers; plants still need water; field too weedy - needs weeding; number of BPH/plant average 3-4/plant, while predatory spiders average 1/plant, insecticide application not needed, because number of pests and their natural enemies are still in “balance”. If the number of pests exceeds that of its predators, for example, in the case of BPH, 10 individuals or 20 per plant, they still do not apply insecticide, instead they will closely observe them the next week. Because they know from the exercise on predator-prey relationship that one spider can devour not less than 10 or 20 BPH/day. It is proven to be true that the BPH number a week later has been reduced to only a few. The idea of balance in numbers of predator-prey came from the farmers themselves, not from researchers.

Each sub-group presents its findings and analysis to the whole group of farmers. The discussions were intense and sometimes



FFS participants discussing their analysis of field condition

generated heated debate, because each sub-group tries to defend its own ideas. Different opinions arise in particular with regards to applying insecticides or about a newly discovered insect. In this situation, the trainers facilitate and help to solve the problem.

The rest of the day is spent conducting discussions on special topics, such as making insect collections, preparing an insect zoo in a caged rice plant, experimenting on the action of a predator species on an insect pest, studying of the effects of an insecticide formulation on the predator and some non-target species such as frogs and fish. Some social/community programmes are also organized with the objective that group actions are more efficient and successful to solve many field problems, for example in controlling rat epidemics.

In these training sessions, the farmers seriously participate, but the way the training is conducted is informal, both the trainers and the trainees participate together as a group. Such an environment is important to encourage the participants to think and feel free to express their ideas.

Benefits and impacts gained by educating farmers on IPM

The ten-year period since the issuance of the Presidential Decree No. 3/1986 and educating the farmers in IPM is only a short time in the rice production in Indonesia. It remains to be demonstrated that high production levels can be sustained for a long period of time and in particular on the contribution of the farmer-ecological-based IPM in stabilizing production, reducing the environmental pollution, and increasing the efficiency of production inputs. In this respect, it is encouraging to note that achievements and benefits are favourable which include the following:

Broaden farmers' knowledge and skills

Adopting the active participatory learning by doing approach to convey the farmer-ecological-based IPM to the farmers proved to be highly effective to broaden their knowledge and learning skills towards decision making on how to cope with pest problems following IPM principles. For example, how to grow a healthy rice crop and why? what is the need for carrying out periodic monitoring of the pests and how to do it? how to carry out simple field trials for increasing efficiency inputs; how to distinguish between pests and their natural enemies and why natural enemies need to be preserved? After they observe that these natural enemies are actually devouring the insect pests, they consider these creatures as their good friends. The idea of balance between pests and natural enemies proved to be working well for decision making on applying insecticides. They sensed that it is wrong to decide to apply insecticides based on the result of one time of observation, because it is only a short moment of the long time process of pest-natural enemy interaction. They have a clear understanding that pesticides are actually dangerous poisons capable of destroying beneficial creatures, polluting the river water and soil, and causing human hazards (Fig. 8). This is contrary to earlier beliefs,

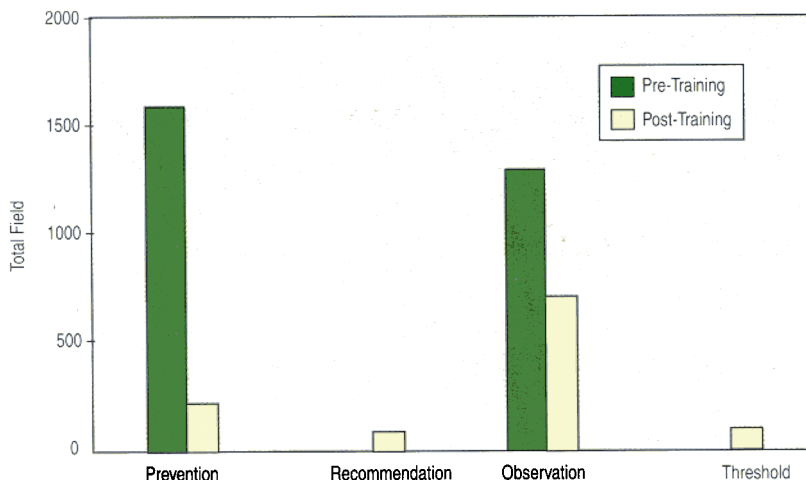


Fig. 8 : Impact of training on pesticide application

that pesticides were effective agricultural medicines badly needed to heal sick plants. This concept is gradually being replaced by the new IPM paradigm.

