Pest Management Plans for Major Crops of Shaanxi Project Area, World Bank Agricultural Technology Project
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Provincial plan of diseases and pests management

1 Management of diseases, pests and weeds in Shaanxi province

1.1 Management of institution and its function

Management system of diseases and pests, constituted of four levels of country, province, city and town, has been conducted in China at present. Every institution manages the diseases and pests, supervises pesticides quality, detects residual of pesticides according to its duty. Agro-technical Extension Center of China is the top management institution, responsible for forecasting of the diseases and pests, IPM, extension of pesticides and instruments, and plant quarantine. Agriculture Ministry Pesticide Detecting Institution, in charge of the pesticides register, quality inspection and residual detection, is the management of pesticides in country level. In order to legally manage production, operation and sale of the pesticide, and diseases and pests, Pesticide Management Ordinance and Plant Quarantine Ordinance were enacted by the State Council, Enforcement Measures of Pesticides Management Ordinance and Enforcement Particulars of Plant Quarantine Ordinance were constituted by the Ministry of Agriculture. At the same time, Ministry of Agriculture and Agro-technical Extension Center of China had framed serial criteria, prescripts and measures of diseases and pests forecasting, IPM, pesticides management and plant quarantine, which had been widely conducted and more effective in specification controlling, legally application of the pesticide.

In recent years, the Ministry of Agriculture had conducted action, including air pollution treatment, agricultural resources utilization and watering cleanly, to insure the agricultural product quality in the whole country. High poisonous pesticides were forbidden to register or cancelled on the basis of reinforcing management to five high-poisonous organophosphor pesticides (methamidophos etc.) by Ministry of Agriculture. (1) forbidden pesticides: Agroicide, DDT, Toxapene (3956), Dibromochloropropane (BBC 12), Chlordimeform, Fluoroacetamide, Glifor, Tetramine (TME), Sodium fluoroacetate (1080), Silatranes (RS 150), Nitrofen (FW 925), Alandrin, Dieldrin, Arsenic, Lead, TF 128;(2) pesticides forbidden or limited using in vegetable, fruit tree, tea and Chinese traditional medicine: Dichlorvos (DDV), Methamidophos, Methyl paraoxon, Paraoxon, Monocrotophos, Phosphamidon, Phorate, Isofenphos-methyl, M82, Sulfotep, 1059, Carbofuran, Aldicarb, Phenamiphos, Phosfolan, Coumaphos, Fonofos, Isazofos and Dicofol were forbidden to use in tea trees. All of the pesticides were confined using only within the registered range.
Shaanxi Plant Protection Station was the institution in province level, which managed the diseases and pests of crops plants in Shaanxi province, responsible for the inspecting of diseases, pests, weeds, rats, and its forecast, framed the integrated controlling criterion and directed farmer to conduct, researched, developed and extended the new plant protection technique, recommended to farmers the practicable pesticides ( safe, effective, low-poisonous, low residual ).

Shaanxi Pesticide Manage-Detecting Institution was the institution in province level, which was responsible for the registering, supervising, managing the labels, inspecting the incompetent pesticides including non-certificate, counterfeit, and the transferential production, supervising application safely, auditing ad. and detecting the pesticide residual.

City ( country ) Plant Protection Quarantine Station was the institution in city ( country ) level, which managed the local diseases and pests of crop, responsible for the pre-alarming to local diseases, pests, weeds and rats, recommending the pesticides to farmers, managing of the integrated controlling, supervising the pesticides market, directing the use of pesticides and techniques of nuisancefree production, detecting the pesticide residual.

Town Agro-technical Integrated Service Station was the institution in town level, which was responsible for the investigation of diseases, pests, weeds and rats in local town, directed farmers to control the diseases, pests, weeds, rats according to criterion published by higher agency, recommended practicable pesticides to the farmers on the basis of local condition, supervised the local pesticides quality and reported the results to the superior agency.

1.2 Pesticide Presentation

At present, the plan, direction and supervision of pesticide production are responded by Chemical Industry Department of Chinese State Council. Province Chemical Industry Department issued the certificate and documents of pesticides production to the local agency. The management to pesticide industry was enforced, which led the industry structure of pesticides develop scientifically and internationally. The pesticide industry dealt with the production legally according to the criterion. At present there are more than two thousands industries and ten thousands pesticides all over the country. There are above forty pesticide industries in Shaanxi province and the production could reaches 1,5000 tons.

