Desertification Control and Ecological Conservation Project in Ningxia, China

Pest Management Plan

Forestry Bureau of the

Ningxia Hui Autonomous Region

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Contents

1. Introduction

The **Ningxia Desertification Control and Ecological Conservation Project** (the Project) will be implemented in the Ningxia Hui Autonomous Region (hereafter Ningxia) including the counties/cities/districts of Pingluo in Shizuishan, Xingqing District in Yinchuan, Lingwu, Yanchi, Litong District in Wuzhong, Qingtongxia, and Zhongwei. The project areas cover parts of the Maowusu Desert, sections along the lower reaches of the Yellow River, and parts of the southern Tenger Desert in Ningxia. The project will control desertification and improve management of a total area of 76,000 hectares over a period of five years and include 19,900 hectares of sand dune stabilization through grass and shrub planting, 42,900 hectares of mountain closure and vegetation rehabilitation, 6,000 hectares of shrub planting, and 6,100 hectares of shelterbelt development along the Yellow River banks and farmland areas. The project includes investments in infrastructure, capacity building, and research and demonstration.

The project aims at improving ecological conditions and arid desert ecosystems in the project areas and at speeding up desertification control and ecological protection in Ningxia. The project will focus on sand dune stabilization, water and soil conservation improving the living environment and enhancing income opportunities of farmers in the project area. The project will contribute to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) and help conserve the biological gene bank. Implementation of the project is also expected to enhance agricultural and animal husbandry production, accelerate industrial restructure and alleviate poverty and support rural development. It will also include scientific research and new practices in desertification prevention and will make Ningxia a leading area in comprehensive desertification that can be extending to the whole country and even globally. The project is regarded as ecological and social-oriented community project, whose great economic benefit will be achieved through promotion of the whole social economy development under improvement of ecological environment.

As part of its implementation, the project will also address the issues of pest management control in the project areas, as well as the related overall policy and management issues. This Pest Management Plan (PMP) was prepared to guide the implementation and to ensure compliance with the **World Bank's Operational Policy (OP4.09) on "Pest Management".** Also, this PMP has been formulated in accordance with the "Regulations of Forest Pest and Disease Management" promulgated by the State Council. Based on laws and regulations to promote health by prevention and scientific control, this PMP promotes various prevention and control methods for the main pests and disease that may be encountered under the project. The plan highlights natural mediating roles and advocates biological and

environmental control of pest/diseases, and to reduce and minimize the use and dependence on pesticides.

2. Pest and Disease Control Management in Ningxia.

2.1 Occurrence of Pests and Diseases

Located in the middle and upper reaches of the Yellow River, Ningxia's natural conditions are characterized by frequent disasters of drought, sand storms and frost. In recent years, rainfall has decreased across the region, and persistent droughts have resulted in poor tree growth and decrease of tree vitality. Large areas of plantations of single species exist in Ningxia and are characterized by poor stability and low resistance to disasters, which often induces the outbreak of secondary pests, such as longhorn beetles, jewel beetles, and other diseases. On the other hand, winter temperatures have been rising in recent years and have likely reduced the mortality of pests and increased the rates of winter survival of insect population, increasing the risk for early spread and outbreak of pests.

Ningxia Autonomous Region is one of provinces (regions) in China with frequent occurrence of forest pests. In April 2003, the State Forestry Administration released for the first time the list of 233 kinds of risky forest pests, among which 79 species are present in Ningxia. The annual infested area is average 300,000 hectares which occupies 20% of forest area. In 2010, the occurrence area of Pests and Diseases is 336,000 hectares, the prevention area is 206,000 hectares, the pollution-free prevention area is 162,000 hectares, the cause disaster area is 13,300 hectares.

There has been a clear trend in the last decades in the number of forest pests with significant impacts as well as in the occurrence areas. In the mid-1980s, there were only 10 species that can cause serious damage to forest, including *Anoplophora glabripennis*, *A.nobilis*, *Quadraspidiotus gigas*, *Eulecanium kuwanai*, *Saperda populnea*, *Triozamagnisetosa*, *Ivela ochropoda*, *Apocheima cinerarius*, and *Melanophila decastigma*. Since 2003, 9 new species have been added, including: *Eucryp torrhynchus brandti*, *Cossus cossus*, *Eulecanium gigantean*, *Orgyia ericae*, *Holcocerus insularis*, *Holcocerus vicarious*, *Apocheima cinerarius* and *Quadraspidiotus perniciosus*.

In addition, eruptive forest pests become more and more serious. Infested areas of *Orgyia ericae* are 15600 ha in Yanchi County with average population density of 10 larvae/stem, which seriously threatens growth of *Ulmus pumila*, *Caragana intermedia* , *Hedysarum scoparium* and *Haloxylon ammodendron* in arid desert region. Area of Ash Holcocerus occurred 1334 ha, severely infested area was 200 ha in Pingluo. Also, pest/disease invasion has become more serious. *Eucryptorrhynchus brandti* has extended to 4000 ha covered Pingluo, Xingqing, Lingwu, Lee Tong

District, Qingtongxia, Yongning, Zhongwei of Ningxia since it was first discovered in 2002 in Yinchuan. It mainly attack trunk and root of *Ailanthus altissima* and lead to host death, which has become serious threat to *Ailanthus altissima* shelterbelts and affected the ecological benefits.

The main forest pests/diseases in Ningxia are presented in Tables 1 and 2. Table 3 presents the average standards of occurrence and the levels of damage in Ningxia.

Table 1. Areas of main tree species and type of pests in Ningxia

Tree species	**Area（ha）**	**Major Pests**
Poplar	*550*	*Valsa sordida, Melampsoralarici-populina, Cerura menciana, Clostera anachoreta, Leuoma candida, Apochemia cinerarius, Parathrene tabaniformis, Anoplophora glabripennis, Microtus fortis, Lepus tolai，Anoplophora nobilis*
Robinia pseudoacacia	*1500*	*Obolodiplosis robiniae, Zamacra excavata, Eulecanium kuwanai*
Ailanthus altissima	*500*	*Eucryp torrhynchus brandti, Eucryptorrhynchus chinensis*
Fraxinus chinensis	*500*	*Cossus cossus, Holcocerus vicarius, Agrilus planipennis*
Elaeagnus angustifolia	*1300*	*Trioza magnisetosa, Apochemia cinerarius*
Malus pumila	*95*	*Marssonina coronaria,Cytospora mandshurica, Malacosoma neustria testacea, Tetranychus cinnbarinus, Grapholitha inopinata, Cicadella viridis，Cydia pomonella*
Vitis vinifera	*42*	*Pseudocercospora vitis, Uncinula necator, Plasmopara uiticola*
Zizyphus jujuba	*98*	*Eulecanium gigantea, Contaria sp., Epitrimerus zizyphagus*
Shrublands	*25,095*	*Paleacrita vernata, Orgyia ericae, Omphisa plagialis,Euryoma neocargamae, Holcocerus arenicola, Pristophorodes florella, Agrilus zanthoxylumi, Rhombomys opimus, Lepus tolai，Aceria pallida*

Table 2. Forest pests and rates of damage in Ningxia

No.	Species	Investigation stage	Statistical unit	Attack (damage) density		
				Mild	Moderate	Severe
1	*Apocheima cinerarius*	Pupa	Head / plant	1-3	4-6	7 or above
		Larva	Bar / 50cm standard branch	2-4	5-8	9 or above
2	*Leuoma candida*	Larva	Bar / 50cm Standard branch	1-4	5-8	9 or above
3	*Stilprotia salicis*	Larva	Bar / 50cm Standard branch	1-4	5-8	9 or above
4	*Micromelalopha troglodyta*	Pupa	Head / plant	5-10	11-20	21 or above
		Larva	Bar / 50cm Standard branch	2-5	6-10	11 or above
5	*Clostera anachoreta*	Larva	Bar / 50cm Standard branch	7-10	11-15	16 or above
6	*Malacosoma neustria testacea*	Ovum	Grains / plant	50-100	101-200	201 or above
7	*Anoplophora glabripennis*	Larva	Attacking rate (%)	5-9	10-20	21 or above
8	*Saperda populnea*	Cecidium	A / m Standard branch	0.2-0.3	0.4-0.6	0.7 or above
9	*Parathrene tabaniformis*	Larva	Attacking rate (%)	2-5	6-15	16 or above
10	*Holcocerus hippophaecolus*	Larva	Attacking rate (%)	10-30	31-70	71 or above
11	*Cydia pomonella*	Larva	Attacking rate (%)	2-3	4-5	6 or above
12	*seed insects*	Seed	Damage rates of seed(%)	5～9	10～19	20 or above
13	*Eulecanium gigantea*	Branch	Damage rates of leaf (%)	5～10	11～35	36 or above
14	*Botryosphaeria dothidea;*	Trunk	Infection rate (%)	5～10	11～20	21 or above
15	*Valsa sordida*	Trunk	Infection rate (%)	5～10	11～20	21 or above
16	*Agrobacterium tumaciens*	Root	Infection rate (%))	3～5	6～10	11 or above
17	*Mycosphaerella dearnessii*		Infection rate (%))	5～20	21～40	41 or above
18	*Microtus fortis*	Trunk	Affected rate (%)	1～5	6～15	16 or above

Table 3. Standards of forest pest occurrence and levels of damage.

No.	Species		Standard of occurrence and damage
1	Forest quarantine pests		Forest pests occurrence and disaster including new discoveries in the region did not occur and new plantation in the region have occurred; Quarantine pests occurrence and disaster caused in the area which have occurred by the death of host plants. According to the following non-quarantine pests 2,3,4,6 indicators define the corresponding 10 percent reduction standard disaster which did not cause the death of host plants. The small areas that reach the standard of quarantine pests infested were included in the whole disaster area.
2	Foliar pest/disease	Evergreen	Leaf loss over 50%; Infected plant over 40; Death rate over 3%。
		Deciduous	Leaf loss over 60%; Infected plant over 50 Death rate over 3%.
3	Branch pest/disease		Affected rate over 30%; Death rate over 3%。
4	Seed pest/disease		Damage rates of seed over 20%.
5	Rat/rabbit		Host mortality of immature forest over 15%; Forest mortality rate over 3%; affected Forest rate over 30%.
6	Harmful plant		coverage rate over 60%； death rate over 3%
7	Forest non-quarantine pests		Death rate over 6%
8	Production forest, avenue trees and landscape forest non-quarantine pests		Leaf loss rate, infected plant rate, affected rate, damage rates of seed and coverage rate Were reduced by 10 percentage points above the corresponding and 1 percentage point reduction in mortality (the mortality of forest rat/rabbit was reduced by 5 percentage points in immature forest).

2.2 Current Pest Control Methods in Ningxia

The main methods of forest pest control in Ningxia are biological control and no-harm chemical control; however, in cases of large area of pure plantations such as poplar and orchards, chemical control is effective because of easy use and machine operations. Chemical insecticides have been widely used in the forest pests/diseases control particularly during large area outbreak due to its quick efficacy. Tables 4 and 5 show the amounts of pesticides used from 2005 to 2009 and the rates of current use of the main types.

