OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

22956

FINAL REPORT

++

MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL ON OZONE DEPLETING SUBSTANCES PROJECT COVER SHEET

COUNTRY:	China	
IMPLEMENTING AGENCY:	UNIDO and Italy	
PROJECT TITLE:	National phase out of Methyl Bromide	
PROJECT IN CURRENT BUSINESS PLAN:	Yes	
SECTOR/SUB-SECTOR:	MB	
CONSUMPTION BASELINE:	1106.6 ODP tons	
PRODUCTION BASELINE	776.3 ODP tons	
CURRENT CONSUMPTION (2002):	1087.8 ODP tons	
CURRENT PRODUCTION (2002)	744 ODP tons	
CONSUMPTION ODP TO BE PHASED-OUT:	**1087.8 ODP tons**	
PRODUCTION ODP TO BE PHASED-OUT	**744 ODP tons**	
PHASEOUT CONSUMPTION (First Phase)	**389 ODP tons**	
PHASEOUT PRODUCTION (First Phase)	**45.4 ODP tons**	
PROJECT IMPACT:	About 6% of the production and 36% of the consumption	
PROJECT DURATION:	First phase: 30 months	
TOTAL PROJECT COST:		
→ Incremental Capital Cost	US$	59,902,210
→ Contingency	US$	5,9990,221
→ Incremental Operating Cost	US$	-25,761,743
→ **TOTAL PROJECT COST**	**US$**	**40,130,689**
COST-EFFECTIVENESS:	US$/Kg ODP	**36.89**
PARTIAL GRANT (First Phase) to phase out The consumption of 389 ODP tonnes	US$	**17,235,749**
AGENCY SUPPORT COSTS (First Phase)	US$	1,2923,681
COST FOR THE MLF (First Phase)	**US$**	**18,528,431**
PROJECT MONITORING MILESTONES INCLUDED:	Yes	
NATIONAL COORDINATING AGENCY:	SEPA	
INTERNATIONAL IMPLEMENTING AGENCY	UNIDO	

PROJECT SUMMARY: The project first phase aim is to phase out 389 ODP tons of methyl bromide used by 647000 growers, cultivating 126000 hectares of eggplant, cucumber and tobacco. Methyl bromide is also used in the fumigation of commodities. The second objective of the first phase objective, subject to audit and future approval by the ExCom is the phaseout of 45.4 ODP tonnes produced in China's factories

IMPACT OF PROJECT ON COUNTRY'S MONTREAL PROTOCOL OBLIGATIONS: By implementing this project, China will comply with the 20%, 2005 reduction

Prepared by: SSI. Ahmed — Date: 21 August 2002

Project technically reviewed by R. Sanz. CSIC. Spain — Date: 30 August 2002

TABLE OF CONTENTS

1. THE CONSUMPTION SECTOR

1.1 The Agriculture in China

China is a developing country with 900 million farmers, which represents about 3/4 of the total population. China experiences the same situation and problems encountered by many developing countries but any solution to the existing problems shall take into account that China has the largest population in the world. About 15% of world farmers live in China and cultivate about 7% of the world arable land.

According to the data from the State Statistical Bureau, the area of arable land in China is 95,650,000 ha, which is about 10% of the total area. The distribution of population is not balanced in China. The population is less than 10% of the total in Qing-Tibet Plateau, while the area of arable land account for about 57% of the country.

Main crops are rice, wheat, maize, cotton, soybean and other economic crops, but n the last 10 years, with reform and economic development, the area of plastic greenhouses developed very rapidly in China. The area of protected agriculture, mainly vegetables, is now more than 2 million hectares and over 10,000 hectares for strawberries. The figures have been rapidly increasing after China joined WTO because traditional crops are losing their competitiveness in the international market. Greenhouses are a key technique for increasing farmers' income and an important measure that enables traditional agriculture to become modernized. So, it will continue to boom. The varieties of cultured crops will be diversified. The area for flowers, melons, nurseries, medicinal herbs, etc., in addition to vegetables and strawberries, will increase.

China is also a country with a huge population. The limited land cannot fulfill the demand for agricultural products. Therefore the multiple cropping index (i.e. the number of crops grown in the same field in one year) will increase. The land has become exhausted due to little or zero rotation, lack of green manure and over-use of chemicals, which has resulted in decreased fertility, increased pollution and soil erosion.

In general, the characteristics of Chinese agriculture are family management of tiny farms, usually 3 to 6 people in a family. The average land for most farmers is a Chinese mu (1/15 ha.) per person. Farmers have simple equipment, such as small

tractor or tri-wheeled tractor. Drip irrigation is seldom used because power and water are not available in the field. They work by experience. Due to the above characteristics, the development and extension of advanced agricultural technologies, such as drip irrigation systems, soil-less cultivation, grafting technique, IPM, and sustainable agriculture, are quite slow because farmers could not stand the risk and they are limited by the problems mentioned above.

Because of the huge area of the country, the weather in different regions varies distinctly. The weather is influence mainly by monsoon in China. In wintertime, the cold try air masses go down to the South from the North and form winter monsoon. The marine warm air masses meets with winter monsoon and forms rainfalls in the winter in the south while the weather keeps very dry in the north. In the summer time, the summer monsoon formed by marine warm air masses moves from the south and stay in south for about six months and about three months in the north. The rainfalls are convergent in the summer in most regions in the country. The annual precipitation varies also from region to region. It is 2000 mm along the southeast coast, 1000-1500 mm in central China, 500-700 mm in North China Plain, 400-600 mm in Northeast China plain and less than 200 mm in Northwest China. The summer is hot in most regions except Qing-Tibet Plateau. The average temperature is over 20℃ in the country in July. The temperature in the south to Qinling Mountains is over 28℃, 24-28 ℃ in North China Plain and 20-24℃ in northeast and northwest. The temperature in the winter changes dramatically from the south to the north. In January, it is above 10 ℃ in southeast coast, 0℃ in the south to Qinling Mountains, 0 to minus 10℃ in the North China Plain and Loess Plateau, -10 to -24℃ in Northeast and it can be as low as -30℃ in northwest regions where it is 50° north latitude. The diverse weather causes the difference in adoption of cultivation systems, crop types and the time of seeding and harvesting in different regions. In order to round the low temperature problem in the winter in north of China, and provide fresh vegetables, fruits, flowers, etc., to the market during Chinese New Near, the protected land increased rapidly since 1980s. This way of cultivation has become the most important income source for the farmers because the prices are higher in wintertime.

Due to the liberalisation of the market, intensive mass production has become a new characteristic in Chinese agriculture. Many tomato townships, celery townships, cucumber townships, cabbage townships, etc., appeared in recent years. Growing of the same crop caused severe soil-borne diseases and/or nematodes. Rotation becomes more and more difficult.

1.2 Strawberries sub-sector

Strawberry is an important crop in China and the largest consumer of MB in China. Due to the economic development in the latest 10 years, the demand for strawberry increased enormously. Presently strawberries are produced in more than 20 provinces. The total planted area is up to 40,000 ha, mainly in Hebei Province (about 5300ha), Shangdong Province (about 4600ha, mainly in Yantai City), Liaoning Province (about 3500ha, mainly in Donggang County Dandong region), Jilin Province (about 2000ha), Zhejiang Province (3000ha), Jiangsu Province, Beijing and Shanghai Municipality (about 4000ha). The total yield is more than 400,000 tonnes. There are more than 1.8 million growers involved in strawberry production.

As a consequence of the expansion of the strawberries sector, the areas treated with Methyl Bromide have increased fast because this fumigants solves most of the rootpests faced by the farmers namely; fungi, nematodes, virus and some bacteria

In China, there are three kinds of cultivation methods for strawberry. One is in open field, another one is cold plastic tunnel, and the third one is greenhouse. Greenhouse is a main cultivation method for strawberry in north of China. The total area of cultivation is about 10,000 ha but the area treated with MB is 13% of this figure. Plant density is about 225000 plants per hectare

Greenhouse strawberries are transplanted in August and start to ripe in early January. The last 10 days of January is the peak period of harvesting, when is during the season of Chinese New Year. The price is the highest. The price of strawberry is about USD1.00/kg for wholesale. The normal yield of strawberry is 22500-30,000kg/ha.

Strawberries planted in open field are also transplanted in August but the harvesting period commences in April next year and last until May- June. The yield is about 30000-37500 kg/ha for open field. The price is lower than that in greenhouse.

Before greenhouse covered with plastic sheet in November, fertilizer such as diamine phosphate $(NH_4)_2PO_4$ 37.5 g/m^2 or 15% compound fertilizer (N:P:K=1:1:1) 12.5g/m^2 was applied.

The irrigation of strawberries is by flooding of underground water. The tunnel is flooded immediately after transplanting. The rate of water is about 750 t/ha. Because

the transplanting meets the period of high temperature, 35℃, and the evaporation is high, the soil needs to be watered once every 3-5 days especially in draught years. This means the soil needs 2-3 times of irrigation before the plants survive. Mid-tillage is applied after spear leaves appear in order to keep the humidity of the soil. One flooding, 400 t/ha, is applied before there are 5-6 new leaves if the soil is dry. It is not irrigated in general after mid- or late September to control over-growth of strawberry plants.

The mulch is covered on soil. When the temperature drops to about 5℃ in late October, the plastic film is covered on tunnel. No irrigation is applied after tunnel film is covered in the whole winter. The temperature of the tunnel is kept at 10-15℃, humidity about 70%.

The major strawberry diseases are plant death caused by combined infection of fusarium, verticilium, phytophthora and rhizoctonia pathogens. The specific cause of disease has not been fully clarified. The diseased plants showed poorly developed root system, fewer new roots, slow growth, and weak vigor. The growth of plant lags behind the healthy ones obviously. The number of flowers and berries decreases and the yields are much lower. In many cases, the plants die when the ripening of berries starts. The yield is generally 60-70% of the normal if strawberry is continuously cultivated. It is possible to loss completely the yield.

Root-knot nematodes were found in Shandong Province and Liaoning Province recently, which become an important soil pest gradually.

Because the popular method of irrigation is flooding, the soil pests spread very fast. Because the seedbeds do not have good disinfestations, the seedlings are also an important source of infection. So, soil pests become more and more severe.

Currently, main methods to control soil pests are rotation with corn, wheat and change soil due to lacking of effective measures. Growers have no other choices except MB. Currently, MB is the most effective method to control soil pathogens.

Area cultivated treated with MB, mainly in Hebei province, as well as the number of farmers involved are given in the following table

STRAWBERRIES: MB CONSUMPTION AND AREA CULTIVATED

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Number of growers
Hebei	490	1,222	30,580
Liaoning	5	13	312
Jilin	2	5	112
Heilongjiang	2	5	135
Shanghai	5	13	310
Jiangsu	2	5	126
Zhejiang	5	12	193
Anhui	2	5	122
Shandong	5	13	311
Hubei	2	5	110
TOTAL	520	1,297	32,311

It is worth to mention that the area cultivated by each farmer is, on average 400 m2, and this fact complicates enormously the process of dissemination of new technologies. The relative isolation of the farmers also facilitates the increased use of MB.

1.3 Cucumber

Cucumber is a very important crop in China and it is cultivated all over the country. Cultivated area in greenhouse is more than 1 million hectares in China but usual method is crop rotation generally with tomato. The largest cultivated regions are Shandong Próvince, Hebei Province, Henan Province, Liaoning Province, Jilin Province, Beijing and Tianjin.

Because cucumber favors higher temperature and has tolerance to weak light, it is a suitable culture in protected field. In the north of China, most cucumber was grown in Spring or Autumn. In the winter-spring cultivation, cucumber is seeded, in greenhouse, in middle of October, transplanted in late November or early December and harvested from February to June. The yield is about 60 to 80 tones/ha. In the Autumn-winter cultivation, cucumber is seeded in middle of September, transplanted in early October and harvested from early November to February. The yield is about 40 to 60 tones/ha. Cucumber is also cultivated in plastic tunnels. It is seeded in middle of January, transplanted in late March and harvesting from middle of April to early July in plastic tunnels.

