PROYECTO PARA LA ELIMINACIÓN GRADUAL DEL BROMURO DE METILO COMO FUMIGANTE EN LA PRODUCCIÓN Y REPLANTACIÓN DE ÁRBOLES FRUTALES (CON DEMOSTRACIÓN)

CHI/01/G61

PROGRAMA DE LAS NACIONES UNIDAS PARA EL DESARROLLO
PROYECTO DEL GOBIERNO DE CHILE

DOCUMENTO DEL PROYECTO

Número y Título del Proyecto:	**CHI/01/G61** - Proyecto para la eliminación gradual del Bromuro de Metilo como fumigante en la producción y replantación de árboles frutales (con demostración).
Duración:	5,5 años
Sector y subsector CAC/PNUD:	200 Medio Ambiente / 201 Políticas, Planificación y Legislación
Organismo de Ejecución:	Instituto Investigación Agropecuaria, INIA
Organismo de Supervisión:	Comisión Nacional del Medio Ambiente
Fecha estimada de inicio:	2 de febrero, 2001
Aporte PNUD:	US$ 805,000

Breve descripción: Este proyecto cubre el uso de Bromuro de Metilo para la fumigación de árboles frutales, viñas, nogales y viveros (frutales, forestales y ornamentales). El Bromuro de Metilo en este sector se utiliza principalmente para la replantación de árboles frutales y viñedos, y en una cantidad menor en viveros. La primera fase adaptará cuatro tecnologías de otros países para la erradicación de ciertas pestes y condiciones específicas en Chile, y evaluará su factibilidad técnica y económica en las regiones agrícolas más importantes. La segunda fase del proyecto comprende un programa de capacitación y actividades de extensión para la transferencia de alternativas a todas las regiones donde se utiliza el BM (10 de las 13 regiones de Chile). También se desarrollará un plan de acción y políticas tendientes a la eliminación gradual sustentable del compuesto, en conjunto con todos los actores relevantes del sector. El proyecto será implementado/ejecutado por el Instituto de Investigación Agropecuaria (INIA) conjuntamente con personal de extensión, técnicos y agricultores, y supervisado por la Comisión Nacional del Medio Ambiente (CONAMA).

El Gobierno de Chile se ha comprometido a cumplir con la agenda de reducción de Bromuro de Metilo como se describe en el Anexo 9 de este documento. PNUD hará entrega de los fondos aprobados en tramos según la reducción propuesta y retendrá el financiamiento si no llegara a cumplirse la agenda de reducción. Se elaborarán informes

anuales sobre el progreso alcanzado en su implementación, los que se remitirán al Secretariado del Fondo.

Contexto legal: Este documento de proyecto regirá según las disposiciones normales del PNUD referidas a revisiones de proyecto/monitoreo/evaluación, y los procedimientos especiales de consecución pertinentes del Programa del Protocolo de Montreal. Este proyecto se implementará según el acuerdo de las partes celebrado en 1992. En ese encuentro se demostró científicamente el efecto que tiene el Bromuro de Metilo sobre la disminución potencial de ozono (ODP), (0.6). Este proyecto será implementado por el PNUD según la modalidad de ejecución nacional. El proyecto será implementado con el apoyo del INIA conjuntamente con personal de extensión, técnicos y agricultores, y supervisado por la Comisión Nacional del Medio Ambiente (CONAMA). El INIA se encargará de la planificación y administración general de las actividades técnicas y de capacitación del proyecto, presentación de informes, contabilidad, monitoreo y evaluación.

Se designará a un(a) funcionario de gobierno como Director(a) Nacional del Proyecto. El proyecto será implementado en coordinación con el Programa de Protección Capa de Ozono de CONAMA, en colaboración estrecha con los distintos actores del sector del proyecto.

Firmas:

María Soledad Alvear Valenzuela
Ministra de Relaciones Exteriores
Ministerio de Relaciones Exteriores

30 AGO. 2001
Fecha

Adriana Hoffmann
Directora Ejecutiva
Comisión Nacional del Medio Ambiente

Fecha

p. Francisco Gonzalez del Río
Director Nacional
Instituto Investigaciones Agropecuarias

INSTITUTO INVESTIGACIONES AGROPECUARIAS DIRECTOR NACIONAL CHILE

13 AGO 2001
Fecha

Thierry Lemaresquier
Representante Residente
Programa de las Naciones Unidas para el Desarrollo

07.09.01
Fecha

Project Submitted to the 32nd Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

COUNTRY	Chile
PROJECT TITLE	Phase-out project (with demonstration) for methyl bromide soil fumigation for fruit tree production and replant
SECTOR	Methyl bromide: fruit tree replant and tree nurseries
ODS USE	127 metric tons = 76.2 ODP-tons
PROJECT IMPACT	Phase out 76.2 ODP-tons
IN BUSINESS PLAN	Yes
PROJECT DURATION	5.5 years
PROJECT TOTAL COST	
Incremental capital cost	US$ 805,000
Incremental operating cost	US$ 0
Total project cost	US$ 805,000
COUNTERPART FUNDING	US$ 98,500
REQUESTED MLF GRANT	US$ 805,000
COST EFFECTIVENESS	US$ 10.56 per ODP-kg
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	5% exported by growers themselves
IMPLEMENTING AGENCY	UNDP
COUNTERPART INSTITUTION	National Agricultural Institute (INIA), Chile
NATIONAL CO-ORDINATING INSTITUTION	Ozone Group, CONAMA
PROJECT MILESTONES	Monitoring milestones included

SUMMARY

This project covers the use of methyl bromide as a soil fumigant for fruit trees, vines, nut trees, and tree nurseries (fruit trees, forest and ornamental). Methyl Bromide in this sector is mainly used for replant of fruit trees and vines, and to a lesser extent for tree nurseries. The first phase will adapt 4 technologies from other countries to Chile's specific pests and conditions, and evaluate their technical and economic feasibility in key agricultural regions. The second phase of the project comprises a focussed training program and extension activities to transfer alternatives to all the regions where MB is used (10 of the 13 Regions of Chile). An action plan and policy measures for the project sector will also be developed with stakeholders, to ensure sustainable phase-out. The project will be implemented by INIA agricultural support institute working with extension personnel, technicians and farmers, and supervised by part of the Environment National Commission (CONAMA).

