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STRATEGIC FRAMEWORK FOR CONTROL OF METHYL BROMIDE IN CHINA
(Submitted by UNEP DTIE)

Executive Summary

Strategic Framework to Control Methyl Bromide in China

1. Introduction:

The strategic framework to control methyl bromide growth in China is being submitted for information to the Executive Committee. The Committee members may wish to be aware of how the project was implemented, what main recommendations and conclusions were reached and what future activities have been identified. Copies of the full document are attached for the information of the 32nd ExCom.

This strategic framework is being submitted by UNEP as an output of the Chinese working group on methyl bromide, as requested by the State Environmental Protection Administration (SEPA). Any conclusions and recommendations contained therein are those of the working group's alone and does not necessarily follow the policies of SEPA.

2. Background

SEPA is committed to complying with the provisions of the Montreal Protocol. In order to proceed strategically to control Methyl Bromide (MB) use in China without jeopardizing agricultural productivity, SEPA approached UNEP for assistance in developing a Strategic Framework to Control Methyl Bromide in China.

At the 24th Meeting of the Executive Committee in March 1998, UNEP was requested to develop a sectoral policy plan to control the growth of methyl bromide consumption in China in close cooperation with SEPA. Canada, France and Germany indicated their interest to be involved in this project.

In undertaking this project, UNEP worked very closely with the Institute for Horticultural Development, Australia which has been in the forefront of developing a national strategy for methyl bromide phase out in Australia.

In early March 1999, an action plan to collect data needed for the development of the strategy was prepared, including consultations with the various ministries within the Chinese government and other stakeholders. Short, medium and long-term policy and research options were also discussed to see how these would fit in within China's regulatory structure.

In July 1999, a Consultative Workshop was convened to provide an opportunity for the methyl bromide stakeholders in China to be consulted on the various policy options that may be implemented in China. Participants to this workshop included representatives from bilateral agencies (Canada, France, Germany, USA) implementing agencies (UNDP, UNIDO, World Bank) and other invited experts. The main recommendation during this workshop was that China should ratify the Copenhagen Amendment to the Montreal Protocol in order for the strategic framework to be effective, and for the activities included therein to be implemented.

It was also recommended that this report be submitted to the Executive Committee for information in order that the results of the project are known and understood by the members.

3. Main Objective of the Strategic Framework

The preparation of this strategic framework will provide China with an action plan to control the growth of methyl bromide use. Considering that China is both a producer and a large consumer of methyl bromide with a potential for rapid growth, a coordinated plan is critical to ensure that China meets its obligations under the Montreal Protocol to phase out methyl bromide, upon ratification of the Copenhagen amendment.

4. Strategic Framework (see attached)

**Strategic Framework for Control
of Methyl Bromide In China:**

Action Plan

**Final revised draft
January 2000**

The Strategic Framework to Control Methyl bromide in China

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1. SUMMARY

1.1 Background

This framework report is completed by the methyl bromide working group with the support of the China State Environmental Protection Administration (SEPA), Ministry of Agriculture, State Administration for Entry-Exit Inspection and Quarantine, the National Petroleum and Chemical Industry Administration and the Bureau of Internal Trade etc. UNEP has provided great support and been in close cooperation with the working group. Some countries, such as Canada, Germany and France, have also offered some special assistance, mainly the experiences they have obtained from the developing countries.

SEPA has set up a working group for this project, consisting of the members from the Policy Research Center for Environment and Economy, China Research Academy of Agricultural Sciences, Management Center of Pesticide Registration, National Agrora-Technical Extension and Service Center of Ministry of Agriculture, State Administration for Entry-Exit Inspection and Quarantine, National Foodstuff Reserve Bureau and Zhejiang Chemical Industry Institute.

The data in the Report is only for the mainland of China not include that in Hongkong and Taiwan.

- 1.1.1 The 9th Meeting of the Parties to the Montreal Protocol in September 1997 set new control measures for methyl bromide phase-out. These Adjustments specify that Article 2 Countries are required to phase-out methyl bromide by 2005, with interim reductions prior to phase-out. Article 5 countries will freeze consumption and production of methyl bromide in 2002 at average level at 1995-98, with a 20% reduction in 2005 and a complete phase-out in 2015. Some necessary use exemptions will be allowed after phase out, but only for certain significant uses where no viable, proven alternatives are available. QPS uses which comprise 22% of the consumption of methyl bromide worldwide, are currently exempt from these controls.
- 1.1.2 At the 24th meeting of the Executive Committee in March 1998, UNEP was requested to develop a sector policy plan to control the growth of methyl bromide consumption in China in close cooperation with SEPA. Canada, France and Germany indicated their interest to be involved in this project.
- 1.1.3 Some afterwards, SEPA, UNEP and representatives from Canada and Germany held a meeting in Cairo in November 1998. The scope of the project was redefined, that is to develop a sector plan considering the past and future production and consumption of MB in China under an overall strategic framework on MB control. As the guideline for MB control was set on the 9th MOP, the emphasis of the sector plan was laid on the controlled MB uses.
- 1.1.4 In order to formulate this action plan, China exclusively organized a Working Group, responsible for data collection, report compilation, and the cooperation with UNEP consultants.

1.1.5 An initial data report on past, present and future consumption of methyl bromide was prepared and reviewed in March 1999, in preparation for a consultative workshop on the strategy held in Beijing in July 1999. This workshop reviewed those confirmed policy options including research and training, and raised prior short, medium and long term options that will be helpful for China to control growth of MB, and the eventual phase out.

1.1.6 This strategic framework and plan provides a reference for Chinese government to decide whether or not ratify Copenhagen Amendment.

1.2 Production, Importation and Consumption of MB

1.2.1 China is not only a consumer but also a producer of methyl bromide. The production capacity of two producers is 3300 tonnes annually (2330 tonnes real in 1998), and the import production is 920 tonnes annually from Israel, most of which are in small canisters. In 1995, a joint venture was established between Israel and the Lanyungang Seawater Chemical Industry Plant, it was agreed to produce these canisters in China.

1.2.2 In 1998, 2300 tonnes of methyl bromide was used for preplant soil disinfection, 230 tonnes for durable and other non QPS commodities, 150 tonnes as chemical feedstock and 570 tonnes for quarantine and preshipment uses (QPS).

1.2.3 The production and consumption of MB in China is managed by the State Ministry of Agriculture, National petroleum and Chemical Industry Administration. Registration is required for producers and importers, and the producers should get permits from the Head Office of the State Bureau of Petroleum and Chemical Industry. The sale and production of methyl bromide is prohibited in China without the production and sales permit, standard certificate and registration certificate (Ref: Order No. 216, State Council, 1997).

1.2.4 Methyl bromide is registered and mainly used as a soil treatment for four main crops, tobacco seedlings (48%), strawberries (29%), and tomatoes and cucumbers (18%). A smaller amount (5%) is also used for registration experiment of other crops (including melons, flowers, Chinese medicinal crops, turf, etc.). Most of MB are used for preplant soil disinfection. The main commodities treated by MB include grain and cotton. The main QPS uses are for imported timbers and softwood packaging materials used for exporting commodities.

1.3 Future Consumption of MB

1.3.1 If not constrained, basing on current trend, the consumption of MB in China is predicted to increase dramatically over the next few years. Soil fumigation uses are predicted to increase by 80% from 1998 to 2002, durables by 9% and chemical feedstock by 33%. The large predicted increase in use for soils is mainly attributable to the product's effectiveness, relative low cost, short

replant periods and ease of application.

- 1.3.2 Quarantine use is expected to increase by 216%, mainly due to the following reasons: i) new regulation stipulates that all softwood packaging materials exported to U.S and Canada need to be treated (effective since November, 1998); ii) As China prohibits deforestation, the imported wooden products need to be treated are greatly increased. The former use alone has increased MB consumption by approximately 100tonnes per month.

1.4 Overview of MB Alternatives

- 1.4.1 To date, UNIDO is the only implementing agency that has conducted a demonstration project assessing the suitability of alternatives for preplant soil disinfection in China. This project commenced in 1997 and has successfully identified that whilst there are a number of potential alternatives in China, no single alternative can replace the MB on soil applications, although a number of potential combinations have shown promising possibilities. Further demonstration projects of this kind is seen as necessary if China is to control consumption of MB.
- 1.4.2 The UNIDO project also demonstrated that due to the special characteristics of some medicinal plants especially ginseng, seeking alternatives for preplant soil treatments for herbal medicine appears to be the most difficult task at present as no alternatives have shown the potential to replace MB.
- 1.4.3 The promising alternatives demonstrated include alternative fumigants (ie. dazomet, metham sodium, chloropicrin) applied alone or as mixtures, specific pesticides: (eg. Avermectin), solarisation, resistant varieties and changed production practices using substrates and/or floating trays for specific crops, such as tobacco.
- 1.4.4 The production cost of alternatives fumigants is usually lower than some developed countries, therefore, the production capacity is the key element for MB phaseout. Several key alternatives, chloropicrin, metham sodium, dazomet and methyl iodide are either in production or could be produced in China. However, their full potential as a cost effective replacement to MB has yet to be determined.
- 1.4.5 Although the trials and the demonstrations implemented by UNIDO for alternatives has made great progress in China and some control measures that are effective to soil-borne diseases and nematodes were identified, these methods have limitations. China is a vast country with diversified weather and various cultivation systems. The sorts of soil-borne diseases, insect pests and weeds are various. Recently, the rapid area development of sheltered land together with the high multiple cropping indices bring about the severe occurrence of pests. The current control techniques and chemicals do not have a spectrum as wide as MB and the efficacy. An especially different situation in China is that the high multiple cropping indices set great difficulties to the alternatives that require long time of treatment such as fallow, flooding and rotation, etc. The scale of agriculture production in China is very small due to

the large population, which causes the cultivated land for each family is very limited. The income for farmers is low in general. The area for sheltered land is usually one *mu*, around 1/15 ha, for each tunnel. It is therefore difficult for large machinery used in large farms in other countries to be used in small plastic tunnels in China. The power and water supply in rural areas is not sufficiently available. It is in lack of training for applying alternative fumigants in semi-permanent tunnels and the farmers have little idea about the difficulties and the harm in using them. The agro-machinery and the cost of using them are in great short. The road condition is poor in many areas. Hence, further trials and tests are urgently needed for searching for alternatives that are suitable to the status of China and can solve the problems existing when MB is phased out. The machinery for applying the chemicals and other necessary supporting devices need to be equipped for trials for alternatives. Obstacles exist in techniques and in social, economic and administrative aspects are to be settled.