There is a relatively small amount of growers specialized in cucumber all over the year, which have plastic greenhouses and some equipment. These farmers are relying on Methyl Bromide

The main soil-borne diseases are root-knot nematode (*Meloidogyne incognita*), cucumber damping-off (*Pythium vltimum*), *Rhizoctonia* rot (*Rhizoctonia solani*), *Fusarium* wilt (*Fusarium oxysporum*), and anthracnose (*Colletotrichum orbiculare*). Cucumber green mottle mosaic virus and cucumber mosaic virus (cucumis virusi. Cucumber is easy to suffer to root knot-nematodes and yield was affected heavily. The plants will die after being severely infected.

Grafting with black-seeded pumpkin is one effective method to control cucumber *Fusarium* wilt, and many other diseases but many farmers do not grow grafted seedlings because the cost of purchasing seedlings is high and they lack of proper training and proper equipment

CUCUMBER: MB CONSUMPTION, AREAS AND FARMERS

STATE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Number of growers
Beijing	5	12.32	308
Shanghai	3	7.30	177
Anhui	2	4.99	134
Shandong	25	62.03	1640
Henan	3	7.56	194
Hubei	2	5.10	127
TOTAL	40	99.30	2580

1.4 Tomato

The vast territory of China and the largely different climatic conditions, makes the country very suitable for vegetable growing. About 200 sorts of vegetables are cultivated in China and distributed nationally. Total yield is over 42 million tonnes. Since 1980s, vegetable production developed very fast and the areas planted are increasing, especially the protected agriculture. The vegetable cultivation area in protected field reached about 2,000,000 ha and continues to increase.

Tomato is one of the most important crops, and it is cultivated all over China. Cultivated area in greenhouse is more than 1 million hectare in the China. The largest cultivated regions are Shandong Province, Hebei Province, Henan Province, Liaoning Province, Jilin Province, Beijing and Tianjin. There are more than 50 million growers engaged in tomato production.

Generally, farmers use 30000-45000 seedlings per hectare. Price of seedlings is about US$ 0.06/plant. A hectare seedlings costs US$ 1800-2700. Price of tomato in China is low, about USD$0.12-0.24/kg and therefore, farmers can not afford seedlings from certified nursery companies. Farmers cultivated the seedlings by themselves instead of buying certified seedlings. Because the nursery bed does not disinfest very well, many seedlings have been infected by nematodes and soil pathogens, which result in spread the pests after transplanting. Water flooding and poor agricultural practices are another reasons for spread nematodes and soil pathogens. MB is solving many of these problems and that is why its use in increasing

Main soil pests in greenhouse are root-knot nematodes (Meloidogyne sp.), Fusarium solani, F. oxysporum f.sp. lycoperisici, Pseudomonas solanacearum Sclerotinia sclerotiorum, ,*Colletrichum cocodes*, as well as TMV, cut warm, crickets, grubs *etc.* In recent years, root-knot nematodes have been a increasingly serious disease in many provinces and it is controlled by MB

In open field, tomato is usually transplanted early January for harvesting in April-May but the number of greenhouses is growing because protected agriculture allows early harvesting and better prices. Nematodes cause enormous losses and that is the reason why MB is becoming more and more popular

The areas planted and consumption are the following:

TOMATO: MB CONSUMPTION, AREA AND NUMBER OF GROWERS

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Number of growers
Beijing	5	12.59	289
Tianjin	5	12.32	267
Hebei	5	12.53	300
Liaoning	10	24.39	609
Shanghai	10	24.15	710
Jiangsu	8	20.67	587

Zhejiang	5	12.89	322
Anhui	5	12.63	312
Shandong	85	213.03	5700
Henan	2	4.81	126
Hubei	5	12.44	350
Guangdong	10	25.13	679
Sichuan	5	12.41	401
TOTAL	160	399.98	10652

1.5 Eggplant

Eggplant likes high temperature with the favorable growth temperature of 22-32 ℃ and requires plenty of sunlight. It is thereby suitable to be grown in greenhouses especially to meet the demand of the market in the winter. The most common cultivation system for eggplant include autumn-winter season in greenhouse, winter-spring season in greenhouse, early spring in plastic tunnel, and in different seasons in open fields. The autumn-winter season is to seed in late July to mid-August, transplant in mid-September and harvest in late December to late February, the winter-spring season is to seed in late December, transplant in late February and harvest in early April to late June. The early spring season in plastic tunnel is to seed in late December, transplant in late March and harvest in early to mid-May to mid-July.

Eggplant has wide adaptability to soil types, i.e., it is suitable for growing in both sandy and clay soils. It is hence grown in all over the country. The total area cultivated is 680,000 ha in 2002. The total yield is 21 million tones with the unit yield of 45-75 tonnes per hectare. The regions with large area of cultivation are mainly Shandong, Hebei, Henan, Hubei, Anhui, Guangdong, Liaoning , Shanghai, Beijing and Tianjin. The area cultivated in greenhouses in Shandong Province is 56700 hectares, for example, in which the disease incidence area is 17,900 hectares.

The main soil pests in eggplant include Verticillium wilt (*Verticillium dahliae* and *V. albo-atrum*) and Phytophthora rot (*Phytophthora parasitica*) damping-off (*Pythium aphanidermatum*), basal stem rot (*Rhizoctonia solani*), Fusarium (*Fusarium oxysporum*) wilt, root-knot nematode (*Meloidogyne incognita*), etc. Verticillium wilt can also occur in other vegetables and crops, such as pepper, tomato, tomato, cucurbits, sesame, tobacco, etc. The rotation is very difficult. The disease is pertinacious and the harm is severe. It is therefore called destructive disease.

A small amount of farmers in the disease incidence area use MB with good results and the popularity of the fumigant is growing.

However, a significant number of growers rely on grafting eggplants on wild water eggplant or red eggplant as rootstock. It has good efficacy, but most of growers do not have the minimum required equipment to obtain consistent results

EGGPLANT: MB CONSUMPTION, AREA AND NUMBER OF GROWERS

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Number of growers
Liaoning	5	12.92	323
Shanghai	4	10.31	328
Jiangsu	2	5.05	128
Anhui	5	12.53	313
Shandong	30	72.12	1942
Henan	2	4.98	120
Hubei	2	5.03	118
Guangdong	10	24.81	714
TOTAL	60	147.74	3986

1.6 Hot pepper

Hot pepper market is increasing and prices are lucrative. Cultivation area increased steadily in the past years and today hot pepper is cultivated in more than 200000 hectares. The area to produce and the yield of hot pepper is the biggest in the world. The Main cultivation regions are in Hebei, Shandong, Sichuan, Chongqing, Hunan, Shaanxi, Guangxi, Guangdong, Jilin, Liaoning, etc. There is an increase of demand to hot pepper in recent years because of the development of vegetable process industry.

There are many kinds of cultivation systems, such as open field, plastic tunnel and greenhouse. Because peppers do not like strong sunlight and the sunlight in the north of China is very strong, the yield of pepper is higher when they are cultivated in greenhouses. The main cultivation systems include open field, cold plastic tunnel and plastic greenhouse. The seed is sown in January and transplanted in late April in open field. The harvest of pepper starts in mid-June for open field. The yield is generally 40-50 tonnes per hectare. the seed of pepper is sown in December and transplanted in mid-March in cold plastic tunnel. The harvest starts in early May and yield is about 45-

55 tonnes per hectare. Pepper is seeded in plastic greenhouse in November or July, transplanted in either early Feburary or August and the harvest starts in April or mid-October. That makes two seasons in a year. The time of cultivation differs from region to region according to the temperature and the systems adopted by the growers. The described system above is a general idea for North China.

Main soil pest in pepper is Phytotophthora capcici, anthracnose (Colletotrichum capsici (Syd.) Butler et Bisby and C. coccodes (Wallr.) Hughes), TMV and CMV, which cause big yields losses and affect quality. For example, the area of pepper is 73,300 hectares in plastic greenhouses in Shandong Province, in which the area of disease incidence is 70,300 hectares. Phytophthora blight of pepper is destructive. The reduction of yield is 20-30% in general and can be up to 90% or without any harvest. The disease can also occur in tomato, eggplant, etc.

Most of the farmers rely on seed disinfections with hypoclorhide and using carbendazim powder but the efficacy is poor

A relatively small number of growers are using Methyl Bromide with good results

HOT PEPPER: MB CONSUMPTION, AREA AND NUMBER OF GROWERS

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Total growers
Anhui	5	12.20	312
Shandong	30	75.19	1930
Hubei	5	13.23	410
Sichuan	10	23.64	598
Yunnan	5	12.14	315
Xinjiang	5	12.14	356
TOTAL	60	148.52	3921

1.7 Flowers, ornamentals and medicinal plants

With the development of economy and improvement of living standards, the demand for flowers and ornamentals has a greatly increased especially after 1987 when the cultivation in plastic greenhouses became reality in the north of china. Economic benefit of flowers is very high among agriculture products. Because flower is a high value crop, most modern bases are set up.

The production value was over US$ 356 million in 1996. The figures for the cultivation area and the value have been growing in. However, the areas treated with MB are relatively small, 149 hectares.

Main cultivation varieties are chrysanthemum, carnation, rose, peony, gladiolus, violet, musky lily, tulip, azalea, etc.

Flowers and ornamentals are grown in many places of China and it is estimated that more than 11000 hectares are dedicated to this purpose. However, the areas treated with MB are relatively small, 149 Hectares.

MB is used in crops like roses, carnation, etc., in areas were infestation by *Meloidogyne* nematodes, *Fusarium, Verticillium Rhizoctonia, Phytophthora*, etc are important.

Another important area of use of MB is ginseng mainly grown in the provinces of Liaoning, Jilin and Heilongjiang. However, the most important of them is Jilin. So far, none of the chemicals tested was able to control the ginseng rust rot (Cylindrocarpon spp), damping-off (Rhizoctonia solani, Pythium debaryanum), ginseng black spot (Alternaria panax), Phytophthora of ginseng (Phytophthora cactorum), and rootknot nematodes (Meloidogyne hapla).

The occurrence of low temperatures for long periods prevented a good vaporization of the fumigants tested (all of them including , but excluding the combination of 1-3 D and chloropicrin) and created phytotoxicity. Only steam was able to control but at a high fuel cost.

MB CONSUMPTION IN FLOWERS, ORNAMENTALS AND GINSENG

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Total growers
Liaoning	2	4	126
Jilin	40	124	3345
Heilongjiang	3	8	284
Shanghai	3	7	165
Shandong	2	5	124
TOTAL	50	149	4044

1.8 Tobacco

China is the largest producer of tobacco in the world and over one million farmers make their living from this activity. Due to the fact that China is a vast country with a diversified climate and ecological systems, tobacco can only been planted in one season due to its rather strict requirement on weather conditions. From seeds to mature leaf, the growing period for tobacco plant can be divided into three stages out of a total of 180 -200 days. The seedling stage is about 60 days; field growing after being transplanted is about 60 days; harvesting from beginning to the end also need about 60 days. Flue-cured tobacco is the dominant type grown in China, both in the growing area and the leaf total quantity, the flue-cured accounted for over 95%, the other types of tobacco are burley tobacco and aromatic tobacco.

The traditional seedling production technology is to sow tobacco seeds, which are very small, on a small field called seedbed. Transplanting to open field is carried-out when the seedlings reach the mature stage characterized by sufficient root and aerial system as well as an appropriate stem diameter. This method has disadvantage of relying on a good soil fumigant. MB is the choice fumigant but the farmers also use pesticides during the seedling stage.

