

Pest Management Plan

The Client: RURAL ENERGY & ENVIRONMENT AGENCY,
MINISTRY OF AGRICULTURE

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1. Project overview

As international community attaches more importance to climate change, greenhouse gas mitigation and grain security, the unprecedented concern will be given to the research on the soil carbon sequestration and carbon emission technology for the farmlands in science circles. The climate conditions, land resources and planting system have evident regional characteristics, there are different requirements and effects of carbon sequestration and carbon emission technology in different regions and it is difficult to promote some management measures due to the influence on yield. The wheat, rice and corn are three primary grain crops in China and their yield accounts for over 85% of total food output in China. Major grain producing areas are also faced with potential and huge practical demand for the serious loss of organic carbon, urgent carbon sequestration, consumption of nitrogen fertilizer and greenhouse gas mitigation. Therefore, promote and use energy conservation and carbon sequestration technology provided that the grain yield is guaranteed in the major grain producing areas and evaluate demonstration and emission reduction effects in order to mitigate greenhouse gas and improve soil fertility and productivity. Thus, the said measures work as the strategic choice to maintain agricultural sustainable development in China.

According to actual agricultural production in the project area, strive to reduce pesticide and chemical fertilizer in use, carry out integrated pest control, control pest damage degree and reduce pesticide pollution provided that the grain yield is guaranteed in project implementation, therefore, the integrated pest management technology and the application of professional unified prevention and control are further valued in project implementation.

The integrated pest management is an integrated pest management (IPM) strategy and based on the whole agricultural ecosystem. This strategy is used to coordinate various measures such as agricultural, physical, biological and chemical control measures in application, make full use of natural control factors in agro-ecology and control the agricultural pests under the economic loss level. The control measures will be taken only when the pests may result in economic loss, that is to say, certain bacteria or pests on the crops are allowed as long as they are enough to endanger economic level. In respect of IPM, the application of integrated control technology such as resistant variety, cultivation measures, natural enemies and chemical agents is quite valued.

The biological control factor such as natural enemies is especially used for pest control. The prudence is required for chemical pesticide application.

With the reform of agricultural production mode and development of social service system, the specialized unified prevention and control of crop diseases and pests gradually springs and is on a rapid rise. The specialized control means that the service agency with specialized plant protection technology and equipments carry out socialized, large-scaled and intensive crop pest control service. The organization which provides specialized control service to the society is called a specialized control organization. As a product of agricultural development in a definite stage, the specialized control, which conforms to the general rules of world agricultural development now, is an important support to implement “public plant protection and green plant protection”, a critical measure to promote the steady growth of food production and various cash crops, an effective means to ensure food production safety, food quality safety and agroecological environment safety, and a pivotal guarantee for improving agricultural efficiency, farmers’ income and rural stability.

Pursuant to the rules of World Bank Group, we have prepared *PMP Pest Management Plan* according to pest occurrence status of project area and some problems caused by the project activities. By encouraging the farmers to take environment-friendly agricultural practice and integrated pest management (IPM) technology, PMP plan will provide technical support, farmer training, equipment procurement and monitoring evaluation, improve agricultural product quality and safety level and reduce pesticide in use. The key emphasis in work is as follows:

(1) Introduce and promote PMP technology in the project area, protect and make use of natural enemies, enhance prediction and forecast of agricultural pests and information, accurately diagnose and acquire the information of diseases, pests and weeds in the fields, release prediction and forecast, guide the farmers for appropriate, rational and efficient pesticide application, maximize the utilization rate of pesticide and keep total pests in the allowable level of economic harm according to integrated pest management and unified prevention and control technology;

(2) Carry out the model application and promotion of high-efficiency and new pesticide and new technology. The high-activity pesticides have ideal control effect to reduce the pesticide in use substantially. In addition, spray adjuvants are added into the pesticide solution to improve distribution performance and adhesive capacity of

pesticide solution to improve pesticide efficiency and reduce pesticide application;

(3) Carry out the promotion and application of new agricultural plant protection machine in the project area. The model application of new plant protection machine can solve such problems as low efficiency and low effective utilization of traditional pesticide application, largely reduce pesticide application and enhance working efficiency to achieve energy conservation and emission reduction;

(4) Carry out specialized control for plant protection in the demonstration area of the project and implement the socialized service of plant protection. In the project area, the legal service organization with plant protection technology conditions adopts advanced equipments and technology to implement the full-course contract service behavior which means safe, uniform and efficient pest prevention and control for the crops in growing period, in compliance with modern agricultural development requirements and the plant protection policy of “prevention first and integrated control”;

(5) The professional technology training and popularized training to the farmers can improve the farmers’ actual practice skills and cultivate the farmers to acquire integrated pest management technology. The pesticide storage and application training is provided to the farmers in the project area to deepen the farmers’ acquisition of pesticide management and application rules. The training is provided to agricultural technicians, pesticide dealers and county-level and municipal project offices to improve their understanding of pest management plan (PMP).

2. Management status of pests in current project area

2.1 Occurrence and control status of diseases, pests and weeds in Ye County, Henan Province

2.1.1 Damage and control technology for diseases, pests and weeds of wheat

Henan Province lies in huang-huai winter wheat area where the climate is very suitable for wheat. Henan Province is the No. 1 province of national wheat production and export where the area of wheat reaches 5 million hectares. Commodity wheat of Henan Province supplied to the market accounts for 25%-30% of that of the whole country. For a long time, Wheat in Henan Province maintains “Three first” (Area first, yield first and commodity grain supply first). In 2013, wheat of 80.5 million mu in the province was harvested. The total yield of grain was expected to reach about 31.5

billion kg in summer and the average yield would exceed 400 kg.

According to the statistics, the total area of wheat where diseases, pests and weeds occurs was 290 million mu among which diseases area was 160 million mu and pests area was 130 million in 2013. Wheat ear aphids, sheath blight, midge, leaf rust, wheat red mite and powdery mildew mainly occur at some regions. Fusarium head blight is popular in a wide range. Diseases such as root rot, cyst nematode disease and loose smut can cause damage to some wheat field.

2.1.1.1 Diseases

Main diseases are powdery mildew, sheath blight and fusarium head blight.

Powdery mildew

The occurrence of powdery mildew is less in recent years because of the cultivation of disease-resistant variety. Varieties such as 19-198, Zhoumai 22, Luomai 4, Wenmai 6 are disease-resistant. However, Diseases are easy to occur in fields where the rainfall is rich and planting is intensive.

Sheath blight

The occurrence area of sheath blight is large, but the damage is slight. Farmers should not control this disease generally. Some most-affected areas regions adopt validamycin, triadimefon and tebuconazole to control it.

Fusarium head blight

Fusarium head blight is the most serious plant protection problems and occurs severely. Along with straw returning, the adaptability of the disease is enhanced. The disease should become popular once climate condition is suitable.

Current pesticides that can control the disease include carbendazim and tebuconazole, but the effect of these pesticides are only moderate. Spraying before flowering or early should obtain a good effect. However, farmers usually are not aware of prevention and should spray pesticides until the disease has occurred, resulting in bad effect.

Yellow mosaic disease

Yellow mosaic is a soil-borne disease which occurs in recent two years. Occurrence of it is closely related to the climate when seeding wheat. It occurs severely in 2012

while slightly in 2013.

Take-all

The disease occurs in some areas of Ye County. Good effect should be obtained when the seed is mixed with Latitude (RMB 30/mu) or Butylate (RMB 5-6/mu).

Rust

Occurrence of the disease is slight in Ye County and has a slight effect on the yield according to the instruction from local technical personnel. Triadimefon and tebuconazole can make a good effect on the control of wheat rust.

2.1.1.2 Pests

Main wheat pests are underground pests, aphid, red mites and midge.

Underground pests

Underground pests among which are mainly grub and wireworm occur throughout the year. Main control methods are soil treatment, e.g. broadcasting granules, this method accounts for 60% of all methods. Another method is seed dressing with pesticides, mainly adopting phoxim and seed dressing agent for wheat specially.

Aphid

Seedling aphid occurs in some areas. With adopting seed dressing technology in recent years, seedling aphid is controlled effectively. Because ear aphid is harmful, the control of it should be focused on.

Red mite

Red mite occurs during regeneration period and heading stage from March to April. The red mite occurs at the same time with seedling aphid. The occurrence of red mite is slight at average year, although it can be severe in some areas.

Midge

Midge occurs frequently in the region. Soil treatment and pesticides spraying in heading stage should be adopted to control it. Pesticides spraying in heading stage can make a good effect above 80% on the control of midge. In particular, prediction and forecast technology should be mastered and control in proper time is the key to obtain a good effect.

2.1.1.3 Weeds

Main weeds in wheat field include cleaver, flixweed, shepherd's purse, wild oats and ryegrass which can be controlled by pesticides.

2.1.2 Damage and control technology for diseases, pests and weeds of corn

2.1.2.1 Diseases

The occurrence of corn diseases is not severe and the main disease is root rot at seedling stage which can be controlled by coating the seed. Therefore, the control of leaf diseases of corn is not required usually.

2.1.2.2 Pests

Corn pests include underground pests, armyworm and corn borer. The underground pests occur throughout the year and need to be controlled. Armyworm occurs severely in recent years and need to be controlled. Core borer occurs frequently in the region, but it can be controlled by spraying pesticides at the bellbottom period.

2.1.2.3 Weeds

Main weeds in corn field are: *Digitaria sanguinalis*, *eleusine indica*, *amaranthus retroflexu* and purslane. Theses weeds should be controlled mainly by soil treatment or pesticides sprayed after emergence of seedling.

2.1.3 Pesticide application

2.1.3.1 Pesticide application in wheat field

Generally, pesticide is applied to wheat for 5 times.

First time is soil treatment or seed dressing before seeding. The pesticides include phoxim of 25 ml (At the cost of RMB 1), imidacloprid of 25-30 g (At the cost of RMB 30-40), tebuconazole of 10 ml (At the cost of RMB 2), celest of 30 ml (At the cost of RMB 2-3) and difenoconazole of 40-60 ml (At the cost of RMB 3-5) etc. The control objects of these pesticides are underground pests, aphid at seedling stage, and take-all etc.

Second time is herbicide application. Chemical weeding should be conducted before winter or after the year. The pesticides include tribenuron-methyl of 10 g (At the cost of RMB 30-40), Starane of 20-25 ml (At the cost of RMB 5-8), thifensulfuron methyl

of 10-20 g (At the cost of RMB 3-5), puma super of 30-50 g (At the cost of RMB 12-16) and sigma of 20-40 g (At the cost of RMB 15-18) etc.

Third time is red mite control (as well as seedling aphid and sheath blight) during regeneration period and jointing stage. The pesticides include imidacloprid of 20-30 g (At the cost of RMB 1-2), of Beta cypermethrin of 30-50 ml (At the cost of RMB 2), imidacloprid + abamectin of 25-50 ml (At the cost of RMB 4-5), validamycin of 15 g (At the cost of RMB 1-2) and triadimefon of 50-100 (At the cost of RMB 2-3) etc.

Fourth time is ear aphid control after heading stage. The pesticides include imidacloprid of 20g (At the cost of RMB 1-2), acetamiprid of 10-20 g (At the cost of RMB 2-3), Beta cypermethrin of 30-50 ml (At the cost of RMB 2) and emamectin benzoate of 20-30 ml (At the cost of RMB 2-4) etc.

Fifth time is integrated control at flowering stage and filling stage (Diseases and pests, dry-hot wind and increasing yield). Main pesticide formula is “imidacloprid + Fungicide such as tebuconazole + foliar fertilizers such as disodium octaborate tetrahydrate” with dosage of “20-30 g + 20-50 g + 10 g = 50-90 g at the cost of RMB 6-10.

2.1.3.2 Pesticide application in corn field

Pesticide is applied to corn for 4 times in whole growth period.

First time is underground pests control by seed dressing with pesticide and broadcasting granules. Adopted pesticides include phoxim and chlorpyrifos.

Second time is weeds in corn field control by soil treatment or herbicide after emergence of seedling.

Third time is armyworm control from 3 leaf stage to 6 leaf stage. Pesticides include pyrethroid, organophosphorus, abamectin and diflubenzuron etc.

Fourth time is corn borer control through broadcasting granules. Adopted pesticides include phoxim and isofenphos powder granules.

2.1.3.3 Pesticide application problems

Table 1-1 Common Diseases and Pests and Corresponding Control Pesticides in Ye
County, Henan Province

	Common diseases, pests and weeds	Common control pesticides
Corn	Underground pests, armyworm and corn borer	Phoxim (II), chlorpyrifos (II), abamectin (III) and diflubenzuron (III).
	Root rot	thiophanate methyl(U) and carbendazim(U)
	Digitaria sanguinalis, eleusine indica, amaranthus retroflexu and purslane.	Acetochlor (III), atrazine (III), metolachlor (III), and mesotrione
	Underground pests, aphid, red mite and midge.	Phoxim (II), imidacloprid (II), Beta cypermethrin (II), imidacloprid +abamectin, acetamiprid and emamectin benzoate (III).
Wheat	Powdery mildew, sheath blight, fusarium head blight,	Tebuconazole (II), validamycin (U) and Triadimefon
	yellow mosaic disease	(II)
	Rust	
	cleaver, flixweed, shepherd's purse, wild oats and ryegrass	Tribenuron-methyl (U), Starane (U), thifensulfuron methyl (U), fenoxaprop-p-ethyl (O) and mesosulfuron-methyl (U).

Note: Classification of toxicity (WHO 2009), the Classification was shown in Table2-4-1, O: obsolete.

In project area, Ye county, moderately hazardous (Class II) and obsolete pesticides are still in use, for example, phoxim, chlorpyrifos, imidacloprid, beta cypermethrin are used for controlling underground pests and aphid. Tebuconazole and triadimefon are still applied for controlling powdery mildew and rust disease. Fenoxaprop-p-ethyl is still applied for controlling weed in wheat field. When the project is under construction, Class III and U pesticides will use in our project instead of class II and O.

2.2 Occurrence and control status of diseases, pests and weeds in Huaiyuan

County, Anhui Province

Rice cultivation systems mainly have wheat/rice along Huai river, naked oats (wheat)/rice, single-season rice in mountain area, double-season rice along Yangtze river and south of Yangtze river. Cultivated area of rice is about 2.3 million hectare, in which middle –season rice occupies main position. The area and output of middle –season rice are 66.43% and 71.65% of the rice production respectively.

