RODENT BIOLOGY AND CONTROL
(with Special Reference to the Philippines)

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Chapter 9

RODENT PESTS: CURRENT STATUS AND NEEDS

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ORGANIZATION

The Philippines and other countries of Southeast Asia are now in a much better position to tackle their rodent pest problems.

A number of government and university-based research institutes in the region are actively engaged in research, extension, and pest surveillance. In the Philippines, a Rodent Research Center (RRC) was established in 1968 through an agreement between the United States of America Agency for International Development (USAID). Based at the University of the Philippines at Los Baños, College of Agriculture, RRC became a leading center for rodent research and training scientists in the region. The programs of the RRC were absorbed by the National Crop Protection Center (NCPC) in 1976.

The Philippines, through its Bureau of Plant Industry (BPI), Ministry of Agriculture (MA), also entered into another agreement with the Federal Republic of Germany through the German Agency for Technical Cooperation (GTZ). Starting as a Philippine-German Field Rat Control Project in 1969, it expanded into the Philippine-German Crop Protection Program supporting among others, MA's Surveillance and Early Warning System (SEWS). SEWS awakened the farmers to the importance of early pest detection and transformed them from passive to active participants in combating their pests.

The two bilateral programs enabled the Philippines to update its physical facilities as well as develop expertise and expand its pool of trained personnel in the general area of vertebrate pest control. Among the notable achievements were the Masagana 99 rice rat control recommendations and the regular pest monitoring with the help of organized farmer groups called BRAPPs (Barangay Rats and Other Pest Patrols) which resulted in significant reductions in rodent damage (Fig. 9-1 and 9-2).

Rodent research in plantation crops is conducted by other specialized agencies such as the Philippine Coconut Authority and the Philippine Sugar Commission. Rodent research in food storage is undertaken by the National Post Harvest Institute for Research and Extension.

Following the success in the Philippines, Thailand through its Department of Agriculture requested financial and expertise support from the

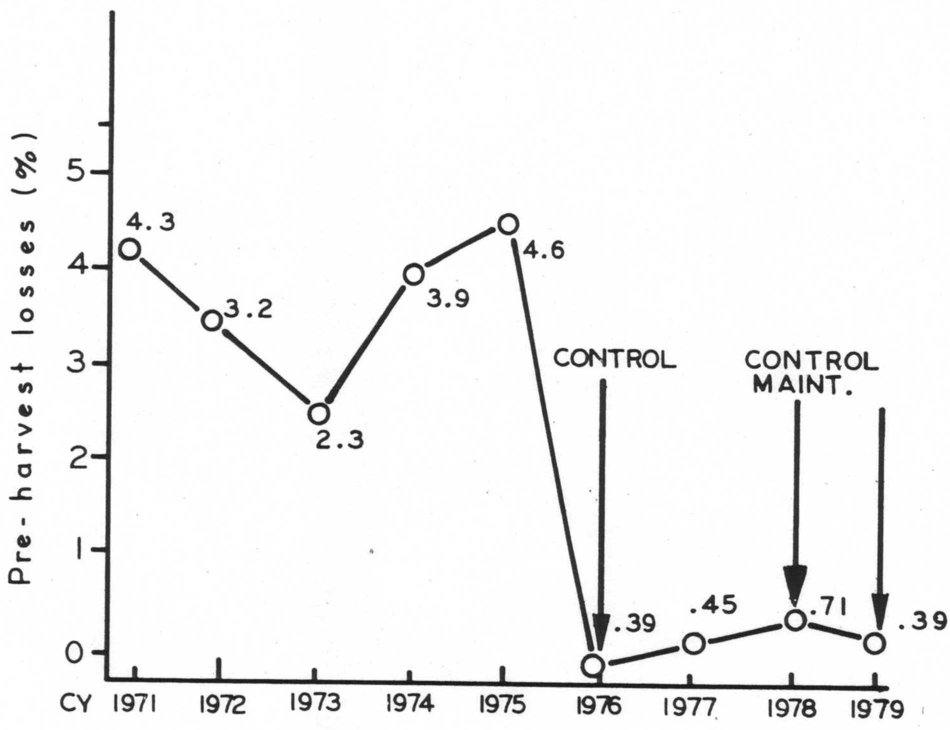

Fig. 9-1. Reduction of pre-harvest losses due to rodent damage in rice from 1971 to 1979. Note effective management in 1976 and 1979. (Source: Bureau of Plant Industry).

