Jiangxi Integrated Agricultural Modernization Project (JIAMP)

Pest Management Manual

September 23, 2003
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Acronyms and Abbreviations

CPPQS  County Plant Protection and Quarantine Station
EDC    Ecological Demonstration County
FAO    Food and Agriculture Organization (of the United Nations)
GTZ    Gesellschaft fuer Technische Zusammenarbeit (German development assistance agency)
IPM    Integrated Pest Management
JIAMP  Jiangxi Integrated Agricultural Modernization Project
JPPQS  Jiangxi Plant Protection and Quarantine Station
Mu     667m² (1/15th ha)
PMP     Pest Management Plan
PPQS    Plant Protection and Quarantine Station
PRC    People’s Republic of China
SEPA    State Environmental Protection Agency
WHO    World Health Organization
WUA    Water User Association
WUG    Water User Group
1 INTRODUCTION

The Jiangxi Integrated Agricultural Modernization Project (JIAMP) aims to improve the livelihood of the rural households in Jiangxi through establishment of integrated, economically and environmentally sustainable, and market-driven agricultural production systems focusing primarily on productivity and high quality agricultural output. The project consists of the following components:

1. Irrigation and Drainage
2. Farm Production Improvement
3. Market Systems Development

The Farm Production Improvement component comprises the following subcomponents:

1. Agricultural Training and Extension
2. Farm Production Investment
3. Soil Fertility Improvement

The Farm Production Improvement component, and particularly its Farm Production Investment Subcomponent, will lead to more intensive agriculture production and likely increase in the use of production inputs, such as agro-chemicals (fertilizers, pesticides and herbicides). The project will put strong emphasis on mitigating any adverse effects of increased agro-chemical use by introducing more efficient application techniques to farmers. The project would support integrated pest management (IPM), including: (a) managing pests (keeping them below economically damaging levels) rather than seeking to eradicate them; (b) relying, to the extent possible, on non chemical measures to keep pest populations low; and (c) selecting pesticides (when they have to be used) that are less toxic, and applying them in a way that minimizes adverse effects on beneficial organisms, human beings, and the biophysical environment. As a result, there is a need for preparation of a Pest Management Plan.

The JIAMP Pest Management Program (PMP) will promote the use of biological and environmental control methods for pests and diseases, which will reduce the reliance on synthetic chemical pesticides. The Jiangxi Plant Protection and Quarantine Station (JPPQS) and its county subsidiaries already promote IPM approaches to the control of pests and diseases in Jiangxi province (Annex 1).

2 CURRENT PEST MANAGEMENT APPROACH IN JIANGXI

2.1 Current and Anticipated Pest Problems

The major insect pests of economic significance in the Jiangxi agriculture sector and relevant to the project are shown in Table 1.
Table 1. Areas of Crop Production under the JIAMP

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area</th>
<th>Major Insect Pests in Jiangxi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mu</td>
<td>ha</td>
</tr>
<tr>
<td>Paddy rice</td>
<td>147,960</td>
<td>9,864</td>
</tr>
<tr>
<td>Field vegetables</td>
<td>29,857</td>
<td>1,990</td>
</tr>
<tr>
<td>Greenhouse vegetables</td>
<td>4,139</td>
<td>276</td>
</tr>
<tr>
<td>Medicinal herbs</td>
<td>5,174</td>
<td>345</td>
</tr>
<tr>
<td>Lotus</td>
<td>8,312</td>
<td>554</td>
</tr>
<tr>
<td>Cotton</td>
<td>3,006</td>
<td>200</td>
</tr>
<tr>
<td>Naval orange</td>
<td>12,088</td>
<td>806</td>
</tr>
<tr>
<td>Total</td>
<td>210,536</td>
<td>14,035</td>
</tr>
</tbody>
</table>

The major rice pests in the project area are rice stem borers (*Chilo suppressalis*, *Tryporyza incertulas*), planthoppers (*Nilaparvata lugens*, *Sogatella furcifera*), leaf rollers (*Cnaphalocrocis medinalis*) and rice gall midge (*Orseolia oryzae*) (Table 1).

Cotton production under the project may be either irrigated new bushes or irrigation of existing cotton. The major cotton pests are bollworm (*Helicoverpa armigera*) with secondary pests including Cotton aphid (*Aphis gossypii*), Agrotis ypsilon, *Lygus lineolaris*, Prodenia spp., and *Empoasca biguttula*.

Citrus (oranges) are susceptible to damage by a wide range of insects in Jiangxi. These include *Panonychus citri* McGregor, *Phyllocnistis citrella* Stainton, *Coccoidea sp.*, and *Phyllocoptruta oleivora* Ashmead. Other species causing lesser damage include *Dialeurodes citri* Ashmea, *Aphis citricidlus* Kirkaldy, *Papilio sp.*, *Cerambycidae sp.*, and *Contarinia citri* Barnes.

Capsicum (peppers) and cabbage are two of the major vegetable species to be grown on the project. In capsicum, Agrotis ypsilon is the main insect pest during the vegetative growth phase, while aphid, bollworm, and *Tetranychus urticae* also occur during the fruiting phase. The main insect pests on cabbage are aphids, *Laphygma exigua*, *Prodenia litura*, *Plutella xylostella*, and cabbage caterpillars.

Lotus is the other main cash crop to be grown under the project. Major insect pests for lotus include aphids and *Prodenia litura*.

2.2 Agricultural and Physical Control Methods

Agricultural and physical methods used by farmers to help control insect pests include:

- Tillage practices, including deep tillage to bury straw and vegetative trash to prevent insect pest egg buildup, and soil tillage in rice paddy immediately after harvesting to prevent buildup of rice stem borers.
- Regular rotation of dry land crops to avoid buildup of soil-borne insect pests and diseases, e.g., vegetables followed by beans followed by vegetables.
- Regular rotation of dry land and water land crops to avoid buildup of soil-borne insect pests and diseases.
- Straw and trash control to prevent buildup of insect pests and eggs in crop straw and trash.
- Cutting and burning of diseased or egg/insect infected leaves in vegetable crops; and branches in cotton and citrus orchards.
- Deep flooding practices in rice paddy to assist control of soil-borne eggs and pupae of rice pests and other insects, e.g., *Chilo suppressalis* eggs.
- Use of lure boxes to collect worms and caterpillars, e.g., boll worms in cotton, aphids in vegetables.
- Light lures making use of insect phototaxis to attract pests in vegetables and lotus.
- Handpicking of eggs, caterpillars and larvae during periods of high infestation, e.g., *Laphyqma exiqua* and *Prodenia litura* eggs on cabbage leaves; boll worms and larvae in cotton; and cabbage caterpillars.
- Use of fruit bagging in citrus orchards to prevent insects entering fruit, and also keeping chemicals off the fruit.

### 2.3 Biological Control Methods

Biological and control measures used by farmers include:

- Extension of crop varieties resistant to insect pests. Examples include cotton varieties, such as 32B, GK22, Zhong 38F1, Zhong298F1 that are resistant to cotton boll worm; and rice variety KanwenqingzhanF1 that is resistant to rice gall midge.
- Intercropping of target species to attract insect pests away from the main cash crop, e.g., planting of *Ageratum conyzoides* L. in citrus orchards to control mites; planting of peanuts and soybeans rather than sweet potato in young citrus orchards to minimize damage by *Noctuidae sp.*; planting of soybean on rice bunds to protect predators of rice pests.

The JPPQS is conducting research programs and surveys in progress on natural predators of some pests, mainly rice and cotton. However, field observations and farmer interviews during project preparation did not indicate that farmers were actually practicing predator control of crop pests yet.

### 2.4 Chemical Control Methods

#### 2.4.1 Non-Pesticide Chemical Control Methods

Non-pesticide chemicals are used to control specific insect pests on some crops. These include: (i) diluted oil emulsions to control mites on citrus (navel oranges); (ii) liming of citrus tree trunks for disease control, Bordeaux (CuSO₄) sprays for disease control on citrus; (iii) use of sugar-vinegar mixtures to attract and trap insects in vegetable greenhouses and lotus (*Prodenia litura, Laphyqma exiqua*) and in citrus orchards (*Noctuidae sp.*); these can also be used in conjunction with lights to initially attract insects.

#### 2.4.2 Overall Pesticide Usage

Pesticides are the main form of chemical control of insect pests. The total application level of pesticides in Jiangxi and in some project counties is listed in Table 2.
Table 2. Total Pesticide Applications in Jiangxi and some Project Counties

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiangxi Province</td>
<td>36,482</td>
<td>41,932</td>
<td>44,482</td>
<td>45,259</td>
<td>48,704</td>
<td>54,502</td>
</tr>
<tr>
<td>Wuning</td>
<td>174</td>
<td>NA*</td>
<td>186</td>
<td>218</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Pengze</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>521</td>
</tr>
<tr>
<td>Hengfeng</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>431</td>
</tr>
<tr>
<td>Nancheng</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>336</td>
</tr>
<tr>
<td>Gan</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>697</td>
</tr>
<tr>
<td>Hukou</td>
<td>117</td>
<td>455</td>
<td>362</td>
<td>322</td>
<td>315</td>
<td>372</td>
</tr>
<tr>
<td>Guangfeng</td>
<td>487</td>
<td>477</td>
<td>433</td>
<td>446</td>
<td>487</td>
<td>443</td>
</tr>
<tr>
<td>Yugan</td>
<td>512</td>
<td>527</td>
<td>538</td>
<td>549</td>
<td>578</td>
<td>592</td>
</tr>
<tr>
<td>Quannan</td>
<td>62</td>
<td>73</td>
<td>190</td>
<td>376</td>
<td>412</td>
<td>438</td>
</tr>
<tr>
<td>Longnan</td>
<td>23</td>
<td>84</td>
<td>50</td>
<td>65</td>
<td>47</td>
<td>55</td>
</tr>
</tbody>
</table>

Note: Data from the Statistical Book of Jiangxi Province (1990-1999). * NA: Data not available

The data in Table 2 and findings of the farm production improvement feasibility study indicate that:

1. From 1990 to 1995, the average rate of pesticide use in Jiangxi increased by 3% per year, and by 7.5% per year from 1995 to 1999.

2. In the project counties, the average rate of pesticide use also increased annually. However, the rates in Wuning, Hukou, Guangfeng, Yugan, and Longnan counties showed no obvious increase from 1995 to 1999, while that in Quannan increased by 8-10% per year, possibly caused by increased production of cash crops and vegetables.

2.4.3 Pesticide Use by Crops

Table 3 shows data on the type and application probabilities of pesticides for crops based on a survey of 70 households in 15 project counties in 2001 (Jiangxi Academy of Agricultural Sciences, 2001).

Table 3. Type and Application Probability of Pesticide Use for Crops in the Project Area

<table>
<thead>
<tr>
<th>Crop</th>
<th>Type and Application Probability</th>
<th>Amount (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early rice</td>
<td>Organophosphate 50%, Dimthypo 90%, herbicides 90%, fungicides 80%</td>
<td>7.5</td>
</tr>
<tr>
<td>Late rice</td>
<td>Organophosphate 50%, Dimthypo 90%, herbicides 80%, fungicide 100%</td>
<td>10.5</td>
</tr>
<tr>
<td>Cotton</td>
<td>Organophosphate 50%, pyrethrins 10%, herbicide 100%, fungicide 100%</td>
<td>33</td>
</tr>
<tr>
<td>Peanut</td>
<td>Herbicide 70%, fungicide 100%</td>
<td>1.5</td>
</tr>
<tr>
<td>Vegetable (1 crop)</td>
<td>Organophosphate 20%, pyrethrins 90%, fungicide 100%</td>
<td>7.5</td>
</tr>
<tr>
<td>Greenhouse vegetable (1 year)</td>
<td>Organophosphate 20%, pyrethrins 80%, fungicide 100%</td>
<td>22.5</td>
</tr>
<tr>
<td>Lotus</td>
<td>Organophosphate 50%, pyrethrins 50%</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Organophosphate pesticides account for 50-60% of total pesticide use on rice, cotton, lotus and mulberry; and 20% on vegetables and herbs (Table 3). The wide use of organophosphate pesticides was confirmed through field checks and farmer interviews during project preparation. Farmer interviews indicated that many farmers knew that many organophosphate pesticides were extremely hazardous, but they continued to use them because of their effectiveness and lack of cheap, effective, labor-efficient alternatives.

Findings from the farm production feasibility study on pesticide application indicated that:
1) The application rates of dimthypo and organophosphate on rice exceed the limits of the State Standard (GB4285-89), i.e., dimthypo 250 ml/mu.
2) According to the PRC’s national rules for safe use of pesticides, high toxicity pesticides have been banned for use on vegetable, tea, fruit trees, and traditional medicine crops. However, Table 3 indicates that there is clearly a gap between the regulations and farmer practice with 20-30% of the pesticides used on these crops being highly toxic.
3) The rates of pesticide use on cotton, greenhouse vegetables, and fruit trees were excessively high (Table 3).
4) 100% of farmers used herbicides, but in general don’t know the effects of the herbicides on soil and ground water.