China's tobacco production is strictly under the authority's plan and tobacco is planted and purchased according to the contract between the farmer and the tobacco company. The local tobacco company handles the production, purchasing and selling of tobacco leaf under the guidance of the State plan. The local tobacco company is responsible for training and giving technical assistance to the farmers; there are relevant preferential policies for farmers for growing tobaccos. In recent years, the area engaged for tobacco planting has been constant. In China, the area for tobacco growing in 2002 was 960,000 hectares, which yielded over 1.6 million metric tons of tobacco leaves. More than 4.75 million households in rural areas contracted to grow tobaccos, over 50,000 villages are involved in growing tobacco with in average 20-30 hectares devoted to grow tobacco for each natural village, around 0.3 hectare for each household.

The data from investigation results show that among over 20 provinces, autonomous regions and a special municipality, are growing tobacco in China, 15 of them are involved in using methyl bromide (MB). Provinces like Yunnan, Hubei, Fujian, Henan, etc, are the major MB users in growing tobacco. In 2002, the whole tobacco sector in China consumed 713 tons of MB; 1500 hectares of tobacco seedbed

were fumigated with MB; seedlings produced by this way were transplanted to 250,000 hectares of the land field. More than 14,000 natural villages and almost 1 million households were engaged in using MB.

Tobacco sector in China began to use MB in the early 1990s. Through the experiment and the demonstration for several years, it proved that MB could effectively kill the fungi, bacteria, nematodes, and weeds, as well as underground pest insects in the soils; the tobacco seedlings produced from seedbeds fumigated by MB were free of diseases; when transplanted into the fields, the seedlings grown very well, the quality and the quantity of tobacco leaves improved. Therefore, the application of MB had been extended quickly and was a well well-received by tobacco companies as well as the farmers. Begun from 1996, the technology of fumigation the seedbed with MB was promoted in use in the tobacco production areas extensively.

The tobacco production has been carried out under planned economy, and the whole production in terms of leaf quantity produced has been strictly controlled. The tobacco companies have taken the measure of "company plus farmers" to organize the production. Each household signs a contract with the local tobacco company, the area for planting and the amount of leaves purchased should be confirmed according to the contract.

Tobacco companies establish the varieties, the ways to produce the seedlings, the cultural practices, etc. Due to the complex procedures for seedling production, the tobacco sector in China concerning the technical guidance and planned management, stipulated that seedling production should be conducted collectively and managed individually in each natural village; while the MB fumigation has been a relatively new technology for producing the seedling, during the promotion of this technology, some favorable policies were given to the farmers who use it. The tobacco companies at country level distributed MB, and provided the technical training for using MB. In China, tobacco seedlings produced in 50-60m2 of seedbeds can be transplanted into 1 hectare of the field; there are about 17,000 plants per hectare. Generally speaking, one tin-can of MB (454 g per tin-can) can be used in 10 m2 of seedbed.

TOBACCO: MB CONSUMPTION AND AREA TREATED

PROVINCE	MB Consumption (Tonnes)	Area treated with MB (Hectares)	Number of "Natural Villages"	Number of "Natural villages" larger than 36 He	Number of farmers
Liaoning	12	3,900	340	70	15,220
Jilin	11	3,950	190	30	13,200
Heilongjiang	10.8	3,600	810	120	12,145
Anhui	15	5,010	320	40	21,700
Fujian	62	21,970	570	140	79,200
Shandong	45	15,932	1,650	260	67,048
Henan	61	21,140	1,240	230	73,467
Hubei	80.2	29,800	980	190	103,246
Hunan	32	10,800	910	180	39,242
Guangdong	31.6	10,745	890	170	37,817
Chongqing	41	13,972	760	130	52,356
Sichuan	20	6,130	580	90	24,875
Guizhou	32	10,997	860	190	39,674
Yunnan	256.4	91,954	4,300	900	326,513
Ningxia	3	1,094	30	6	5,645
TOTAL	713	250,994	14,430	2,746	911,348

1.9 Commodities fumigation

The State Bureau of Grain Reserve is the central administration authority responsible for enacting and implementing policies and control of institutions involved in the sector. Each province, district and county have bureau of grain reserve to implement the policy of State Bureau of Grain Reserve.

The General Corporation of National Grain Reserve Administration is a state owned enterprise. It has several subsidiaries in China is responsible for enacting policies for national grain reserve and national grain reserve warehouse.

Grain and other commodities are stored in each province, district and town in warehouse facilities, which belong to the State but are managed by the province district and towns. There are about 1000 warehouses with a capacity of more than 50000 tonnes each, about 3000 warehouses with a capacity of more than 10000 tonnes each, and about 10000 warehouses having a capacity of less than 10000 tonnes each

The national reserve warehouses belongs to the central government and this includes the warehouses, equipment and grain. The central government is the owner of

the grain, however the general corporation of grain reserve operates the national grain reserve warehouse. The warehouse should guaranty the quantity and quality of the grain reserve, the central government will disburse the fund for reserve based on the quantity they store. All the warehouses are responsible for their profit and deficit. Each reserve warehouse is authorized to use fumigation chemicals according to their needs.

MB CONSUMPTION IN THE COMMODITIES SECTOR

STATE	MB Consumption (Tonnes)	Number of large warehouses	Number of medium warehouses	Number of small warehouses	Total warehouses	Amount of Commodities treated (1000 Tons)
Tianjin	24	3	8		11	600
Hebei	5	3	1	1	5	150
Liaoning	20	5	6	2	13	650
Jilin	3	2	1		3	750
Shanghai	11	2	4		6	300
Jiangsu	28	8	3	2	13	1000
Anhui	39	7	14	3	24	1000
Fujian	3	2	2		4	750
Jiangxi	12	4	13		17	310
Shandong	20	4	5		9	450
Henan	11	3	6	2	11	300
Hunan	15	4	6	2	12	350
Guangdong	16	5	7	1	13	450
Guangxi	3	3	1	1	5	
TOTAL	210	55	77	14	146	7060

There are three kind of warehouses in China, first is the warehouse like the ordinary house, second is silos and third is big silos. Nearly all the grain is stored in bulk. The silos and the big silos have fumigation equipment but the ordinary warehouses do not have any. When they fumigate the grain, they just put the bottle of MB in the warehouse

Total storage capacity of China is about 200 million tons and in the event of an average of 1.5 fumigations per year, the total consumption of MB would be more than 10000 tons. However, since 1995, the State Bureau of Grain Reserve Grain reserve sector encouraged the use of alternatives like Aluminum Phosphide as fumigation chemical.

Presently the consumption of Aluminum Phosphide is about 4,000 tonnes but there is still a consumption of 210 tonnes of MB. This has been the result of improper use of Phosphine and building up insect resistance due to three factors:

- Lack of gas tightness is several warehouses
- Lack of instruments to monitor Phosphine concentration and leakages
- Improper training

2. THE PRODUCTION SECTOR

Since 1995, MB has been produced in China by three companies namely: (1) Lianyugang Seawater Chemical 1# Plant (2) Zhejiang Linhai Jianxin Chemical Corporation and (3) Shandong Changyi Chemical Plant

In 1996, Lianyugang Seawater Chemical 1# Plant was participated by the multinational Deadsea Bromine and the name of the Company was modified. The multinational Deadsea Bromine now owns 60% of the joint venture Lianyungang Deadsea Bromide Corporation

Initially MB was only used in QPS in China; and this limited the development of MB production. However, along with Chinese economic development, especially agriculture structure regulation with planting new crops, the demand of MB went up rapidly by different usage. Now, the production capacity is 8,400 tons of MB, and 2002 production was 3559 tons. In the event of an unrestricted demand, the production/consumption of MB amount would steadily rise in the future.

MB PRODUCTION IN CHINA IN 2002 [ODS Tonnes]

	Lianyungang Deadsea Bromid Corporation	Linhai Jianxin Chemical Corporation	Changyi Chemical Plant	**Total**
Location/Province	Jiangsu	Zhejiang	Shandong	
Production Capacity	5,000	2,500	900	8400
Production	2582	828	149	3559
MB Sold	2689	829	174	3692

2002 DATA FROM PRODUCING COMPANIES

	Lianyungang Deadsea Bromid Corporation	Linhai Jianxin Chemical Corporation	Changyi Chemical Plant*	**Total/average**
Location/Province	Jiangsu	Zhejiang	Shandong	

	Lianyungang Deadsea Bromid Corporation	Linhai Jianxin Chemical Corporation	Changyi Chemical Plant*	**Total/average**
Capacity	5,000	2,500	900	8,400
Production	2582	828	149	3,559
Sale	2689	829	174	3,692
Production Cost (RMB/t)				
Variable Cost	8,406	7,166		
Direct manual labor	372	332		363
Weighted Direct manual labor in US$				***44***
Manufacturing Cost	839	2,493		
Administrative cost	105	1,390		
Financial cost	321	278		
Sales cost	809	2,844		
Production Cost	10,852	14,503	0	
Production (t/y)	2,582	828	149	3,559
Total cost （RMB/y）	28,020,639	12,008,625		
Price （RMB/t）	16,000	15,030		
Sales （t/y）	2,689	829	174	3,692
Sales income （RMB/y）	43,024,000	12,456,864		55,480,864
Annual Profit （RMB/ton）				
Unit profit	5,811	541		
Depreciation	321	1,394		
Cash margin	**6,132**	**1,935**		**5,143**
Weighted Cash margin in US$				***621***

3. METHYL BROMIDE CONSUMPTION

Historic data consumption in the period 1995-1998 gives a baseline consumption of 1101.6 ODP tonnes

MB HISTORIC DATA PRODUCTION/CONSUMPTION IN ODP TONNES

	1995	1996	1997	1998	1999
Production	171	660	876	1398	876
Consumption	372	720	1356	1960	1598

Consumption baseline is 1101.6 ODP tonnes while production baseline is 776.3 ODP Tonnes. Consumption assessment carried-out during the preparation of this National Plan gave the following results

2000-2002 PRODUCTION AND CONSUMPTION DATA

	ODS Tonnes			ODP Tonnes		
YEAR	**2000**	**2001**	**2002**	**2000**	**2001**	**2002**
Baseline consumption 1995-1998: 1101.6 ODP tonnes						
Production	2397	2319	3559	1438.2	1391.4	2135.4
Imports	2150	1431	1355	1290	858.6	813
Exports	1047	1016	1500	628.2	609.6	900
Consumption including QPS and feedstock	3500	2734	3414	2100	1640.4	2048.4
QPS and feedstock uses	-800	-1074	-1601	-480	-644.4	-960.6
Consumption excluding QPS and feedstock	2700	1660	1813	1620	996	1087.8

The breakdown of 2002 consumption in agricultural uses and in fumigation of commodities is as follows:

MB 2002 CONSUMPTION

	ODS	ODP
Strawberry	520	312
Cucumber	40	24
Tomato	160	96
Eggplant	60	36
Hot Pepper	60	36
Flowers and others	50	30
Tobacco	713	427.8
Commodities	210	126
TOTAL	1813	1087.8

4. JUSTIFICATION AND STRATEGY OF THE PROJECT

China has signed the Vienna Agreement for the protection of the ozone layer, the Montreal Protocol, the London amendment as well as the Copenhagen amendment. By 2005, China has to reduce its production by 20%, less 10% allowance for Article (5) basic needs.

