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### **Socioeconomic Study on Farmers' Adoption of Integrated Pest Management (IPM) Strategies in Brassica Vegetable Crops in China**

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**Australian Centre for International Agricultural Research**

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# **Socioeconomic Study on Farmers' Adoption of Integrated Pest Management (IPM) Strategies in Brassica Vegetable Crops in China**

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## Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
AIN	Anti-insect net
Bt	<i>Bacillus thuringiensis</i>
CBO	Community-based organization
CIAD	Center for Integrated Agricultural Development
FAO	United Nations Food and Agriculture Organization
IPM	Integrated Pest Management
KAP	Knowledge, attitude and practice
NGO	Non-governmental organization
PHPDK	Pesticide of high poison and deposit kind
PRA	Participatory rural appraisal
SBI	Soft and biological insecticide
SVP	Secure vegetable project
ZU	Zhejiang University, Hangzhou

# 1. Introduction

## 1.1 General background and justification of the study

China is both a big vegetable consumer and a big vegetable producer in the world. At present in China, the total value of annual vegetable production in China is more than 250 billion Yuan RMB (30 billion US dollars), and the average vegetable output per person is more than 340 kg. In 1999, China's total vegetable export reached 2.186 million tons, which brought the country ca. 0.139 billion US dollars. According to the Chinese dietary customs vegetables are main food for Chinese people. Since 1980s, as the demand for vegetables has been increasing, more efforts have been made to increase the total yield, but less attention paid to improve vegetable quality. Due to the ignorance of vegetable quality, following problems and challenges have been faced by the Chinese vegetable production:

1. Increase of pest varieties. In early 1980s, there were less than 500 kinds of pests, but by the end of 1990s, the pest varieties were increased to 1500;
2. Increase of vegetable pests affected areas. In early 1980s, the pests affected area was about 40 million hm<sup>2</sup>, but at present, the affected area has been increased to 120 million hm<sup>2</sup>;
3. The vegetable loss due to pests damage has been increasing;
4. Vegetable farmers have no consciousness of vegetable safety and can not apply proper pest management strategy. Pesticides of high poison and deposit kinds (PHPDK) were still used, and farmers made application decision once they detected pests in the field, so that they spray pesticides with too high frequency. In addition, some farmers sprayed pesticides in larger dose than necessary, which caused waste of pesticides and decreased profit in vegetable production;
5. Vegetable consumers suffered the health danger due to the bad quality of vegetables affected by PHPDK;
6. Current extension service for implementation of IPM strategies can not meet the needs of farmers. According to the relevant statistics, the IPM-applied vegetable growing land is less than 5 percent of total vegetable growing land.

Many vegetable farmers are managing pest problems in traditional ways.

The problems in vegetable pest management have drawn attention from China's central government, Ministry of Agriculture (MOA) and local governments at different levels. International organizations such as United Nations Food and Agriculture Organization (FAO) and Australian Centre for International Agriculture Research (ACIAR) have also launched IPM promotion projects in China.

The central government has put more emphasis on the production of 'green food'. IPM-related policies have been made by central government, MOA and local government at different levels. Actions have been taken to promote the research on IPM, to facilitate the extension mechanism of IPM for providing better technical service to vegetable farmers. At the same time, research on vegetable quality test methods were also conducted. Through these efforts, great improvements have been made towards establishing an integrated IPM extension system throughout the country. Up to now, following achievements have been made:

1. MOA of China has incorporated IPM into its 'Bumper Harvest Programme'. In the program, IPM is regarded as an important technique, and more efforts and energy are advocated to put into the research and extension of IPM;
2. Technical indicators and instructive regulations related to IPM have been formulated by government of Beijing, Jiangsu, Sichuan, Fujian, Zhejiang, Shanghai, Guangzhou and Hubei, etc. Many of these regulations are of law nature and implemented by institutions such as Agricultural Bureau, Commercial and Industrial Administration, Technical Supervision Bureau and market inspection institutions;
3. New progress is made in the research, extension and quality control of vegetable products. In Shandong province, vegetable quality test instruments imported from Taiwan are used to control the quality of vegetables in the market. Scientists in Shanghai have designed new instruments for quick testing PHPDK in vegetables.

4. IPM demonstrations in many provinces have changed local farmers' traditional pest management customs. More and more farmers have accepted the idea of IPM and apply IPM strategies to their vegetable production practices. In Shandong, Hebei, Sichuan, Zhejiang and Fujian provinces, IPM demonstration sites were set up, systematic research on IPM technique and package were conducted and effective IPM training was provided to farmers.

Food and Agriculture Organization (FAO) has carried out IPM projects in China for many years. The IPM projects financed by FAO are mainly focusing in two crops: cotton and rice, but the project activities are very comprehensive, including:

1. Providing various types of training on safer and more efficient use of pesticides for farmers, extension workers, retailers and plant protection technicians;
2. Strengthening national technical and physical facilities for effective implementation of pesticide regulatory schemes;
3. Organizing regional workshops to harmonize pesticide registration requirements and quality control procedures among different stakeholders and actors; establishing national training centres for providing continuous training in project areas, including training for policy-makers, senior pesticide registers and technical personnel for quality control operation, including data evaluation, risk/benefit analysis, and decision-making; Trainees also include pesticide inspectors on quality control, residue monitoring, pesticide chemists, pesticide storage workers, pesticide disposal specialists, extension workers, farmers and other users, plant medical practitioners and retail shop workers, etc;
4. Undertaking national and regional survey missions on laboratory facilities for pesticide analysis and assisting to establish/strengthen relevant infrastructures;
5. Supplying technical and financial assistance for improving registration, control, management, safe and efficient use of pesticides and other aspects of the IPM.

In FAO-financed IPM projects, many new participatory training models are developed, such as

'Training of Trainer', 'Training Farmer's Trainers' and 'Farmer Field School' (FFS). Through effective training in large scale, more and more rice and cotton farmers have adopted IPM package in their pest management practice.

Considering the IPM application situation in China, since 1995, the Australian Centre for International Agriculture Research (ACIAR) financed some Chinese institutions for improving IPM research and extension service in China.

As a cooperation project within this framework, the ACIAR project CS2/1992/013, 'Improvement of integrated pest management of brassica vegetable crops in China and Australia' was implemented with significant success over the past years. Excellent progress has been made towards the growers' adoption of IPM strategies both in Australia and China. Due to the one-year extension work after the project completion, advances have been made in the extension of IPM strategies among brassica vegetable crop growers. The project activities have been implemented in 5 pilot areas of Zhejiang Province (Hangzhou, Ningbo, Jiaying, Wenzhou, Qinghai) and another one in Shanghai municipality. Main activities implemented in the pilot areas including IPM package demonstrations, field days and training courses have promoted the adoption of IPM strategies at the household level. Among the six pilot areas, Hangzhou can represent the situation and conditions in the whole region.

In Queensland, the pilot research area in Australia, the widespread use of *Bacillus thuringiensis* improved application methods and the use of scouting information in decision making. The strong involvement of cooperative growers in the Lockyer Valley has greatly facilitated implementation of IPM. Despite all achievements, further research and extension are needed to ensure that the adoption rate of IPM practices by farmers continues to increase. Thus the project is to be run for another three years.

In the production practice, growers' adoption of IPM package depends on many factors, such as technical skills of growers, farm size and scale of production, social-economic conditions of the community and households, as well as economic, psychological, and cultural factors. Farmers are the final decision-makers for adoption of the developed technology, therefore it is important for the technology development agency and technicians to identify how farmers react to the provided

techniques and what about the adoption process of certain innovations. To answer these questions and formulate recommendations for facilitating the decision making process of households are also important for the above mentioned Sino-Australian Cooperation Project. Since there are no systematic social-economic studies conducted for ACIAR funded cooperation projects, College of Rural Development (CORD) of China Agricultural University, a professional institution for community development and working directly with farmers in participatory approach since the 1990s, prepared a proposal to conduct complementary study for the implemented ACIAR/China research project (CS2/1992/013).

This final report was prepared by the CORD study team based on the findings of the mid-term report and findings of the follow up field study and policy analysis.

## **1.2 Objectives and expected output from study**

The overall objective of this study is to investigate the IPM impacts on households through identifying farmers' decision-making process and the factors influencing their adoption of IPM practices in Brassica crops in China and Australia. Recommendations are to be made for further extension of IPM technology in the areas. To achieve this objective, the following sub-objectives are proposed:

1. To identify and rank major social-economic, institutional and technical factors which positively or negatively affect growers behavior in adoption of IPM technology and how they make decision in the adopting process at the household level in the down reach areas of Yangtse River.
2. To identify how different growers (i.e. demonstration households, non demonstration households, households with different income) perceive and react to the IPM technology;
3. To compare the household economic benefit of using IPM with conventional pest management model;
4. To analyze perceptions and judgements of IPM researchers to farmers' problems and attitude in adopting the recommended IPM technical package;
5. To analyze how the technical service institutions and other stakeholders participate in technology development and extension processes, which kind of problems and constraints they are facing in delivering the technical service during IPM extension process;

On the basis of findings, to formulate concrete proposals on how to improve IPM extension system and how to effectively incorporate farmers' socioeconomic conditions and needs into the extension strategy.