### 2.4.4 Handling of Chemicals

The Regulations for Safe Use of Pesticides were publicized by the Public Health Ministry of the PRC in 1982. Field checks and farmer interviews indicated that farmers in many project areas did not practice safe handling of chemicals or use protective clothing. In many farmer houses, it was observed that pesticides are stored near food, on lower shelves in easy reach of children, and in bottles with caps that are easy to unscrew by children. This also applies to many sellers of pesticides with Class I chemicals often being stored in shops near food, and on lower shelves in the front of shops where children can easily access them. Few farmers were observed wearing long sleeved shirts or protective face masks when spraying. Spraying is often done in windy conditions resulting in spray drift. In most cases, farmers use backpack sprayers although some were observed using bucket and hand pumps to spray fruit trees. In summary, there is a need for improved handling of chemicals, spraying under appropriate weather conditions, use of safe spray equipment, and use of protective clothing. This suggests that the State policies and regulations are not adequately applied in the rural areas. Therefore, training on safe use of pesticides should be strengthened.

### 2.5 General Assessment of Current Pest Management Approach

Studies conducted during project preparation indicated the following issues on the current pest management approaches used in the project area:
- Dependence on chemical control methods, especially for large areas of mono-crop species, such as rice, cotton
- Over application of pesticides
- Use of high toxicity chemicals (Class I, WHO)
- Use of unregistered chemicals
- Inappropriate handling and management of pesticides and other agricultural chemicals
- Environmentally unsound disposal of chemicals and chemical packaging
- Inadequate enforcement of laws and regulations on labeling and sales of agricultural chemicals
- Low level of awareness amongst farmers, extension services and chemical resellers of IPM.
- Poor sense of safe use of pesticides.

3 POLICY, REGULATORY FRAMEWORK, AND INSTITUTIONAL CAPACITY

3.1 China and Jiangxi Policies on Plant Protection and IPM

Relevant national and Jiangxi policies on plant protection and integrated pest management include:

- Regulation on Management of Pesticides of PRC (Issued by the State Council and implemented on May 8, 1997)
- Methods for Implementing Pesticides Management Regulation (Issued by Ministry of Agriculture on April 27, 1999)
- Management Methods on “Pollution-Free” Farm Products issued by Ministry of Agriculture and State Quality Supervision, Test and Quarantine Bureau in 2002
- Standard for Safe Use of Pesticides GB4285-89
- Standard for Safe Use of Pesticides GB8321.2-87
- Testing on the residues of organophosphate pesticides in Food GB/T 5009.20-1996
- Notice on prohibiting use of highly toxic pesticides (animal drugs) issued by Jiangxi Provincial Agricultural Department (implemented in June 2002)
- Technical Operation Norms for producing “safe” potato, chilli pepper, eggplant, bean, cucumber, cabbage, green cabbage etc. formulated by Jiangxi Plant Protection and Quarantine Station (JPPQS).

3.2 Description and Assessment of IPM Capacity

JPPQS and its county subsidiaries promote IPM approaches to the control of pests and diseases in Jiangxi (Annex 1), particularly for rice, vegetable and cotton pests (Annex 2). However, it has limited technical staff numbers (25 at the provincial level) at all levels who are able to spend time in the field promoting IPM and training farmers in these approaches. There does not appear to be wide availability or circulation of IPM training materials at county or township levels.

At the township level, Department of Agriculture extension staff provide pest and disease control advice. However, many of these township technicians also sell agricultural chemicals as part of their mandate to raise funds to finance agricultural extension. As a result, there is some conflict of interest for these staff to promote non-chemical pest control methods as part of an IPM approach. Removal of this conflict requires changes in government policy and funding as it relates to agricultural extension. This has been raised as an issue with the Jiangxi Provincial Government during project preparation.
There is clearly a need for:

- Training of crop protection specialists, and extension staff at county and township levels in improved methods of pest management and IPM
- Training for farmers that is farmer-needs driven, using hands-on practical training approaches
- Preparation and distribution of IPM training materials prepared simple, local language, and well-supported by appropriate audio-visual aids
- Support for IPM research for priority crops/pests under the applied research activity.

Activities to address these needs are listed in Sections 7.3 and 7.4.

3.3 Institutional Control of Distribution and Use of Pesticides

Jiangxi Pesticide Test Management Institute and JPPQS at provincial, municipal and county level are responsible for the supervision and management of pesticides.

Production, Distribution and Use of Pesticides: Pesticides are classified as dangerous chemicals. Any company and units involved in the production, distribution and use of pesticides should obtain a business license in accordance with the State regulations. Companies and units that can operate in the pesticide business include:

- Agricultural production input operation units under Supply and Marketing Cooperatives
- Plant Protection and Quarantine Stations
- Soil Fertility Stations
- Agriculture and Forest Technical Extension Stations
- Forest Pest and Disease Prevention and Control Institutions
- Pesticides Production Enterprises
- Other operational units specified by the State Council.

4 GENERAL APPROACH OF THE JIAMP PEST MANAGEMENT PROGRAM

4.1 Objectives

In addressing the issues listed in Section 2.5, the JIAMP Pest Management Program will aim to:

- Prevent the use of highly toxic chemicals by farmers
- Decrease the levels of sales of inappropriate and inadequately labeled chemicals to farmers
- Promote the awareness, knowledge and adoption of IPM
- Promote safe use and management of chemicals.

The project will further support the efforts of JPPQS to promote the concept of IPM through:

- Introduction of chemical quality standards into the procurement policy for assessing farmer loan applications
- Capacity building of the government extension service in IPM approaches, and
- Education of agricultural chemical distributors and resellers in IPM approaches.
4.2 **Focus Areas of the JIAMP Pest Management Program**

The focus areas for the JIAMP Pest Management Program will be:

- **On farm** – develop with farmers approaches relevant to their farm
- **Farm Production Investment Sub-component Activities** – use lending guidelines to enforce procurement of approved chemicals and to monitor application rates and usage
- **Chemical resellers** – training and monitoring to ensure that all pesticides sold meet labeling laws requirements, are approved products (Class II and below), and that IPM approaches are promoted to farmers
- **Policy** – through the JIAMP Leading Groups, influence the development of environmentally sound policies on the sale and use of agricultural chemicals.

**On Farm.** IPM approaches will be incorporated into the training of project-supported extension staff who will be responsible for training the farmers. Many extension staff are also involved in the reselling of agricultural chemicals through input supply shops managed by township and county extension stations. Field demonstrations using established IPM approaches (farmer schools) will be conducted in all project irrigation areas by extension staff in collaboration with WUAs and WUGs.

**Farm Production Investment Sub-component Activities.** Procurement of chemicals will be monitored and adjusted as required through the loan assessment procedures of the Farm Production Investment Funds to ensure that no Class I chemicals are procured or used by project beneficiaries.

**Chemical Resellers, Distributors and Manufacturers.** Chemical resellers will be provided with training in chemical use and handling by both extension staff (many of whom are involved in chemical reselling), and approved distributors and manufacturers.

**Policy.** Review and strengthening of policies and the regulatory environment to ensure the provision of quality agricultural inputs at reasonable prices to project beneficiaries is a major focus of the project provincial and county leading groups. Through the Provincial Leading Group, chaired by the Provincial Governor, the project will aim to exert influence on the policy-making mechanism within Jiangxi on the quality and use of agricultural chemicals, and the expansion of the “green” agricultural production strategy of the province.

5 **PROPOSED ON-FARM PEST MANAGEMENT PRACTICES UNDER JIAMP**

The JIAMP Pest Management Program will promote use of a combination of crop-specific agricultural, physical, biological, and chemical pest and disease control methods that will reduce reliance on synthetic chemical pesticides.

5.1 **Agricultural and Physical Control Methods**

Agricultural and physical control methods include further extension of the practices listed in Section 2.2, including:

- **Tillage practices.** including deep tillage to bury straw and vegetative trash to prevent insect pest egg buildup; soil tillage in rice paddy immediately after harvesting to prevent buildup of rice borer.
- **Regular rotation of dryland crops** to avoid buildup of soil-borne insect pests and diseases, e.g., vegetables followed by beans followed by vegetables.
- **Straw and trash control** to prevent buildup of insect pests and eggs in crop straw and trash.
- **Cutting and burning of diseased or egg/insect infected leaves** in vegetable crops; and branches in cotton and citrus orchards.
- Deep flooding practices in rice paddy to assist control of soil-borne eggs and pupae of rice pests and other insects, e.g., *Chilo suppressalis* eggs.
- Use of lure boxes and light traps for relevant crops (e.g., greenhouse vegetables).
- Light lures making use of insect phototaxis to attract pests in vegetables and lotus.
- Hand-picking of eggs, caterpillars and larvae during periods of high infestation, e.g., *Laphyqua exigua* and *Prodenia litura* eggs on cabbage leaves; boll worms and larvae in cotton, and cabbage caterpillars.
- Use of fruit bagging in citrus orchards to prevent insects entering fruit.

5.2 Biological Control Methods

Biological control methods include further extension of the practices listed in Section 2.3, such as:

- Extension of crop varieties resistant to insect pests. Examples include cotton varieties, such as 32B, GK22, Zhong 38F1, Zhong298F1 that are resistant to cotton bollworm; and rice variety Kanwenqingzhan1 that is resistant to rice gall midge.
- Intercropping of target species to attract insect pests away from the main cash crop, e.g., planting of *Ageratum conyzoides* L. in citrus orchards to control mites; planting of peanuts and soybeans rather than sweet potato in young citrus orchards to minimize damage by *Noctuidae* sp.; planting of soybean on rice bunds to attract a range of insects away from the rice crop.
- Duck raising in rice fields. This can control pests and wild grass in the rice field without applying pesticides or herbicides.
- Extension of biological pesticides. The biological pesticides usually are applied 2-3 days before application of chemical pesticides in order to get ideal results.
- Nurturing and protecting predators for rice pests, making good use of predators such as frogs and spiders to control pests.

If appropriate predators for major insect pests can be identified from the research conducted by JPPQS, then the project would assist with trial applications of these. For example, release of *Phytoseiulus persimilis* to attack mites on citrus and vegetables.

5.3 Chemical Control Methods

Chemical control methods will apply the following principles:

1. Use of non-pesticide chemicals where these are appropriate and cost-effective in control.
2. Use of “biological pesticides” (e.g., BT, abamectin to control rice stem borers and vegetable insect pests), and pesticides of plant origin (e.g., nicotine to control vegetable pests) where these are cost-effective.
3. Application of highly effective, low toxicity, and low residue pesticides, such as imidacloprid.
4. Extend control techniques that have low toxicity to human beings, domestic animals, and fauna; low residues in agricultural products; and little environmental pollution. Such techniques include:
   - Use of low toxicity and low residue pesticides.
   - Spraying of pesticides before transplanting.
   - Applying timely, effective low concentration pesticides to control various insect pest species when the density of insect pests is above a critical threshold to ensure optimal effectiveness of each pesticide application.
   - Maintaining safe intervals between pesticide applications.
5. Use of safe spray equipment (e.g., backpack sprayers, optimal nozzle sizes) to increase the efficiency of pesticide use and control effectiveness.

6. Extension and training in safe methods of pesticide application (e.g., correct clothing, spraying in still conditions, application of soil-based pesticides as relevant).

7. Safe storage of chemicals (e.g., away from children and food, etc).

8. Proper disposal of chemical wastes and used chemical containers (e.g., by deep burial).

6. PESTICIDE MANAGEMENT UNDER JIAMP

6.1 Proposed Pesticide Use and Application of IPM

6.1.1 IPM for Major Crops

(1) **Objective:** a) control pests; b) reduce use of chemical pesticides

**Specific Objectives**

(i) Reduce the damage caused by pests to less than 5%  
(ii) Decrease use of chemical pesticides by more than 50% within 3-5 years  
(iii) Eliminate any poisoning accident caused by unsafe management, storage and unreasonable handling of discarded waste  
(iv) Prohibit use of highly toxic pesticides (WHO Class I) and those causing diseases (such as cancer, etc.)  
(v) Pesticide residue in farm products will not exceed WHO and the State standards  
(vi) Maintain the biological diversity of farms and establish farm biological models.

(2) **IPM Measures**

**Principle:** Strengthen pest forecasts, apply agricultural control measures first, then choose physical and biological control measures, and finally chemical control measures.

(i) Strengthen forecasts of diseases and pests. County Plant Protection and Quarantine Station (CPPQS) should provide timely disease and pest control information to farmers including control targets, appropriate timing of control measures, technology and pesticides, etc. Such information should be given to farmers 7-10 days ahead of implementing control measures. The CPPQS should ensure that control measures are implemented in the neighboring counties at the same time to improve control effectiveness.

(ii) Agricultural control measures:

- Choose resistant varieties: This is an important measure for improving crop resistance to pests and reducing use of chemical pesticides.
- Crop rotation to avoid buildup of insect pests and diseases.
- Intercropping e.g. planting maize in tomato and pepper fields to reduce the damage by cotton boll worm; intercropping maize and cabbage and pepper can reduce the migration of aphids.
- Reasonable timing of the planting season to minimize crop damage from diseases and pests.
• Tillage practices, including deep tillage to bury straw and vegetative trash to prevent insect pest buildup; soil tillage in rice paddy immediately after harvest to prevent buildup of rice borer.
• Nurturing of healthy seedlings: Sterilizing seeds and soil. Removal of poor quality seedlings and nurturing high quality seedlings.
• Tillage and grass control to reduce occurrence of diseases and pests.
• Land should be deep-tilled to 26-33 cm depth after harvest of dry land crops to avoid buildup of pests in the topsoil and to freeze pests hibernating in the soil for winter.
• Appropriate use of fertilizers and timely implementation of irrigation and drainage. Application of abundant base manure and limited use of nitrogen and phosphate fertilizers, and increased use of calcium to strengthen pest resistance of crops. Sound irrigation and drainage management will be effective in pest and disease control.
• Improve tillage and weeding to reduce pest and disease occurrence.
• Clean land: Removal of infected leaves and crop plants from the field to reduce diseases and pests.