PRODUCTION SECTOR PHASEOUT [ODP Tonnes]	
Baseline 95-98	776.3
10% reduction	77.6
Maximum authorized production in 2005 (A)	698.6
Current total production in 2002	2,135.4
Exports for use as QPS and feedstock	-1396.0
Production subject to phaseout (B)	744.0
Amount to be phased-out in the first phase	45.4

Simultaneously, by 2005, China has to phaseout its consumption by 20%. This would represent a phaseout of 206.5 ODP tonnes and a maximum consumption of 881.3 tonnes

CONSUMPTION SECTOR PHASEOUT [ODP Tonnes]	
Baseline 95-98	1101.6
Maximum consumption in 2005 (B)	881.28
Current 2002 consumption (A)	1087.8
Theoretical amount to phaseout by 2005 (A-B)	206.52
Maximum authorized MB produced in China (D)	698.6
Amount to be phased-out in the First Phase	**389**

This scheme will put China in the paradoxical situation of having to import more than [redacted] MB tonnes by 2005 and to rely on external sources from Article (2) Countries. Being the situation of dependence unacceptable to China, the Government decided to phase out the necessary amount in consumption in order to match production and consumption.

The strategy to phaseout production and consumption will be based on the following principles:

- Under support of "*Air Pollution Prevention and Treatment Law in China*", to enforce production and imports restrictions with production and import quota system in order to comply with 2005 reduction of consumption
- To issue licenses to QPS users for controlling QPS consumption
- To control consumption in tobacco sub-sector under support of STMA

- To control consumption in Commodities sub-sector under support of State Bureau of Grain Reserve
- Decide the future phaseout schedule, after 2005, in accordance with what would be decided in the Meeting of the Parties in November 2003
- Implement a good training programme in order to transfer the necessary alternate technologies to all MB users
- Make the phaseout verifiable at Country, State and growers level

Concerning phaseout alternatives and crops, the strategy of the Government of China consist in minimizing risks, giving priority to those crops for which alternatives are already in use by a large number of farmers. These sectors are:

- Tobacco seedbeds where the floating technology has already been introduced and it is in use by around 50,000 growers
- Commodities fumigation where more than 4000 tons of Phosphine are already used, and the resistance problems were due to lack of equipment, too low concentration and poor training
- Cucumber and eggplants sub-sectors, where Chinese farmers have developed simple grafting techniques applicable at farm level, no matter how small are the fields. More than 5000 growers have phased-out a substantial amount of MB using this locally developed technology

In consequence, phasing-out consumption will be implemented as follows:

PHASING-OUT CONSUMPTION BY SUBSECTOR		
Sub-Sector	ODS	ODP
Commodities	210	126
Tobacco	356.5	213.9
Eggplant	60	36
Cucumber	21.5	12.9
TOTAL	**648**	**389**

5. PROJECT OBJECTIVES

China's National Phaseout plan has two objectives, namely (a) to phase-out 1087.8 ODP tonnes in the consumption sector (389 ODP tonnes in the first phase) and (b) to phaseout 744 ODP tonnes in the production sector (45.4 ODP tonnes in the first phase).

The achievement of the second objective is subject to ExCom approval of the corresponding production project

6.PROJECT DESCRIPTION

6.1 Alternative Technologies Available

The demonstration project, as well as other bi-lateral projects implemented in China focused on: (a) alternative chemical fumigants in soil, alone or combined with solarization and (b) the use of non-chemical alternatives, such as bio-fumigation, soil-less substrates, steam and grafting. Several alternatives have also been tested in grain fumigation but none has given so good results as phosphine. China is using a large amount of phosphine and has a large experience on this fumigant

Soil fumigation alternatives

Chemical alternatives in combination with IPM

The application of an Integrated Pest Management Programme could improve the effectiveness of mixtures of certified pesticides, nematicides, herbicides and fungicides applied. Nevertheless today's most widely used combination of two chemicals namely 1-3 Di-Chloro Propene and chloropicrin is not registered in China and there are no signs that this combination of chemicals can be registered in a near future. This leaves China with less options and practically only Metam Sodium is available. In this context, the use of chemicals in areas heavily infested with nematodes is quite risky

Soil-less substrates

In nurseries, glasshouses and seedbeds, as well as in other cases, synthetic or natural sterilized soil substitutes provide reliable support to prevent infestation by bacteria and fungi. Soil-less media might be roughly classified into two classes: organic and inert. Organic media, such as peat, sawdust, straw bales, etc., have high to good caption-exchange and water-holding capacity. Inert media, such as rock wool, perlite, polyurethane, expanded clay, polystyrene, etc., have high water-holding capacity but low caption-exchange capacity. Vermiculite is not completely inert.

Solarization in combination with IPM

This technique consists of simply heating the soil, by covering it with a plastic sheet. It is quite effective against many pathogenic bacteria, a wide range of nematodes, and to some extent also against fungi. The usefulness of the technique strongly depends on climatic conditions, availability of rain or irrigation and good application procedures. The IPM component is required to complement the efficiency of solarization against pests.

Bio-fumigation combined with solarization

Fermentation of organic residues buried in the soil generates gases, which are lethal for many microorganisms, including several nematodes. This old technique has been recently improved with the use of plastic sheets that trap the gases generated by fermenting organic waste. In countries with a moderate climate, this cheap technique, which combines solarization and bio-fumigation, has been successfully tested and is now in use at commercial scale.

Steam

The use of steam to pasteurize soil or substrates is being widely applied in European countries, Colombia, Morocco, Zimbabwe and Uganda, particularly in the production of cut flowers. The technology is relatively costly, but eliminates the waiting period and can be graduated according to the intensity of the incidence of the disease. This technique needs to be applied within the framework of an Integrated Pest Management system.

Grafting

Grafting is an effective method to control soil borne diseases, as vascular diseases caused by *Fusarium* spp and *Verticillium* spp, nematodes like *Meloidogyne* spp, virus as Melon Necrotic Spot Virus (MNSV) transmitted by a soil fungus *Olpidium bornovalus*, and Vine decline (caused by *Monosporascus canonballus*) which for the ethiology are not yet well know in all the aspects. The most suitable rootstocks available are the hybrids *Cucurbita maxima* x *Cucurbita moscata*, but large populations of indigenous cucurbits are available for a future selection of local rootstocks carrying the resistances required.

In principle, this technology was not selected for testing in the demonstration project due to the fact that melon growers did not have sufficient information on it and considered this technology to be too complicated. However, due to severe incidents of Fusarium and MNSV, the project successfully tested this alternative in Colima.

In general terms, the available alternatives are the following:

ALTERNATIVE	CONTROL			ADVANTAGES	DISADVANTAGES	APPLICATION	NOTES
	FUNGI.	NEMATODE	WEEDS				
CHEMICAL ALTERNATIVES (FUMIGANTS)							
1-3 Dicloropropene		X		Highly effective against nematodes	High toxic	Drip irrigation system or injection	Telone C17 or C35
Chloropicrin	X				High toxic, pungent odor, unknown effect at long terms		

Metam sodium	X	X	X		Low effective against nematodes	Drip irrigation system	
Basamid	X	X	X	Granular formulation easy to apply	Phytotoxicity, high cost	Granular	Dazomet
CHEMICAL ALTERNATIVES (NON FUMIGANTS)							
Ethoprop		X			Nemastats, do not kill nematodes	Granular	Mocap
Aldicarb		X			High toxicity. Low action on nematodes	Granular	Temik
Oxamyl		X			High toxicity. Low action on nematodes	Granular	Vydate
Fenamiphos		X			High toxicity. Low action on nematodes	Granular	Nemacur
Systemic fungicide	X				Specific target	Sprinkler	Benlate, Ridomil
NON CHEMICAL ALTERNATIVES							
Solarization	X	X	X	Increase self resistance	Efficiency related to environmental condition		
Bio Fumigation	X	X	X	Increase self resistance and soil fertility	High amount of organic matter requested		
Grafting	X	X		Adaptable to every cultivars	High labor input		
Soiless media	X	X	X		High crop management skills, High equip. ment cost.		
Floating system for tobacco	X	X	X	High seedlings quality			
Steam sterilization	X	X	X		High cost		
Crop rotation	X	X	X	Increase soil fertility	Limited pathogens range		
Biological control	X	X			Efficiency strictly related to environmental condition		
Resistant varieties	X	X			Limited pathogens range, long time for developing		

Alternative technologies available for stored commodities

Fumigants

Phosphine is a colourless gas which is about 3 times lighter in weight than MB and a much better penetrator of products. Phosphine fumigation, when conducted properly, provides complete mortality of the relevant insect pests and rodents. It requires about 3 to 10 days treatment time, depending on the temperature and pest species present. In many cases phosphine fumigation takes several few days longer than MB fumigation. However, several methods can be applied to reduce the treatment time where necessary.

Diatomaceous earth

Diatomaceous earths (DE) are composed mainly of silicon dioxide. They are produced from the fossilised remains of diatoms, microscopic single-celled aquatic plants that had fine shells of amorphous hydrated silica. Sometimes they are combined with silica aerogels. They have abrasive and sorptive properties and can be effective

against a wide range of insect pests when mixed with grain or applied to the surfaces of structures. Their use can be limited by high humidity.

Cold treatments and aeration

Chilling and aeration are used in many temperate regions with the aim of cooling grain to a temperature low enough to prevent the development of insect pests (typically less than 14°C). Ambient cold air – such as cool, dry night air – is fed into the stored commodity through an aeration system. Cooling can also be achieved by transferring commodities from one bin to another in cooler weather or by using refrigeration units to chill and dehumidify incoming air. Many grain silos in the Mediterranean and sub-tropical regions use the latter technique.

Very cold temperatures can kill many pests. Museums in many countries now use cold treatments of minus 18°C for 6 days or more, depending on pest species.

Heat treatments

Raised temperatures can also be used as a means of killing or inactivating pests. Heat treatment systems have been developed for grain and similar stored products, but are not available for large volumes of commodity. Heat combined with controlled humidity is used for the disinfestation of delicate museum items and other artifacts in northern Europe. Heat treatments and kiln equipment are used in some countries for the disinfestation of wood and wooden products.

Controlled and modified atmospheres

The level of oxygen can be reduced to levels at which insects stop activity and reproduction. This can be achieved by placing stored products in gas-tight storage vessels, such as flexible cocoons, or covering with gas-tight sheeting. The oxygen is largely replaced by carbon dioxide and/or nitrogen. These treatments are generally slow, although this is not a problem in cases where products remain in storage for several months. In cases where fumigation needs to be achieved in several days, a vacuum-hermetic treatment can be applied in a flexible PVC container.

6.2 Justification of the alternatives chosen and equipment needed

6.2.1 Strawberries

Results of the demonstration project as well as successive experiments with Metam Sodium with solarization applied though Venturi drip irrigation system was the best alternative in strawberries so far. The best results were obtained using 35% Metam Sodium at a dose of 1000 liters/hectare.

However, the common system for irrigation in China is flooding and only few growers have drip irrigation systems. The cost of installing such systems for 32000 growers would be too high.

In these circumstances, the only viable alternative is to apply Metam Sodium by means of injection machines shared by groups of 60 farmers which is the average number of farmers in a "natural village".

MS injection machines can be produced in China at a cost substantially lower than in other Countries. The number of "natural villages" formed by an average of 60 farmers is about 539. This is the amount of MS injection machines needed

STRAWBERRIES: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Equipment	Natural Villages	Amount in units	Unit price US$	TOTAL
MS injection machines	539	539	3050	1,642,476
TOTAL				**1,642,476**

6.2.2 Cucumber

Currently, many Chinese farmers are growing grafted cucumbers and the results are quite good if the appropriate local variety is used. At the beginning, many consumers did not like grafted cucumbers because were too big and the taste was different. However by selecting varieties and plant density, good results were obtained.

Chinese authorities have chosen the grafting alternative using black seed pumpkin as rootstock. Other alternatives like MS were less efficient, and the use of substrates, although have given good results, is too expensive.

Grafting commercial experiments, using simple equipment like trays and micro-tunnels, gave consistent and reliable results. Most of the farmers manage very well this alternative and there is no need of centralized production nurseries, which would be costly and would require complicated logistic support.

Scion and rootstock will be growth in about 21 m2 of micro-tunnels made with bamboo bowls and high quality PE film, in some cases thermal film. A separate micro-tunnels will be used for healing the grafted plants. The basic equipment will be completed with expanded polystyrene trays.