- 1.4.6 The major alternatives for grain fumigation in China include phosphine through improved application, carbon disulphide, chloropicrin, protectants including dichlorvos, cold and insect pest management, inert dusts, heat and exclusion. Some of these alternatives are already in use in China, and some are in adaptation or improvement.
- 1.4.7 The main use of MB in durable is required due to the difficulty to seek the alternatives basing on rapid action requirement. The suggested alternatives include heat, new fumigants, Carbon dioxide and avoiding pests.
- 1.4.8 Use of methyl bromide in perishables in China is almost all for quarantine purposes. The possible use of alternatives almost always require bilateral agreement and the agreement of long test between countries. Local adaptation of alternatives for QPS is also needed. Some of the possible alternatives include heat and vapour treatment, hot water dips, cold treatments, pre-harvest IPM, other fumigants such as phosphine and carbon dioxide for cut flowers, irradiation, physical removal of pests and insecticide dips.
- 1.4.9 In general, the alternatives mentioned above need further improvement, trials and demonstrations. The farmers need to be trained for the new technologies. It is possible to apply alternatives and replace MB only after the necessary basic facilities are improved, the construction of technique supporting institutions is established, and the financial support and the production of related chemicals and devices are available.

1.5 Action Plan for Demonstration and Training Programmes

- 1.5.1 The adoption of substitutes for soil and Non-QPS uses need to get fund support from MLF in China.
- 1.5.2 The priorities that should be given to alternatives to MB in soil fumigation before planting include:
 - 1) Survey to the application of MB and of alternatives every year.
 - 2) Trials on chemical alternatives.

- 3) Application of artificial substrate and/or floating tray.
- 4) Physical sterilization.
- 5) Resistant cultivars.
- 6) Biological control.

1.5.3 The project in priority for durables (eg. mostly grain) and perishables include (i) improvement in phosphine fumigation technology (i.e. gas tightness and circumfluence), (ii) combinations of Phosphine and CO₂ for cut flowers, (iii) use of protectants such as dichlorvos; (iv) evaluation of heat and vapour treatments, (v) hot water dips and cold treatments, (vi) use of inert dusts for food protection, (vii) mechanical refrigeration for stored product, (viii) controlled atmospheres using CO₂ and Nitrogen, (ix) consideration of alternative fumigants including carbon bisulphide and carbon oxysulphide, and (x) the use of sulphuryl fluoride for cotton.

Some of these alternatives are already in use in China, and some need to be improved or adjusted to meet China's situation. It is important to note that adoption of alternatives almost always requires bilateral agreements between countries and a long trial period.

1.5.4 A QPS project to address alternative treatments for softwood packaging material and imported wood is an urgent priority for China. Issues to be addressed include the demonstration, application and promotion of kiln treatments for wooden packing, research and promotion of sulphuryl fluoride fumigation and development and promotion of paper packing. It is however recognized that as the QPS use is not within the scope of control terms, it means the substitution projects on QPS use is ineligible for MLF fund.

1.5.5 TA projects including information distribution, information dissemination at national level and provincial level, training for trainers and peasants are essential to the adoption of alternatives in China. Some training programmes carried out in other developing countries can be used as a model for such programmes.

1.6 Policy Plan for Controls on MB

1.6.1 The Consultative Meeting in Beijing in July, 1999, defined possible control policies and schedule on production, import and consumption of MB, and the responsible agency to assist implementing these control measures. The priority rank of these policy measures are defined basing on China's real situation and in the light of the experiences in other developing countries.

1.6.2 The possible policies that could be put in place include legislative and regulatory controls on production and imports, economic incentives, among them the alternative-related technical policy is crucial.

1.6.3 China agreed to set up a leading group that is responsible to related affairs in coordinating the increased use of MB during the workshop in July (this group may be possibly integrated into the Chinese Leading Group of Phasing out ODS, as a part of the latter). The workshop discussed the possible policy of control measures

deeply. The academic exchanges on the applicability of the alternatives to MB were conducted and the precedence of the alternatives was discussed.

- 1.6.4 The most ideal approach for methyl bromide phase out in China would be following the sector approach that has been proven successful in both the halon and production sector. It was however emphasised that certain specific activities should be done jointly by China, World Bank and UNEP.

1.7 Policy Controls on Production of MB

- 1.7.1 SEPA and the Petrochemical Bureau are the authorities in China responsible for policy controls on production.
- 1.7.2 The policy controls on MB production which were considered most appropriate are (i) restriction on the number of MB produce, and (ii) the imposition of a quota in each factory. An immediate restriction could limit production to the present capacity in China to 3300 tonnes per year. Together with restrictions on imports of MB, this would provide a most practical and feasible way of limiting of production until 2002, when the freeze on MB would be imposed under the Montreal Protocol guidelines. The benefits of this outcome are that consumption of MB would also be restricted, thus enabling growers are easier transition to alternatives.
- 1.7.3 MB producer presently should pay a license fee in China. Limiting approval of production licenses could also restrict any increase in production. An increase in license fees would also be a disincentive to further production.

1.8 Policy Controls on Importation of MB

- 1.8.1 SEPA, the Ministry of Foreign Trade are the agencies in China responsible for imposing policy controls on MB importation.
- 1.8.2 Despite that imported methyl bromide is ten percent more expensive than locally produced methyl bromide, imports from Israel is keeping continued due to its better quality, and effectiveness, but now, China and Israel established a joint venture to produce MB, the quality of locally produced MB should get better.
- 1.8.3 In spite of the slight difference in efficacy, controls on methyl bromide imports, either a complete ban, a restriction or the introduction of tariffs, are considered feasible and could be implemented provided they are within World Trade Organization Rules. (Under such a rule, restrictions could not be applied on importers without similar restrictions also applying to domestic producers).

1.9 Policy Controls on MB Use

- 1.9.1 The Ministry of Agriculture, is the agency responsible for most of the policy controls that could be imposed on use of MB in China.

- 1.9.2 The policy controls which were considered most appropriate include; (1) mandatory buffer zones for preplant soil uses, (2) rate limits and limitation by region. Present limits for use of methyl bromide already exist in China, however the potential exists to further restrict rates. At present, MB applications at 60-80g/m² for tobacco, 75g/m² for cucumber and tomato, and 50-80g/m² for strawberry are permitted under the register for preplant MB treatment. If VIF is used, the consumption of MB could be reduced largely. (3) Strength the publicity and education, technology promotion.
- 1.9.3 The use of methyl bromide in China is presently limited by regulation to crops and uses specified on the label of the methyl bromide canister.
- 1.9.4 Another policy option for control of MB use is the mandatory use of VIF barrier films. Constraints to implementing this option, however, would be the cost of the film, and the fact that this is not produced in China. It is also possible that such a change may require legislation so adoption is not considered likely in the near future.
- 1.9.5 Tax exemptions for effective alternatives and deregistration of MB uses when effective alternatives become available are other possible options that should be considered in the future.
- 1.9.6 Limitations on use by region are possible, but it would need to follow a planned strategy in line with a staged legislative approach that restricted use for crops where alternatives were found to be effective.

1.10 Conclusions

- 1.10.1 Two possible scenarios emerge for China once it ratifies the Copenhagen Amendment:
 - (1). China agrees to phase out methyl bromide following the control measures under the Montreal Protocol. This means that China would freeze MB use in 2002 using average consumption of 1995-1998 as a baseline, if no other action would be taken before the freeze date. This could then be a burden to MB users as they would have to make drastic reductions in current MB use by 2002.
 - (2). China immediately imposes voluntary domestic controls on importation and production of methyl bromide for all regulated uses in advance of, and to prepare for the freeze in 2002, at production and consumption levels on or close to the baseline, or as decided by the Chinese government. This will send important signals to both the MB industry and the MB users that the Government is serious about shifting to alternative technologies. Some measures such as reorganizing methyl bromide production plants and stopping importation could be imposed by China to execute a quick phase-out of methyl bromide efficiently

This report believes that the actions for searching more alternatives now is better for expenditures on forbidding the use of MB in future. The scenario (2) is the best choice for Chinese farmers.

1.10.2 The Chinese government is active to take steps to prepare for ratifying the Copenhagen Amendment. Following issues should be fully considered before the decision would be finally made.

- (1) To make a full technical and economic assessment for to reduce the impact from control of MB on national economy.**
- (2) To integrate the research and development of alternatives of MB into the State Scientific and Technological Plan to get the alternatives that are suitable for Chinese characters.**
- (3) To actively search for the support from MultiFound to meet the additional cost caused by phasing out the production and consumption of MB.**

1.10.3 The adoption of policy options to restrict the possible increase in consumption of methyl bromide for soil and non QPS commodity uses before 2002 will ensure that alternatives will be adopted and better developed to allow them to meet the freeze on the baseline, which, is calculated at 1485 tonnes.