Table 4. Use of Pesticides in the Participating Counties in Ningxia[1]

(Million hectares, metric tons)

Ningxia	Prefecture, County or District	Year	2005	2006	2007	2008	2009
		Control area	18	18.3	18.4	19.7	20.7
		Amount of pesticides	21.73	21.71	21.68	21.75	23.52
Project areas	Pingluo	Control area	2.3	2.6	2.5	2.5	2.7
		Amount of pesticides	2.5	2.7	2.53	2.52	2.8
	Xingqing	Control area	1.1	1.2	1.1	1.5	1.7
		Amount of pesticides	1.6	1.24	1.13	0.87	1.45
	Lingwu	Control area	2.2	2.1	2	2.2	2.3
		Amount of pesticides	2.3	2.2	2.3	1.9	2.1
	Yanchi	Control area	2.6	2.4	2.3	2.6	2.1
		Amount of pesticides	1.95	1.65	1.57	1.99	1.85
	Litong	Control area	2.1	2.2	2.3	2.3	2.5
		Amount of pesticides	2.2	2.6	2.6	2.5	2.7
	Qingtongxia	Control area	3	3.1	3.5	3.6	3.8
		Amount of pesticides	4.55	4.64	4.85	4.9	5.2
	Zhongwei	Control area	3.1	3	3.2	3.2	3.8
		Amount of pesticides	4.28	4.15	4.35	4.42	4.53

Table 5. Probability of Use of Different Pesticides in Ningxia

Species	Types of pesticides	Probability（%）	Amount kg/ha
Poplar	Pyrethroid	20	30-45ml/ ha
	Biopesticide	60	3.75-7.50 kg/ha
	Others	20	3.75-7.50 kg/ha
Fruit tree	Pyrethroid	50	30-45ml/ ha
	Biopesticide	30	3.75-7.50/ kg/ha
	Others	20	3.75-7.50 kg/ha
	Pyrethroid	20	30-45ml/ ha

[1] Data from the annual statistical report（2005-2009）of Ningxia forest pests/diseases control station

Shrub	Biopesticide	60	3.75-7.50 kg/ha
	Others	20	3.75-7.50 kg/ha
Rats	Biopesticide	50	3.75-7.50 kg/ha
	Others	10	3.75-7.50 kg/ha

In recent years, release of natural enemies has been advocated, such as longhorn beetles control in poplar plantations, pheromones for *Holcocerus artemisiae* and *Holcocerus hippophaecolus* control. However, chemical pesticides are still required to control other pests or defoliators in high-temperature season, such as *Apocheima cinerarius*, *Porthesia similis* and aphid.

By consulting relevant departments and on-site inquiry of local farmers, the preliminary conclusion is that the project area is complex with diverse forest types, where climatic conditions are suitable for *Clostera anachoreta*, *Leuoma candida*, *Apocheima cinerarius*, *Parathrene tabaniformis*, *Anoplophora nobilis*, *Microtus fortis*, scale, fruit borer, *Tetranychus cinnbarinus*, aphid, stem rot, ash holcocerus and other pest infestation. The forest pests/diseases control stations at all levels have sound system of monitoring and forecasting with mature technology that are in leading positions in the area.

The main issues related to the use of pesticides are the following:

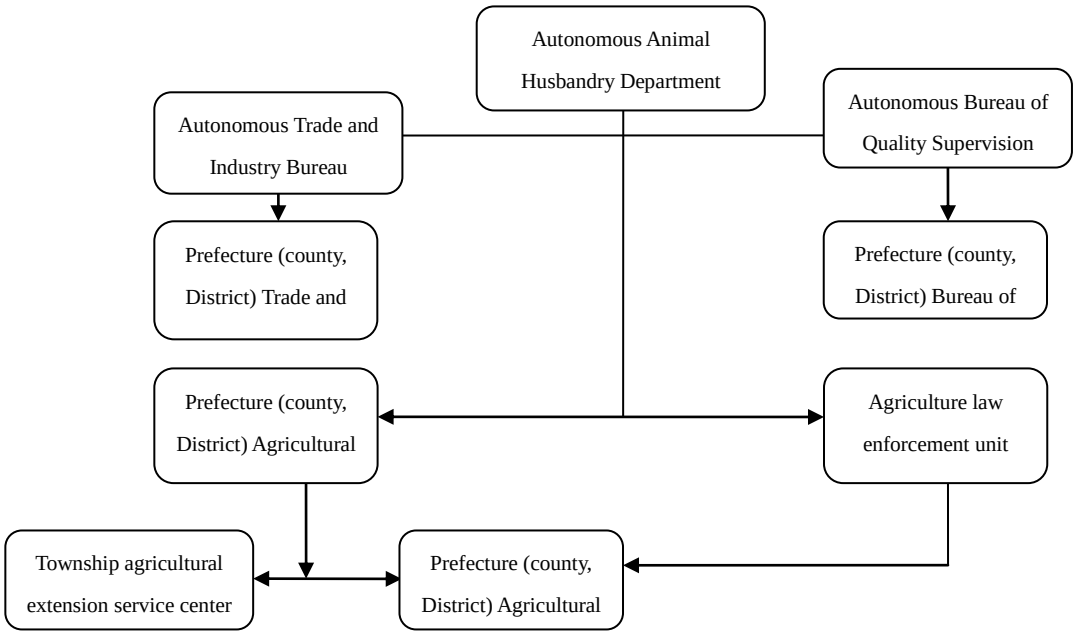
(a) High dependence on agricultural chemicals, especially in smaller areas of pure forest with high population, such as *Populus* spp., *Sophora* spp., and shrub seed parent trees;
(b) Excessive and unrestrained use of pesticides;
(c) Improper use and management of insecticides and other pesticides;
(d) Improper dealing with agricultural chemicals and package waste, causing potential pollution problems;
(e) Inadequate supervision of agricultural chemicals;
(f) Lack of awareness of safe use of pesticides and measures of personal security;
(g) Lack of awareness of the pests/diseases management by promotional institutions, dealers of agricultural chemicals and farmers;
(h) Forest pests monitoring mainly based upon traditional ground survey methods that are costly and time-consuming with low accuracy. Advanced monitoring techniques need to be widely extended to improve forecasting accuracy.

(i) Transfer of technology for prevention and monitoring, extension of demonstration effects and corresponding measures of organization of training campaigns are not sound. In addition, real time monitoring of regional forest pest is not achieved due to insufficient awareness of forest pest risks.

3. Institutional Organization and Regulatory Framework.

3.1 Pesticide regulatory framework in Ningxia

Figure 1: Regulatory Framework for Pesticides



Institutional Responsibilities

The Animal Husbandry Department is responsible for registration, supervision and management of pesticides in Ningxia, as well as for formulation or participation national or industry standards of pesticide residues, safe use of pesticides, and pesticide product quality.

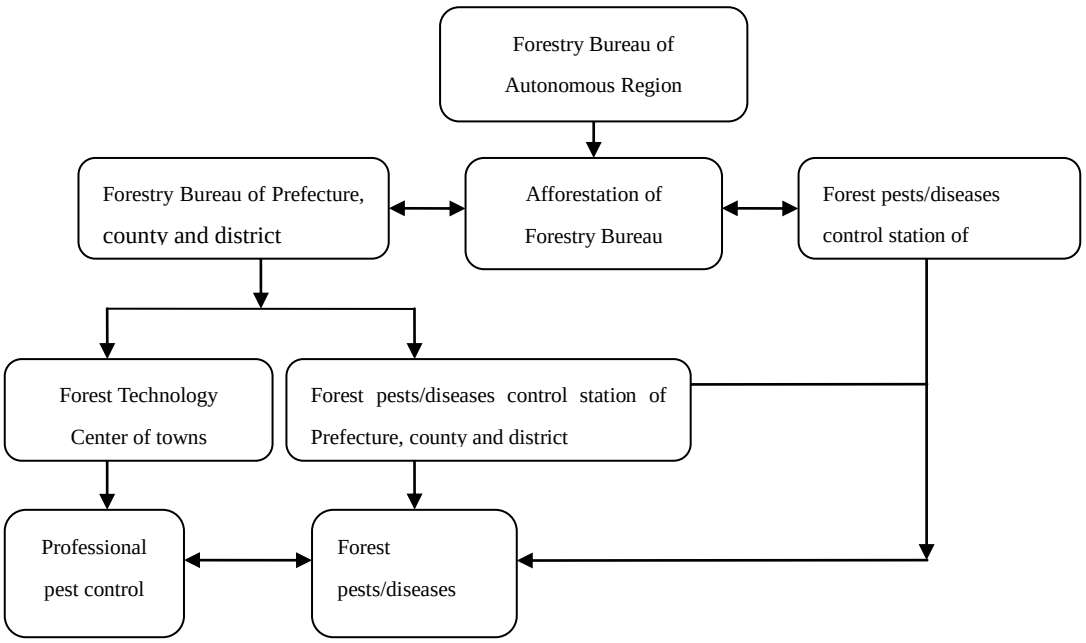
The Trade and Industry Bureau is responsible for the management of market sectors of pesticide.

The Bureau of Quality Supervision is responsible for the management of production processes of pesticides.

The Law Enforcement Agencies of Agriculture are responsible for the quality of agricultural chemicals for market supervision and management.

3.2 Administration of pests/diseases control

Figure 2: Main agencies involved in pest/disease control management



Institutional Responsibilities

The Forestry Bureau of the Ningxia Autonomous Region is in charge of forestry work in the region and responsible for forestry departments at all levels in the region and responsible for the organization of forest pests/diseases control.

The Forestation Department is responsible for organization and management and supervision and guidance of forest pests/diseases control.

Forest pests/diseases control station of the Region is in charge of carrying out related work of forest forestation office, and responsible for technology promotion.

Forestry Bureaus of Prefectures, counties and districts are responsible for area forestry affairs, organization, planning, coordination, supervision, decision-making and management system for forest pests/diseases control.

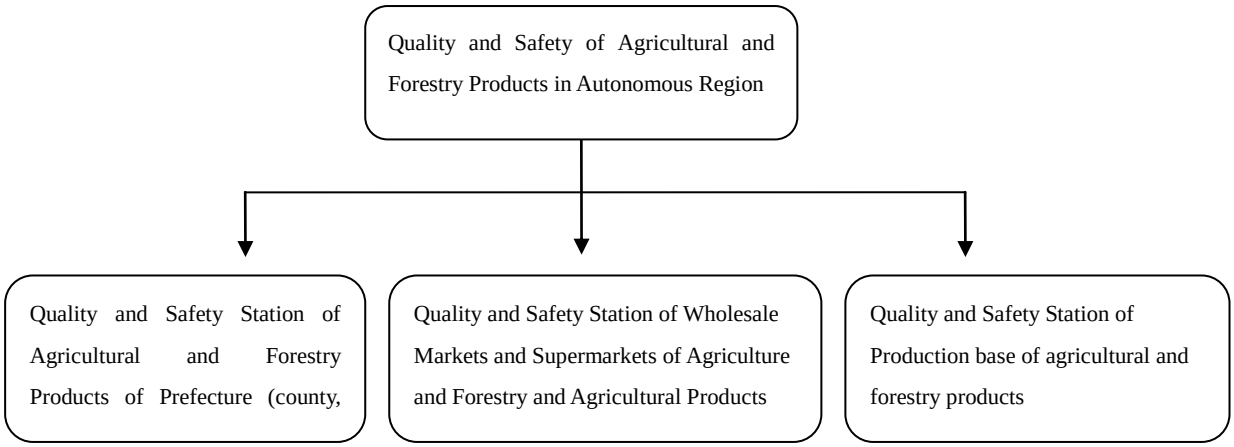
Forest pests/diseases control stations at the level of the prefecture, county and district are responsible for organization, management, guidance and supervision of pest control in the area; and assist in coordination of law enforcement and technical departments to carry out information dissemination, training and guidance of pesticide management and integrated pest management techniques.

Forest pests/diseases monitoring station is responsible for monitoring and investigation the occurrence of major pests/diseases in the area, regularly forecasting long-term, medium term and short-term prediction of forest pests/diseases.

Professional pest control team is responsible for timely treatment to the major pests/diseases in the area.