The agency which sold the pesticides included the agricultural resources company, Agrotechnique station, plant protection station, soil and fertilizer station, institution of forest diseases and pests controlling, the direct agency of the company. The industry wholesaled pesticides to the shopkeeper and the latter sold them to farmers. Above 100 pesticides,
including insecticides 35%, fungicide 40%, herbicide 10~15% and other 10%, were sold, one which had the certification entirely could be protected, otherwise, forbidden.

1.3 Occurrence and controlling of disease and pest in item province

1.3.1 Occurrence:

Wheat: Pests included underground pests, aphids, red spider, gall midge. Wheat diseases included stripe rust, sharp eyespot, leaf blotch, powdery mildew, head blight. The epidemic level of wheat stripe rust has significant difference in different years. The wheat head blight occurred in some years. Seeds in wheat field included cleavers, etc.

Rice: Pests included rice grasshopper, rice leaf folder, rice caddice fly, rice moth borer, paddy borer. In recent 2 years, rice grasshopper and moth borer have more serious tendency. Diseases included rice blast, sheath blight, false smut. Seeds in rice field included Cockspur grass, etc.

Maize: Pests included corn borer, corn red spider, corn thrips, underground pests, corn cutworm moth, common army worm. Diseases included corn leaf spot minor, northern leaf blight, corn dwarf mosaic, physiological disease. Seeds in maize field included Cynosarus grass, etc.

Fruit tree: Pests includes red spider, scale, scarab, leaf miner, leaf roller, aphid. Diseases included valsa canker, gloeosporium rot, powdery mildew, leaf spot, perennial canker, physiological disease. Weeds in orchards included Indigo plant, Inferior meal, Asiatic plantain, etc.

Vegetable: Pests included aphid, red spider, underground, cabbage caterpillar, common army worm, thrips, leguminous pod-borer, cucurbit leaf beetle, turnip, leafhopper, leaf beetle, cricket. Diseases included downy mildew, anthrancnose, powdery mildew, virus, white rot, etc. Weeds in vegetable field included cockspur grass, Purslane, etc.

1.3.2 Controlling

Wheat: The controlling strategy should be conducted according to the actual occurrence of diseases and pests on the basis of resistant cultivars. Seeds coated with pesticides should be applied to prevent the soil insect according to the species. Mites should be mainly controlled in early spring. Resistant cultivars should be used to control rust disease and powdery mildew at the initial stage in local sites. Disease and pests in early stage should be conducted with the techniques of “one spraying and three protecting” in May.. weeds in wheat field should be pulled out and sprayed herbicides (Matrix etc.).

Rice: The controlling strategy should be conducted according to the actual occurrence pattern of diseases and pests on the basis of agricultural measures (watering scientifically
and deep plough et.), including cleaning seedling bed during the sowing time, sowing with pesticide during transplanting, controlling the pests in medium time and extending the technique of “two protecting and one spraying” during the tasseling stage. The herbicide should be extended to remove the weeds in rice field.

**Maize:** There were more less kinds of diseases and pests, and 3 steps as below were necessary for controlling them. First, seeds coated with pesticides were used to prevent the soil insects. Second, corn worm was controlled during trump stage. Finally, corn leaf spot minor and larger were controlled in the serious infected fields. The controlling measures were to spray the fungicides and biological pesticides. The herbicides (Acetochlor, Atrazine, etc.) and manual methods were more effective.

**Fruit tree:** There were many kinds of diseases and pests in the fruit trees. The special controlling measures, including trapping and killing by light, sexual attractant, controlling mites with mites, spraying biological pesticides and effective low-toxicity & residual pesticides, should be conducted according to the different diseases and pests in the orchard on the basis of cleaning location and brushing the trunks. The most important events were spraying volumes and intervals in order to prevent the diseases and pests from resistance as well as residual. The recommend herbicides were Apache.

**Vegetable:** The controlling of vegetable diseases and pests was more difficult because of the kinds of diseases and pests increasing, and generations overlapping with the extension of cultivated technique. The controlling measures should be conducted by resistant cultivars, crop rotation, plowing deeply and shining, spraying biological pesticides and effective low-toxicity & residual pesticides on the basis of agricultural measures. The manual measures and herbicides were necessary to remove the weeds.