The Government of Chile has agreed to follow the methyl bromide reduction schedule outlined in Annex 9 of this document. UNDP will disburse the funds approved in tranches according to the proposed reduction and will withhold funding for the subsequent tranche until such time as the required reduction has been met. Annual progress reports on implementation will be submitted to the Fund Secretariat.

Prepared by: Ing. Ricardo Muñoz Cisternas, national consultant; Dr. Melanie Miller, international consultant
Reviewed by: Dr. Saad Hafez, international consultant

1. INTRODUCTION

The Methyl Bromide Technical Options Committee (MBTOC) of the TEAP (Technology and Economics Assessment Panel), was established by the Montreal Protocol to assist Parties to identify existing and potential alternatives to methyl bromide and to evaluate the technical feasibility of chemical and non-chemical alternatives for the current uses of methyl bromide, except for its use as chemical feedstock.

The MBTOC defined alternatives as non-chemical or chemical treatments and/or procedures that are technically feasible for controlling pests, thus avoiding and replacing the use of methyl bromide. The existing alternatives are those in present or past use in some regions, while potential alternatives are those that are in the investigation or development process.

The MBTOC assumes that an alternative demonstrated in a region of the world would be applicable in another part unless there were obvious restrictions for example, climates or complex of different pests.

Methyl bromide is a fumigant that has been used commercially for more than 40 years for the control of pests, such as fungi, bacteria, soil-borne viruses, insects, mites, nematodes and rodents. It has sufficient toxicity for the control of numerous weeds and seeds in soils. Worldwide, methyl bromide is used mostly for soil fumigation for crops such as strawberry, tomato, cucurbits, tobacco seedbeds, nurseries and tree replant, while a moderate quantity is used for disinfestation of durable products (grains, nuts and dried fruit) and perishables (fruit and fresh vegetables, flowers) and a smaller quantity for disinfestation of buildings, ships and aeroplanes.

MB has features that make it a versatile chemical with a wide range of applications. In particular, it is quite penetrative and usually effective over a broad range of temperatures.

Although methyl bromide is clearly a most useful pest management technique in specific instances it was listed under the Montreal Protocol as an ozone depleting substance in 1992, which necessitates ultimately that its production must cease.

Because of the controls that have been placed on Methyl Bromide, both globally via the Montreal Protocol and via different control programs in countries, an important number of government institutions and the private sector are engaged in work to develop and implement economically viable and environmentally sound alternatives to methyl bromide. MBTOC has noted that it is difficult to find suitable alternatives for replant uses and propagation materials. To address this, this project will carry out a technical adaptation of alternatives techniques developed in other countries. A module will be implemented for technological transfer, dissemination and an effective training program for methyl bromide users in the sector, so that the fumigant will be phased-out for replant and tree nurseries.

2. OBJECTIVES

The project objectives are:

1. To adapt alternatives and carry out trials to identify technically and economically viable alternatives to the use of methyl bromide as a soil fumigant in replant and fruit tree nurseries.

2. Conditional on success in Objective 1, to transfer the identified viable alternatives to users by activities of technological transfer, training and dissemination.

3. To elaborate an action plan and policy package to ensure that methyl bromide will be reduced and phased-out in the replant and tree nursery sector, and that reintroduction will be prevented after phase-out.

The project is a phase-out (investment-type) project. The technology transfer will include training and extension programs preceded by adaptive trials. The project will be in two phases. In the first phase (Module 1 - demonstrations) alternative techniques from other regions will be adapted for Chile's pests and conditions, and trialled during two agricultural seasons. Efficacy and costs will be evaluated. Growers must be assured that this economically important sector will have viable methods of pest control in future. After identifying viable alternatives, the second phase (Module 2) will implement a training and extension program to ensure that the alternative technologies are adopted by all MB users. An action plan for this sub-sector will assist users to achieve reductions and ensure a sustainable phase-out.

It is important to note that demonstration trials are absolutely essential in the case of replant and propagation materials in nurseries, because alternatives have to be adapted in order to develop technically and economically viable alternatives for Chile's pests and conditions. It is necessary to provide workable and realistic alternatives for farmers. The project has been designed with a business approach, aware that the livelihoods of farmers are at stake. Experts with appropriate skills, who have been carefully consulted, are confident that alternatives will be adapted successfully for Chile. These experts have developed, and introduced into practical use, effective alternatives for replant and tree nurseries in a variety of conditions in other countries. They will work with Chilean experts to adapt the techniques to local conditions and make them viable for farmers.

Project preparation for Chile was originally approved for a demonstration. We have acted on ExCom's Decision 27/32 which noted the need to move quickly to the preparation of investment projects in the MB sector, and therefore this project has been designed as a phase-out investment project.

3. POLICY ASPECTS

Chile ratified the Montreal Protocol in 1990, and ratified the Copenhagen Amendment in January 1994. A Country Program for the Protection of the Ozone Layer also started implementation in 1994, and Chile has established a substantial programme for ODS since that time. The Ozone Unit of CONAMA has successfully implemented a number of projects to eliminate ODS. In 1999 the Council of Ministers approved a new policy document (Acuerdo No 127/99) to set up sectoral quotas for imports of ODS including MB. Following this, the government is developing a law which will establish an import reduction schedule for all ODS.

Chile has one MB project funded by the Multilateral Fund: a demonstration project for tomato and peppers, with the World Bank.

This fruit project is compatible with the national policies and approach on MB. Chile has provided a letter of support for the project and confirms that it will lead to the phase-out of 34% of the baseline MB consumption. The project will be essential in helping Chile to meet its freeze, reduction and phase-out commitments under the Protocol. The project will include policy dialogue with stakeholders to develop a sectoral action plan, to ensure that MB will be reduced and phased out in the fruit tree sector.

4. BACKGROUND ON FRUIT TREE SECTOR

4.1 Fruit production

Chile produces a wide variety of tree fruit, including plums, peaches, nectarines, apricots, cherries, citrus, kiwifruit, apples, pears, table grapes, avocados, olives, walnuts, almonds and many others. The fruit industry has great economic importance because it is the nation's third largest economic sector after industry and mining. Chile produces more than 1.5 million tons of fruit, with a value of about $1433 million in 1998/9. The sector employs many thousands of people in Chile. It is therefore crucial that effective and viable MB alternatives are developed for this sector as soon as possible.