3.3 Organizational Responsibilities for Quality and Safety

Figure 3: Organizational Responsibilities for Quality and Safety



Institutional Responsibilities

Quality and Safety Station of Agricultural and Forestry Products of the Prefecture, county or district are responsible for supervision and management of quality and safety of local agricultural products.

Quality and Safety Station of Wholesale Markets and Supermarkets of Agriculture and Forestry and Agricultural Products are responsible for quality inspection of agricultural products access to the market (supermarkets).

Quality and Safety Station of Production base of agricultural and forestry products is responsible for quality inspection of agricultural products market exit in agricultural production base.

4. Framework for Implementation of Pest Management Control.

4.1 The basic principles

The public sector agencies of the Ningxia region are responsible for the implementation of forest resources protection and development, adhering to local management and performance of department duties. Epidemic should be restricted through prevention firstly, combining prevention with control to ensure security of hot region. Control efficacy could be achieved by insisting on reasonable regionalization and classification for application approaches. To enhance scientific control, protection and management should be according to law and standardizations.

The main basic principles of forest pest/disease control to be applied in the proposed Project include:

(a) Ban the use of high toxic pesticides by farmers and plantation operators;
(b) Reduce sales of toxic pesticides to forest farmers with inappropriate and incomplete label;
(c) Improve awareness, knowledge and capacity of integrated pest management (IPM);
(d) Improve awareness and management capability of safe use of chemicals;
(e) Introduce chemical quality standards that match sound and modern market demands;
(f) Improve the capacity-building of government in integrated pests/diseases management services; and
(g) Train the pesticide distributors and sellers on the knowledge of integrated pests/diseases management methods;

4.2 Improving pesticide use for forest pest control

Development and dissemination of modern preventive methods, using physical, biological and other non-chemical approaches, are very slow due to lack of technical personnel at all levels; thus, single-control methods applied for long periods of time results in low efficacy. In addition, non-chemical control in forest pest management is still occupying a small proportion further training in a wide range of publicity and promotion applications are needed. Therefore, the following aspects should be strengthened during the project implementation:

(a) Enhancing pest control efficacy through training of forest conservation experts and technical-extension worker at county and township levels;
(b) Training farmers with basic knowledge of pest identification and control according to local conditions and demands;
(c) Editing training materials, and supplementing with necessary audio-visual

equipment;

(d) Increasing support for research and demonstration of integrated precaution and control for main pests and diseases.

In order to implement these aspects, there are four main areas of action:

(1) Forestry administrative department of government at all levels must conduct technical trainings for the farmers or plantation operators in building plantations periodically every year according to the plant protection policy of "prevention primarily, comprehensive prevention and control". The contents include: promoting and extending safe and efficient pesticides, improving efficacy of pesticide application technology by forest workers and farmers, popularization the common sense, laws and regulations of forest pests and diseases, emergency response and prevention.

(2) Forestry administrative department at all levels should guide in using these pesticides safely and reasonably, strengthen the purchase of approved chemicals, monitor usage and service condition of chemical pesticides, particularly for those plantations built by project loans. According to occurrence of disease, insect, rodents in the project area, rotation use of pesticide should be carefully planned in order to reduce the resistance to chemicals and improve the control effect.

(3) Chemical vendors should ensure that all the pesticide labels must conform to prescribed and through auditing (II class or below) through training and monitoring, and to ensure that farmers has understood the method of IPM so that they can use pesticides properly according to anti-virus regulations of pesticides. Pesticides should be complied properly, applied reasonably. Waste should be disposed safely to prevent occurrence of environment pollution and poisoned by pesticides.

(4) To prevent pollution the agricultural products, use of pesticides shall comply with relevant state pesticide safety and rational use regulations, in accordance with the drugs dose, the application times, and safety intervals. Highly toxic pesticides shall not be used to control health pests, neither used on vegetables, fruits, tea and Chinese herbal medicine materials. Use of pesticides should be noted to protect the environment, beneficial organisms and rare species. Using pesticides to catch fish, shrimp, birds, and animal is prohibited.

4.3 Management of pesticides distribution and use.

Agriculture administrative department of the regional government assists agriculture administration department of the State to fulfill pesticide registration in the area, and is responsible for supervision and management of pesticides in the administrative area, according to “Regulation on Pesticide Management of the People's Republic of China”. The administrative department of prefecture, county

(district) is responsible for administration and supervision of pesticide in the administrative area. Departments of county or above the county level are responsible for the supervision and management of pesticides in their respective areas.

In the project areas, the autonomous region, as well as the municipal/ county/ district governments are responsible for the supervision and management of pesticides unified purchased by the project offices; to register in accordance with the "Regulation on Pesticide Management" and comply with the control conditions of safety and quality, environment and pollution.

Any pesticide vendors can operate only after obtaining a license, and can only sale registered pesticides of contract production. Highly toxic and toxic pesticides cannot be produced and sold for food production.

Pesticides residues in excess of pesticide residue standards (especially in vegetables, fruits and food crops) are banned in the market for sale.

Pesticide product packaging must be labeled or accompanied by instructions with content including name, manufactures, product lot number and registration number of pesticides or pesticide temporary registration number, license number or pesticide production approval document and active ingredient, content, weight, performance, toxicity, use, use of technology, methods, production date, expiry date and precautions; pesticide products should be subject to quality inspection and contain the product quality inspection certificate before delivery.

The main companies and units handling pesticide in Ningxia are:

(1) Supply and marketing cooperatives of agricultural production business units;
(2) Plant Protection Station;
(3) Soil and Fertilizer Station;
(4) Agriculture, forestry technology promotion agency;
(5) Forest pests/diseases control agency;
(6) Pesticide manufacturers;
(7) Units under the State Council and other central government agencies.

4.4 Measures of pesticides use

Measures of pesticide applications are determined on basis of pest occurrence, ecological points, site conditions and types of pesticides, see Table 6.

Table 6: Main measures for pesticide use.

No.	Measure	Content
1	Scientific application of pesticide	Accurately identify the types of pests/diseases and determine the control object according to morphology, symptoms, biology and ecology of pests/diseases, select the most cost-effective pesticide or formulations, which are safe, economic and effective.
2	Optimal pesticide application time	In the critical period of prevention and treatment, according to indicators of pesticide control, result in economic losses in the prior. Disease control must grasp to the principles of protection for the first, protective agent spraying before the disease occurrence, and therapeutic agents have to spray after the occurrence of disease. Pest control in young stages.
3	Rationale for pesticide application	In the case of ensure the control effect, in the range of effective concentration should make use of low concentrations of drugs for prevention, the number of control according to the degree of residual validity and the occurrence of pests/diseases to be. Cannot only effective control of pest damage, but also not produce injury and no pollution to the environment. According to the duration of pests/diseases, the amount of occurrence and the length of agents to determine the number of persistence spraying.
4	Appropriate method of pesticide application	Different formulations of pesticides should be used in different application methods. General emulsion and dissolve powder mainly by spray and splash water; powder mainly by spray; granule mainly by applicator or deep basal; strong absorption within the pharmaceutical mainly by powder, spray, splashed water and smear. Different action mechanism of pesticides, should take a different application methods to achieve maximum control effect for the purpose. According to the part of disease occurrence, insect activity patterns and different pesticide formulations to choose the different methods and time of application.
5	Safety of pesticide application	According to state pesticide regulations, strictly control the use of highly toxic pesticides, determined disable high-residue and the "three-induced effects of pesticides, earnestly implement the safe use of pesticides and crop safety procedures interval requirement, and make sure safe medication, to avoid environmental pollution, to prevent livestock poisoning.

5. Integrated Management Measures of Pest/Disease Control

5.1 Purpose of an Integrated Pest Management (IPM) System

The main goal of an Integrated Pest Management (IPM) system is to control the disease in a balanced level that is considered safe from the point of view of the ecosystem. According to the relationship between the environment and the pests, they include as well the physical, mechanical, and biological control methods, to make the best use of natural factors in forestry ecology, and forest pests will control the level of permissible economic victims. Only when the forest pest/disease have caused economic losses, could prevention and control. In other words, it allows a certain amount of bacteria or pests of crops, as long as the population is not enough to reach the level of economic harm. IPM has consistently paid attention to application of control technology, including resistant varieties, cultural practices, biological predators and chemicals, especially such as natural enemy of biological control factors to control forest pest/disease. It takes a prudent attitude to the use of chemical pesticides. IPM is an approach of system management, it attaches to the participation of growers, quality of growers, improvement of decision-making and the support of policy.

The concrete procedure of this method is to promote fitness cultivation, to protect natural enemies; to adhere to the field ecological analysis once every 2 weeks, to observe the growth of trees, pest/disease, natural enemy and population dynamics of other insects; to ecological analysis of forest take place to the traditional experience threshold; finally, to self-determination.

The Guideline of IPM change from pursuit of high-yield forestry to develop sustainable forestry as the purpose, improve net income, the rational use of limited resources and improve the quality of producers as the core. The implementation of the strategy can be divided into three stages, including prevention, monitoring and intervention. Prevention is emphasized as a prerequisite, with the main goal to reduce the use of chemicals pesticides and the pollution of the natural environment, to create an environment not conducive to pest and conducive to the growth and reproduction of beneficial organisms and crop.

The proposed Project supports Integrated Pest Management (IPM), involving primarily the following aspects:

(a) Pest management targeted at controlling the pests/disease at a tolerable level, rather than trying to eliminate pests/diseases;
(b) Make full use of the adjustment function of natural factors and use non-chemical measures to keep the rate of pests/diseases at a low level of

total;

(c) When make use of forest chemicals, it must choose the varieties and methods to minimize beneficial organisms, humans and ecological impacts.

5.2 Main Forest Pest Control Methods and Pesticide Types Proposed

5.2.1 Control methods

Pest management under this Project will contribute to reduce reliance on chemical pesticides through a series of integrated approaches, such as silvicultural, physical and biological methods, as well as chemical controls. These are:

(a) **Silvicultural measures and control methods.** Silvicultural and physical methods mean to control the severity of pests and diseases, including selection of tree species/clones resistant to pests/disease and healthy seedlings, planting adaptive trees, intercropping or mixed planting, reasonable and timely thinning, removal of infected plants, branches and leaves, closed forest, etc.

(b) **Biological control**s. These include: (i) Use of natural enemies, such as release larvae and eggs of parasitic beetle (*Bethylus* Latreille or *Dastarcus longulus*) to control *Anoplophora glabripennis, Coccinella septempunctata* and *Chrysopa perla* to control aphid; (ii) Use of viruses, bacteria, fungi and other microorganism to infect leaf-eating insects-*Apocheima cinerarius*, such as application of *Bacillus thuringiensis* and polyhedrosis viruses; and (iii) Use of metabolites of microorganism to control forest pests/diseases, such as Polyoxin, Validamycin and Abamectin for *Eulecanium gigantean* control. Attract *Mustelidae* spp., fox and owl for rats' control.

(c) **Physical control**s. These include: (i) Artificial capturing (such as removal of pest larva and egg, clip rats, etc); (ii) Separation (such as tied poison ropes or hanging plastic rings or tied plastic sheeting to prevent insect pest from climbing up on to the trees or hiding themselves under the trees); (iii) Trapping and killing. (use of leaves to trap and kill larvae of *Agrotis* spp. in nursery pest management, bound straw or wheat straw at trunk base together to trap larvae of *Hyphantria cunea* and *Lepidoptera* spp; (iv) Use of poisonous food bait, such as sweet and sour solution for control moths; black light trap, iodine tungsten lamp, fire and high-voltage power net are used for adult; use of yellow sheet-trapping to attract *Grapholitha molesta* adult.