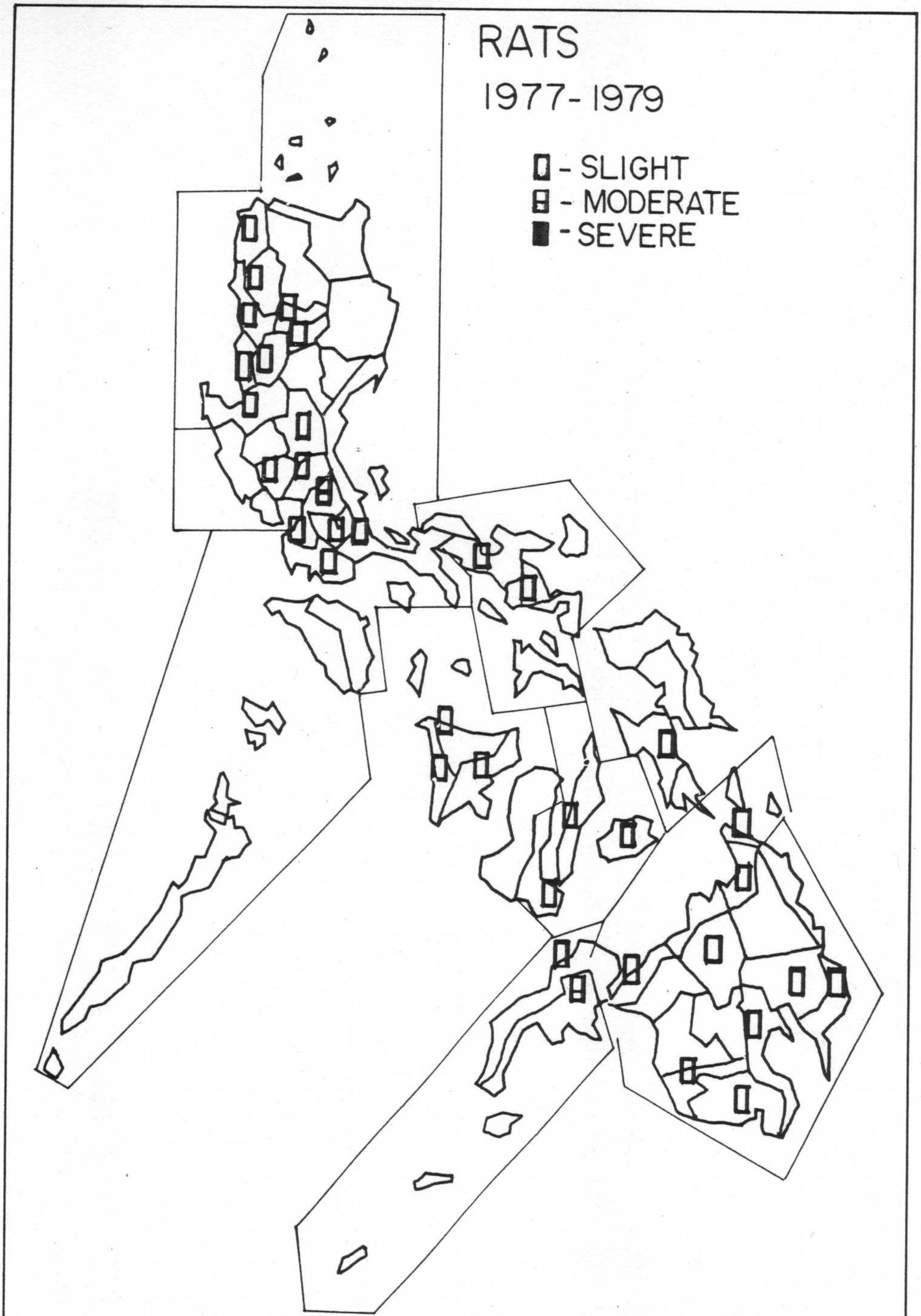

Fig. 9-2. Relative severity of ricefield rat infestation in the Philippines. (Benigno and Menguito, 1982).