Many of the products are exported (fresh or processed) but most growers do not export fruit themselves; they sell to other companies that supply and export fresh or processed products. It is estimated that only about 5% of growers export fruit themselves. The growers' associations are separate institutions from the exporters' associations, and the two groups have very different economic and technical interests. Fruit are exported mainly to industrialised countries: USA, Japan and Europe. Plants from tree nurseries (mainly grape vines and walnut trees) are exported only to Article 5 countries such as Argentina, in the few cases where they are exported. It is reported that almost 100% of farms and nurseries in the sector are owned by Chileans.

Chile covers half the length of the South American continent, and has many diverse climates, from tropical to cool temperate. The area planted in fruit trees and vines was 208 025 ha in 1998 (ODEPA data). Table 1 shows the major types of fruit trees in Chile and planted area. Use of methyl bromide is important for the intensive producers of table grape vines, peach, nectarine, plum, citrus and avocado. Methyl bromide is used for the other tree crops, but to a lesser extent. The farms vary in size from very small holdings of less than one hectare, up to 50 ha or even 200 ha in some cases.

Table 1: Area planted with fruit trees and vines (1998)	
Trees types where MB use is important	**Area planted (hectares)**
Table grapes	44 360
Peach	11 852
Nectarine	6 462
Plum	13 167
Lemon	7 460
Orange	7 100
Avocado	18 330
Sub-total	**108 731**
Other trees where MB use is less important	
Almond	5 750
Cherry	4 830
Apricot	2 310
Kiwi	7 817
Apple	37 594
Walnut	7 440
Olive	4 680
Pear	12 200
Others	16 673
Total	**208 025**
Source: ODEPA / MINAGRI	

4.2 Tree nurseries

The nurseries that grow young trees are also an important part of this sector. Chile has 1,321 nurseries that produce fruit trees and about 543 that produce vines, as shown in Table 2. More than 1,864 grapevine and fruit tree nurseries are distributed in ten of the thirteen regions of Chile, representing very diverse climates from the north to the south of the country. More than 800 nurseries produce forest trees. The majority are found in six Regions: V, VI, VII, VIII, IX and the Metropolitan Region, with smaller numbers in four other regions.

Table 2: Number of nurseries growing trees and vines						
Region	**Fruit trees**	**Vines**	**Forestry**	**Ornamental**	**Mixed, others**	**Total**
I	4	-	1	-	18	23
II	-	-	3	10	4	17
III	3	(a)	4	6	7	20
IV	30	30	6	10	-	76
V	398	19	58	211	41	727
VI	243	189	161	130	2	725
VII	355	305	122	81	116	979
VIII	63	0	212	33	9	317
IX	-	-	164	101	53	318
X	8	-	39	15	54	116
XI	1	0	9	10	3	23
XII	-	-	2	6	1	9
Metropolitan	216	(a)	38	299	236	789
Total	**1.321**	**543**	**819**	**912**	**544**	**4.139**

Source: Servicio Agricola y Ganadero (SAG)
(a) Other data shows that there are also nurseries in these regions

Table 3 below provides estimates of the area of nurseries in Chile for economically important trees and selected regions. The total area of fruit tree nurseries is greater than 1127 ha. There are many small nurseries, although the size of nurseries can vary from very small (less than 0.1 hectares) to medium and large (about 20 ha). In the case of grape vines, the total nursery area is about 120 ha and there are about 543 nurseries. This indicates an average nursery size of about 0.2 hectares.

Table 3: Estimated area of tree nurseries				
Region	**Grapes (ha)**	**Prunes (ha)**	**Total fruit tree nurseries (ha)**	**Total forest and ornamental (ha)**
V	10		46.1	18.2
VI	35	30	234.2	234.3
VII	15	20	351	66.3
Metropolitan	20	50	307	209.8
Other regions	40	35	> 188.8	> 677.7
Total	**120**	**135**	**> 1127.1**	**> 1206.3**

5. MB CONSUMPTION

5.1 National overview

Chile is the sixth-largest consumer of methyl bromide in Latin America after Mexico, Brazil, Argentina, Costa Rica and Guatemala. Methyl bromide is commonly used in Chile to fumigate soils with the purpose of controlling a wide spectrum of soil-borne pests such as insects, nematodes, weeds, fungi, and viruses. Table 4 presents the evolution of methyl bromide imports for all uses (including quarantine and pre-shipment), according to country of origin.

Table 4: Total methyl bromide imports according to country of origin (kg)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
USA	142 596	80 719	76 724	89 838	31 525	47 793	114 018	30 681	90 941
Belgium	75 608	89 136	106 815	87 568	40 268	53 168	87 568	70 368	140 736
Israel	117 691	86 498	135 947	122 484	127 178	193 669	192 007	188 449	305 224
France								2 113	
TOTAL	**335 895**	**256 353**	**319 486**	**299 890**	**198 971**	**294 631**	**393 593**	**291 611**	**536 901**

Source: Central Bank of Chile

Between 1990 and 1998 national methyl bromide imports increased by an average of 25 tons per year, but in the last four years the rate increased to 61 tons/year (average 1995-98). There was a dramatic increase in 1998, when Chile imported 537 tons of methyl bromide, almost 250 tons more than the previous year. This significant increase was due partly to increased demand in specific agricultural sectors, such as replanting trees and vines. In the case of grapevines, for example, new varieties of table grapes are demanded by the market in some years. A Chilean expert panel which evaluated MB consumption figures for 1998 believed that some of the additional imports were carry-over stocks ie. MB that was surplus to requirements in 1998 and used the following year.

The baseline 'controlled' MB consumption reported to the Ozone Secretariat is 369.2 tons (221.5 ODP-tonnes) average for 1995-98.

In Chile there are several companies that import and supply methyl bromide: Table 5 presents a list of the companies and the amount imported in 1998.

Table 5: Methyl bromide imported by Chilean companies during 1998

Importing Company	Weight (kg)	Percentage (%)
ANASAC SAC & I.	278 223	52
Soc. Fumigaciones Ltd.	103 200	19
Degesh de Chile Ltd.	72 256	14
BAYER S.A.	37 536	7
UTC	14 783	3
Dole Chile S.A.	15 000	3
David del Curto S.A.	12 000	2
TOTAL	**536 900**	**100**

Source: Chile Customs Office, 1998

Since the importers and distributors do not maintain registrations about the use of methyl bromide at their client level (clients are mainly small farmers with fumigation requirements), it was difficult to obtain detailed information on uses. So a panel of experts in August 1999 evaluated the available information. They determined that in Chile, nearly 80% of methyl bromide is used for treatments of soil and the remaining 20% for postharvest treatments of fruits, wood and others. Based on the average use in 1995-98 and figures available in 1998, they estimated the distribution of the use of methyl bromide, which is presented in Table 6.