2.2.1 Injury and control technique of diseases, pests, weeds of rice.

2.2.1.1 Diseases

The main diseases of rice are sheath blight, rice blast, rice false smut. Rice false smut is a disease which occurred frequently in local rice and has a higher recurrence frequency. Rice blast has a higher recurrence frequency on round grain glutinous rice in recently years. Rice false smut and Paddy Rice Pestilence often occur in rice heading stage. Prevention of rice false smut must be 7-10 days before crevasse. Prevention of Paddy Rice Pestilence should do during the period of crevasse. During full heading time, control must do again. The pesticides chose for control of Paddy Rice Pestilence are 75% tricyclazole, 40% isoprothiolane, 2%kasugamycin. The pesticides chose for control of rice false smut are 43% tebuconazole, 30% difenoconazole• propiconazole, validamycin+ bacillus cereus and so on.

Seed soaking and seed dressing Pesticide technology has applied by local rice planting. The bacteria-carrying diseases of seed mainly are rice bakanae disease and root lesion nematode, and the other diseases are rice blast, bacterial blight and other diseases. In order to effectively control the occurrence of seed-borne disease. the key point of the seed treatment must be seed soaking with pesticide prevention, except that seed basking and seed screening should done before sowing. The seed soaking pesticide is 10% disulfide cyano methane emulsifiable which can directly germinate and sow after seed soaking and prevent bakanae disease and root lesion nematode. Bakanae disease and seeding blasts can be prevented by 25% peochloraz emulsifiable seed soaking treatment. The seeding dressing with pesticide can be carried out through the seed treatment and the using of 35%Carbosulfan wettable powder or 10% imidacloprid wettable powder, which can be used as the prevention of rice planthopper and rice thrips.

2.2.1.2 Pests

The main pests are rice planthopper, rice snout moth. The main snout moth which damages the rice is rice leaf folder. They generally happened about 3-4 generations and have obvious overlapping of generation phenomenon. It is very important for the control the occurrence of rice leaf folder to control the period of spraying pesticide. The prevention must do before 3-generation pests. The pesticides of the prevention of rice leaf folder are: 40% Fuge, or 5% prodain wettable powder, or 3.2% abamectin emulsifiable concentrate. The pesticides of the prevention of rice planthopper are: 50% pymetrozine or 25% buprofezin+20% fenobucarb or 40% Fuge (rice leaf folder also can be controlled), or 25% buprofezin +48% dursban.

2.2.1.3 Weeds

The occurrence of weeds is closely related to the rice planting area. Total planting area of rice in Wanfu Town is 800,000 mu. Plant area which uses mechanical transplanting rice is less than 100,000 mu. Most of the rice planting is direct seeded rice. The main harmful weeds are *Digitaria sanguinalis*, barnyard grass, cyperaceae, *leptochloa*, *alternanthera philoxeroides* and *monochoria vaginalis* and other monocotyledon weeds and broad leaf weeds. Because mechanical transplanting rice is small, herbicide can not be used casually. In order to avoid producing pesticide hazard, young seedlings herbicide used for mechanical transplanting rice can be chose generally. 53% Benzyl rimsulfuron + benzene thiamethoxam acyl mechanical transplanting rice special herbicide combined with fine soil and urea can be broadcasted all field after 5-7 days of mechanical transplanting rice. The key point of direct-seeded rice high yield cultivation is to control weeds. Seedlings and weeds grow at the same period. If the weeds in direct-seeded rice grow quickly, farmland running to weeds can occurs easily, which can cause drop in crop yields and even no grain. After sowing but before emergence, spraying can be used generally and soil closing treatment can be carried out. After 3 leaf stage of seedling, the weeds are 2-4 leaf stage. If the effect of weeding in earlier stage is bad, stem leaf treatment herbicide can be used for once again and the weeds can be eradicated basically.

2.2.2 Injury and control technique of diseases, pests, weeds of wheat.

Anhui Province which is a granary is located in the winter wheat region along the

middle and lower reaches of the Yangtze River. Perennial planting area of food crop is about 6.1 million hectares, which occupies 6% of nationwide planting area and is in sixth place. Where, Perennial planting area of wheat is 1.96 million hectare, which occupies 8% of nationwide planting area and is in forth place. It is an important commodity grain base which plays a pivotal role in the assurance of the national food security.

2.2.2.1 Diseases

The main diseases of the local wheat planting are fusarium head blight, powdery mildew, rust, sheath blight.

Fusarium head blight of wheat which can damage the local wheat growth of wheat is the main disease occurring from early April to end May. Fusarium head blight belongs to typical climatype disease. If the wheat suffers cold and rain or foggy weather in heading stage and flowering stage, fusarium head blight will occur moderately or heavy. Most of the wheat varieties growing in the local place are not disease-resistant wheat. The main wheat varieties are Yannong 19, Yannong 5158, Yanzhan 4110 and so on. None of the wheat varieties can resist fusarium head blight. Generally, the pesticide control can carry out in the early stage of the flowering stage of wheat. The selected pesticides are 25% JS399-19 suspension concentrate, 40% carbendazim suspension concentrate.

Powdery mildew often occurs from late March to early May in rice stubble no tillage field and small part of rice stubble farmland which used for sowing. When disease incidence of the powdery mildew is 20%, it must be controlled generally. The chemical pesticides which selected commonly are 20% triadimefon emulsifiable concentrate, 12.5% diniconazole emulsifiable concentrate, 30%propiconazole emulsifiable concentrate combined with 30-40 kg water, used in spray evenly.

The sheath blight of wheat occurs moderately, Control can be done by spraying evenly to the root of wheat by using 20% Validamycins powder or 12.5 grain mold Shimizu agent or 24% thifluzamide combined with 40 kg of water.

2.2.2.2 Pests

The main pests of wheat are aphid and red mite. Where, the damage of aphid is more severe and it often occur in heading stage and filling stage. Generally, the suitable date for control of the aphid is from the late April to mid May. The selected pesticides

are 24% pirimicarb+myzus persicae wettable powder or pymetrozine, acetamiprid, myzus persicae and other pesticides, combined with water in the way of spraying. This also can control laodelphax striatellus in field.

2.2.2.3. Weeds

As the growth period of the local rice variety is quite long (about 150 days), the plantation of wheat is later. The weeding control in the field is handled during the wheat regeneration period. The weeds are mainly cleaver, flaxweed, polygonum aviculare, chickweed, amur foxtail, beckmannia syzigachne, sclerochloa kengiana tzvel and other broad leaf weeds or gramineous weeds. The weed control period is about in the middle of February and weeds can be controlled in 3-4 leaf stage. 20% CFC pyrazole oxygen ethanoic acid emulsifiable solution, 10% benzene sulfonic long wettable powder, or 36% wettable powder can be used when broad leaf weeding control is handled. 6.9% refined oxazole grass ling emulsifiable concentrate or 15% grass ester wettable powder can be used when gramineous weed control is handled. The pesticide can be added 30 kg water per mu and can be sprayed homogeneously.

2.2.3 Pesticide application

2.2.3.1 Pesticide application in rice field

The usage of herbicide: 33% pendimethalin emulsifiable concentrates (200mL per mu) or 10% pyrazosulfuron-ethyl wettable powder (20g per mu) can be used seeded rice fields for sealing treatment. 15% cyhalofop-butyl emulsifiable concentrate (80~100mL per mu), 10% hanqiu hao emulsifiable concentrate (100mL per mu) or 48% bentazone water aqua (100~150mL per mu) are used for the treatment of stems and leaves. Machine planting rice can use 60% dinge emulsifiable concentrate (150mL per mu) or 15% cyhalofop-butyl emulsifiable concentrate (100mL per mu) once.

The usage of herbicide: The rice leaf folder of Generation IV, Generation V and Generation VI control can be treated for 4 or 5 times. 1.8% abamectin emulsifiable concentrate (150mL per mu), 48% chlorpyrifos emulsifiable concentrate (100mL per mu) or 25% Dupon Coragen (10g per mu) are mainly used. The rice planthopper of Generation IV, Generation V and Generation VI control can be treated for 4 or 5 times. 25% buprofezin wettable powder (50g per mu), 48% chlorpyrifos emulsifiable concentrate (100mL per mu), 25% pymetrozine suspending agent (25g per mu), or

80% DDVP emulsifiable concentrate (100mL per mu) are used for treatment. The thrip control in rice seeding period can be treated by 48% chlorpyrifos emulsifiable concentrate (100mL per mu), 10% imidacloprid wettable power (20g per mu) and can control lissorhoptrus oryzophilus kuschel at the same time.

The usage of herbicide: 12.5% validamycin bacillus cereus water aqua (200mL per mu), 5% hexaconazole suspending agent (80mL per mu), 50% carbendazim wettable powder (100g per mu) are used to control sheath blight for rice. 75% tricyclazole wettable powder (20g per mu) or 40% isoprothiolane emulsifiable concentrates (100mL per mu) to control rice blast. 30% difenoconazol • propiconazole emulsifiable concentrate (20mL per mu) or tebuconazole concentrate emulsion or 5% hexaconazole suspending agent (80mL per mu) are used to control rice false smut.

2.2.3.2 Pesticide application in wheat field

The usage of herbicide: 16.9% fenoxaprop-p-ethyl emulsifiable concentrate (80~100mL per mu) to control gramineous weeds in wheat field and 10% benzene sulfonic long wettable powder (12~15g) to control broad leaf weeds.

The usage of herbicide: The main purpose is to control aphid. 10% imidacloprid wettable power or 25% pymetrozine suspending concentrate (20g per mu) are used.

The usage of herbicide: 20% triazolone emulsifiable concentrate (50mL per mu) to control powdery mildew. 20% water soluble powder (200mL per mu) or 12.5% validamycin bacillus cereus water aqua (150mL per mu) is used to control sheath blight. 40% carbendazim suspending agent (150mL per mu), 25% JS399-19 suspending agent (100mL per mu) or 70% thiophanate methyl wettable powder (100g per mu) is used to control fusarium head blight for wheat.

2.2.3.3 Pesticide application problems

Table 1-2 Common Pest Variety and General Pesticides in Huaiyuan County, Anhui Province

Common diseases, pests									
and weeds					General pesticides				
Rice	Rice	leaf	folder,	rice	Foggo (III),	chlorantraniliprole (III),	emamectin		
	planthopper		and	rice	benzoate (III),	abamectin (III),	pymetrozine,		

	dichocrocis	buprofezin (III), chlorpyrifos (II) and fenobucarb.
		Tricyclazole (II), tebuconazole (II), difenoconazole (U) and methyl group
	Sheath blight, rice blast disease and rice false smut	Thiophanate (U), carbendazim (U), kasugamycin (U), validamycin (U) and bacillus cereus (U).
	Digitaria sanguinalis, barnyard grass, cyperaceae, leptochoa, alternanthera philoxeroides and monochoria vaginalis	Bensulfuron methyl (U), cyhalofop-butyl (U), bentazone (II), butachlor (III) and pretilachlor (U)
	Aphid and red mite	Pirimor (II), imidacloprid (II), pymetrozine and acetamiprid (III)
	Fusarium head blight, powdery mildew, puccinia graminis and sheath blight	JS399-19, carbendazim (U), triadimefon (II), diniconazole (II), propiconazole (II), validamycin (U), grain mildew clear and trifluzamide (U)
Wheat	cleaver, flaxweed, polygonum aviculare, chickweed, amur foxtail, beckmannia syzigachne, sclerochloa kengiana tzel	Fluroxypyr (U), fenoxaprop-p-ethyl (O), tribenuron-methyl (U), Benteng (U) and clodinafop-propargyl

Note: Classification of toxicity (WHO 2009), the Classification was shown in Table 2-4-1, O: obsolete,

In project area, Huaiyuan county, moderately hazardous (Class II) and obsolete pesticides were also still in use, for example, pirimor, phoxim, chlorpyrifos, imidacloprid, triadimefon, diniconazole, beta cypermethrin. When the project was under construction, Class III and U pesticides will be used in our project instead of class II and O.

2.3 The Analysis of disease pest control technology in the project area

2.3.1 The assessment of current control technology

According to the disease pest control technology in Ye County in Henan Province and Huaiyuan County in Anhui Province, the main technologies are disease-resistant variety and chemical control. The chosen pesticides are high efficiency and low toxicity pesticides and the methods are correct. But the fusarium head blight in the two counties is serious and it can not be controlled easily.

For the number of times that pesticides are used, they are can not be reduced. Usually, one pesticide can prevent or control various disease pests. The number of times for control pesticides can not be reduced furthermore. If the disease-resistant variety is imported, bactericide can be used less.

2.3.2 Energy saving and emission reducing technology for local plant protection

2.3.2.1 Unified prevention and control technology

In the survey, as many farmers are lack of the knowledge for diagnosing disease pest and using pesticides scientifically, they mainly depend on the recommendation of dealers. As the pesticide operators are excessive, and the selling means are various, many famers are at a loss for choosing pesticides and they may have their choice by hearsay. The misunderstanding for using pesticides also exists, such as adding pesticides casually, adding the number of spraying pesticides, spraying pesticides whenever they see a pest. According to the technicians in Huaiyuan County in Anhui Province, in the regeneration period of rice, the disease pests can be sprayed for 3-4 times and weeds are killed 1-2 times. The whole costs of pesticides are RMB 200 / mu and if the pesticides are not serious, pesticides can be reduced.

As the technology is not powerful enough, dealers can not diagnose the damage of disease pests and they always persuade farmers to use pesticides more and more, or persuade them to use several kinds of pesticides together. However, famers can not broadcast whether exactly and they usually spray pesticides when pests are found. It may cause the increase of pesticides and the inefficiency of control and it may also cause the resistance to pesticides increase.

So the disease pests, weeds should be diagnosed exactly and forecast should be predicted. Pesticide application instrument is expected to be improved and the shelter for pests should be avoided. Centralized control should be handled one one-off to get the effect of control pests and reduce the quantity of pesticides.

2.3.2.2 Model application of new pesticide and new technology

Demonstrate and promote high-efficient new pesticides, multifunctional mixtures, new botanical pesticides and high-efficient technologies in pesticide selection and applications.

2.3.2.3 Model application of new protection machine

The agricultural mechanization elevates labor productivity substantially, promotes to increase grain yield and improves the quality of crops. The new plant protection machine in use can solve such problems as low efficiency and low effective utilization of traditional pesticide application, largely reduce pesticide application and enhance working efficiency to achieve energy conservation and emission reduction.

2.3.3 Measures for energy conservation and emission reduction

For integrated pest control, we can enhance the socialization services and informationization services, as well as demonstration and promotion to improve pest control and realize energy conservation and emission reduction.

2.3.3.1 Build an integrated pest supervision system in the demonstration area

Enhance pest monitoring and field investigation, advocate pests and diseases control and adopt classified guide to realize scientific control on disease and pest. Guide the farmers to carry out disease and pest control after determining the control object and optimum control period based on local disease and pest situation.

At present, the project area is fully equipped for disease and pest prediction and forecast except for such mobile field observation device as rapid microclimate tester, mobile spore capture instrument and tool box for observation and prediction.