1.10.4 The following aspects are considered by the **Chinese working group** to be important in the development and subsequent implementation of this strategic framework:

- The Strategy should not have negative effects on either the producers and users.
- That producers and consumers be equally eligible for financial assistance from the Multilateral Fund of the Montreal Protocol in order for the phase out to be easily implemented.

1.10.5 The **Chinese working group** also recommended that following the ratification of the Copenhagen Amendment:

- The World Bank & UNEP jointly coordinate a sector approach similar to the halon and production sector approaches, to phaseout methyl bromide
- Funds be made available either from the Multilateral Fund or bilateral agencies to continue the research, demonstration, extension and training programs identified in this strategy to assist adoption of alternatives
- Sector subgroups by crop/commodity be set up with bilateral assistance to assist adoption of alternatives.
- A communication support system be created to ensure effective delivery of information about alternatives.
- A framework be developed for setting control policies on methyl bromide.
- That Chinese experts be given the opportunity to observe the successful implementation of alternatives in other developing countries.
- Further research should be done on possible social and economic impacts caused by the phase out of MB. Related departments need to be promoted to formulate MB phase out policy and the strategy for alternatives development.

This will benefit Chinese government to consider the ratification of Copenhagen Amendment.

2. INTRODUCTION

2.1 Background

Methyl bromide is an ozone depleting pesticide that has a wide range of uses: as a disinfection treatment for soils before planting horticultural crops, for post-harvest treatment of perishables and durable, and for structural fumigation. An estimated 71,500 metric tonnes of methyl bromide are used worldwide.¹ Methyl bromide is extremely toxic, acting as a broad-spectrum biocide that kills most living organisms exposed to it. Presently developing countries consume between 14,350 – 17,500 tonnes of methyl bromide or between 23-26% of global consumption². Of this approximately 70% is used for preplant soil fumigation and 20% for durable commodities.

Under present application methods between 32 to 95% of the applied methyl bromide is emitted to the atmosphere². Once a bromide atom reaches the stratosphere it acts quickly to break down ozone, up to 60 times as much ozone as a chlorine atom from CFC emissions. The resultant hole in the ozone layer lets through UV radiation which contributes to human health problems. UV-B is known to affect human health in a variety of ways, including increases in eye cataracts, skin cancer, and suppression of the immune system. Owing to methyl bromide's degradation of the ozone layer, the international community established controls on the pesticide under the Montreal Protocol on Substances that Deplete the Ozone Layer.

Industrialized countries, which account for an estimated 75% of global consumption of methyl bromide, have a more rapid phase out schedule. The Montreal Protocol deadlines for these countries call for a 25% reduction in 1999 (based on 1991 consumption levels), a 50% reduction in 2001, a 70% reduction in 2003, and full phase out in 2005. Many countries, both industrialized and developing, have made a commitment to phase out methyl bromide well in advance of the Montreal Protocol schedule (see Appendix 2.).

In September 1997, the 9th Meeting of the Parties to the Montreal Protocol on substances that Deplete Ozone Layer set control measures for phase out of methyl bromide in developing countries. Those countries which have signed the Copenhagen Amendment will freeze consumption and production of Methyl Bromide at the average level in 1995-1998 by 2002. In 2005, there will be a 20% reduction and total phase out by 2015. Quarantine and pre-shipment uses are currently exempt from these controls.

2.2 Purpose

Under the Multilateral Fund of the Montreal Protocol, a number of demonstration, other non-investment and investment projects are being proposed and implemented in

¹ See *Methyl Bromide: Getting Ready for the Phase Out*, UNEP IE, 1998.

² See Report of the MBTOC Committee 1998 Assessment of Alternatives to Methyl Bromide.

many Article 5 Countries to evaluate and apply alternatives for soil and post harvest uses of methyl bromide. Funding for methyl bromide alternative demonstration and investment projects is only available to those countries that have ratified the Copenhagen Amendment. The Multilateral Fund's Strategy and Guidelines for Projects in the Methyl Bromide Sector recommends that the Fund should support a range of activities to help countries which have rapidly accelerated the use of methyl bromide, or have the potential for further increase in its use. This assistance can be in the form of policy dialogues, information exchanges programs and demonstration and investment projects.

One of the projects approved under UNEP's 1998 Work Programme is the Development of a Strategic Framework to Control Methyl Bromide in China. The State Environmental Protection Administration (SEPA) of China is committed to comply with the provisions of the Montreal Protocol. In order to proceed strategically to control Methyl Bromide use in China without affecting its agricultural development, SEPA approached UNEP for assistance for the development of a Strategic Framework to Control Methyl Bromide in China.

The following strategic plan has been developed after a series of consultative workshops in China between UNEP, the lead consultant Dr Ian Porter from Agriculture Victoria, Australia, the Chinese Working Group and the bilateral countries, Canada, Germany and France.

The main aim of this project is to; i) control the predicted increase in methyl bromide consumption, ii) provide technical support for ratification of the Copenhagen Amendment.

2.3 Methodology

- Review and discuss policy instruments to control growth of methyl bromide use and production in China identified in the draft strategic framework, including research priorities;
- Consult Chinese MB stakeholders and exchange ideas on how such policy instruments and research priorities and alternatives will affect Chinese agricultural production, and how these could be used to assist China in reducing and phasing out methyl bromide use;
- Determine an Action Plan identifying policy options and research priorities that can be implemented by China in a short, medium and long term perspective.

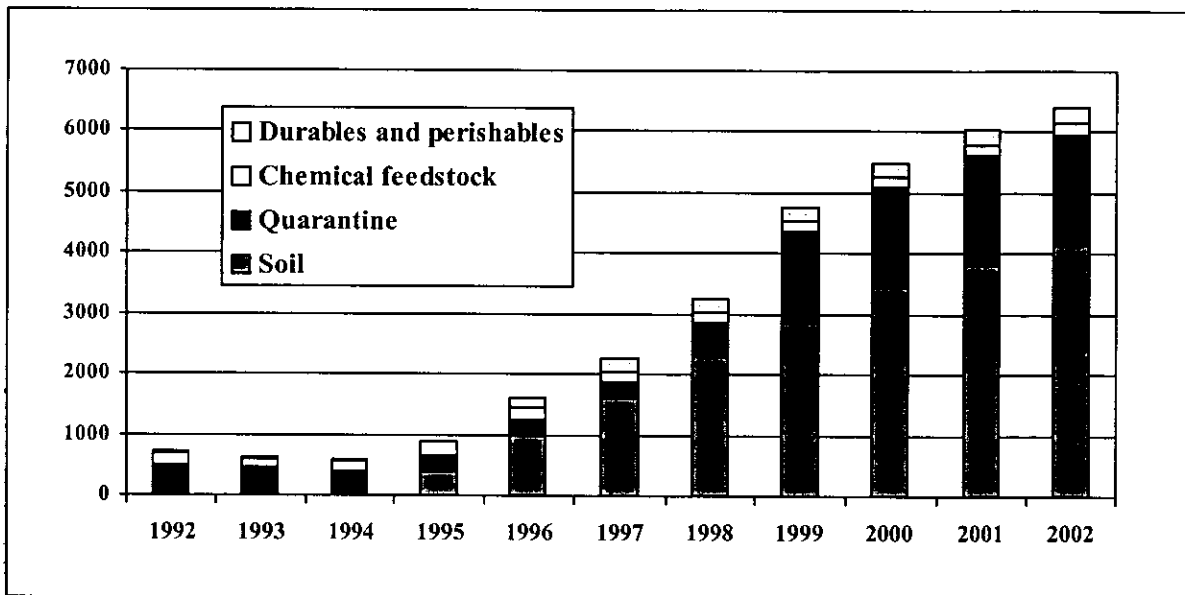
The expected outputs from the strategy are;

- Presentation of a draft of China's Strategic Plan at the 11th Meeting of the Parties.
- To establish a series of priority research and demonstration projects with Multilateral Funds to evaluate the most cost effective alternatives to MB in China, so that China can implement after ratifying the Copenhagen Amendment.
- Adherence by China to the Action Plan for China to implement specific short and medium term policy options and research priorities;

3. CURRENT STATUS OF MB PRODUCTION AND CONSUMPTION IN CHINA

3.1 Sector Background

China is both a consumer and producer of methyl bromide. In 1998 the total consumption was estimated at around 3250t with approximately 72% produced in China and 28% imported from Israel. In 2002, consumption is conservatively estimated to have increased to 6400t without control(Fig 1.).



Lianyungang enabled the production of small cannisters (681g) of methyl bromide, and this has assisted the expansion of MB especially for preplant soil fumigation (Fig. 1). Cannisters have also been imported from Israel since 1993 (Table 1.) and recent estimates indicate that over 1500t are likely to be imported in 1999. The MB cannisters have provided farmers with, an easy treatment for preplant soil disinfestation which does not require any machinery.

Table 1. The Import and Export Quantities of Methyl Bromide ¹

Unit: ton

	1993	1994	1995	1996	1997	1998
Import	17	46	340	100	800	920
Export	4	4	5	0	0	0

¹ For figures of 1993-1995, see *Survey On The Production and Consumption of Methyl Bromide in China*, Zhejiang Chemical Industry Research Institute, August 1996.

3.2 Present and Future MB Consumption by Application and Crop from 1997 – 2002

3.2.1 MB for Preplant Soil Disinfestation

In 1995, 50 tonnes of MB was used for soil treatment, however, by 1998, 2300t was used. In 1998, approximately 70% of MB in China was used for preplant soil fumigation mainly for treatment of 4 main crops, tomatoes and cucumbers 18%,

strawberries 29%, tobacco seedlings 48% and 5% for other crops (including melons, flowers, Chinese medicines, lawn, etc.) (Table 2.). Most of this use is presently in plastic houses, however without any restrictions on MB, use for preplant soil disinfestation is predicted to double to approximately 4150t in 2002.