Table 6: Estimated Uses of Methyl Bromide in Chile (based on use patterns in 1998)	**Quantity (tons)**	**Percentage (%)**
I. Soil Treatment	304	80
1.1 Greenhouses (tomatoes and peppers)	141	37
1.2 Seedbeds (industrial tomato)	32	8
1.3 Tobacco	4	1
1.4 Replants (vines and fruit trees)	98	26
1.5 Nurseries (fruit trees, forest, ornamental)	29	8
II. Warehouses, storage, containers, sacks, misc. uses	36	9
III. Quarantine	40	10
Total including QPS (average 1995-98)	380	100 %

Table 6 shows that MB soil treatments are mainly for tomato and pepper (about 45% of all uses), followed by replant treatments for grape vines, fruit trees and nut trees, and the production of fruit trees and forest trees – representing about 34% of total use.

5.1 Use of Methyl Bromide in tree sector

MB is applied in intensive production systems in the fruit sector. It is used for replant and nurseries for a wide range of fruit trees, vines and nut trees:

- Grape vines for table grapes
- Citrus - orange, lemon
- Stone fruit – peaches, nectarines, apricot, plum, sweet cherry
- Avocado
- Pome fruit – apples, pears
- Kiwifruit
- Olive
- Walnuts
- Almond
- Ornamentals and forest trees are also included for practical purposes in this sector.

The plants which rely most heavily on methyl bromide are grape vines, peach, nectarine, plum, citrus and avocado trees. Use of MB is generally increasing for these tree crops. Methyl bromide is particularly important for grape replants, for example, because the varieties demanded by the market are constantly changing.

As with other Article 5 countries, MB is not used by all the farmers in the sector. It is primarily used by the intensive and small producers. These farmers are not able to move production to spare land nor to rotate with less valuable crops, and for them MB is very important. Such farmers rely very heavily on MB and are dependent on it for controlling soil-borne pests and therefore for their livelihoods. There are at least 3175 - 4400 farmers (conservative figures) who use MB in this sector, although the number is higher if one considers replant users over the full crop cycle of fruit trees (see below).

As shown in table 6 (above), an estimated 127 tons of methyl bromide are used in this sector for tree replanting and production of small trees in nurseries. This represents 34% of the total imports of MB. Within the sector, the breakdown is 98 tons (77%) for replants and 29 tons (22%) for tree nurseries. It is estimated that most of this methyl bromide is used for peaches, plums, citrus, avocado and vines for table grapes.

Methyl bromide is used to control the following soil-borne pests affecting trees:

- Nematodes eg. *Meloidogyne, Xiphinema*
- Fungi eg. *Phytophthora, Verticillium, Xylaria, Armillaria*
- Bacteria and viruses eg. *Agrobacterium tumefaciens*
- Weeds
- Soil-borne insects

For replant purposes, MB is applied to an estimated area of at least 245 ha each year. However, it is important to note that the total area treated with MB for replant is much larger than the area treated in one year. Since vines and trees can be replanted in cycles of 10-30 years this indicates that the area dependent on MB for replant fumigation is about 2450 ha in any 10-year period; about 3675 ha in any 15-year period; and twice that area during 30 years or a full crop cycle.

In the case of nurseries, it is estimated that about 72.5 ha are treated with MB each year. Most nurseries use MB every two years, so about 145 ha of nurseries rely on MB at present. This amounts to about 725 individual nurseries.

MB is available in containers of 1.5 lb (about 680g) and 220 lb (about 100 kg). MB in flasks costs about $5.58 per kg. Methyl bromide is sometimes mixed with chloropicrin in concentrations of 75% to 98%. The methods of applying MB are as follows:

a) For replant – MB is typically injected into the soil using equipment designed in Chile many years ago. The equipment consists of a chisel pulled by a tractor for row treatments and an injection device that injects MB to a depth of 30cm in the soil. Where spot treatments are made, a hand-held injection device is used. The soil is not covered with plastic after MB is applied. Application rates are about 400-500 kg/ha, although the typical rate is 400 kg/ha. MB is applied by growers and farm labourers, and also by some specialised personnel in fumigation companies. It is applied in different regions of Chile, normally between May and October.

b) For nursery plants – Soil in propagation beds in open fields is covered with plastic sheets and fumigated manually by releasing MB from cylinders. Bulk soil is also treated. While recommended label application rates may vary from 35 to about 70 g/m^2 for nurseries, the typical rate is about 40 g/m^2. Fumigations are typically carried out by farmers and farm workers. MB is normally applied between May and August.

Annex 6 presents material inputs and costs of soil treatments using methyl bromide.

6. PROJECT DESCRIPTION

Module 1: Adaptation and Trials to Identify Effective and Cost-Effective Alternatives
Module 2: Training, Dissemination and Technology Transfer to MB users
Module 3: Policy Package

The project is a phase-out project with a small demonstration component. The project will take 5.5 years, and will be in two phases. In the first phase (Module 1) the alternatives will be adapted and trialled during two agricultural seasons. The results of the trials will be objectively monitored and evaluated. Conditional on identifying effective and economically viable alternatives for this sector, the second phase (Module 2) will develop a training and extension program to ensure that the alternative technologies are adopted by MB users. The second phase of the project can proceed only if effective and economically viable alternatives are identified. However, phase 1 has been carefully designed in a manner that will ensure the development of viable alternatives (transferring and adapting alternatives from relevant countries). Experts from other countries will work with Chilean experts to adapt the techniques to local conditions and make them viable for farmers.

6.1 Module 1: Adaptation of Alternatives

Module 1 will adapt and trial alternative techniques for selected varieties of fruit trees, assessing their technical and economic feasibility for the wide range of pests, climates and agricultural conditions found in the fruit tree sector in Chile, particularly in replant areas. The most appropriate techniques will be selected by experts and growers. Subsequently, the best techniques will be transferred to all MB users via the training and extension programs in Module 2.