Revising the training methodology for the farmers

Since the beginning of the large scale rice intensification programme, the method of training the farmers was the well known 'train and visit' (T and V) programme. The field extension workers were scheduled to visit a farmers' group once every two weeks. The extension worker was informing the farmers of various aspects of modern rice production technologies with little demonstration or none at all. The trainer did most of the talking and the farmers were expected to listen carefully. The way the trainer conveyed the message to the farmers was more instructing rather than requesting them to actively participate in carrying out programmes in fields. There might be some discussion but the inputs did not come from the actual experience from the fields. This one way talk by the trainer made the farmers somewhat more skilled in carrying out things, the how,

but little to increase their understanding of the why. They were still almost entirely dependent on help from outsiders to solve their production problems. There was no IPM approach to cope with the increasing pest problems. The given recommendations consisted mostly of applying insecticides. The participatory approach of training the farmers already existed within the Ministry of Agriculture, but due to the busy schedule of the field extension workers there was not much time left to implement the participatory method. All efforts were geared towards boosting the rice production to arrive at self-sufficiency as soon as possible.

On the other hand, the active participatory learning by doing approach adopted by the farmer-ecological-based IPM significantly increases the farmers' knowledge and understanding of the cause and effect relationship of the components in the rice ecosystem and make them capable of deciding by themselves what to do following IPM principles.

As the Ministry of Agriculture realizes that the IPM approach of training the farmers is highly promising in developing a strong and sustainable agriculture, it is revising the old T and V programme with the active participatory learning by doing approach. For this purpose, a comprehensive programme has been made to first train the D3 graduates from the Academy for Agricultural Extension in IPM for a full one year period. Thereafter, these graduates are programmed to train the FEWs and the farmers in IPM and other agricultural technologies following the participatory approach.

Number of farmers graduated from the farmers' field schools

The activities of the IPM field schools are not carried out by the central government only, but the district governments and a number of NGO's have also been actively participating to carry out the same

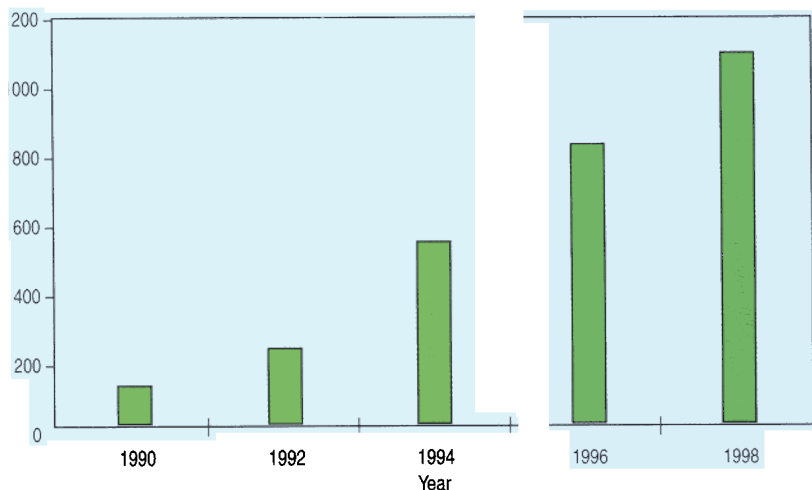
training since 1992. In field the training activity is going on all the time. Therefore, it is difficult to obtain the exact figure on the number of farmers who have already graduated in IPM. However, a conservative estimate made in 1998 indicated that around 1,100,000 farmers have already been trained in IPM (including those trained in high altitude vegetable crops around 10,000); 2,000 FPOs, and 6,000 FEWs (Fig. 9). These field officers are the real spearheads in training the farmers in the farmers' field schools. In addition, a number of other field officers, sub-district heads, agricultural high school teachers, and influential village personalities have also been exposed to IPM on a short term basis (Table 4).