CUCUMBER: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Equipment	Units	Amount in units	Unit price US$	TOTAL
21 m2 scion and rootstock production micro-tunnel, with PE cover, 16 PVC arches, and cords	set	1	23.1	23
36 m2 micro-tunnel for grafting healing, with PE cover, 28 PVC arches, and cords	set	1	39.6	40
30 ml cell EPS tray for rootstock	piece	49	0.82	40
20 ml EPS tray for scion	piece	40	0.82	33
90 ml EPS trays for grafted plants	piece	153	0.82	125
Pegs	piece	10000	0.01	100
TOTAL per HECTARE				361
Number of Hectares				99
TOTAL FOR 99 HECTARES				35,860

6.2.3 Tomatoes

Grafting could be a suitable alternative because Mi gene rootstock has very good resistance to root-knot nematodes. However, this alternative is unfeasible in the case of China due to the problem of loosing resistance when the soil temperature is over 28 degrees Celsius as well as the cost of widespread distribution. Very few tomato cultivars carry Mi gene currently in China.

Another alternative tested with success in the demonstration projects is the use of Metam Sodium combined with solarization. However, as in the previous case of strawberries, the common system for irrigation in China is flooding and drip irrigation systems are almost unknown and for this reason it has been chosen to apply, as in strawberries, Metam Sodium by injection

MS injection machines can be produced in China at a cost substantially lower than in other Countries. The number of "natural villages" formed by an average of 60 farmers is about 178. This is the amount of MS injection machines needed

TOMATO: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Equipment	Number of natural villages	Amount in units	Unit price US$	TOTAL
MS injection machine	178	178	3050	541,477
TOTAL				**541,477**

6.2.4 Eggplant

Chinese authorities has chosen to extend the grafting experience acquired in the past 2-3 years by many Chinese eggplant growers but using some simple material to make it more reliable avoiding pitfalls. The technology will use EPS trays and the micro-tunnels will be built using PE and bamboo. Water eggplant or red eggplant will be used as rootstock.

Grafted eggplant as well as cucumber, are gaining popularity among growers who have proven that making grafted plants individually is a better solution than building-up centralized installations

Scion and rootstock will be growth in about 21 m2 of micro-tunnels made with bamboo bowls and high quality PE film, in some cases thermal film. A separate micro-tunnels will be used for healing the grafted plants. The basic equipment will be completed with expanded polystyrene trays.

EGGPLANT: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Equipment	Units	Amount	Unit price US$	TOTAL
21 m2 scion and rootstock production micro-tunnel with PE cover, 16 PVC arches, and cords	set	1	23.1	23
36 m2 micro-tunnel for grafting healing with PE cover, 28 PVC arches, and cords	set	1	39.6	40
30 ml cell EPS tray for rootstock	piece	49	0.82	40
20 ml EPS tray for scion	piece	40	0.82	33
50 ml EPS trays for grafted plants	piece	76	0.82	62
Pegs	piece	10000	0.01	100
TOTAL per HECTARE				298
Number of Hectares				148
TOTAL FOR 148 HECTARES				44,027

6.2.5 Hot Pepper

The only available alternative tested with success after the finalization of the demonstration projects is the use of Metam Sodium combined with solarization. However, as in the previous case of strawberries and tomatoes, the usual system for irrigation in China is flooding and drip irrigation systems are almost unknown. For this reason it has been chosen to apply Metam Sodium by injection

MS injection machines can easily be produced in China at a cost substantially lower than in other Countries. The number of "natural villages" formed by an average of 60 farmers is about 65. This is the amount of MS injection machines needed

HOT PEPPER: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Equipment	Number of natural villages	Amount in units	Unit price US$	TOTAL
MS injection machine	65	65	3050	199,318
TOTAL				**199,318**

6.2.6 Tobacco

Since 1999, China has been very active in testing, experiencing and implementing alternatives to MB. About 300 ODS tons of MB have been phased out by using the floating tray technology which is widely used all over the world. Metam Sodium has also been used in some cases but the results are poor compared to MB

Taking into consideration the larger number of farmers, which are close to one million, the sector is organized by grouping farmers according to a geographical criterion. The so-called "natural villages" group on average about 60 farmers and their area ranges from as small as 5 hectares up to 100 hectares. However, this figure are national averages and some of the natural villages group larger areas

This system has deep implications on the kind of equipment needed for applying the floating try technology. Small groups of farmers, up to 20 hectares, can use about 20 small micro-tunnels per village, but large "natural villages" with areas over 30 hectares need to install large (750 m2) greenhouses because a such large number of micro-tunnels would be unmanageable.

Another factor, which makes the adoption of the sole available alternative relatively costly, is the duration of the transplanting window opportunity, which is just 4 to 5 weeks. Being the seedlings production cycle of 7 weeks, it is impossible to produce two crops of seedlings in a single campaign

Practically, 50% of natural villages could manage with small micro-tunnels, which are cheaper than the large installations. 30% would need a so large area of micro-tunnels that they absolutely need large greenhouses. Use of a so large number of micro-tunnels would be unmanageable and very risky in terms of pests spreading.

There is still a 20% of villages with areas which would need large greenhouses. However, due to cost considerations they have been included in the group of small micro-tunnels bearing in mind that, from the technical point of view, this is a riskier option.

TOBACCO: CAPITAL COSTS PER HECTARE FOR 70% OF THE TOBACCO AREA (SMALL NATURAL VILLAGES)				
Item	**Quantity per micro-tunnel**	**Units**	**Unitary Cost**	**Total Cost**
EPM trays of 240 cells, dimensions 345 x 670 x 6 cm.	80	pce	0.82	65.6
200 micron UV protected transparent polyethylene sheet	41.1	sq.m	0.37	15.207
150 micron black polyethylene sheet	33	sq.m	0.28	9.24
Galvanized steel arches of 3.1 m, diameter 6.3 mm.	22	pce	0.78	17.16
4 mm. Elastic bidders, length 2.3 meters	2.3	m	0.09	0.207
Clipping device with nylon cord	1	pce	2.7	2.7
5 mm.Nylon cord, length 3.5 meters	3.5	m	0.024	0.084
Compactor tool	1	pce	4	4
Bloks 5x15x40 cm for pool	94	pce	0.08	7.52
Manual seeder	1	pce	22	22
Cost per hectare				143.72
Number of Hectares				175,696
TOTAL FOR 138047 HECTARES				**25,250,649**

TOBACCO: CAPITAL COSTS FOR 30% OF THE TOBACCO AREA (VERY LARGE NATURAL VILLAGES)				
Item	**Amount**	**Units**	**Unitary Cost**	**Total Cost**
Greenhouse with PE UV protected,high diffusion cover, prunning bridge and hot galvanized structure	22.5	m2	8.78	197.55
EPM trays of 240 cells, dimensions 345 x 670 x 6 cm.	80	pce	0.82	65.6
150 micron black polyethylene sheet	33	m2	0.28	9.24
Lawn clipper 0.5 HP	0.02	pce	123	2.46
Bloks 5x15x40 cm for pool	94	pce	0.08	7.52
Semi-automatic trays filler and seeding machine	0.01	pce	3210	32.10
Cost per unit				314.47
Number of Hectares				75,298
TOTAL FOR 112947 HECTARES				**23,679,025**

6.2.7 Flowers and others

Steam sterilization (pasteurization) is a technology that has been used in horticulture for many years. It is more efficient and easier to use within economical feasibility when raised or at least confined beds are used for production. Steam is a

feasible alternative to MB fumigation if combined with an Integrated Pest Management (IPM) program where control is mainly preventative, allowing for good results when treating the top 30 cm of soil.

Steam seems to be for the time being the only available alternative to phaseout MB in ginseng. In spite of the fact that the amount of fuel necessary to heat-up a very cold soil is not negligible, the cost of the fuel in China makes this alternative relatively less costly than expected

Small boilers can be mounted on a light platform and connected to a flexible hose. There are four methods for steam application namely (a) low pressure steaming on soil top under a plastic steaming sheet; (b) medium pressure injection of steam through 30 cm buried perforated pipes (c) "negative" pressure steaming which consist in low pressure steaming on soil top under a plastic steaming sheet combined with a network of draining pipes buried is soil connected to a vacuum Venturi device and (d) medium pressure steaming on aluminum boxes on top of the soil.

The alternate technology chosen consist in steaming soilbeds with tractor operated aluminum boxes and with manually operated boxes when the slopes are too high

FLOWERS AND MEDICINALS: AMOUNT AND COST OF THE EQUIPMENT NEEDED

STATE	Total growers	Area to be treated	Planting period (Days)	Hectares to be treated per day	Number of 1000 kg/boilers	Unitary cost of 1000 kg/hr boilers with 17 m2 sterilization plates, water softener and power generator	TOTAL (US$)
Liaoning	126	4.4	60	0.073	1	53,000	53,000
Jilin	3,345	124.2	60	2.070	30	53,000	1,590,000
Heilongjiang	284	8.2	60	0.137	2	53,000	106,000
Shanghai	165	7.5	60	0.125	2	53,000	106,000
Shandong	124	5.0	45	0.111	2	53,000	106,000
TOTAL		149		3	37		1,961,000

6.2.8 Commodities

China is largely using Aluminum Phosphine in grain fumigation and the original plan was to phaseout all MB by using Phosphine. However in a certain number of cases phosphine failed controlling insect development at what it is worst insect resistance to phosphine seems to have been developed.

The main causes of phosphine failure can be summarized as follows:

- Insufficient gas tightness in silos and warehouses with the result of too low phosphine concentrations
- Lack of ready to use low phosphine detectors to detect leakages
- Lack of sampling lines and phosphine detectors for continuous monitoring of phosphine concentration
- Inadequate training programme to instruct fumigators on time requirements for fumigation of highly infested grains
- Areas of high infestation

China is in agreement to extend its phosphine programme to phaseout the remaining consumption of MB, as far as the above issues are properly addressed in order to prevent the extremely risky situation of developing insect resistance.

The first step would be to examine gas tightness in all silos and/or warehouses experiencing problems. Low concentration phosphine detectors are essential for this purpose.

By using fans to re-circulate phosphine and monitoring and recording its concentration, the problem of building-up resistance due to poor exposure can be totally solved.

COMMODITIES FUMIGATION: AMOUNT AND COST OF THE EQUIPMENT NEEDED

Materials and Equipment	Amount	Price $	Total $
Recirculation systems with fan	562	1475	828,950
Phosphine meters/recoders for high concentrations	900	1200	1,080,000
Phosphine meters for low concentrations	300	750	225,000
Gas sampling lines	87000	0.4	34,800
Full face gasmasks, 2for each team	1500	108	162,000
Filters B2, 5 per mask	6000	11	66,000
TOTAL			2,396,750

6.3 Training needs

China agriculture is characterized for having a large number of growers with very small areas each. Plots of 3000 square meters are common. That is the reason why training programmes are relatively costly compared with Countries having fewer farmers cultivating the same area.

Training needs of the four sub-sectors phasing out MB, are distinctly different:

- The some short term international expertise to improve some aspects of the technology already in place but above all needs a large effort for training more than 35000 growers linked to every "natural village" centre.
- About 6500 growers in the eggplant and cucumber sectors need to trained in grafting
- Training on commodities fumigation shall cover 146 storage facilities located in almost all provinces. A minimum of 5 individuals per facility shall be trained on us of phosphine and on procedures to prevent insect resistance to this fumigant.

Area of action of the project is given in the following table

CROPS	HECTARES	% FIRST PHASE	FIRST PHASE AREA (Hectares)
Strawberries	1,297	0	0
Cucumber	99	54	54
Tomato	400	0	0
Eggplant	148	100	148
Hot pepper	149	0	0
Flowers and Others	149	0	0
Tobacco	250,994	50	125,497
TOTAL	**253,235**		**125,698**

Details of the training programme and its cost are given in Annex B.