Each system will have at least three tests in the field. The trials for replant will be implemented on farms in four selected regions with different climates and conditions (V, VI, IV and Metropolitan Region). The trials for nurseries will also be carried out in four regions with varied climates and conditions for MB users (V, VI, VII and Metropolitan). Based on the use patterns of MB, we have selected the following tree species for the trials: peach, plum, citrus, avocado and table grape (Table 7). More information is given in Annex 1.

Table 7: Tree crops selected for trials
Peaches
Plum trees
Citric
Avocado
Table grape

6.1.1 Alternative Techniques

In Chile, several chemical products have been trialled to substitute methyl bromide. These products include formaldehyde, dazomet and enzone, but they are not sufficiently effective on their own. In Colchagua County, organic crop methods are becoming increasingly interesting to some farmers and might offer some cultural techniques as part of IPM systems.

The project has identified alternative techniques that are being used with success in certain other countries, and will adapt these techniques to the specific pests and conditions in Chile. Virtually all the techniques must be combined, in order to control the wide range of pest species. In all cases, preventive practices and good hygiene will be an important part of the pest control system. The national experts involved in this project support the IPM approach advised by MBTOC.

International experts will assist in adapting the alternatives and will train national experts and senior technicians in theoretical and practical aspects, so that the techniques will be sustainable. While a few of the soil-borne pests are known (section 5.1), it is necessary at the start of the project to identify the precise complex of pest species responsible for replant diseases in the major tree species. When this has been done the precise mix of techniques for adaptation and trials will be selected by national and international experts in consultation with growers and other stakeholders. The project will develop workable alternatives that suit the agronomic and economic needs of growers. The coordinators will pay particular attention to the business needs of growers, and the special needs of small-scale farmers.

Alternatives relevant to Chile include the following:

a) Chemical controls

There is no chemical product that gives a better performance than methyl bromide, in terms of consistency and effectiveness against pests. Selected fumigants and pesticides will be trialled, bearing in mind the specific pest complex for each crop. It will be necessary to have combinations of products and other control methods, using an IPM approach. INIA has received agreement letters from chemical suppliers, such as BASF and Novartis, who will give co-operation and specific chemical products such as Basamid, Dual herbicide, Vertimex nematicide and Ridomil fungicide, depending on the final selection of techniques, which will be determined after the precise pest complexes have been identified at the beginning of the project.

b) IPM and cultural practices

In New Zealand a combination of cultural practices, such as disease-suppressive soil amendments and biocontrol root dips, have been developed and used successfully for *Armillaria* control. Resistant rootstock can also play a useful role as part of IPM systems for specific pest and diseases. Cultural practices such as water management can be a significant factor in controlling certain diseases such as *Phytophthora*. Suitable combinations of cultural practices will be adapted and trialled for key crops. The implementation of systems based on know-how requires significant effort in the training of technicians and farmers.

c) Solarisation with IPM – for selected regions

Soil solarisation occurs when the heat of the solar radiation is caught under a plastic cover to elevate the temperature from the humid soil to a lethal level for the soil pests including virus, insects and acari. Solarisation can also be used for nursery soil packed and stored in plastic or plastic greenhouses during high-temperature days. The effectiveness of the solarisation can be improved when this it is combined with other controls.

In relation to solarisation, several regions present Mediterranean climate with good climatic conditions. The annual solar radiation registered in the Quillota Station (V Region) it is of 9049,8 (cal/cm^2/day), with 146,2 and 88,52 hours of theoretical and real hours sun per year, respectively, with annual average temperatures from 8,2 until 22,5 centigrade degrees and annual average mean of 15,25° C. La Platina (Metropolitan Region) registers an annual solar radiation of 8995,4 (cal/cm^2/day), with 146,2 and 90,1 theoretical and real hours sun per year, respectively, with minimum and maximum average temperatures of 6,27°C and 21,56°C and a annual average mean of 13,91° C. The Rengo Station (VI Region) registers 145,2 and 78,41 annual theoretical and real sun hours per year, respectively, with minimum temperatures of 6,69°C, and maximum of 20,69° C, with a mean of 13,69°C, with a total of 8.955 (cal/cm^2/day) per year. Solar radiation in some northern regions is higher. These conditions would indicate that the solarisation process is feasible in some cases, depending on the length of treatment, pests and degree of control required.

d) Substrates (nurseries)

Although it has not been trialled in Chile, the international technical literature points out that in tree nurseries and beds, natural and synthetic soil substitutes of the soil can be used to avoid problems with nematodes, bacteria, fungi and other pests. The effectiveness of the organic matters depends on its quality control and the chemical and physical characteristics. Many substrate systems and imported substrates are too expensive for use in Chile, so it is important to trial local materials which are more likely to be cost-effective for growers. Materials will include residuals of marine algae and a mixture of substrate and pine bark (suppression and antagonistic microorganisms). These substrates have been selected by the success obtained in other countries.

e) Steam (nurseries)

Pasteurisation of the soil is achieved at temperatures from 70° to 80°C. This reduces the pests and at the same time maintains some soil microorganisms which may assist as protectants against reinfestation. Soil sterilisation to temperatures over 80° C gives good conditions for recolonization by microorganisms, including pathogens (MBTOC 1998). However, the highest temperatures can lead to phytotoxicity. Negative pressure steaming is the most fuel-efficient method. For this objective, the project covers the purchase of steam equipment (one unit).

For both replant and nurseries, 4 techniques will be examined, because different techniques will be required by different users, crops and regions. Treatments normally have to be combined in order to control the same wide range of pests that MB controls. Special work will be undertaken for *Armillaria* which is a particularly difficult disease. In all cases preventive practices and orchard management will be very important for providing on-going control for diseases. An IPM approach (focusing on the specific pests that require control and preventive practices) will be used for all treatments, as advised by MBTOC.