(iii) Physical control measures:
• Use pestproof nets in vegetable and fruit cultivation to keep out pests, diseases, rain and wind, or to keep out sunlight and maintain moisture as required.
• Trap and kill pests: Use yellow boards to trap white flies and aphids; use black light lamps to trap and kill moths, beetles and Orthopteroids; use sugar and vinegar solution to trap and kill moths.

(iv) Biological control measures:
• Use of biological pesticides such as Bt, Polynacfin, NPV, etc.
• Use of natural pest enemies, such as Trichogramma.
• Use of sex attractants to trap and kill pests, such as cotton bollworm, leafworm and beet armyworm.

(v) Chemical control measures:
Use of pesticides combined with other control measures is an effective and economic way to increase control efficiency, and guarantee agricultural harvest. High quality pesticides should be used that are effective in pest control, have no- or low-toxicity to human beings and animals, and are safe on crops. Key pesticide control measures include:
• Prohibit use of severe or highly toxic and high residue pesticides
• Use different pesticides to control different pests
• Spray pesticides at proper times based on pest occurrence
• Spray appropriate amounts of pesticide
• Appropriately mixed or alternative use of pesticides
• Strictly implement safe harvest intervals (GB4285-89).

IPM measures for major crops are listed in Annex 2.
6.1.2 Pesticides Recommended for Use in JIAMP

During project implementation, it will be necessary to use pesticides in conjunction with agricultural control, physical and biological control measures. Pesticide use must follow the principles of economic, safe and effective application. Table 4 lists pesticides recommended for JIAMP implementation. These are existing and newly registered pesticides that are highly effective, have low toxicity, and nil or low residues.

Table 4. Pesticides Recommended for Use in JIAMP

<table>
<thead>
<tr>
<th>Crop</th>
<th>Main Pests</th>
<th>Biological Pesticides</th>
<th>Chemical Pesticides (PRC Classification) (WHO Class in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Chilo suppressalis</td>
<td>Bt (Bacillus thuringiensis) (III)</td>
<td>Dimthypo (II), Regent (II), chlorpyrifos (II)</td>
</tr>
<tr>
<td></td>
<td>Tryporyza incertulas</td>
<td>Diflubenzuron (U), imidacloprid (II)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sagatella furcifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nilaparvata lugens</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cnaphalocrocis medinalis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Orseolia oryzae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>Helicoverpa armigera</td>
<td>NPV (nuclear polygon virus) (U) of cotton boll worm, Polynacfin (III), Bt (III)</td>
<td>Springtac (II), cypermethrin (II), deltamethrin (II), phoxim (II), thiodicarb (II), azacyclotin (II), amitraz (III), benfuracarb (II)</td>
</tr>
<tr>
<td></td>
<td>Pectinopho ragassypiella</td>
<td>Cascade (flufenoxuron, U), Torque (fenbutatin oxide, U), chlorfluazuron (U), betacyfluthrin (II), imidacloprid (II), buprofezin (U), propargite (III), trichlorphon (II)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetranychus cinnaticarum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aphis gossypii</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Empoasca biguttula</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Lygus lucorum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adelphocoris suturalis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agrotis ypsilon</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prodenia sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Earias cupreovirids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>Phyllocnistis citrella</td>
<td>Polynacfin (III)</td>
<td>Springtac (II), cypermethrin (II), deltamethrin (II), phoxim (II), thiodicarb (II), azacyclotin (II), amitraz (III), benfuracarb (II)</td>
</tr>
<tr>
<td></td>
<td>Panony chuscitri</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phyllociptura oleivora</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coccoidea sp.(e.g. Unaspis yanonensis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anoplophora chinensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dialeurodes citri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>Main Pests</td>
<td>Recommended Pesticides</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Biological Pesticides</strong></td>
<td><strong>Chemical Pesticides (PRC Classification)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(WHO Class in parentheses)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Low Toxicity</strong></td>
<td><strong>Medium Toxicity</strong></td>
</tr>
<tr>
<td>Vegetables</td>
<td>Aphid citricidus</td>
<td>propargite (III), bromopropylate (U), trichlophon (II), sulphur (III)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Papillo sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contarinia citri</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Co. citricidus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aphiis citricidus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Papillo sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contarinia citri</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biological Pesticides</td>
<td>Chemical Pesticides (PRC Classification)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(WHO Class in parentheses)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Low Toxicity</strong></td>
<td><strong>Medium Toxicity</strong></td>
</tr>
<tr>
<td>Vegetables</td>
<td><em>Prodenia litura</em></td>
<td>Di flubenzuron (U), Cascade (flufenoxuron U), Torque (fenbutatin oxide, U), chlorfluazuron (U), imidaclopid (II), buprofezin (U), propargite (III), cyfluthrin (II), betacyfluthrin (II)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Laphygma exiqua</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Pieris rapae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Plutella xylostella</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Myzus persicae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Lipaphis erysini</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Brevicoryne brassicae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Agrotis ypsilon</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Heliothis assulta</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other measures for pest management of major crops are summarized in Table 5 and are fully described in Annex 2. The main points to note are:

1) The pest management approach for each crop contains elements of an IPM approach, but there is a strong dependence on chemical pesticides.

2) Non-chemical control measures are largely agricultural/physical measures with few biological control measures.

Extension of tested and validated biological control IPM techniques developed under the programs of JPPQS (Annex 1) should be introduced into the project, where appropriate.
Table 5. Agricultural, Physical and Biological Measures for Pest Management of Major Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Agricultural and Physical Measures</th>
<th>Biological Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsicum</td>
<td>Pest forecasting. Deep tillage. Burn infested leaves. Trap and kill aphids by yellow boards, moths by sugar and vinegar solution or lamps.</td>
<td>Crop rotation</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Pest forecasting. Deep tillage. Burn infested leaves. Trap and kill aphids by yellow boards, moths by sugar and vinegar solution or lamps.</td>
<td></td>
</tr>
<tr>
<td>Silver lotus</td>
<td>Pest forecasting. Trap and kill aphids by yellow boards, moths by sugar and vinegar solution or lamps.</td>
<td></td>
</tr>
</tbody>
</table>

6.2 Type and Quantity of Pesticides to be Financed

Agricultural, physical (e.g., lures), biological control practices or bio-pesticides (e.g. Bt, Abamectin) that have the same cost-effectiveness as synthetic pesticides, would be used in preference to pesticides (Tables 4 and 5). Unregistered chemicals or any that have WHO Class I active ingredients will not be financed.

Table 6 estimates the increase in the amount of pesticides used under the project, assuming:

1) The current average rate for pesticide usage in Table 1 applies to the project area.
2) The target reduction in pesticide usage for each crop (Annex 2) is achieved.
3) One crop per year is grown, except for greenhouse vegetables for which the projection is for a full production year. If two crops of rice or field vegetables are grown, pesticide use may be slightly higher.

Based on these assumptions, the estimated increase (129 tonnes/year) in pesticide use under the JIAMP is expected to be very small (0.2%) in relation to total pesticide use in Jiangxi (54,505 tonnes in 1999).
Table 6. Estimated Increase in Pesticide Use Under the Project

<table>
<thead>
<tr>
<th>Crop</th>
<th>Estimated Area (ha)</th>
<th>Current Estimated Total Year (kg)</th>
<th>Estimated Average Rate (kg/ha)</th>
<th>Estimated Rate Reduction (%)</th>
<th>Estimated Rate Pesticide/Crop (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>12,416</td>
<td></td>
<td>9</td>
<td>-20</td>
<td>7.2</td>
</tr>
<tr>
<td>Cotton</td>
<td>200</td>
<td></td>
<td>33</td>
<td>-50</td>
<td>16.5</td>
</tr>
<tr>
<td>Orange</td>
<td>806</td>
<td></td>
<td>45</td>
<td>-50</td>
<td>22.5</td>
</tr>
<tr>
<td>Field vegetables</td>
<td>1,990</td>
<td></td>
<td>7.5</td>
<td>-30</td>
<td>5.25</td>
</tr>
<tr>
<td>Greenhouse vegetables</td>
<td>276</td>
<td></td>
<td>22.5</td>
<td>-30</td>
<td>15.75</td>
</tr>
<tr>
<td>Medicinal herbs</td>
<td>345</td>
<td></td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Lotus</td>
<td>554</td>
<td></td>
<td>7.5</td>
<td>-40</td>
<td>4.5</td>
</tr>
<tr>
<td>Total</td>
<td>16,587</td>
<td></td>
<td></td>
<td></td>
<td>129,153</td>
</tr>
</tbody>
</table>

1 Based on average rate of pesticide application in Table 2.
2 Based on target reduction in pesticide use for each crop listed in Annex 2.

75% of the cropping area in the JIAMP is expected to be in rice production (Table 6). Most of the benefits from JIAMP will come through irrigation of rice land that is currently inadequately irrigated. The supply of irrigation may result in some farmers changing their rice cropping patterns (e.g. growing both early and late rice, while others may only grow late rice (higher quality, more profitable) rather than early or middle rice. While changes in rice cropping patterns may occur, the total area of rice cropped per year is not expected to increase significantly. The types of rice pests are not expected to change significantly either. As a result, pesticide usage is not expected to increase simply through an area increase, but may do so through more intensive management, particularly if farmers move to growing late rice. Table 6 assumes an area increase of 12,416 ha. For the above reasons this may be an overestimate with the result that the projected increase in pesticide use may also be over-estimated.

The areas of vegetables, herbs, lotus and orange (Table 6) are expected to replace other, less profitable crops as a result of the benefits of irrigation. Therefore, the change in land use will result in a change in the types of pests and diseases in these production areas. However, the area increases in all of the above crops are relatively small compared to the total area of these crops in Jiangxi (refer Jiangxi Agricultural Statistics Yearbook 2000). The change to more intensively managed crops may result in a higher incidence of agro-chemical use compared to the pre-project situation in some areas.

The area increase in cotton is relatively small compared to the total area of cotton production in Jiangxi. There is already a very large area of citrus being grown in Jiangxi, and the additional area proposed under the project will not add significant pest problems to the existing citrus production areas.

The expected area increase in field vegetables under the project is significant and less complete pest control is likely compared to greenhouse vegetables where the production environment (and, therefore, pests) is more easily controlled. The project will promote production of "pollution-free" vegetables that utilize lower pesticide inputs than is the current practice in much of Jiangxi. Specifications for production of such vegetables are given in Annex 3.

The proposed area increase in lotus is relatively small compared to the total existing production area in Jiangxi. The additional production area is unlikely to result in significant increases in insect pest incidence.

In summary, the area increases in crop production under the project are relatively small compared to the total production area for each crop in Jiangxi. As a result, the overall incidence of insect pests and pesticide use is not expected to increase significantly if the estimated targets for reduced pesticide use are
achieved. The type of insect pests and pesticides used may change as a result of changes in land use on any given piece of land in the project area.

6.3 Capability/Competency of End-Users to Handle Products within Acceptable Risk Margins

Assessment of current practices (Section 2.4.4) indicates there is currently variable competency of farmers and chemical resellers in handling chemical products within acceptable risk margins (i.e., safe storage, use of safe equipment, protective clothing, safe disposal of packaging and waste chemicals). The proposed training programs (Section 7) for both farmers and chemical resellers will address this. However, the local monitoring and evaluation program (Section 8.1) is designed to regularly monitor the capability/competency of both farmers and chemical resellers in safe handling of chemical products. Where such handling continues to be unsafe, further training would be provided.

6.4 Environmental, Occupational and Health Risks

6.4.1 Environmental Risks

The main environmental risks from pesticide use in the project include:
- Deterioration in water quality from pesticide residues and potential for increases in pesticides in aquatic biota (e.g., fish).
- Contamination of water supplies resulting from spraying or chemical spills near drinking water sources.
- Possible impacts on non-target species (especially bees, birds, domestic animals, and natural enemies of pests) from high toxicity pesticides.
- Development of pest resistance from continued overuse of some pesticides (e.g., in cotton bollworms (Annex 2)).
- Deterioration in soil quality from pesticide residues.

Measures to mitigate the above risks include:
- Awareness training of village leaders, farmers (men, women) and chemical resellers in the likely environmental impacts of specific chemicals, and recommended spraying methods and equipment.
- Spray monitoring to ensure that spraying of toxic chemicals is not conducted near water sources, and working with village leaders to enforce this.
- Procurement of approved safe spray equipment under the project.
- Use of pesticides with low residual half-lives.
- Minimizing use of chemical pesticides near areas with rare or endangered fauna (e.g., near wetlands, and/or adjacent to Poyang Lake).
- Use of a range of pest control techniques (agricultural/physical, biological, chemical) to ensure that pest resistance to chemical pesticides does not build up.

6.4.2 Occupational/Health Risks

The main occupational/health risks from pesticide use include:
- Sickness resulting from inhalation of pesticide fumes when handling concentrated chemicals and/or pesticide vapor during spraying if protective masks are not used.
- Skin damage from sprays or chemical spillage during handling if protective clothing is not worn.
• Contamination of drinking water if spraying is conducted close to drinking water sources, or if there are chemical spills near drinking water sources.

Measures to mitigate the above risks include:

• Awareness training and demonstrations for village leaders, farmers (men, women) and chemical resellers in:
  o Likely occupational/health impacts of specific chemicals
  o Recommended handling and spraying methods
  o Approved equipment and its use (e.g., sprayers, nozzle sizes, etc)
  o Wearing of safe clothing (long sleeve shirt, mask, hat, gloves, long trousers, footwear)
  o Spraying in still conditions
  o Safe storage of chemicals in locked cupboards that children cannot easily access
  o Safe disposal of chemical packaging and wastes by deep burial or burning (if appropriate).