Table 4: *Number of human resource personnel trained for IPM Programme in Indonesia (1993-1998)*

Type of training	Number trained	Per cent over the target
1. IPM Diploma 1	700	140
2. Orientation for FEW/FPO	1,500	136
3. Farmers	1,000,000	125
4. Field leaders (FL)	25,000	100
5. IPM Management for FL	6 units	100
6. Refreshing Technology for FPO/FEW	250	100
7. Foreign participants	16	100

Increasing efficiency of production inputs

Increasing efficiency of production inputs is mainly due to drastic reduction in insecticide applications. As substantiated by field surveys of 2,013 rice farmers in 72 districts carried out in 1991, the average application of insecticides were reduced by about 56 per cent (Table 5). This same trend was obtained in 1993 as a result of second



ig. 9: Number of farmers graduated from farmers' field school (1990- 1998)

impact studies, based upon 3,335 farmers (Fig. 10). In terms of money, the IPM farmers are able to save about Rp 100,000 (US \$ 1 = Rp 2250) per hectare per season as compared to those still practising the insecticide-based pest control (Fig. 11). It is important to note that despite reduction in insecticide use, no adverse effects on rice yields have been observed. In many instances, same yield increases have been found. Various factors may contribute to the yield increases in the IPM fields, but improved crop management practices (as mentioned

Table 5: Average application of all pesticides farmer before and after training

Province	Before		After		Per cent Change
	Mean	N	Mean	N	
North Sumatra	6.39	195	2.09	193	67
West Java	3.17	580	1.37	576	57
Central Java	3.10	483	1.93	476	38
East Java	3.02	394	1.51	384	50
South Sulawesi	2.99	318	0.58	315	81
All provinces	3.41	1970	1.48	1944	57

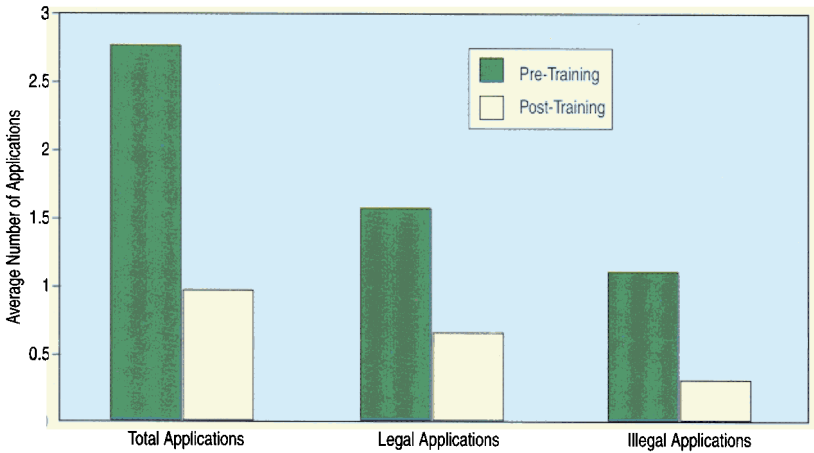


Fig. 10: Average number of insecticide applications per farmer

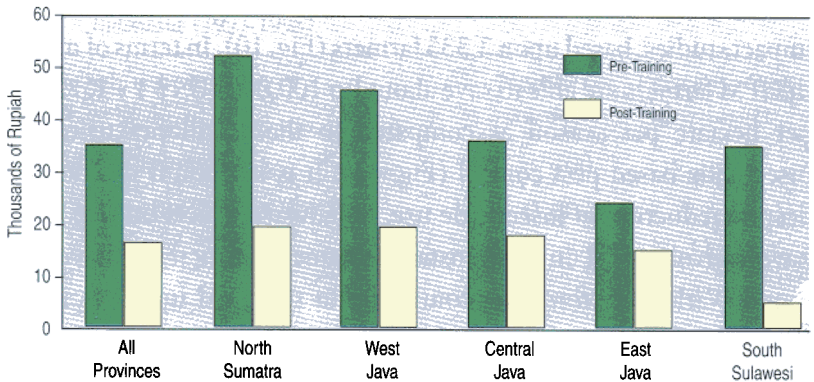


Fig. 11: Average expenditure on pest control per farmer

in the IPM guidelines: how to grow a healthy crop), may be the one contributing significantly.