(d) **Sex pheromones trapping**. The use of the synthetic sex pheromones added pesticide to control adults. The sex pheromone commercial products have been developed mainly for control of *Parathrene tabaniformis, Holcocerus artemisiae* and *Caragana* spp.

(e) **Chemical Pesticides methods.** The application of toxic chemical substances (chemical pesticides) to eliminate pests/diseases. Chemical methods have advantages of high efficiency, quick in effect and no geographical and

seasonal restrictions; while the improper use of chemical pesticides can cause insect resistance, plant injury and poisoning of man and beast.

(f) **Chemical Non-pesticide methods.** Use of Matrine agents for control of *Tetranychus cinnbarinus* and *Apocheima cinerarius* on apple. Application of lime on trunk to prevent disease from infection, pest egging and physiological diseases. Combining with sweet and sour solution, use of black light trap for control of pest (*Noctuidae* spp.) of apple, pear and peach; Spray of Bordeaux mixture for control of diseases.

5.2.2 Pesticide types

The main types of pesticides to be used include:

(a) Organic pesticides, also called organic synthetic pesticides, made of organic synthesis materials by artificial synthetic, including benzene, alcohol, fatty acids and organic amines.

(b) Inorganic pesticide, also called mineral pesticide, made of mineral raw materials. The main components are arsenic, fluorine and sulfur, such as sulfur, Bordeaux mixture, etc.

(c) Botanical pesticide is made of plant ingredients. Its main active ingredient is the alkaloid (such as the nicotine in tobacco and stemonine in radix stemonae, etc.) and glycosides. These substances change into toxic substances in insect body that can kill the insect. It is harmless or small virulence to humans and animals and no injury to plants; therefore it is now widely advocated and applied in forest pests/diseases control with its safe trait.

(d) Microbial pesticide is made of microorganisms or metabolite of microorganism. The active ingredient is spores or antibiotics, such as *Beauveria bassiana* and kasugamycin, etc. Microbial pesticide is characterized by its safe, harmless to humans and animals, and pests will not produce resistance. Main examples are: (i) *Beauveria bassiana*, a fungal species that is known as the stiff white worms because of its white zombie-like when insect was infected and which is widely used in production; and (ii) *Bacillus thuringiensis*, a spectrum bacteria, it is now used for control of hundreds of pest species, particularly *Lepidoptera* spp., such as *Apocheima cinerarius* and *Malacosoma neustria testacea*, which is safe to human, animal, and natural enemies, and no injury to plants.

(e) Diflubenzuron insecticides: Insecticide is efficient for control of larvae of *Lepidoptera* spp., particularly the 3 instars or younger. It has the advantages of long persistence and no harm to natural enemies.

(f) Insect pheromones are released by adult, mainly used to attract insects to mate with the same species of opposite sex. In terms of the principle, it can set traps with pheromone in the forest to kill pests, such as

pheromones of *Holcocerus hippophaecolus*, *Cossus cossus* and ash holcocerus.

5.2.3 General restrictions in the use of pesticides

The State Council of the People's Republic of China has promulgated the "Regulation on Pesticide Management" and China's Ministry of Agriculture has promulgated the "Standard on Safe Use of Pesticides". In order to safe and effective use of pesticides, the file provides:

(a) Pesticides which are applicable for pests/disease control in agricultural production (very dangerous and major toxicity is disabling);
(b) Pesticides with high efficiency, low toxic and low residue are recommended when pesticides is the only effective control mean;
(c) Agricultural products with pesticide residues over the set standards are not allowed to access into the market;
(d) Safe application methods for pesticides: range of use of pesticides, methods of safe and rational of use and concentration (or dose), frequency and security interval of pesticides;
(e) The Regulation of Pesticide Management encourages the use of pesticides which are highly effective, low toxic and with low residue (HLL), and defines the standards for pesticides marketing. Use of some pesticides is forbidden by the "Standards for Safe Use of Pesticide" and the" Regulation on Pesticide Management".

5.2.4 Banned/restricted pesticides

Banned Pesticides. The Chinese government banned the use of pesticides (23 kinds) including: BHC, DDT, toxaphene, DBCP, chlordimeform, dibromoethane, nitrofen, aldrin, dieldrin, mercury preparations, arsenic, lead type, BIS-A-TDA, Fluoroacetamide, glyftor, tetramine, sodium fluoroacetate, silatrane, methamidophos, methyl parathion, parathion, monocrotophos, phosphamidon.

Restricted pesticides. The forbidden and restricted pesticides used on vegetables, fruit trees and herbal materials (total 19 types) include: (i) use of omethoate on cabbage; (ii) use of dicofol and fenvalerate on tea; (iii) use of hydrazide (B9) on peanut; (iv) use of tert-parathion on sugar cane; (v) use of phorate, isofenphos-methyl, terbufos, posfolan-methy, sulfotep, systox, carbofuran, aldicarb, phosphorus, posfolan, coumaphos, dyfonate, isazofos and fenamiphos on vegetables, fruit trees and herbal materials.

5.3 Principles for use of chemical methods

Chemical control should follow the following principles:

(a) Use of cost-effective non-pesticide chemicals, such as Ca(OH)2;
(b) Use of high efficiency, low toxicity and low residue pesticides (category III of WHO);
(c) Extension of the application technologies that have low toxicity to humans, animals and plants and with reduction of pollution to environment. It includes the following contents:
- Use of low toxicity and low residue pesticides;
- To ensure control efficacy, timely use of high efficiency and low concentrations of pesticides to control various pests is recommended in central area and at larval stages of insects. Pesticides which have lethal effect on the natural enemies will be prohibited to increase natural enemies when the late of pest rampant occurrence
- Ensure safe interval time of using pesticides;
- A single pesticide should not be continuously used for a long period of time;
- Alternative use of pesticides is strongly recommended.

(d) Use of safe spraying devices (such as back-type sprayers, the best nozzle size) to enhance the efficiency and effectiveness of the pesticides;
(e) Strengthen the publicity and education on safe and proper use of pesticides, extend safe application of pesticides through training, follow strictly regulations on pesticide application, and pay attention to safety;
(f) Safe storage of chemicals (e.g. keeping pesticides away from food and children);
(g) The used chemical containers and the application equipment are forbidden to be cleaned in the natural water systems. Safe treatment and safe location should be chosen, such as deep burial

6. Pest Management under the Project

6.1 Objectives

The objectives of IPM are: (1) to control pest, disease and rodent; (2) to use chemical pesticides reasonably and rationally, and to reduce pesticide residues effectively.

Therefore, the goals are:

(a) Reach a level of efficacy rate of control of pest, disease and rodent above 85%; while the quarantine rate of origin site should be 100%;
(b) The losses caused by pest, disease and rodent should be limited to less than 5%;
(c) Biological control rate of leaf-eating pests should be 80%, non-pollution prevention and control rate to reach 100%;
(d) Must eliminate any poisoning incidents due to poor management and storage or disposal of waste pesticides;
(e) Highly toxic pesticides (category I of WHO) and pathogenic pesticides should be prohibited;
(f) Agricultural pesticide residues (assuming that allows to inter-cropping, i.e. agroforest system) can't exceed the WHO and national standards;
(g) Maintain the biodiversity of plantation.

6.2 Main Approach

Principles. The fundamental principle of this project is the biological diversity conservation and forest ecosystem stability. Self-regulation capability of the system will be improved through starting from completing structure and ecosystems functions in order to strengthen system's own immune function against pest, disease and rodent. Effective dynamic monitoring, timely and accurate forecasting of forest pests and diseases outbreak in the project area will be conducted. Social and economic benefits will be achieved through timely and appropriate measures (forestry, physical and biological control measures, chemical) to control the pest/disease and rodent population density within the range of habitat in the project area.

Measures. They include the following:

- Plant quarantine: Plant quarantine should be strengthened in the afforestation areas. The systematic quarantine of the plant origins should be strictly followed and effective hazard elimination should be secured when transportation. Introduction of seeds, scions or seedlings from the pest/disease

affected areas is prohibited. For purpose of standardizing the production and marketing of the seedlings, registration of forest seedlings is adopted and strictly followed which includes "tree seedling production license", "tree seedling quality certificate" and "tree seedling production management license". Strengthen quarantine on imported wood and wood products. Once the quarantine target is discovered, spot elimination is carried out, so as to prevent them from spreading into the project areas.

- Insect forecasting: The county-level forest pest control station shall provide timely pest messages to the forest owners, including control objectives, measures, technologies and pesticide types, etc. This information shall be provided to foresters 7-10 days before they carry out the control measures. The county-level forest pest control station shall ensure that implement the control measures in the forest and the near county simultaneously; it can improve the control effect.
- Forestry measures:
    - Selection of tree species which are pests/disease resistant, to raise forests resistance capacity;
    - intercropping or mixed planting: properly intercropping trees with crops to reduce hazards
    - Production of sturdy seedlings: Sterilization the seeds and soil, this refers to culling unhealthy seedlings and cultivating high-quality and strong seedlings;
    - Planting adaptive trees: Selection of tree species which are adaptable to the local site conditions;
    - Select proper planting season;
    - Rational use of fertilizers is referring to apply adequate amount of organic manure, with limited application of nitrogen and phosphorus fertilizers and increased utilization of calcium fertilizer;
    - Slashing of forest land: tilling the soil to expose pests to the extreme weather conditions, removal of infected plants, branches and leaves;
    - Reasonable thinning: promoting tree growth and improving the forest pest resistance capacity of the forests by reasonable thinning.
- Physical methods
    - Capturing pests: The black light trap is used for moths, beetles and orthoptera pests and sweet. Sour solution is used for some moths. The method also includes artificial capturing, removal of coleoptera adults and lepidoptera larvae, pupae and egg masses; artificial clearing of overwintering pupae in the earth; prunning the plant with pest/disease leaves, etc.
    - Separation pests: This is to use the habits of some pest to prevent damage from happening, such as hanging on the trunk the plastic rings to prevent some pest which have the habit of overwintering under the trees or damaging the trees at night by climbing up on to the trees and hiding themselves under the trees during day time.

- Biological methods

Use of biological pesticides, such as Bt, Polynacfin, NPV, etc; natural enemies such as the genus ***Bethylus* Latreille**, ***Parasiotid Chouioia cunea,*** wood peckers etc.

Use of attractant traps to kill pests, such as Artemisia Holcocerus, Salixwood moth, elm wood moth, aromatic Holcocerus;

- Chemical methods

Pest and disease control efficiency can be improved combining pesticides with high-quality, low toxicity or non-toxic to humans and livestock, and safe to trees crops. Use of the most economical and efficient method combining pesticides with other controls to improve the pest and disease control efficiency. This measure must use pesticides which have high-quality, low toxicity or non-toxic to humans and livestock, and safe to trees crops.

The main measures of improving the control effect of pesticides include: prohibiting the use of highly toxic or high toxicity and high residue of pesticides, and use of different pesticides to control different pests and use of broad-spectrum pesticides is forbidden; according to pest occurrence, the frequency and the amount of pesticide spraying shall be appropriate; pesticides shall be used appropriate mixed or interactive; strictly implementation of safety harvest interval time(GB4285-89);
the main problems of forestry, physical, biological and chemical control measures are shown in Table 7. Ningxia desertification control and ecological protection measures for the project integrated pest management plan in Appendix 2.