• Monitoring of implementation of the above practices followed by refresher training if not correctly implemented.

• Implementation of the project management measures listed in Section 6.5.

6.5 Project Management Measures to Reduce Specific Risks Associated with Envisaged Pesticide Use under the Project

The IPM Sub-committee of the JIAMP Provincial Technical Advisory Group will periodically review changes to the list of chemicals for use in the project area. The Sub-committee will ensure that chemicals used by the beneficiaries are:

• Manufactured, packaged, labeled, handled, stored, applied, and disposed of according to standards acceptable to the World Bank

• Not formulated products that fall in WHO Classes IA and IB, or formulations of products in Class II whose concentration of active ingredients exceed acceptable WHO levels.

In addition, any pesticide to be procured by project beneficiaries will be assessed for:

• The nature and degree of associated risks by proposed use and intended user

• The proposed use and the intended users

• The classification of pesticides and their specific formulations as in the Recommended Classification of Pesticides by Hazard and Guidelines to Classification (Geneva: WHO 2000-01), and its future updates.

Pesticides selected for use must meet the World Bank’s OP 4.09 criteria. Such pesticides:

• Must have negligible adverse human health effects.

• Must be shown to be effective against the target species.

• Must have minimal effect on non-target species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies. Pesticides used in public health programs must be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them.

• Their use must take into account the need to prevent the development of resistance in pests.

Additions or deletions to the recommended pesticide list in Table 4 will be authorized by the IPM Sub-Committee of the Provincial Technical Advisory Group. The local pesticides with unknown active ingredients listed under “Not Classified” in Table 4 will be added to the approved list of pesticides once their active ingredients and concentrations are provided to, and approved by, the World Bank.
6.6 Selection of Pesticides Authorized for Procurement

No pesticides will be procured through National or International Competitive Bidding. Pesticides will be purchased directly by project beneficiaries with loans from the Farm Production Investment Component. Any pesticides to be purchased by project beneficiaries will be assessed by the Loan Facilitators during loan application processing. The Loan Facilitators will check that the pesticides are on the recommended list of chemicals (Table 4).

7 STRENGTHENING PEST MANAGEMENT CAPACITY UNDER JIAMP

7.1 Policy Issues

Pest management policy measures to be promoted by the Project include:

- Reduce current usage rates of chemical pesticides on project activities, and enforcement of laws against banned pesticides.
- Pesticide regulation.
- Banning the use of unregistered pesticides for project activities.
- Banning the use of WHO Class I pesticides, and requiring their replacement with less toxic alternatives for project activities.
- Strict adherence to regulations following the:
  - FAO Code of Conduct on the Regulation, Distribution and Use of Pesticides (or Chinese equivalent)
  - FAO Guidelines for Packaging and Storage of Pesticides (or Chinese equivalent)
  - FAO Guidelines on Good Labeling Practice for Pesticides (or Chinese equivalent)
  - FAO Guidelines for the Disposal of Waste Pesticide and Pesticide Containers on the Farm (or Chinese equivalent).

Where Chinese equivalents to these FAO Guidelines do not exist, then such Guidelines should be prepared for implementation by the Project.

- Adherence to the State Environmental Protection Agency (SEPA) environmental standards on agro-chemical use, including pesticides. For Ecological Demonstration Counties (EDC), SEPA standards for EDCs should be followed.

- Encourage county and township governments to promote and support IPM approaches through discussions and by providing examples of successful IPM programs and their benefits (particularly long-term benefits).

- Requiring Loan Facilitators to restrict household loans only to use of recommended, registered pesticides (Table 4).

- Encourage the provincial government to provide funding support to IPM research and extension programs.

7.2 Infrastructure, Capacity, Institutional Arrangements and Collaboration

Strengthening of the basic plant protection infrastructure and institutional control on distribution and use of pesticides under the Project will be undertaken through:

- Training of county crop protection specialists, township extension workers, and farmers (Section 7.3).
• Establishment of a monitoring program (Section 8) to assess pest management and application of IPM techniques in project implementation.

• Appointment of a PMO staff member to have specific responsibility for overseeing agricultural pest management and application of IPM approaches. The JPPQS or Chinese IPM consultant could be funded by the Jiangxi Provincial Government to support the project in this role.

• Working with the JPPQS and other institutions, such as the Jiangxi Academy of Agricultural Sciences, in orienting their research and extension programs towards IPM.

• Establishment of collaborative links with national institutions to strengthen cooperation, local capacity and knowledge in Jiangxi of IPM techniques for project-specific crops.

• Promoting support and collaboration of provincial, county, township, and village leaders in promoting safe pest management measures, and IPM approaches where relevant.

• Promoting the project approach of reduced use of toxic pesticides and encouraging IPM approaches to the private sector, particularly the agro-chemicals sector.

7.3 Overview of Training and Human Resource Development

The project Training, Extension and Research Subcomponent provides for training of county and township technicians, farmers, and training of trainers. It also provides for preparation of extension materials, including audio-visual; motorcycles to enable technicians to spend more time in the field visiting farmers; agricultural extension field demonstration sites; rehabilitation of activity and teaching centers; provision of books, journals, and magazines on agricultural technology.

Under the Training, Extension and Research Subcomponent, the following pest management capacity-building activities are proposed:

1) Visits by county crop protection specialists and technicians to qualified agencies, such as the JPPQS and Jiangxi Academy of Agricultural Sciences, to receive training in new pest control methods, including IPM methods for specific crops/pests.

2) Regular training courses for extension staff by county crop protection specialists on new pest control methods, including IPM for specific crops/pests.

3) Training of county and township extension staff to ensure effective enforcement of pesticide regulations.

4) Regular, timely training of farmers in new pest control methods and IPM for specific crops/pests conducted by township technicians using techniques such as Farmer Field School approaches. In each of items 1-3, terms of reference should be provided for trainers, and, if necessary, training experts should be engaged to assist with training of trainers (see Section 7.4).

5) Preparation and distribution of IPM training materials prepared in simple language, and well supported by appropriate audio-visual aids. These may need to be obtained from, or prepared by, national- or provincial-level agencies, such as the JPPQS.

6) As many women as possible should be encouraged to participate in the pest management and IPM programs, and provided with lead roles in such programs.

7) Conduct of farmer-need driven research towards IPM implementation under the Applied Research activity.

7.4 Training of Farmers

The aim of farmer training is to strengthen farmers’ ability to safely and cost-effectively control insect pests (as stated in the Project Implementation Plan). This includes training farmers how to identify insect pests, make appropriate control decisions, and take proper measures to control them.
Each farmer would receive 3-4 training courses (1 day for 50 farmers) per year, with relevant courses conducted during the pest control period each year. Training content would include:

- Characteristics of insect pests
- Damage caused by different insect pests
- Natural enemies of each major insect pest
- Field sampling approaches
- Control thresholds
- Control measures, including IPM approaches involving agricultural, physical, biological, and chemical control methods.
- Safety in storage, handling, and disposal of chemical wastes and containers
- Chemical application methods and protective clothing requirements.

Possible training providers include:

- Leading farmers and demonstration households
- Trained township, county and province extension services
- Chemical resellers
- JPPQS
- Other providers in Jiangxi (e.g. Jiangxi Academy of Agricultural Sciences) and China
- FAO
- Bilateral donor programs, such as the GTZ co-funded project in Jiangxi – using ecological approaches to cash crop production.

8 MONITORING AND EVALUATION UNDER JIAMP

8.1 Activities Requiring Local Monitoring during Implementation

The following activities require local monitoring during project implementation:

- Extent of IPM adoption by farmers
- Pesticide use pattern
- Crop production
- Changes to the agro-ecosystem
- Other indicators.

A detailed list of possible monitoring indicators is provided in Annex 4.

The above monitoring should be done by County Plant Protection and Quarantine Station (CPPQS) staff based on a sample of project households in the project area in each county. Early World Bank supervision missions should assist the County PPQS with establishment of an appropriate monitoring system, sampling procedure, and provide training in implementation and analysis of the monitoring system (Annex 4).

8.2 Activities Requiring Monitoring during Supervision

The following activities require external monitoring during World Bank supervision missions:

- Pesticide registration
• Use of Class I pesticides
• Policy issues
• Implementation of the local monitoring program, and assistance in analyzing results.

A detailed list of possible monitoring indicators is provided in Annex 4.

Supervision mission inputs should be conducted 2 times per year, preferably during periods of high pest control activity to observe field implementation of pest management practices. This supervision work should be undertaken by an Agriculture Specialist with experience in agricultural pest management in China. Supervision costs would be financed from World Bank funds.

8.3 Monitoring and Supervision Plan

• Monitoring of pest management: The monitoring work will be done jointly by PPQS and PMO at Provincial, municipal and county level with the participation of farmers. Once a pest is discovered, it should be reported and handled in a timely manner.

• Supervision plan: The PMO at each level will be responsible for ensuring regular supervision is undertaken. During peak pest infestation periods, the PPQS will be responsible for supervision and control.

• Responsibilities: The PPQS at each level will be responsible for guidance, supervision, monitoring and training on IPM. The PMOs at each level and stakeholders have duties and responsibilities for discovering and timely reporting of pest attacks and for implementing the IPM plan in accordance with the requirements.

• Professional technology required: Plant protection expertise and methods supplied by the PPQS at each level.

• Budget: Pest management work should be listed in the daily management work of PMOs at each level, and the budgets should be included in the overheads of the PPQS and PMOs at each level.
Annex 1: Current Programs of Jiangxi Station of Plant Protection and Quarantine

Programs currently undertaken by JPPQS include:

- FAO inter-country rice IPM program
- China Korea Rice Hopper Monitoring Program
- Base line surveys of natural predators of rice and cotton pests
- Long and mid term forecasting of rice stem borers populations
- Rice variety resistance to *Pyricularia oryzae*
- Climate-crop pest monitoring and early warning program
- Integrated control techniques of *Phytophthora capsici*
- Research on occurrence and control of *Phomopsis asparagi*
- Research on control effects of *Phytoseiulus persimilis* to tetranychids on vegetables
- Studies on damage and control thresholds of *Chilo suppressalis*
- IPM programs for rice pests, *Orseolia oryzae*, and vegetable leaf miner
- Middle school training programs in IPM for rice pests
- Extension of application techniques of imidacloprid
- Forecast standards of cotton insect pests
- Research and extension of "no-pollution" vegetable production.

In addition, Jiangxi Academy of Agricultural Science and Jiangxi Agricultural University are engaging in research in this field.
Annex 2: Integrated Pest Management for Major JIAMP Crops

1. Rice

The major pests are rice stem borers (*Chilo suppressalis* and *Tryporyza incertulas*), leaf roller (*Cnaphalocrocis medinalis*), and planthoppers (*Nilaparvata lugens* and *Sogatella furcifera*), and rice gall midge (*Orseolia oryzae*).

The aim of rice pest control is to:

- Keep yield loss caused by pests under less than 5%.
- Decrease chemical pesticide use by more than 20% by limiting pesticide applications to 2 to 2.5 times in a growing season.
- Avoid accidents arising from unsafe use,
- Ensure safe storage of pesticides and pesticide-related waste disposal,
- Increase population of natural enemies of rice pests (i.e. spiders and frogs).

1.1 IPM Measures

**Pest Forecasts.** A key role of the County PPQS will be to improve forecasts of the occurrence and outbreak of rice pests. The CPPQS will also advise farmers when and how to control rice pests at least 3 times per growing season. This should be done 7 to 10 days in advance of the likely pest occurrence.

**Varietal Selection.** Appropriate high quality pest resistant varieties that are suitable for each location should be selected. Specific varieties should be decided by seeking advice from the County PPQS and Seed Management Stations.

**Field Management.** Rice fields that do not have winter crops should have the soil turned over in winter. Rice fields with winter crops should also have the soil turned over before 20th April in northern Jiangxi, and 15th April in southern Jiangxi. Remaining rice straw should be removed from the fields or tilled into the soil.

Land for early rice, middle rice and rice seedling beds must be allocated to avoid the situation of field fragmentation where land belonging to one type of rice is enclosed in that of another. If the latter occurs, consistent and effective pest management is difficult.

Planting of soybeans on the rice field bunds will be encouraged to attract natural predators of rice insect pests, and also add to farmer financial return.

Rice seedlings should be sprayed once 3 to 5 days prior to transplanting. It is recommended to use 18% Dimthypo AS* at 200 ml/667m².

In the second 10 days of May to the first 10 days of June, Bt AS* at 200 ml/667m² is used to control first generation of *Chilo suppressalis*, and 5% Regent SC (fipronil) at 15-20 ml/667m² is used to control the second and third generation of this pest. In areas where bees and shrimps are raised, Regent SC should not be used.

Deep irrigation can be used to kill *Chilo suppressalis*. At the beginning of the peak of egg hatching, there should be less than 3 cm depth of water in rice fields. After the peak and at the end of egg hatching, 12 to 15 cm water depth should be maintained for 3 days to drown the rice leaf sheath. Before the beginning of the pupa stage, the field should be drained to 3 cm water depth, and after the main period of pupa development, rice fields should again be irrigated to 12 to 15 cm depth for 3 days.