## 2. Study Methodology

### 2.1 Overall study process

According to the objectives, the study was implemented in three stages, namely:

#### 1. Survey preparation activities in Beijing

- A. Reviewing the national and provincial pest management policy and the experiences learned from other pest management projects (FAO supported project) and the documents from the ACIAR project;
- B. Designing the study process and drafting the outline of questionnaires used during the survey. During this stage professor Liu Shu-sheng (the project leader in China) and professor Zhang Guang-mei (a senior specialist in field of plant protection and also the project stakeholder) commented the research proposal and the questionnaire. Changes were incorporated to the final research proposal.
- C. Selection of research sites, sampling methods, and procedures: Hangzhou was selected as the main research area, with 3 villages in its suburb as research sites. 160 households (120 within the IPM demonstration communities and 40 within the non-demonstration communities) were to be interviewed.

#### 2. Field studies

- A. Institutional survey. Interviewing of the IPM researchers, agricultural bureaus and extension centres/stations at the provincial, county and community level; In this stage, provincial responsible officers, village and township leaders, and extension staff were interviewed:
  - Relevant data were collected, including the growing area of brassica vegetables and the current pest management situation, overall performance of the project, and the importance of brassica vegetables to local households.
  - The operational mode of agricultural bureaus and extension centres/stations in IPM extension and implementation were

investigated; also, the main efforts and energy they put in IPM extension and implementation were identified, as well as the main barriers and difficulties they faced.

- B. Households interviews in the demonstration and non-demonstration communities. Concerning the similarity of the household conditions in the same village, totally 100 selected households were interviewed.

#### 3. Data analysis and writing up the study report

Detail study activities are shown in Annex: Itinerary of the study.

##### The study team

Professor Liu Yong-gong, rural development researcher and socioeconomic specialist acted as team leader of the study and were mainly responsible for designing and preparation of the research. He also reviewed the final report with focus on the findings and recommendations.

Mr Qiu Guo-jun, postgraduate student of CORD, majored in rural community development and experienced in development studies (PRA) for international collaboration projects, was mainly responsible for the field studies and writing up the report.

Miss Guo Jin-ping, a specialist in data processing has assisted the data processing and information analysis.

### 2.2 Field investigations

The main activities conducted during the field survey were as follows:

1. Semi-structured interviews with 100 vegetable growers and governors, community leaders, village leaders and local extension agencies. Questions related to farmer households, vegetable production, and farmers' knowledge, attitude and practice (KAP) on insect, pesticide, pest management method and IPM were asked systematically.

2. Workshop and group interview on IPM with agriculture bureau officers, extension staffs and demonstration farmer households were applied in Jianggan district of Hangzhou. Interviewers used group processes to allow the vegetable growers to actively discuss the questions. The agenda and topics were pre-designed and structured by the study team, who also facilitated and moderated the group discussion process. Also, group 'brainstorming' was applied to identify solutions for solving the existing problems in IPM extension and implementation.
3. During the household and group interviews, participatory mapping and ranking were also applied, so that participant could be involved in the whole process and assisted by the visualized approaches.
4. Each evening during the field survey, the survey results and findings were consolidated and summarized and issues and points to be further verified by the next step were identified and integrated into the survey schedule for the coming days.

### **2.3 Methods and tools used during the survey**

This study used PRA tools to collect data and develop action plans. PRA based techniques were

developed in the past twenty years, and have been effectively applied in the rural development practice. The main feature of PRA is to provide interviewees a communication opportunity to be involved in the whole process. During the field survey, the following techniques were applied:

1. Semi-structured household, key informant interview and group interviews for getting household basic information and assessing their perceptions and evaluation of the extension service performance.
2. Ranking was applied in the group interview in which farmers were invited to give their ranking scores to the identified difficulties in their adoption of IPM strategies.
3. Venn diagram was used for identifying farmer's institutional contact and communication pattern, particularly with extension agencies at the community level.
4. Seasonal and daily work calendars of vegetable growers were developed for identifying their production and social activities at the community level. By doing this, we can judge the proper time for extension agencies to provide their service and thus could identify whether their previous service was effective.

### 3. Findings made during the study

#### 3.1 Systematic analysis on IPM (SVP) project in Hangzhou

According to interviews with IPM researchers, extensionists and local agricultural bureaus, in Hangzhou, the extension of IPM package is implemented as part of ‘Secure Vegetable Project’ (SVP), which is in the first place of ‘ten projects to increase public confidence’ of local government. ‘Secure vegetable’, means a clean, green and uncontaminated vegetable. Therefore, as far as production is concerned, SVP and IPM basically have the same philosophy and requirement. However, IPM would be far beyond practical if effort and energy were only limited to the production field. SVP makes IPM more practical in local area because various sectors and units are involved (as Figure1 shows), and efforts and countermeasures are mainly focused on production, marketing and service.

Although SVP has a much broader scope than IPM, it is essentially aiming at better implementation of the IPM project under current socioeconomic conditions of the local areas. So in the following part, IPM project and SVP are regarded as the same scheme.

Farmers and other stakeholders as shown in Figure 1 are essential actors of SVP (IPM) system. According to theories of systematic science, during the operation of an entire system, its elements interact with each other and each element forms a subsystem of the whole system. The operation of one subsystem is inevitably affected by other subsystems (elements) of the senior system. As far as SVP system is concerned, farmers’ adoption of IPM is the core of the system, and it itself forms a subsystem. The operation of this core subsystem is affected by factors from other subsystems of SVP, also, is affected by factors from itself. Therefore, in the following part,

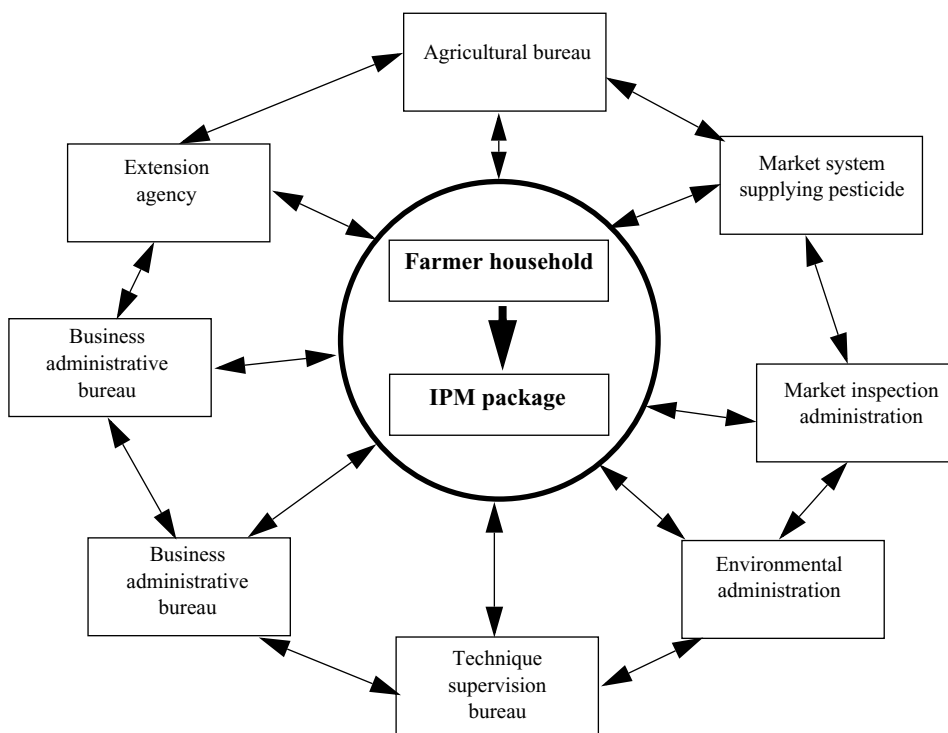


Figure 1. Structure of IPM (SVP) system

by discussing subsystems shown in Figure 1, we will try to find factors affecting farmers' adoption of IPM in a systematic view. Discussion of each subsystem will focus on its roles, operation mechanism and problems existing during its operation. And during the process, the overall situation of farmers' adoption of IPM will be described.

### 3.2 Factors affecting farmers' knowledge, evaluation and practice of IPM

#### 3.2.1 Affecting factors from farmer household

IPM is a new thing for farmers. Within the current Family Responsibility System, farmers are the final decision-makers to adopt IPM package. Farmer households are the most active sub-system and core in the whole SVP system, thus factors from themselves may determine their understanding, evaluation and application of IPM. Affecting factors identified during this study are as follows:

##### *Quality of growers*

Most vegetable farmers in Hangzhou are more than 45 years old and only have elementary school education, some are even illiterate (see Table 1). But the understanding and application of IPM requires that farmers have knowledge on insects, pesticides and ecology, so there are basic qualification barriers for them to understand IPM concept systematically. Most of farmers get incomprehensive understanding of IPM. In their minds, IPM is simply 'not to use pesticide of high poison and deposit kind (PHPDK)', although their application of IPM is beyond simply rejection of PHPDK. Only those who were ever trained at the district or township level have a comprehensive understanding of IPM.