### 2. Management Plan of diseases, pests and weeds in project area

#### 2.1 The new controlling measures

The controlling measures of diseases, pests and weeds should be on the basis of IPM, and develop gradually towards the sustainable controlling techniques. Applying the inner function of ecosystem, enforcing the natural controlling factors, widely applying the non-chemical measures and decreasing the poisonous pesticides, should be conducted with the unit of ecosystem and on basis of integrated system adjustment. The damage, caused by diseases, pests and weeds, should be kept under the economic threshold by the use of adjustment technology scientifically and the accurate prediction. The centered objects of diseases and
pests were to optimize system structure with perfect resistant cultivars and scientific cultivation technology.

Specific measures as bellowing:

Establishing the scientific prediction system to insure the accuracy reach to above 90%.

Formulating scientific controlling criterion.

Selecting the priority cultivars.

Rational fertilizer and water management, more farm manure and fertilizer formulate to enhance the resistance of plant.

Optimizing the ecosystem including planting more grasses in orchard, applying and protecting the natural enemy, decreasing the use of the pesticides, extending the biological pesticides such as validamycin etc, extending agricultural measures (crop rotation and plowing deeply) to control the diseases, pests and weeds.

Effective low-toxicity & residual pesticides will be applied on the basis of experiments, forbidding the poisonous pesticides.

2.2 List of pesticides recommended:

**Wheat:** Phoxim, Aimcocyper, Attatox, Acidazim, Acizol, Ambassador, Matrix, Alon, Puma.

**Maize:** Admire, Mancozeb, Bovinox, Acetochlor, Atrazine.

**Rice:** Fipronil, Hotathion, Applaud, Validamycin, Blascide, Ambassador, Acord, Aimchlor.

**Fruit tree:** Hotathion, Abamectin, Lime sulfur mixture, Aimcocyper, Adagio, Chlorbenzuron, Agretol, Thiophanate methyl, Dhiophante methyl, Daconic, Ambassador, Carbendazim, Mancozeb, Bordeaux, Apache.

**Vegetable:** B.t., Aimcocyper, Mostar, Puma, Hotathion, Abamectin, Daconic, Mancozeb.

The pesticides above were all safe, effective, low residual and toxicity, according the prescription of pesticide management recommended by production standard and norm on some crops in Shaanxi province.

2.3 Management of diseases, pests and weeds in the experimental area

2.3.1 Forecasting group

Prediction of diseases and pests was the base and precondition of implementing control. So the experiment area of Shaanxi province would establish 20 new sites monitoring diseases, pests and weeds, complete 4 forecast station construction and monitor the occurrence of disease, pest and weed in sub-experiment area systematically. Perfect information transmitting system, improved the efficiency and accuracy, trained the staff.

2.3.2 Implementing group
Specialist staff was grouped in provincial level to manage and direct the control of diseases, pests and weeds in each sub-projects. Specialist staff mainly composes of experts from Northwest A&F University and Plant Protection Station of Shaanxi Province. Each sub-project had the specialist staff to support sub-project technology, and was responsible for the formulation and implement of the control measures.

2.4 Training of diseases and pests management technology

2.4.1 The content and materials of training

Objects included the technical personnel, household in the project area implement. They were trained on the occurrence principle of diseases and pests, control measures, knowledge of pesticides and pesticide apparatus, pesticides and how to use apparatus. The trained manual was complied by specialists staff in provincial level, which consists of the technology and the management calendar of diseases and pests to guarantee one book per executer and each household.

2.4.2 Training plan

There was a systematic training at the early project. After that, they would be trained on the control technology of the crop before it was cultivated. Then there was a brief training at the key period of diseases and pests control. Every farmer can acquaint himself with the occurrence pattern of crop diseases and pests and mastered the control measures.

2.4.3 Funds budget

See the fund budget of sub-project

2.5 Results evaluation and report of management plan

2.5.1 Expected objects

The objects of the project was “three increase and three decrease”. That was increase yield, synergy, enhancing the capacity of ecology adjustment, reducing the loss, dosage of pesticides and lighten the pollution.

Concrete objects see below:

(1) implement IPM in experimental area and total area above 90%.
(2) The accuracy of main diseases and pests was improved from 70% to 90%.
(3) the ratio of loss cut down from 10% to 5%.
(4) implement all-round continuous control, and attain positive cycle of economic benefits, effect upon social and ecological benefits.

2.5.2 Project Monitor

Drafting the monitoring plan, establishing monitoring groups in provincial level monitor and track the sub-project. If some problems were found, they would be corrected in time. At the
end of year (crop cycle), management to diseases and pests would be tested and made a conclusion.

2.5.3 Report on Implementation effects.
Every sub-project gave the conclusion report of the year at the end of November and reported to headquarters. The headquarters gave the conclusion reports before the end of February and prepare for the checking by experts.