Table 2. Actual and predicted amounts of MB (tonnes) consumed for preplant soil fumigation from 1997 to 2002

Crops	1997	1998	1999	2000	2001	2002
Tomatoes, cucumbers	300	410	550	700	850	1000
Strawberries	500	660	780	900	1000	1100
Tobacco seedlings	720	1100	1300	1500	1500	1500
Others	80	130	240	350	470	550
Total	1600	2300	2870	3450	3820	4150

At present there is between 1 to 25% adoption of methyl bromide for preplant soil treatment for crops where methyl bromide could be used. Without controls on methyl bromide, a huge expansion could occur in methyl bromide for all crops now using methyl bromide (Table 3.).

Table 3. Present and possible future adoption of methyl bromide for soil disinfestation in the major MB user crops in China

Parameter	Major Crops Using Preplant Fumigation with MB			
	Vegetable crops (eg. tomato & cucumber)	Tobacco seedbeds	Protected strawberry	Others, eg. medicinal herbs
Total Production in China (hectares)	1,500,000 ^A	20,000	5,000	10,000
MB Use in 1998 (tonnes)	410	1,100	660	130
% Adoption of MB at 1 Jan., 1999	<1%	11%	25%	3%
Possible future adoption (%)	25%	100%	100%	100%

^A – An estimated 750,000 ha of vegetable crops are grown under protected cropping, (predominantly plastic houses)

3.2.2 MB for Durable and Perishable Commodities (non QPS), Storage and Buildings

In 1998, approximately 230t of MB were used annually for treatment of durable and perishable commodities, mainly grain. Use is only expected to increase slowly to a total of 250t used in 2002 (Table 4.) In the past, pest management in stored goods, including grains and food stuffs, was undertaken by fumigating with phosphine. Recently it has been found that many pests have developed resistance to phosphine, so methyl bromide use in storage and building treatments has and will continue to increase.

Table 4. Actual and predicted amounts of MB (tonnes) consumed for commodities (non QPS), storage and buildings from 1997 to 2002

	1997	1998	1999	2000	2001	2002
Commodities, storage and building	230	230	230	230	240	250

3.2.3 MB for Preshipment and Quarantine

Recent legislation imposed in several developed countries has caused a dramatic increase in use of MB for quarantine and preshipment (Table 5). In September 1998, the U.S.D.A promulgated a temporary regulation, which requires softwood packaging material imported from China to undergo fumigation, heat treatment or preservative treatment. In November 1998, Canada raised the same request and this has increased use for this purpose by approx. 100t/month. At present, China is not able to heat treat products in large number because facilities are not available and cost is high. Therefore the majority of softwood packaging exported to the U.S.A and Canada must be fumigated using methyl bromide. Other countries, eg. Australia, also requires mandatory treatment of softwood packaging, however it will accept a range of other treatments used offshore.

In order to protect the native forest resources the Government of China will undertake stricter quarantine measures. From 1999 onwards, it is prohibited to cut natural forests in China therefore quantities of imported wood will increase. The methyl bromide used in fumigating imported wood, wooden products and wooden wrappers is therefore expected to increase accordingly.

Table 5. Actual and predicted amounts of MB (tonnes) consumed for preshipment and quarantine from 1997 to 2002

	1997	1998	1999	2000	2001	2002
Preshipment and Quarantine	270	570	1500	1650	1800	1800

3.2.4 MB as a Chemical Feedstock

Methyl bromide is also used as a methylating agent for the chemical synthesis of drugs, herbicides and surface-active agents. The total consumption of feedstock methyl bromide in China in 1998 was about 150 tonnes and the estimated average increase in the next 3-5 years is about 8%.

The existing or potential substitutes of methyl bromide used as a feedstock in the chemical synthesis are methyl chloride, methyl iodine, dimethyl sulfate and dimethyl carbonate.

3.3 Present and Future MB Production

In China, production levels and future growth of methyl bromide are determined by consumption and this is controlled by Government policy. There are currently only two plants producing methyl bromide in China. They are Lianyungang Seawater

Chemical 1st Plant of Jiangsu Province and Changyi Chemical Plant of Shandong Province.

Lianyungang Seawater Chemical 1st Plant's projected capacity is currently 3000t per year (estimates of the future production limit of the plant has varied from 4000t to 10,000t/per year) and Changyi Chemical Plant's projected capacity is 300t per year. The large increase in Quarantine and Preshipment. Use for softwood packaging material (wooden wrappers) exported to U.S.A and Canada makes it difficult to estimate the production capacity of the plants over the next 3-5 years.

In spite of the slightly higher price (approx. 10% more expensive) (Table 6), the imported methyl bromide from Israel tends to be more effective and is often preferred in China. Farmers are able to compensate by using rates approximately 10% greater for this product.

Table 6. Factory production cost and factory selling price for methyl bromide (\$USD/tonne)

	About 1990 (90kg cylinder)	About 1995 (90kg cylinder)	March 1999		Imported Price (Israel - Approx.)	
			90 kg cylinder	680g cannister	90kg cylinder	680g cannister
Factory Production cost	1100	1460	1650	2683-3050		
Wholesale Price	1400	1830	2195-2440		2440	3290-3415

4. STATUS OF CHEMICAL AND NON CHEMICAL ALTERNATIVES IN CHINA

The 1998 MBTOC report concluded that integrated pest management strategies which combine various pest management methods (both chemical and non chemical) are the best alternative approach to the use of MB. This includes cultural practices, biological controls, physical methods and strategic application of selective pesticides.

4.1 Preplant Soil Fumigation

The following products are being considered as alternatives to methyl bromide in China, but as yet have limited commercial use and experimentation. Difficulties and barriers to their implementation are shown in Appendix 3. One of the major difficulties to be overcome includes the problems associated with application of these alternatives in protected cropping systems. The hazards associated with their use create extreme occupational health and safety issues for the farmers. As yet, methods are only poorly developed to apply these products and mechanised machinery is generally unavailable or cost prohibitive.

4.1.1 Chemicals

(a) Chloropicrin: It has been commercialized in 1950's. The current capacity is

3300t/a, the production is 2850t. Most of the chloropicrin produced is exported to developed countries where it is formulated into mixtures with methyl bromide and injected into soils for preplant soil fumigation. Chloropicrin is a highly effective fungicide, 20 times more effective than methyl bromide. The major disadvantage to its use in China includes difficulty in application as the product requires injection by machinery and this limits potential in plastic tunnels. It also cannot be applied as a gas, and it produces a chronic odour and irritates eyes. Chloropicrin used alone or mixtures with other fumigants (metham, 1,3 dichloropropene) are suitable replacements for MB broadacre open field are the most likely fumigant alternatives in developed countries

- (b) **Dazomet.** It was produced in 1982 at a capacity of 200t/a (50% wettable powder). Dazomet's advantages as a replacement to MB are that it is a granular fumigant with minimal odour. Owing to its ability to be applied without highly technical machinery, this product is likely suitable for Chinese cropping systems. Although expensive, this product has previously been produced in China at much cheaper costs than in other countries. Safe application methods will still need to be developed in China.
- (c) **Metham-Sodium.** China can produce 1500 t (35% SL) per year, but the production has not yet been registered. Presently, trials are being conducted and it is anticipated that metham sodium will be registered by the end of this year. Consistent treatment effects and its putrid odour have limited uptake as an alternative to MB in many countries and application in plastic houses is difficult with machines. Application through drip irrigation with proper surface sealing needs further evaluation in China.
- (d) **D-D mixture (the mixture of 1,3-dichloropropene and 1,3-dichloropropane).** It is the by-product from the production of chloropropene and its output is quite small and not considered a suitable alternative to MB in China.
- (e) **Mixtures of 1,3 - dichloropropene and chloropicrin, or metham and chloropicrin:** These mixtures are being considered as a short term replacements for MB in many other developed countries of the world but are as yet unavailable in China.
- (f) **Selective nematicides and fungicides:** China has access to a wide range of pesticides due to its huge network of production facilities and the support given by the government to these. Several new pesticide products are showing great potential for supplementing use of MB, eg. Abamectin on nematodes, fenaminosulf, quintozone, thiram, thiophanate-methyl, thimexazol, etc. As nematodes (particularly *Meloidogyne* spp.) are a major cause of yield loss in China, further research on development of effective nematicides or resistant plants is a high priority for China.

4.1.2 Non Chemicals

- (a) **New and pest resistant varieties:** The introduction of new varieties of crops from other countries offer huge potential to offset the yield increases obtained by farmers in China. For instance recent results from the UNIDO MB project have

shown that Spanish varieties of strawberries out yielded the Chinese varieties dramatically (47%). Although some improvements were still required in flavour and colour, these varieties or many other imported varieties offer excellent pest and disease resistance and thus reduce the need for methyl bromide and the use of other pesticides.