**Table 1.** Basic data of vegetable farmers

	Sanbao village	Yunfeng village	Sanwei village
Sex			
Male (%)	43	48.6	44.8
Female (%)	57	51.4	55.2
Average age	50.4	46.2	48.3
Education background			
Elementary school and below (%)	86	87	91.4
Middle school (%)	12	13	9.6
Senior high school (%)	2	0	0

Source: processed according to the field survey

*Difference between demonstration and non-demonstration sites: Farmers of Sanbao village have a better understanding of holistic concept of IPM than those of Yunfeng and Sanwei village (see Table 2 and Table 3), because Sanbao village is a demonstration site, farmers can obtain more assistance from IPM (SVP) project. Farmers in demonstration village can obtain more support and service from IPM project. For example, they can gain free AIN and SBI from IPM project, they can attend more field demonstration courses conducted by IPM agency and they can gain more guidance from IPM experts.*

**Table 2.** Farmers' knowledge on concept of IPM

Content of IPM	Percentage of farmers understanding IPM to the extent (%)		
	Sanbao village (demonstration village)	Yunfeng village	Sanwei village
Rejection of PHPDK	100	100	100
Precaution first, less pesticides, more non-chemical methods	36	20	23
Allow certain number of pests exist within tolerant economic loss	10	3	2

Source: processed according to the field survey

##### *Vegetable farm size and income structure*

The application of IPM strategies requires farmers to put more invest in vegetable production, such as invest in anti-insect net (AIN), soft or biological insecticides (SBI) and plastic green house. Also, IPM needs farmers' more energy input in field investigation and management. In rural areas of Hangzhou, young members of most farmer households have non-agricultural job and can earn more than their parents whose income mainly come from vegetable production. Because the average land area per household in Hangzhou is only around 1 Mu (1/15ha) and the price of vegetables is not high, agriculture in local area is a kind of low-profit business. For most farmer households, income from vegetable production accounts for a smaller part of total family income. Therefore, farmers would not invest more on vegetable production. For example, during the farmer interviews, a lot of farmers have explained that they would not apply AIN if they paid the piper themselves. In local areas, the price

of AIN is 1.2 to 1.5 Yuan per square meter, and a whole set of AIN usually costs 1000 to 1200 Yuan. For local farmers, to spend such a big amount of money simply on one of the means to prevent insects is not a worthwhile thing. Both in demonstration and non-demonstration areas, the anti-insect nets some farmers are using are donated by local government as an incentive measure to produce clean vegetable.

*Number of family labor*

In demonstration and non-demonstration villages, households with more farm labors perform IPM better than those with fewer farm workers, this is because at the present stage, IPM is a time-consuming job for them in certain cases.

*Diversity of farmers’ production activities*

The vegetable farmers are small scale, numerous and highly scattered. The climate condition in Hangzhou allows vegetable production with all varieties throughout the year (see annex 7.4). Therefore, farmers’ vegetable production systems are quite diversified and integrated. It is really difficult to get them together for IPM related training, because at any time, some farmers may be busy harvesting their vegetables, some may be on the way to local market and some may have to buy fertilizer and pesticides.

*Social mobility and interaction*

Farmers’ knowledge on SVP (IPM) mainly comes from retailers of agricultural materials at the village

level, neighbors and relatives, and their former experiences (see Table 4). So farmers who have a good relationship with extensionists, neighbors and relatives can have more information sources of knowledge on IPM, especially when they have a good relation with village leaders and village extensionists, which could bring them more training chances.

**Table 4.** Farmers’ source of knowledge on pest management

Source of knowledge on pest management	Percentage of farmers whose knowledge come from the way (%)		
	Sanbao village	Yunfeng village	Sanwei village
Insecticide shop in village	93	92.5	94.
Farmer’s own experience	100	100	100
Neighbors and relatives	76.5	68.4	73.7
TV and newspaper	21.6	22.4	17.4
Extensionist	37.8	18	13.6

Source: processed according to the field survey

Because IPM knowledge is comprehensive and complicated, systematic training can’t be delivered by these sources, for example, pesticides retailers can only supply guidance on the application of pesticides. In addition, both retailers and farmers receive rather limited training on IPM. Information from extension agencies, operational brochures and leaflets, newspapers and TV is limited or ignored by farmers. However, systematic knowledge can be gained from

**Table 3.** Farmers’ knowledge on pest management methods

Pest management method	Percent of farmers					
	Sanbao village		Yunfeng village		Sanwei village	
	Know of	Understand	Know of	Understand	Know of	Understand
Chemical methods	100	100	100	100	100	100
Anti-insect net	100	96	79	58	71	53
Seed sanitizing	76	65.2	81	74	75	65.4
Soil sanitizing	100	100	100	100	100	100
Adjustment of planting	58	42	49	47	42	40
Rotation	100	89	97	75.5	100	91
Selection of excellent seeds	100	100	100	100	100	100
Manually catching	100	100	100	100	100	100
Irrigation	70	53	75	56	69	46
Weeding land timely	100	100	100	100	100	100

Source: processed according to the field survey

these resources. All these elements lead to a partial understanding of IPM by farmers. But as Table 2 shows, farmers in demonstration area have a better understanding of IPM, which indicates the contribution of IPM project.

#### *Social network and social capital*

According to interviews with local farmers, there are few cooperative activities between farmers. The reasons are as follows:

1. No effective farmers' organizations exist in local area. Local farmers are organized in traditional forms — production team and production group, which are quite loose organizations these days. In these nominal organizations, farmers could gain little support from other farmers, at the same time, they would not supply any support to other farmers, either. All these lead to the lack of trust among farmers.
2. Big differences exist between farmers in their production activities. As for vegetable kind, some farmers may grow cauliflower, some may grow cabbage, and others may grow cucumber. And as for time arrangement, at a certain time, some may be weeding, some may be irrigating, and some may be busy selling their vegetables. What is important is that there is a lack of reliability between local farmers. Usually they don't believe in others, even their neighbors. They don't believe others will nurse their vegetable carefully. So little possibility for cooperation exists in production process.
3. Different farmers sell their vegetable products at different places, and different farmers have different income expectations and therefore have different sensitivity to price. Moreover, they don't believe each other, which prevents them from cooperating in marketing process.
4. Farmers don't think it is necessary to cooperate with other farmers in the implementation of IPM. Firstly, they grow different vegetables and they have little effect on the vegetables of others. Secondly, they think they can perform very well when they are dealing pest management independently, because they have been producing vegetables for many years, they think they are experts themselves. Thirdly, they think it will be inconvenient to cooperate with others. For example, in cooperative cases, mechanisms have to be made, and it is not a easy thing to ensure that everyone all obey the

rules of cooperation. Fourthly, they have been used to conducting production activities independently, because after the China's rural reform in late 1970's, they have to manage their production individually.

*Difference between demonstration and non-demonstration sites: in demonstration village, farmers interact with each other more frequently in the implementation of IPM package because: (1) they have more training chances and know more about IPM, so they are interested in IPM communication, and (2) the training from IPM project offer them chances to stay together and to communicate together, which can strengthen their relationship. This means that to some extent, IPM project has made farmers' interrelationships more harmonious, and in turn increased the possibility of farmers' cooperation with each other.*

#### 3.2.2 *Affecting factors from extension agency*

County and township extension agencies are playing important roles in the extension of IPM-related technology. Their current roles include:

1. Provide technical training, advice and guidance service to farmers on adoption of IPM strategies;
2. Forecasting insect trends, diagnosing plant diseases and insect pests and assisting the solution to the problems that farmers meet in vegetable production.

When offering technical and training service to farmers, local extension agencies faced many problems, which prevent extensionists from supplying effective service in farmers' implementation of IPM. The problems include:

1. Shortage of technical personnel at village level can't meet the demand of the extension work. In both demonstration and non-demonstration village, there is only one technique extensionist called plant protection technician serving hundreds of widely scattered farmer households. On average, the ratio between extensionist and vegetable farmers at the village level is less than 1:300. Besides responsibility for guiding and supervising farmers in the implementation of IPM, the village extensionist must also deal with irrigation, construction of village roads, land distribution, moderation of conflicts between

farmers and other daily affairs. With so many responsibilities, he can't work full time on plant protection (IPM). Even for a responsible village extensionist (such as the one in Sanbao village), his maximum service can only covers 15% of all vegetable households in his village. Most interviewees were not satisfied with the current extension system except those of Sanbao village, where the extensionist, Mr. Jin Jincai has frequent contact and a friendly relationship with the farmers. Many farmers in other villages complain that the plant protection technician seldom visits them and thus offers little technical advice on pest management.

2. Because the farmers are in large number, widely scattered and have different farming patterns, it is really a demanding job to organize them for training, as the cost for training may also be very high. When conducting training, an allowance of 30 Yuan RMB per day per farmer must be offered to cover the 'time loss' of farmers. Therefore, field demonstration, action learning and training at township or district level can only invite a small number of farmers, which is obviously a big barrier to enlarge the extension scope.
3. A relative deficit in an extension budget occurs when such a large number of vegetable farmers need to be trained. Training materials and free equipment can only reach part of vegetable farmers.