3. Concrete measures

3.1 Enforce the prediction of diseases and pests
Sub-project organization should coordinate with local Agro-technique station and plant protection station to predict the occurrence of diseases and pests.

3.2 Enforce the pesticides management.
Limited pesticides were forbidden to sell. Pesticides were bought and sale unifiedly in the project area. According to the prediction, the diseases and pests were controlled unifiedly in the project area.

3.3 Enforce training farmers
Many farmers were trained in each sub-project in order to improve their consciousness to environment protection and plant protection.

3.4 Compensate the loss of farmers
In order to encourage farmers to apply IPM technology and reduce the use of pesticides, it was necessary to compensate the loss for farmers because of stopping using high toxicity and high residual pesticides. At the same time, extension, the price of agricultural products and the income of farmers were increased.

3.5 Strengthen the research on IPM
IPM technology was a developing technology. With the change of farmland ecological communities, the diseases, pests and weeds of crops would change. In order to apply IPM to harmful organism, the research on IPM should be strengthened greatly. During the research on diseases, pests and weeds of crops, the research on natural enemies such as spiders and frogs should be strengthened particularly, moreover the research on new technology. Only mastered the principle of farmland biological community, the control can be carried out definitely, the loss would be reduced greatly.
Management plan of Hanyin sub-project

1. Agriculture fundamental information

Hanyin country of Shaanxi province depended on agriculture. The major crops were rice, maize, rape and mulberry, particularly ginger, taro vegetables. Hanyin had a historical tradition of cultivation mulberry and silkworm. Silkworm and mulberry are the dominant industry in Huayin country. There were 80,000 acres mulberry fields, of which fruit mulberry 1,5000 acres. And Shengsang company built the base of mulberry in recent years. The pattern of “enterprise + base + farmer” was formed gradually, and extended continuously. This project promoted extremely the development of local agriculture development.

2. Major diseases and pests analyzation in mulberry fields.

2.1 Diseases
Scerotinia, Wilt dwarf, Purple root rot, Brown spot, Powdery mildew, Rust.

2.2 Pests.
Mulberry small weevil, mulberry tussock moth, cutworm, mulberry looper, mulberry jumping plant louse, mulberry longicorn, cerambycid, yellow-spotted longicorn beetle, scarab, mulberry red spider, mulberry leafhopper, mulberry pyralid, wild silkworm, flower leaf roller, mulberry thrips, snail, scale, mulberry black gall-midge, caltrop-marked leafhopper

The damage level was unequal every year. The light damage reduced production, the serious one results in the mulberry tree die. At present, the major problems in the control of diseases and pests by local farmers were: ignoring agricultural and biological measures, unsuitable use of pesticides and controlling not in time.

3. Measures Design of IPM

3.1 Pre-Protection, Enforcing integrated control
Establishing diseases and pests alarming system, records of diseases and pests control information, and implements IPM. Adopting comprehensively agricultural, physical and biological measures, chemical measures reasonably. During the chemical control, biological source pesticides and safe, efficient, low toxicity and residual pesticides were preferred. The technology norm of IPM was formulated and spread to be applied in experimental area. Then the mulberry residual was controlled below the permitted level.

3.2 Control measures
3.2.1 Agricultural Measure

3.2.1.1 Cultivate resistant cultivar
According to the result, cultivate mulberry 8632, red fruit serious cultivars.

3.2.1.2 Enforcing plant quarantine, prevent dangerous disease and pests come in.

3.2.1.3 Plow soil deeply
Plowing could bury the pathogens and pests in winter, At the same time, pathogens survived in the soil would be exposed to die. Farmers should clear the leaves and weeds off and burn all to kill lots of pests and pathogens.

3.2.1.4 Brushing the trunk and sterilization in the orchard.
Brushing the trunk with 20% lime solution (put some sulphur or diesel oil) which could prevent the tree from freeze injury and killed lots of pathogens. Sterilizing orchard with bleaching powder solution could control air-borne effectively.

Eradicating diseased plants
Eradicating and burning the plants that infected by severity wilt dwarf and purple root.

3.2.1.6 Fertilizer measures
Applying farm manure and increasing the organic matter of the soil could kill some pathogens and pests. accelerated the growth of mulberry and improved its resistance.

3.2.2 Physical control

3.2.2.1 Trap and kill cutworm and mulberry pyralid with black light, high mercury lamp, sugar and vinegar.

3.2.2.2 Capture manually
The beetle could be captured before sunrise and after rain, and put it into oil bottle to kill it. In autumn, it was the key period for mulberry worm to bore trunk. dropping several drops of oil in the entrance of bore may kill the larvae of mulberry yellow tail moth.