To predict the occurrence of disease and pest, it is necessary to analysis the local historical materials and create an occurrence database for disease and pest.

2.3.3.2 Train technicians and farmers

Provide training for agricultural technicians and farmers to help them to learn occurrence regularity of the disease and pest. However, it is preferable to train farmers by the trained technicians and in this way the whole demonstration area will be covered. Train the technicians during slack season by providing lectures and train the farmers mainly by field instructions.

Prepare relevant materials before training, and then systematically explain regularity of disease and pest, knowledge of scientific pesticide application and IPM technology.

2.3.3.3 Organize a professional team for disease and pest control

Organize a high-quality team to scientifically select appropriate pesticide and purchase large-sized spraying machine backed by plant protection professional cooperatives to realize unified provision and control.

2.4 Risk of commonly used pesticides for rice crops on eco-environment

Pesticide used in rice field will enter the waters with field water leakage, artificial drainage and surface runoff generated by rainfall. The pesticide polluted water may imperil aquatic life (Fish and shrimps) and may cost aquatic lives for acute intoxication. Furthermore, the survived aquatic lives in which pesticide has been absorbed and accumulated may endanger people's life through food chain.

2.4.1 Classification of pesticide toxicity

Classification of pesticide toxicity determines application scope of the pesticide and attention degree of the producer, seller and user for their own safety. The WHO recommended standard classification of pesticides was approved by legislative sessions of WHO in 1975. Hazard of the pesticide is mainly classified according to LD₅₀ value of acute oral and dermal toxicity.

Table 2-4-1 The WHO Recommended Classification of Pesticides by Hazard

Classes of pesticide toxicity	Semiotics of those classes	LD ₅₀ of oral toxicity in mice(mg/kg)	LD ₅₀ of dermal toxicity in mice (mg/kg)
Ia	Extreme high toxicity	<5	<50
Ib	High toxicity	5-50	50-200
II	Moderate toxicity	50-2000	200-2000
III	Low toxicity	>2000	>2000
U	Acute toxicity is not indicated		≥5000

Note: The WHO Recommended Classification of Pesticides by Hazard, 2009

2.4.2 Pesticides having high toxicity and high risk to aquatic lives

Water pollution generated by pesticides used in rice field is the main cause of the hazards to aquatic lives (Fish and shrimps). Pesticides commonly used in rice field can be classified according to their toxicity to the fish (Table 2-4-2).

Table 2-4-2 Standard of classification of pesticide toxicity to fish

Classes of pesticide toxicity	96h LC ₅₀ (mg/L)
Extreme high	≤0.1
High toxicity	0.1-1.0
Moderate toxicity	1.0-10
Low toxicity	>10

Toxicity of pesticides to fish: high-toxic pesticides: Carbofuran, 1605, sodium pentachlorophenate, deltamethrin, sumicidin and rotenone, etc. Moderate-toxic pesticide: dipterex, DDVP, monocrotophos, phenthoate, malathion, fenitrothion, kitazin, isoprothiolane, etc. Low-toxic pesticides: carbendazim, methamidophos, bisultap, MTMC, BHD, chlordimeform, validamycin and tetrachlorophthalide, etc. Pesticides that cause high toxicity and high risk to aquatic lives are listed in Table 2-4-3.

Table 2-4-3 Main Pesticides Causing High Risk to Fish

Pesticide	LC ₅₀ (mg/L)	Toxicity to fish	Toxicity of the pesticide (WHO 2009)	Pesticide	LC ₅₀ (mg/L)	Toxicity to fish	Toxicity of the pesticide (WHO 2009)
Organochlorine pesticide				Organophosphorus pesticide			
Hexachloro-cyclohexane	0.31	High toxicity	II	Pirimioxyphos	0.22	High toxicity	
DDT	0.22	High toxicity	II	Chlorpyrifos	0.13	High toxicity	II
Dieldrin	0.018	Extrem	O	Phoxim	<1.0	High	II

		e high				toxicity	
		toxicity					
Endosulfan	0.0072	Extrem	II	Triazophos	5.62	Moderate	Ib
		e high				toxicity	
		toxicity					
Lindane	0.036	Extrem	II	Parathion-met	0.55	High	Ia
		e high		hyl		toxicity	
		toxicity					
Pyrethroid pesticides				Other pesticides			
Fenvalerate	6.77×10 ⁻³	Extrem	II	Fipronil	0.43	High	II
		e high				toxicity	
		toxicity					
Deltamethrin	0.54×10 ⁻³	Extrem	II	Chlorothalonil	0.11	High	U
		e high				toxicity	
		toxicity					
Cyhalothrin	0.25~0.45	High	II	Ziram	0.075	Extreme	II
		toxicity				high	
						toxicity	
Fenpropathrin	0.25~0.45	High	II	Azocyclotin	0.012	Extreme	II
		toxicity				high	
						toxicity	
Tetramethrin	0.18	High	U	Pentachloroph	0.1	High	Ib
		toxicity		enol		toxicity	
Cyfluthrin	≤0.5	High	Ib	Folpet	0.12	High	U
		toxicity				toxicity	
Flucythrinate	0.52	High	O	Dinoseb	0.07	Extreme	O
		toxicity				high	
						toxicity	
Fenvalerate	6.8×10 ⁻³	Extrem	II	Anilazine	0.095	Extreme	O

	³	e high				high	
		toxicity				toxicity	
Cypermethrin	1.78×10 ⁻³	Extrem	II	Butachlor	0.32	High	III
		e high				toxicity	
		toxicity					
Carbamate pesticide				Carbendazim	0.61	High	U
						toxicity	
Carbofuran	1.4	Modera	Ib				
		te					
		toxicity					
Carbosulfan	0.55	High	II				
		toxicity					

Note: Classification of toxicity (WHO 2009)

2.4.3 Pesticide application for rice crops in Wanfu Town

Table 2-4-4 Common Diseases and Pests of Rice Crops in Wanfu Town and Conventional Control Pesticides

Common disease, pests and weeds	Conventional control pesticides
Cnaphalocrocis medinalis, rice planthopper, sesamia inferens	Virtako(III), chlorantraniliprole(III), emamectin benzoate(III), abamectin(III), pymetrozine, buprofezin(III), Chlorpyrifos(II), BPMC(II)
Sheath blight, rice blast, false smut	Tricyclazole(II), tebuconazole (II), difenoconazole (U), thiophanate methyl (U), carbendazim (U), kasugamycin(U), validamycin(U), bacillus cereus(U)
Digitaria sanguinalis, barnyard grass, cyperaceae, leptochloa, alternanthera philoxeroides and monochoria vaginalis	Bensulfuron methyl(U), cyhalofop-butyl(U), bentazone(II), butachlor(III), pretilachlor(U)

Note: Classification of toxicity (WHO 2009)

Organophosphorus pesticides with moderate and low toxicity used in rice pest control such as chlorpyrifos and triazophos are used to control rice borer. However, they can be very toxic to aquatic life and honeybee, so the use is restricted. The toxicity of

pyrethroid pesticides is moderate or low. Although it has characteristics such as high efficiency, broad spectrum, high efficiency in pest control and low residue, but it is forbidden to be used in paddy fields for a long time because it is very toxic to aquatic life and may result in rice planthopper rampant. Carbamate pesticides are mainly used for planthopper control, such as BPMC, MTMC, isoprocarb and dimethacarb. The advantages of this kind of pesticide include good planthopper control effect and strong knockout ability. Disadvantages include short effect. Some are selective and have a less kill ability to their natural enemies than organophosphate. Pymetrozine of heterocyclic pesticide has significant effect on planthopper and brown planthopper control and high control efficiency. The pesticide has high selectivity and low toxicity to mammal, and is safe for birds, fish and non-target arthropods. Main biological pesticides used for rice include abamectin, spinosad and emamectin benzoate. New rice pesticides in recent years include chlorantraniliprole and flubendiamide etc. Chlorantraniliprole with the trade name of Dupon Coragen is a kind of ryanodine receptor. It is characterized by broad spectrum, high efficiency and safety. It is mainly used for cnaphalocrocis control and has characteristics such as basipetal and acropetal conduction in plant, ovicidal properties, high efficiency, long effect and low toxicity. Table below shows the toxicity of pesticides mainly used for rice crops.

Table 2-4-5 Toxicity of Pesticides Mainly Used for Rice Crops

Name	Acute toxicity (Mice)			Toxicity				
	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀ (mg/kg)	Inhalation (4h) LC ₅₀ (mg/kg)	of the pesticide (WHO 2009)	Green algae EC ₅₀	Water flea EC ₅₀ (48 h)	Fish LC ₅₀ (96 h)	Soil and water
Pesticide								
Chlorantr aniliprole	>5000	>5000	> 2 mg/l	III	5d/ > 20 mg/l	35 ug product/L	> 9.9 mg/l	
Thiametho xam	>5000	>2000	> 2.56 mg/l		4d/ > 97 ppm	> 106 ppm	> 100 ppm	Degradable in soil and stable in

								water
Abamectin	300	> 1800	3.5 mg/l	III	9d/ > 100 ppm	> 0.34 ppb	3.6 ppb	Degradable in soil and stable in water
Emamectin benzoate	2950	> 2000	9.6 mg/l	III	5d/ > 3.9 ppb	>1 ppb	174 ppb	Stable in soil and water
pymetrozine	>5000	>2000	> 3.09 mg/l		5d/ 17ppm	87 ppm	>128ppm	Stable in water
Lambda-cyhalothrin	92.91	>2000	> 0.55 mg/l	II		0.04 ppb	0.19 ppb	Degradable in soil and water and immovable in soil
Imidacloprid	768	>5000	> 1.752 mg/l	II	3d/>100 mg/L	85 mg/L	237 mg/L	Immovable in soil
Chlorpyrifos	135-163	>2000	>0.2 mg/l	II		1.7 µg/l	0.003 mg/L	Slowly degradable in soil
Bactericide								
Cyproconazole	>2000	>4000	> 5.0 mg/l		5d/0.026 ppm	26 ppm	19 ppm	Stable in soil and water
Chlorothalonil	>5000	>2000		II	5d/190 ppb	70 ppb	47 ppb	Degradable in water and soil
Difenoconazole	3129	>2000	> 5.4 mg/l	U		0.77 ppm	1.06 ppm	Stable in soil and water
Propiconazole	1587	>2000	> 5.5 mg/l	II	9d/ 0.72 ppm	3.2 ppm	0.83 ppm	Degradable in soil and stable in water
Tebuconazole	3,776	>2011	> 2.5 mg/l	II	4d/ 15.2 mg/l	31.0 mg/l		

Carbendazim	>15000	>2000	10 g/l	U	3d/ 1.3 mg/l	0.13-0.22 mg/l	0.83 mg/l	
thiophanate methyl	>5000	>2000	> 2.0 mg/l	U	4d/ 0.8 mg/l	20.2 mg/l	7.8 mg/l	Maintained in the soil for 3-4 weeks
Carmazine	>5000	>2000	> 4.8 mg/l	U	2d/0.43 mg/l	0.073 mg/l	0.073 mg/l	Dangerous to fish and may cause pollution to water or aquatic lives
Kasugamycin	>5000	>2000	> 4.892 mg/L	U				
Herbicide								
Bensulfuron methyl	>5000	>2000	>7.5 mg/l	U		>100 mg/l	>150 mg/l	
Cyhalofop-butyl	>5000	>2000	>5.63	U		>100 mg/l	1.65 mg/l	
Bentazone	>5000	>2000	>3.34	II	3d/ 47.3 mg/l	125 mg/l	>100 mg/l	Maintained in the soil for 6-18 weeks
Butachlor	>5000	>2000	>3.34 mg/l	III		2.4 mg/l	0.52 mg/l	Maintained in the soil for 6-10 weeks
Pretilachlor	6099	3100	>2.8 mg/l	U	0.002 mg/l	13 mg/l	2.7 mg/l	High absorption capacity, no leaching

The table below shows the application guideline for bactericide, pesticide and herbicide commonly used for rice:

Table 2-4-6 Application Guideline for Bactericide, Pesticide and Herbicide
Commonly Used for Rice

Name	Object	Formula tion	Content (%)	Suggested dosage (g ai/hm ²)	Application method	Maximum application frequency	Safety intervals (Day)
Isoprothiolane	Rice blast	EC/WP	40	400~750	Spray	3(Early rice) 2(Late rice)	14(Early rice) 28(Late rice)
Tricyclazole	Rice blast	WP	75	225~303.75	Spray	2	21
Kasugamycin	Rice blast	LD	2	24~30	Spray	3	21
Thiophanate methyl	Rice blast and sheath blight	WP	70	1050~1500	Spray	3	30
Chlorantraniliprole	Borer and cnapthalocrocids	SC	20	15~30	Spray	2	15
Pymetrozine	Rice planthopper Borer,	WG/WP	50/25	60~90	Spray	2	7
Chlorpyrifos	cnapthalocrocids and rice shell pest	EC	20/40/48	300~600	Spray	3	14
Bensulfuron methyl	Annual weed	WP	10/30	22.5~37.5	Spray or pesticide-clay mixture	1	-
Cyhalofop-butyl	Gramineous weeds	EC	10	60~90	Spray	1	-

Butachlor	Annual weed	EC/G	60/5	747~1278	Spray or pesticide-clay mixture	1	-
Cyhalofop- butyl	Broad leaf weeds and cypereales	LD	48	957.6~1440	Spray	1	-

Note: Pesticides formulation in both English and Chinese: EC (emulsifiable concentrate), WP (wetable powder), LD (liquid), SC (suspension concentrate), WG (water dispersible granules) and G (granule).

2.4.4 Control measures on harmful effect to aquatic organism by using pesticide

(1) Regarding the use of pesticide varieties high toxic to aquatic organism in the paddy field, make ecological risk assessment to aquatic organism. Forbid (or restrict) the use of pesticide varieties in the paddy field that have a great harmfulness and influence to aquatic organism, and, the use of some organophosphorus pesticides, carbamates pesticides and pyrethroid pesticides that are extreme high toxic to aquatic organism in the paddy field should be prohibited. Low toxicity and high efficiency biological source pesticide and bactericide are mainly recommended in chemical control, for instance, the mainly used biological pesticide varieties in the paddy field are validamycin and wax gemma bacillus, which can prevent rice sheath blight, and kasugamycin, which can prevent rice blast.

(2) For pesticide varieties that have a relatively high risk and great harmful influence to aquatic organism, strict management measures should be taken if they are used in rice field or other paddy field. In order to prevent the pollution influence to water by pesticide, the maximum acceptable concentration of water pesticide should be determined according to the toxicity to aquatic organism by pesticide.