6.4 Phase-out schedule

The phaseout schedule will be as follows:

PHASEOUT SCHEDULE IN PRODUCTION AND CONSUMPTION

YEAR	2004	2005	2006
PRODUCTION PHASED-OUT		45.4	
REMAINING PRODUCTION		698.6	698.6
CONSUMPTION PHASED-OUT	206.52	130	52.68
REMANINING CONSUMPTION	881.28	751.28	698.6

6.5 Compliance with country strategy

China has ratified the Copenhagen amendment and its country strategy is based on compliance with ODS reduction. If the present project is approved, China will comply with the 2005 reduction in consumption and production and will go behond in

phasing-out consumption. The future phaseout reduction will be agreed after the meeting of the Parties in December 2003

7. PROJECT IMPACT

By implementing this project China will comply with 2005 MB consumption reduction and will phaseout a further 16.5% by 2006.

If the corresponding phaseout production project is approved, China will comply with the 2005 20% reduction less 10% allowances for Article (5) countries

At the completion of the project, about 40 % of the current production and 36% of current consumption would be phased-out

8. PROJECT INPUTS

8.1 Capital goods

The following items will have to be purchased and installed:

- Metam Sodium injection machines with liquid dosing pump operated by a tractor
- PE covered micro-tunnels, EPS trays and accessories for grafting at farmer's sites
- 1000 kg/hr boilers with 17 m2 alumium plates for soil sterilisation
- Micro-tunnels and all accesoires for the production of tobacco seedlings using the floating technology (70% of the area)
- Large greenhouses and all accesoires for the production of tobacco seedlings using the floating technology (30% of the area)
- Recirculation system for phosphine in silos, phosphine detection equipment and safety equipment

8.2 Training

Training programme details are given in Annex B.

9. PROJECT IMPLEMENTATION

Following the approval of the first phase of the Sector Plan by the Executive Committee of the MLF, SEPA and UNIDO will sign an agreement, which will indicate that UNIDO entrusts SEPA to implement the Sector Plan, hereafter referred to as the Agreement. According to the Agreement, UNIDO will disburse grants to SEPA based

upon (a) a detailed workplan on the implementation and (b) phaseout performance. The Agreement will come into effect when the following conditions are met:

a) The Sector Plan has been approved by UNIDO and the Executive Committee the MLF
b) UNIDO and SEPA have signed the Agreement.

The Work Plan will include the key activities and schedule for MB phaseout, the amount of MB to be phased-out in each sector, conditions and amount of fund disbursement, necessary technical assistance, training and demonstration activities and their schedules.

After receiving SEPA's funding request, UNIDO will disburse funds to a special account — ODS Special Account set up in SEPA, based upon the satisfaction to SEPA's progress report and phaseout target achievment

After signing the Agreement with UNIDO, SEPA, and State Tobacco Monopoly Administration (STMA), Ministry of Agriculture (MOA), State Bureau of Grain Reserve (SBGR) will establish a special working group—MB Work Group.

A. Roles and Responsibilities

The MB Sector Plan will be executed by SEPA, acting on behalf of Chinese Government. PMO in SEPA, STMA, MOA, SBGR will jointly set up a Work Group, whose office will be located in SEPA. The Work Group will be responsible for preparing the Annual Work Plan. PMO and other ministries will jointly selected, through bidding, a domestic implementing agency (DIA) for the management of daily works during the implementation of the Sector Plan. DIA should be a consultation company with experiences of financial and project management.

Roles and Responsibilities of each institution involved are described as follows.

UNIDO will be responsible for overall implementation of the Sector Plan and accomplishment of its objectives as approved by the ExCom. UNIDO will:

a) Establish working and reporting arrangement with SEPA and other ministries;

b) Supervise SEPA to complete this Sector Plan;

c) Provide necessary technological and managerial support to SEPA and other ministries for the implementation of this Sector Plan;

d) Monitor the implementation of the Annual Work Plan, conduct necessary audit and inspection, review bidding processes of selecting DIA, units and institutions undertaking technical assistance, training or demonstration projects; and

e) Report to ExCom on the implementation of the Sector Plan

SEPA will, through PMO, one of its affiliated institutions, be responsible for overall project management and coordination for the implementation of the Sector Plan. SEPA will:

- Set up a Work Group consisting of staff from PMO, STMA, MOA and SBGR as well as selected technical experts from the sectors concerned
- Set up an ODS Special Account
- Select a DIA jointly with STMA, MOA, SBGR; supervise the work of DIA
- Review the funding request submitted by the Work Group and DIA, and approve the disbursement
- Review the license and quota requests submitted by the Work Group, establish the total amount of quota, establish the units and amount of critical purpose
- Submit progress report to UNIDO when requested
- Verify and ensure the achievement of the MB phaseout target of the Sector Plan, and the use of quota.

STMA, MOA and SBGR will assist SEPA implementing this Sector Plan. STMA and its subsidiary companies will be responsible for the implementation of the phaseout in the Tobacco Sector, so will MOA and local Plant Protection Stations in the Agriculture Sector. SBGR will implement phaseout in the commodities Sector. They will:

- Assist PMO in setting up the MB Work Group and selecting qualified technical experts for the Work Group
- Set up MB Work Group office and facilitate its operation
- Select a DIA jointly with SEPA
- Coordinate the relationships among SEPA, MB Work Group, DIA and involved units
- Collect information of license and quota requests in the sector and submit it to MB Work Group
- Assist SEPA achieving the MB phaseout target indicated in the Sector Plan, monitor the use of license and quota in involved units
- Provide support on sector policy and technology, lead MB users to eliminate MB consumption
- Assist the State Economic and Trade Commission and SEPA to prepare relevant regulations so that they can be issued and come into effect subsequently.

The MB Work Group will, with the backstop of PMO and other ministries, be responsible for implementing the Work Plan and undertake the following activities

- Implement the Sector Plan, coordinate the relationships among all relevant institutions
- Establish an implementing and monitoring mechanism as well a computerized database in English, which should include the status of the implementation of the Sector Plan for all MB manufacturers and users, so that UNIDO, SEPA/PMO, MB Work Group and other ministries can easily know project's situation
- Through bidding, select most cost-effective enterprises to provide inputs or implement certain project activities
- Through bidding, select undertakers of technical assistance, training, and manage their implementation
- Prepare TOR's of equipment to be purchased and under supervision of UNIDO, organize international biddings for this purpose
- Review DIA's payment requests and submit them to PMO for disbursement
- Accept the license and quota requests and submit them to PMO for approval, dispense the license and quota to users at the beginning of each year
- Monitor DIA's work, submit progress report to PMO quarterly, report to PMO timely on technical, managerial, or implementation problems, which might arise
- Visit beneficiaries, inspect project implementation, take part in the destruction of MB production equipment in manufacturers
- Help SEPA/PMO prepare quarter and annual reports on ODS Special Account, including budget revision requested by PMO and UNIDO. With PMO's entrustment, prepare request for replenishment fund and submit it to UNIDO
- Provide assistance to auditing exercises which might be requested by the Government, UNIDO and the ExCom.

DIA, with the backstop of PMO, MB Work Group and other ministries, will be responsible for the project activities at growers/enterprise level as follows:

a) Provide necessary managerial and technological assistance to MB Work Group;

b) Conduct equipment and service procurement for selected enterprises, help the enterprises converse their production line;

c) Prepare payment request for beneficiaries, or review beneficiaries payment request before submitting it to PMO;

d) Submit regular report on project implementation to MB Work Group, help the Work Group prepare progress report on project implementation;

e) Verify and inform MB Work Group and PMO of problems that arise in enterprises; and

f) Organize project commissioning.

B. Supervision and Reporting

MB Work Group will execute the Work Plan and submit progress reports to PMO four times a year. PMO will submit semi-annual and annual reports to UNIDO. The reports will be prepared in a format agreed by SEPA and UNIDO.

UNIDO will entrust an audit organization with the task of conducting independent audit of each year's project implementation. UNIDO will supervise implementation of the Work Plan, including spot check of project records and periodic check on enterprises or users.

SEPA will be responsible for conducting a domestic annual audit according to regulations for the ODS Special Account. The State Audit Administration should conduct this audit.

10. PROJECT COSTS

10.1 Incremental capital costs

The summary of investment costs given in chapter 6.2 and Annex B are the following:

ELIGIBLE INVESTMENT COSTS IN US$

Equipment cost for strawberries	1,642,476	0
Equipment cost for cucumber	35,860	19,275
Equipment cost for tomato	541,477	0
Equipment cost for Eggplant	44,027	44,027
Equipment cost for Hot Pepper	199,318	0
Equipment cost for flowers and others	1,961,000	0
Equipment cost for tobacco	48,929,674	24,464,837
Equipment cost for commodities fumigation	2,396,750	2,396,750
Sub-Total equipment	55,750,580	26,924,888
Training	4,151,630	1,184,685
TOTAL CAPITAL COSTS	59,902,210	28,109,574

10.2 Incremental operating costs

The incremental operating costs are given in Annex A and summarized in the following table:

	100 % PHASEOUT	First Phase	
Crop	US$	%	US$
Tobacco Incremental Operational Costs	-27,034,396	50	-13,517,198
Strawberries Incremental Operational Costs	757,531	0	0
Tomato Incremental Operational Costs	429,993	0	0
Eggplant Incremental Operational Costs	-142,603	100	-142,603

Cucumber Incremental Operating Costs	-96,484	54	-51,860
Hot pepper Incremental Operating Costs	84,058	0	0
Flowers and others Incremental Operational Costs	213,279	0	0
Commodities fumigation Incremental Operating costs	26,880	100	26,880
TOTAL INCREMENTAL OPERATIONAL COSTS	**-25,761,743**		**-13,684,782**

10.3 Contingency fund

A contingency fund consisting of 10% of the investment cost will be included, in order to cover unforeseen expenses that might occur during project implementation such as the purchase of small testing equipment, price escalation, unforeseen transport costs, etc.

10.4 Total Project costs

TOTAL PROJECT COSTS (US$)

TOTAL CAPITAL COSTS	59,902,210	28,109,574
CONTINGENCY FUND	5,990,221	2,810,957
OPERATIONAL COSTS	-25,761,743	-13,684,782
TOTAL PROJECT COSTS	**40,130,689**	**17,235,749**

11. PREREQUISITES

In accordance with the regulations of the Executive Committee of the Multilateral Fund, project funds will only cover incremental costs up to the amount of US$ 39.941,214 (17,046,274for the first phase). All other expenses, such as:

- Activities needed to install the equipment
- The cost of necessary technical staff during the installation of equipment
- Local transportation of imported equipmentmelon from the nearest harbour to farmer's association sites
- Any additional equipment not included in the present project document
- Any deviation of costs of the equipment to be purchased

shall be borne by the MB users

Prior to the start of the project, a Memorandum of Understanding (MOU) will be prepared by the implementing agency in cooperation with SEPA. This memorandum will specify the above-mentioned responsibilities of the counterpart, and the counterpart enterprises or institutions.

This Memorandum will be considered as an integral part of this project document.