Preserving the environmental quality and minimizing human hazards

Significant reduction of insecticide use since the issuance of the Presidential Decree No. 3/86 and in particular since the implementation of the national IPM programme by about 56 per cent in rice

or none at all in many farmers' field school, markedly reduces the risk of polluting the environment. This is substantiated by the increased number and diversity of organisms in the system such as the beneficial species (bees, natural enemies), and non-target organisms (frogs, eels, worms, snakes, water insects, carabids, and fish). Reduction of insecticide use to zero in many cases is advantageous for the rice-fish culture combination, which is commonly practiced in the rice ecosystem in many parts of the country, especially in the West Java province. Fish production provides the farmers with additional income and supplies animal proteins. In addition, it is believed, that fishes help maintain the soil productivity.

Additional advantage of reduction of insecticide applications is minimizing the risk of human hazards (poisonings of many kinds and death, to the applicators (the farmers themselves or the hired labour). Suggestions for safe use of insecticide applications, such as wearing heavy protective clothing, masks, and booth shoes is impossible in the humid and hot tropical climate. Instead, they wear thin T-shirts or keep upper body naked, and trouser or shorts, which subject them to poisoning through skin and breathing. The risks of insecticide contamination of the irrigation and river water is also minimized, which makes it more safe for use by many villagers for bathing, drinking and cooking.

Production stabilized due to reduction/elimination of serious pest outbreaks

Serious pest outbreak, for example the BPH, has not been encountered since the comprehensive implementation of the IPM programme. The pest caused light damage only occasionally in a limited area in some intensive rice centres, but could be contained well below economically damaging levels. The main reason for the come back of the BPH in those areas was when the farmers previously treated the rice with the

prohibited insecticides to try to kill other insect pests. Attacks of some other rice insect pests, for example the white stemborer in the northern parts of West Java in 1989/91 and 1991/92 crop seasons could be contained following IPM principles (Fig. 12).

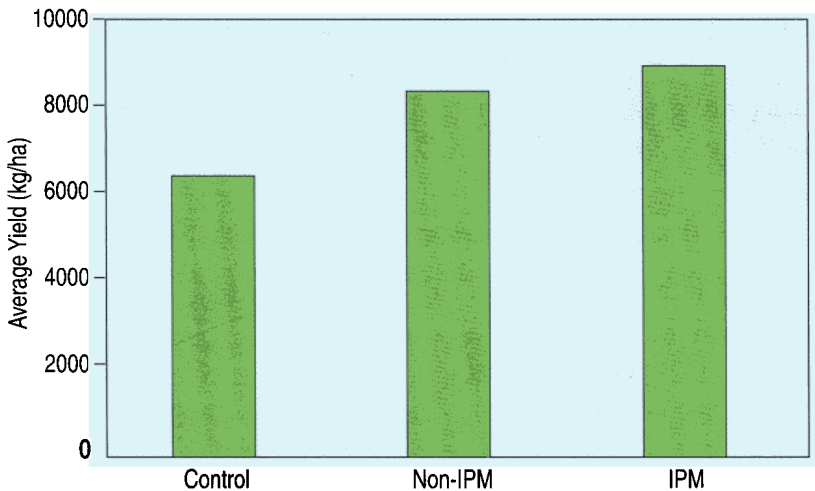


Fig. 12: Yield of rice of IPM and non-IPM fields

The RTV transmitted by the green leafhopper, and rats are still threatening in some parts of the country's rice bowls. Some of the important management tactics (synchronized planting over extensive areas, rotating of the rice varieties having different resistance genes against the insect vector, and sanitation of the field prior to planting to reduce the initial population of the pests) are difficult to carry out, because of certain socio-economic conditions of the farmers (jobs in other sectors, weak farmers' organizations, and uncontrolled water supplies).