Table 7: Main issues with the proposed control measures

Control Methods	Tree species	Issues and Limitations
Silvicultural	Poplar, willow, ash, Ailanthus altissima, Robinia pseudoacacia, Elaeagnus,apples, grapes, dates, Caragana, flower sticks, wolfberry, Salix, Hedysorm leaveMaxim	There are some limitations in forestry production. Other methods must be taken in case of major outbreak. It requires high implement technical requirements and high cost.
Physical		As a complementary approach, it has limitations that they are only effective to some kinds of pests. Other measures must be taken during outbreak.
Biological		It requires technical requirements and costs high. The control effect is lag effect. Other measures are needed when outbreak.
Chemical Pesticides		It will pollute environment, affect human and animal health. Pests/disease prone to develop resistance, harmful to beneficial organisms, destructing ecological balance. Control costs in a substantial upswing.

6.3 Recommended Pesticides for Use in the Project

During implementation of the project, the use of pesticides shall combine with silvicultural, physical and biological measures. The principle for use of pesticides should be economic, safe and effective.

Methods to control pests should be biological agents, pharmaceutical plant, bionic agents and non-pollution chemicals. According to the IPM approach mentioned above, the World Bank pesticide procurement guidelines (Operational Policy 4.09) and the principles of integrated pests/disease control, the project recommends the following pesticides with appropriate usage (see Table 8).

The other pest/disease control methods of the main tree species were summarized in Table 5, and described in detail in Appendix 2.

Each pest/disease control methods are strongly dependence on pesticides control, includes the main factor of IPM.

Non-chemical control measures are mainly silvicultural, physical and biological measures. Biological control measures will be introduced into the project and will be extended by Ningxia Forest Pest Control and Quarantine Station, which had been tested by IPM technology and had been proved to be effective.

A systematic control approach is formed coordinate with forestry, physical, biological and chemical control methods and other effective means according to local conditions, to give full advantages of various control measures and to complement each other. An integrated IPM technology will form to guide forest pest and disease control in the whole region through the project implementations.

Table 8: Summary of recommended pesticides to be used under the Project

Forest Species	Major Pest	Recommended Pesticides		
		Biological Pesticides	**Chemical Pesticides PRC Classification (WHO classification are in the brackets ）**	
			Low toxicity	**Moderately toxic**
Protection Forest Poplar Willow White wax Ailanto Locust Elaeagnus	*Clostera anachoreta* Fabricus; *Micromelalopha troglodyta* (Graeser)*;* *Stilpnotia salisis* Linnaeus，*Parathene tabaniformi;* Locust leaf gall midge, Sang fold looper, SJ ball Kuwana, Ailanthus altissima orbital groove like, aromatic wood moth, elm codling moth, ashcodling moth, emerald ash borer, Elaeagnus sucker, Elaeagnus inchworm, etc.	Matrine; Printing the Cambodia n Prime; Nicotine; Bt SNPV	Diflubenzuron (U) Diflubenzuron (U) Kill Chrysopa urinary (U) Imidacloprid (U) Fenoxycarb (U) Sen get insurance (U) Thiacloprid (U)	Green Wei Lei (II) Abamectin (II) Deltamethrin (II) Fenvalerate (II)
Economic Forest Apple Grape Dates Wolfberry	Apple leaf spot, apple rot, neustria, apple spider mite, apple fruit moth,Folium cicadas, big ball Kuwana jujube, jujube weevil, dates looper, jujubefruit shrink disease, date leaf spot, rust date , Aphids, fleas, gall mite, Red gall midges, negative mud worm	Matrine; Printing the Cambodia n Prime; Nicotine; Bt SNPV	Diflubenzuron (U) Diflubenzuron (U) Kill Chrysopa urinary (U) Imidacloprid (U) Fenoxycarb (U) Sen get insurance (U) Thiacloprid (U)	Deltamethrin (II)
Grass fencing Caragana Swab Hedysorm leaveMaxim Salix Artemisia	Bruchid Caragana, Caragana pod borer, looper Caragana, Caragana seedwasps, moths old gray leaf spot, Salix Holcocerus, Holcocerus Artemisia,Artemisia Gidding insects	Matrine; Printing the Cambodia n Prime; Nicotine; Bt SNPV	Diflubenzuron (U) Diflubenzuron (U) Kill Chrysopa urinary (U) Imidacloprid (U) Fenoxycarb (U) Sen get insurance (U) Thiacloprid (U)	Green Wei Lei (II) Abamectin (II) Deltamethrin (II) Fenvalerate (II)
Others	canker break;*Botryosphaeria dothidea*; Grape leaf spot; grape powdery mildew; grape downy mildew		Chlorothalonil (U) Triadimefon (III) Chlorothalonil (III) Triadimefon (III) Thiophanate-methyl (U) Dimetachlone (III)	

6.4 Recommended Handling of Chemicals under the Project.

6.4.1 Environmental Risks.

The main environmental risks of pesticides using in the project include that:

- Pesticide residues potentially reduce number of aquatic organisms (such as fish and aquatic insects) due to deterioration of water quality;
- Overflow leakage of insecticides or chemicals near the drinking water will lead to contaminate water supplies;
- The non-target species may be impacted due to the use of highly toxic pesticides(especially bees, birds, livestock, natural enemies);
- Resistance caused of pest and rodent increases after long-term excessive use of certain pesticides;
- Contamination soil quality by soil residues.

The measures of mitigation the above risks include:

- The potential impact of particular chemicals on environment will be acknowledged to village leaders, farmers, plantation operators and vendor, and alternative spraying methods and equipment will be recommended;
- Pesticides will be sprayed under cooperation among township leaders, plantation managers and their staff to monitor and to ensure that no spraying of toxic pesticides near water resources;
- Project requires to purchase the audited and safety spraying equipment;
- Select low toxicity pesticides with low residue half-life;
- Use of low residue half-life pesticides;
- Improving and promoting biological control measures to reduce use of chemical pesticides;
- Minimizing the use of chemical pesticides in the treasure or endangered species area (such as wetlands or in the vicinity of nature reserves);
- Combining range of pest control methods (silvicultural, physical, biological, and chemical means) to ensure that pest resistance will not increase.

6.4.2 Occupational / Health Risks

The major occupational/health risks of pesticides application include:

- physical discomfort will occur by inhalation of pesticides when compounding concentration and spraying without wearing protective masks;
- skin burns caused by overflow leakage without wearing protective

clothing;

- drinking water source was polluted when pesticides were sprayed close to the location of drinking water source or chemical overflow leakage near drinking water sources.

The main measures of mitigation the above risks include:

- training and display will be conducted to village leaders, farmers (female and male), plantation operators and vendors, mainly include: impacts of certain pesticides on occupational/health; proposed operation and spraying methods; approved equipments and their usages(such as sprayers, nozzle size, etc.); wearing safety clothing (long sleeves, masks, hats, gloves, trousers and footwear); spraying in the case of static (no wind); the chemicals stored in locked cabinets which can't be easy accessed by children; chemicals and their packaging waste handled safely by deep buried or burned;
- monitoring the implementation of these measures, if failure to execute the measures, the further training is needed.

6.4.3 Management measures to reduce risk generated by pesticide use

A project technical advisory group will set up an IPM committee. The committee will check the chemicals use regularly in the project area to ensure that the chemicals in the project used by beneficiaries. It includes:

- The production, packaging, labeling, transportation, storage, application and handling are in line with international standards and governmental policies;
- To avoid the preparation of pesticides are the World Health Organization classes IA and IB products, or active ingredients concentration of category II pesticides is exceeding the World Health Organization standards.

Any pesticide purchased by beneficiaries of the project must be audited by the following reviews:

- Type and severity of hazards lead by the methods and users;
- Reliability of the method used and the user's application level;
- According to the "recommended by the pesticide risk classification and classification procedures" (Geneva: WHO2004-05) and the latest information on the classification, audit the level and the preparation of pesticides.
- Minimal damage to human health;
- Effective to control the target;
- Minimally impact on non-target species and natural environment. The selection of pesticide using method, time and frequency must have minimal damage to natural enemies. Pesticides for public health programs must be proven to be safe to local residents, species and application users.

7. Institutional Capacity for Pest/Disease Management in Ningxia

7.1 Policy Issues

The policy measures to be implemented under the project include:

(a) Reduce the proportion of use of current chemical pesticides;
(b) Recommend the government to pass legislations and enforcement to strengthen pesticide management;
(c) Implement regulations on the use of pesticides;
(d) prohibit the use of pesticides with high toxicity and high residue and those without a license;
(e) Prohibit using pesticides belonging to Class I in the World Health Organization (WHO) requirements and replace by low toxicity pesticides.

7.2 Main Provisions

The Project would ensure compliance with the following main established provisions:

(a) FAO criterion for pesticide regulations, distribution and usage (or corresponding to Chinese standards);
(b) FAO specification for pesticide packaging and storage (or corresponding to Chinese standard);
(c) FAO specifications for pesticides packaging labels (or corresponding to Chinese standard);
(d) FAO specifications for pesticides remaining on-site and pesticide containers disposition (or corresponding to Chinese standard);
(e) Comply with pesticides emission standards of the State Environmental Protection Administration (SEPA);
(f) Encourage county and town (township) governments to discuss and establish models, support and promote IPM methods. To show the benefits derived from using this method, particularly its long-term benefits;
(g) Financing under the Project should be strictly limited to the list of recommended and registered pesticides in the project;
(h) Request the Ningxia autonomous region government to financially support for pests and diseases management project.

7.3 Policy Awareness

The awareness of the established policies for pest management would be significantly strengthened under the Project, giving emphasis to the following aspects:

①the amount and frequency of daily use of chemical pesticides reduced;

②pesticides without registration are prohibited;

③highly toxic pesticides (category I of WTO) are forbidden or replaced by low-toxicity pesticides.

④rules and regulations of Food and Agriculture Organization (FAO) (or the Chinese equivalent regulations) on restrictions, distribution and application of pesticides are fully implemented;

⑤Implementing of FAO guidelines on pesticides packaging and storage (or the Chinese equivalent regulations);

⑥Implementing of FAO guidelines on pesticide labeling and application (or the Chinese equivalent regulations);

⑦ ~~Implementing of FAO guidelines on disposal of waste pesticide and packaging (or the Chinese equivalent regulations);~~

⑧China Ningxia pest/disease management project plan;

In addition, counties and township governments are encouraged to promote and support the IPM method through seminars and implementations of the project (especially the long-term benefits).

7.4 Strengthening capacity for forest protection

Basic level capacity of forest protection would be strengthened through the implementation of the project, by:

- Training county and municipal forest protection specialists, township extension workers and technology demonstration households;
- During the project implementations, the forest protection staff are familiar with and master the IPM approach, farmers have some knowledge about the IPM methods;
- Through implementing the project, the connection of forest conservation among counties, towns, and villages should been strength, which can further promote implementing the IPM plan.

In order to increase the implementation capacity, the Project will adopt the following methods:

(a) The forest protection staff and forest protection specialists of prefecture and county (district) need to strength training to agricultural extension workers and farmers from county, township;

(b) Develop a monitoring plan to assess pest/disease management and to implement IPM techniques;

(c) Project Office appoints a fulltime staff to supervise the implementation of the pest/disease control measures;

(d) In order to play a role in IPM, the forest pest/disease control station of this project and domestic IPM consultancy experts will be financially supported by Ningxia autonomous region government in the project;

(e) Project Office will cooperate with the Ningxia autonomous region of forest

pest/disease control and quarantine station and other pest management research institutions units such as the Beijing Forestry University, Ningxia Agriculture and Forestry Academy, to broadening the knowledge of pest/disease control and improve capacity of IPM;

(f) Strengthen the pest/disease control technologies and experiences exchange among the towns and counties in order to share fruit;

(g) Leaders of counties, township and villages are encouraged and supported to apply of safe pest/disease control methods and IPM techniques.