- (b) **New production techniques:** Floating dishes offer great potential to offset the need for production of seedling crops in soil and therefore negate the need for MB. Particular industries, eg. Tobacco are particularly suited to production by this method. In other countries, eg. Australia, over 50% of the tobacco seedlings are produced by this method. Outcomes from a recent project set up in Brazil will be particularly relevant to the success of this technique in China. The potential for using this method for production of other crops needs evaluation.
- (c) **Artificial substrates:** A very good alternative, which increased the yield of crop and shortened the growth period. The occurrence of soil-borne diseases is initially very low with this method. To consider that the imported substrates from Europe are too expensive for most cropping situations in China and the funds for the development of local substrates would be considered prior by Chinese researchers.
- (d) **Biofumigation:** The efficacy of biofumigation has varied in trials in China and has markedly affected by soil and weather conditions. The residue of the plants used for biofumigation is not always available when needed.
- (e) **Solarisation:** Owing to the shape and construction of the plastic tunnels, and the present season for fumigation in some horticultural industries in China (ie. In summer for Strawberries), solarisation offers great potential to replace methyl bromide in several cropping systems.
- (f) **Biological Control Products:** China has developed several biological control agents for control of plant diseases, (three new products have been recently commercialised in horticultural crops) however results are still seen to be too variable to adopt this practice as a replacement to MB. In China, 6 products have been registered as biocontrol agents to control disease caused by *Phytophthora capsici*, *Rhizoctonia solani*, *Sclerotinia sclerotiorum*, *Pseudoperonospora cubensis*, *Botrytis cineria*, *Gaeumanomyces graminis var tritici* on different crops. Within 2-3 years, more biocontrol agents are expected to be registered.
- (g) **Electrical heating of the soil.** For example, Ohmic electrical heating soil probes. It is reported that using this method can reach the same effect as using methyl bromide. But this method has not yet been evaluated in China.
- (h) **Suppressive Soils:** Relies on biological diversity as the basis for competition against pests and pathogens. One of the best systems of suppression understood includes control of the Take All fungus on wheat due to the production of 2,4 - acetylphloroglucinol by a bacterium, *Pseudomonas fluorescens*.

4.2 Durable and storage

China is the biggest developing country in the world and the speed of development

and consequently the infrastructure for storing durable commodities is better in the east than that in central and west area. Normally, the pest infestation is more serious and the time needed for chemical control is greater with poor storage facilities. This means that any alternative to methyl bromide must be effective under the range of different storage conditions in China or that funds for research must be made available to develop better storage facilities throughout China. There are four kinds of storage facilities for durable commodities, national storage facilities, local storage facilities, commercial (turnover) storage facilities and farmer storage facilities.

In China, there are many pest species infesting durable commodities and because the climate and storage conditions differ among areas the pest species and infestation also vary. Although many chemicals have been tried, the predominant chemical control measures for durables are phosphine and methyl bromide fumigation.

In many areas, especially under poor storage, or under conditions which are not gas tight or where phosphine concentrations are not monitored, fumigation has not always been successful. Thus stored products pests have obtained resistance to phosphine fumigation in storage facilities of many areas and in some areas phosphine fumigation is no longer effective and MB must be used.

Integrated pest management (IPM) is considered as the most effective way to replace use of methyl bromide for the control of pests in stored products. But the predominant condition to make IPM functional is to monitor the pest population in durable commodities. If the population surpasses the threshold, then suitable control measures need to be taken. In China, this kind of pest population monitoring system has not been set up and requires substantial funds to be set up.

The food storage sector in China uses phosphine to control pests. Due to the increase of resistance to action of phosphine, the use of MB will increase correspondingly. To avoid the increase of MB consumption, Chinese food management authority requires the users to use phosphine as far as possible. For this reason, China has done some tests to combine phosphine with SO₂ in the fumigation, or combine the phosphine and protected agent.

4.3 Perishable commodities

Developing alternatives to disinfestation of perishable commodities is seen to be more complicated in China. As with other countries worldwide most treatments for perishable commodities in China tend to be for quarantine treatments. MBTOC has identified at least thirteen different categories (Appendix 4) of alternative treatments, eg. heat, cold, irradiation, that are approved by one or more regulatory agencies in one or more countries around the world. Substantial improvement in technology and construction of treatment facilities is needed before effective methods will be available to replace MB. Presently, the most promising alternatives include physical treatments (heat, cold, modified atmospheres, etc).

In the 1998 report of MBTOC, the importance of effective preharvest practices and routine inspection procedures were highlighted as critical to the reduction of pest infestations on perishables.

The advantages of all existing alternatives to methyl bromide for the control of pests of durable and perishable commodities are summarized as follows: no damage to ozone layer, safety to environment and operational persons, relatively low or no chemical residues in commodities after treatment.

Phosphine, the only in-kind direct alternative to methyl bromide, has been widely used in China. Phosphine fumigation is normally easier to operate and has lower cost. But further technical training and investment to improve construction of the facilities to increase the gas-tightness must be strengthened. Otherwise, the fumigation effectiveness will not be guaranteed and the resistance to phosphine will also be developing. As the result, methyl bromide will be used again. Except for the phosphine fumigation, all alternatives known have higher costs and are more difficult to operate and need highly qualified operator and facilities.

China produces two of the key alternatives for perishables.

- (a) Aluminium Phosphide. It was commercialized in China in 1950's. Present production is 2330t/annum from factories with a production capacity of 6400t/yr.
- (b) Sulphuryl fluoride. Production started in 1970's under restrictions. Present production is approximately 50t from three factories in China that have a capacity of 100 t/yr.

4.4 Quarantine and preshipment

Fumigation of imported durable and perishable commodities with MB is used to prevent the introduction and establishment of pests of quarantine significance, eg. cotton imports, empty ships possibly carrying Khapra beetle, imported fruits intercepted at receival port because of fruit flies; fumigation of exported commodities, especially, the wood packing materials to USA, Canada, Australia and European countries to kill the longhorn beetles.

Phosphine: Is used on a limited basis for crops such as rice and maize. It is impossible to use phosphine in ports because of the long exposures, pest resistance and lack of infrastructure. The larvae of the Asian Longhorn beetle are also resistant to phosphine.

Sulphuryl fluoride: Methods of chemical synthesis, production and application of sulphuryl fluoride have been investigated since 1970 and a commercial product 'Xunmiejin' marketed in 1983. This product was used successfully on books, cultural treasures, buildings imported timbers and empty freight containers. It's use is still limited, however, because of the high price (2.5 times MB) and the poor ability of the product to kill insect eggs. It can not be used on cereals because of the effect on proteins.

Carbon disulphide: Research the late 1980's assisted the development of this product for a few varieties of fruit (oranges, pears, mango), however difficulties with high doses and implementation on a broad scale have restricted use.

Vapour heat: Is successfully used for all lichi exported to Japan.

Irradiation: Despite experiments on many fruits and garlic, there is no effective QPS irradiation treatment used commercially.

4.5 Activities for Adopting of Alternatives

During the July Workshop in Beijing, priority projects for support through MLF, bilateral programs or internal funding from China were proposed (Appendix 5 and 6).

4.5.1 Preplant Soil treatment

To date for preplant soil treatment, only one project conducted by UNIDO and supported by funds from the MLF has been conducted. Whilst several promising alternatives have been identified, no alternative has been identified which will offset the use of methyl bromide immediately. It is anticipated however, that commencement within the next 3 years of further projects identified in Appendices 5 and 6 is essential if China is to control present and future consumption of methyl bromide.

The major priority program is to assess the feasibility of floatation tray technology for tobacco seedlings on a local or regional level. This could reduce annual MB consumption for soil treatment by 1,100 of MB, almost halving the amount of MB used for soils at present. Improved application methods and consideration of production of dazomet in China could provide the best fumigant option for use in plastic houses and use of IPM and other methods, solarisation, biofumigation, etc. are potential non chemical methods worth implementing on a wider scale.

The introduction of resistant varieties which have the desirable cultural characteristics for China are seen to present a major benefit for horticulture in China. In the UNIDO project, several varieties of strawberries outperformed the performance of local cultivars by up to 67%, thus offsetting the yield gain on local cultivars given by MB.

Owing to the huge proportion of MB use in plastic houses, emphasis is required on safe, low technology alternatives for these structures. User safety is of utmost importance for alternatives. China is also in the unique situation that presently steam is not considered a viable alternative for soil treatment in plastic houses, because poor roads, fragmented industry structures on farm, unavailability of fuel or electricity make treatment impractical.

4.5.2 Durables

For most non QPS commodities, MBTOC identifies alternatives for almost all situations, including structures, pests can generally be managed without MB, by using IPM. MB is only needed where other processes have failed. Appendices 5 and 6 list the key priority areas for further projects.

4.5.3 Perishables and QPS

As the majority of perishable treatments are also quarantine treatment, many of the suggested alternatives for QPS duplicate those suggested for perishables (see Appendices 5 and 6). Research and adoption of alternatives for softwood packaging

material and imported timbers are a major priority and this would have a major impact on controlling present and predicted future increases in consumption of methyl bromide.

5 HIGHLIGHTS OF CHINA'S AGRICULTURAL POLICY

5.1 Existing Government Policies that Affect Pesticide Use and Production

On April 10, 1982, the State Ministry of Agriculture, together with the Ministry of Forestry, Ministry of Chemical Industry, Ministry of Public Health, Ministry of Commerce, and the Environment Protection Leading Team of the State Council, issued the *Regulation of Pesticide Registration*. According to the Regulation, all new pesticides, herbicides and other similar products used in agriculture, forestry, and plant-growth regulation are required to be registered before production, and no pesticide can be produced, sold or used without the approval of registration.

The Ministry of Chemical Industry began to distribute production certificates to some pesticides in 1985, four years later, the State Council determined that a strict production certificate be used to regulate all pesticides. Plants without certificates were not permitted to produce pesticides. On February 19, 1990 the Department of the Ministry of Chemical Industry and the Department of the Ministry of Agriculture issued the notice that the distribution of pesticide registrations and production certificates should be reviewed, and determined that the production of pesticides without a registration certificate should cease immediately.

On May 8, 1997 the State Council of PRC issued the *Pesticide Management Regulation* No. 216 order of the State Council in 1997, which demanded that all the pesticides produced, sold or used in China should abide by the Regulation. It stipulated: (1) the State carries out the regulation of pesticide registration. Only pesticides which have been registered and given the pesticide registration certificate by the department charged with agricultural administration of the State Council can be produced, imported and sold. (2) the State carries out pesticide production permit system. Producers of pesticides are required to apply to the Ministry of the Chemical Administration of the State Council for the production certificate. Further more, pesticide management certificate or business certificate is needed for the sale of pesticide.