12. PROJECT MONITORING

MILESTONES FOR PROJECT MONITORING

Date of project approval: November 2003

Milestone	Date	Month	Results			Remarks
			Achieved	Not Achieved	Delay	
Memorandum of understanding submitted	01/2004	1				
Memorandum of understanding signed	01/2004	2				
Equipment bids prepared	02/2004	2				
Contract for equipment awarded	04/2004	4				
First training of trainers workshops	02/2004	2				
First training of farmers programme initiated	02/2004	2				
First set of equipment delivered	05/2004	5				
Equipment installed	06/2004	6				
2004 Training of farmers programme completed	12/2004	12				
2004 Phase-out achieved	12/2004	12				
Second set of equipment delivered and installed	01/2005	13				
Second training of farmers programme implemented	12/2005	24				
2005 Phase-out achieved	12/2005	24				
Fourth set of equipment delivered and installed	04/2006	26				
Third training of farmers programme implemented	05/2006	29				
2006 Phase-out achieved	05/2006	29				
Project Completion Report	06/2006	30				

13. POLICY MEASURES AGREED BY THE GOVERNMENT OF CHINA

A. Policy Objectives

To accomplish the phaseout strategy in MB sector, it is necessary to establish policies and measures. The MB sector comprises three producers and a large number of users, including numerous farmers, lacking of advanced technology and management. Only by establishing and enforcing policies and measures, can it influence the activities of producers and users to participate in phaseout actively and quickly. The objectives of policies are:

- To achieve the phaseout targets set in Country Program, follow the general policy framework designed in Country Program.
- To establish relative policies and measures to limit production and use of MB.
- To ensure the benefits of users, meet the demand of MB in critical uses when controlling supply of MB, encourage use suitable alternatives.
- To encourage users to participate actively and quickly in phaseout activities through public propaganda.

B. Policy Design

China will adopt a package of various policy instruments to ensure achievement of a cost-effective phaseout in the MB sector. China's policy design for MB phaseout will be based on

- The *Law for Prevention and Control of Air Pollution* issued on April 29, 2000
- Framework of policies for ODS phaseout in Country Program
- Chinese situation, especially the characteristics of MB producers and users
- The need to maintain continuity and consistency of these policies with the existing policy and measure system, ensuring feasibility of the policies, as also continued supervision and management
- Economic efficiency and fairness

Based on the above considerations, China will introduce new policy instruments to guarantee that MB phaseout is achieved in the most cost-effective matter. The policies to be designed would include command and control instruments and market-based instruments.

C. Existing Policies that work on Phaseout of MB

For implementing the Montreal Protocol, a series of measures have been taken in China. These policies and measures will contribute to facilitate the phaseout targets of MB being achieved. Key policies include the following.

- *Circular on bans of establishment of new production sites for production and consumption of ODS* was issued by SEPA, SPC, SETC and ICA in November 1997. The ban requires all regions not to build, enlarge or renovate ODS-producing equipment and other equipment using ODS as material. The measures will ensure the production capacities of MB not be increased in China, which settled foundation for MB control
- *Import & export license system of ODS.* SEPA, SETC and GCA issued a Circular for management ODS of import and export in December 1999. This circular has entered into force in April 2000. The regulation requires ODS import and export activities to be registered.
- *Regulation for pesticide management* was issued in 1997 and revised partly in 2002. The regulation supervises the production, distribution and application of pesticides to ensure the quality of pesticides, protect agriculture, forestry, ecological environment and safety of human and livestock.
- *Production license system of pesticide.* This system requires the manufacturers to apply for the Production License of Pesticide from General Administration of Quality Supervision, Inspection and Quarantine, while BM is in the list controlled.

D. Policies and Measures to be introduced for phaseout of MB

SEPA will establish a Four-License System to control the production and consumption of MB, namely: the Production Quota License, Import/Export License, Trade License and Consumption Quota License

With this system, the targets of controlling and phasing out MB could be achieved. The key principle in the system is following.

- The producer must have a production license to produce MB according to the quota.
- Companies must have import/export licenses to trade MB according to the quota.
- Only those dealers having a license can purchase and sell MB according to the quota.
- Only those users who have a license buy and use MB according to the quota
- All quota will be issued by SEPA.

E. Production and Quota Licenses

Production License and Quota System is the most important measure to ensure phaseout of MB year after year. It is an important guarantee for China to meet the demands of the protocol and achieve the annual phaseout targets.

SEPA will issue a Circular on the *Management method of Production Quota License for MB.* All the MB manufacturers should apply for Production Quota License by submitting Application Form to MB Work Group of SEPA. The Work Group should confirm their qualifications and issue a Production Quota to enterprises. The production quota should be issued once a year at the beginning and is available only in that year. The manufactures will produce MB no more than the quantity of quota.

At present, there are only three MB manufactures in China. The production quota can be transferred among these three enterprises but excluding others.

F. Controlling Imports and Exports

As imports and exports of MB in China are roughly of the same amount, it is reasonable to ban imports and to regulate exports of MB. The domestic production may meet the domestic demand. Import of MB will be totally banned and the export of MB would be controlled through a quota system. The companies will apply for Export Quota License from the MB Work Group. The export quota must not be transferred to other enterprises.

SEPA should issue a Circular on the Management method of MB Import and Export.

G. Trading Licenses

SEPA will issue a Circular on the *Management method of trade License for MB.* All the MB dealers should apply for Trade License by submitting Application Form to MB Work Group of SEPA. The Work Group would confirm their qualifications, issue and verify the Trade License once each year. The dealers must sell MB to the customers with Consumption Quota License, and the quantity sold should be no more than the quantity of quota.

H. Consumption Quota License

SEPA will issue a Circular on the *Management method of Consumption Quota License for MB*, cooperating with related sub-sectors such as Tobacco, Agriculture, Grain reserve and QPS. All the MB consumption sectors should apply for Consumption Quota License by submitting Application Form to MB Work Group through DIA. The Work Group should confirm their qualifications and quantity of quota and dispense the Consumption Quota License to them. The consumers must purchase MB from the manufacturers or dealers with the License, and the quantity should be no more than that of quota.

In Tobacco sector, the enterprises should report their demand of MB to State Tobacco Monopoly Bureau, who should apply for Consumption Quota License from SEPA and dispense the license to local tobacco companies, and these companies purchase MB depending on the quota. The State Tobacco Monopoly Bureau should take charge in the supervision of MB use.

The Grain Reserve Companies should report their demand of MB to State Bureau of Grain Reserve, who should apply for Consumption Quota License from SEPA and dispense the license to the Companies. State Bureau of Grain Reserve should take charge in the supervision of MB use.

In purpose of QPS and feedstock, the users should submit the application to MB Work Group to apply for Consumption Quota License. The quantity of consumption quota may not be limited until suitable alternative is found. The MB they purchased should not be transferred to others. The related administration should take charge in the supervision of MB use.

In Agriculture sector, the users are a huge number of farmers, so it is impossible to dispense Consumption Quota License to each of them. The local Station of Plant Protection should keep the record of local MB demand and submit it to the Ministry of Agriculture, who should apply for Consumption Quota License from SEPA and dispense the license to local Station of Plant Protection, and these Station of Plant Protection purchase MB depending on the quota and then dispense them to farmers. The local Station of Plant Protection should also take charge in registration of consumption information such as name of the crops, planting area, dosage, etc. The Ministry of Agriculture should take charge in the supervision of MB use.

I. Other Policies

- Alternative technologies and products will be encouraged. Policies will be established to promote the development of alternative technologies and products. Simultaneously, health and safety of alternative technologies or products will also be considered. A national standard for MB alternative technologies and products is necessary.
- Through various media, such as broadcast, TV, newspapers and Internet, disseminate knowledge of depletion of Ozone Layer by ODS and raise public awareness (such as TV advertisement). Public should be encouraged to take part in phaseout activities.
- Before 2015, a ban on consumption of MB will be issued. After 2015, or if it is possible earlier, all uses of MB except QPS, feedstock and MLF approved critical uses will be forbidden.

ANNEX A INCREMENTAL OPERATIONAL COSTS

Eligible operating costs for Methyl Bromide in Strawberries (per hectare)								
Item	Amount	Unit	$/unit	Cycles	Year 1	Year 2	Year 3	Year 4
Methyl bromide	401	Kg	3.30	1	1,323	1,323	1,323	1,323
Labour for fumigation	3	wd	4.00	1	12	12	12	12
TOTAL COST (A)					**1,335**	**1,335**	**1,335**	**1,335**
Eligible operating costs for solarized Metam Sodium (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Metam Sodium 33%	1000	liters	1.50	1	1,500	1,500	1,500	1,500
Labour for fumigation	3	wd	4.00	1	12	12	12	12
Labour for covering	2	wd	3.00	1	6	6	6	6
TOTAL COSTS (B)					**1,518**	**1,518**	**1,518**	**1,518**
INCREMENTAL OPERATING COSTS (B minus A)					183	183	183	183
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					166.14	151.53	136.93	129.63
Net present value over 4 years/ha								584
Hectares treated								1,297
TOTAL for 1297 HECTARES								**757,531**

Cucumber: Eligible operating costs for Methyl Bromide (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Methyl bromide	403	Kg	2.80	1	1,128	1,128	1,128	1,128
Labour for fumigation	3	wd	4	1	12	12	12	12
Seeds	16,800	Seed	0.008	2	269	269	269	269
Fertilizer and pesticides	390	m^2 x day	0.0004	2	0.31	0.31	0.31	0.31
Transplanting	23.5	wd	3	2	141	141	141	141
TOTAL COST (A)					**1,550**	**1,550**	**1,550**	**1,550**
Eligible operating costs for Grafting (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Rootstocks seeds	9,800	seeds	0.029	2	568	568	568	568
Scion seeds	9,800	seeds	0.008	2	157	157	157	157
Substrate	1.5	m3	97	2	291	291	291	291
Fertilizer and pesticides	2,339	m^2 x day	0.0006	2	3	3	3	3
Labour for grafting	12.5	wd	4	2	100	100	100	100
Selection and cleaning graft	6.3	wd	4	2	50	50	50	50
Transplanting	12.9	wd	3	2	77	77	77	77
TOTAL COSTS (B)					**1,246**	**1,246**	**1,246**	**1,246**
INCREMENTAL OPERATING COSTS (B minus A)					-303.65	-303.65	-303.65	-303.65
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					-276.32	-252.03	-227.74	-215.59
Net present value over 4 years/ha								-971.68
Hectares treated								99
NET PRESENT VALUE FOR 99 HECTARES								**-96,484**

Eligible operating costs for Methyl Bromide in Tomatoes (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Methyl bromide	400	Kg	2.80	1	1,120	1,120	1,120	1,120
Labour for fumigation	3	wd	4.00	1	12	12	12	12
TOTAL COST (A)					**1,132**	**1,132**	**1,132**	**1,132**
Eligible operating costs for solarized Metam Sodium (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Metam Sodium 33%	1000	liters	1.5	1	1,450	1,450	1,450	1,450
Labour for fumigation	3	wd	4.00	1	12	12	12	12
Labour for covering	2	wd	3.0	1	6	6	6	6
TOTAL COSTS (B)					**1,468**	**1,468**	**1,468**	**1,468**
INCREMENTAL OPERATING COSTS (B minus A)					336	336	336	336
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					305.71	278.84	251.96	238.52
Net present value over 4 years/ha								1,075
Hectares treated								400
TOTAL for 400 HECTARES								**429,993**

Eggplant: Eligible operating costs for Methyl Bromide (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Methyl bromide	406	Kg	2.80	1	1,137	1,137	1,137	1,137
Labour for fumigation	3	wd	4	1	12	12	12	12
Seeds	17,000	Seed	0.007	2	238	238	238	238
Fertilizer and pesticides	390	m^2 x day	0.0004	2	0.31	0.31	0.31	0.31
Transplanting	23.5	wd	3	2	141	141	141	141
TOTAL COST (A)					**1,528**	**1,528**	**1,528**	**1,528**
Eligible operating costs for Grafting (per hectare)								
Item	**Quant.**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Rootstocks seeds	9,800	seeds	0.029	2	568	568	568	568
Scion seeds	9,800	seeds	0.007	2	137	137	137	137
Substrate	1.5	M^3	97	2	291	291	291	291
Fertilizer and pesticides	2,339	m^2 x day	0.0006	2	3	3	3	3
Labour for grafting	12.5	wd	4	2	100	100	100	100
Selection and cleaning graft	6.3	wd	4	2	50	50	50	50
Transplanting	12.9	wd	3	2	77	77	77	77
TOTAL COSTS (B)					**1,227**	**1,227**	**1,227**	**1,227**
INCREMENTAL OPERATING COSTS (B minus A)					-301.63	-301.63	-301.63	-301.63
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					-274.49	-250.36	-226.23	-214.16
Net present value over 4 years/ha								-965.23
Hectares treated								148
NET PRESENT VALUE FOR 148 HECTARES								**-142,603**