The annual rice production at the national level continued to increase, which was mainly the result of yield increases per hectare. However, due to prolonged droughts, the rice area planted in the

1991, 1994 and 1997 crop years were reduced by about 2.10, 4 and 3.6 per cent, respectively. But the 1995, 1996 and 1998/99 crop years were good so that the rice demands for those years could be met.

Spread of IPM from farmer to farmer

Trained farmers are eager to share their knowledge of IPM with other neighbouring farmers not yet having the chance to participate in the farmers' field schools. The farmer trainers have been given additional courses and practices for a couple of days on methods of training after which they organize the training by themselves. Of course, in this regard both the FLs and the FPOs are always ready to help them. Field surveys indicated that there is a great interest of the farmers joining the IPM field schools. Observations indicated that there is no difference on the quality of their alumni with those trained by the FPOs. Again the exact numbers of alumni from these farmer to farmer IPM training is difficult to obtain because of poor reporting and the fact that the activity is happening all the time. This type of diffusing IPM to the farmers is an efficient way to help increase the number of farmers implementing IPM.

Institutionalizing IPM at the farmers' level

Since 1992 a follow up programme of IPM has been initiated with the objective of broadening the farmers' knowledge in the various production aspects other than only on how to deal with pest problems, such as choice of crop to be raised in the following crop season, assessment of the various production inputs, looking for financial resources, simple field studies for more effective and efficient inputs, and plans for diffusing IPM from farmer to farmer. This approach will guarantee the farmers to continue implementing (institutionalizing) IPM, after the project is terminated eventually. For this purpose, a farmer-based crop protection team is being established at the village

level, where the already trained farmers in IPM are actively making plans together with progressive and influential village personalities. The FL1s and FL2s, the FPOs and the FEWs also actively help them in facilitating their activities. To date, there are already available a large number of well trained farmers in IPM in the sub-districts (*kecamatan*), as key members of the team. Collaborative programmes are devised to establish strong linkage not only among members within each team, but also among teams to better cope with similar field problems, such as implementation of synchronized planting, crop rotation, and extensive sanitation.

Domestic and international collaboration

Collaboration with the FAO Regional IPM Programme was made in the 1980's when a number of pilot projects were designed together on how to implement IPM in fields with active participation of the farmers. Included in the programme were the dynamics of pests (BPH) - natural enemies as affected by insecticide applications. Also through the FAO periodic meetings, an exchange of information on IPM topics among participating countries in the region has been made possible.

Collaboration with the IRRI existed since its establishment in 1962. In our attempts to boost our rice production, IRRI provided us with the earliest developed modern varieties IR5 and IR8, followed by other modern ones with better agronomic qualities, including those resistant to a number of pest species. Exchange of germplasm has always been active between Indonesia and the IRRI which made us possible to develop our own modern rice varieties. Training of various kinds leading to both degree or non-degree provision for Indonesian scientists at the IRRI in collaboration with foreign universities has been highly rewarding for us to strengthen our research institutes and extension. Bilateral collaboration has also been developed between Indonesia and the Netherlands and Japanese Governments



Collaboration with neighbouring countries

in research as well as implementation aspects of food crop protection including training of our technical staff.

Interested neighbouring countries (India, Bangladesh, Sri Lanka, Thailand, Myanmar, Malaysia, the Philippines, Vietnam, South Korea, China, and from some African countries) sent their policy makers and high ranking officials to Indonesia to observe first hand how Indonesia is implementing the IPM by the ecological farmers' method. A number of these countries sent their field technicians to Indonesia for training in IPM for 2 to 3 weeks and upon request, Indonesia sent eight of her FLIs abroad to help them to train their trainers in IPM for a couple of weeks.