During the last 10 days of May to mid-June, 18% Dimthypo AS* at 200 ml/667m² should be evenly sprayed when the number of *Cnaphalocrocis medinalis* on 100 rice plants is above 30. In the areas where silkworms are raised, dimthypo cannot be used, and it is recommended to use 48% chlorpyrifos.
If the number of planthoppers on 100 rice plants exceeds 1,000 during rice tillering stage, and/or 1,500 during tasselling stage, 10% Imidacloprid WP should be sprayed evenly at a rate of 15 g/667 m². When harvested, rice should be cut near the mud and rice straw should be bundled and removed from the fields. After harvest of early rice, the soil should be tilled immediately to kill the stubble and rice stemborers.

During the last 10 days of August to mid-September, caseworm and planthoppers on late rice should be controlled using the same methods for early and middle rice.

The timing of control measures for fourth generation Chilo suppressalis and Trporyza incertulas should be based on the egg density, the peak time of egg hatching, and the heading stage of rice. Regent SC in the same quantities and spraying methods is recommended.

Chemical pesticides should not be used to control pests in 30 days before harvest.

After rice harvest, the paddy must be dried in the sun, winnowed to make it clean of straw and fumigated to prevent pest damage.

2. **Cotton**

The main cotton pests are bollworm (*Helicoverpa armigera*) and pink bollworm (*Pectinophora gassypiella*). There are more than 10 species of secondary pests, such as *Agrotis ypsilon*, *Aphis gossypii*, *Lygus lucorum*, *Prodenia sp.*, *Enpasaica biguttula*. These secondary pests are important in some years.

The aim of the cotton pest control program is to control insect pests, and decrease the quantities of chemicals used over a 3-5 year period. Specific targets are to:

- Decrease the number of times chemicals are used by 20% yearly
- Decrease the annual quantities of chemicals used by 50%
- Increase the density of natural predators of cotton pests on 100 plants above 100 (i.e., average of one predator per plant)
- Ensure careful handling of chemicals
- Safe disposal of package and chemical wastes.

2.1 **IPM Measures**

At different stages of the cotton plant's growth, different measures should be taken to control different pests. There are three main stages:

2.1.1 **Seedbed Stage (from the first 10 days of April to the second 10 days of May)**

The aim is to ensure good seedlings for planting. The main pests are *Agrotis ypsilon* and *Adelphocoris suturalis*, and secondary pests are *Aphis gossypii*, *Thrips tabaci* and *Tetranychus cinnaritius*.

Treatment of cotton seeds: Mix 1.2 kg/667 m² of 5% benfuracarb GR evenly with cotton seeds and then plant into nutrition bags. Benfuracarb is effective on all the above seed pests for 40 days. In some seed beds where occurrence of some seedling pests may be serious, the following additional remedial measures may be used:

(i) Seedbeds with serious infestations of *Agrotis ypsilon*: Dissolve 50 g of 90% solid trichlorphon in 0.5 kg water and spray it on 667 m² seed bed in the evening. One application should be adequate to control *Agrotis ypsilon*.

(ii) Seedbeds with serious snail infestations: Snail pests often occur seriously in northern Jiangxi. They can be controlled by spraying 8% Morex GR (a class II pesticide that is specifically effective on snails) at 2 kg/667m² on seedbeds.
(iii) Seedbeds with serious infestations of *Adelphocoris suturalis*: After planting in the seed bed, spray 2000 ppm 2.5% deltamethrin EC to kill it.

(iv) Seedbeds where *Tetranychus cinnaticus* is serious: Miticides should be sprayed on infestation sites rather than on the whole seedbeds.

2.1.2 Transplanting to Bud Formation Stage (the last 10 days of May to the second 10 days of June)

The aim is to protect the crown of cotton plants and control leaf pests such as *Lygus lucorum*, *Thrips tabaci*, *Earias cupreoviridis*, *Aphis gossypii*, *Tetranychus cinnaticus*.

While transplanting, 1.2 kg/667 m² benfuracarb GR should be mixed with fertilizer and sprayed together into planting holes. This can be effective on the above pests for 30 days. To control serious occurrence of *Lygus lucorum*, *Thrips tabaci* or *Earias cupreoviridis*, 100 ppm solution of phoxim should be applied in drops onto leaves and on the crown of cotton plants. Only 3 to 4 drops should be applied per plant, because more than that will cause damage to cotton plants.

Farmers are encouraged to use agricultural control measures such as inter-row tillage and earthing up around plants to kill straw and stubble during the last 10 days of May. These measures can kill about 30% of the pupa of first generation bollworm and decrease the occurrence of second-generation.

2.1.3 Cotton Boll-forming Stage (Last 10 days of June to late September)

The aim is to decrease pest damage to buds, flowers, cotton boll and protect cotton yield. The main pests are *Helicoverpa armigera*, *Tetranychus cinnaticus*, *Aphis gossypii*, *Prodenia litura*, *Earias cupreoviridis*, *Emeposca biguttula*, and *Pectinophora gassypiella* of the second to fifth generation in July and August.

Agricultural control measures include regularly cutting the top, side and surplus cotton crowns; and carrying infected buds and leaves out of cotton fields followed by deep burial. These measures aim to decrease the food supply for pests, and also carry eggs away. Irrigation during drought periods is also used to kill the pupa of the third generation bollworm during late July to early August.

Bollworm lure boxes will be used in many areas during August to September. The sex bait is placed in colored lure boxes that are spaced at a density of 15 boxes per hectare. The bait is replaced once per month to maintain effectiveness.

1% calcium superphosphate solution is sprayed 1-2 times from about mid-July to mid-September to decrease the quantities of bollworm eggs.

Emphasis will be given on hand-killing the remaining larvae in late July and August in some cotton fields that have a high density of old larvae. The purpose of this is to decrease the occurrence of subsequent generations.
2.2 Chemical Control Measures

Spray Frequency. The project will aim to encourage use of cotton varieties with resistance to bollworm. This would reduce spray frequency to 5-6 times, i.e., no spray on second-generation. 1 spray on the third generation on or about 18th July. 2 sprays with an interval of 7 days on the fourth generation during 15-25 August, 3 sprays on the fifth generation in high-yield cotton fields (2 times in low-yield cotton fields) during mid-late September. If *Tetranychus cinnaticarpus* is also a pest, miticides (see Table 4) should also be used.

2.3 Key Practices

2.3.1 Choose Appropriate Chemicals and Spray Alternately

Selection of appropriate chemicals (e.g. Bt, NPV) or chemical mixes is the first step in good control of bollworms. The chemicals to be used are based on the number of bollworm eggs and larvae in different stages (generations). Chemicals (e.g. phoxim, see Table 4) which mainly kill eggs are normally used on the early stage of each generation. In the middle stages, chemicals that kill both eggs and young larvae should be used. On the last stage, chemicals that are most effective against old larvae. The same chemical pesticide can only be used once on every generation and should only be used once per year to prevent the build up of pest resistance to pesticides.

2.3.2 Spray Pesticides on Time

To optimize control effectiveness and chemical use, it is most important to *spray pesticides on time*. The most appropriate time to control bollworm is at the 2nd stage of larva or earlier because young bollworm larvae do not have chemical resistance and can be easily killed. In contrast, 4th stage larvae have strong chemical resistance and pesticides are less effective on them.

2.3.3 Increase Spray Efficiency

Measures to improve the efficiency of spraying chemicals include: a) promote use of highly efficient sprayers such as “weisi” brand hand sprayer, “Dongfanghong” brand engine-driven sprayer; and b) use appropriate amounts of chemical/water solution. For example, to control the third generation bollworm in July, 50 kg/667m$^2$ chemical/water solution is sufficient for a 667m$^2$ cotton field; to control fourth generation bollworm in August, at least 60 kg chemical/water solution is needed; and c) spray chemicals after 4 p.m.

3. Orange


The following targets should be attained at the project orchards:

- Extend use of bio-pesticides and reduce the quantity of chemical pesticides used in orchards by more than 50%.
- Reduce chemical pesticide applications to 3-5 times a year, with no prohibited pesticides being used.
- Fruit loss caused by insect damage is less than 5%.
- Pesticide residues in orange fruits are lower than the national standards.
3.1 Control Measures

3.1.1 Build Eco-Orchard

By planting peanut, soybean, etc in orange orchards, an environment will be established that will provide good conditions for the survival of natural predators of orange insect pests. Measures for protection and introduction of natural enemies of orchard insect pests, such as ladybirds and predator mites, will maintain the bio-diversity and reduce pest incidence in the orange orchards.

3.1.2 Extend Use of Fruit Bagging

Oranges on trees should be bagged before they begin to expand in size. This can keep pests and pesticides away from the fruit. The bagged fruits are also usually of better size and color, resulting in better sale price.

3.1.3 Use Bio-Pesticides and Effective Chemical Pesticides with Low Toxicity and Low Residues

Polynacfin, oil emulsion should be used to control mites; fenbutatin oxide to control *Phyllocoptruta oleivora* Ashmead; imidacloprid, BT to control *Phyllocnistis citrella* Stainton; oil emulsion and buprofezin to control *Coccoidea* sp. and *Aleurocanth us spiniferus* Quaintance; imidacloprid to control *Aphis citricidus* Kirkaldy.

3.1.4 Strictly Implement Safe Intervals of Pesticide Use

No pesticides should be applied for a month before harvest. If pest control is necessary during this time, only bio-pesticides can be used. The regulations on application of pesticides should be strictly adhered to.

3.2 Pest Forecasts and Control Thresholds for Major Pests

Pest forecasts are an important measure to guarantee prompt pest control. Trained persons (extension staff or leading farmers) should conduct pest forecasts at each project orchard. Control thresholds for major pests are:

* **Panonychus citri** McGregor: More than 5 per leaf in early spring, or more than 15 per leaf before the end of spring, or more than 10 per leaf before mid-fall.
* **Phyllocoptruta oleivora** Ashmead: The ratio of leaves or fruits on which there are pests is higher than 20%, or more than 2-3 pests per leaf (fruit) on average.
* **Phyllocnistis citrella** Stainton: More than 10% of the tender leaves have pest damage.
* **Coccoidea** sp.: One or more adult pests per over-winter spring branch.

3.3 IPM Measures

According to the occurrence of pests in different periods, the following integrated measures are adopted:

3.3.1 Period from Sprouting of Spring Branches to Flowering (Early February to late April)

Main pests are: *Panonychus citri* McGregor, *Aphis citricidus* Kirkaldy, *Coccoidea* sp., and *Dialeurodes citri* Ashmea. Control methods include:

* Spray 1.3 Baume degrees of lime sulfur on all trees in the orchard
* Integrated management measures: Cut branches damaged seriously by pests and take them out of the orchards to be burned so as to minimize the pest population. Plant in the orchards to establish a feed source for pest predators.
* Control the newly infested trees: When the spring branches are 2-3 cm long, spray pesticide (1-2 applications) on the trees which are seriously affected by *Panonychus citri* McGregor. Spraying
the whole orchard is not necessary at this time. The pesticides can be chosen from Bt, 50% sulphur F. and 10% imidacloprid WP.

- Control of Aphis citricidus Kirkaldy, Diaureodes citri Ashmea: Imidacloprid can be used.
- Control of Coccoidea sp., Diaureodes citri Ashmea, Panonychus citri McGregor and Phyllocoptruta oleivora Ashmead: After the first physiological fruit fall, spray solution of Cascade (flufenoxuran), cypermethrin, buprofezin or oil emulsion and imidacloprid.

3.3.2 Period from Shooting of Summer Branches to Physiological Fruit Fall (May to mid-July)

The principal pests are Panonychus citri McGregor, Phyllocoptruta oleivora Ashmead and Anoplophora chinensis Forst.

Control methods include:

- Establish a suitable pest control environment: Plant peanut and soybean in young orchards to minimize damage caused by Noctuidae sp., sweet potato should not be planted in or around orchards. When the dry season sets in, shallow ploughing and spreading hay around the trunks of trees are effective methods to fight drought and maintain soil moisture.
- Control of Anoplophora chinensis Forst: During the main egg hatching period, flick away the earth around the base of the trees. Spread clay on the base of the trunk to prevent the pest laying eggs and to minimize the number of the eggs. At the same time check on the trunk for adult pest, larva and eggs.
- Control of Phyllocoptruta oleivora Ashmead and Panonychus citri McGregor: These pests cause significant damage in summer. Cutting branches of seriously damaged trees is the normal method, but when the whole orchard is affected, pesticides such as Bt, amitraz should be sprayed all over the orchard.
- Control of Phyllocnictis citrella Stainton: Plucking of buds and removing the head of summer branches to reduce pest food supply are the main control measures.

3.2.3 Period from Shooting of Early Fall Branches to Inflation of Fruit (From late July to early September)

The principal pests are Phyllocoptruta oleivora Ashmead, Phyllocnictis citrella Stainton and Panonychus citri McGregor.

Control methods include:

- Extend use of fruit bags: Fruit should be bagged promptly when the fruit begin to inflate.
- Control of Phyllocoptruta oleivora Ashmead and Tortricidae sp., Cie: Spray oil emulsion, trichlorphon or pyridaben on trees, especially on the fruit.
- Control of Phyllocnictis citrella Stainton and Coccoidea sp.: First spray of pesticides should be done when the new branches are 5 cm long and about 20% of bud shooting occurs. Pesticide should then be sprayed 2-3 times every 5-7 days, especially on the outside of the tree cap and damaged branches. The following pesticides may be used: chlorpyrifos, BT etc.
- Control of Phyllocoptruta oleivora Ashmead, Panonychus citri McGregor and Coccoidea sp., Diaureodes citri Ashmea: Pyridaben, chlorpyrifos, BT are appropriate pesticides.
3.3.4 Period from Shooting of late Fall Branches to Fruits Ripening (Mid-September to mid-December)

The main pests are Noctuidae sp., Phyllocnistis citrella Stainton, Panonychus citri McGregor and Phyllocoptruta oleivora Ashmead.