*Difference between demonstration and non-demonstration sites: extension agencies in demonstration area have stronger ability to supply technical service to farmers. Firstly, the extensionists in demonstration area have more access to information and knowledge on IPM, so they have better qualification to offer guidance to vegetable farmers. Secondly, extension agencies in demonstration receive more financial and material support. Thirdly, the supervision from IPM project agency made the operation of IPM-extension work smoothly.*

### 3.2.3 Affecting factors from market system for supplying insecticides:

At present, for local vegetable farmers, chemical methods are still dominant methods. As chemical pesticides (mainly SBI) are still widely used, pesticide suppliers act an important role in IPM project. Their roles are showed as follows:

1. Supplying SBI, seeds, fertilizer and other agriculture materials and equipment.
2. Controlling the circulation of PHPDK and ensuring no PHPDK are available within Hangzhou.
3. Supplying certain guidance and demonstration service to farmers. Actually, in demonstration and non-demonstration village, pesticides retailers contribute greatly to the growth of farmers' knowledge on pesticides. Jianggan Agriculture Material Company is the biggest supplier of agriculture material, and it has its own field-test system which often demonstrate new seeds and new pesticides to farmers.

### *Main problems faced by local insecticide suppliers*

1. Within the framework of SVP (IPM), pesticides suppliers can only sell soft pesticides or biological pesticides. Both soft pesticides and biological pesticides bring lower profit than PHPDK does, but no compensation is made by any administrations for the loss of pesticide suppliers. Most pesticide suppliers market SBI because PHPDK is severely forbidden in local pesticide market. They're fear of the possible punishment so they dare not market PHPDK. As they are private sectors and their activities are profit-oriented, they are not eager to market SBI. According to the interviews with farmers, in some pesticide shops at village level, PHPDK is still available, which increases the possibility of farmers' adoption of PHPDK.
2. Fake pesticides erode farmers' trust to insecticide suppliers and thus to SBI. Among the pesticides in village shops, there are some fake ones, sometimes even the retailers don't know the truth and they sell them to farmers. Farmers apply the fake insecticides and can not kill the pest, thus some farmers don't trust retailers and SBI any more. They doubt about the quality and effect of the insecticides supplied by local pesticide traders or retailers.

### 3.2.4 Affecting factors from local agricultural bureau:

Enlightened by the IPM project financed by ACIAR, SVP project was initiated by local government. Local agricultural bureau is the representative and executive sector of local government in implementing SVP project. So local agricultural bureau plays an important role in the

implementation of IPM. The roles cover the following:

1. Leading and organizing different sectors in enabling and impelling farmers to adopt IPM package.
2. Supplying financing support and equipment to extension agencies and farmers.
3. Organizing training on IPM to technicians at different levels;
4. Organizing extension of IPM to farmers at county and village level;

#### *Problems faced*

1. At present, under the local socioeconomic conditions, there is no obvious economic increase resulting from farmers' adoption of IPM, so agricultural bureau has to take instructive and 'top-down' measures for controlling PHPDK application in farmers' fields. However, these measures are less effective and of high cost, especially with so many of vegetable farmers to be supervised. The compulsory nature of this top-down measures aroused farmers' repulsion of IPM to some extent.
2. Due to the large number of farmer's households, scattered location of them and diversified production patterns, it is really a difficult job to organize them for training, and the cost for organizing training is very high. Local agricultural bureaus are not able to put such a big amount money and energy into the operation of SVP project, so at present, the support from local agricultural bureau and local government seems quite deficient.

#### *3.2.5 Affecting factors from business administrative bureau, technique supervision bureau and environmental administrations*

Besides the institutions mentioned above, the implementation of IPM also needs the cooperation from other institutions, such as business administrative bureau, technique supervision bureau and environmental administrations, which contribute to the implementation of IPM in the following aspects:

1. Supervising the implementation of quality control of market administrations;

2. Supervising the operation of pesticide suppliers to ensure that proper pesticides are supplied;
3. Supervising the production of farmers in cooperation with agricultural bureaus, to ensure PHPDK is disused.

#### *Problems faced*

As there are many administrations, agencies and farmers to supervise, an obvious lack of personnel and budget is the biggest barrier to implementing their functions in SVP (IPM);

#### *3.2.6 Affecting factors from vegetable market*

In March of 1999, when the concept of clean vegetable first appeared, consumers showed a strong interest in it. At that time, only one vegetable producer — 'Baixing Ltd. vegetable and fruit' supplied clean vegetable. The company sold their vegetables themselves and declared that their vegetables were produced without PHPDK applied. Local consumers believed this, and most of them were eager to buy clean vegetables. Yet at the end of 1999 when SVP was brought out by local government, and to produce clean vegetable became an activity to respond to the work of local government. From then on, more and more producers claimed that their vegetables were of 'clean' kinds. Yet not all producers could ensure their vegetables were produced clean. Some of them acclaimed that their vegetables were clean ones simply in order to increase vegetable sales. Therefore, consumers may buy vegetables with high pesticides residues from some nominated 'clean vegetable producers', and they don't believe the brand of 'clean vegetable' any more.

#### *Findings from vegetable consumers*

According to interviews with more than 30 consumers in Wulinmen Market (a big market in Hangzhou), the findings are summarized as follows:

1. Local consumers don't believe in vegetable producers any more. Although there are many vegetable producers declared that their vegetables are 'safe', in fact their vegetables may be affected by PHPDK. They name their vegetables 'safe' simply in order to increase their sales. Therefore, local consumers don't believe them any more.
2. Local consumers don't trust local government. Because SVP is a kind of government

campaign, local farmers are not interested in it very much. They regard it as externalism of local government.

3. Consumers don't believe that local market administration can supervise the quality of vegetables effectively. The market supervisors themselves are private proprietors, their activities are profit oriented. If one supervisor severely punishes his clients who sell vegetables with PHPDK in his market, then few vegetable sellers would do business on the market, and the income of the market manager will reduce. Therefore, most supervisors just warn those SVP violators — often, they suggest them to bring their vegetables back and not to sell them in the market they are supervising.

#### *Findings from vegetable market supervisors*

According to interviews with vegetable market supervisors, at present, they are short of practical and convenient measures for vegetable quality control. Simple measures can not bring exact and reliable test result, while the complicated measures are time and energy consuming and can not supply test result timely. At present, vegetable control staffs in the market use a kind of test paper to detect whether the vegetable is affected by PHPDK. According to the interviews with IPM scientist, this kind of test paper brings unstable results with different temperature, moisture and water during the operation of the test. Because market inspectors themselves can not ensure the quality of vegetables, they dare not guarantee the safety of vegetables to consumers.

#### *3.2.7 Affecting factors from macro socioeconomic environment*

1. The serious pollution from industry in Hangzhou partly discounts the effect that IPM brings on the quality of vegetables. The industries in Hangzhou are highly developed, which consequently brings heavy pollution in water, soil and atmosphere. Measures have been taken to reduce the pollution, but it will take a rather long time to have positive effects. The industrial waste pollutes the vegetables and discounts the efforts in producing 'clean vegetable'.

Vegetables affected by PHPDK from other places ruin the deputy of native 'green vegetable'. The vegetables in Hangzhou come from many places, such as Shandong, Guandong and Hainan province. Native

vegetables only account for less than 1/3 of total vegetables in local market. Because IPM may not be conducted in the vegetable production process in other places, so these vegetables can not gain the recognition of local consumers. But local consumers are not able to distinct the native vegetables with foreign ones and would not pay more even for the real native 'green vegetable'. Thus local farmers can not gain the additional benefit they should obtain due to the additional effort in the production of 'green vegetable'.

#### *3.2.8 Affecting factors from IPM package*

For local farmers, the symbol of IPM lies in two aspects: (1) the application of SBI, and (2) the usage of anti-insect net (AIN). Some characteristics of SBI and AIN are disharmonious with the culture and customs of local farmers. And the right application of SBI and AIN often needs farmers to have a better knowledge background and abilities than they have at present. Thus the socioeconomic characteristics of IPM inevitably form the factors affecting farmers' implementation of IPM package.

#### *Characteristic of SBI*

As mentioned earlier, SBI is the main pesticide local farmers applying. But some farmers have a negative attitude towards SBI. The reasons are as follows:

1. Comparing with the pesticides they used before, SBI has much higher price, which causes higher costs of pest management (see Table 5). SBI is a new kind of product and its production, transportation and storage are more complicated than the former conventional pesticides. Also, there is a long marketing channel between pesticide manufactures and farmers, and before SBI reaches farmers, it has been wholesaled for several times. In the practice, farmers themselves are not allowed to buy SBI at wholesale price because they have no license do pesticide business, so they have to accept the higher price of SBI. In addition, it is not advisable for them to store large amount of pesticide, because some SBI requires special storage conditions and allows a short storage period before application.
2. Farmers are not satisfied with the effect of SBI. Reasons for that are:
  - A. They have been used to seeing the immediate death of pests after application

of pesticides, but SBI requires a longer time to kill pests. Actually, after application of SBI, although pests are still alive, they are not able to eat vegetable any more; unfortunately farmers don't understand this, and they therefore cannot easily accept the new pesticides.