3.2.3 Chemical control

3.2.3.1 Principle of insecticides application
All applied insecticides should be effective, low-toxicity, low-residue and safe. Any high-toxicity, high-residue and dangerous pesticides, such as Methyl-Parathion, Parathion, Azodrin, Parathion, Isofenphos methyl, M82, Sulfotep, 1059, Phosphamidon, Phorate, Phenamiphos, Phosfolan, Coumaphos, Fonofos and Isazofos were strictly forbidden to use in mulberry orchard.

3.2.3.2 Pesticide application method

3.2.3.3.1 Mulberry brown leaf spot
At the primary infection stage of the disease, 50% WP of Carbendazim with 800 folds or 75% Chlorthalonil with 500~600 folds may be used to prevent and eliminate, which should be sprayed for 2-3 times with interval 7~10 days.

3.2.3.3.2 Powdery mildew
At the primary infection stage of the disease, 25% WP of Triazolone with 1500 folds may be used to prevent the disease.
3.2.3.3.3 Insect pests
Select wide-spectrum, low-toxicity insecticides, such as DDVP and Dipterex, to control the pests.

4. Control measures for main diseases and pests

Mulberry sclerotinia rot (*Sclerotinia* sp.), dwarf (*Phytoplasma* sp.), small weevil (*Baris deplanata* Roeloffs) and yellow tail moth (*Porthesia xanthocampa* Dyer) were major target diseases and pests in Hanyin Area.

4.1 Mulberry sclerotinia rot
The mulberry sclerotinia rot mainly caused by *Sclerotinia* spp.
4.1.1 To reduce the primary infection source, the fruiting body should be deeply buried at the first ten days of March with intertill.
4.1.2 To improve the air and light of orchard, flower and fruit selection should be strengthened.
4.1.3 To decrease the source for infection, the infested fruits and twigs should be found in time and buried deeply outside the orchard.
4.1.4 To spray 70% mildothone with 1000 folds during young flower and fruit stage to mulberry tree and ground surface 2-3 times alternatively.
4.1.5 Clear orchard (such as summer pruning) after harvest and spray pesticides mentioned above, then intertill.

4.2 Mulberry dwarf
4.2.1 Remove and eradicate the infested trees in time.
4.2.2 Control the leafhopper vectors with trap method.
4.2.3 Summer pruning early than normal.
4.2.4 To fertilize reasonably.

4.3 Mulberry small weevil
4.3.1 Prune the half dead trunk.
4.3.2 Spray 50% Suminthion EC with 1 000 folds after summer pruning.
4.3.3 Capture manually.
4.3.4 Capture adults by Light-traps and sex pheromone traps.

4.4 Mulberry yellow tail moth
4.4.1 Trap larvae with grass strips to the tree trunk before overwinter of larvae. Then remove and burn the strips.
4.4.2 Keep the orchard clean through removing and killing the cocoons in winter.
4.4.3 Spray 80% DDVP EC from late-Spring to early-Summer and late-Autumn.

4.5 Kill trunk and branch insects with insecticide
To inject insecticides, such as Dipterex and 9207, into the bore before the pests dormancy, then envelop the bore with clay.
5. Project content and implementation

The project plan to establish a mulberry plant base of 30,000 acres, expect fresh mulberry yield reach up to 450,000 tons and 2,000 tons drink of mulberry per year. The project consisted of three parts: (1) To establish a mulberry raw material base; (2) To build a station of raw material collection and primary processing; (3) To set up a research and development center and a process factory.

5.1 Project Organization

5.1.1 Leader Group for the project
The leader Group had been formed at the beginning of the implement. All the members came from enterprise, World Bank Office, Committee of Fruit & Silkworm Society and professional personnel.

5.1.2 Project governing body
The management group was led by enterprise. Enterprise was responsible for production and process of mulberry. Committee of Fruit & Silkworm Society was charged in planting. Technician offered direction, training and consults to production. World Bank Office supervises the implementation of the project. General manager led by board of director was charged in the enterprise, and established scientific and completely internal manage mechanism. Corporation regulated the activity of production and sale through setting up strict and scientific management mechanism to insure high efficiency, flexible rotation and coordination development. Based on the production and management, post and personnel, the target was decided. Self-inspiring mechanism was set up through linking the staff salary to the economic benefits and personal task.