(3) During agricultural production, to prevent the influence to aquatic organism by pesticide, the rice safe drainage period should be determined according to the pesticide degradation half-life, the dosage of pesticide and the water depth of rice field.

(4) Change the pesticide formulation and improve the application method are recommended for alleviating the harmful influence to aquatic organism. And, for

pesticide varieties with strong water solubility and long degradation half-life, if they are changed to the form of slow-release particle, it should be appropriate.

2.5 The occurrence of tree pests and diseases

In the demonstration area, we will carry out model application of carboning technologies with agriculture and forestry. We need to grow a lot of trees and carry out the research, according to the main trees diseases and insect pests of growing period. Then we can take a development of integrated control measure for reducing the tree diseases and pests.

2.5.1 Root-feeding insect

It is very difficult to prevent the pests' occurrence, because root-feeding insects live in the soil. The root-feeding insect mainly feed on the tree seeds or young plants. Most of root-feeding insects live in a stable environment, their life cycle are long and mobility are weak, they move and act according to soil's temperature variation. Because the root-feeding insects' occurrence is related to the soil's character, water content and not rotting organic matter content. It's very useful for control the root-feeding insects' occurrence to change the environment. The main common root pests like grub, Cutworms and mole cricket.

2.5.2 The topmost pests

The topmost pests mainly feed on topmost, young stem and leaf, it affects tips' and main stems' growth. When the pests occur seriously, it causes loss of green leaves, some can cause coal pollution disease and affect plants' growth. Common kinds of topmost pests like coccid, dioryctria splendidella, aphid, phylloxera and mite.

2.5.3 Defoliator

Defoliator is the ornamental trees' and shrubs' main pest. There are many kinds that mainly belong to four orders of insects, like lepidoptera, hymenoptera, coleopteran and a part of orthoptera. Defoliator mainly feed on the health trees, it causes weakening the trees' potential and death for createing the happening conditions of stem boring pest as longicorn. Most of defoliators happen intermittent and periodicity, a large population cause a large damage of ornamental trees and shrubs. In addition, lepidoptera pests are mostly larvae to damage. They eat more after G4, so we need to treat early between G1 and G3. The main common defoliator like pine moth, looper,

loudonta dispar Kiriakoff, lymantriid.

2.5.4 Trunk borer

There are many kinds of trunk borer, mainly including scolytidae, cerambycidae and some of termitidae. The trunk borer lives in a hidden place. It's difficult to find in initial stage. The trunk borer mainly feed on the trees of sub-health state and create the conditions for other pests. So we need to plant disease-resistant species, optimize tree species collocation and enhance the management of water and fertilizer for reducing the pests. The main trunk borer like Sawyer, termites and cryptorrhynchus lapathj Linne.

2.5.5 Common diseases

There are a lot of pathogens caused illness of trees, which mainly introduces landscape destruction, tree diseases, and the death of biological pathogens as following. Biological pathogens will infected individuals first that the formation of disease center, and then from the infected trees spread to healthy trees around, the infection is more and more serious. Common diseases such as: rust, anthracnose, powdery mildew, root rot, leaf blight, leaf spot disease, brooming etc.

Table 2-5-1 The main plant diseases and insect pests of willow trees category

Species of plant diseases and insect pests	Generation times per year	Occurrence time of each generation
Leucoma candida	2	The overwintering generation larvae (Between early April and the end of May), The first generation larvae (Between late June and early August), The second generation larvae (mid-september).
Anoplophora glabripennis	1/(1-2 years)	Pests occurring stage: Between early June and early August; Development stage: July; Eggs stage: Between mid-June and mid-August; Larvae hatching stage: Between mid-July and late August.
Populus tomentosa Carr Nadezhdiella cantori(Hope)	1/(1-3 years)	Larval stage: Between April and June & August and November; Adult stage: July.
Cossidae	1/(2 years)	Adult spawning stage: Between May and June; Larvae hatching stage: Between June and July; Larvae can stay in wood to make damage about 1 years
Clostera anachoreta	4	The first generation larval stage: Between early May

		and late May, The second generation larvae stage: Between mid-June and early July
		The third generation larvae stage: Between mid-July and late July, The fourth generation larvae stage: Between mid-August and late September.
Tetranychus cinnabarinus	5-6	Pests occurring stage: early May; The most serious damage stage: Between June and July; damage deciduous leaf stage: July.
Drosicha contrahens	1	Pests occurring stage: early and mid-February; bulk climbing tree stage: early and mid-March; damage stage: Between March and June.
Populus tomentosa		
Lopholeucaspis jopomca	2	The first generation larvae hatching stage: Between late May and mid-June; The second generation larvae hatching stage: Between late July and mid-August.
Cockerell		
bacterial canker disease		Mainly damage new transplanting and weakened trees, and the most serious damage times is between April and May.

3. Our policy and standards in plant protection and pest management

3.1 Integrated pest management

Integrated pest management (IPM) is, starting from the overall situation and based on the whole agricultural ecosystems, aimed at achieving the high and stable yield by economically, safely and efficiently controlling the pest damage through organically using various kinds of necessary controlling measures and, while putting prevention first, making full use of the natural factor and creating the conditions that are unfavorable for the occurring of pest damage. The basic idea of IPM is, based on making maximal use of natural regulation factors and assisted by adopting measures such as agricultural control, biological control, physical control and chemical control, etc, to establish an ecosystem that is unfavorable to the occurring of pest damage so as to promote the sustainable development of agriculture. The pest control working policy of “giving priority to prevention and integrated prevention” is determined in national plant protection work conference held in 1975. In April, 2006, ministry of agriculture proposed the concept of “public plant protection and green plant protection”, which further strengthen the guiding thought of pest pollution-free sustainable control, thus guiding our pest control work into a new phase. Through the

summary of lessons learned from dozens of years, we reacquaint and evaluate the function of pesticide and emphasize the importance of keep the environment ecological balance, and propose that the chemical control is the final choice for integrated pest management while striving to adopt multiple methods and measures for making the pest control accord with the three “economic, social and ecological” benefit requirements. The national and local related departments successively enact and implement a series of laws, regulations, standards, methods, rules and norms, and, through the implementation of these laws and regulations, make the IPM get a further promotion and application.

(1) *Law of the People's Republic of China on Quality and Safety of Agricultural Products* (Order No.49 of the President of the People's Republic of China, approved by the 21st Session of the Standing Committee of the Tenth National People's Congress of the People's Republic of China on April 29, 2006; implemented since November 1, 2006). The law is hereby formulated to guarantee the quality and safety of agricultural products, maintain public health and promote and the agricultural and rural economic development. The agricultural products as specified in the law mean the primary products sourced from the agriculture, namely, the plants, animals, microorganisms and other products from the agricultural activity;

(2) *Regulations on the Pesticide Control of the People's Republic of China* (Issued by the State Council, implemented since May 8, 1997 and revised on November 29, 2001). The regulations are promulgated to strengthen the supervision of pesticide production, operation and application, guarantee the quality of pesticide, protect agricultural production, forestry production and ecological environment, and maintain the safety of people and livestock;

(3) *The Measures for the Implementation of Pesticide Management Regulations* (published in Ministry of Agriculture on April 27, 1999 and revised on January 8, 2008). The measures are published to ensure the implementations of *Management Regulations of Pesticides* (abbreviated as *Regulations* to improve pesticides registration and the operated and used supervision management, to improve the progress of pesticide industry technology and stable development of agricultural producing, to protect ecological environment and to ensure the safety of human-beings and animals. They are formulated according to the related rules of *Regulations*.

(4) *Regulations on Pollution-Free Agricultural Product* is published by General Administration of Quality Supervision, Inspection and Quarantine of the PRC of Ministry of Agriculture in 2002. The regulations is published to intensify the management of pollution-free agricultural product, protecting rights of consumers, improving agricultural products, protecting agricultural ecological environment and improving agricultural sustainable development.

(5) *Regulations on Plant Quarantine* (Published by State Council on January 3, 1983 and revised according to *Decision of the State Council Concerning the Amending of Regulations on Plant Quarantine* on May 13, 1992) is published to prevent the spread of dangerous diseases, pest, and weeds and to protect agricultural and forestry producing safety.

(6) The related national standard:

- a) The Pesticide Safety Use Standard GB4285-84;
- b) The Standard for Pesticide proper Use (I) GB/T8321.1;
- c) The Standard for Pesticide Proper Use (II) GB/T 8321.2;
- d) The Standard for Pesticide Proper Use (III) GB/T 8321.3;
- e) The Standard for Pesticide Proper Use (IV) GB/T 8321.4;
- f) The Standard for Pesticide Proper Use (V) GB/T 8321.5;
- g) The Standard for Pesticide Proper Use (VI) GB/T 8321.6;
- h) The Standard for Pesticide Proper Use (VII) GB/T 8321.7;
- i) The Standard for Pesticide Proper Use (VIII) GB/T 8321.8;
- j) The Standard for Green food Use NY/T393-2000;
- k) The maximum residue limit of pesticide in food GB2763-2012;
- h) The Antitoxic Regulations for Storing, Transporting, Selling and Using Pesticides GB 12475-2006;

3.2 Unified prevention and control for the pests

After household contract responsibility system is implemented in 1981, the pest control system that is used for more than 20 years is dissolved. The pest control

system is changed into farmers' dispersed spraying control. However, 1983 No. 1 document — *The Current Village Economic Policy Issues* indicates “The commune that mainly manages family splitting, should deal with the things that are needed by most commune members according to the requirement of producing development and the principles of mutual benefit, such as tractor-ploughing, water conservancy, plant protection, epidemic prevention, production of hybrid seeds, hybridization and so on and all the procedures should be arranged wholly, managed uniformly, contracted separately. Besides that the system should be formed and farmers should be mainly serviced. The rudiment of professional control exists in the “plant protection”, “all the procedures should be arranged wholly, managed uniformly, contracted separately. Besides that the system should be formed and farmers should be serviced mainly”. Then on May 23, 1983, National Economic Council, ministry of fisheries, Ministry of Finance, Ministry of Commerce, Ministry of Chemical Industry, Ministry of Machine-Building Industry and Agricultural Bank of China publish *Joint Notification about Active supporting and developing plant Protection Company* together and the words “professional control” is indicated. In the joint notification, the organization form, organization development, economic efficiency, social efficiency and supporting policy are introduced in detail. Under the encouragement and support of government, the professional control organization is greatly developed in the 1980s.

For adapting the modern agricultural development requirement and improving pest control organization and scale level, the No.1 document in 2008 indicates “implore and establishing professional control team, improving unified prevention and control for the pests of major plants”. The professional control work should be explored and after 2 years of attempt, No.1 document in 2010 clearly indicates “greatly promoting professional unified prevention and control for crop pests” to require professional control.

In Agricultural Office in Ministry of Agriculture N [2010], No. 31 document (*The Issued 2010 Agricultural Disease Pest Professional Unified Control Technology Model Work Plan*) indicates that according to Scientific Outlook on Development, the plant protection policy of “Prevention and Integrated Control” should be implemented and plant protection concept of “Public Plant Protection, Green Plant Protection” is considered as the purpose. According to the principles of government support, market operation, farmers’ volunteer, step by step method, increasing control, reducing costs, reducing pesticides, and insuring production are considered as the main purposes and

intensifying projects, purifying technology, creating service and regulating management are considered as the main breakthrough. The agricultural disease pest professional service organization is expected to be developed largely and the service field and service scope should be developed gradually. The quality and level of pest control should be improved and the major pest control ability should be improved totally.

4 PMP Integrated pest management plan

4.1 The goal of implementation

(1) Integrate and demonstrate integrated pest control technology and reduce chemical pesticide dosage by 20%;

(2) Recommend WHO Class III and Class U pesticides in the demonstration area of the project, and prohibit using Class I pesticide, do not use Class II pesticide and enhance farmers' level for technical and rational pesticide application;

(2) Enhance cognition and ability of farmers' application for integrated pest management;

(3) Standardize the production and sale of pesticide step by step and promote safety production, sale of agricultural chemicals;

(4) Ensure that the crop yield is free from loss base on project implementation;

4.2 Key task

PMP integrated pest management plan is implemented in two demonstration areas of the project which are Ye County, Henan Province and Huaiyuan County, Anhui province.

The following key points should be implemented:

(1) Introduce and promote PMP technology, protect and utilize natural enemies recourse, enhance forecast prediction and informatization for agricultural pest, diagnose and obtain the information about diseases, pests and weeds accurately, announce forecast and prediction, guide farmers to use pesticide duly, reasonably and effectively, enhance utilization rate of pesticide furthest, and keep the pest amount to be the level which is approved according to economic harm combining with technology of the integrated pest control and the unified prevention and control.

(2) Demonstrate and promote efficient and new pesticide and new technology in area of the project. If high-active pesticide control result is good, it can sharply reduce pesticide dosage. Add spray additives in pesticide solution, enhance the scatter performance of pesticide solution, increase sticky ability of pesticide solution, improve the utilization rate of pesticide and reduce pesticide dosage;

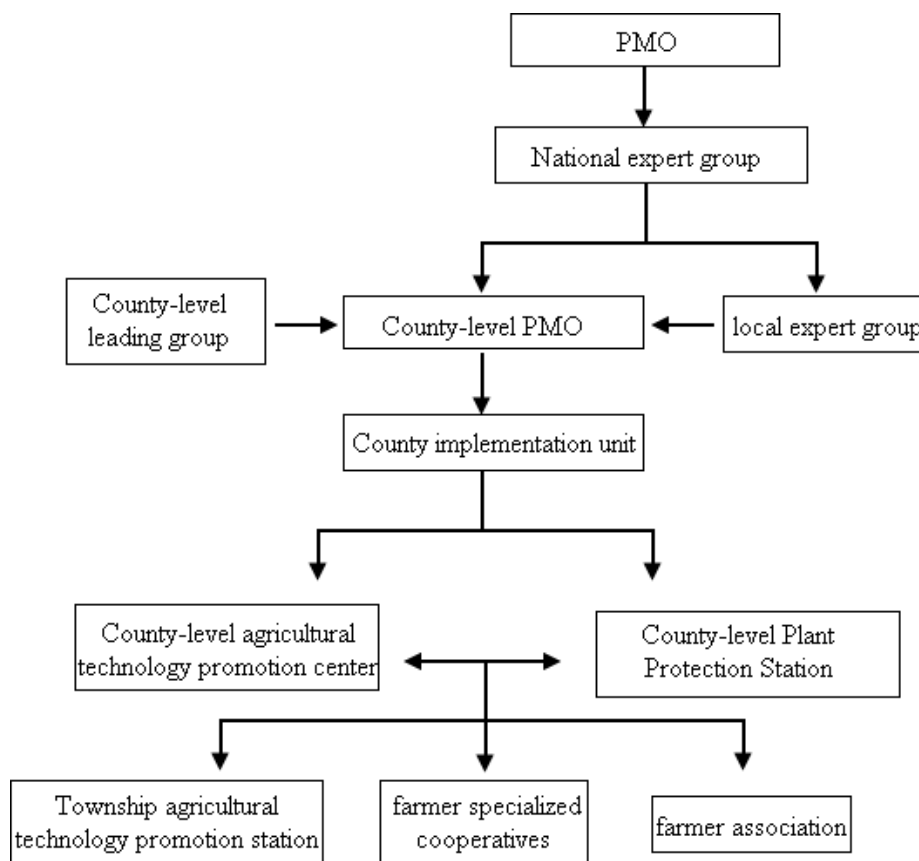
(3) Promote new-style agricultural plant protection machine in area of the project. Solve the problem that the efficiency of traditional pesticide application is low and utilization rate is also low through demonstration for new-style agricultural plant protection machine. Reducing pesticide dosage sharply and improving operation efficiency can achieve the aim of energy conservation and emission reduction;

(4) Promote professional control for plant protection in demonstration area of the project, implement social service for plant protection, comply with plant protection policy which is “prevention first and integrated control” and make advanced devices and technologies to implement safety efficient and unified prevention and management for the pests for crops in growing period by legal service organization with plant protection professional technical condition;

(5) Improve the actual operation skill of farmers through specialized technical and promoted training for farmers, make farmers to have integrated pest management skill, make the training of pesticide storage and using for farmers in area of the project, improve the management and use rule for pesticide and provide the training for agricultural technicians, pesticide dealers, counties and cities institution of project, improve their cognition for pest management plan (PMP).