The following alternative techniques will be the focus for trials for replants (in an IPM system):

1. Selected fumigants and pesticides
2. IPM system based on cultural practices including resistant rootstocks, techniques to enhance disease-suppressive soil organisms
3. Solarisation as part of IPM system – for selected regions with sufficient temperatures and limited pests
4. *Armillaria* control – adaptation of New Zealand IPM system

The following alternatives will be the focus for nursery trees (with preventive practices in an IPM system):

1. Steam
2. Substrates
3. Solarisation with IPM – for selected regions with sufficient temperatures
4. IPM systems including selected fumigants, pesticides, techniques to enhance disease-suppressive soil organisms

Initial planning workshops

At the start of the project there will be a workshop in each demonstration region to assist in the design of specific details of the project for each region. It will also establish a stakeholders consultative group in each region, so that growers will continue to be informed and consulted during project implementation. This will help to ensure that the project continues to be supported by different types of stakeholders (growers, experts, extension agents, growers' associations, etc.). Each workshop will have 30-50 people for one day, and will be organised by INIA.

6.2. Module 2: Technology Transfer, Training and Dissemination

Module 2 will carry out the activities of technology transfer, training and dissemination of information. This is the second phase of the project, and will be carried out on the provision that effective and economically viable alternatives will be identified in the first phase. This is necessary to address the concerns of growers that this economically important sector must have viable methods of pest control.

All the relevant horticultural and extension organisations in Chile, as well as organisations involved in supporting farms as businesses, will be brought into the project (see section 7). These include INIA (the state agricultural institutes which carry out practical technology transfer and business development with growers), SAG (the Agricultural and Livestock Service of the agricultural ministry), and INDAP (the state Institute of Agricultural Development) , as well as the farmers' associations, technicians and extension personnel working in the fruit tree sector. INDAP will play a particularly important role because it conducts extension services and practical business support for small farmers; in the project INDAP will carry our special technology transfer, training and extension services at farm level as part of the programs coordinated by INIA.

Using the results from the trials, the project will establish a training program for (i) training trainers (ie. extension staff, technicians and farmers who can train others) and (ii) training farmers how to use alternatives. It will also carry out activities such as field days, and produce brochures, technical manuals and a video. INIA will coordinate the training and extension program. It will be assisted by INDAP, the Institute of Agricultural Development, which is the state agency in charge of extension and credit activities for small farmers.

Field days: Farmers, technicians and other stakeholders will be brought to demonstration sites to see alternative results in each major region. The characteristics, advantages and limitations of the demonstrated techniques will be pointed out to growers. There will also be opportunities for discussing the necessity to replace the use of the methyl bromide in agricultural production.

Training of trainers: The main training programme will commence as soon as viable alternatives are identified by the trials. A detailed training package will be prepared, including technical manuals and teaching materials. The experts who provide expertise for the selected alternatives will assist in the training. 17 selected extension personnel (or experienced technicians with skills in extension and training) will be trained to be Leading Trainers. One training workshop will train 17 Leading Trainers, and will last 10 days, covering practical and theoretical aspects of alternatives and effective training methods. In addition, 40 extension personnel and technicians who can act as leading extension and diffusion agents will be trained in similar workshops (approx. 20 per workshop).

Training program for farmers and extension personnel: The Leading Trainers will then train 1000 leading technicians, extension personnel and farmers. Persons to be trained will be selected on the basis that they will be able to extend the alternatives effectively to others in the sector. Farmers will be selected for training on the basis that they are respected by other farmers who tend to copy their production methods, and their willingness to allow other farmers to visit their farms to see alternatives and related extension activities. To conduct the training, the Leading Trainers will hold local one-day meetings on farms or other convenient premises. Each meeting will train on average 10 people in alternative techniques (a higher number of people in areas where farms are clustered). The Leading Trainers will make 5 follow-up visits to trainees during the active season. There is a large number of small farmers, distributed in 10 Regions. In areas where the orchards/farms are clustered, each Leading Trainer will visit 5 farms (average) per day. But where farms are scattered, each trainer can visit only 1 farm per day (on average). The project will provide funds for the Leading Trainers, transport and related costs.

Precise data on the number of growers in each region are not available in Chile, but Table 8 below gives a graphic representation of the regions where training and information dissemination needs to occur.

The training needs are calculated in Tables 9 and 10 below.

Table 8: Graphic representation of training needs by region	
Region	**Training needs (based on estimated numbers of farms)**
I	xx
II	
III	xxxxxx
IV	xxxxxxxxxxxx
V	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
VI	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
VII	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
VIII	xxxxxxxxxxxx
IX	
X	xxxxxx
XI	xxx
XII	
Metro	xxxxxxxxxxxxxxxxxxxxxxxx

Table 9: Calculation of training needs for replant	
Estimated number of farms/orchards that depend on MB for replant	More than 3675 (1225 in 5-year period, 2450 in 10-year period, 3675 in 15-year period, 7350 in 30-year period)
Number who will be given direct training (by Leading Trainers)	770 selected extension personnel, technicians and growers
Additional training	Special training courses will also be held at 3 agricultural colleges to train 900 students
Number to receive information dissemination and indirect extension	More than 6000 farms
Estimated average area per farm/orchard	1 hectare
Training meetings conducted by Leading Trainers	One-day meeting for every 10 people (but more in clustered areas)
Number of follow-up visits to each trainee	Total 5 visits in 1-2 years
Number of follow-up visits by each Leading Trainer	For scattered farms: visit one farm per day. For clustered farms: visit 5 farms per day
Working days per month for Leading Trainers	21 days average

Table 10: Calculation of training needs for nurseries	
Estimated number of nurseries that use MB	725
Estimated average size of nursery	0.2 hectares
Number who will be given direct training by Leading Trainers	230 selected extension personnel, technicians and growers
Numbers for information dissemination and indirect extension	725 nurseries (plus 900 students in 3 agricultural colleges as above)
Training meetings conducted by Leading Trainers	One day meeting for every 10 trainees
Number of follow-up visits to each trainee	Total 5 visits in 1-2 years
Number of follow-up visits by each Leading Trainer	For scattered farms: one nursery per day. For clustered farms: 5 nurseries per day
Working days per month for extension trainer	21 days average

Training Program for Agricultural Students: a special training program for 900 agricultural students in 3 training colleges will be carried out in several major horticultural regions. The students are future technicians and growers. This activity will be conducted with the assistance of the Education Ministerial Secretary (SEREMI) of the relevant regions.