Control methods include:

- Control of Noctuidae sp.: Hang mothballs on trees to keep pests away. Use “Jiaduo” brand frequency variation lights or black lights to trap and kill pests. If lights cannot be afforded, sugar-vinegar mixture can be used. These methods should be applied earlier in the season in orchards with early ripening species. Fruit bagging can prevent damage to fruit by insect pests.

- Control of Panonychus citri McGregor, Phyllocnistis citrella Stainton and Phyllocoptruta oleivora Ashmead: Cut late fall and winter branches until the middle of December to reduce pest food supply.

- Control of Coccoidea sp.: Orchards with adult trees generally have higher frequency of this pest. Spray Cascade or amitraz on infected trees.

- Prevent damage caused by storeroom pests: Spray 0.3 Baume degrees of lime sulfur solution or thiophanate-methyl solution diluted 1,000 times.

3.3.5 Period from Winter Resting to Blossom Bud Differentiation (late December to middle February)

The aim of tree management during this period is to clean vegetative trash and close the orchard.

Control measures include:

- Control of mites, scales: After harvest, spray oil solution diluted 80 times.

- Smear the trunk with lime and bury the trunk base with soil (which will be flicked away in spring) to protect the tree against low temperature, sun damage, and pest damage.

- Clean and close the orchard for the winter: Spray 0.5-1 Baume degrees of lime sulfur solution to clean the orchard. Spread 375 kg lime per ha after ploughing.

4. Capsicum

The common pests that damage capsicum seedlings planted in spring and autumn are mainly aphid, Agrotis ypsilon, Tetranychus urticae, Heliothis assulta and Helicoverpa armigera. These vary by season.

Capsicum planted in spring: The main pest during planting and emergence is Agrotis ypsilon, while aphid, boll worm, and Tetranychus urticae are the main pests during the emergence to fruit formation period.

Capsicum planted in autumn: The main pests are aphid, boll worm, and Tetranychus urticae during the emergence to flowering period.

Control targets for the main pests are:

- Aphid: less than 5 per plant on average

- Heliothis assulta, Agrotis ypsilon, Tetranychus urticae: Plants having the pest are less than 2%.
4.1 Control Methods

The main control methods are:

4.1.1 Agricultural Control Measures

Agricultural control measures include:

- Crop rotation of different vegetable species being grown on a particular piece of land during the wet and dry seasons to prevent soil build up of insect pest eggs, larvae, etc. Intercropping to increase crop diversity with different insect pests (e.g. beans, cabbage).
- Deep tillage of the soil to 18 to 24 cm, allowing the tilled soil to dry for 10 to 15 days, collection and burning of diseased leaves.
- Excision of *Laphygma exigua* and *Prodenia litura* eggs from leaves.

4.1.2 Physical Control Measures

Physical control measures include:

- Yellow board aphid lures: 15 to 20 solid yellow lure boards are used per 667m$^2$ of cabbage field. The boards are 30 cm wide, and are covered with oil to trap the aphids.
- Use of sugar and vinegar liquid lures to attract and kill *Prodenia litura* and *Laphygma exigua*. This makes use of the pest chemical taxis during the main period of insect occurrence. A mixture of sugar, wine and vinegar is prepared. 1% trichlorphon is added to the mixture which is put into a 20 cm wide box. The box is placed in the field in the evening so that it is 10 cm higher than the cabbage plants. The adult insects are collected in the morning, and the box stored during the day with a lid placed on it to prevent evaporation of the liquid.
- Make use of pest phototaxis to attract insect pests. One horse lamp or black lamp per 1/3 ha of vegetable field is lit. A plate containing water and oil is placed under the lamp. The method is the same as that of sugar and vinegar liquid lures. Either of these methods can be used to lure adult pests and decrease the quantities of eggs in the field.
- Promote use of 7 mm radius spray nozzles to provide more accurate spray and decrease the quantity of chemicals used.

4.1.3 Chemical Control Measures

The pest management approach aims to stop use of highly toxic, high residue chemicals. The recommended approach is to use biological chemicals, followed by highly effective, low toxicity, and low residue chemicals to control pests. This approach will also protect non-target species, and help retain biological diversity in the vegetable field.

Recommended control measures are:

- *Agrotis ypsilom*: When the number of 1st or 2nd stage larvae exceed the control threshold in the field, apply cotton powders with trichlorphon added to produce poison baits to kill the larvae. Poison baits should be sprayed before hoeing the land or following rain.
- *Prodenia litura* and *Laphygma exigua*: Before larvae of these pests hatch, spray NPV3#, diflubenzuron, Springtac (Nabam), chlorfluazuron or Cascade during the main period of egg hatching.
- Aphid: Spray imidacloprid.
- *Tetranychus urticae*: Spray Polynacfrin in the evening during the first insect growth stage.
- *Heliothis assulta*, *Helicoverpa armigera*: It is important to control these pests during the flowering and fruit formation stages. Spray Bt. NPV 3#, cyhalothrin, or cypermethrin in the evening on 1 or 2 stage larvae.
Any one of the above chemicals can be used. The exact quantities of chemicals to be used per 667m² can be determined by the size and density of the plants. In general, about 30 to 50 kg water/chemical solution is used per 667m², with the chemicals sprayed evenly on both sides of the leaves.

Capsicum is harvested regularly, with the first and middle harvest period (May to June) coinciding with the main period of pest occurrence. The following strategies should be followed when spraying:
- Spray after fruit is harvested
- Stop spraying highly toxic pesticides during the 7 days prior to harvest
- Harvest during safe periods after spraying chemicals.

5. Cabbage

Cabbage pests depend on the period when the crop is planted:
- January to March: Major insect pest is aphid.
- April to June: Spring planting in open land, with aphid again being the main pest.
- July to September: Major insect pest is Laphyqma exiqua.
- October to December: Aphid is the major insect pest.

The pest management targets for cabbage are:
- Use of chemical pesticides should decrease 30%.
- The remaining quantities of chemicals in cabbages should not be above GB.
- Chemical poisoning accidents must be prevented.
- Crop diversity must be maintained in the vegetable fields to reduce pest numbers.

5.1 Control Targets

Control targets for the major pest species are:
- *Plutella xylostella*: 30 per hundred plants
- *Aphid*: 5 per plant
- *Laphyqma exiqua and Prodenia litura*: Less than 10% of plants are damaged
- *Cabbage caterpillar*: 25 per hundred plants.

5.2 Integrated Pest Management Measures

The County PPQS must strengthen pest forecasting, and advise farmers when to apply control measures to achieve the control targets.

5.2.1 Agricultural Control Measures

These measures include:
- Crop rotation of different vegetable species being grown on a particular piece of land during the wet and dry seasons to prevent soil build up of insect pest eggs, larvae, etc. Intercropping to increase crop diversity with different insect pests (e.g. beans, cabbage).
- Deep tillage of the soil to 18 to 24 cm, allowing the tilled soil to dry for 10 to 15 days, collection and burning of diseased leaves.
- Excision of *Laphyqma exiqua* and *Prodenia litura* eggs from leaves, and leaves damaged by *Plutella xylostella*. The eggs and leaves are then burnt.
5.2.2 Physical Control Measures

Physical control measures include:

- Yellow board aphid lures: 15 to 20 solid yellow lure boards are used per 667m$^2$ of cabbage field. The boards are 30 cm wide, and are covered with oil to trap the aphids.

- Use of sugar and vinegar liquid lures to attract and kill *Prodenia litura* and *Laphygma exiqua*. This makes use of the pest chemical taxis during the main period of insect occurrence. A mixture of sugar, wine and vinegar is prepared. 1% trichlorphon is added to the liquid which is put into a 20 cm wide box. The box is placed in the field in the evening so that it is 10 cm higher than the cabbage plants. The adult insects are collected in the morning, and the box stored during the day with a lid placed on it to prevent evaporation of the liquid.

- Make use of pest phototaxis to attract insect pests. One horse lamp or black lamp per 1/3 ha of vegetable field is lit. A plate containing water and oil is placed under the lamp. The method is the same as that of sugar and vinegar liquid lures. Either of these methods can be used to lure adult pests and decrease the quantities of eggs in the field.

- Promotion of the use of 7 mm radius spray nozzles to provide more accurate spraying and decrease the quantity of chemicals used.

5.2.3 Chemical Control Measures

The pest management approach aims to stop use of highly toxic, high residue chemicals. The recommended approach is to use biological chemicals, followed by highly effective, low toxicity, and low residue chemicals to control pests. This approach will also protect non-target species, and help retain biological diversity in the vegetable field.

Recommended chemical control measures are:

- Control larvae of *Prodenia litura* and *Laphygma exiqua*: Spray NPV 3#, diflubenzuron, Springtac, chlorfluazuron or Cascade during the main period of egg hatching.

- Control of *Plutella xylostella*: Spray Cascade, Regent.

- For the egg stage of the above insects, spray chlorfluazuron.

- Control of cabbage caterpillar: Spray Bt.

- Control of Aphid: Spray Bt, imidacloprid, cypermethrin.

Any of the above chemicals can be used. The exact quantities of chemicals to be used per 667m$^2$ can be determined by the size and density of the plants. In general, about 30 to 50 kg water/chemical solution is used per 667m$^2$, with the chemicals sprayed evenly on both sides of the leaves.

The growth period of cabbage is short, and pest damage can be serious. Spraying must be done regularly to achieve good control. Spraying must be carefully timed to allow safe harvesting.

6. Silver Lotus

The main period of aphid occurrence is during the last 10 days of May to early June. Early and mid-June is the main period of *Prodenia litura* occurrence.

The main control targets are:

- The chemical residues in silver lotus cannot be above GB
- The quantities of chemical pesticides used should decrease by 40%
- The number of plants damaged by pests must be less than 5%
- Crop diversity must be maintained in the vegetable fields to reduce pest numbers.
6.1 Control Measures

6.1.1 Physical Control Measures

Physical control measures include:

- **Yellow board aphid lures:** 15 to 20 solid yellow lure boards are used per mu of cabbage field. The boards are 30 cm wide, and are covered with oil to trap the aphids.

- **Use of sugar and vinegar liquid lures to attract and kill** *Prodenia litura* and *Laphygma exiqua*. This makes use of the pest chemical taxic during the main period of insect occurrence. A mixture of sugar, wine and vinegar is prepared. 1% trichlorphon is added to the liquid which is put into a 20 cm wide box. The box is placed in the field in the evening so that it is 10 cm higher than the cabbage plants. The adult insects are collected in the morning, and the box stored during the day with a lid placed on it to prevent evaporation of the liquid.

- **Make use of pest phototaxis to attract insect pests.** One horse lamp or black lamp per 5 mu of vegetable field is lit. A plate containing water and oil is placed under the lamp. The method is the same as that of sugar and vinegar liquid lures. Either of these methods can be used to lure adult pests and decrease the quantities of eggs in the field.

- **Promotion of the use of 7 mm radius spray nozzles to provide more accurate spraying and decrease the quantity of chemicals used.**

6.1.2 Chemical Control Measures

The pest management approach aims to stop use of highly toxic, high residue chemicals. The recommended approach is to use biological chemicals, followed by highly effective, low toxicity, and low residue chemicals to control pests. This approach will also protect non-target species, and help retain biological diversity in the vegetable field.

Before larvae of *Prodenia litura* and *Laphygma exiqua* hatch, spray NPV 3#, chlorfluazuron during the main period of egg hatching.

To control aphids, spray imidacloprid. Any of the above chemicals can be used. The exact quantities of chemicals to be used per 667m² can be determined by the size and density of the plants. In general, about 30 to 50 kg water/chemical solution is used per 667m², with the chemicals sprayed evenly on both sides of the leaves.
Annex 3: Production Technology for ‘Pollution-Free’ Vegetables (for Trial Implementation)

The production of ‘pollution-free’ vegetables is a systematic approach that deals with a wide range of disciplines, departments and technologies. ‘Pollution-free’ vegetables must be safe, high quality, and nutritious with residues of pesticides, nitrate and other harmful substances lower than the allowable level. To produce pollution-free vegetables that conform to the said requirements, a full set of production and management measures shall be adopted to minimize contaminants from the air, water, soil, fertilizers and pesticides.

Rules for production of pollution-free vegetables in Jiangxi province:

1. Production Base Construction

Sites for producing pollution-free vegetables must be free from contaminants (including air, water, soil pollution and industrial “three-wastes”); free from pollutants such as urban rubbish, wastes, sludge and dust; free from acid rain and other pollutants. Large scale bases for pollution-free vegetable production shall be constructed at locations that are 50-100 m away from major traffic roads and where there is a relatively large stretch of land with groundwater level of at least 80 cm.

The limit content of pollutants in various kinds of soil for pollution-free vegetable production bases is listed in Table 1.

The limit concentration of pollutants in irrigation water for pollution-free vegetable production bases is listed in Table 2.

The limit concentration of pollutants in the atmosphere over pollution-free vegetable production bases is listed in Table 3.

Sites that don’t conform to the above limits require amelioration measures so that pollutant concentrations are reduced to the required levels. Only those sites that meet the requirements after treatment shall be allowed for pollution-free vegetable production.