OLD PARADIGM/NEW PARADIGM

Agriculture and agricultural development have undergone changes that have been far reaching. The following table draws a comparison between older approaches to agriculture and agricultural development and approaches that are more recent and reflected in the Indonesian National IPM Programme. It is hoped that information tabulated below will help the reader to more clearly understand some of the underpinnings of the Indonesian IPM Programme.

Table 6 : Comparison of the old and new paradigm

Old Paradigm	New Paradigm
TIME AND SOCIAL CONTEXT	
The technological fix model. Post WWII approach made heavy use of industrial fertilizers and pesticides. In the 1960's this approach was intensified in reaction to increasing hunger, geopolitics, and pesticide producer competition. Green Revolution was a result of this intensification; people had to be fed. Pesticide producers were not opposed by entomologists or by environmentalists. Plant breeding was seen as the answer to hunger with miracle varieties requiring high nitrogen inputs being developed as the technological fix. Centralized planning approaches were put in place to develop and implement plans that would quickly solve the problem.	People centered systems model. Began in late 70's as environmental health came to be seen as important as economic health. People centered development and educational approaches were worked out. People became the focus of development as a way of getting the economy and society moving ahead. The Green Revolution was successful in getting enough food produced, but questions such as sustainability, health, environmental quality and local responsibility for development pose questions that Green Revolution central planners seem unable to answer. The Post-war saw nations become independent of colonizers; the Post-cold war will see individuals gain independence from central planners.

Old Paradigm	New Paradigm
PACKAGE TECHNOLOGIES	
Seen as essential to development of 'modern' agriculture. Seen as quick fix to avoid heavy investment in human resource development. People manipulated to 'grow' the economy.	Packaged technologies not working. Human resource development becomes a major focus, 'modern' agriculture grows because farmers are seen as the central focus for development activities. People must develop before economy can develop.
PESTICIDES	
Use of pesticides was unquestioned, considered as an essential element in increasing yields. Part of package that also uses high yielding varieties and chemical fertilizers.	Pesticides seen as problematic. They cause problems, must be used based on farmer's analysis of ecosystem and as a last alternative.
FERTILIZERS	
Necessary to increase yields. Use of fertilizers subsidized by governments to ensure application and thus maintain high yields.	Necessary to increase yields, but should be used on a need basis. P and K do not need to have continuous high application rates. N fertilizers are important for high yields. Use of organic fertilizers encouraged to maintain the high quality of soils and micronutrients.
HIGH YIELDING RESISTANT VARIETIES	
Necessary to increase yields and can be effective without training of farmers. Sufficient if used in a package that includes pesticides and fertilizers to give high yields.	High N response and high tillering varieties are useful for compensation against disease and insect damage. New varieties should be able to better compensate for insect damage. 'Resistance' is best limited to disease resistance and to some insects. Most pests can be controlled biologically.
PEST AND NATURAL ENEMY RECOGNITION	
Too difficult for farmers. Farmers, even if they could recognize pests and natural enemies are not capable of making complex decisions relating to populations and their interactions.	Recognition requires only a little training since farmers have seen these insects for years. Farmers able to analyze agroecosystem as a basis for making field management decisions.

Old Paradigm	New Paradigm
DEFINITION OF IPM AND DECISION MAKING IPM makes use of count and spray approach focused on pest populations in the field as they relate to a centrally determined Economic Threshold Level (ETL). ETL is based on conditions found at central research site. Mechanical instructions given to farmer: count, compare with ETL, spray when pest numbers over ETL. ETL often artificially low because government researchers are afraid of being challenged if outbreaks occur. ETL largely considers only pest populations and is based on partial budget calculations. Basic approach is that pesticides are a necessity.	
FARMER AS Impossible! Must be done with a highly technical centrally planned package.	OPTIMIZER Essential element. Farmers better able to optimize their own environment than a centrally planned package.
FARMERS AND TRAINING Must use extension system that markets centrally developed message. Extension field workers bring message that farmers are supposed to implement. Farmers can carry message, but they can't train other farmers. Only elements of centrally organized extension system can conduct training. Dependence of farmers increased.	Farmers are capable trainers. Approach is based on process of training not on a message to be conveyed. Farmers work in the field with assistance of local IPM expert to expand their field and analytical skills. Farmers can replicate this process with other farmers. Local situation defines topics and direction of training. Independence of farmers increased.