In addition, the following are the proposals about strengthening capacity building and human resource development of pest/disease management:

- The control method of new pests can be obtained by consulting plant protection experts and technicians;
- Regular training of agricultural technology extension staff from county, town, and village will be conducted to ensure effective enforcement of pesticide regulations;
- Agricultural technicians use the farmer field school (FFS) approach to teach farmers the new pest control methods, or invite experts to participate the training if necessary;
- Compile the practical training materials, supplemented with necessary audio-visual equipments;

The objective of training forestry workers and other relevant staff is to enhance their ability of controlling the pest/disease safely and effectively (described in project implementation plan). The training includes pest identification, appropriate management decisions and application of appropriate control measures. A 4-day training course will be held in each quarter to each forest farmer with relevant references (50 farmers per day).

Training curricula. The main aspects to be covered in the training events are:

- Pest/disease features;
- The losses caused by different insects , diseases and rodent;
- The natural enemies of main pests;
- The methods of pest and disease field investigation and sampling;
- The control scope and intensity (the threshold of pests and diseases);
- Control measures, including the IPM techniques of forestation, physical, biological and chemical control methods;
- Secure storage of agricultural chemicals and disposal packaging waste of agricultural chemicals;
- The method of using chemical pesticides and the standard use of protective clothing.

Optional Trainer Sources. The following are the main agencies and agents that

would be considered as sources of knowledge to organize the required training events:

- Main national and provincial institutions which can offer training (Ningxia University Agriculture College, Academy of Agriculture Sciences, Academy of Forestry Sciences, Ningxia ecological engineering schools);
- Ningxia forest pest control and quarantine station;
- Food and Agriculture Organization (FAO);
- Bilateral donation projects, such as the forestation projects by ecological protection measures;
- Pesticide vendors;
- Promotion service units of district, county and township which had been trained;
- Large forest farms, large horticultural orchard and cultivation demonstration base of apples, grape.

8. Monitoring of Pest Management Aspects under the Project

8.1 General view

During project implementation, field monitoring should be conducted with the following work:

a) Use of IPM management technologies by foresters;

b) The usage of pesticides;

c) Detailed monitoring indexes (see Annex 3).

The staff of the county PMO and the forest pest management competent agencies is responsible for the monitoring activities. Monitoring could be demonstrated in one district within project area or in a non-timber forest plantation. Project office assists forest station of the relevant county (district) to establish appropriate monitoring system, sampling procedure and to provide training courses of the application and analysis of the monitoring system.

8.2 Main contents of pest management monitoring

The following work need to be field monitored during normal supervision by the Project staff (see Annex 3):

(a) Pesticide registration (documents);

(b) Potential use of class I pesticides;

(c) The implementation of relevant policies;

(d) Field monitoring program of the implementation and support measures for analysis results.

Monitoring should be conducted in the project cities, countries and districts by professional and technical personnel of the Agro-Technology Extension and Service Center (D/C ATESC) assisted by local personnel of local prefecture, country and district-level Forest Protection Departments.

Figure 8.2: Pest Management Monitoring

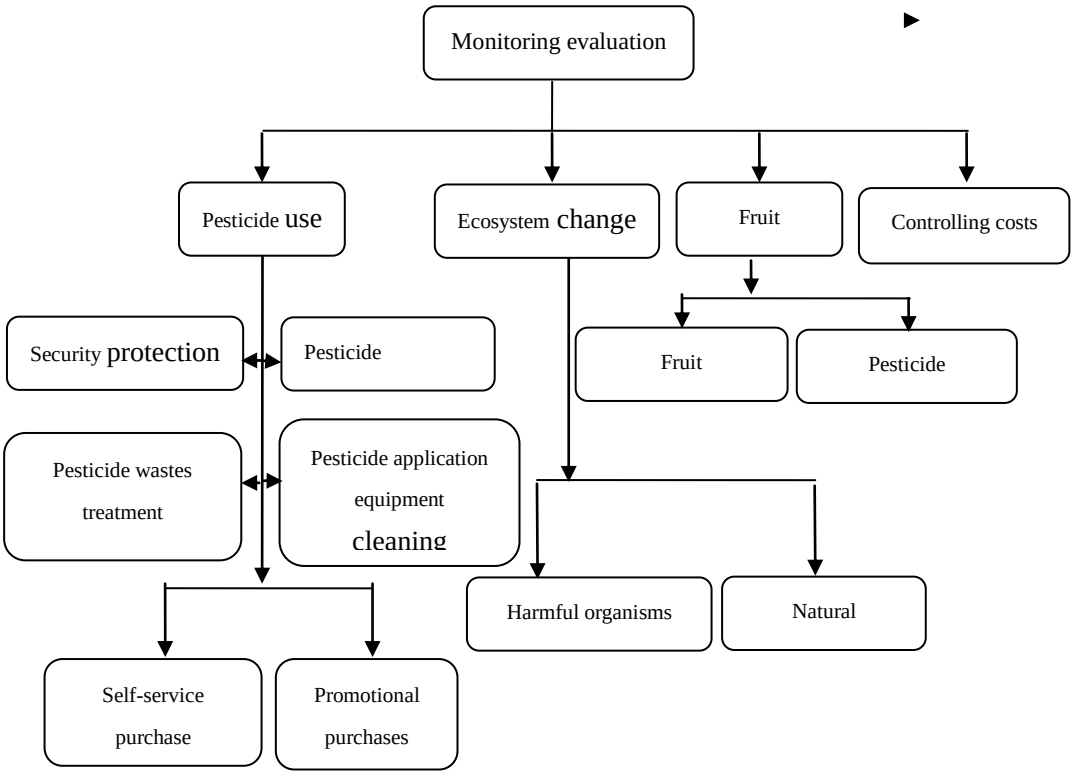
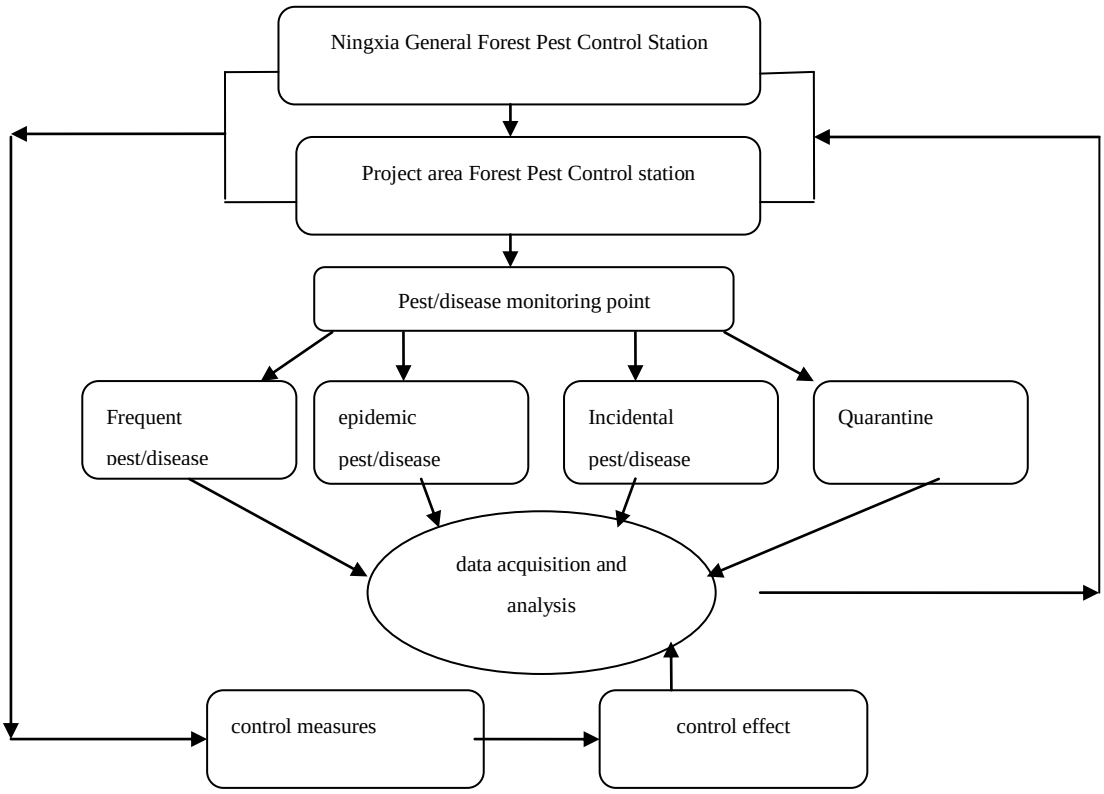


Figure 8.3: Procedures for pest management monitoring



8.3 Institutional Responsibilities

Various levels of forest pest management agencies are responsible for providing IPM technology guidance, supervision, monitoring and training. Project offices at all levels (PPMO and CPMO), as well as the finance bureaus, have also the responsibility to detect and report pests/diseases situation as well as to act according to this Pest Control Plan.

All levels of projects office will run the pests/diseases control work into routine work. The budget should be included in the project office and the forestry sector in the total cost of administration, into the rational use of pesticides, forest pests/diseases monitoring and forecasting, training, propaganda and administrative expenses. Cost estimates are shown in table 9 and table 10.

Table 9: Annual training plan and costs

(RMB ten thousand)

Training level	Project	Training content	Training receptor	Number of training	Training frequency	Budget	Implementing agency	Supervising institution
A: prefecture/ county/district level	Fixing sandy dune	IPM	Cm, Ct	16	20	6.4	PPMO	Provincial and county level Department of Agriculture (as well as other relevant agencies)
	Control of degraded land and vegetation restoration			16		6.4		
	Shelter construction			16		6.4		
	Integrated management			8		3.2		
B: towns-hip/ town/ forest farm level	Fixed mobile sand dune	IPM plan and implementation, procurement and safe use of pesticides	Tt, Ft	100	10	15	CPMO	
	Control of degraded land and vegetation restoration			100		10		
	Construct forest for non-timber products			50		5		
	Integrated management			20		2		
C: village level	Fixed mobile sand dune	Identification, prevention and control measures of main pests/diseases, safe use of pesticides	Fm	330	20	33	CPMO	
	Control of degraded land and vegetation restoration			660		66		
	Shelter construction			205		20.5		
	Integrated management			230		23		
total				1751		196.9		

Table 10: Annual training needs and costs

(RMB ten thousand)

Project	Receptor	Frequency	Unit price	Total	Implement agency
Forestry harmful biology integrated management strategy and action plan seminar		2 times a year	10	10	PPMO and CPMO
Training material CD chart and equipment consumption			10	70	
Expert technical support services	specialist		5	35	
Instructor remuneration	Tt, Ft, Fm		5	35	
Project area pests/diseases monitoring evaluation and pesticide supervision management		2 times a year	20	140	
Total					

Note: PPMO: Provincial Project Management Office; CPMO: County Project Management Office; Cm: county project management staff; Ct: county technical staff; Tt: township technical staff; Ft: forest farm staff and household group; Fm: project farmers.

Training budget for prefecture, county and district-levels are RMB 200/person/day, for town countryside and forest-levels are RMB 100/ person/ day, and for village level is RMB 50/ person/ day. The preliminary estimates for the number of people/staff needed to be trained are:

- 690 people is needed for 100 ha management of fixed sandy dune, control of degraded land and restoration of vegetation according to each farmer management;
- 205 people is needed for protection forest area of 30 ha;
- 230 people is needed for management forest for non-timber products area of 2 ha according to each farmer capabilities.