- B. SBI has a shorter effect period than PHPDK, for example, the effect period of carbofuran and omethoate is about 3 months, while that of SBI is less than 1 month.
- C. Actually, the fundamental cause of farmers' dissatisfaction with SBI is that most of them lack of knowledge on stadium of pests and SBI, and thus they are not able to apply SBI timely. The usage of many kinds of SBI requires farmers' on time application based on the early time insect identification. Unfortunately local farmers know little about the stadium of insects, which leads to untimely use of insecticides and failure in killing insects effectively.
- D. Farmers waste SBI a lot and they have to spend more on pesticides. Most of farmers apply SBI simply when they see pests, they don't count the number of pests before pesticide application. Often, they spray the whole land of certain kind of vegetable when they see a few pests in the field. Also, as mentioned above, due to farmers' untimely use of SBI, they have to spray more pesticide each time and do this more frequently than IPM experts do. All these lead to the wasting of SBI and they have to spend more money on pesticides.

**Table 5.** Price comparison between SBI and PHPDK

		Cost /Mu/ production season (Yuan)	Effect
SBI	Chlorfluazuron	5.6	Short term
	Imidacloprid	2.8	
	Abamectin	6	
PHPDK	Phosphorami dothioic acid	1.8	Long term
	Omethoate	0.8	
	Trichlorphon	1.2	
	Carbofuran	1.1	

Source: processed according to the field survey

### *Characteristic of AIN*

The characteristic of AIN affect farmers' evaluation and application because of:

1. The high price of AIN: in local areas, the price of AIN is 1.2 to 1.5 Yuan per square meter, and a whole set of AIN usually costs 1000 to 1200 Yuan. For local farmers, to spend such a big amount of money simply on one of the means to prevent insects is not a worthwhile thing. Both in demonstration and non-demonstration areas, the anti-insect nets some farmers are using are donated by local government as an incentive measure to produce clean vegetable. A lot of farmers have explained that they would not apply AIN if they paid the piper themselves.
2. AIN must be accompanied with the plastic greenhouse, but in those villages where plastic greenhouse is not applied in vegetable production, AIN can't be used.
3. According to the interviews with local vegetable experts, it would be more economical if a set of AIN covers a land area of 7 Mu. But the average land holding per household in local area is less than 1.5 Mu. As different farmer households plant different vegetables and their production activities are varying, it is impossible for several farmer households to share one AIN. This means that farmers have to use AIN not cost-efficiently.
4. AIN has its own disadvantages, too. According to the interviews with IPM scientists, extensionists and vegetable experts, AIN has a negative effect on aeration and sunlight inside the production area, especially under rainy weather, though it contributes to the secure prevention of insects. According to Mr. Jin Jincai, the extensionist of Sanbao village, with the application of AIN, vegetable output will be decreased by 20 percent, while the application amount of pesticide is reduced by 50 percent. In non-demonstration areas, little anti-insect net is used.

### *Economic effect of IPM for local farmers*

Some farmers don't favorite IPM project mainly because after adoption of SBI, the net benefit of vegetable production is not significantly increased. According to periodical project report and interviews with IPM researchers and extension staff, after adoption of IPM, the net profit of farmers' vegetable production has been dramatically increased with a dramatic decrease in

pesticide input and labor input, and an obvious increase in the vegetable yield. The variation was calculated on the base of farmers' pre-IPM production mode. However, some farmers don't think IPM has brought them additional net benefit. In local area, farmers' production is profit-oriented, whose goal is to gain maximized economic return. So, some farmers have strong complaint over the decreased profit of vegetable production, which are partly brought by SVP (IPM). This would affect their evaluation and practice of IPM strategies, as mentioned below.

1. Findings from interview with local vegetable growers. According to the results of interviews with 100 vegetable growers, negative economic changes were experienced as a result of IPM due to the facts of:

- A. Although relatively less pesticides were used, pesticides cost have increased remarkably due to the price increase of pesticides;
- B. A small decrease in frequency of pesticides exertion brings relatively less labor input in pesticides exertion, but farmers don't put much cash value on this part of labor, so labor cost remain almost the same as that in pre-IPM condition;
- C. No significant yield increase in vegetable production, but the price of vegetables has been decreasing in recent years due to the large import of vegetables from other places.

2. Reasons for the difference in views on benefit of IPM between researchers and extension agents and farmers:

According to IPM researchers and extension agents, the additional benefit resulting from IPM includes two parts: (1) Decrease in pesticide cost. (2) Additional value from increased vegetable yield. The calculation of the two parts were under following preconditions:

- A. Vegetable producers have perfectly implemented IPM strategies in production process: application of right kinds of pesticide and timely use of them;
- B. Prices of pesticide and vegetables remain the same.

However, at farmer household level, these preconditions can not be met. Local farmers' have limited knowledge on SBI and they can't make the right choices of insecticide. Moreover, the usage of many SBI requires farmers' application of them at early age-class period of insects, but local farmers know little about the stadium of insects, which leads to untimely use of insecticides and failure in killing insects effectively. Thus, farmers have to spray more pesticide each time and do this more frequently than IPM experts. Therefore, as far as the pesticide amount is concerned, farmers have wasted them a lot.

- A. Local farmers don't put much cash value on their working time, so even they have spent less time in pest management due to IPM, they usually ignore this when consider the benefit of IPM.
- B. As for certain amount of pesticide, the price of SBI is much higher than that of PHPDK, which means that farmers have to spend more on pesticide than in pre-IPM condition, especially when they are unable to use SBI properly.
- C. Due to the import of vegetables from other places, prices of vegetables have been declining. Therefore, yield increase of vegetables is discounted by decreased prices.

*Difference between demonstration and non-demonstration sites: as Table 6 indicates, the proportion of farmers positively evaluating IPM, SBI and AIN in demonstration area is significantly larger than that in non-demonstration area. The result can be explained as: Farmers in demonstration area can receive more support and service from IPM project, they have better access to the knowledge on SBI, AIN and thus on IPM, so they can implement IPM strategies more properly. For example, contrasting to farmers in non-demonstration areas, they know more knowledge on SBI and insects, so they can apply SBI more timely and properly. Thus they can save more cost on pesticide management. For farmers in demonstration areas, it is more possible to gain the additional net benefit of IPM, so they evaluate IPM positively.*

### 3.3 Farmers' decision-making process in pest management

According to interviews with local farmers, their decision-making process in pest management can be illustrated in as Figure 2:

From the farmers' decision-making process described in Figure 2, we can find the following problems:

1. Some farmers don't account the number of insects before making spray decisions. Once they find insects on their vegetables, they decide to spray. This disobeys rules of IPM. According to philosophy of IPM, certain amount of insects within the tolerance of economic loss can be ignored in pest management. Therefore, field investigation has to be conducted before making the decision for spray. Otherwise, unnecessary pesticide cost would happen. There are reasons for farmers' ignorance of field investigation: (1) they have

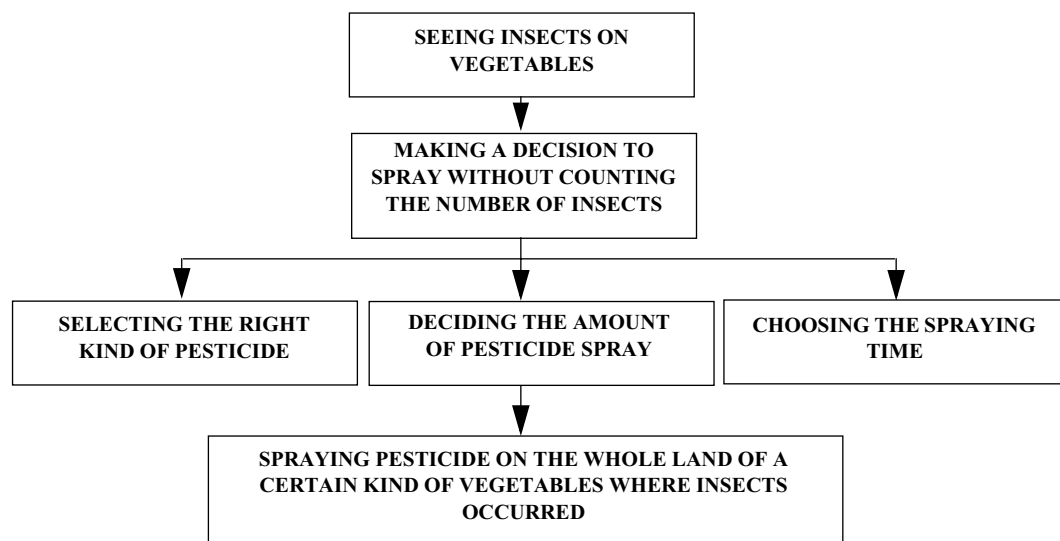
no such habits; (2) they are too busy to account the number of insects; (3) lack of basic knowledge and qualification for understanding the methods of field investigation; (4) they don't know or don't believe the action threshold. As for the above aspects, farmers in demonstration areas perform better than those in non-demonstration areas.