Old Paradigm	New Paradigm
RESEARCH Technology is developed in a central research institute and given to extension planners who then pass the technology down through training of trainers of extension workers and finally to farmers. Farmers and field extension workers are passive (sometimes forced) recipients of packages based on these technologies. On occasion, the research based packages become 'menus' or researchers for increased status. Research is not training driven, but drives training.	
FUTURE ADAPTATION OF NEW TECHNOLOGY Requires centrally developed message to be passed down through extension system to field workers and then to farmers.	
TRAINING EVALUATION Training results are evaluated based on the extent of a package's adoption by farmers. Evaluation is based on package and message planners' needs. Evaluation is conducted by central staff. Results of evaluation are used to determine if farmers are 'modern', 'accepting', or 'capable'.	
Research is carried out at all levels. Research centres continue to do basic studies where developing processes are employed to test research results locally. Local studies are initiated with full farmer participation. Thus varietal and fertilizer trials, sampling methods, natural enemy exclusion, and other research are conducted locally in the field. Field extension workers and farmers are full partners in the process. Research fulfills farmers needs, responds to real field problems and is training-driven.	
Farmers are both creating new technologies and processes as well as testing centrally developed packages.	
Training results are evaluated based on extent of modification and integration of new ideas/methods being presented in training and their benefit to farmers. Evaluation is used as a decision making tool to improve training so that farmers benefit from training and research. Field staff and farmers are involved in the development and implementation of evaluation. Results of evaluation are used by researchers to determine future research agenda. Extension system staff is evaluated by farmers.	

FACTORS RESPONSIBLE FOR SUCCESS

Six factors are considered very important in contributing to the success of IPM in Indonesia. These are as follows:

Faith in farmer's abilities

The IPM by farmers credo puts the farmers themselves at the centre of IPM development, and in the guiding philosophy of the Indonesian IPM Programme as well as a major reason for its success. Through IPM field school farmers become experts in their fields, mastering local ecology.

Broad-based policy support

In order for IPM to be successful, field implementation and supportive policy formation must progress in tandem. All the central level, government policy makers create and maintain a conducive policy framework, including regulation of pesticides, budgetary support, and mandates for IPM training and research. At local levels, the “buy-ins” by local government at provincial, district, and village levels, help to sustain IPM momentum. Collaboration with public organization, consumer groups, the press and supporting agencies involved in health, environment, and education provide further strength to the IPM movement.

Supporting research

Research breakthroughs in rice IPM produced by research institutions and universities enabled early programme to be built upon a sound

scientific foundation. Field oriented research on the cropping systems, most importantly, research and field studies have been integrated into farmers, extension workers, and researchers together to strengthen and refine IPM in response to the highly local specific ecology of tropical agriculture.

Learning through discovery

At the heart of successful IPM is an innovative, participatory learning process allowing farmers and field workers to discover for themselves the principles of IPM in their own fields. Through this process, farmers become the owners, and not just the implementors of IPM knowledge and IPM practices. IPM learning methods allow farmers to master effective crop management techniques, while gaining important interpersonal communication, problem solving, and leadership skills through direct practice.

Responsive, field oriented management

Implementing IPM on large scale requires an effective and committed field management system to be established that can respond rapidly to the ever evolving demand emerging from IPM farmer groups and network field staff. Farmers, in IPM are never purely “technical” because training always involves the development skills at all levels down to the farmer group. One of the keys to success in the Indonesian IPM programme has been the establishment of a 2,000 strong system of IPM field leaders and field workers. These field managers are responsible for both developing local strategies and responding to farmers technical needs, while building farmers organizational capabilities.

An ecological approach

The first thing one notices upon visiting an IPM-Farmer Field School is the agro-ecosystem analysis drawing accomplished by farmers.

From the outset, the IPM approach centred upon operationalizing an ecological perspective in farm management. IPM is not a pest about insect, rather it is a holistic approach encompassing a complete system: soil, water, weather, plant, nutrient cycles, food web, energy flows, farm economics, and farmers' health issues.