It is stipulated by the "*regulation of pesticide management*" that both local and imported pesticides should be registered. Before registration, two successive years of field efficacy trials must be conducted on one crop in two different climatic regions, and then if effective the pesticide can be given temporary registration for use on that crop.

As a pesticide, the production and use of methyl bromide should abide by the laws and regulations of the Chinese government. According to the No.216 order of the State Council in 1997, the producing and importing MB should be registered by the State Ministry of Agriculture; and the firm which plans to produce MB should be granted a production certificate by the former Ministry of Chemical Industry (now the State Bureau of Petroleum and Chemical Industry). It is prohibited to produce and sell

methyl bromide in China without a production and registration certificate. It is also important that products that have gained registration, have labels which clearly identify the crop, kind of pests and the dosage rate. At present MB applications at 60-80g/m² for tobacco, 75g/m² for cucumber and tomato and 50-80g/m² for strawberry are registered uses for preplant MB treatment. These can not be changed without permission. Trials must be conducted if MB use is to be extended to other crops.

The State Foodstuff Reserve Bureau has the right of management and guidance on the use of pharmaceutical products for foodstuff sectors throughout the country. It can constitute the legal regulations to restrict use and stop use of the pharmaceutical products. And now it can't stop use of MB until alternatives have to be found.

5.2 Analysis and Management of MB Distribution Network

The specific regulations for the distribution channels of pesticides, including methyl bromide, have constituted by the Government of China. According to *the Pesticide Management Regulation of People's Republic of China*, the Departments permitted for marketing pesticides are as follows:

- ① Company of Agricultural Means of Production (CAMP) in the Supply and Marketing Cooperative (SMC);
- ② Plant Protection Station (PPS);
- ③ Soil and Fertiliser Station (SFS);
- ④ Agricultural or Forest Technical Extension Stations (ATES or FTES);
- ⑤ Forest Diseases and Insect Pest Control Station (FDIPCS);
- ⑥ Enterprises of Manufacturing and Formulating Pesticide;
- ⑦ Others.

The strict conditions on marketing pesticides by the PPS (county level) are as follows: When a new pesticide becomes available, the PPS in the counties firstly conduct a demonstration trial in the field where registration is required. If the results of the trial are good, more product will be purchased and sold at a wholesale price to the ATES of the township or directly sold to farmers. The ATES of the township also sell the products to farmers.

Similar to the PPS, the CAMP of the counties purchase pesticide products and sell them to the SMC of the township, who then sell to the farmers. The difference between the CAMP and the PPS is that the CAMP usually supply and sell conventional products and the PPS mainly sell new pesticide products. Sometimes the SFS sell a few pesticides products to farmers, but the amounts and varieties are very small. They mainly sell plant growth regulators.

Since 1987, the Institute of Plant Protection, and the Institute for Tobacco Research of Chinese Agricultural Academy have carried out the technical research for applying the MB into protected crops such as cucumber, tomato and tobacco. Studies have determined the optimal amount of MB required for different crops under protected cropping systems with warm climates and in open fields with colder climates.

Until recently, MB has been effectively promoted by pesticide production firms (i.e. Lianyungang Seawater Chemical Plant) through publication of brochures, supply of

free samples of MB for trial, and active participation of Israeli Dead Sea Bromide and experiments conducted by Chinese Research Institutes (Crop Protection Department of Chinese Agriculture Science Institute, the Beijing Agriculture Science Research Institute, the Liaoyang Agriculture Science Research Institute, the Flower Research Department of Chinese Agriculture Science Institute and the Daqin Warm-Room Corporation). As part of China's commitment to controls on methyl bromide, effective methods to restrict future promotion for use of methyl bromide should be implemented.

6. CONTROL POLICIES IN STRATEGIC FRAMEWORK

6.1 Contest of Copenhagen and Montreal Amendment and Need for a Strategy

In 1990, the international community established a financial mechanism called the Multilateral Fund to support efforts in developing countries to phase out ozone depleting substances. The Fund is financed by contributions from industrialized countries, and projects are coordinated by four implementing agencies: the UN Environment Programme (UNEP), UN Development Programme (UNDP), UN Industrial Development Organization (UNIDO), and the World Bank. Methyl bromide substitute projects became eligible for support from the Fund in 1995. When the 2002 freeze in developing countries was established, projects supporting on-site trials of alternatives ("demonstration projects") have been approved by the Fund, as well as several larger-scale "investment projects" which promoting national information dissemination and training. The importance of policy measures to support these efforts, however, has become increasingly apparent.

Ratification of the Copenhagen Amendment² to the Montreal Protocol is the first step of the national governments beginning to develop the national policy framework. Ratifying this amendment means confirm at a national level the agreements made under the Protocol to phase out methyl bromide. In developing countries, taking this step also means greater access to financial support under the Multilateral Fund to implement alternatives programs.

6.2 Importance of Policy Controls on MB

At the Beijing workshop in July, 1999, the possible policy controls on MB production, importation and use, and the timelines and responsible agencies that could assist implementation of these controls which would have been reported to the national government was confirmed. The policy options successful in other countries (Appendix 1) were discussed and prioritized and only those with a moderate to high priority have been considered in the following action plan.

The general policies that were considered most possible for implementation in China were also discussed at the International workshop in July, 1999. They included:

- Strengthening existing legislative controls applying to methyl bromide.
- Control on production, import and consumption (permits, quantitative limits,

² The Copenhagen Amendment to the Montreal Protocol, adopted by the Parties to the Protocol in 1992, brings methyl bromide under jurisdiction of the Protocol as an ozone depleting substance.

- import fees, etc.).
- Continuation of a research program to evaluate the cost and effectiveness of alternatives.
 - Development of a farmer education and training programs to promote the application of alternatives.

6.3 Action Plan

At the International workshop in Beijing in July, 1999 it was agreed for China to established a Leading Group to take charge of the relations on controlling methyl bromide increase (this group may be possibly integrated into the Chinese Leading Group of Phasing out ODS, as a part of the latter) The leading group will be responsible for deciding on which MB control scenario is most appropriate for China, and which policy controls will help maximize adoption of alternatives to MB and have least impact on agricultural production in China.

The two possible scenarios for China are that:

1. China agrees to phase out methyl bromide following the control measures under the Montreal Protocol. This means that China would freeze MB use in 2003 using average consumption of 1995-1998 as a baseline, but no other action would be necessary before the freeze date. This could then be a burden to MB users as they would have to make drastic reductions in MB use in 2002 to prepare for the baseline in MB consumption by 2003.
2. China imposes voluntary domestic controls step by step on importation and production of methyl bromide for all regulated uses in advance of, and to prepare for the freeze in 2002. The Chinese government will decide the baseline of the controlled levels on production and consumption. This will send important signals to both the MB industry and the MB users that the Government is serious about shifting to alternative technologies. Some measures such as reorganizing methyl bromide production plants and stopping importation could be imposed by China to execute a quick phase-out of methyl bromide efficiently.

This report believes that once the Copenhagen Amendment is signed, Option 2, the adoption of several policy options which restrict the consumption of methyl bromide for soil and non QPS commodity uses before 2003 is seen as the best option for farmers in China. This will ensure the alternatives' production practices and development. It will also ensure less hardship for farmers to meet the freeze in 2003. Actions for searching more alternatives now is better for expenditures on forbidding the use of MB in future.

The adoption of policy options to restrict the possible increase in consumption of methyl bromide for soil and non QPS commodity uses before 2002 will ensure that alternatives will be adopted and better developed to allow them to meet the freeze on the baseline, which, is calculated at 1485 tonnes.

The Chinese government is active to take steps to prepare for ratifying the Copenhagen Amendment Following issues should be fully considered before the decision would be finally made.

- (1) To make a full technical and economic assessment for to reduce the impact from control of MB on national economy.
- (2) To integrate the research and development of alternatives of MB into the State Scientific and Technological Plan to get the alternatives that are suitable for Chinese characters.
- (3) To actively search for the support from MultiFound to meet the additional cost caused by phasing out the production and consumption of MB.

6.3.1 Policy Controls on Production of MB

SEPA and the Petrochemical Bureau are the agencies in China responsible for imposing policy controls on production.

The policy controls on production that are considered more likely to succeed include a restriction on the number of factories able to produce MB, and the imposition of a quota on production capacities of factories. The most directive restriction is capping production at present levels in China that the MB production would be limit to 3400t. Together with restrictions on imports of MB, this would provide a most practical and feasible ceiling on production until 2003, when the freeze on MB would be imposed under the Montreal Protocol guidelines. This is the most practice and feasible method of methyl bromide production restriction. The benefits of this outcome are that consumption of MB would also be restricted before 2003, and this would enable an easier transition for growers to adopt alternatives.

Production factories presently pay a licence fee in China. Restriction on further approval of production licences would be considered as an appropriate method to limit future production. An increase in licence fees would also be a disincentive to further production.

6.3.2 Policy Controls on Importation

SEPA, the Petrochemical Bureau and the Maritime Customs Ministration are the agencies in China responsible for imposing policy controls on importation.

In spite of the slightly higher price (approx. 10% more expensive), the imported methyl bromide from Israel tends to be more effective and is often chosen by farmers in preference to the Chinese product because of the better quality. Now the enterprises of China have already produced methyl bromide co-operated with Israel, therefore the products which produce in domestic also has better efficacy.