4.3 Implementation arrangements

4.3.1 Management agencies



4.3.2 Institutional settings and responsibilities

The national project management office hired experts to set up a plant protection advisory group. The expert group includes nation group and local group.

Main responsibility of the nation expert group: drafting the scheme of pest management plan and pesticide reduction application technology and directing the PMP implementation of the project construction agencies in subordinate cities and counties. Assist in organizing study tour activities, to establish contacts with international PMP project. Preparation of field operations instruction manual, as well as other work related to the PMP project.

Main responsibility of the local expert group: assist in drafting the scheme of pesticide reduction application technology. Provide technical assistance to the PMP technical problems. Involved in the training of project personnel.

County implementation unit: Municipal and county-level Plant Protection Station is responsible for organizing the implementation. County-level agricultural technology promotion center is the project's commitment unit and is responsible for

technical training of the technical personnel of the township. The promotion center should take effective approaches and measures, to ensure that the successful implementation of the works of local PMP.

Township agricultural technology promotion station is responsible for guiding the investigation of the farmer association on plant diseases, insects and weeds, and subsequently reporting to the county (city) level of agriculture bureau. Under the guidance of the county (city) level agriculture bureau, the promotion station is responsible for organizing the implementation of IPM programs, and technically guiding and training the involved farmers.

4.4 The content of implementation

4.4.1 Unified prevention and control technology

Promote plant protect professional control in demonstration area of the project, implement social service for plant protection for pest unified prevention and management, implement unified prediction and forecast, unified prescription and dispensing, unified control with pesticide in demonstration area, means: as requirement of modern agricultural development , comply with plant protection policy of “prevention first and integrated control”, make advanced devices and technologies to implement safety, efficient and unified prevention and control for pest of crops in growing period that it is a kind of contract service behavior in the whole process.

Promoting professional unified prevention and control can get the advantages of three aspects: firstly, reduced pesticide dosage, production cost and the pollution for environment. Service organizations bought efficient, low-toxic and large package pesticide, applied pesticide by the motor driven sprayer which is efficient and is good at pesticide application, that reduced pesticide pollution and solved the problem of pesticide packaging non-point source pollution; secondly, improved sharply control efficiency for pest; thirdly, ensured crops production, agricultural products and agricultural environment to be safe. Unified prevention and control organizations from different places implemented that they chased big package pesticide from factories uniformly and dispensed pesticide uniformly and implemented unified operation as professional unified prevention and control technical requirement, checked result after pesticide application uniformly, thereby prevented the behavior of

the entrapping farmers that the prescription abuse and wrong prescription are provided, prevented this kind of unscientific behavior that farmers applied pesticide as long as they found the pest and ensured crops production, agricultural products and agricultural environment to be safe fundamentally.

4.4.2 Model application of new pesticide and new technology

The chemical control method is the most economic and effective method of pest control for the crops. This method has such advantages as quick effect, desirable control effect and simple application. However, there is improper processing, which will result in environmental pollution, affect the safety of people and livestock and cause phytotoxicity, etc. When the farmers use chemical control method in the project area, they do not have PMP concept or do not use the pesticides and application method that have a low impact on people and livestock as much as possible to reduce agricultural environmental protection as the result of chemical pesticides. As the high-toxic pesticide is banned, the substitutes for high-toxic pesticide have been continually developed, high-activity pesticides have ideal control effect to substantially reduce the usage of the pesticides and the environment-friendly pesticides developed reduce the environmental pollution by the pesticides largely. In addition, the same kind of pesticides always comprises different dosage forms. The good pesticide has high dispersity and improves the pest control effect. The different aids can be added to improve pesticide effect in pesticide application so as to reduce the dosage of application. Furthermore, the application of various new pesticide technologies can reduce the pesticide used in the crop cultivation, e.g. straw mulching for weed control, seed processing technology, soil treatment technology, etc.

4.4.3 Model application of new plant protection machine

At present, the main application of plant protection machine is spraying machine, which plays a vital role in pest chemical control. Along with the improvement of people's requirement on living environment, how to improve the pesticide's service efficiency and effective availability and how to avoid or alleviate the influence to non-target organisms and the pollution to environment have been two scientific problems facing the pesticide use technology and its research of spraying instrument. At present the effective availability for domestic pesticide is only around 20%, and the 80% pesticide may drift into atmosphere, fall into water, or cause harms to human

and etc. The major advantages of new plant protection machine are embodied in the improvement of machines and tools working efficiency and the effective availability of pesticide while in decrease of the pollution to environment and the harms to human. The main recommended plant protection machines for this project include: wide boom sprayer, electrostatic sprayer, low altitude spraying equipment, ultra-low-volume and low-volume sprayer, smoke sprayer, etc.

4.4.4 Pest and disease control of trees

Trees were planted in project area because of demonstration of carbon sequestration technologies. Integrated control measures should be designed in order to reduce the damage caused by disease and pest.

Table 4-4-1 PMP activities

Activities	Activity content	The specific activities	output
Demonstration of pesticide reduction and integrated pest control technology	Demonstration of new pesticide and new technology	1) Select 2-3 kind of high-efficiency and new pesticide, bactericide and herbicide for each crop every year to demonstrate and promote; 2) Application and demonstration promotion of selecting seed processing technology for each crop; 3) Application and demonstration of 3 kind of synergistic adjuvant for the commonly used pesticide, bactericide and herbicide; 4) The application and demonstration and promotion of straw mulching for weed control.	The implementation plan of demonstration technology, Evaluation report of economic efficiency for demonstration technology; Carry out new pesticide and new technology training for farmers
	Demonstration of new plant protection machine	1) Using electrostatic sprayer to carry out the demonstration and promotion of disease pest control 2) The application and demonstration and promotion of wide boom sprayer 3) The application and demonstration and promotion of thermodynamic smoke sprayer;	The implementation plan demonstration technology; Evaluation report of economic efficiency for demonstration technology, Carry out training for the use of new plant protection machine
	Pest and disease control of trees	1) Drafting the disease and pest control schedule 2) Carry out controlling activities according to the schedule.	disease and pest control schedule, Controlling activities

4.4.5 Farmers training

4.4.5.1 Training target

Farmers are the main part for project implementation. The farmers training is an important content of pest control, through training, the trained farmers will improve their IPM knowledge, plant protection skill and strengthen their sense of ownership of environment protection and IPM activity participation.

Annual training target tasks for demonstration counties for each project:

Farmer professional technology training: 500 persons/year;

Farmer popularization training: 50,000 persons/year;

4.4.5.2 Training method

Training includes the farmer professional technology training and farmer popularization training. The farmer popularization training can be undertaken through participative training and flow training.

Agricultural professional technology training, organized by national expert group:

Training mainly for model households of agricultural technology extension technology demonstration, grain producing individuals and agricultural technicians, etc;

Farmer popularization training, organized by county implantation unit:

Training mainly for model households of agricultural technology extension technology demonstration in demonstration area and its radiant households as well as all of the growers;

(1) Participative training: farmer field school should be set up in project implementation area, and instructors should be composed of agricultural extension staff at town level and farmer technicians who are specially trained and have rich pest management experiences. The instructors should, according to the actual situation of pest occurring at different growth stages of local agriculture crops in the field and the questions raised by farmers, give farmers targeted instruction and training in the field on how to carry out the pest identification and prevention, and strengthen farmer trainees' technical knowledge as well as cultivate their skills in organization, communication and management.

(2) Flow training: the project team should periodically organize the flow training group composed of experts coming from agricultural science institutes, colleges and

universities and extension agencies to give trainings to local agricultural extension staff, farmer technicians, farmers and pesticide dealers on the latest idea of IPM, the newest technology of pest harmless control, the safe use of pesticide technology and the related policies and regulations on merchandising and sales of pesticide, etc.

The following points should be paid attention to during training activities:

Firstly, provide good centralized trainings to farmer technicians, and by adopting multiple forms such as intensive classes given by experts and professors, experts answer doubts and so on, improve farmer technicians' scientific integrated qualities and their demonstration and leading abilities;

Secondly, every farmer should example and lead 20 farmer model households and, by the form of field technical demonstration and technology consulting, give full play to their exemplary and leading role for improving the model households' levels in scientific pesticide use and scientific farming;

Thirdly, adopt many forms, such as by giving live lectures by experts and technicians going into the farmer households and the field and by printing and distributing technical materials as well as making use of broadcast, TV stations and newspaper, etc, to increase the popularized training effort to many farmers and ensure the training quality and training effect.

4.4.4.3 Training plan and content

Training plan:

- a) IPM pest integrated treatment
- b) Common pest identification, occurring law and prevention method
- c) Modern pest monitoring technology and method
- d) Common plant protection machines and pesticide application technologies
- e) Pesticide safe and appropriate use
- f) Good agricultural practices for rice, corn and wheat

Training work plan should include two parts, training of agricultural professional technology and farmers' popularized training. Training work plan is listed below:

Table 4-4-2 Farmer Training Schedule

	Activity content	Specific activity content	Activity output
Farmer training	1) Compile training materials for agricultural technicians and farmers	1) Compile training materials for pest monitoring; 2) Compile training materials for common plant protection machines and pesticide application technology; 4) Compile training materials for good agricultural practices; 5) Compile training materials for pesticide safe and appropriate use;	1) 1) Complete the compiling of 4 training materials; 2) Complete the revision of 4 training materials;
	2) Organize training activities for agricultural technicians and farmers	1) Training of common plant protection machines and pesticide application technology; 2) Training of modern pest monitoring technology and method; 3) Training of pesticide safe and appropriate use; 4) Training of good agricultural practices for rice, corn and wheat	1) Print training materials: 5000 copies/year; 2) Train agricultural technicians: 500 persons/year; 3) Train farmers: 5,000 persons/year;
	3) Production of pest database, propaganda poster and training CD	1) Database, information submission and release system for pest occurring in project area; 2) Production of pest wall chart and CD for 3 common crops; 3) Production of poster and CD for pesticide safe and appropriate use;	1) Establish the database, information submission and release system for pest occurring in project area; 2) 5,000 copies/year respectively of pest wall chart and CD for 3 common crops; 3) 5,000 copies/year respectively of poster and CD for pesticide fair use technology

4.5 Integrated pest management for major crops

4.5.1 Rice

As for rice pest control, the personnel should always observe the changes in production, understand the objective laws of interrelations among pest, natural enemy and environment, and, on the basis of full utilization of local natural advantages and reasonable arrangement of crops pattern and farming system, establish a relatively stable favorable ecological balance. On this basis, further play the role of improved variety and natural enemy, and improve the cultivation management measures as well as apply the pesticide reasonably so as to control the pest harms under the allowed economic level.

4.5.1.1. Agricultural control technology

(1) Breeding disease resistant variety: we can take some key measures to control rice blast, such as breeding rice blast disease resistant varieties and bacterial leaf blight. Moreover, the disease-resistant variety is only relative, for once pathological race adapted to the new varieties, disease-resistant also becomes infection disease, so we need to breeding new disease resistant varieties at the appropriate time.

(2) Eliminate the source of pest

a) Completely processing rice stubs and weeds

There are varieties of pests spend their winter on the rice stub and weeds existing on the groove edge, such as rice borer, leafhopper, rice plant skipper and rice blast. We pick rice stub in winter; irrigate plasma field and plough timely in spring; eradicate weeds on groove edge, wipe out or lower the survival insect population which use for going through the winter. When we irrigate for plowing and harrowing fields in the seedling bed and Honda, if we pick up the wave slag floated on the surface in an organized way, it can greatly reduce the probability of sheath blight and stalk break in occurrence.

b) Processing weeds and grain with disease

There are many varieties of pathogenic bacteria and pests spend their winter on the straw, such as rice blast, bacterial blight, sheath blight, sheath disease, stalk break, chilo suppressalis, sesamia inferens and other bacteria and pests. We should distribute unhealthy straw and store them in a different place during reaping rice. Ensure that we burning those types of straw as earlier as possible and make the best use of them, the diseases grain should be eaten first, for diseases blighted grain and cereal chaff, they should be strictly kept and could be edible only after disinfecting and processing. There is no need for using disease straw to accelerate germination, cover seedling, bundle up seedling, return field, build house and put up a shed, if we can't avoid using straw to accelerate germination and bundle up seedling, bringing them to a boil at least 10 minutes before we use them. The fertilizer made of disease and pests need to be fully rotten. We should eliminate weeds in the field before spring sowing; seal the field with muddy and treading it to prevent the spreading and extending of pathogenic bacteria.