2. In most cases, local farmers follow the advice of pesticide retailers at village level in selecting right kinds of pesticide. But they often spray more than suggested on pesticide label. Usually, they mix dichlorvos with other kinds of pesticides in order to increase killing effect. In this way, they further increase the spray density and spraying cost. In demonstration areas, the phenomenon of farmers' mixing of pesticides is less found.
3. Some local farmers can not spray timely. Because they are both vegetable producers and sellers, they are too busy to spray at certain time, which disobeys the discipline of IPM.

**Table 6.** Farmers' attitude toward IPM project

Item	Percent of farmers who hold the attitude (%)								
	Sanbao village			Yunfeng village			Sanwei village		
	positive	neutral	negative	positive	neutral	negative	positive	neutral	negative
IPM project	68	23	9	48	27	25	46.7	20	33.3
SBI	57	17	16	41	16	43	37.6	21	41.4
Anti-insect net	73	27	0	***	***	***	63	15	22

Source: processed according to the field survey



**Figure 2.** Farmers' decision-making process in pest management

According to rules of IPM, pesticide spray has to be conducted at a certain time, otherwise, insects can not be killed effectively. For example, to kill diamondback moth, it is proper to do spraying in the evening, but sometime, farmers can not ensure the time, because at the time, they may be on the way back from urban vegetable markets. Farmers' not spraying timely often leads to failure in killing insects effectively. They have to spray much more than usual to kill the more mature worms. Farmers in demonstration areas can spray more timely than those in non-demonstration areas.

4. Farmers spray the whole vegetable land when they find insects in it, this may cause the waste of pesticides. According to rules of IPM, farmers can only spray the part where they find insects. But local farmers believe that once insects have occurred at certain part of vegetable land, then the whole land will be affected with insects in a few days, so they spray pesticide to the whole land. Moreover, they are too busy to spray fragmentally. For them, it is more convenient to spray to the whole land at one time.

### **3.4 Experience from other project areas**

#### *3.4.1 Wenzhou project area*

##### *Problems:*

1. The production of clean vegetables is badly affected by industrial wastes. The air, soil and water in vegetable production areas are heavily polluted by industries in the surrounding areas. Measures have been taken to reduce the pollution, but it will take a rather long time to have positive effects. The industrial waste pollutes the vegetables and discounts the efforts in producing 'clean vegetable';
2. Some kinds of PHPDK such as phosphorami dothioic acid, are still used by some farmers. Meanwhile, over-dose and over-frequent spray are still existing in the practice. Some farmers still ignore pre-harvest withholding period when choosing the time to sell their vegetables;
3. Some farmers irrigate their vegetable field with polluted water, which affects the quality of vegetables;
4. Some vegetable farmers are ignorant of knowledge on IPM and have a poor education background.

##### *Experience from Wenzhou project area*

1. By making plan of developing new village programming, locate the areas of vegetable production in the exurb, where there is less pollution from industries;
2. Make corresponding constructions with the development of vegetable base;
3. Provide subsidy to farmers in adopting SBI.

#### *3.4.2 Jiaxing project area*

##### *Problems:*

1. Vegetable quality test methods need to be further elaborated. The test with instrument made in Shanghai needs about an hour to complete, which can not meet the demands of market to conduct quickly test. The instrument made in Taiwan only needs about 10 minutes to complete quality test, but it can not identify phosphorami dothioic acid due to the limits of test methods used. Therefore, at present, no effective and quick test methods are available.
2. Laws and regulations for punishing IPM (SVP) violators are not available at present, therefore, punishment to SVP violators can not be elaborated in practice.
3. Many other measures have to be taken with the application of AIN, especially during the hot and rainy season. Up to now, very few techniques related to this have been developed.
4. The deputy of native vegetable is ruined by the vegetable from outside. Until now, there are no quality control stations to test the quality of outside vegetables.

##### *Experience*

1. Local government signed contract with villages. In the contract, measures for encouraging and punishing regulations concerning the application of IPM are made to structure farmers' behaviors;
2. Provide subsidy to farmers applying AIN, and guarantee the least bottom price of marketing their vegetables;
3. Set up special market stands for selling clean vegetables; vegetable retailers of these stands can spend only one half of usual market facility renting fee; meanwhile, regulations are made to structure the behavior of these retailers;

4. The certificate of 'clean vegetable' will be set up in 2001;
5. Vegetable packages marking different producers are used in markets and circulation process of vegetables. In this way, every farmer is responsible for the quality of his vegetables.

### 3.4.3 Situations in other regions

The situations of IPM project in other areas, such as Ningbo, Shanghai, Jinhua are quite similar to the places mentioned above. Farmers have similar problems in implementation of IPM.

## 3.5 Contributions of IPM project financed by ACIAR to local vegetable production and socioeconomic development

As mentioned above, big differences exist in farmers' understanding, evaluation and practice between demonstration areas and non-demonstration areas. The main reason for this is that farmers in demonstration areas received more assistance from IPM project. The IPM project financed by ACIAR has been conducted in Hangzhou for about 6 years, and it has contributed a lot to the local vegetable production and socioeconomic development. The contributions are described as follows:

1. Introducing the idea of IPM into local area. To produce 'green vegetable' was ever ignored by local government and some accidents ever appeared due to the application of PHPDK in vegetable production. Enlightened by ACIAR's IPM project, SVP was initiated by local government to urge the production of 'green vegetable'. Now, a lot of government officers, extensionists and vegetable farmers have accepted the idea of IPM.
2. Supplying support to technical development of IPM. Local IPM research agencies and scientists have received much assistance from ACIAR. In cooperation with scientists from Australia, great progress has been gained towards researches on SBI, insect and new pest management methods. Now more and more new research findings have been incorporated into the pest management methods in practice. The research financed by ACIAR concerns the following respect:
  - A. Major factors affecting levels of pests in brassica crops and role of beneficial;

- B. Effectiveness and safety of pesticide application;
- C. Impact of major pests on yield and quality in different brassicas;
- D. Performance of different pest management strategies

3. Supplying technical service and financial support to the extension of IPM package to farmers. Supported by IPM project agency, a lot of training courses and field demonstrations have been conducted to local agricultural extensionists and vegetable farmers, especially in demonstration areas. Some farmers can receive guidance directly from IPM scientists. IPM researchers also supply pest broadcast to farmers, which makes the work of pest management more successful.
4. Directing, supervising and facilitating the operation of SVP and the extension work of IPM. With the regular review of IPM project, SVP was also reviewed, thus local government officers, IPM researchers and extensionists can have an idea of the current situation in farmers' adoption of IPM. Consequently, they can solve the problems timely to facilitate the operation of SVP project.
5. Having a major beneficial impact on the environment through reduced inputs of chemical pesticides, resulting in less chemical residue in soils and groundwater and less mortality of beneficial insects and other non-target organisms (including fish).
6. Benefiting local vegetable growers and consumers as human health is concerned. Women are bigger beneficiaries as most of insecticide spraying is done by them.
7. Having profound positive impact on the social network and social capital of project areas, as to some extent, the project activities have facilitated the social interaction among local vegetable farmers, extensionists and government officers.

In general, the IPM project financed by ACIAR has significantly facilitated local farmers' adoption of IPM strategies. The success of SVP of local government owes great to the implementation of IPM project supported by ACIAR.

## 4. Conclusions

Based on the above findings and analysis, the following conclusions can be made:

### **Farmers' practice of IPM**

Owing to the implementation of the IPM (SVP) project, great improvement has been made towards farmers' understanding and implementing of IPM strategies. In project areas,

1. PHPDK is seldom used;
2. SBI have been widely used by vegetable farmers;
3. Pesticide usage is decreased;
4. AIN is being accepted by more and more farmers;
5. More non-chemical pest management methods have been developed and accepted by local farmers;
6. There is less vegetable affected by PHPDK in local vegetable markets.

Although there is still a long way to go for local farmers to understand IPM comprehensively and implement IPM strategies perfectly, in general, they have adopted IPM to a larger extent, as the facts indicate presented above.

### **Factors affecting farmers' adoption of IPM package**

According to the systematic analysis in part 3, the factors affecting farmers' knowledge, evaluation and practice of IPM package are summarized in Table 7.

### **Roles of IPM project financed by ACIAR**

Although there is still a long way to go for local vegetable farmers to implement IPM perfectly, the IPM project financed by ACIAR has gained significant success. It has contributed a lot to local

vegetable production and to the upward changes of farmers' idea, habits and practice in pest management activities. The contributions can be summarized as:

1. Introducing the idea of IPM into local area;
2. Supplying support to technical development of IPM;
3. Supplying technical service and financial support to the extension of IPM package to farmers;
4. Directing, supervising and facilitating the operation of SVP and the extension work of IPM;
5. Contributing a lot to the success of SVP of local government.
6. Having a major beneficial impact on the environment through reduced inputs of chemical pesticides, resulting in less chemical residue in soils and groundwater and less mortality of beneficial insects and other non-target organisms (including fish).
7. Benefiting local vegetable growers and consumers as human health is concerned. Women are bigger beneficial as most insecticide spraying is done by them.
8. Having profound positive impact on the social network and social capital of project areas, as to some extent, the project activities have facilitated the social interaction among local vegetable farmers, extensionists and government officers.