Federal Republic of Germany. A Thai-German Field Rat Control Program was established in 1975. Before this, rodent control research work was carried out by the Rice Protection Research Training Center of Thailand (Sudto, 1980). Results of their field researches indicate that rats could be economically controlled by anticoagulants. Farmer interactions were made possible by their quarterly bulletin called "Know How". The Department of Agricultural Extension helps in organizing farmer associations to stimulate farmers to do rat control in their fields. The Department of Public Health also cooperated in the control of rodents in rural areas.

In Malaysia, the bulk of rodent research activities is conducted by the Department of Agriculture. Other researches are undertaken at the University of Malaya and the Institute of Medical Research .

In Indonesia, rodent research is conducted by institutes under the Department of Agriculture such as Central Research Institute for Agriculture, Directorate of Food Crop Protection, Marihat Research Station for Oil Palm and Pasuruan Sugar Research Station, by universities like the Gadjah Mada University and by Museum Zoologicum Bogoriense (Soekarna et al., 1980). Farmers are encouraged to do rodent control individually or in groups with rodenticides provided by the Indonesian National Rice Production Program (BIMAS).

Table 9-1 summarizes the advances made by each ASEAN country. Significantly, most of these advances were realized only during the last decade. One tangible product to come out of current research is the formulation of economic and effective rat control recommendations for the individual farmer. Research in the Philippines resulted in recommendations for rice MASAGANA 99 program, corn MAISAGANA program, coconut and other crops.

RESEARCH

With NCPC's creation, the rodent research component attached to the Denver Wildlife Research Center (DWRC) was retained until the middle of 1983. Besides rodents, the group also worked on bird control in rice and sorghum. Research findings are reported in the DWRC Annual Reports since 1977 as the Rodent Research Center Annual Reports were phased out in 1975.

Rodent researches are now being conducted under the different NCPC commodity teams such as rice, corn and sorghum, surveillance and forecasting and special projects. The projects are aimed at making the existing recommended technologies (e.g. Masagana 99, Maisagana, coconut crown baiting) more cost effective and finding alternative systems of rodent control. New projects contemplated in the near future include monitoring of anticoagulant resistance and modeling.

Table 9-1. Research and training activities related to small-mammals pest problems in Southeast Asia (Sanchez, 1980).

	Indonesia	Phil.	Malaysia	Thailand	Singapore
1. Taxonomy	++	+++	++	+++	+++
2. Habit and habitat	+	++	++	++	++
3. Breeding/Biology	+	++	+	+	+
4. Parasites	+++	+++	++	++	++
5. Genetics (Immunology, zoonoses)	--	++	++	+	+
6. Distribution	++	++	++	++	++
7. Predators (Biological Control)	--	++	+	--	--
8. Population Dynamics	+	++	+	--	+
9. Exploitation (Utilization	--	+	--	+	--
10. Education	++	++	+	+	++
11. Training and Extension	++	++	++	++	++

-- no work ++ extensive
\+ started +++ achieved

Anticoagulant resistance monitoring

With the increased use of anticoagulant rodenticide, we anticipate development of resistant rat populations as reported in other countries (Boyle, 1960; Jackson and Kaukeinen, 1972). A model for monitoring development of resistance (Hoque, 1979; 1983) is shown in Fig. 9-3. Controlled quantity is the resistance in a given rat population. The screening method used in this study is included in the sensor part or the model. The effector includes the various methods and rodenticides available to protect crops. In as much as sustained baiting is the best developed method so far to protect crops from rats, it will be beneficial to use chronic anticoagulants for as long as necessary.

Theoretically, resistance is always present in a given rat population but the extent is unknown in the Philippines. For urban rodents, Brooks and Bowerman (1975) recommended a 10% level of resistance as the cut-off point at which chronic rodenticides should not be used until resistance level decreases to 5%.