5.2 Establishment of diseases and pests prediction system

5.2.1 To set up expert consultant group
All the members of expert consultant group came from the Northwest A&F University and Plant Protection Station of Shaanxi province. They were responsible for training, consulting, guiding the production and diseases and pests management for the base.

5.2.2 Construct county-countryside-village forecasting net
The project had covered 9 townships and 41 villages, with 1-2 farmer household selected from a village for planting example demonstration. The forecasting apparatus including black light lamp would be equipped in the mulberry orchard. The farmer household would be trained for learning forecast and statistic knowledge and regularly report the information of diseases and pests to township and county. The township office would collect and analysis the data, then provide the control advice to local area.
Diseases and pests control station leaded by local forest bureau and silkworm station would be constructed to direct pests management and forecast net construction all over county. Ten monitoring sites and 2 forecast station of diseases and pests would be set up in the project area.

5.2.3 Necessary basic condition and equipment
Some laboratories used as specimen-room, documents-room, analysis and detection-room, tools and chemicals-room, etc. Necessary instruments included computer, microscope, reagent and other staple tools. Some staff or workers were also needed.
It needed 600,000 RMB to accomplish the forecast system.

5.2.4 Plan of county-countryside training

The training includes two steps: firstly, Specialist consultant group trained the staff from sub-project and farmers selected through face-to-face. Then experts would demonstrate in field to make them grasp the technology and knowledge. And secondly, the trained staff and farmers would train mulberry farmers came from 41 villages.

The project would train about 300,000 persons and cost 300,000 RMB.

5.2.5 New technique demonstration

The new technique must meet the need of Green-Food-Quality through making use of agricultural, physical and biological control. The new technique mainly focused on light-trap, pheromone-trap of diseases and pests and organic fertilizer treatment by marsh gas zymolysis. The whole act needed about 300,000 RMB to supply the demonstration of 10,000 acres.

6. Monitoring and evaluation of the system

According to the principle of IPM, strictly conquered the application of chemicals and kept the residue within the international standard. Ensured the total economic loss less than 5% in 60% mulberry orchards (about 50,000 acres). Extended the IPM technology in 41 villages and controlled the use of DDVP, Dipterex, Carbendazim and Topsin in serious damage orchard. Applied pesticides must be low-toxicity, non-pollution to environment and safe for human beings and other animals.

7. Achievement extention

7.1 Decrease chemical fertilizer

With the project applied, the decrease rate of chemical fertilizer consumption reached 80%, from 750 kg per hectare every year to 150kg. At the same time, the use of organic fertilizers not only reduced the cost, created economic benefits for local resident, but used most of waste, made the environment beautiful.

7.2 Decrease application of pesticide, cease high-toxicity pesticide application

With the project applied, the quantity of applied pesticides decreased greatly from more than 50kg per acre to 10kg, decrease rate reached 77%. No incident happened just because of using high-pesticides from then on.

7.3 Increase yield and improve quality

After the project implementation, the grape yield increased 5%, each fruit weight increased over 17% than before, and the color, luster, sweet degree of fruit also improved to some extent.

Plan of Grape IPM Sub-project

1. Current cultivation status in project area
Being a branch of the whole project, grape pests management area lied in central of Shaanxi province involved Yangling, Wugong, Fufeng and Qishan county. The area covered in mildness climates, moderation rainfall, sufficient sunlight and relatively long non-frost. The major cultivated crops in the area included wheat, corn, vegetable, grape, and so on. According to the ecological factors such as climates and soil, it was very suit to the growth of grape. According to the plan of the project, the new-built grape orchards expected to occupy 5000 hm², plant density is 50-60×150-200 cm. A majority of the new orchard were exposed with ground micro-drop irrigation, the rest part were protected with spray and micro-drop irrigation.

2. Status analysis of main pests

2.1 Consist of the mainly pest

2.1.1 Main diseases

*Sphaceloma ampelinum* de Bary  
*Colletotrichum gloeosporioides* (Penz.) Sacc.  
*Coniothyrium diplodiella* (Speg.) Sacc  
*Uncinula necator* (Schw.) Burr  
*Plasmopara viticola* (Berk. Et Curtis) Berl.et toni

2.1.2 Main insects and mites

*Lvcorma delicatula* White  
*Erythroneura apicalis* nawa  
*Parathrehe regalis* Butler  
*Oides decempunctata* Bilberg  
*Colomerus viti* (Pagenstecher)

2.2 Loss caused by diseases and pests

The grape orchard would be destroyed completely by diseases and pests if there were no management to it. This meant that natural control was hard to keep the diseases and pests under economic injury level (EIL). In order to ensure the yield and quality of grape, maintain the balance of natural ecosystem, insure the life quality and safety of producers and consumers, protect and improve the quality of environment and soil, the most suitable and economical control measures were needed. The loss caused by diseases and pests was closely related to the level of scientific management. Under the direction of experts and forecast system, the loss would be controlled less than 10%. Otherwise, the loss would be 15% to 30%.