**Table 7.** Summary of factors affecting farmers' adoption of IPM

Source of affecting factors	Content	Affecting result	Affecting degree		
			High	Medium	Low
Vegetable farmers	• Quality of growers	• Farmers' lack of culture and capacity in understanding IPM comprehensively;	✓		
	• Vegetable farm size and income structure	• Some farmers would not invest more on vegetable production, including on IPM;		✓	
	• Number of family labor	• Deficiency in labor in pest management;		✓	
	• Diversity of farmers' production activity	• Difficulty in organizing unite and regular IPM training to farmers; • Decreased possibility in farmers' inter-cooperation;	✓		
	• Social mobility and interaction	• Difference in farmers' ability to obtain information on IPM;	✓		
	• Social network and social capital	• Decreased possibility in farmers' inter-cooperation; • Increased pest management cost; • Difficulty in applying IPM at larger-scale;			✓
Extension agency	• Shortage of technical personnel	• Technical service on IPM can only reach a small part of vegetable farmers;	✓		
	• Deficit in extension budget	• Farmers can not obtain enough assistance such as IPM-related equipment and training materials;	✓		
Pesticide suppliers	• No allowance is offered to pesticide suppliers	• Insecticide suppliers have no incentive in supplying SBI;		✓	
	• Some pesticide suppliers market fake pesticides	• Fake pesticides erode farmers' trust to SBI and local extensionists	✓		
Local agricultural bureau	• 'Top-down' measures have to be taken;	• Arousing farmers' repulsion of IPM		✓	
	• Deficit in an extension budget	• Assistance to farmers is not enough;	✓		
Vegetable market	• Short of practical and convenient measures for vegetable quality control	• Vegetables affected by PHPDK can not be recognized effectively; • Consumers' distrust in local 'green vegetable'; • Farmers can not gain additional benefit from the production of 'green vegetable'	✓		
	• Short of personnel in conducting quality control		✓		
Macro socioeconomic environment	• The serious pollution from industry	• Discounting the effect that IPM brings on the quality of vegetables		✓	
	• IPM is not applied in some big vegetable production areas	• Vegetables from non-IPM-applied areas ruin the deputy of local 'green' vegetable; • Local 'green vegetable' can not be sold at a higher price.	✓		
IPM package	• The characteristics of SBI, AIN and IPM conflict with the pest management customs of farmers	• Farmers can not accept IPM smoothly;	✓		
	• For some farmers, IPM has not brought additional benefit	• Some farmers can not implement IPM strategies actively.	✓		

## 5. Recommendations

### 5.1 Measures to increase farmers' knowledge on IPM

1. Organize more technical training courses at the village level. The training should be focus on: the systematic philosophy and principle of IPM, the identification of different stadium of insects, the timely and proper usage of SBI, and integrated and conscious application of different IPM strategies;
2. The training opportunities should be provided to more farmers. Farmers in one production team or production group should share the training opportunities in turn.
3. Facilitate the communication between trained farmers and non-trained farmers, demonstration households and non-demonstration households, vegetable farmers and extension staff by organizing regular demonstration activities;
4. Extension agencies at the village level should provide more assistance to vegetable farmers and maintain a constant contact and cooperation with their clients;
5. Supply more training courses to pesticide retailers at village level and increase their knowledge on selection and usage of pesticides;
6. More training materials should be offered to farmers to inform them the information on insect broadcast, pesticides usage and integrated usage of different pest management methods.
7. The mass media, such as TV and newspaper should be further applied to transfer information and knowledge on IPM to local farmers;
8. Facilitate the communication between vegetable farmers and IPM researchers, students at universities and extensionists;
9. More field demonstrations should be organized in vegetable production areas.

### 5.2 Measures to increase farmers' preference to IPM

1. Decrease farmers' total cost of SBI by facilitating farmers' timely and proper application of SBI and shortening marketing channels between SBI manufactures and farmers; a farmers' self-help groups are highly recommended;
2. Increase farmers' understanding towards the roles and function mechanism of SBI by increase their knowledge on SBI;
3. Help farmers to change their traditional habits of pesticide application, such as over-density spray and pesticides-mixture spray, to further decrease the spraying cost;
4. To teach more farmers for applying the methods of field investigation; make more farmers know the action threshold; encourage farmers' making pest management decision based on accounted insects number; in doing so, farmers spray cost may be reduced dramatically;
5. Conduct research and trials to decrease the negative effects of anti-insect nets, and to reduce the cost by finding appropriate application modes, such as neighboring farmers sharing one anti-insect net together;
6. Local government should continuously provide subsidies to farmers who adopt AIN to reduce the cost of AIN and increase the application rate of AIN among farmers;
7. Increase the price of 'clean' vegetables to encourage farmers' adoption of IPM;
8. Formulate rules to punish those selling vegetables affected by PHPKD to protect the incentives of 'clean vegetable' producers;
9. Offer training courses to vegetable consumers in Hangzhou and enhance their awareness of the dangers of vegetables with PHPDK; increase their recognition of 'secure vegetable'; develop user's friendly vegetable quality testing methods for both quality control technicians and consumers;

10. Increase the fame of 'clean vegetable' through TV, newspaper and other mass media to increase the society's recognition of 'clean vegetable' and IPM;

### 5.3 Measures to facilitate farmers' application of IPM

1. Take measures to increase farmers' knowledge on IPM and increase farmers' reference to IPM, as mentioned above.
2. To conduct field inspection of PHPDK more often to decrease the possibility of farmers' spraying of it;
3. Introduce vegetable labeling system into the market process, so that every farmer could be responsible for his product, and consequently, they will give up PHPDK consciously;
4. Provide more subsidy to local farmers in adoption new methods of IPM (such as AIN) to increase their ability to implement IPM strategies;
5. Promote the adoption of participatory extension methods in the current IPM extension system; provide training courses on participatory problem identification and solution and other participatory methodologies for local extension staff.
6. Combine a 'top-down' approach with the 'bottom-up' participatory extension approach before the new technologies, households survey should be conducted in order to include vegetable farmers' consideration and proposals into the IPM research and extension programs.

### 5.4 Institutional enforcement

1. Establish a vegetable farmers' association at the village or community level to facilitate cooperation among farmers with respect to: sharing knowledge and experience of IPM, identifying and solving problems in implementation of IPM strategies; taking cooperative action in purchase of production materials and sale of their vegetables;
2. Strengthen functions and roles of: quality control office in market; industrial and

commerce administration bureau; technique supervision bureau and environmental administrations. Strict tests on pesticide deposit in vegetables should be conducted to ensure that only the genuine 'secure vegetable' appear in production and marketing process;

3. Stabilizing the land tenure for drawing long term investment of farmers to vegetable production within SVP (IPM) framework;
4. Local extension agencies should be as priority supported by provincial government. Concrete support should focus on: personnel training; recruiting new staff or extension agencies; financial support to improve training materials and equipment, and to enlarge the training capacity and scope;
5. Suppliers for pesticides and other agricultural materials should be further involved into the framework of SVP (IPM) and should bear more responsibility for training farmers, especially at village level; more IPM training should be conducted for pesticide suppliers at the village level to enhance their ability to guide farmers to implement IPM strategies;

### 5.5 Policy recommendations

1. Promote inter-household cooperation by strengthening the coordination roles of growers' group leaders and village leaders.
2. Strictly implement the current policies and roles on: pesticide usage; quality control of vegetables; marketing of pesticides;
3. Decrease the price of main agriculture materials involved in SVP (IPM) such as SBI, anti-insect net and new varieties of vegetables by shortening the marketing channel between manufactures and farmers;
4. Allow and encourage a higher price of clean, uncontaminated vegetables (secure vegetable) to stimulate farmers' further adoption of IPM strategies;
5. Forbid the import of vegetables with PHPDK from other places by setting up vegetable-quality-control stations on main roads to Hangzhou.

## **6. Recommendations for the follow up activities of the Australian/China IPM projects**

Concerning the already positive socioeconomic impact of ACIAR's IPM project on project areas and some problems existing, we highly recommend that ACIAR initiate follow up activities to continue the success and solve the current problems. The follow up activities can focus on the following aspects:

1. Further technical research on AIN, SBI and other pest management methods to improve the socioeconomic adaptability of IPM in local area, such as research on decreasing the cost of SBI, more economical application of AIN, easy decision-making process, economical and efficient spraying equipment and diminishing the negative effect of AIN.
2. Set up more demonstration sites to enlarge the IPM impact in vegetable production areas;
3. Supplying further finance and technique support for the training courses to local farmers and extensionists;
4. Under the current socioeconomic conditions of communities in project area, conducting separate research on the establishment of effective IPM extension system.