The inputs needed to feed the sensor include sample, size and frequency of sampling. Annual sampling of no less than 40 animals should be conducted in areas which may represent a town or barrio where anticoagulants have previously been in constant use. The NCPC and the 12 Regional Crop Protection Centers under the aegis of the Bureau of Plant Industry, strategically located all over the country, may serve as sensing centers. Before laboratories

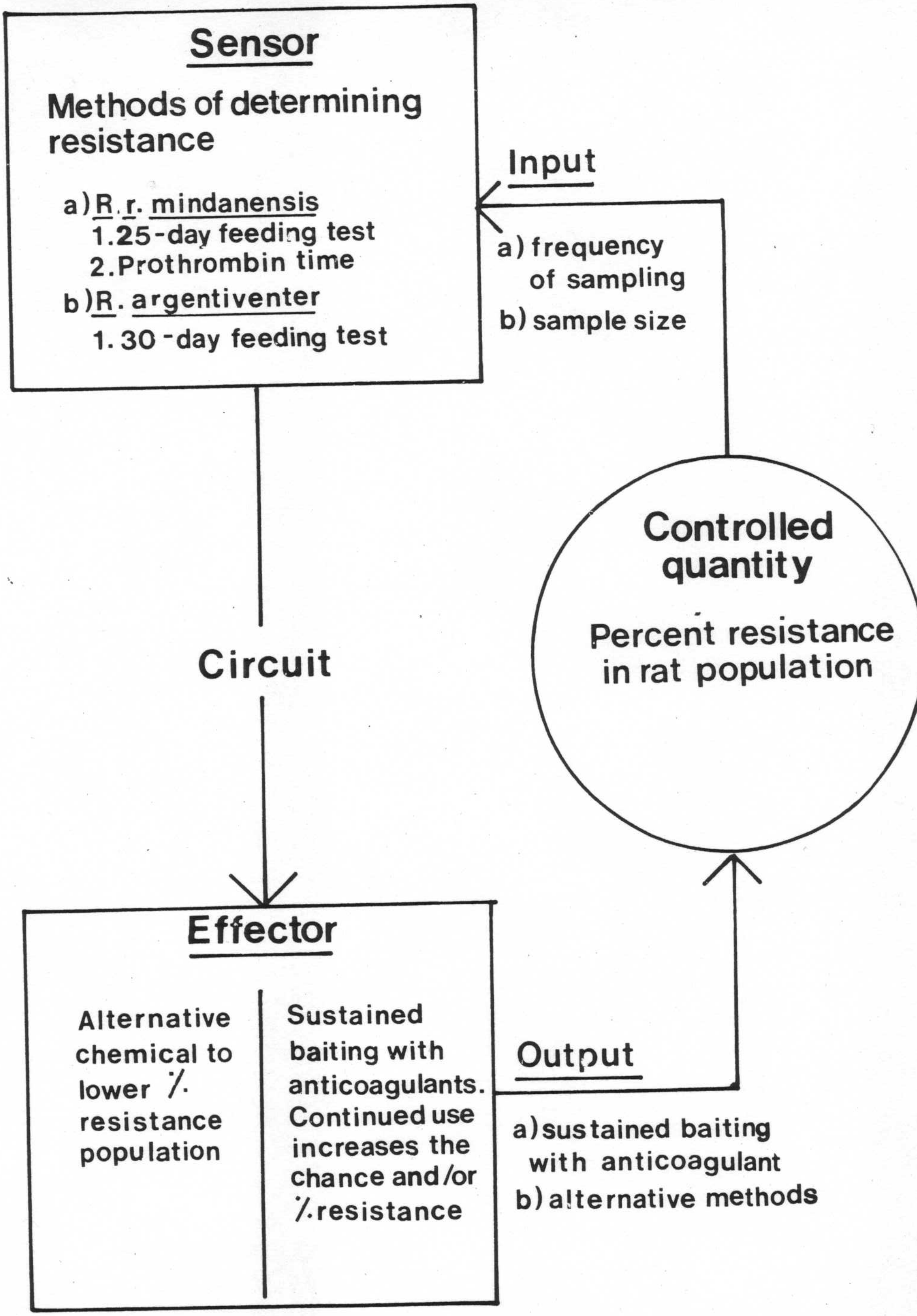

Fig. 9-3. *Schematic diagram of a proposed anti-coagulant resistant monitoring system for the Philippines. (After Odum's 1971 cybernetic model).*

are established, personnel should be trained on the rudiments of the method for screening resistant rats. NCPC can provide training and quality control to standardize procedures and minimize variability of results.

The sensor for *R. r. mindanensis* is the 25 day no-choice feeding tests using 0.025% warfarin. *R. argentiventer* should be subjected to a 30-day feeding test using the same chemical and concentration. Animals that survive 14 days after the poisoned bait is withdrawn may be considered resistant.