2. Agricultural Measures

To reduce use of agricultural chemicals, it is very important to adopt crop production and management measures that enhance vegetable resistance to pests and diseases, reduce pest and disease damage as well as the application of fertilizers and pesticides.

2.1 Cultivate high-quality resistant varieties. High-yielding and high-quality vegetable varieties with strong resistance to adverse conditions and pests, but with good commercial value shall be selected for cultivation. Cultivars appropriate to the local ecological conditions and resistant to diseases and insect pests will be used. Major efforts will be devoted to growing new kinds of pollution-free vegetables, such as bud or seedling vegetables and wild vegetables. Laws and regulations of China on plant quarantine shall be strictly implemented.

2.2 Disinfect seedbeds and seeds to reduce the occurrence of diseases and pesticides use.

Disinfect seedbeds by drying seedbeds in the sun, freezing soil or applying nonharmful agrochemicals.

Disinfect seeds. Pick out pest-infected, mouldy, rotted and blighted seeds. Reduce seed-borne fungi on seeds by hot water treatment, dry and hot sterilization, fungicide seed dressing or soaking. Promote use of seeds coated with agrochemicals.

2.3 Sow at the correct time. The occurrence of vegetable diseases and insect pests is closely related to the sowing period. Choosing the proper time to sow vegetable seeds based on local meteorological forecasts and varietal characteristics is a good way to minimize pest damage. For example, slightly earlier field planting may make tomato enter the growth period with resistance to virus diseases and avoid the
occurrence of *Alternaria solani*. Later seeding of Chinese cabbage may significantly reduce the occurrence of three major diseases.

2.4 Cultivate healthy seedlings by using nutrition trough or grafting.

Healthy seedlings should have good vegetative growth (thick branches and leaves), free from damage and pest infestation, with short nodes and petioles. They should also have a strong root system and flourishing lateral roots. Only healthy seedlings shall be planted.

During the seedling period, it is necessary to strengthen management of fertilizer, water, light, temperature and ventilation conditions to reduce air humidity and pest infestation on seedbeds. To prevent seedlings from root rot, avoid too much watering when it is cloudy and drizzly. Clear away disease-infested seedlings or spray fungicides (such as Chlorothalonil) whenever disease-infested seedlings are found. Seedling strengthening practices and field planting at the proper seedling stage should be implemented.

2.5 Strengthen management. Improve soil structure by deep ploughing, summer drying and winter freezing. Extend high and narrow ridge cultivation to form a complete set of "three furrows", i.e. ridge furrow, middle furrow, and encircling furrow. Ridges shall be aligned properly to prevent water logging. Conduct close planting and plant thinning to let in air and sunlight. Strengthen management of fertilizer and water; remove old and pest-infested leaves, branches and fruit, making the field environment favorable to vegetable growth and unfavorable to pest occurrence.

2.6 Improve cultivation technologies. Adopt greenhouse or screen cultivation to reduce deposition of airborne dust and acid substances on vegetables. Develop organic soilless culture. Extend vegetable grafting technologies to enhance resistance to diseases.

2.7 Implement crop rotation, intercropping and interplanting. Avoid continuous cropping by adopting water-dryland crop rotation or other methods of rotation to promote vegetable growth and enhance its resistance to adverse conditions. Encourage intercropping and interplanting onion or garlic to reduce pest occurrence and pesticide use.

3. Integrated Pest Control

3.1 Biological Control

Biological control methods include:

- Use of predators and parasites, such as seven spot ladybird, *Trichogramma*, to control insect pests.
- Use of bacteria, fungi and viruses, such as *Bacillus thuringiensis*, *Beauveria bassiana*, to control insect pests.
- Use of insect hormone attractants to trap and kill insects.

3.2 Physical Control

Manage light, temperature, humidity and use appliances to control pests. For example, use silver grey film or yellow stick boards to trap aphids and white flies, or prevent them from damaging vegetables. Use black light lamps or insect prevention nets to trap or keep out insect pests. Conduct soil disinfection by ridge freezing in winter and hot fumigation in summer.

3.3 Chemical Control

Prohibit application of highly toxic and residual chemical pesticides listed in Annex 3, Table 4. Strictly implement the Standards of People's Republic of China on safe use of pesticides. Carry out the plant protection strategy of "putting prevention first and integrated control". Apply chemical pesticides classified as "high effect, low toxicity and low residue" based on pest forecasts to delay pesticide
resistance of pests. Encourage use of a complementary range of pesticides and micro-spraying to increase control effects and broaden the pest control spectrum.

3.4 Safe Interval of Pesticide Use

Prohibit pesticide use before harvesting commercial vegetables. The safe interval between the last application of pesticides and harvest of vegetables differs for different pesticides and vegetables. Generally, it is 5-7 days in autumn and 7-12 days in spring and winter (Tables 5, 6).

3.5 Pesticides prohibited from use for Pollution-free Vegetable Production


4. Rational Use of Fertilizers

4.1 Application of Organic Fertilizer

Farm manure shall be fermented under high temperature to kill eggs of various parasites and pathogens and make it conform to required hygiene standards. The following organic fertilizers are permitted for use:

Farm Manure. Farm manure refers to fertilizers that contain a high proportion of biological substances or biological wastes. It includes remains and excrements of animals and plants, compost, wet compost, barnyard manure, methane manure, crop stalks, sludge and cake fertilizer.

Commercial Fertilizer: Commercial fertilizer includes commercial organic fertilizer, humic acid fertilizer, micro-organic fertilizer, organic compound fertilizer, inorganic fertilizer and foliar fertilizer.

Urban Waste: Urban waste may be used in small quantities only if its quality conforms to the national standard after treatment to remove contaminants. Application rates using urban waste for fertilizer shall not be more than 45,000 kg/ha for clay soils and 30,000 kg/ha for sandy soils.

4.2 Scientific and Rational Use of Chemical Fertilizer

Prohibit use of nitrate nitrogen, and promote mixed use of nitrogen, phosphate and potassium fertilizers. Chemical fertilizers shall be used in conjunction with organic fertilizers. Organic fertilizer use should be at least equal to inorganic fertilizer use, i.e. applying 1000 kg high-quality barnyard manure as a basal fertilizer and topdressing with 10 kg urea.

Methods for Fertilizer Use: In general, it is adequate to incorporate nitrogen fertilizer into the soil. Topdressing of nitrogen fertilizers on to the surface of the soil may place nitrogen in direct contact with air causing it to volatilize if the soil is dry. It may also be converted into nitrate that may be leached quickly through the soil (especially in sandy soils) and causing groundwater pollution. Topdressing of nitrogen fertilizers shall be prohibited for these reasons even though it increases yield and income. Shallow application of non-volatile fertilizers shall be conducted on shallow-rooting vegetables and deep application of volatile fertilizers on deep-rooting vegetables.

Timing of Fertilizer Applications: To prevent vegetables from contamination induced by chemical fertilizers and micro-organisms, the last topdressing of fertilizers shall be carried out 30 days before harvest of vegetables.
5. Harvest and Post-harvest Management Measures

Vegetables should be harvested on time. Appropriate harvest and post-harvest measures include preventing fruit vegetables from handling damage; clearing away yellow, old leaves and soil on leaf vegetables; and washing vegetables immediately with good quality water. Encourage grading, packing and use of decomposable packing materials permitted by the People’s Republic of China. Adopt pollution-preventive measures during transportation and marketing.

Table 1. The Limit Content of Pollutants in Soil; in mg/kg.

<table>
<thead>
<tr>
<th>Cultivation Condition</th>
<th>Dry land</th>
<th>Paddy field</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>&lt;6.5</td>
<td>6.5-7.5 &gt;7.5</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.30</td>
<td>0.30 0.40</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.25</td>
<td>0.30 0.35</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>25</td>
<td>20 20 15</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>50</td>
<td>50 50 50</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>120</td>
<td>120 120 120</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>50</td>
<td>60 60 60</td>
</tr>
</tbody>
</table>

Notes: 1. The limit content of Cu in orchard soil is two times that in dry land soil. 2. The limit content of pollutants in soil for rotation of dry land crops and water crops shall be the lower limit of that for dry land and paddy field.

Table 2. The Limit Concentration of Pollutants in Irrigation Water; in mg/l.

<table>
<thead>
<tr>
<th>Item</th>
<th>Limit Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.5-8.5</td>
</tr>
<tr>
<td>Total Hg</td>
<td>0.001</td>
</tr>
<tr>
<td>Total Cd</td>
<td>0.005</td>
</tr>
<tr>
<td>Total As</td>
<td>0.05</td>
</tr>
<tr>
<td>Total Pb</td>
<td>0.1</td>
</tr>
<tr>
<td>Total Cr</td>
<td>0.1</td>
</tr>
<tr>
<td>Fluoride</td>
<td>2</td>
</tr>
<tr>
<td>Dung colon bacteria</td>
<td>10000/l</td>
</tr>
</tbody>
</table>

Note: Dung colon bacteria in surface water for irrigating vegetable gardens shall be tested.

Table 3. The Limit Concentration of Pollutants in the Atmosphere; in mg/m^3 (standard condition).

<table>
<thead>
<tr>
<th>Item</th>
<th>Limit concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspension particles (TSP)</td>
<td>0.3</td>
</tr>
<tr>
<td>SO₂</td>
<td>0.15</td>
</tr>
<tr>
<td>NO₅</td>
<td>0.1</td>
</tr>
<tr>
<td>Fluoride (F)⁴</td>
<td>7 (µg/m³), 1.8 [µg/(dm³d)]</td>
</tr>
</tbody>
</table>

Note: 1. Average limit concentration per day means average limit concentration of any day. 2. Average limit concentration per hour means average limit concentration of any hour. 3. Samples are taken for three days continuously and 3 times (morning, noon, evening) per day. 4. Sample for fluoride may be taken by way of dynamic sampling filter film or lime filter on the basis of the limit concentration of each other. Lime filter shall be placed for 7 days.
Table 4. Pesticides Prohibited from use for Pollution-free Vegetable Production.

<table>
<thead>
<tr>
<th>Type of Pesticide</th>
<th>Common name of Pesticide</th>
<th>Prohibited-use on crops</th>
<th>Reasons for Prohibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organochloride</td>
<td>DDT, BHC, Gamma, Methoxychlor, Endosulfan</td>
<td>All crops</td>
<td>Highly-residual</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dicofol</td>
<td>Vegetables, fruit trees</td>
<td>Its industrial product contains DDT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organophosphate</td>
<td>Organophosphorus (phorate), Disulfoton, Monocrotophos, Parathion, Paraion-methyl, Methamidophos, Isofenphos-methyl, Sulfotep, Omethoate, Phosphamidon, Fonofos, Ethoprophos, Isocarbophos, Isazofos, Cadusafos, Methidathion, Terbutyl, Sebufos, Phosfalan-methyl</td>
<td>All crops</td>
<td>Violently toxic, highly toxic</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbamate</td>
<td>Aldicarb, Carbonfuran, Methomyl, Carbosulfan, Benfuracarb</td>
<td>All crops</td>
<td>Violently toxic, highly toxic or its metabolite is highly toxic</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethamidine</td>
<td>Chlordimeform-hydrochloride</td>
<td>All crops</td>
<td>Chronic toxicity, cancerogenic</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>All kinds of pyrethroid insecticides</td>
<td>Rice and other water crops</td>
<td>Too toxic for aquatic organisms</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fumigation</td>
<td>Ethylene dibromide, Ethylene oxide, DBCP, Methyl bromide</td>
<td>All crops</td>
<td>Highly toxic, cancerogenic and deformity-induced</td>
</tr>
<tr>
<td>insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abamectin</td>
<td></td>
<td>Vegetables, fruit trees</td>
<td>Highly toxic</td>
</tr>
<tr>
<td>Propargite</td>
<td></td>
<td>Vegetables, fruit trees</td>
<td>Chronic toxicity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organoarsenic</td>
<td>Zinc methane arsonate, Calcium methane arsonate, MAFA, Urbacid, Asomat</td>
<td>All crops</td>
<td>Highly residual</td>
</tr>
<tr>
<td>fungicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organotin</td>
<td>Fentin acetate, Fentin chloride, Fentin</td>
<td>All crops</td>
<td>Highly residual, chronic toxicity</td>
</tr>
<tr>
<td>fungicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organomercury</td>
<td>Ethylmercury chloride, Phenylmercury acetate</td>
<td>All crops</td>
<td>Violently toxic, highly residual</td>
</tr>
<tr>
<td>fungicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organophosphate</td>
<td>EBP, Iprobenfos</td>
<td>Rice</td>
<td>Strong smell</td>
</tr>
<tr>
<td>fungicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aromatic</td>
<td>Quintozene, Blastin</td>
<td>All crops</td>
<td>Cancerogenic, highly residual</td>
</tr>
<tr>
<td>fungicide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D compound</td>
<td>Herbicides or plant growth regulators</td>
<td>All crops</td>
<td>Foreign matter cancerogenic</td>
</tr>
<tr>
<td></td>
<td>Nitrofen, Chlomitorfen</td>
<td>All crops</td>
<td>Chronic toxicity</td>
</tr>
<tr>
<td>Plant growth</td>
<td>Organic synthesized plant growth regulator</td>
<td>All crops</td>
<td></td>
</tr>
<tr>
<td>regulator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide</td>
<td>All types of herbicides</td>
<td>Vegetable growth period (usable for soil disinfection and pre-emergence treatment)</td>
<td></td>
</tr>
</tbody>
</table>