Table 11: Annual pest management monitoring costs

Unit: RMB ten thousand Yuan

Project	Monitoring objects	Area ha	Collecting points	frequency	Unit price	Total	Implementing organization	Monitoring organization
Fixing sandy dune	Artificial grass square engineering bushes	19926.61	40	14	0.05	28	Tt，Ft	Cm，Ct
Control of degraded land and vegetation restoration	shrubs	6003.54	12	14	0.05	8.4		
	Closed cultivation of forest	42856.60	86	14	0.05	60.2		
Construct forest for non-timber products	Arboreal forest	6141.96	12	20	0.1	24		
Integrated management	Ecological economic forest	458.65	9	20	0.1	18		
Total			159			138.6		

Forest pest/disease investigation station will be set up in project implementation area and it is responsible for frequently collecting data. In sandy dune fixing area, each monitoring station covers 500 ha of and total 40 such stations will be established. The monitoring will last 7 months and investigations will be carried out once every 15 days. In control of degraded land and vegetation restoration area, each monitoring station covers 500 ha of and total 98 such stations will be established. The monitoring will last 7 months and investigations will be carried out once every 15 days. For constructing forest for non-timber products area, each monitoring station covers 500 ha of and total 12 such stations will be established. The monitoring will last 10 months and investigations will be carried out once every 15 days. For integrated management, each monitoring station covers 50 ha of and total 9 such stations will be established, monitoring period will last monitoring 10 months and every 15 days to survey once. As an average rule to calculate the costs, it is estimated that one single monitoring event costs RMB 500-1000 Yuan.

Annex 1

Policy Framework in Ningxia

At the national level, the State Forestry Administration is responsible for forest pest/disease control and quarantine, while the Agricultural Department is responsible for the registration and supervision of pesticides. The main relevant laws, regulations and standards concerning forest pests/diseases management in China and Ningxia are summarized below.

(1) "Forest Law of the People's Republic of China" (National People's Congress, September 1984);
(2) "Agricultural Product Quality Safety of the People's Republic of China" (National People's Congress, April 2006);
(3) "Implementation Regulations of Forest Law of the People's Republic of China" (State Council, January 2000);
(4) "Regulation on Forestry Pest Control" (State Council, December 1989);
(5) "Regulation on Pesticide Management of the People's Republic of China" (State Council, January 29, 2001);
(6) "Technological Rules for Forest Quarantine" (State Council, May 13, 1992 amendments published);
(7) Ningxia Agricultural Environmental Protection Regulations Ningxia Autonomous Region People's Congress, December 1994);
(8) "Implementing Measures of Regulation on Pesticide Management". (December 8, 2007, the Ministry of Agriculture Decree No. 9 of 2007 Amendment);
(9) "Guidelines for the use of pesticides of Green Food." NY/T393-2000 (China's Ministry of Agriculture, March 2000);
(10) "Plant Quarantine Implementation Rules (Forestry)" (Ministry of Forestry, July 1994);
(11) Standards of pesticide safety use GB4285-1989(National Environmental Protection Agency, September 1986);
(12) "Standard on Safe Use of Pesticides" GB8321.2—1987 (National Environmental Protection Agency, September 1986);
(13) "Guidelines for the reasonable use of pesticides "GB/TB8321.1 ～ 8321.8(China's Ministry of Agriculture)
(14) "Pesticide storage, sale and use of anti-virus procedures" (GB 12475-2006) (Ministry of Agriculture);
(15) "Ningxia pesticide management practices" (People's Government of Ningxia Autonomous Region, March 2006);
Integrated Pest Management (IPM) has been promoted by the implementation of the "Standard on Safe Use of Pesticides" and "Regulation on Pesticide Management".

Annex 2

Main tree species pest/disease integrated control for project area

1. Poplar (willow, Elm)

Main pests/diseases: Clostera anachoreta, Micromelalopha troglodyte, Clostera anastomosis, Cerura erminea，Stilpnotia salicis，Apocheima cinerarius, Lymantria dispar, Anoplophora glaripennis, poplar canker, etc.

Target of pest/disease control

(1) yield loss below 5% caused by pest/disease damage

(2) biological control of leaf pest reaches 80%, the non-environmental damage prevention rate reaches 100%;

(3) Through limit the number of pesticide application in the growing season no more than two times in order to reduce 20% use of pesticide or more;

(4) Avoid any accident caused by the incorrect usage;

(5) Ensure safe storage of pesticides and pesticide-related waste;

(6) Increase the amount and types of poplar pest natural enemies.

Pest integrated management measures

Pest forecasting

County-level forest pest/disease station is responsible for monitoring and forecasting the occurrence and epidemic of poplar pest. Each monitoring point is set up covered every 20,000 acres of host trees with 3-5 permanent plots for regular detection. Field investigation will be conducted twice a year, one in spring before overwinter pupa beginning to act and another in autumn after leaves fall. Comprehensive walk-over survey must be conducted along the designed route according to forest resource distribution map or shelterbelt farmland network to ascertain the distribution, occurrence area and severities. Once dieback, exit hole, entrance hole and other suspicious symptoms were found, further detailed investigation must be taken in the vicinity or inviting the expert appraisal to identify the distribution, occurrence area and the extent of damage. County-level forest pest/disease control station should forecast the poplar diseases epidemic to farmers and farm workers 7 to 15 days before diseases outbreak, and to show control methods to people mentioned above no less than three times each year.

Variety selection

Poplar cultivar/clone should be selected and applied by those with traits of high pest/disease resistance from various areas. Selection should be decided by the Ningxia Forestry Bureau, Ningxia Academy of agriculture and forestry, Ningxia economic

forest center, General Forest Pest Control Station, County forest pest control and quarantine stations and jujube cultivation base.

Control method

(1) Silvicultural measures

Mixed planting for new plantation of different forms is created under principle of species matching the site and reasonable tree species arrangement. For existing pure plantations, renewal and transforming can be made by selecting tree species or clones resistant to pest and adjusting the proportion to improve the environment and enhance the ability of self-regulations.

(2) Set the bait tree

Bait trees, such as Acer negundo, Populus opera, Salix chaenomeloides, etc, can be planted at proportion around 5% to attract longhorn beetles. Micro capsule can be sprayed during adult stage onto bait trees to control them. In addition, it is recommended to advocate local people to capture adult pests and use hammer or stone to hit the eggs to protect target trees.

(3) Chemical control

Control time should be made according to egg density and the peak of hatching. In the peak of the adult emergence period, to spray 8% Green –weilei 300~600 times dilution or trunk coating (2.5% Deltamelthrin: Vaseline =1: 9) or coating pesticides on the trunk with a circle with 4-5 cm wide to control adult, or injection of pesticides into stem (2o% Confider, 0.3ml/cm DBH). In addition, eggs and subcutaneous larvae can be controlled by spraying contacted breaking pesticides 100-200 times dilution on stem. Poisonous stick and pesticides stick is also effective for control of larvae.

(4) Biological control

4~5 section of nest wood can be set covering every 15~20 hectares to attract woodpeckers with around 100 meters apart each other.

Field management

economic plants are recommended to be planted in newly plantations, which not only improve soil fertility and enhance the ability of trees to resist against pests/diseases, but also increase farmers' income.

2. Grape

Main pests/diseases: Spike-stalk brown spot, Grape gray mold, Grape black pox, Grape black measles, Grape axel blotch, Grape white rot, Grape anthracnose, leafhopper, red/yellow spider, etc.

Target of pest/disease control

(1) yield loss below 5% caused by pest/disease damage

(2) The pests/diseases biological control rate reaches 80%, the non-environmental damage prevention rate reaches 100%;

(3) Through limit the number of pesticide application in the growing season no

more than two times in order to reduce 20% use of pesticide or more;;

(4) Avoid any accident caused by the incorrect usage;

(5) Ensure safe storage of pesticides and pesticide-related waste.

Pest integrated management measures

Pest forecasting

County-level forest pest/disease station is responsible for monitoring and forecasting the occurrence and epidemic of grape pest. Each monitoring point is set up covered every 5,000 acres of host trees with 3-5 permanent plots for regular detection. Once dieback, exit hole, entrance hole and other suspicious symptoms were found, further detailed investigation must be taken in the vicinity or inviting the expert appraisal to identify the distribution, occurrence area and the extent of damage. County-level forest pest/disease control station should forecast the grape pest epidemic to farmers and farm workers 7 to 15 days before outbreak, and to show control methods to people mentioned above no less than three times each year.

Variety selection

Grape cultivar/clone should be selected and applied by those with traits of high pest/disease resistance from various areas. Selection should be decided by the Ningxia Forestry Bureau, Ningxia Academy of agriculture and forestry, Ningxia economic forest center, General Forest Pest Control Station, County forest pest control and quarantine stations and grape cultivation base.

Prevention and treatment methods

(1) Agricultural measures

To keep the grapery clean, pathogen must be removed. Litter, deciduous old barks, infested leaves, fruits and branches must be cleared and concentrated burned or buried. To improve the situation of the ventilation and light, strengthen management of the irrigation and fertilization. Environmental conditions are improved by deep plugging and weeding. Grape vigor is enhanced by selecting disease resistant species/cultivars.

(2) Chemical control

Grape white rot can be controlled by 5 degrees Baume lime sulfur mixture, 75% chlorothalonil WP 600 times dilution, 50% carbendazim WP 600 times dilution, 50% retreat bacterium WP 800 times dilution. Grape downy mildew is controlled by bordeaux mixture or 78% Coppola WP 600 times dilution, 58% metalaxyl MZ 600 times dilution. Herbivorous insect is controlled by 10% imidacloprid pesticide 2000 times dilution. Larvae is controlled by spraying 20% chlorbenzuron suspending agent 2000 times, 1.2% bitter smoke EC 800 ~ 1000 times, 10% of Cypermethrin 2000 times or budworm bacterium, Bacillus thuringiensis, fenitrothion bacillus, etc.

(3) Physical control

The methods includes: trapping and killing the pests by black light and sweet and sour solution (sugar 6: sour 3 : water 10), artificial shaking down the adult pests and digging trunk borer for grape clearwing moth, fruit bagging.

(4) Biological control

Biological control agents 120A and 120BF is recommended for control of Grape powdery mildew and Grape black pox.

(5) Use of natural enemies

To protect, breed and use beneficial insects, birds and predators.

Field management

Legume is advocated to be planted in vine site, which not only improve soil fertility and enhance resistance to pests/diseases, but also increase farmers' income.

3. Jujube

Main pests/diseases: Jujube inchworm, Ancylis sativa, Carposina sasakii, Scythropus yasumatsui, Jujube witches, Jujube rust, *Eulecanium gigantea*, *Quadraspidiotus perniciosus* Comstock, *Epitrimtrus zizyphagus* keifer, Jujube mosquito, Jujube weevil, *Sucra jujube*, Jujube fruit shrink, Jujube brown spot, etiolation and curl, etc.

Target of pest/disease control

(1) Yield loss below 5% caused by pest/disease damage

(2) The pests/diseases biological control rate reaches 60%, the non-environmental damage prevention rate reaches 100%;

(3) Through limit pesticide application in the growing season no more than two times in order to reduce use of pesticide more than 20%;

(4) Avoid any accident caused by the incorrect usage;

(5) Ensure safe storage of pesticides and pesticide-related waste.

Pest integrated management measures

Pest forecasting

County-level forest pest station is responsible for monitoring and forecasting the pests/diseases occurrence and epidemic during jujube growth period. Every fixed monitoring point should cover 5000 acres with 3-5 permanent plots. , equipped with hand to conduct regular monitoring and express forecast. Once dieback, exit hole, entrance hole and other suspicious symptoms were found, a detailed survey must be taken in the vicinity, or inviting the expert to identify the distribution, occurrence area and the extent of damage. County-level forest pest station should forecast the jujube diseases epidemic situation to farmers and farm workers 7 to15 days ahead of diseases outbreak, and to teach the staff for jujube pest control methods no less than three times each year.