Percent level of resistant population indicates whether the present sustained baiting with anticoagulants is still "safe" to use or to switch to an alternative method/chemicals whcih can drastically lower the level of resistance. If percentage of resistance is high (maybe 5% or more), the government may call for emergency control measures to lower or eradicate pockets of resistant rat populations.

Delivery systems for alternative chemicals that are effective against resistant rats should also be studied before they could be recommended for farmer use. Ideally these other rodenticides should be used alternately so that resistance will isolate within the tolerable level, and thus permit resumption in the use of anticoagulant.

Modeling

A model which is a "synthetic representation of a real system or part of a system" (French, 1982) can be an effective tool for understanding and managing rodent populations. A model may take the form of a single differential equation or several pages of computer programming language. The advance reader with good mathematical background may be interested to examine some small mammal models developed elsewhere: Stenseth (1977, 1982), French (1982), Poulet (1982), Xia *et al.* (1982). Stenseth's (1977) model indicates that the best way to prevent rodent outbreaks is to have heterogenous habitats with the favorable habitats (crops) divided into small patches intermingled with non-supportive habitats and that control treatments should be applied during periods of low mobility and reproduction. In Poulet's (1982) model, population movement and dispersal occur from potential reservoir habitat and follow a nomadic pattern from one favorable habitat to another with concentrations occuring in cropfields.

Using most of the information reviewed in this book, models are now being constructed to describe movement behavior and population dynamics on ricefield rats. Population modeling appears to be relatively easier to construct than movement models using Leslie projection matrices that vary with crop stage. The damage function using Nicholson-Balley equation and some yield loss functions can also be incorporated in the model.

The big problem that follows modeling is the validation. As stated earlier in this book, it may take several experiments away before these models can be operational and useful. Once we have realistic models, however, we can play "management games" that would otherwise require long-range and intensive actual field experiments right in the computer and gain insights on the possible consequences of a pest management system several cropping seasons into the future. Thus, using movement models we could study effect of baiting or intensive trapping (predation) in the different habitats and effect of uniform, staggered or multiple cropping. Population models could show effects of intensive off-season control as opposed to within-season control.

TRAINING

ASEAN countries feel there is a general lack of trained personnel in the area of vertebrate pest management-scientists with expertise in specialized vertebrate pest research methodologies as well as of technicians and extension personnel well trained in recommended control practices and communication techniques. Apparently, these countries have the capabilities to carry out manpower training programs. SEAMEO Regional Center for Tropical Biology (BIOTROP) based in Bogor, Indonesia includes rodent pest control in its small mammals programme. The University of the Philippines at Los Baños offers MS graduate programs in vertebrate pest management. The College of Agriculture recently instituted the Diploma in Agriculture major in crop protection, a 36-week program designed to meet the growing need for professional staff development of government institutions. The courses are presented in Table 9-2.

Besides the formal degree courses, there are occasional informal courses ranging from one-hour lectures to 10 months participatory training. NCPC staff also serve as resource speakers in outside courses such as the rice production training of the International Rice Research Institute (IRRI), in farmers and out-of-school youth training programs at the Bulacan Farmer's Training Center and in other farmer's training centers in the country. Principal clientele of these programs include farmer leaders, farm managers, technicians and extension workers. Through these interactions, training modules are developed and tested. The slide-tape audio-visual is well received. IRRI has produced "Identification and Biology of Rats" and "Methods of Rat Control", while UPLB recently produced "Control Rats by Sustained Baiting" and "Sugpuin ang Daga sa Pamamagitan ng Patuloy na Pagpapain" using the above audio-visual medium.

Since 1968, the Center has been conducting short courses in response to request of agencies in Asia, Africa and South America. The generalized course outline is presented in Table 9-3. Clientele to this type of training include researchers, technicians and vertebrate pests control officers.

The apprenticeship or participatory format of the rodent training provides an excellent opportunity for the trainees to actively participate in the on-going research of the Center, complimentary to the formal classroom

Table 9-2. The Diploma in Agriculture major in Crop Protection Program.

- o CROP PROTECTION B. Integrated Pest Control. Pests and their relation to the ecosystem; strategies and techniques in integrated pest control.