The above is a list of pesticides currently prohibited from, or limited for, use. The list shall be revised according to new regulations of the People's Republic of China as they are developed.
Table 5. Standards for Safe Use of some Pesticides.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pesticide</th>
<th>Form of pesticide</th>
<th>Dosage Rate</th>
<th>Common dosage per hectare (kg or ml) and dilution rate</th>
<th>Maximum dosage per hectare (kg or l) and dilution rate</th>
<th>Application Method</th>
<th>Maximum times of application</th>
<th>Safe interval (days between last application and harvest)</th>
<th>Maximum residue level stipulated by FAO/WHO</th>
<th>Implementation statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green vegetables</td>
<td>Dimethoate</td>
<td>40%EC</td>
<td>0.75 2,000</td>
<td>1.5 800</td>
<td>Spray 6</td>
<td>≥ 7 days</td>
<td>8 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>90%KP</td>
<td>0.75 2,000 1.5 800</td>
<td>Spray 5</td>
<td>≥ 7 days</td>
<td>8 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acephate</td>
<td>40%EC</td>
<td>1.875 1,000</td>
<td>3.75 500</td>
<td>Spray 2</td>
<td>≥ 7 days</td>
<td>9 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permethrin</td>
<td>10%EC</td>
<td>90 1,000</td>
<td>0.36 2,500</td>
<td>Spray 3</td>
<td>≥ 2 days</td>
<td>9 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese cabbage</td>
<td>Dimethoate</td>
<td>40%EC</td>
<td>0.75 2,000</td>
<td>1.5 800</td>
<td>Spray 4</td>
<td>≥ 10 days</td>
<td>8 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>90%KP</td>
<td>0.75 2,000 1.5 800</td>
<td>Spray 5</td>
<td>≥ 7 days</td>
<td>8 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acephate</td>
<td>40%EC</td>
<td>1.875 1,000</td>
<td>3.75 500</td>
<td>Spray 2</td>
<td>≥ 7 days</td>
<td>9 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permethrin</td>
<td>10%EC</td>
<td>90 1,000</td>
<td>0.36 2,500</td>
<td>Spray 3</td>
<td>≥ 2 days</td>
<td>9 days in autumn &amp; winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td>Dimethoate</td>
<td>40%EC</td>
<td>0.75 2,000</td>
<td>1.5 800</td>
<td>Spray 5</td>
<td>≥ 5 days</td>
<td>3 days in summer for beans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrot</td>
<td>Dimethoate</td>
<td>40%EC</td>
<td>0.75 2,000</td>
<td>1.5 800</td>
<td>Spray 6</td>
<td>≥ 5 days</td>
<td>9 days if leaves are for eating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber</td>
<td>Dimethoate</td>
<td>40%EC</td>
<td>0.75 2,000</td>
<td>1.5 800</td>
<td>Spray 3</td>
<td>≥ 2 days</td>
<td>1 mg/kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foliar vegetables</td>
<td>Cypermethrin</td>
<td>10%EC</td>
<td>375</td>
<td>0.75 800</td>
<td>Spray 3</td>
<td>2-5 days</td>
<td>1 mg/kg</td>
<td>For green vegetables, 5 days in summer &amp; 12 days in autumn &amp; winter</td>
<td>1 mg/kg</td>
<td>Green vegetables in southern Jiangxi, Chinese cabbage in northern Jiangxi</td>
</tr>
<tr>
<td></td>
<td>Deltamethrin</td>
<td>2.5%EC</td>
<td>300</td>
<td>0.6 800</td>
<td>Spray 3</td>
<td>2 days</td>
<td>0.2 mg/kg</td>
<td>For green vegetables, 5 days in summer &amp; 12 days in autumn &amp; winter</td>
<td>1 mg/kg</td>
<td>Green vegetables in southern Jiangxi, Chinese cabbage in northern Jiangxi</td>
</tr>
<tr>
<td></td>
<td>Cypermethrin</td>
<td>20%EC</td>
<td>225-375</td>
<td>0.6 800</td>
<td>Spray 3</td>
<td>2 days</td>
<td>0.2 mg/kg</td>
<td>For green vegetables, 5 days in summer &amp; 12 days in autumn &amp; winter</td>
<td>1 mg/kg</td>
<td>Green vegetables in southern Jiangxi, Chinese cabbage in northern Jiangxi</td>
</tr>
<tr>
<td></td>
<td>Quinalfos</td>
<td>25%EC</td>
<td>900</td>
<td>1.5 800</td>
<td>Spray 2-Jan</td>
<td>9 days for 1 application, 24 days for 2 sprays</td>
<td>0.2 mg/kg</td>
<td>Wild cabbage and Chinese cabbage</td>
<td>1 mg/kg</td>
<td>Wild cabbage</td>
</tr>
<tr>
<td></td>
<td>Pirimicarb</td>
<td>50%WP</td>
<td>375</td>
<td>0.75 800</td>
<td>Spray 3-Jan</td>
<td>6 days for 1 spray, 11 days for 3 sprays</td>
<td>1 mg/kg</td>
<td>Wild cabbage</td>
<td>1 mg/kg</td>
<td>Wild cabbage</td>
</tr>
</tbody>
</table>
**Table 6. Pesticides that may be applied in limited amounts for Pollution-free Vegetable Production.**

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Toxicity</th>
<th>Maximum residue level (mg/kg)</th>
<th>Days between last application and harvest</th>
<th>Common dosage per hectare (kg or l) and common dilution rate</th>
<th>Method and maximum times of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethoate</td>
<td>Medium</td>
<td>0.5 (1)</td>
<td>Vegetables 15 (9) days</td>
<td>40% EC 0.75-1.5</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Phoxim</td>
<td>Low</td>
<td>0.05 (0.05)</td>
<td>Green vegetables, Chinese cabbage, cucumber ≥ 10 (7) days</td>
<td>50% EC 0.75-1.5, 2000-500</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>Low</td>
<td>0.1 (0.2)</td>
<td>Green vegetables 10 (7-8) days</td>
<td>90% KP 1.5, 1000-500</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Pirimicarb</td>
<td>Medium</td>
<td>0.5 (1)</td>
<td>Foliar vegetables 10 (6) days</td>
<td>50% WP 0.15-0.45</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>Medium</td>
<td>0.5 (1), 0.2 (0.5)</td>
<td>Foliar vegetables 7 (2-5) days</td>
<td>10% EC 0.3-0.45, 25% EC 0.18-0.24</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>Medium</td>
<td>0.2 (0.5)</td>
<td>Tomato 5 (1) days, Green vegetables 7 (2) days</td>
<td>20% EC 0.225-0.6, 20% EC 0.45-0.6</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Fenvelerate</td>
<td>Medium</td>
<td>0.2 (0.5), 0.1 (0.2)</td>
<td>Green vegetables 7 (2) days, Tomato 10 (3) days</td>
<td>2.5% EC 0.3-0.6</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Chlorfluazuron</td>
<td>Low</td>
<td>0.2 (0.5)</td>
<td>12 (7) days</td>
<td>5% EC 0.6-1.2</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Chlorthalonil</td>
<td>Low</td>
<td>1 (1)</td>
<td>Tomato 30 (23) days</td>
<td>75% WP 1.5-3</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Metalaxyl</td>
<td>Low</td>
<td>0.2 (0.5)</td>
<td>Cucumber</td>
<td>50% WP 1.125-1.8</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Carbendazim</td>
<td>Low</td>
<td>0.2 (0.5)</td>
<td>Cucumber 10 (7) days</td>
<td>25% WP 1000-500</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Procymidone</td>
<td>Low</td>
<td>1 (2)</td>
<td>Cucumber 5 (1) days</td>
<td>50% WP 0.6-0.75</td>
<td>1 Spray</td>
</tr>
<tr>
<td>Triadimeton</td>
<td>Low</td>
<td>0.1 (0.2), 0.1 (0.2)</td>
<td>Apple, chilli, tomato, cucumber 7-10 (5) days</td>
<td>20% WP 1000-500</td>
<td>1 Spray</td>
</tr>
</tbody>
</table>

Note: 1. The number of maximum residue level in the parentheses is taken from national or international standards. 2. The number of days between last application and harvest in the parentheses is taken from national or international standards.

**Table 7. Hygiene Requirements for High Temperature Compost.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Hygiene Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature for compost</td>
<td>Maximum 50-55°C, 5-7 days</td>
</tr>
<tr>
<td>2</td>
<td>Mortality of roundworm eggs</td>
<td>95-100%</td>
</tr>
<tr>
<td>3</td>
<td>Dung colon bacteria</td>
<td>10-1-10-2</td>
</tr>
<tr>
<td>4</td>
<td>Flies</td>
<td>Flies shall be effectively controlled, there are no living maggots, pupae and newly emerging adult flies around compost.</td>
</tr>
</tbody>
</table>
Table 8. Hygiene Requirements for Methane-Fermented Fertilizer.

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Hygiene requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sealed storage period</td>
<td>≥ 30 days</td>
</tr>
<tr>
<td>2</td>
<td>Temperature for methane fermentation</td>
<td>53±2°C, 2 days</td>
</tr>
<tr>
<td>3</td>
<td>Drop rate of parasite eggs</td>
<td>≥ 95%</td>
</tr>
<tr>
<td>4</td>
<td>Eggs of blood fluke and hookworm</td>
<td>Living eggs of blood fluke and hookworm are not permitted in the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dung liquid for use.</td>
</tr>
<tr>
<td>5</td>
<td>Dung colon bacteria</td>
<td>Common methane fermentation 10-1, high temperature methane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fermentation 10-1-10-2</td>
</tr>
<tr>
<td>6</td>
<td>Mosquitoes and flies</td>
<td>Mosquitoes and flies should be effectively controlled, there are</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no wrigglers in dung liquid and no living maggots, pupae and newly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>emerging adult flies around methane-generating pits.</td>
</tr>
<tr>
<td>7</td>
<td>Remains in methane-generating pit</td>
<td>Remains in methane-generating pit shall be used only after</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disinfection.</td>
</tr>
</tbody>
</table>
Annex 4: Draft Monitoring and Evaluation Indicators

1. **Indicators to be Monitored Locally**

**Extent of Adoption of Non-Pesticide or IPM Control Measures:**
- Number of farmers per sample adopting non-pesticide or IPM control measures
- Total area of farms adopting non-pesticide or IPM control measures
- Number of farmers using pest resistant varieties
- Number of farmers able to recognize natural pest enemies
- Number of farmers involved in community action programs related to IPM

**Pesticide Use Pattern:**
- Number of pesticide applications per crop/ha/cropping season
- Types/quantity/volume of pesticides used per crop/ha/cropping season (checking for use of WHO Class I or non-registered chemicals)
- Cost of pesticide applications per crop/ha/cropping season
- Amount of any pesticide subsidies
- Number of farmers practicing safe pesticide handling and application procedures (e.g. safe storage, use of protective clothing, etc)
- Incidence of excessive pesticide residues on crop produce
- Number of complaints on pesticide residues on crop produce
- Number of trade rejections because of pesticide residues on crop produce (e.g. oranges)
- Incidence of pest resistance
- Incidence of pesticide poisoning in humans
- Incidence of other forms of environmental poisoning or contamination in domestic animals, wildlife, honey bees, water pollution, soil pollution, other.

**Crop Production:**
- Crop yields per hectare, fluctuation in crop yields from season to season
- Profit per hectare, profit fluctuation from season to season.

**Agro-ecosystem:**
- Number and type of pest outbreaks per crop/year
- Number of insect predators, parasitoids per unit per sampling area
- Abundance of beneficial insects (e.g. honeybees per unit sampling area) in terms of numbers and diversity

**Other Indicators:**
- Frequency of visits of agro-chemical salespersons to the project area
- Frequency of media (TV, radio, newspaper) agro-chemical advertisements
- Number of pesticide brands on display in retailer outlets in the project area
- Number of acceptable types of pesticides on display
- Number of small-scale businesses related to pesticide sales or IPM (e.g. production of natural enemies, etc)
- Number of business operations dependant on clean environment (e.g. fish, eel production).

The above monitoring should be done by County PPQS staff on a sample of project households in the project area in each county. Early supervision missions should assist the County PPQS to establish an appropriate monitoring system, sampling procedure, and provide training in implementation and analysis of the monitoring system. Once the monitoring system has been fully designed in collaboration with the JPPQS and county stations, a detailed budget, work plan, and responsibilities should be prepared.
2. Activities Requiring Monitoring during Supervision

Pesticide Registration:
- Spot checks of chemical supply stores and project farmers pesticide cupboards to determine if unregistered pesticides are being sold/used in project areas
- Inspection of pesticide registration lists to check on new pesticides being registered.

Use of Class I Pesticides:
- Spot checks of chemical supply stores and project farmers pesticide cupboards to determine if WHO Class I pesticides are being sold/used in project areas

Policy Issues:
- Extent of government subsidies (if any) for pesticides
- Assessment of effectiveness of household loan application system in controlling use of non-approved pesticides.
- Provincial and local government policies and regulations on pesticide use and promotion of IPM approaches.

Implementation of the local monitoring program:
- Assessment of the implementation of the local monitoring program in counties visited by the supervision mission
- Assist county staff to resolve any implementation problems with the local monitoring program
- Provide on-going training to county staff in monitoring procedures, data analysis, and interpretation of results in terms of project actions to be taken to rectify unsatisfactory pest management practices.

Supervision mission inputs should be conducted 2 times per year, preferably during periods of high pest control activity to observe field implementation of pest management practices. This supervision work should be undertaken by an Agriculture Specialist with experience in agricultural pest management in China.