FUTURE CHALLENGES

Achievement and benefits gained so far with the implementation of the farmer-ecological-based IPM motivates the government to continue this policy as one important way to develop a strong agricultural sector leading toward agri-business, which should be sustainable, efficient and environmentally focused. Knowledgeable farmers educated from IPM farmers' field schools are an important national asset leading towards these goals. Developing a strong agriculture is a must for Indonesia for the following reasons:

- to better prepare Indonesia to meet the challenges in her agricultural enterprise for the coming 21st century globalization process with increased competition in terms of quality products, continuity of supplies, and good services, increased concern on environmental issues, depleting natural resources and increasing human population.
- in the decentralization process more responsibilities are being transferred to the district (*kabupaten*) governments from the central government. A number of agricultural programmes, including plant protection, has also been given to the local government. In this regard the district governments should be prepared to take up these challenges.
- to guarantee a continuous self-sufficiency of food supplies in terms of quality and quantity to all people, which play an

important role in the sustainability of the development programmes of the country.

To meet these challenges the establishments of the farmer-ecological-based IPM linkages within and among farmers groups as mentioned earlier, is most appropriate. It is a form of decentralized IPM activity where the farmers can make their own decision at the micro level in coping with various production problems, including pests.

It will need sometime before this approach becomes a general practice by the farmers themselves. To hasten the progress, consistent policy support to back up the current ongoing IPM is a must. For example, the existing pesticide regulation should be strengthened with respect to the status, coverage, enforcement, and administrative manpower. Pesticides belonging to class 1A and 1B (highly dangerous and dangerous) should be forbidden for use in Indonesia. In this regard the Ministry of Agriculture has taken a decision not to allow the re-registration of 28 active ingredients of pesticides belonging to these groups. Instead, only those pesticides with intrinsic specificity and those relatively least harmful to the environment and man should be encouraged e.g. microbial insecticides.

A well planned research programme to strengthen the IPM implementation is another form of policy support, such as developing durable resistant varieties, developing reliable and simple monitoring techniques and how the natural enemies continue their survival before the target insect pest arrive in the system. Also socio-economic and anthropological studies are needed to investigate why farmers in some areas readily accept the IPM while in other locations IPM does not progress well.

Another problem that needs to be addressed is how to bring the research results from Universities and research institutions to the

farmers as soon as possible. In this context the Ministry of Agriculture established a *Balai Pengkajian dan Penerapan Teknologi* (=Institute for Assessment of Agricultural Technology) in a number of districts, where the scientists together with extension staff and farmers work together to try out new technologies on a wider scale and solve local rice production problems.

EPILOGUE

The Indonesian National IPM Programme which was started in 1989 has resulted in positive impact on agricultural development, both on farmers human resource and natural resource aspects. The main impact is the change and development of farmer's conceptual framework so that farmers have a strong will to change their position from: treated as an "object" to "become a subject" of the national agricultural development programme. Achievements and benefits of this new approach increase farmers' skills, knowledge and motivation, increase production efficiency, drastically reduce insecticide use, protect the environment, and stabilize production.

Since 1990, the National IPM Programme has graduated more than 1,000,000 farmers from season-long IPM-FFS in the 12 major rice growing provinces. In addition to rice, field school has been tackling soybean, cabbage, potatoes and shallots. The IPM-FFS model has also been adopted for a wide range of agriculture extension activities, and exported even to countries across Asia. Since 1998, the IPM-FFS has been adopted for estate crops: cotton (South Sulawesi), tea (West Java), coffee (East Java), pepper (Lampung), and rubber (North Sumatra).

The Indonesian National IPM Programme continues to evolve: beyond IPM and beyond Field Schools, the future vision of a farmer-based system is beginning to take concrete form in the villages of Indonesia. In the future, the IPM farmers, their emerging farmer

groups, networks, associations, and organizations, plus the back-up support supplied by agricultural field workers and researchers, will form the basis for a truly sustainable agricultural sector.

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