Variety selection

Jujube cultivar/clone should be selected and applied by those with traits of high

pest/disease resistance from various areas. Selection should be decided by the Ningxia Forestry Bureau, Ningxia Academy of agriculture and forestry, Ningxia economic forest center, General Forest Pest Control Station, County forest pest control and quarantine stations and jujube cultivation base.

Prevention and treatment methods

(1) Agricultural measure

To keep the jujube orchard clean, pathogen must be removed. Some measures in winter or early spring such as wiping out overwintering pupae artificially through thoroughly scraped old barks and plugged tree holes by mud. Litter, deciduous old barks, infested leaves, fruits and branches must be cleared and concentrated burned or buried. Strengthen management of the irrigation and fertilization. Environmental conditions are improved to reduce diseases occurrence by deep plugging and weeding, reasonable pruning, pay attention to ventilation and increase transmittance. Jujube vigor is enhanced by selecting disease resistant species/cultivars.

(2) Chemical control

In the case of population density particularly high can be controlled by spraying 2.5% of deltamethrin 4000 t times dilution or 25% of insecticidal star 1000 times dilution. Larvae is controlled by spraying 20% Mieyouniao suspension concentrate 2000 times dilution, 1.2% EC bitter smoke 800 ~ 1000 times dilution, 10% beta-cypermethrin 2000 times dilution or budworm bacterium, Bacillus thuringiensis, fenitrothion bacillus, etc.

(3) Physical control

Trapping and killing insects by black light, frequency trembler grid lamps and sweet and sour solution. Dugged pupas or drifted soil to kill cocoons by hand when deeply tillaged tree disks in soil preparation of spring. Killed overwintering larvae by mulching film, molding under the tree and others measures. Bunched grass on the base of trunk or limb in autumn, winter or early spring removed grass and overwintering pupae to concentrated burned. Larvae can be controlled by artificial measures such as pick dropping fruits.

(4) Biological control

Make use of Trichogramma or microbial agents to control the pests such as larvae can be controlled by spraying budworm bacterium or fenitrothion bacillus 200 times dilution.

(5) Insect pheromone control

The amount can be effectively controlled by use of synthetic sex pheromone to trap the Ancylis sativa and Carposina sasakii.

(6) Use of natural enemies

To protect, breed and use beneficial insects, birds and predators.

Field management

Legume is advocated to be planted in jujube orchard, which not only improve soil fertility and enhance resistance to pests/diseases, but also increase farmers' income.

4. Caragana (Hedysarum scoparium, Hedysarum fruticosum and Salix)

Main pests/diseases: Orgyia ecricae, Paleacrita vernata, *Crdia nigricana* Fabric. , *Eurytoma neocaraganae* Liao, Etiella zinckenella, Chlorophorus diadema, Pterolophia multinotata, *Caragana korshinskii* Kom.

Target of pest/disease control

(1) Yield loss below 5% caused by pest/disease damage

(2) Biological control of leaf pests reaches 80%, the non-environmental damage prevention rate reaches 100%;

(3) Through limit pesticide application in the growing season no more than two times in order to reduce use of pesticide more than 20%;

(4) Avoid any accident caused by the incorrect usage;

(5) Ensure safe storage of pesticides and pesticide-related waste.

(6) Increase the amount and types of poplar pest natural enemies.

Pest integrated management measures

Pest forecasting

County-level forest pest/disease station is responsible for monitoring and forecasting the occurrence and epidemic of poplar pest. Each monitoring point is set up covered every 20,000 acres of host trees with 3-5 permanent plots for regular detection. Field investigation will be conducted twice a year, one in spring before overwinter pupa beginning to act and another in autumn after leaves fall. Comprehensive walk-over survey must be conducted along the designed route according to forest resource distribution map or shelterbelt farmland network to ascertain the distribution, occurrence area and severities. Once aphylly, dieback, entrance hole and other suspicious symptoms were found, further detailed investigation must be taken in the vicinity or inviting the expert appraisal to identify the distribution, occurrence area and the extent of damage. County-level forest pest/disease control station should forecast the poplar diseases epidemic to farmers and farm workers 7 to 15 days before diseases outbreak, and to show control methods to people mentioned above no less than three times each year.

Variety selection

Caragana cultivar/clone should be selected and applied by those with traits of high pest/disease resistance from various areas. Selection should be decided by the Ningxia Forestry Bureau, Ningxia Academy of agriculture and forestry, General Forest Pest Control Station, County forest pest control and quarantine stations, Ningxia forest seedling management station and species cultivation base.

Prevention and treatment methods

(1) Silviculture measure

Selecting drought-resistant breeding for new plantation under principle of species matching the site and developing the afforestation management model and technology of control Holcocerus hippophaecolus. Adjusting the proportion to improve the environment and enhance the ability of self-regulations. For existing shrub pure plantations, renewal and transformation can be made by the strong ability of resistance stumping, rejuvenating and natural restoration. Boring-insect can be controlled by stumping and rejuvenating.

(2) Chemical control

Selecting and applying environmental compatibility agent for high efficiency and low toxicity, the initially hatched larva can be controlled by 2.5% deltamethrin and 20% fenvalerate 3000-5000 times dilution.

(3) Physical control

Trapping and killing insects by black light, frequency trembler grid lamps and sweet and sour solution. Insect light trap hanging from the ground about 2 m advisable, turn on the light from 20:00 to 23:00.

(4) Sex pheromone trapping control

Using insect sex pheromone to trap insects: the dose of lure is 0.5mg, traps hanging on the belt between two trees and interval 60~150m, trapping from 18:30 to 21:30 per night.

(5) Use of natural enemies

To protect, breed and use beneficial insects, birds and predators.

Field management

Legume is advocated to be planted in planting site, which not only improve soil fertility and enhance resistance to pests/diseases, but also increase farmers' income.

5. Rodent damage

Main species: Microtus fortis, Rhombomys opimus.

Target of pest/disease control

(1) Yield loss below 5% caused by rodent damage

(2) Biological control rate reaches 80%, the non-environmental damage prevention rate reaches 100%;

(3) Through limit pesticide application in the controlling season no more than two times in order to reduce use of pesticide more than 20%;

(4) Avoid any accident caused by the incorrect usage;

(5) Ensure safe storage of pesticides and pesticide-related waste.

(6) Increase the amount and types of natural enemies.

Pest integrated management measures

Rodent population forecasting

County-level forest pest station use of advanced technical means and scientific investigation methods and adopt the density investigation measures such as mound coefficient method and cut hole plugging method to monitoring and forecasting the rodent damage occurrence and epidemic under the foundation of biology, ecology and physiology. Established the representative fixed plots in the project area according to the different site conditions and forest type, selected sample plots 20-30 pieces for the area is 1 hectare. The sample plot will be dividing into 10-15 quadrats and identified 3quadrats which required the trees not less than 100. Investigation strains whether the victim and damage degree, record the number of victim and death at all levels combined population density investigation with sample survey method.

Prevention and treatment methods

(1) Silviculture technique

Mixed forest formed by selecting species suit local growth and reasonable collocation to avoid building single pure forest. The underground rodents can be prevented by optimization forests and species structure, reasonable planting and the root system of shrubs and secondary forest.

(2) Biological control

Forestry natural enemies of harmful rodents in many species, including eagles, falcons and carved in the birds, snakes in the reptile, yellow weasel and fox in the mammal, and so on. Reducing human disturbances through the measures such as closed forest and forbidden hunting to protect natural enemies living environments. In the conditional place can be artificially bred on forest to improve its population for a long pressing against rodent’s density.

(3) Use of natural enemies

Attracted Mustelidae animals by stacking stone, firewood or haystack in the plantation. In the edge or open space of plantation to retaining large broad-leaves trees, hanging rods or placing wooden section with natural holes will helpful food rat birds perched and reproduction.

(4) Reproductive sterile technology control

Application sterile drug can reduce the reproductive ability for male and female rodents, make harmful rodents keep for a long time in the low density state. In present used in production have the male sterility rodenticide and curcumol anti-fertility agents.

(5) Physical control

The control measures of artificially killing the rodents by physical instrument such as arrow, bow clip, bomb and lightning.

(6) Chemical control

Some regions should have used the chemical rodenticide to control which have

the bigger population density and caused certain harm. Adopt chemical rodenticide in the case of prevention measures and other control measures can not effectively control the rodents. Reagent selection: Fenshu Ling, bait casting commonly used plug-hole and open hole method, recommended dosage is 0.75 Kg / ha; Shubi Ke, each bag 10 grams, recommended dosage is 4.5 Kg / ha.

Field management

Legume is advocated to be planted in planting site, which not only improve soil fertility and enhance resistance to pests/diseases, but also increase farmers' income.

Annex 3

Monitoring and evaluation index of the draft

1. The field monitoring index

1.1 The degree in the absence of insecticide or IPM

(1)The number of farmers/forest staff involved non-pesticide control measures or IPM;

(2) The area of planting forest / forest farm involved non-pesticide control m2easures or IPM;

(3) The number of farmers/forest staff about using species of strong resistance pests ability;

(4) The number of farmers/forest staff to distinguished insect natural enemies;

(5) The number of farmers/forest staff involved IPM technology community promotion plan.

1.1.1 Pesticide usage model

(1) The number of times each species using pesticide per hectare a year;

(2) The type and quantity each species using pesticide per hectare a year

(3) The cost each species using pesticide per hectare a year

(4) The number of farmers/forest staff safety in the use of pesticide (which security deposit, the use of labor protection articles, etc.);

(5) The influence scope about other forms of environmental poison or pollution on wild animals, bees and water.

1.1.2 Economic forest output

(1) Per hectare (mu) fruit production, as well as the floating situation in different planting site;

(2) Per hectare (mu) fruit profit.

1.1.3 Agroecosystem

(1) The number and type of pests/diseases every year each kind of timber forest;

(2) The quantity of insect eater and parasitoid in every test area;

(3) By unit type and quantity expression useful insects resources (for example, the honeybee quantity of each Sampling unit area).

The above monitoring activities should be responsible by the forest pest/disease controls and quarantine station staff in project county, and take the project area or non-timber forest for sample. Project office to assist world bank supervisory group shall assist county forest pest/disease controls and quarantine station in the early to establish appropriate monitoring system, sampling procedures and provide training of application and analysis. Once the monitoring system site collaboration operate by autonomous region forest pest control and quarantine station and county level forest pest control and quarantine station, shall formulate detailed budget, work plan and the division of responsibility.

1.2 Project supervision and inspection need the on-site monitoring activities

1.2.1 Pesticide registration

(1) Check whether the unregistered pesticides sold/used in the chemical supply stores and farmers' pesticide cupboards in the project area;

(2) Verify the registration situation of new pesticide through check pesticide registration list.

1.2.2 The use of 1 type pesticide

Check chemical supply stores and farmers' pesticide cupboards to verifying whether the World Health Organization project category I pesticide sale/use in the project area.

1.2.3 Policy

(1) The government subsidies on pesticide use (if any);

(2) Assess the effectiveness on the use of home / forest planting of loan application system in the control of refuses unregistered pesticides;

(3) The policies and regulations for local Government on pesticide use and IPM.

1.2.4 Field monitoring program execution

a) assess the implementation of field monitoring plan on the counties which inspects to the world bank supervision group;

b) help project county relevant personnel solve any problems caused by execution field monitoring plan;

c) provide timely training for project county relevant personnel on the field monitoring process, data analysis and interpretation of the results, and adjusted the place which need improve on the pest control.

World Bank monitoring group to supervision the project should be twice a year which made up of experts, generally at the period of pests high incidence in order to facilitate observe the control.