  8 hours a week (2 hours class, 6 hours lab) for 36 weeks;
  credit — 8 units
  Prerequisite: Consent of Instructor

- o CROP PROTECTION C. Pesticide Management. Chemical and biological characteristics of pesticide groups; pesticide use, formulation, transport, storage, and disposal; poisoning; pesticide regulations.

  8 hours a week (2 hours class, 6 hours lab) for 36 weeks;
  credit — 8 units
  Prerequisite: Consent of Instructor

- o EXTENSION AND COMMUNICATION A. Dynamics of Rural Development. Processes and strategies of extension and communication as they relate to rural development.

  5 hours a week (2 hours class, 3 hours lab) for 36 weeks;
  credit — 6 units
  Prerequisite: Consent of Instructor

- o CROP PRODUCTION A. Crop Production Technology. Current technologies in crop production and critical aspects in optimizing crop performance.

  5 hours a week (2 hours class, 3 hours lab) for 36 weeks;
  credit — 6 units

- o DEVELOPMENT ECONOMICS AND MANAGEMENT A. Agricultural Business Systems. Comparative analysis and survey of tools in decision-making at different levels of complexity of agricultural business systems.

  3 hours a weel (class) for 36 weeks;
  credit — 6 units
  Prerequisite: Consent of Instructor

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*Specially designed and instituted for this program, the courses are integrative and multidisciplinary in character. They are not only practical and skill-oriented but, at the same time, impart concepts and new developments in research.

Table 9-3. Course Outline of NCPC participatory training on rodent research and control.*

Rodents
- o Taxonomy and distribution
- o Outbreaks: history and causes
- o Biology, ecology, population dynamics
- o Anatomy and physiology
- o Animal behavior

Rodent Control
- o Principles and methods
- o Organization and administrative support in rat control programs.
- o Sustained baiting with anticoagulants in rice, corn coconut and other crops.
- o Rat control in storage

Rodenticides
- o Chemistry and physiology
- o LD_{50} determination
- o Laboratory and field evaluation
- o Anticoagulant resistance

Rodent Research
- o Management problems and research needs
- o Setting up experiments
- o Data collection
- o Data analysis and reporting
- o Participant's research problem

*Certain topics maybe given more emphasis to strengthen the participant's weak points and satisfy specific needs of his agency.

lecture/discussions. Each trainee is required to work on a project proposal related to pest problems in his country for presentation to his parent agency.

Field trips are also included in the course to enable the participants to visit and observe related studies being conducted by other agencies. They also have a chance to observe operational rodent control programs in various parts of the country.

Training lasts from 2 weeks to as long as 10 1/2 months but 3 months seem optimum. Special arrangements is made regarding training activities to accommodate both local and foreign participants with different time limitations. For a three-month course, two months is spent in the classroom, laboratory and library and the remaining month for field work or for more advanced topics of particular interest to the participant or sponsoring agency.

TECHNOLOGY TRANSFER

Castillo (1983) calls technology transfer as a "trickledown" process which is very leaky — the content and essence of technology dwindle and even get distorted progressively down the line from the source to the farmer.

This is illustrated by Dizon's (1979) study where only 18.5 percent of the Masagana 99 (M-99) farmers surveyed in Laguna were aware of the rat control innovation (sustained baiting technology) two years after its introduction despite the fact that all the M-99 administrators and most of the technicians interviewed were aware of the innovation (Table 9-4). There is clearly information loss or leak somewhere along the line from the research center to the technicians to the farmers.

There is also a lag, ranging from 0-5 years or more (Table 9-5) between time of awareness and adoption as observed by Ocampo (1980). While majority of the farmers interviewed (57.7%) adopted sustained baiting immediately, it took another 1-2 years to have an additional 23.1% adoption. The first time farmers heard about the innovation was around 1974 while the average time for adoption was a year later (Table 9-6).

Dizon (1978) stated that theoretically the adoption of the rat control innovation (technology) is hastened by these antecedents (see Fig. 9-4):

1) the compulsory effects of an authority innovation decision
2) the crisis effect of high rat damage incidence; and
3) the extent of the M-99 technicians' promotion efforts.

Dizon, however, noted in his survey that Memorandum No. 15 series of 1975 on compulsory rat control was not in fact strictly enforced, and that there is lack of technical adequacy on the part of some technicians.