Information Materials will include:
i) Promotional and awareness-raising materials: extension specialists have identified effective methods of raising awareness among growers. The project will produce posters for distribution in the field, mainly in the areas where the demonstrative units will be implemented. It will also distribute to methyl bromide users 2000 pencils, 2000 calendars and 1000 schedule books that contain messages and information about the project.

ii) Information leaflets or newsletters: the successful techniques identified in the trials will be described briefly in promotional leaflets, comparing their performance with methyl bromide, their advantages, limitations and their economic evaluations. When successful alternatives have been identified, leaflets will be produced for replant users and nurseries, highlighting any advantages for farmers.

iii) Technical Manuals: two technical manuals will be elaborated – one for the replant sector and another for tree nurseries, these will compile the theoretical and practical information of the most successful techniques that are identified in the project. These manuals will provide very practical information and will be important in the technology transfer and training activities of the project. They will also be distributed to the agricultural libraries of the country.

iv) Technical video: audio-visual material will be obtained during the demonstration trials, in order to produce a technical video for training – it will focus on the techniques that were found successful in trials, comparing growth and vigour etc. with MB.

The training program and materials will be designed in a farmer-oriented manner, with assistance and advice from growers, to ensure that it meets their needs and concerns. The materials will be focused on the practical and business needs of growers.

6.3. Module 3: Policy package

This module will develop and implement an action plan for the sector and related policy measures to ensure that MB will be phased out in the replant and tree nursery sector. The details of the package will be decided by a process of dialogue with the stakeholders. With the help of the local consultative groups, the project will organise several local workshops, to enable growers, growers associations and the sector to discuss and develop an action plan and other measures that will assist phase-out in a practical manner in all the regions. They will also identify activities to prevent the re-introduction of methyl bromide. These discussions will lead to the production of a policy package and action plans for the replant and tree nursery sector in the third year.

7. COORDINATING INSTITUTION AND PARTICIPANTS

7.1 Consultation

The national consultant has contacted a wide variety of stakeholders, including farmers, nurseries, MB suppliers, extension agents, INIA (national institute supporting agricultural production), universities, pesticide companies, SAG (the state Agricultural and Livestock Service of the agricultural ministry), and INDAP (the state Institute of Agricultural Development) and others. They have provided information for the development of the project. The project beneficiaries will be the growers of fruit and nut trees, and nurseries who produce trees. Organisations involved in the project include growers' associations, extension agents, agricultural technicians, agricultural experts, technical and farm business advisers who belong to INDAP, economists, the Agricultural and Livestock Service, agricultural institutes, representatives of agrochemical companies and others. All the relevant extension and farm business organisations in the sector will be involved in the project.

The project will establish consultative groups in the regions, so that key stakeholders continue to be consulted throughout the project, to ensure their support. This will contribute to the sustainability of the project.

7.2 Administration and implementation of project

The entity responsible for the implementation of the project will be the agricultural institute INIA, while CONAMA's Ozone Group is the agency in charge of co-ordinating and monitoring all the activities related to the Montreal Protocol in the country.

The Agricultural Development Institute (INDAP) provides extension services and practical business support to small growers in particular. INDAP will work on the activities related to technology transfer, distribution of information, training and technical assistance to growers. INDAP will have a particularly important role in technology transfer for small growers, in the field days and training events.

INIA will provide its buildings and technical personnel to carry out the coordination, analyses and other activities. The INIA also has strong business development links with growers and can therefore provide important practical experience. As the local implementation institution INIA will manage the necessary personnel in the project.

The project will enlist farmers to participate at field level in the main regions from the early stages. These farmers will be selected from the farmers co-operatives and associations of growers, to ensure the dissemination and up-take of the trial results. Also, INIA will link with local agri-chemical companies that have confirmed their intention to assist the project by giving specific chemical products and know-how in their efficient handling.

It is necessary to highlight the fact that INIA carries out practical agricultural development projects linked to private entities, among these, it drives projects in alliance with fruit growers in key regions. Furthermore INIA has a business unit which is very conscious of the real-life economic needs of growers.

8. PROJECT COSTS

The total project costs are summarised in Table 11. The budget details for each year are presented in Annex 2.

The incremental capital costs comprise the investment costs of training and materials, as detailed in Annex 2 and 3. The incremental operating costs/savings are estimated in Annex 6. The incremental operating costs are not requested in the budget.

Table 11: Summary of project costs (US$)	
Incremental capital costs	805,000
Incremental operating costs	0
Total project costs	805,000
Funds requested from Multilateral Fund	**805,000**
Counterpart contributions (additional)	98,500

Counterpart contributions

The counterparts are making contributions such as staff time, laboratory facilities, office space, land and use of equipment. It is estimated that these in-kind contributions amount to about $98,500.

9. TIMETABLE

The duration of the project will be 5.5 years. This comprises Years 1-2 for the adaptation and trials (Module 1), and Years 3-4 for the training and dissemination program (Module 2). Module 3 will be implemented in Years 2-3. The project activities will be implemented according to the timetable presented in Annex 4.

Monitoring milestones that can be objectively monitored are listed in Annex 5.

10. IMPACT

The prospective project results are:

a) Identification of economically and technically feasible alternatives to the use of methyl bromide, which will constitute the basis for designing and implementing a strategy for substituting methyl bromide soil disinfestation in the fruit tree sector (including nut trees and tree nurseries).
b) Training of trainers and growers, including extension personnel, in the use of viable alternatives.
c) Awareness-raising about the problems of methyl bromide, results of demonstrations, availability of training and other technical support for growers.

d) The replacement of MB with successful alternatives in this sector, so that MB can be phased out without causing economic damage to growers.
e) The development and implementation of a viable action plan and policies to eradicate the use of methyl bromide in the sector.
f) The achievement of a methyl bromide decrease at the rate of 13% per annum (consumption), leading to permanent phase-out in this sector.

Sustainability of alternatives and phase-out

The project will be coordinated and implemented by INIA, which has experience in working directly with farmers, extension personnel and business organisations in this sector. Consultative groups of stakeholders will be set up so that growers continue to be consulted and involved throughout the project, to ensure that the programs meet the needs of growers. The project will involve all the key agricultural organisations in the sector.

The project counterparts in Chile are strongly committed to the goal of developing suitable alternatives for this sector. Alternative techniques have been identified for replant and tree nurseries in other countries, and international experts will work with national experts to adapt these techniques for Chile's pests and conditions. The selected experts will have the skills to adapt/develop viable techniques, and will focus on the practical needs of growers in each region, to ensure that alternatives will be sustainable.