2.3 Evaluation of control measures

The available control measures includes:

- Plant quarantine: To prevent the dangerous pests from spreading.
- Agriculture measure: To control diseases and pests with agricultural measures such as resistance to pests, rational density, controlling the growth of plants, inter-strip coverage, etc.
- Physical measure: To control diseases and pests with physical measures, such as cutting off the infected twigs, hunting the pests, etc.
Biological control: To control diseases and pests with natural enemy, antagonistic action of natural products, etc.

Chemical measure: To control diseases and pests with pesticides.

The control measures mentioned above are all applied in production at present. The plant quarantine executed by the custom and other quarantine departments mainly focused on inspection for importing seedlings and scions. The control measures of grape diseases and pests were still not been normative due to insufficient knowledge, ignorance for law, low awareness for environment protection and safe usage for pesticides. Farmers were preference to spray pesticides to eradicate the diseases and pests. Those would inevitably result in high residuals, resistances and recurrences (3R), and also bring un-safety to the production, high control cost estimated to 1140.00(RMB) per square hectare.

3. Integrated control measures to main diseases and pests

3.1 Principles

Based on the local situation of the project, the natural control measures were first of all. Only if the natural control measures were not able to keep the diseases and pests under economic injury level, the most suitable and economic chemical control measures would be considered. Our ultimate goal was to ensure the yield and quality of grape, to maintain or establish the balance of natural ecological system, to insure the life quality and safety of producers and consumers, to protect and improve the quality of environment and soil.

3.2 Control measures

The ideal control measure of diseases and pests should be integrated pests management (IPM). Agricultural measures assisted with chemical measures should be adopted mainly. In order to achieve most favorable effects in diseases and pests control, different agricultural, physical, biological, and chemical measures should be used at different growth period of grape.

A. Winter bud stage: Control objects included spot anthracnose (Sphaceloma ampelinum), downy mildew (Plasmopara viticola), powdery mildew (Uncinula necator) and anthracnose (Colletotrichum ampelinum). Control measures mainly included cleaning grape orchard, scraping old bark, spraying lime sulfur mixture to kill the infection source of overwintering pathogens and pests after cleaning the orchard.

B. Leaf extension stage: Control objects included white rot (Coniothyrium diplodiella), spot anthracnose (Sphaceloma ampelinum), downy mildew (Plasmopara viticola), powdery mildew (Uncinula necator), etc. Control measures mainly include pruning away the diseased or pests twig, spraying lime sulfur mixture or cuprofix to protect the fruit branch with dripping wash type.

C. Fruit setting stage: Control objects included downy mildew (Plasmopara viticola), spot anthracnose (Sphaceloma ampelinum), leafhopper (Erythroneura apicalis). Control measures included spraying Bordeaux mixture, Cuprofix, or Mancozeb, cleaning the diseased center.

D. Weak fruit bearing stage: Control objects included downy mildew (Plasmopara viticola), powdery mildew (Uncinula necator) and anthracnose (Colletotrichum ampelinum). Control measures included spraying Bordeaux mixture, Cuprofix or Daconil, cleaning the
infected twigs.

E. Grain Closing stage: Control objects included downy mildew (Plasmopara viticola), powdery mildew (Uncinula necator), anthracnose (Colletotrichum ampelinum), white rot (Coniothyrium diploidiella) and leafhopper (Erythroneura apicalis). Control measures mainly included spraying Oxadixyl mancozeb, Mancozeb, Dhiophante-methyl, and Bordeaux mixture cleaning the infected young fruits and twigs.

F. Color transformation stage: Control objects included powdery mildew (Uncinula necator), anthracnose (Colletotrichum ampelinum), and leafhopper (Erythroneura apicalis). Control measures mainly included spraying Oxadixyl mancozeb, Cuprofix, Carbendazim or Topsin, cleaning infected young fruits and twigs timely.

G. Ripening stage: Control objects included anthracnose (Colletotrichum ampelinum), powdery mildew (Uncinula necator) and white rot (Coniothyrium diploidiella). Control measures mainly included spraying Cuprofix, Carbendazim, Penncozeb or Benomyl, cleaning infected young fruits and twigs.