(3) Improving cultivation technology

The center is building an ecological environment which benefits rice seedlings growth and natural enemies' inhabitation & survival, but does not benefit the disease and pests reproduction. It aimed to improve the effect that rice resistance and endurance to disease and pests, as well as the effect for enhancing the ability to restrain disease and pests.

a) Select and use high yield variety which suit local environment and have the ability for resistance to disease and pests: there are so many different kinds of rice disease and pests variety, we should focus on the local variety, breeding good resistance variety with advantages such as multiply resistance, good quality and high yield, when we speed up reproduction and use the present good variety, we also need to pay attention to disease and pests physiological race and the dynamic state of biotype changes, continue to breeding new succession variety and carry out the work for purifying and rejuvenating good variety, to guarantee the sustained and steady good characters of variety.

b) Establish rational variety layout and farming system: according to the local climate and other natural conditions, highlighted its own variety, appropriately match early, middle and late variety rational layout, make the variety growth period, sowing period and cutting period fit with tassel maturity period. In the growth period which susceptible to disease and pests, avoid exceedingly adapt to the disease and pests occurrence period, especially in the place where the growth period is shorter, we strive to avoid invading by autumn cold snap during tassel period, so that we could reduce the loss. Moreover, on the variety and plant system layout, we also reduce "bridge girder" as far as possible, reduce disease and pests inhabit and the joint of nutrients source to lower its harm. We advocate planted soybeans in rice field, providing supplementary host (for example bean aphid) for predatory natural enemies such as spider and sheltered site. It benefits reproduction of natural enemies.

c) Using water scientifically, applying fertilizer, improving rice field niche: water is the necessary condition for invading, spreading, extending of many rice disease and pests. Bacterial blight, rice blast, sheath blight and *Nilaparvata lugens* need ecological niche with high humidity on the basis of water demand regulation of different variety, roast field timely. According to rice fertility characteristics, we insist on scientific principle for applying adequate fertilizer, applying additional fertilizer early, applying supplementary fertilizer skillfully, and mixing phosphorus and potassium fertilizer.

Guarantee growth and development of single rice and rice population and improve rice resistance to disease and pests.

4.5.1.2 Physical control technology

The pest control by using various physical agents and mechanical equipments is considered as physical control. The main methods are as follows:

(1) The main measures for disease and pests: artificial catching, picking egg mass, pullout dead heart group, trapping or luring to destruction

(2) Measures for disease and pests control: screening variety, remove disease grain, use 20% of salt water or muddy water soaking seed to remove disease grain, use basket seed also can reduce the invasion of pathogenic bacteria.

4.5.1.3 Biological control technology

Protect and utilize the natural enemies: first, we need to find out the quantitative distribution of the main pests in dominant species, and the high parasitic rate, large amount of predations, strong searching ability and tight following need to be screened accurately, as well as the strong ability for adapting to the local environment, ensure there are no other tough rivals, such as natural enemies species. Second, we need to do some research about dominant natural enemies, occurrence, and growth and decline regularity. Set up Practical protection and use methods; and revise the control index of the main pests in the rice field, reduce the drug as much as possible, promote the reproduction of natural enemies and the establishment of natural enemies in dominant species.

(1) Protect and use spiders in rice field

Spiders are important natural enemies of pests in rice fields. They have great effects on protecting rice from the main pests like plant hopper, rice leafhopper and rice borer. The dominant species of spiders in rice planting area in the north are *erigonidium gramincola*, *oedothorax insecticeps*, *lycosa pseudoamulata*, *theridion octomaculatum*, *tetragnatha* and so on. When the ratio of spiders to pests reaches 1:4~5, pesticides can't be used. If there are far more pests for spiders to control, in order to kill the rice leaf roller, leafhopper and adjust the ratio we can use pesticides which have less harm to spiders like isoprocarb, mtmc, mpmc + xmc to kill them or use used oil to flood them. As the spiders are wingless which have weak migration, we should take

appropriate measures to protect them in farming activities. Generally, when plowing and irrigating, we put sticks in field to help *erigonidium gramincola* to fly away as they can spin to fly; or we can drive them away after irrigating, then plow the field; also we can plant beans or reserve shelters to protect spiders' habitat.

(2) Protect and use parasitic wasps in rice field

Trichogramma japonicum, *trichogramma confusum*, *telenomus rowani*, *apanteles cypris nixon*, *cotesia ruficrus*, *apanteles baorus wilkinson*, *pimpla* and *anagrus nilaparvatae* in rice field live on the pests like rice borer, *cnaphalocrocis medinalis*, rice planthopper, rice leafhopper, *paranara guttata*. To protect and use parasitic wasp in rice field, firstly we should use pesticides rationally, and try to use systemic insecticides avoiding the peak time when wasp feather is in emergence with low-dose spraying, and relax the existing control index appropriately. Secondly, we should provide shelters and put protectors for parasitic wasp and add host manually to promote their breeding and protect them for living through winter safely and ensure their increase.

(3) Protect and use predatory natural enemies and frogs

The common predatory natural enemies in rice field are *cryptorhinus lividipennis*, rove beetle, carabid, *micraspis discolor* and so on. When using them, we should pay special attention to the contradiction between chemical control and them. Frogs can breed rapidly and catch large quantity of pests. When frogs are breeding in spring, we can't allow duck staying in ponds, ditches which tadpoles live in. Dig holes to protect tadpoles when rice field sunning and avoid spraying chemicals like ammonia which has killing effects on tadpole.

4.5.1.4. Chemical control technology

Chemical control means eliminating pests directly using chemical pesticides, which is an important method to control rice pests and have many advantages like instant, effective and convenient. Chemical control plays an important role in comprehensive protection system. But chemical control alone can only work in emergency, which can't create conditions that prevent the great amount of pests. And it also leads to higher costs, the resistance to pesticides and rampant of pests, and residues hazards. We should fully understand the comprehensive protection effects of chemical pesticides; strengthen pest forecasting and field investigating to grasp the dynamic

population of pests. To determine the control field and narrow the spraying scope according to control index and the rice condition. Strive to spray on time and improve the control effects. When there are many kinds of pests, we should refer to pest situations in the latest several years and put more energy in main pests, but also pay attention to the minorities at the same time in order to reduce the spraying times. Adhere to use low-toxic, less-persistent pesticides that are selective for natural enemies to spray in low-dose. Improve the pesticide application technology positively; improve the economic benefit of control; preserve the ecological environment, and make sure to be safe, economical and effective.

4.5.2 Wheat

4.5.2.1 Agriculture control technology

(1) Strengthen the quarantine in producing area to control the pests from sources. Execute regulations on plant quarantine when introducing seeds from the seed producing base. Firstly, choose disease-free fields as seed producing base and forbid breeding seeds in disease field, and the seeds producing base should carry out the quarantine strictly according to the producing area quarantine regulation; secondly, monitor the pests, diseases strictly in seeds producing procedure, moreover, prohibiting introducing seeds from disease area can prevent the distant spreading of wheat diseases, pests effectively.

(2) Choosing high quality variety to improve the resistance of wheat to diseases and pests. When choosing wheat varieties, we should not only pursuit good quality and high output, but also pay attention to the property of disease-resistant, high and stable yield, and good comprehensive characters. Rotate regularly and use the superior cultivation techniques; fertilize evenly, irrigate scientifically, clear the ditch, promote the irrigation and drainage, clear the weeds on the ridge or in the field, purify the environment and reduce the places that diseases, pests and weeds live in.

4.5.2.2 Physical control technology

Use the phototaxis of pests like wheat armyworm to kill them in wheat field. The project area uses the technique of black light lamp and frequency vibrational lamp and set one in 3~4 hm² to trap and kill the pests like wheat armyworm. Use the yellow trending habit of aphids to trap them with yellow sticky card.

4.5.2.3 Biological control technology

Select and apply moderate toxic and low toxic chemical pesticides which have less damage to natural enemies in wheat field and avoid the sensitive period of natural enemies such as ladybird, hoverfly and parasitic wasp against pesticides to play the control effect of natural enemies on pests such as aphid and wheat armyworm; model apply biological pesticides of take-all to control wheat take-all and extensively apply validamycin to control wheat sheath blight, pymetrozine to control wheat aphid and powdery mildew, carbendazim to control wheat fusarium head blight and abamectin to wheat mite and wheat armyworm.

4.5.2.4 Chemical control technology

(1) Enhanced treatment of seeds: Reduce pest occurrence degree, control the wheat loose smut and sheath blight through coating the seed with 3% difenoconazole (1:400 of pesticide and seed) and control the take-all through coating the seed with pesticide (1:180 of pesticide and seed). Coat 100kg of wheat seed with 2.5~5g fludioxonil (Celest) to control wheat common smut.

(2) Integrated control: Chemical control to effectively control pest is a main method to control diseases, pests and weeds of wheat. In order to improve the control effect, monitoring of pests and weeds should be strengthened, control index should be properly relaxed and application technology should be improved; integrated control should be taken to reasonably use pesticide, improve the pesticide availability and reduce the application frequency and dosage of pesticide; it is not allowed to apply pesticide and excessively apply pesticide within safety interval of application to ensure the application safety and control pest damage.

a) Conduct chemical control in autumn and reduce the reference number of weeds in spring. ①Soil treatment; remove weeds in wheat field through soil treatment when sowing in autumn. Spray 250~300g of 25% chlortoluron after dilute with 50~60kg of water per mu over the wheat field mainly dominated by gramineous weeds such as amur foxtail, sclerochloa kengiana tzvel and beckmannia syzigachne after sowing and before sprout. ②Foliage treatment after sprout; spray 70~80ml of 6.9% puma super or 125g of 50% isoproturon after dilute with water per mu over the wheat field mainly dominated by gramineous weeds such as amur foxtail after sprout and before 3 leaves and in the period of weeds with 1~2 leaves. It is not allowed to apply the isoproturon before cold current or during the cold current to avoid worsening of freeze injury. Spray 10g of 10% tribenuron-methyl into which 30ml of 20% starane is added after

dilute with water per mu over the wheat field mainly dominated by broad leaf weeds such as cleaver and shepherd's purse when the weeds have 2~4 leaves. As for the wheat field with monocot and dicot weeds, two steps are followed. Firstly remove the gramineous weeds after sowing and then remove the broad leaf weeds after all weeds grow out with isoproturon, puma super, tribenuron-methyl and agroxone.

b) Good primary pest control based on sheath blight. Most of wheat is sown in our area. Machine sowing in drill is relatively little. Due to poor ventilation and transmitting and canopy cover in field, sheath blight is very common. Therefore, the primary integrated control of pests such as wheat sheath blight to prick wheat red mite and wheat aphid should be conducted in last February and in early March. Select 200~300ml of 12.5% water aqua of validamycin and bacillus cereus or 60~80g of 20% wettable powder of validamycin after dilute with 50kg of water per mu; control the wheat red mite and wheat aphid with 30~40mL of 2% abamectin per mu.

c) Control “three diseases and two pests” during wheat ear period. Pests occurring in the wheat ear period mainly include sheath blight, powdery mildew, fusarium head blight, aphid and laodelphax striatellus. Control policy of “prevention first and integrated control” should be insisted to positively control such pests, comprehensively apply pesticide, control diseases and pests and spray the mixture of pesticide and fertilizer. Spray 70g of 18% pymetrozine + 40mL of 3% acetamiprid + 50g of 40% carbendazim + 30g of Anlisu after dilute with water per mu in full heading period to effectively control the pest damage in ear period.

d) Control laodelphax striatellus and effectively control wheat stripe leaf blight. It is the peak season for low instar nymphs of laodelphax striatellus to breed in the early May and it is also the best opportunity to control laodelphax striatellus and wheat stripe leaf blight. At this moment, pests should be found and controlled and the pesticide should be immediately applied on standard plot. 20g of 25% wettable powder of pymetrozine per mu should be selected for spraying to kill laodelphax striatellus in wheat field, reduce the control pressure of seedling field and wheat field and ensure the harvest of wheat.

4.5.3 Corn

4.5.3.1. Agricultural control technology

(1) Selection of disease-resistant variety (Tolerant): According to local natural

ecological conditions and categories of main pest damages, select disease-resistant variety (Tolerant) according to local conditions and adopt health cultivation to improve the stress resistance of corn and reduce pest damage.

(2) Clean pastoral: Remove corn straw (Corn cobs) in courtyard, farmhouse and field thoroughly before the end of April and collect residual straw (Corn cobs) to seal with mud. Reduce the reference number of corn borers and control the damage of corn borers.

(3) Properly Delay sowing and shallow seeding: Properly delay sowing and shallow seeding in the area where maize head smut occurs to reduce infection rate of smut (head smut).

(4) Strengthen field management: Remove the weeds in field and ridge before egg hatch of *Loxostege sticticalis* Linne combined with field management; remove leaves with mite at the bottom of corn immediately in the early period of red mite. Cut the infecting strain of smut (Head smut) immediately before flowering and put the leaves with mite, smut tumor and infecting ear into a bag to take it away from field for deep burial. Remove the lower infecting leaves, immediately ridge corn plant, strengthen ventilation and control disease epidemiology in the occurrence period of northern blight and southern blight.

4.5.3.2. Physical control technology

(1) Induction control technology with frequency oscillation pest-killing lamp: Utilize the light, wave, color and flavor of frequency oscillation to induce and kill corn borers, tiger moth and underground pests. Install the frequency oscillation pest-killing lamp according to conventional lamp installation method in demonstration area (Overhang, woodworking and cross-arm) and fix it with iron wire to avoid swaying under wind. Select 220V AC and overhead line along pole and it is not allowed to hang line anywhere. The pest-killing lamp should overhang slightly higher than corn. The trap radius per lamp is 120m and its control area is 50mu. Switch it on every night from 20:00 to the next 6:00. Collect pests in the bag every morning and deeply bury the induced and killed pests after through kill. Clean the pests scale on pest-killing lamp with brush after switch it off. Clean the lamp box thoroughly and wipe the lamp tube weekly. Overhand the lamp from the early May to the middle August.

(2) Induction and kill technology with sex pheromone: Place sex pheromone of corn

borer in the field and place 4 induction basins per mu in occurrence period of the first and second generation of adult corn borers. Add water to 2/3 and add a small amount of washing powder into the basin. Overhang a sex pheromone of corn borer 1~2cm above the water level with iron wire. Remove pest body every 3 days and add water immediately. The height of induction basin is set to 120cm.

4.5.3.3. Biological control technology

Bt control technology of corn borers: Prepare Bt granula with 200mL of Bt containing 10 billion spores/g per mu when add 5kg of fine sand in occurrence period of a generation of young corn borer and apply the Bt granula into lobus cardiacus at the huge bellbottom period.

4.5.3.4 Chemical control technology

(1) Treatment of seed and underground pesticide in sowing period:

Seed treatment: Dress the seed with 40% phoxim emulsifiable concentrate according to 0.1% of seed weight for the plot where underground pests occur severely. Dress the seed with 2% tebuconazole WS according to 0.3% of seed weight for the area where head smut occurs severely or directly select the seed coated with above pesticide.

Soil treatment: Select 3% phoxim granula and add 40~50kg of fine earth in it before sowing. Apply 2kg of granula per mu in the ridge when ploughing or apply into the soil through random broadcast and plough when shallow ploughing before sowing to control the damage of underground pests.