## 7. Annex

### 7.1 Itinerary of the study

Stage	Time	Activities	Location
<b>Institutional survey</b>	22–26 May, 2000	Preparation of study at CIAD	CIAD, Beijing
	27–28 May, 2000	Travel to Hangzhou Interview IPM researchers at ZU	Hangzhou
	29 May, 2000	Interview plant protection officers at provincial level Collecting data and information from SVP leading office in Jianggan district	Hangzhou
	30 May, 2000	Agricultural bureau interview in Jiubao township Interview of village leader and village extensionist in Sanbao village Visiting demonstration households in Sanbao	Hangzhou
	31 May, 2000	Briefing to ACIAR project leader in China Perfecting questionnaires for field survey Coordinating with local counterparts institutions for field survey schedule	Hangzhou
	1 June, 2000	Back to Beijing	
	<b>Field survey</b>	15 July, 2000	Team travel to Hangzhou
16–17 July, 2000		Arranging the survey schedule at SVP leading office Farmers' household interview in Sanbao village	Hangzhou
18–19 July, 2000		Interview of farmers' household in Yunfeng village Market sectors interview at Sanliting, Jianqiao and Wulinmen vegetable market	Hangzhou
20 July, 2000		Farmers' household interview in Sanwei village Extension agent interview in Jiubao township	Hangzhou
21 July, 2000		Interview Baixing Ltd. vegetable and fruit Interview Jianggan agriculture material Ltd.	Hangzhou
22 July, 2000		Briefing to ACIAR project leader in China Fixing on fields for further study	Hangzhou
23 July, 2000		Study team departure from Hangzhou for Beijing	Hangzhou
1–20 August, 2000		Processing the data and information collected during the field survey	Beijing
1 September 2000		Preparation of the mid-term draft report	Beijing
3–12 November, 2000		Field survey for the third time to elaborate former survey results	Hangzhou
December 2000		Processing the data and information collected during the third time field survey	Beijing
March 2001		Preparation of the final draft report	Beijing

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## 7.2 List of persons contacted by survey team

Name	Position	Institution
Yu Yi-jun	Director	General Plant Protection of Zhejiang Province
Zheng yong-li	Staff member	General Plant Protection of Zhejiang Province
Hu Hu-gen	Director	SVP office, Jianggan Department of Agriculture, Hangzhou
Jiang Chun-sheng	Vice director	SVP office, Jianggan Department of Agriculture, Hangzhou
Hong Xiao-qin	Staff member	Jianggan Department of Agriculture, Hangzhou
Sun ren	Staff member	Jianggan Department of Agriculture, Hangzhou
Shen Bo-sing	Director	Jiubao Department of Agriculture
Chen Wenxing	Vice director	Sijiqing Department of Agriculture
Xu Wen-liang	Village head	Sanbao village
Liu Shu-sheng	IPM project leader	Department of Plant Protection, ZAU
Zhang Guang-mei	Staff member	Department of Plant Protection, ZAU
Shen A-hu	Technician	Yunfeng village
Jin Jin-cai	Technician	Sanbao village
Yang Jin-shui	Technician	Sanwei village
Jiang Guo-qiang	General manager	Baixing Ltd. Vegetable and fruit
Jia Guo-ping	General manager	Jianggan agriculture material Ltd.
Zang Wei-yun	Technician	Quality control office of Sanliting vegetable market
Chen Yongyan	Pesticide retailer	Yunfeng village
Mrs. Ma	Pesticide retailer	Sanbao village
Vegetable farmers*		

\*Because farmers in Hangzhou are very sensitive about their names being asked and exposed during the interview, especially when dealing with questions on the performances of local authorities, names of 100 farmers interviewed are ignored during the survey to gain more accurate information

### 7.3 Questionnaire outline

#### 1. Institutional survey

##### 1.1 Leading agency of ACIAR project in China

- Constitution, structure, membership and operational mechanism (inside and outside) of the leading agency;
- Overall situation of IPM in local area;
- Requirements of IPM on local farmers in respect to input, knowledge, organization, pesticide usage, pest management method, vegetable production mode, reception of training, and social capital at community level; main barriers farmers face in IPM adoption;
- Requirements of IPM on: agricultural bureaus, research institutions, extension agencies and other relevant sectors; policies on land, market and circulation;
- Kinds of policies and rules in operation and their effectiveness.

##### 1.2 IPM researchers

- Differences between IPM and conventional pest management strategies in their adaptability of technique, economic, social conditions of local area;
- Requirements of IPM on local farmers in respect to input, knowledge, organization, pesticide usage, pest management method, vegetable production mode, reception of training, and social capital at community level; main barriers farmers face in IPM adoption;

##### 1.3 Agricultural bureaus at provincial, district and township level

- Basic socioeconomic situations of local vegetable farmers: number and structure of population, income, climate, land use status, education, transportation and communication, livelihood system;
- The status of local CBO and NGO relevant to SVP (IPM);
- The current support on SVP (IPM) in terms of personnel, finance and materials; the support to be supplied in future;

- Opinions on problem farmers face in implementation of IPM and recommendation on solutions.

##### 1.4 Extension agencies at district, township and village level

- Structure, qualification of personnel, operational mechanism (inside and outside);
- Extension activities already conducted to facilitate farmers' adoption of IPM; ways these extension activities are conducted; outcomes of these activities; farmers' participation and barriers in adoption of IPM
- Overall evaluation on farmers' adoption of IPM;
- Requirements of extension of IPM on: agricultural bureaus, research institutions, extension agencies and other relevant sectors; policies on land, market and circulation; the already existed policies and rules;
- Differences between IPM and conventional pest management strategies in their adaptability of technique, economic, social conditions of local area;

##### 1.5 Village leader

- Basic socioeconomic situations of vegetable farmers in his village: number and structure of population, income, climate, land use status, education, transportation and communication, livelihood system;
- The already support on SVP (IPM) in terms of personnel, finance and materials; the support to be supplied in future;
- Opinions on problem farmers face in implementation of IPM and recommendation on solutions.

#### 2 Field survey

##### 2.1 Basic aspects of members of farmer household

- Name, sex, age, education background;
- Time engaged in farming
- Family roles and community roles

- 2.2 Vegetable production of farmer households
  - Total land area versus vegetable land area
  - Total net income versus net income from vegetable production
  - Goals of farmers' vegetable production;
  - Degree of emphasis farmers put on vegetable production.
- 2.3 Farmers' knowledge on insects in respect to:
  - Recognition of insects
  - Natural enemy of insects
  - Source of knowledge on insects
- 2.4 Farmers' KAP of some pest management strategies such as:
  - Chemical control;
  - Usage of sterilized seeds;
  - Serializing soil;
  - Adjustment of seedtime
  - Crops rotation
  - Adoption of anti-insect net;
  - Selection of new varieties
- Seizing by hand
- Watering
- Weeding
- 2.5 Farmers' application of pesticides
  - Pesticide varieties;
  - Methods, frequency, decision-making process and self protection methods in pesticides application;
  - Views on SBI and PHPDK;
  - Source of knowledge on pesticides
- 2.6 Farmers' KAP on IPM and self-evaluation
  - Farmers' KAP on IPM;
  - Farmers' source of knowledge on IPM
  - Farmers' self-evaluation of their pest management strategies measured by IPM;
  - Profit comparison between IPM and conventional pest management strategies;
  - Cooperation among farmers in implementing of IPM and farmers' views and expectation towards this kind of cooperation

**7.4 Summer diary work calendar of the Chens, Sanbao village**

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3
Husband	Case	Get up and go to work in vegetable field		breakfast	Work in vegetable field local market to sell vegetables	lunch	Take a nap	lunch	Take a nap	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	supper	Go to bed						
		Case	Back from downtown	Take a nap and have breakfast	Work in vegetable field sometime buy agricultural material at village shop	lunch	Take a nap	lunch	Take a nap	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	supper	Go to bed	Go to bed					
Wife		Get up and go to work in vegetable field		breakfast	Work in vegetable field local market to sell vegetables	lunch	Take a nap	lunch	Take a nap	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	Work in vegetable field or go to local market to sell vegetables	supper	house work	Go to bed						

*Seasonal activities calendar for farmers in Sanbao village*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Partly vacant Preparation for vegetable production		Produce spring vegetable			Produce summer vegetable				Produce winter vegetable			

## 7.5 Selected photographs showing the process of the study and some facts of the project area



Photo 1. A female vegetable farmer who is more than 50 years old



Photo 2. A vegetable farmer says that he has never seen this kind of insect. ( the insect ever emerged 10 years before, according to local IPM scientists )



Photo 3. A male vegetable farmer is spraying with traditional knapsack



Photo 4. An interview with farmers who are working in vegetable field



Photo 5. Interviewer with the managers of Baixing Ltd. Vegetable and fruit



Photo 6 PHPDK test office in Jianqiao vegetable market



Photo 7 Instruments for PHPDK test in Sanliting vegetable market



Photo 8. Demonstration stall selling "clean vegetables" in Jiayou supermarket in Hangzhou



Photo 9. A pesticide retailer interviewed in Sanbao village