In spite of the slight difference in efficacy, controls on importation of MB by either a complete ban, restriction or introduction of tariffs, were considered possible and could be acted immediately providing the restriction applies to all countries, thus satisfying fairness of trade under World Trade Organisation Rules. According to this rule, it isn't restricting the import unless there has the same restriction to the producer of internal.

6.3.3 Policy Controls on Consumption

The MOA is the agency responsible for most of the policy controls that could be

imposed on use of MB in China.

The policy controls on use which were considered most appropriate to implement include (1) Mandatory buffer zones for preplant soil uses; (2) Rate limits and limitation by region. Present limits for use methyl bromide already exist in China, however potential exists to further restrict rates. At present, MB applications at 60-80g/m² for tobacco, 75g/m² for cucumber and tomato, and 50-80g/m² for strawberry are registered uses for preplant MB treatment. If using VIF barrier films, the methyl bromide consumption can greatly decrease. (3) Strengthen propaganda, education and promotion of technology.

China presently limits use of MB to crops and uses specified on the label, however it is not clear whether farmers strictly follow this regulation. All crop uses should be specified on the label; however, it is likely that there may be a number of unspecified uses for which MB is used (e.g. medicinal herbs, turf, etc.). In addition, there appears to be no strict guidelines for labelling MB products so that the directions for use are in Chinese. Greater regulation in these areas could ensure that MB is used only for the approved purpose and safely.

Another policy option for control of MB use includes the mandatory use of VIF barrier films. These films, however, are not produced in China, are expensive to produce and import, and would possibly require strict legislation before being adopted by growers. For these reasons, adoption is not considered likely.

Tax exemptions for effective alternatives and deregistration of MB uses when effective alternatives become available are possible options that should be considered in the future.

Taxes and levies on sales of methyl bromide were not considered an appropriate option as they would only increase the price of methyl bromide and thus reduce farmers' income unless the cost-effective alternatives will be used extensively. Introduction of fees, which are easily being converted into taxes, will also increase the burden of the tax system.

Limitations on use by region is possible, however, it would need to follow a planned strategy in line with a staged legislative approach to restrict use for crops where alternatives were found to be effective.

6.3.4 Further Recommendations from the Chinese Working Group

The Chinese working group considered the following aspects particularly important when they were developing this Strategy.

1. The Strategy should not harm the benefits of the producers and consumers.
2. In order to reach the aim of phase-out methyl bromide easily, the producers and the consumers of methyl bromide have the same rights to get the international aid from the Montreal Protocol Multilateral Fund.
3. The Chinese working group also suggested the recommendations of actions that

once ratification of the Copenhagen Amendment was agreed that:

- The World Bank & UNEP coordinate with each other and then propose a sector phase-out fashion on methyl bromide similar to Holon and the sector of production.
- Funds be made available from the multilateral fund to continue the research, demonstration, extension and training programs identified in this strategy to assist adoption of alternatives
- Sector subgroups by crop/commodity be set up with bilateral assistance to assist implementation of alternatives.
- That a communication support system be created to ensure effective delivery of information about alternatives.
- Provide the opportunity to Chinese experts to travel to other developing countries to see the successful implementation of alternatives.
- A framework be developed for setting control policies on methyl bromide.
- Further research should be done on possible social and economic impacts caused by the phase out of MB. Related departments need to be promoted to formulate MB phase out policy and the strategy for alternatives development. This will benefit Chinese government to consider the ratification of Copenhagen Amendment.

6.4 Roles of Chinese Authorities in MB Control

China has put the MB as ODS into the total control system for all ODS, therefore, the State Environmental Protection Administration (SEPA) has become the head department, while the related sectors are MOA, State Bureau of Petroleum and Chemical Industry, State Bureau of Inner Trade, State Bureau of Quarantine and Inspection for Import and Export, State Foodstuff Reserve Bureau, etc., which can be illustrated as following:

State Environmental Protection Administration:

- Organizing to attend international bargaining and international conference related to MB control;
- Coordinating sectors in terms of MB control issues;
- Organizing to formulate strategic framework and policy plan of MB control;
- Promoting research and development of alternatives of MB;
- Organizing to carry out international cooperation in terms of MB control;
- Supervising and promoting the implementation of actions of MB control.

Ministry of Agriculture:

- Participating international bargaining and international conference related to MB control;
- Formulating strategic framework and policy plan of MB control in agricultural production aspect;
- Setting up special pesticide regulation for MB;
- Promoting development and extension of alternatives of MB to apply in agricultural production;

- carrying out international cooperation in terms of MB control in agricultural system;
- Implementing national action plan of MB control in agricultural system.

State Bureau of Petroleum and Chemical Industry:

- Participating international bargaining and international conference related to MB control;
- Setting up action plan for controlling MB production;
- Setting up special regulation for MB production;
- Developing and producing alternatives of MB
- carrying out international cooperation in terms of production of alternatives of MB;
- Implementing national action plan of MB control in chemical industry system.

State Bureau of Inner Trade:

- Participating international bargaining and international conference related to MB control;
- Formulating action plan to control distribution of MB in domestic market;
- Setting up special regulation for MB distribution;
- Establishing special distribution channel for MB;
- Implementing national action plan of MB control in trading field.

State Bureau of Quarantine and Inspection for Import and Export:

- Participating international bargaining and international conference related to MB control;
- Setting up special regulation
- Setting up special specific action plan for import and export management of MB;
- Implementing national action plan of MB control in import and export management of MB;

State Foodstuff Reserve Bureau:

- Participating international bargaining and international conference related to MB control;
- Formulating strategic framework and policy plan of MB control in;
- Promoting development and extension of alternatives of MB to apply in foodstuff reserve ;
- carrying out international cooperation in terms of MB control in foodstuff reserve system;
- Implementing national action plan of MB control in foodstuff reserve system.

Policy Options to Control Methyl Bromide in China

Appendix 1.

Policy options	Timetable for Introduction	Responsible Agency	How to implement Comment
1. Controls on Production			
Quota -Production	Upon signing CA	SEPA and PCB	Occurs in other countries, use funds for research.
Licence producers	Already exists	SEPA and PCB	
2. Controls on Importation			
Quota - importation		SEPA and PCB Ministry of Foreign Trade	<ul style="list-style-type: none"> World Trade Organisation Rules do not apply if restriction applies to all foreign countries Restriction on imports to Ave. 1995-98 level immediately **Should be based on sectoral approach (ie. halon and CFC), Cooperation with the World Bank to develop this approach Occurs in other countries, use funds for research.
Fee on amount imported		MOA	China law requires Approval from Finance Ministry and State Development and Planning Commission to implement Fees*.

Appendix 1. (Cont.)

Most Probable Policy Options to Control Methyl Bromide in China

Policy options Possibility (Low, Moderate, High)	Timetable for Implementation	Who	How to implement Comment
3. Control on Use			
Buffer zones	By 2003	MOA	Labelling, extension
List of permitted crop uses	Exists	MOA	China already restricts use of MB to specified crops
Limit use by region	By 2003	MOA	Labelling, extension
Upper limit on rate	Exists	MOA	China already imposes maximum rate limits Labelling, extension Review regularly
VIF Plastics	If practical	Govt legislation	Labelling, extension, Not produced in China, too costly
Tax exemptions for alternatives	2002 onwards	State Administration	Govt decision
Deregister MB	As alternatives prove effective	MOA	Legislative requirement Deregister in line with success of alternatives

* May lead to an increase in the cost of MB. If so, possibility of implementation may be less because of lost income to growers. However, a price rise will assist adoption of alternatives.

**Note: The Chinese government has proposed to transfer fees into taxes in order to reduce corruption, so it would be difficult to implement any new fee collection policy

Appendix 2.

Summary of policy options considered by China for controlling production, importation and consumption of methyl bromide for soil disinfestation and commodity uses in China

1. Government and industry regulation and decision making

- ◆ Formation of a dedicated consultative/steering group consisting of representatives from government, research institutes and industry (incl. MB producers and users).
- ◆ Development of sectoral subgroups
- ◆ Federal vs. regional vs. provincial stakeholder forums

2. Controls on Import and Production of Methyl Bromide

(Note: these factors will not necessarily increase the price of MB to growers and many may require incentives for adoption, especially for small farmers!)

- Quota's on production and importation (tighten quota's before phaseout and perhaps up to 2002)
- Limit the usage per crop, township or unit area.
- Limit rates of product used for control (upper limit of 75g of 98:2 and 50g/m² of 70:30 for soil disinfestation)
- Impose upper limits of use in combination with impermeable tarps
- Impose buffer zones which prevent use in populated areas
- Documented list of permitted uses to avoid expansion

3. Economic Incentives (Taxes, Levies, Duties and Subsidies) (Note: these are likely to increase price of MB to growers!)

- Licences to produce or import (paid by producers/importers)
- Activity fee proportional to MB use (paid by producers/ importers)
- Sales levies (will increase MB price, but raise dollars for research)
- Consider exempting MeBr alternatives from taxes, levies, and custom duties.

4. Others:

- Consider regulating approved retail containers and/or application equipment
- Consider introducing ecolabel requirements that would inform farmer about ozone friendly nature and environmental consequences of alternatives and their costs.
- Create disincentives for industry-funded research that promotes MB
- Work with companies and major traders who purchase crops grown using MB, to identify ways in which they can encourage suppliers to change production methods
- Aim for earlier phase out schedules, create additional interim reductions

5. Methyl Bromide Alternatives Program

- Research program on sustainable alternatives for both short and long term replacement of MB
- Demonstration trials with cost effective alternatives (farmers should not be required to spend more money to save the ozone layer) (eg. UNIDO)

6. Technology Transfer and Awareness

- Propose setting up farmer TT programs and a strategic 'Train the trainers' program.
- Involve Chinese farmer organisations to facilitate the adaptation and dissemination of alternative technologies (Focus groups, National Communication Program, etc.). Work with leading farmers.
- Broadcast radio and TV programs on MB and alternatives in local regions, The government should give airtime free.
- Consider amending curricula of agricultural schools and universities. By 2015 all children

of today will be young adults. .