(2) Control of corn borers: Use 1.5% phoxim granula, add 5 times fine earth or fine sand in it and mix them evenly and throw 1~2kg of mixture into the bellbottom per mu at whorl stage of corn; drop the filament with 1,000 times of 2.5% deltamethrin emulsifiable concentrate per mu to control the second generation of corn borers in tassel and flowering period.

(3) Control of northern blight and southern blight of corn: Before and after tassel of corn, when 70% of plants are infected in the field and 20% of leaves are infected, use 500 times of solution of 50% carbendazim wettable powder, 500~800 times of solution of 70% thiophanate-methyl wettable powder and 800 times of solution of 75% chlorothalonil wettable powder per mu to spray and control. Spray for 2~3 times each 7 days.

(4) Control of corn red mite: Use 1~1.5kg of 3% phorate granula per mu mixing with 20kg of fine sand or saw dust and spray the mixture in corn row evenly in point plot of red mite for fumigation control. Spray on both ends along the edge of severe occurrence area of red mite and strip corn field when sowing in spring with motorized sprayer. Control 12 rows through cutting 2 rows for continuous severe occurrence area in corn field in order spray in the field. Spray 2,000 times of solution of 1.8% or 20% pyridaben emulsifiable concentrate or 5% hexythiazox emulsifiable concentrate for control. Spray again according to weather situation after 7 days for severe occurrence area. Where appropriate, mix the acaricide and diesel according to the ratio of 1:1 and spray the mixture for control with smoke sprayer on low pressure in the morning or at dusk.

4.5.4 Trees

4.5.4.1. Strict quarantine

Strengthening garden plant quarantine, and preventing dangerous pest invasion are the prime job of garden plants pest control. Thus, in the process of garden plants seedlings and other materials introduction and transportation, we must strengthen the quarantine, strictly forbid the incoming or outgoing of dangerous pests and blockade timely and destroy locally the passed pests.

4.5.4.2. Strengthen conservation and management , improve resilience of plants

The occurrence of pests and damage is related to the growth potential of plant in a considerable extent. For low growth potential, we should timely apply fertilizer, water, weed and loosen the soil to improve their resistance to plant diseases and pests, and combine to prune in autumn and winter to remove the branches with pests. This method can regulate plant nutrients, and reduce the sources of overwintering pests. We can create the bad environmental condition by ventilation, light, and enhancing vigor to reduce the pests overwintering and multiply.

4.5.4.3. Cultivation and management Prevention Act

(1) Choose and breed pest-resistant varieties. By combining the occurrence of local pests and diseases, choose and breed pest-resistant garden plant varieties.

(2) Plant appropriate trees in appropriate places and keep the diversity of plants and trees. By the method of combination of evergreen and deciduous, plant stratified lawn,

ground cover plants and shrubs. By scientifically matching tree species, establish a reasonable plant community structure to give full play to the role of natural control factors and improve self-regulation capacity of plants to diseases and pests.

(3) Reasonable measures of watering and applying fertilizer. Use the fully decomposed organic fertilizer, and control a reasonable proportion of nitrogen, phosphorus and potassium. Increasing the amount of phosphorus, potassium can improve the disease resistance of plants. The best time of watering is in the sunny morning to timely reduce the humidity of blade surface, which can improve plant disease resistance.

(4) Strengthen the cultivation and management of plants. Enhance vigor, combine with pruning and remove infected plants, diseased branches and residues to reduce the sources of pests.

(5) Clean the sources of pests. Most pathogen of diseases or overwintering eggs of pests overwinter in the plant litters or weeds, so destroying completely the dry branches, fallen leaves and weeds in the winter can greatly reduce the variety of pests sources.

(6) Whitewash trunk of trees. Whitewashing trunk of trees can effectively prevent forest damage, sunburn, improved disease resistance of trees, destroy pests overwintering sites, and kill overwintering mites, scale insects etc. inside the bark.

4.5.4.4. Promote the use of natural enemies control technology

Nuisanceless control will not damage the ecological balance, cause pollution and hurt natural enemies and it is the main direction of future pest prevention research. In the garden plant pest control we should also strengthen research of nuisanceless control, such as control pests with insects, control pests with bacteria and control pests with birds etc., as well as the use of black light, sex pheromones, laser etc. modern science and technology to wipe out pests or to produce hereditary physical defects which can leading to male infertility to improve pest control levels and effects.

4.5.4.5. Choose and use biological pesticides

In the pest control process, biopesticides can effectively protect natural enemies, eliminate pests, cause little environmental pollution and have persistent control effect to pests as opposed to chemical pesticides. In addition to Bt emulsion, chlorbenzuron,

pyrethrins etc. are the preferred plant pesticides to prevent garden plant pests in recent years.

4.5.4.6 Physical and mechanical prevention

According to some of the habits of insects, use of tools, equipment or create the material conditions pest likes to, and the use of light, heat, radiation, and other mechanical, physical and manual methods to control pest . This method is simple, and non- pollution, especially suitable for urban gardens.

4.5.4.7. Manual control

Scrape the trunk or eggs on the building, dug out the ripper looper pupae near the trees, and scrape scale insects on tree trunks, prune diseased branches, diseased leaves etc.

4.5.4.8. Proper use of chemical pesticides

The method using of chemicals to control pests and diseases is to solve large-scale emergencies or serious pests and diseases. The advantage is that it has fast effectiveness, easy mechanization and large-area applications, less affected by factors, but there are also killing predators, resistant, environmental pollution and other significant side effects. When using chemical pesticides, for one thing , it is necessary to seize the meteorological conditions conducive to spraying, in general should be selected before 10:00 pm or after 3:00 am on a sunny day; for another thing, spraying at the time when pests were weakest and the most favorable timing of mass destruction, usually insects hatch before the beginning of the third instar resistant is the weakest time, especially the eggs hatch and the larvae molt period is the best period of pesticide application.

4.5.4.9. Improved application techniques

Currently, most urban pest control using conventional spray methods. This method not only inefficient, wasteful pesticides, but also a large amount of pesticide lost to the non-target environment, caused livestock poisoning and environmental pollution. It is necessary to improve chemical pesticide application technology, especially the spray, improve the utilization of pesticides, and reduces the amount of non-target environment.

5 Application and management of pesticide in project area

5.1 Recommended pesticide category in project area

The application of pesticide must combine with agriculture measures, physical measure and biological measures and comply with the principle of economy, safety and effectiveness in implementation of project. Select and apply pesticide according to the following standard:

- 1) No harm to human health;
- 2) High bioactivity against the controlled target;
- 3) Few influence on non-target and environment;
- 4) Do not apply the same pesticide repeatedly to avoid resistance to pesticides for pests;
- 5) High effective, low toxic, low residue or no residue biological pesticides.

Pesticides purchased and used in this project should comply with the *Category Recommendation of Pesticides Proposed according to Harmfulness and Classification Guideline* of WHO referenced by the World Bank (Geneva, WHO, 2009).

Forbidden pesticides, unregistered pesticides or WHO I and II pesticides are not purchased in this project. Only WHO U and III pesticides were recommended.

Table 5-1-1 Common Pest Category in Project Area and the Recommended Control Pesticides

Crop	Common pests	Common diseases	Common weeds	Recommended control pesticides in this project	Risk evaluation
Rice	Chilo suppressalis, tryporyza	Rice blast, sheath blight, false smut and black-streak	Digitaria sanguinalis, barnyard grass, cyperaceae, leptochloa,	Pesticides: Metaflumizone, flubendiamide, chlorantraniliprole(III), bactericide: thifluzamide,	Pesticides used in this project are low toxic or
	incertulas,	dwarf	alternanthera	pyraclostrobin, azoxystrobin,	slightly toxic
	rice leaf	disease	philoxeroides and	difenoconazole(U),	to human
	folder, rice		monochoria vaginalis	thiophanate-methyl (U),	and have
	planthopper			carbendazim (U) and nitenpyram	significant

					Herbicide:	Penoxsulam(U),	effect on
					flucetosulfuron,	pyribenzoxim,	target object
					cyhalofop-butyl (U),	pretilachlor (U)	
					and bensulfuron methyl (U)		
Wheat	Aphid and red mite	head blight and sheath blight	Fusarium		Cleaver, flixweed,	Pesticides: emamection benzoate	
					polygonum aviculare,	(III), abamectin (III)	
					chickweed, amur	Fungicide: Difenoconazole(U),	
					foxtail, beckmannia	JS399-19	
					syzigachne and	Herbicides: Flucarbazone-sodium,	
					sclerochloa kengiana	clodinafop-propargyl, pyroxsulam,	
					tzvel	pinoxaden and mesosulfuron(U)	
Corn	Underground					Pesticides: emamection benzoate (III)	
	pest, corn borer,	corn	Head smut,				
			gall smut, ear	Digitaria, eleusine	Fungicide: Prochloraz, carbendazim		
	earthworm, leafhopper, aphid and red spider	corn	rot, rust and	indica, amaranthus	(U)		
			southern smut	retroflexus and	Herbicides: Mesotrione, atrazine(III),		
			and northern smut	purslane	mesotrione, flumetsulam and		
					halosulfuron-methyl		

5.2 Reasonable application of pesticides

Select appropriate pesticide variety, formulation and dosage and determine the reasonable application method and application period according to comprehensive understanding and scientific analysis of pesticide characteristics, agent features, biological characteristics of controlled and protected objects and environment to use pesticide reasonably.

5.2.1 Select appropriate pesticide

Identify the category of disease and pest accurately and select the most economical, effective and safe pesticide and agent to scientifically apply and kill pests according to the controlled objects. It is recommended to use systemic and contact pesticides to control the piercing-sucking pests such as aphid, red spider, plant hopper and scale; it is suitable to control the chewing pests with stomach poison and contact insecticide;

fumigant and fumigants can play the best effect in well closed condition such as greenhouse. The control effect of the same variety of pesticide is greatly different due to its different formulation. In general, emulsifiable concentrate has the best effect, wettable powder takes second place and the powder is the worst.

5.2.2 Optimum period of application

Apply pesticide according to the control index in critical control period to avoid economic losses caused by pest damage. In general, the pest of low instar nymphs should be controlled; the pest should be controlled according to the principle of protection first and control.

5.2.3 Appropriate dosage

Select low dosage of pesticide for control as far as possible in effective dosage range provided that the control effect is guaranteed. Application frequency should be determined according to occurrence period and quantity of pest and pesticide effect so as to effectively control the pest damage but not generate pesticide hazard and pollute environment.

5.2.4 Appropriate application method

Firstly, use different application methods according to pesticide formulation. Emulsifiable concentrate and wettable powder are generally sprayed and poured; the powder is mainly sprayed; the granula is mainly broadcast or applied in furrow; High strong systemic pesticides can be applied through powder spraying, mist spraying, pouring and application. Secondly, select different application methods according to infected part, behavior of pests and different pesticide formulation.

5.2.5 Alternate application

Pests can resist against pesticide when apply it with the same mechanism of action repeatedly so as to reduce control effect. For this reason, alternated application method should be used to reduce and avoid resistance to pesticides and improve the service life of pesticides. Since systemic Fungicide are easy to have resistance to pesticides, they should combine with protection bactericide alternately; since organophosphates, pyrethroids, carbamates and organonitrogen among pesticides have their different mechanism of action, alternate application can play a good pesticide effect.

5.2.6 Mixed application

Crop pests always occur one after another or occur simultaneously in a breeding period. Reasonable mixed application can improve effect as well as reach the control purpose. However, mixed application is not prepared randomly. Pesticides which shall decompose and lose effect with alkaline substances are generally not mixed with alkaline substances; it is not mixed if chemical reaction such as flocculation, sediment and layering after mix.

5.2.7 Application depending on weather

The pesticide is generally applied in windless or breezy weather. It is not suitable to apply pesticide in windy and rainy day or when it will rain to avoid drift of pesticide solution and drain washed by rain so as to reduce its effect. The pesticide effect increases with the increase of temperature in a range of temperature. The pesticide is applied generally at 10 a.m. and 4 p.m. when open cultivation or protected cultivation. It is easy to produce pesticide hazard when apply the pesticide under strong sunlight or high temperature.

5.2.8 Safe application

According to the provision of national pesticide management, control the application scope of high toxic pesticide strictly, prohibit using high residue pesticides which can cause cancer, teratogenesis and mutagenesis, seriously implement the safe application specification of pesticide and provision of safe interval of crops and apply pesticide safely so as to avoid environment pollution and poisoning of human and animals.

5.3 The recommend application technology and spraying instruments of pesticide.

The control of diseases and pests of crops must use the spraying instruments which conform to FAO, ISO or China's national standards. Manual sprayers have domestic WS-16P、WS-16、WS-20 and Malaysian PB-16, Spanish MATABI series. Knapsack power sprayer have 3WFB-18AC、3WF-2.6. Motorized jet sprayers have WSJ-36A、3WZ-34 and so on. Expect the above conventional spraying instruments of pesticides. Other application technology has a wide range of application in the control of diseases and pests.

5.3.1 The sprayer with spraying boom

The sprayer with spraying boom is the efficient crop protection instrument in the control of diseases, pests and weeds in large-scale planting plots. The main functions of sprayer with spraying boom are spray pesticide, chemical pesticide, foliar fertilizer and so on. It also can be used for the control of diseases and pests of wheat, corn, rice and other crops and for the soil treatment before sowing. Leveraged wide spray sprayer has a good mechanical property, has a higher spray, saves water, oil, pesticide, has a high efficiency, handles easily, uses safely and adapts to the requirements of modern agricultural production. With the promotion and application of machine, it must play a huge role in the prompting the unified prevention and control of diseases and pests of crops. Currently, the biggest problem is that the cultivated area is large in the whole demonstration area, but the farmers' plot area is small, and planting specifications are inconformity. But this restricts the development of application and efficiency of the advanced efficient crop protection instrument. From the long-term development, it is imperative to unify the scale management and planting specifications of soil. The success of the demonstration of efficient crop protection instrument will promote agricultural production to a developmental direction of Standardization, large-scale, mechanization and modernization.

5.3.2 Electrostatic spraying technology

In terms of electrostatic spraying technology, the electrostatic spraying of fog drips is used via a high voltage electrostatic generator to increase the deposition of pesticide solution on the surface of leaves. This technology can increase the effective availability of pesticide to 90%. In electrostatic spraying technology, the high voltage static electricity is used to form an electrostatic field between the nozzle and spraying target. After the pesticide fluid passes through the nozzle and pulverized, the pesticide is charged in different charging methods to form the group of electrical fog drips. Under the joint effect of electrostatic field force and other external forces, the fog drips will make orientation movement and be attached to all the parts of the target to achieve high settlement rate, low drift loss, improvement of ecological environment and other good properties. The electrostatic sprayers include domestic "Lingxing" electric electrostatic sprayer, America ESS electrostatic sprayer, etc.