Eligible operating costs for Methyl Bromide in Hot Pepper (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Methyl bromide	404	Kg	2.80	1	1,131	1,131	1,131	1,131
Labour for fumigation	3	wd	6.00	1	18	18	18	18
TOTAL COST (A)					**1,149**	**1,149**	**1,149**	**1,149**
Eligible operating costs for solarized Metam Sodium (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Metam Sodium 33%	1000	liters	1.3	1	1,300	1,300	1,300	1,300
Labour for fumigation	3	wd	6.00	1	18	18	18	18
Labour for covering	2	wd	4.0	1	8	8	8	8
TOTAL COSTS (B)					**1,326**	**1,326**	**1,326**	**1,326**
INCREMENTAL OPERATING COSTS (B minus A)					177	177	177	177
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					160.95	146.80	132.65	125.57
Net present value over 4 years/ha								566
Hectares treated								149
TOTAL for 149 HECTARES								**84,058**

Eligible operating costs for MB in flowers (per hectare)								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Methyl bromide	335.06	Kg	3.30	1	1,106	1,106	1,106	1,106
Plastic sheet 0.2 mm	600	Kg	1.6	1	948	948	948	948
Labour for covering	4	wd	3	1	12	12	12	12
Labour for fumigation	2	wd	4	1	8	8	8	8
TOTAL COST (A)					**2,074**	**2,074**	**2,074**	**2,074**
Eligible operating costs for steaming per hectare								
Item	**Amount**	**Unit**	**$/unit**	**Cycles**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Labour for operation	4.0	wd	3.00	1	12	12	12	12
Labour for steaming	2.0	wd	4.00	1	8	8	8	8
Salt	54.0	kg	0.08	1	4	4	4	4
Fuel	7,800	liters	0.32	1	2,496	2,496	2,496	2,496
TOTAL COSTS (B)					**2,520**	**2,520**	**2,520**	**2,520**
INCREMENTAL OPERATING COSTS (B minus A)					447	447	447	447
Discount factor					0.91	0.83	0.75	0.71
Net present value/ha					406	371	335	317
Net present value over 4 years/ha								1,429
Hectares treated								149
TOTAL FOR 149 HECTARES								**213,279**

ELIGIBLE OPERATING COST FOR METHYL BROMIDE IN TOBACCO SEEDBEDS							
ITEM	AMOUNT	UNIT	US$/UNIT	YEAR 1	YEAR 2	YEAR 3	YEAR 4
Fertilizer	20.400	kg	0.370	7.548	7.548	7.548	7.548
Pesticides	1.072	kg	21.200	22.726	22.726	22.726	22.726
Methyl Bromide	2.841	kg	3.300	9.374	9.374	9.374	9.374
Plastic Sheets	1.488	kg	1.560	2.321	2.321	2.321	2.321
Labour	18.000	w/d	4.000	72.000	72.000	72.000	72.000
Seeds	19.000	thousands	0.080	1.520	1.520	1.520	1.520
TOTAL PRESENT COSTS (A)				**115.490**	**115.490**	**115.490**	**115.490**
Soluble fertilizer	4.450	kg	1.124	5.002	5.002	5.002	5.002
Pesticides	1.185	kg	18.900	22.397	22.397	22.397	22.397
Pelletized seeds	19.000	thousands	0.602	11.438	11.438	11.438	11.438
Substrate	168.000	kg	0.098	16.464	16.464	16.464	16.464
Labor	6.553	w/d	4.000	26.212	26.212	26.212	26.212
TOTAL EXTRA COSTS (B)				**81.512**	**81.512**	**81.512**	**81.512**
INCREMENTAL OPERATING COSTS (B-A)				-33.978	-33.978	-33.978	-33.978
Discount factor				0.910	0.830	0.750	0.680
Net present value				-30.920	-28.201	-25.483	-23.105
TOTAL ELIGIBLE OPERATING COSTS PER HECTARE							-107.709
Number of Hectares							**250,994**
TOTAL COST FOR 250994 HECTARES							**-27,034,396**

ELIGIBLE OPERATING OF MB COMMODITIES FUMIGATION COMPARED TO PHOSPHINE						
	Fumigant consumption (Kg)	**Unitary cost ($/Kg)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
MB	210,000	2.8	588,000	588,000	588,000	588,000
Al PH3	42,000	14.2	596,400	596,400	596,400	596,400
Balance			8,400	8,400	8,400	8,400
Discount factor			0.91	0.83	0.75	0.71
Actualized Value			7,644	6,972	6,300	5,964
Total incremental operating costs						**26,880**

ANNEX B TRAINING COMPONENTS AND COST

Training strategy on the agricultural sector

Farmers can be trained during practical field demonstration days and seminars but also by means of video films, leaflets and other printed material. However, taking into account past and present experience, the most efficient way to convince new users and to transfer a different technology is a direct contact in each farmer field

There is only one possible approach to train such high number of farmers, which consist in transfer the technology through the "natural villages" which group on average about 60 farmers. Therefore the training programme will consist of:

- Creation of a training working group which shall include representatives from SEPA, the Ministry of Agriculture, State Monopoly Tobacco Administration (STMA) and the State Bureau of Grain Reserve, which will prepare detailed plans by State and crop and will monitor future implementation
- Recruitment of trainers, having close contact with the farmers, in the environment of the "natural village" and/or in tobacco production
- Organizing seminars to train the trainers.
- Selection of several demonstration growers in each village and crop. These growers will be the first to phaseout and will have the full support of the respective "village" trainers
- Organizing field days in the site of the demonstration growers to discuss the phaseout technology and equipment with other growers
- Monitoring application of alternative technology by at least 3 visits to each grower per cycle
- Monitoring yields and results
- Repeating the direct contact in each production cycle

Based on the above, training needs in terms of work-months are the following:

W/M OF SPECIALIZED TRAINERS IN SOIL FUMIGATION ALTERNATIVES

								100% PHASEOUT		
PROVINCE	Strawberry	Cucumber	Tomato	Eggplant	Hot Pepper	Flowers and Others	Tobacco	TOTAL	W/D	W/M
Beijing	0.0	308.0	289.0	0.0	0.0	0.0	0.0	597.0	5373	179.1
Tianjin	0.0	0.0	267.0	0.0	0.0	0.0	0.0	267.0	2403	80.1
Hebei	30580.0	0.0	300.0	0.0	0.0	0.0	0.0	30880.0	277920	9264.0
Shanxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Inner Mongolia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Liaoning	312.0	0.0	609.0	323.0	0.0	126.0	340.0	1710.0	15390	513.0
Jilin	112.0	0.0	0.0	0.0	0.0	3345.0	190.0	3647.0	32823	1094.1

Heilongjiang	135.0	0.0	0.0	0.0	0.0	284.0	810.0	1229.0	11061	368.7
Shanghai	310.0	177.0	710.0	328.0	0.0	165.0	0.0	1690.0	15210	507.0
Jiangsu	126.0	0.0	587.0	128.0	0.0	0.0	0.0	841.0	7569	252.3
Zhejiang	193.0	0.0	322.0	0.0	0.0	0.0	0.0	515.0	4635	154.5
Anhui	122.0	134.0	312.0	313.0	312.0	0.0	320.0	1513.0	13617	453.9
Fujian	0.0	0.0	0.0	0.0	0.0	0.0	570.0	570.0	5130	171.0
Jiangxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Shandong	311.0	1640.0	5700.0	1942.0	1930.0	124.0	1650.0	13297.0	119673	3989.1
Henan	0.0	194.0	126.0	120.0	0.0	0.0	1240.0	1680.0	15120	504.0
Hubei	110.0	127.0	350.0	118.0	410.0	0.0	980.0	2095.0	18855	628.5
Hunan	0.0	0.0	0.0	0.0	0.0	0.0	910.0	910.0	8190	273.0
Guangdong	0.0	0.0	679.0	714.0	0.0	0.0	890.0	2283.0	20547	684.9
Guangxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Hainan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Chongqing	0.0	0.0	0.0	0.0	0.0	0.0	760.0	760.0	6840	228.0
Sichuan	0.0	0.0	401.0	0.0	598.0	0.0	580.0	1579.0	14211	473.7
Guizhou	0.0	0.0	0.0	0.0	0.0	0.0	860.0	860.0	7740	258.0
Yunnan	0.0	0.0	0.0	0.0	315.0	0.0	4300.0	4615.0	41535	1384.5
Tibet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Shaanxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Gansu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Qinghai	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Ningxia	0.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	270	9.0
Xinjiang	0.0	0.0	0.0	0.0	356.0	0.0	0.0	356.0	3204	106.8
TOTAL	32,311	2,580	10,652	3,986	3,921	4,044	14,430		647316	21577.2

Cost of the training programme in horticulture will be as follows:

TRAINING COSTS IN HORTICULTURE

	Unit	Amount for 100% phaseout	Amount for first phase	Cost for 100% phaseout	Cost of the first phase
Trainers W/M	W/M	21577	5213	3,236,580	781,909
Field days and seminars	Number	84	20	16,800	4,059
Training of trainers seminars	Number	36	9	324,000	1,739
International experts for training trainers	W/M	12	3	162,000	44,728
SUB-TOTAL SOIL FUMIGATION				3,739,380	832,435

Coordination and Management

The magnitude of the project, the numerous inputs and activities to be coordinated in order to deliver the equipment, to train growers, to organize the phase-out schedule and to monitor application of technologies, as well as effective phase-out implementation requires the services of a part time coordinator during the whole implementation of the project.

30 work months of a full time coordinator have been included in the total training cost.

Training in Commodities

Training in commodities fumigation will require the following:

- Organisation of a three days seminar, with the responsible of the provinces and town storage facilities, where MB is still in use, to discuss about the phase-out programme. Topics to be covered include:
    - Insect identification
    - Calculation of dosage rates
    - Monitoring to achieve necessary fumigant concentration
    - Principles of phosphine fumigation, heat treatments, etc. as appropriate to the users
    - Proper use of relevant safety equipment
- Building-up a team of specialists, to monitor gas tightness in the facilities still using MB. The team will measure leakages and recommend repairs to be undertaken by the respective companies
- Building-up a small team of specialist to install re-circulation fans and sampling pipes in the facilities
- Monitoring Phosphine application and specifically concentration/time parameters

	Unit	Amount for 100% phaseout	Cost for 100% phaseout
Seminar for 300 individuals from 146 storage facilities including travel and DSA	SEMINAR	1	132,000
Gas tightness team (two specialists) including travel and DSA	w/m and travel	12	42,000
Recirculation fans installation team including travel and DSA	w/m and travel	12	62,000
Travel for monitoring hosphine fumigation	Trips	150	56,250
TOTAL			292,250

Total training costs

Total training costs will be as follows:

TOTAL TRAINING COSTS

TRAINING COMPONENTS	100% phaseout	First phase
Horticulture	3,739,380	832,435
Coordinator	120,000	60,000
Commodities	292,250	292,250
TOTAL TRAINING	4,151,630	1,184,685

ANNEX C IMPLEMENTING AGENCY PROJECT BUDGET

		100% phaseout	First Phase
Line	**Item**	**US$**	**US$**
21.00	Subcontracts	59,902,210	28,109,574
21.30	Operating costs	-25,761,743	-13,684,782
71.00	Contingencies	5,990,221	2,810,957
99.00	**TOTAL PROJECT**	**40,130,689**	**17,235,749**