Among the reasons given by farmers for non-adoption of sustained baiting are absence of rat damage and lack of information (Table 9-7). Farmer's did not consider damage of 5 to 20% tiller cut as critical to initiate rodent control. Non-adoptors in this study suffered 1.4% rat damage compared with 0.47% for the total adoptors. Another reason observed by Ocampo (1980) for non-adoption is the fact that farmers find the other rat control practices useful (Table 9-8). Even farmers who have undergone training still use acute poisons.

Over fifty percent of the trained group totally adopted sustained baiting practice while 8.4 percent partially adopted it.

The M-99 technician was most instrumental in spreading the rat control technology (Table 9-9) followed by the Samahang Nayon (farmers' cooperative) and other farmers. At the time of Dizon's study, there was practically no mass media support for said technology except Philippine Recommends for Rice and the M-99 recommendation leaflets. In 1981 NCPC came up with Expert Views, a five-minute tape on pest control aired on radio stations throughout the country. However, no follow-up study on it's impact was made. NCPC's slide-tape set on sustained baiting was well received by farmer leaders attending training at the Bulacan Farmer's Training Center. More publications are now made available by UPLB and PCARRD.

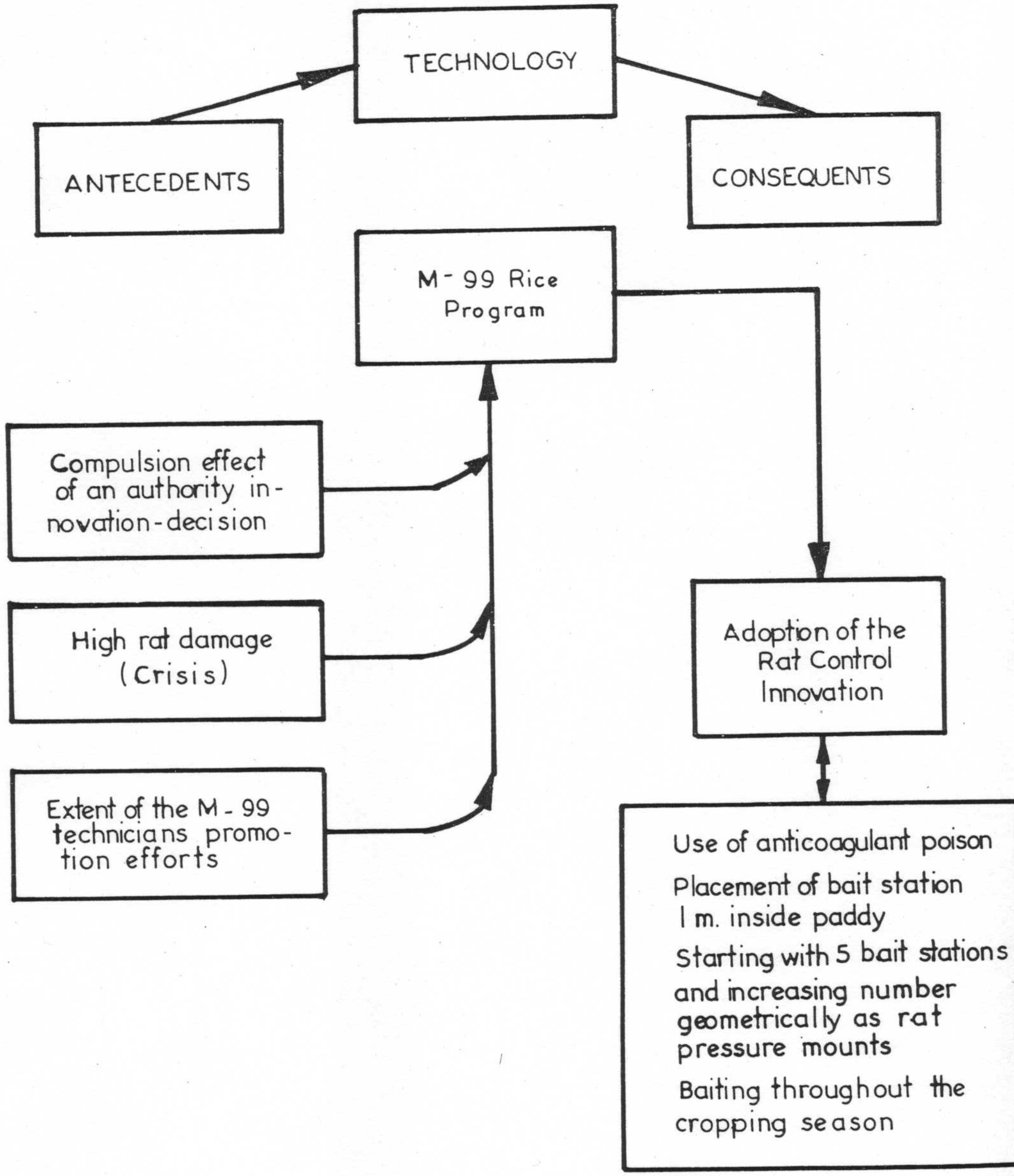

Fig. 9-4. Variable flow in the technology transfer model for rat control. The arrows suggest possible but not necessarily directions of causality. Antecedents and consequents are used here in the sense of a probable time order but not necessarily to mean cause and effect.

Information exchange between scientists and farmers is essential in any technology development and transfer process. "The discipline of bringing technology fully to the level at which farmers can use should be central to all research in technology development" (Goodell, *et al.*, 1982).

Table 9-4. Percentage of respondents aware of the four recommended practices in the rat control innovation. Province of Laguna, 1977 (Dizon, 1978).

Recommended Practices	Percentage of respondents aware		
	M-99 Administrators	M-99 Technicians	M-99 Farmers
	N=2	N=44	N=320
Use of anticoagulant poison	100	100	18.5