Appendix 3

Availability of chemical and non chemical alternatives for preplant soil treatment in China

Alternative	Produced in China	Imported into China	Registered for use by farmers	Research required	Comments
A. Chemical Alternatives					
Chloropicrin	✓	✗	✗	✓	Excellent when mixed with MB and alternative fumigants (ie. 1,3-D). Needs injection equipment
1,3-Dichloropropene	✗	✗	✗	✓	Major alternative being considered in other countries
Dazomet	✓	✓	✓	✓	Cost is much more expensive than MB, so lower rates of application required Phytotoxic in cool, dry regions
Metham Sodium	✓	✗	✗	✓	Variable effects, Application methods need improvement Often long plantback times due to residues
Methyl Iodide	✓	✗	✗	✓	As effective as MB but very expensive, currently being trialed.
Propargyl bromide	✗	✗	✗	✓	Old fumigant with limited potential
Ozone				✓	Being trialed in the US with limited success
Formaldehyde	✓	✗	✗	✗	China has used it previously but efficacy was poor, Irritating to eyes
Sodium tetraborate	✓			✓	Status Unknown
Anhydrous ammonia	✓			✓	Status Unknown
Inorganic azides				✓	Status Unknown
Natural compounds Eg. Furfuraldehyde				✓	Status Unknown

Appendix 3 (Cont')

Alternative	Produced in China	Imported into China	Registered for use by farmers	Research required	Comments
B. Non Chemical Alternatives					
VIF Plastics	-	✓	NA	✓	Can significantly reduce MB dose reqd.
Artificial Substrates	✓	✓	NA ^B	✓	Good alternative but new formulations reqd.
Biofumigant crops	✓		NA	✓	Results not consistent and loss of production crop may reduce farmer income
Biological controls	✓		✓	✓	Only controls specific pests
Resistant varieties 1. Tomatoes 2. Cucumbers 3. Strawberries 3. Tobacco 4. Ginseng	× × × × ×	✓ × ✓ ? ×	× × × × ×	✓ ✓ ✓ ✓ ✓	Good and promising alternative
Grafting -hot peppers -cucumbers -tomatoes -eggplants	✓	✓	✓	×	Has been successful in controlling specific soilborne diseases, but limited to certain crops
PGPR's ^A	✓		✓	✓	Can control some soilborne diseases
Endophytes				✓	
Mycorrhizae				✓	Can control specific pests
Solarisation plastic (special)	×	✓	NA	✓	Can increase temperature
Steam machine	✓	✓	NA ^B	✓	Efficacy is good but the equipment is expensive and resources (electricity and water) not readily available.
Flame weeders	×	×	NA	✓	Good as weeders but do not control diseases
Floataion Dishes	✓	✓	NA	✓	Very good alternative for some crops, (ie. tobacco seedlings).

^A PGPR=Plant Growth Promoting Rhizobacteria; NA – Not Applicable

^B-Must meet certain standard

Appendix 4.

Availability of chemical and non chemical alternatives (identified by MBTOC) for treatment of commodities (perishable and durable) in China

Alternative	Produced in China	Imported into China	Registered for use by farmers	Research required	Comments
A. Perishable/Durable					
Cold storage			NA	✓	
Controlled atmosphere			NA	✓	Depends on facility, expensive
Heat facilities			NA	✓	Depends on facility, expensive
Irradiation	✓			✓	Expensive, difficult to get registration
Modified atmosphere			NA	✓	Depends on facility, expensive
Microwaves	✓			✓	Unpractical
Hydrogen cyanide	✓		✗	✗	Impossible to get registration
Carbon disulphide	✓		✗	✓	Effective, but difficult to use
Sulphur dioxide	✓		✗	✓	Feasible for perishable
Phosphine	✓		✓	✓	resistance
Carbonyl sulphide			✗	✓	Maybe feasible
Aerosols Dichlorvos	✓		✓	✓	
Others					
B. Durable only					
Biocontrols	✓		✓	✓	
Pyrethrum	✓		✓	✓	
Carbon bisulphide	✓		✗	✓	
Carbon dioxide at pressure	✓			✓	
Ethyl formate	✓		✗		
Inert dusts	✗	✓	✓	✓	
Pheromones	✓		✓	✓	
Insecticides	✓		✓	✓	

NA – Not Applicable

Appendix 5.

Priority Research, Demonstration and Training Programs Required on Alternatives to Methyl Bromide in China

A. General
<ol style="list-style-type: none"> 1. Conduct annual surveys on MB use and adoption of alternatives 2. Review traditional Chinese production methods and identify sustainable production systems.
B. Preplant soil treatment
<ol style="list-style-type: none"> 1. Develop floatation systems for tobacco which are suitable for use, either on farm or by cooperatives developed within a specific region. 2. Continue evaluation of alternative fumigants, particularly dazomet, metham sodium, chloropicrin and 1,3-dichloropropene. 3. Review the cost effectiveness for fumigant production in China. 4. Continue trials with soil solarisation combined with other chemical and non-chemical methods. 5. Review the potential for importing high yielding crops with resistance to nematodes and other diseases to replace crops where MB is presently considered necessary. 6. Promote the use of new nematicide treatments, (eg. avermectin, ivermectin, biofumigants and trap crops). 7. Evaluate the potential for local substrate production facilities and alternative soilless culture techniques in China. 8. Develop new glasshouse structures that enable greater access for machinery that can apply alternatives treatments, eg. Rotary hoes for dazomet, etc. 9. Introduce simple machinery that can apply alternative chemical and non chemical alternatives in plastic houses.
C. Durable treatments
<ol style="list-style-type: none"> 1. Improve gas tightness of storage facilities 2. Improve phosphine treatments combined with SO₂ or protective agents (dichlorvos) 3. Develop IPM and threshold levels for pest species
D. Perishable treatments
<ol style="list-style-type: none"> 1. Improve application methods for phosphine (improved sealing of chambers) 2. Develop highly effective, low toxicity protective pesticides (eg. inert dusts) for food storage. 3. Improve production capacity for alternative pesticides 4. Evaluate mixtures of phosphine and carbon dioxide 5. Develop and evaluate controlled atmosphere (CA), sulphuryl fluoride, heat, cold treatments, IPM and protective agents. 6. Evaluate new alternative fumigants, such as hydrofluoric acid.
E. Quarantine and Preshipment
<ol style="list-style-type: none"> 1. Demonstration and extension of the use of mixtures of phosphine and CO₂, high pressure CO₂, carbonyl sulphide, heat (vapour, hot water) and cold treatments, radiation 2. Mixtures of fumigants and combined controlled atmospheres with hot or cold treatments for fresh fruits and vegetables 3. IPM for control of pest infestations 4. Specific projects for fumigation of flowers and bonsai 5. Use of sulphuryl fluoride for cotton, imported timber and softwood packaging material 6. Evaluation of kiln and preservatives for treatment of softwood packaging material for fruit and vegetables. 7. Feasibility of recapture strategies for MB.
F. Technology Transfer and Training (PTO, Appendix 6)

Appendix 6.

Possible Funding Timeline for Future Research Programs on Methyl Bromide Alternatives in China

UNIT: \$USD

Priority Demonstration and Training Projects	Funding Requirements per year ('000)		
	1999-2001	2002-2005	2006-2015
A Surveys:			
1. Methyl bromide and Adoption of Alternatives survey.	100		
2. Documentation of Effective Chinese Production Practices	100		
B. Preplant soil use			
• Alternative chemicals	200		
• Pesticide residue study (soil and water)	250	100	45
• Non fumigant disinfestants (Steam heat, solarisation, biofumigation)	100		
• Biological Methods/Biofumigants	100		
• Organics/substrates	50		
• Resistant varieties	100		
• IPM	100		
• Application technology for alternatives	100		
New machines	100		
Floating trays			
• New glasshouse designs			
C. NON QPS Durable and perishable commodities			
• New effective sealing methods	100		
• New product evaluation & development (eg. carbonyl sulphide, methyl iodide)	400		
D (QPS)			
• Softwood Packaging Material (Asian Longhorn)	500		
• Imported timber treatments, etc.			
B. Technology transfer			
• Video on effective alternatives	25		
• Information Distribution	150	100	50
• National and provincial Extension	150	80	70
• Train the Trainer groups	200	100	100

Appendix 7.

Members of the Working Group with consultants for preparing the strategy framework report in China:

A. Consultant to Working Group:

LIU Yi	SEPA
SONG Xiao zhi	SEPA
LI Lei	SEPA
HU Shaofeng	SEPA
LI Bo	MOA
LANG Bo	The Bureau of Internal Trade
WANG Shu yan	The Bureau of Petrochemical Industry

B. Members of Working Group:

XIA Guang	Policy Research Centre for Environment and Economy, SEPA
SUN Bing yan	Policy Research Centre for Environment and Economy, SEPA
GAO Tong	Policy Research Centre for Environment and Economy, SEPA
CAO Ao cheng	Institute of Plant Protection, CAAS
LIU Nai chi	Institute for the Control of Agrochemicals, MOA, P. R. China
LIANG Gui mei	National Agro-Technical Extension and Service Centre, P. R. China
WANG Yue jin	The Institute of Plant Quarantine , The State Administration for Exit-Entry Inspection and Quarantine, PRC
WANG Pei xiang	The National Foodstuff Reserve Bureau
NI Jia sheng	The Chemical Industry Institute of Zhejiang Province