The training program (training of trainers and farmers) will be a very important component of the project, and will be essential for its success and sustainability. Farmers who are well-trained in alternative techniques will not need to revert MB. INIA and the other organisations involved in the project (eg. INDAP) work actively with growers (especially small growers) to develop successful farm businesses, so they are familiar with the practical and economic needs of growers and farming enterprises. These skills will be used to define training programs that are directly relevant to growers.

The sector action plan and related policy measures, which will be developed in consultation with stakeholders, will also be important in ensuring that the MB phased-out by this project will not be re-introduced at a later date.

ANNEX 1: Demonstration trial units

Based on the use patterns of MB, we have selected the following tree species for the trials: peach, plum, citrus, avocado and table grape (Table 7).

The trials for replant will be implemented in four selected regions with different climates and conditions. Likewise, the trials for nurseries will also be carried out in four appropriate regions with varied climates and conditions.

Meetings in the initial stages of the project (comprising national and international experts and growers) will determine the combination of technical elements for the alternative systems and for the demonstration units.

Each alternative will have at least three replicate trials in the field. The demonstration units will be installed in selected farmers' properties. The area of each unit will be sufficiently large to provide statistically valid data.

Before each trial is set up the soil will be sampled for analysis of key physical and chemical properties, as well as indicator pests and pathogens.

Design of demonstrative units

Example of demonstrative unit based on block random design assays with the corresponding derived treatments of each alternative technique

Block 1

T1	T4	Control	T2	T3

Block 2

T2	T1	T3	Control	T4

Block 3

T3	Control	T1	T4	T2

T1	: Steaming	T3	: Chemical Products
T2	: Substrates	T4	: Integrated Pest Management (IPM)
Control	: Methyl bromide		

Number of demonstration units and trials of alternative techniques to implement during two agricultural seasons (UD – demonstration unit)

		Agricultural seasons							Technical assays for each season		
		(1)			(2)						
Region	Plant	UD1	UD2	UD3	UD1	UD2	UD3	Total	UD1	UD2	UD3
V/RM	Peaches	1	1		1	1		4	5	5	
	Plum	1	1		1	1		4	5	5	
	Citric	1	1		1	1		4	5	5	
	Avocado	1	1		1	1		4	5	5	
	Table grapes			2			2	4			5
VI	Peaches	1	1		1	1		4	5	5	
	Plum	1	1		1	1		4	5	5	
	Citric	1	1		1	1		4	5	5	
	Avocado	1	1		1	1		4	5	5	
	Table grapes			2			2	4			5
VII or IV	Peaches	1	1		1	1		4	5	5	
	Plum	1	1		1	1		4	5	5	
	Citric	1	1		1	1		4	5	5	
	Avocado	1	1		1	1		4	5	5	
	Table grapes			2			2	4			5

ANNEX 2: Budget

BUDGET CHILE						
Approved disbursement (20% per year)	20%	20%	20%	20%	20%	US$
Agreed levels MB (ODP tonnes) to reach	198	198	170	170	121.8	
YEAR	**2001**	**2002**	**2003**	**2004**	**2005**	
BUDGET ITEMS						
100 Personnel						
101 National Coordinator	10,000	10,000	10,000	10,000	10,000	50,000
102 National Experts/Technicians	20,000	21,000	20,000	17,000	17,000	95,000
104 Leading trainers / extensionists	8,750	27,000	66,250	59,000	59,000	220,000
105 Farm Labourers/Assist.	5,000	5,000	5,000	3,800	3,800	22,600
106 Students	800	800	800			2,400
107 International experts (4)	39,700	15,920	4,380	5,000	5,000	70,000
100 Sub total	**84,250**	**79,720**	**106,430**	**94,800**	**94,800**	**460,000**
200 Lab Analysis (2)	**14,000**	**9,000**				**23,000**
300 Equipment / materials (3)	**32,000**	**20,000**	**20,000**	**20,000**	**20,000**	**112,000**
400 Events / Workshops						
401 Planning meetings	2,500	2,500				5,000
402 Consultive meetings	1,000	3,000	1,000			5,000
403 Field days	1000	4000				5,000
404 Train the Trainers Workshops			26,000	22,000	22,000	70,000
405 Agriculture Schools		2,800	2,800	2,200	2,200	10,000
400 Sub total	**4,500**	**12,300**	**29,800**	**24,200**	**24,200**	**95,000**
501 Travel Costs within Chile for all experts	10,500	11,500	23,805	22,000	22,000	89,805
502 International Travel Costs - international experts only (4)	15,750	7,540	1,905			25,195
500 Sub total	**26,250**	**19,040**	**25,710**	**22,000**	**22,000**	**115,000**
Total by Year	**161,000**	**140,000**	**181,940**	**161,000**	**161,000**	
Project Grand Total						**805,000**

(1) US$ 161,000 maximum disbursment per year (not to exceed 60% in 3 years $ 483,000 when first MB reductions will be evaluated).

(2) Laboratory analysis will include $6,500 for work on biocontrols under direction of Dr Robert Hill.

(3) Final list of equipment and materials (specifications and quantities) will be decided jointly by coordination team, and the international experts, after full discussion.

(4) Budget breakdown for international team is shown in Annex 8.

Remarks :

-Where INIA personnel are used, personnel costs are subsidised by INIA. (INIA will charge only 50% of the real hourly labour rate).

-Working hours or months. '12 working months' can mean 3 persons x 4 months, for example.

-Calculations of training costs are presented in Annex 3.

- The analysis of organic matter seeks to measure the C by an analyser of elements to determine the presence of [C], [H], [N], and [S] in the soil (total [C]), humic acid, fulvic acid, and humines. With this analysis it is possible to determine the stability and organic performance a result of different treatments and also to know what soil characteristic or substrate affect the positive or negative treatments behaviour. The analysis of biological activity is necessary to determine the treatment efficiency and dose, with the purpose of comparing the treatments with methyl bromide and alternatives, and also to determine the pathogen presence before and after the treatment. This information will allow the results to be extended other areas.

- Cost of equipment includes the acquisition of negative-pressure steam equipment (one unit) and accessories equipment for the application of the technique. Also dataloggers for the trials. See Annex 7 for equipment costs.

- Travel costs for trials includes the viaticum expenses and transfer by vehicle to the regions where the demonstrations will be implemented, to inspect and evaluate the trials.

-Costs for fields days after year 2 are included in training costs.