Placing bait stations inside paddies rather than on dikes	100	25	0
Starting with five bait stations per hectare and increasing their number geometrically as rat pressure mounts	100	5	0
Baiting throughout the cropping season	100	100	18.5

Table 9-5. Observed distribution of respondent's adoption periods for recommended pest control practices (Ocampo, 1980).

Period (year after first heard)	Insect Control Frequency (%)	Weed Control Frequency (%)	Rat Control Frequency (%)	Disease Control Frequency (%)
Immediately	146 (66.0)	128 (63.4)	60 (57.7)	23 (53.5)
1 - 2	47 (20.7)	63 (31.1)	24 (23.1)	18 (41.9)
3 - 4	11 (4.7)	10 (5.0)	15 (14.4)	2 (4.6)
5 or more	18 (8.6)	1 (0.4)	5 (4.8)	0 (0)

Table 9-6. Dates of awareness and first adoption of recommended crop protection practices (Ocampo, 1980).

Practice	Awareness	First Adoption
	(Mean + standard deviation)	
Insect Control	1974 ± 2.54	1974 ± 2.57
Weed Control	1974 ± 2.36	1975 ± 2.46
Rat control (Sustained Baiting)	1974 ± 2.24	1975 ± 2.49
Disease control	1976 ± 1.75	1977 ± 1.65

Table 9-7. Reasons given by M-99 farmers for not adopting the use of anticoagulant poison (Dizon, 1978).

Reasons	Number of times mentioned[a] (N = 280)
No rat damage	224
Not informed about it	200
Anticoagulant poison not as effective as zinc phosphide	50
Rodenticides arrival late	5

[a]Reasons asked in the survey not limited to only one.

Table 9-8. Other rat control practices of 199 farmer respondents[a] (Ocampo, 1980).

Practice	Trained N (%)	Non-trained N (%)	Total N (%)
Use of acute poison (Zinc Phosphide)	32 (26.9)	43 (36.1)	75 (31.6)
Mass operation or blanketing	12 (10.1)	5 (4.2)	17 (7.1)
Use of traps and physical means	4 (3.6)	1 (0.84)	5 (2.1)

[a] Respondents mentioned one or more practices.

Table 9-9. Effect of interpersonal, mass media and other sources of information upon the awareness of farmer-respondents on the rat control innovation (Dizon, 1978).

Source of Information	Farmer-respondents aware N = 60	
	No. of farmers	Percent
Interpersonal:		
a) M-99 technician	45	75
b) Samahang Nayon	10	16
c) Other farmers	5	9
Mass media:		
a) Radio-T.V.	0	0
b) Pamphlets	0	0
c) Newspaper	0	0
d) Movie and slides	0	0
Other sources:		
a) Demonstrations	0	0
b) Visit to other farms	0	0

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