5.3.3 Pesticide application technology of smoke sprayer

Smoke sprayer is a new spraying machine. Its working principle is very different with other spraying machines. The working principle of the smoke sprayer is generating

smoke of mixed liquid of diesel and pesticide instantaneously in the high temperature nozzle and spraying the mixture in the nozzle. Therefore, the pesticides selected emulsifiable concentrate type pesticide which should not be layered when mixed with diesel. Thus, the pesticide should only form smoke under high temperature and the pesticide selected must have stable pest control effect under high temperature. Main advantages of pesticide application with smoke sprayer: The diameter of smoke particles is very small with strong penetrability; The smoke generated from the mixture of pesticides and diesel is oily smoke which has a strong adhesion and is resistant to rain washing, thus the effect can be sustained for longer time relatively, therefore, the influence on the control effect is not very serious; Smoke sprayer with a high work efficiency can apply pesticide in an area of 2~2.6 hectare per hour which is 40~50 times of that of trailed sprayer with engine drive and save labor and cost, moreover, the smoke spray can apply pesticide without water, which is suitable for drought region and regions which is located at hillside with poor transportation condition. Smoke sprayers include domestic TS-35A thermodynamic smoke sprayer, Korean AN2000 mini-sized portable thermodynamic smoke sprayer, HD95 thermodynamic smoke sprayer and German TF-35 thermodynamic smoke sprayer.

5.3.4 Low volume and ultra-low volume spraying technology

Ultra-low volume spraying technology is a new technology promoted vigorously in plant protection. Oily pesticides below 330 ml are needed to spray per mu. Because the diameter of fog drip is small, spraying is work-saving and time-saving and need not water, which is suitable for mountains and regions in water shortage condition. For low volume spraying (e.g. mist), the diameter of smoke particles is smaller than common volume spraying and larger than ultra-low volume spraying. It is proved according to plenty of research results that: Low volume spraying is more work-saving and pesticide-saving than high volume spraying and can improve pests control effect, ecological benefit, economic benefit and social benefit.

5.3.5 Unmanned low-level pesticide application technology

For the crops with diseases, pests and weeds in large area, the plane spraying is a very important control technology and the work efficiency can be 200 hectares per hour. Especially pest outbreak in a large area, the plane spraying is kind of very timely and effective pesticide application method. The unmanned helicopter low-level spraying is a new technology suitable for the needs of modern agriculture and modern plant

protection. Compared with traditional manual spraying, the unmanned helicopter is characterized by high efficiency, saving water and pesticide, even spraying and others. In case of manual spraying, the plants per mu can be sprayed by one person per hour so that labor intensity is high and manual spraying is useless for high intensive crops. The unmanned helicopter for spraying can reduce 50% of pesticide in use and save 90% of water consumption. Its efficiency is 5 times of ground machines and over 60 times of manual spraying so as to reduce labor cost substantially.

5.3.6 Anti-drift technology

It is unavoidable that the fog drip drift and settlement will cause loss of pesticide in spraying and 70% ~80% of pesticide may be wasted if such loss is severe. The drift nozzle is usually mounted on the sprayer in foreign countries to reduce pesticide loss as the result of fog drip drift. There are few fog drips with small diameter from the nozzle so that the loss due to fog drip drift can be reduced by 33%~60%. Moreover, the wind screen is mounted on the spray boom for the sprayer to prevent interference of natural wind on fog drips effectively. The wind screen comprises 2 types including mechanical type and pneumatic type. The test shows that the wind screen for ordinary spray boom can be used to reduce fog drip drift by 65% ~81%.

5.3.7 Seed treatment technology

The seed treatment is an economic and effective method in plant pest control. The biological, physical and chemical factors and technologies are used to control pest damage, ensure normal growth of crops and reach high quality and high yield. Compared with spraying, powder spraying and soil treatment, the seed treatment technology is the most economic and most effective method in plant pest control. At present, common seed treatment methods mainly include two kinds: non-chemical method and chemical method. With regard to non-chemical method, such means as heat, freezing, drying, electromagnetic wave, ultrasonic wave, nuclear magnetic radiation, laser and biological factor are used to constrain, inactivate or kill the pathogens for the purpose of disease control. The chemical method is to use chemical agents to kill the pathogens on the seeds, protect or cure the seed with disease, make the seed sprouted normally, prevent attack by the pathogens of soil-borne diseases and improve seed activity.

5.3.8 Soil flame disinfection technology

For soil flame disinfection technology, all the soil will be extracted into the flame disinfection machine, smashed and delivered to the high-temperature chamber for transient high-temperature disinfection and pest killing. The temperature at flame ejector in the high-temperature chamber can reach about 1,300 °C, therefore, fungi, bacteria, nematode, weeds, eggs and underground pests can be killed immediately. The advantages of this technology include low control cost, no pollution, immediate planting in availability after disinfection and high control effect on underground pests and soil-borne diseases.

5.4 Pesticide waste disposal

In agricultural production, the pesticide wastes that bring the most influences on agricultural environment mainly include 2 kinds: One is pesticide wastewater (residual solution or container flushing fluid) in pesticide application and the other is pesticide package (packaging bottles or bags). For these packages with pesticide residues and abandoned in the fields, the pesticide residue will be diluted and flow out in case of rain or irrigation: For pesticide packages in the river, the pesticide will be diluted and result in water pollution. The pesticide waste is an important part of agricultural non-point source pollution. Recover pesticide wastewater and such pesticide packages as glass bottle, metal tank, metal drums, plastic containers and paper packages to implement centralized harmless treatment.

The disposal of pesticide wastewater should be strictly controlled in pesticide application and the pesticide should be prepared and used immediately and appropriately to reduce pesticide wastewater. The pesticide dealers should adopt pesticide package recycling mechanism and establish reward mechanism for the farmers who recycle the pesticide package waste actively.

6. Project monitoring and evaluation

In project implementation, the field monitoring and efficiency evaluation must be conducted for implementation of integrated pest management plan, pesticide application mode as well as the dynamic influence of the project on the quality and yield of crops, main pests and population of natural enemies.

6.1 Implementation of monitoring plan

The monitoring work is implemented by county-level agricultural technology promotion center, expert group and farmers together, and is responsible for timely

report and management of the pest. The monitoring work is conducted in each project area. The project expert groups are responsible for the establishment of monitoring system and sampling procedure, and provide implementation and analysis training of monitoring system.

6.2 Establish monitoring sites and crops

According to the planting structure, the following monitoring sites are setup for the project :(1) Wanfu and Liulou Village, Wanfu Town, Huaiyuan County, Bangbu City, main monitoring crops are rice and wheat,(2)Duanzhuang Village, Yeyi Town;Loufan Village, Longquan Country; Ye County,Pingdingshan City. Main monitoring crops are corn and wheat.

Table 6-2-1 Crop acreage in monitoring sites (hectare)

Crop	Rice	Wheat	Corn
Huaiyuan county	52034	108040	-
Wanfu Town	4535	5100	-
Ye county	-	55347	48840
Longquan Country	-	4433	3529
Yeyi Town	-	4381	4040

6.3 Data collection and sampling

According to the monitoring content, data collection and sampling methods were shown in table 6-2-2.

Table 6-2-2 Pest and disease monitoring and evaluation in project area

Sites	Crops	Pesticide application				PMP Efficacy				Production and Quality		Cost (USD 10,000)
		varieties	freq uency	Dosage (kg)	frequency	Disease species	Pest species	natural enemies species	frequency	Production value	frequency	
Wanfu Town	Rice				2				4		2	1.5
	Wheat				2				4		2	1.5

Longquan Country	Corn	1	2	1	0.75
	Wheat	1	2	1	0.75
Yeyi Town	Corn	1	2	1	0.75
	Wheat	1	2	1	0.75

Note:

- 1、Monitor methods of “pesticide application”: 2 villages are selected in each monitor site; Questionnaire and investigation are used to collect the information of pesticide application at harvest time, including pesticide varieties, dosage, application frequency, pesticide package and then summarize and analyze the data.
- 2、Monitor methods of “PMP efficacy”: 1 village is selected in each monitor site; Pest species, quantities and natural enemies’ species are investigated during the crop growing season. The investigation is conducted 4 times each year.
- 3、Monitor methods of “Production and Quality”: 1 village is selected in each monitor site; 3 fields are selected for yield evaluation at harvest time. Crop quality and production value are also evaluated.

6.4 Monitoring items

6.4.1 Pesticide application

- 1) The pesticide application method;
- 2) Pesticide application frequency per year;
- 3) Variety and quantity of pesticide in use per mu/year;
- 4) Pesticide cost per mu/year;
- 5) Number of the farmers who adopt pesticide safe treatment and application procedure (e.g. safe storage, wearing protective suit, etc.);

6.4.2 Monitoring in the demonstration area

- 1) The occurrence area and damage degree of main pests for the crops in the demonstration area;
- 2) The influence on natural enemies after pest management plan is applied;
- 3) Monitoring the pest control effect after pest management plan is implemented;
- 4) Monitoring the quality status of crops after pest management plan is applied

(including quality and pesticide residues);

- 5) Monitoring the crop yield and profits after pest management plan is applied;
- 6) Monitoring the effect of new pesticide, new technology and new machine demonstration on main pests;
- 7) Monitoring the trend of population of natural enemies after new pesticide, new technology and new machine demonstration;
- 8) Monitoring the quality status of crops after new pesticide, new technology and new machine demonstration (including quality and pesticide residues);
- 9) Monitoring the yield and profits of technological crops after new pesticide, new technology and new machine demonstration;

6.5 Inspection items

- 1) Inspect the registration of new pesticide;
- 2) Inspect whether WHO Class I pesticide is applied in the project area;
- 3) Pesticide application policies;
- 4) Implementation of monitoring plan;
- 5) The problems of pest management plan in implementation

6.6 Monitoring and inspection plan

- 1) Monitoring of pest management: All project offices and the agricultural cooperatives should implement such monitoring jointly, find the pests and give timely report and handling;
- 2) Inspection plan: All project offices should be responsible for inspection and the plant protection & plant inspection station should take charge of inspection and control in pest occurrence peak;
- 3) Duties: All plant protection & plant inspection station should be responsible for the guidance, inspection, monitoring and training of pest management plan; and coordinate with the project implementers to share the duties such as finding and reporting pests and implementing pest management plan as required;
- 4) Professional technology: All plant protection & plant inspection stations

provide the plant protection experts and pest management plan.

5) Budget: The pest management of the project should be listed into the routine management in various project offices and all the costs are included in the cost estimation upon monitoring and evaluation.

6.7 Evaluation items

- 1) The occurrence area and damage degree of main pests for the crops in the demonstration area;
- 2) Evaluation on the influences on the population of natural enemies after pest management plan is implemented;
- 3) Evaluation on the pest control effect after pest management plan is implemented;
- 4) Evaluation on the quality status of crops after pest management plan is implemented;
- 5) Evaluation on the comprehensive economic results after pest management plan is implemented;
- 6) Evaluation on the effect of new pesticide, new technology and new machine demonstration;
- 7) Evaluation on the influences on the population of natural enemies after new pesticide, new technology and new machine demonstration;
- 8) Evaluation on the quality status of crops after new pesticide, new technology and new machine demonstration;
- 9) Evaluation on the economic benefit after new pesticide, new technology and new machine demonstration;

7. Cost estimation

Table 7-1 Project budget form

Activities	Activity content	Cost (USD 10,000)		
		GEF	Supporting fund	Calculation details
Demonstration of pesticide reduction and integrated pest control technology	Demonstration of new pesticide and new technology	5.20	0	<p>1) the total cost for demonstration of new pesticide: 3.07, including the cost of preparing the demonstration plan: 0.2, pesticides cost: 0.9, travel cost 1.92, the cost of rent and use farmer's land: 0.05</p> <p>2) the total cost for demonstration of seeds treatment: 0.49, including the cost of preparing the demonstration plan: 0.1, pesticides cost: 0.1, travel cost 0.24, the cost of rent and use farmer's land: 0.05</p> <p>3) the total cost for demonstration of pesticide synergistic adjuvant: 1.15, including the cost of preparing the demonstration plan: 0.04, pesticides cost: 0.12, travel cost 0.96, the cost of rent and use farmer's land: 0.03</p> <p>4) the total cost for demonstration of straw mulching technology for weed control: 0.49, including the cost of preparing the demonstration plan: 0.1, pesticides cost: 0.1, travel cost 0.24, the cost of rent and use farmer's land: 0.05</p>
	Demonstration of new plant protection machine	5.20	0	<p>1) the total cost for demonstration of electrostatic sprayer: 1.37, including the cost of preparing the demonstration plan: 0.2, pesticides cost: 0.16, travel cost 0.96, the cost of rent and use farmer's land: 0.05</p> <p>2) the total cost for demonstration of wide boom sprayer: 1.3, including the cost of preparing the demonstration plan: 0.09, pesticides cost: 0.2, travel cost 0.96, the cost of rent and use farmer's land: 0.05</p> <p>3) the total cost for demonstration of thermodynamic smoke sprayer: 2.53, including the cost of preparing the demonstration plan: 0.2,</p>

				pesticides cost: 0.16, travel cost 1.92, the cost of rent and use farmer's land: 0.25
	Pest and disease control of trees	0	157.9	Supporting fund: the total cost for demonstration of purchase trees and pests control: 157.9, including the cost of planting and daily management of trees: 95, the cost of pest and disease investigate of trees: 18, the cost of pest and disease control of trees: 36, the cost of pesticides and machines: 8.9
Monitoring and evaluation	Monitoring the occurrence of diseases, pests and weeds as well as pesticide application, monitoring pesticide reduction in use and crop yield and evaluating economic benefit	6.00	0	1) the total cost for pest and disease monitoring: 3, including the cost of preparing the work plan and report: 1.08, travel cost: 1.92 2) the total cost for pesticide application monitoring: 1.5, including the cost of preparing the work plan and report: 0.54, travel cost: 0.96 3) the total cost for crop yield and quality monitoring: 1.5, including the cost of preparing the work plan and report: 0.54, travel cost: 0.96
Capacity building	Plant protection technology training	16.00	98.4	GEF: 1) the total cost for pest and disease database establishment: 2; 2) the total cost for pest and disease deliver and report system: 1; 3) the total cost for literatures review, teaching material writing: 4; 4) the total cost for training material printing, travelling expenses: 6; 5) the total cost for disease and pest poster, disc design and print: 3; Supporting fund: including the subsidies for local farmers: 30, the subsidies for local agricultural workers: 30, the subsidies for other agricultural workers: 25, the cost of the relative activities of scientific knowledge promotion: 13.4
Sum		32.40	258.1	