H. defoliating stage: Control objects included downy mildew (Plasmopara viticola) and powdery mildew (Uncinula necator). Control measures mainly included spraying bluestone solution, bordeaux mixture or lime sulfur mixture.

I. Winter bud stage: Control object was leafhopper (Erythroneura apicalis). Control measures mainly included cleaning grape orchard and scraping old bark during winter pruning, spraying lime sulfur mixture to kill the infection source of overwintering pathogens and pests after cleaning the orchard.

3.3 Reasonable use of chemical pesticides

Natural control measures were first of all in the control system of diseases and pests. Only if the natural control measures could not prevent the diseases and pests under economic injury level, the most suitable and economic chemical control measures would be considered.

3.3.1 Pesticides list

Bordeaux mixture, difenoconazole, cuprofix, mancozeb, daconil, chiophante-methyl, oxadixyl mancozeb, badistan, topsin, penncozeb, benomyl, bluestone solution, and lime sulfur mixture.

3.3.2 Dosage of pesticides

In the project area, pesticides had to be safety, high efficiency, low harmfulness, low residuals to human beings and livestock, and without pollution to the environment in order to meet the green food production requirements.

3.3.3 Management of pesticides

Throughout the whole production procedure of grape including prior-production, in-production and post-production, management of pesticides had to comply with the national rules or laws concerned, such as Norms for the Pesticides Use in the Vineyard.

3.3.4 Correct use of pesticides

(1) Maturing agents, herbicides and nitrate fertilizers were prohibited in the vineyard.
(2) Other pesticides, except Bordeaux mixture and lime sulfur mixture, were only used once per year.
(3) If pests occurred, only liuyangmucin EC with 10% concentration as well as lusetong were permitted to spray.
(4) Last pesticide spraying must be strictly executed with the safe interval of chemical
pesticide.

3.4 Control measures comparison before and after project

The project was aimed to establish a high quality and without pollution vineyard. The modern integrated control measures, standards as well as green food production requirements were prioritized considerations for the diseases and pests control. The dosage of chemical pesticides would be reduced by 50 to 60 % dramatically. The cost of control reduced from 1140 (RMB) per square hectare before the project application to 525 (RMB) per square hectare.

4. Construction content and implementation

4.1 Organization

Project steering group as well as its subordinate departments of technical consultancy group, fiscal department, project office and production base were established.

4.2 Forecast system construction

Consultancy group leaded by production base department was responsible for the investigation at regular time on the project sites. According to the analysis of experts, weather and geographic information, forecast results of grape diseases and pests would be published by the aidance of local county, township and village government.

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<th>Table 1 Investigation table of grape diseases and pests</th>
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<tr>
<td><strong>Pests</strong></td>
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The expense of observation sites construction and instrument need 160,000 (RMB).

4.3 Training of plant protection agents and demonstration household

First, consultancy (experts) group and production base department trained the plant protection agents at county and township levels about the management of vineyard, cultivation, control of diseases and pests as well as the correct use of pesticides. The training was planned to be runned 3 times per year for about 200 persons. Then, the production base department would organize the plant protection agents at county and township levels to undertake trainings to the demonstration households for 4 sessions per year embracing 1790 persons for the first year, 533 persons for the second year, 1700 persons for the third year and 5900 persons for the fourth year. The total number of trainees would reach up to 10,123 with 100 (RMB) per person and total cost to be 1,012,300 (RMB).

4.4 Demonstration and extension of new techniques

Through trainings at every levels, new techniques concerning vineyard management, cultivation and diseases and pests control, etc, new rules and new varieties would be extended to household. The extension area was estimated to be 3,500 square hectare costing about
5. Monitoring and evaluation

The monitoring and evaluation of the project mainly dealt with six aspects.

1) Whether the effect of diseases and pests control had met the requirement of *Norms for the Diseases and Pests Control of Vineyard*.

2) Whether the area suffered diseases and pests which the loss were no more than 5% had reached 4,000 square hectare after integrated management.

3) Whether the total area under integrated control of diseases and pests had reached 4,500 square hectare.

4) Whether the kind of chemical pesticides had gone beyond the list recommended by the project, the dosage of pesticide had overflowed the limits of control.

5) Whether the procedure of using pesticides was safe for human and livestock and minimum impact on the environment.

6) Whether the products had been examined and tested to meet the green food product requirements and criteria.