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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Twenty-fourth Meeting
Montreal, 25-27 March 1998

PROJECT PROPOSAL: SYRIA

Fumigant

•	Demonstration project - alternatives to the use of methyl bromide in horticulture and commodities fumigation	UNIDO

PROJECT EVALUATION SHEET
SYRIA

SECTOR: Fumigant (Methyl bromide) ODS use in sector (1996): 440 ODP tonnes

Project Title:
Demonstration project - alternatives to the use of methyl bromide in horticulture and commodities fumigation

Project Data	**Methyl Bromide**
ODS phase-out (ODP tonnes)	N/A
Proposed project duration (months)	24
Incremental capital cost (US $)	509,850
- including contingency (%)	10
Incremental operational cost (US $)	0
Total project cost (US $)	509,850
Local ownership (%)	-
Export component (%)	-
Amount requested (US $) {Original}	509,850
{Revised}	
Cost effectiveness (US $/kg)	N/A
National Coordinating Agency	Ministry of Environment
Implementing Agency	UNIDO
Technical review completed?	-

Secretariat's Recommendations:	
Amount recommended (US $)	
Project impact (ODP tonnes)	N/A
Cost effectiveness (US $/kg)	N/A
Implementing Agency support cost (US $)	
Total cost to Multilateral Fund (US $)	

PROJECT DESCRIPTION

Demonstration project - alternatives to the use of methyl bromide in horticulture and commodities fumigation

1. The project is to demonstrate the technical and economic feasibility of four alternative methods to the use of methyl bromide in horticulture (tomatoes, strawberries, tobacco and cut flowers). These techniques include steam pasteurization, non-soil cultivation, solarization, bio-fumigation, application of low doses of other pesticides and use of resistant varieties, all in combination with an Integrated Pest Management (IPM) programme.

2. The project is also to demonstrate alternatives to methyl bromide used in grain fumigation, mainly phosphine in the form of gas, mixtures of phosphine and carbon dioxide and modified atmospheres.

3. Soil pasteurization by steam (SPS), consists of heating the soil at a depth of 65 centimeters up to 80° Celsius, in order to inactivate nematodes and 95 per cent of the spores of the pathogenic fungi.

4. Non-soil cultivation technique is used in nurseries, greenhouses and seedbeds to prevent infestation by bacteria and fungi. Soil is replaced by synthetic or natural sterilized soil substitutes which provide reliable support. Two types of soil-less media are available: (i) organic media, such as peat, sawdust, straw bales, which have good cation-exchange and water holding capacity, and (ii) inert media, such as rock wool, perlite, polyurethane, expanded clay and polystyrene, which have high water holding capacity but low cation-exchange capacity.

5. Bio-fumigation combined with solarization is an old technique that has been recently improved with the use of plastic sheets that trap the gases generated by the fermentation of organic residues below the surface of the soil that are lethal for many microorganisms. In countries with a temperate climate, this cheap technique has been successfully tested and is now in use on a full commercial scale.

6. Integrated Pest Management (IPM) programme for crop protection utilizes a combination of cultural practices, including crop rotation, cover crops, fertilization and plant nutrition; physical methods, including steam, solarization, and heat, and use of chemical compounds. A combination of SPS and IPM has proven to be an effective approach for the control of pests and diseases in horticulture (annual losses of only 1-2% due to bacterial and fungal diseases, as compared to much higher losses when relying on soil fumigation with methyl bromide only).

7. There is a wide range of alternatives for substituting methyl bromide used for grain fumigation. Phosphine is extensively used, principally for cereals and pulses which are stored in bulk. While insect resistance to phosphine is an emerging problem, particularly in developing countries, resistant pests can be controlled using available phosphine-based technology in combination with an IPM programme. The project will apply a flow-through fumigation system, which is a new technique that works with a

gas distribution system (cylinders containing phosphine in carbon dioxide will be used to generate the gas). The economic advantage of this technique is that sealing costs are reduced.

8. The low cost of propane in Syria makes the use of burner gas a feasible alternative to methyl bromide. This technology consists of providing an atmosphere containing less than one per cent of oxygen and 12 per cent of carbon dioxide through the combustion of propane. Minimum exposure time required will be 14 days. This technique requires use of hermetically sealed storage structures and a gas supply to keep the oxygen concentration permanently below one per cent.

9. Commodities stored in bulk will also be exposed to high concentrations of carbon dioxide (between 60 and 95 per cent at atmosphere pressure), for a minimum of 15 days. Although this technique does not require maintenance of the atmosphere, a sealed storage structure will be used.

10. The project will be implemented in two different climatological regions and in three sites: (i) Tartous in the relatively wet coastal area for horticultural crops; (ii) Koswa in the dry area near Damascus for horticultural crops and cut flowers; and (iii) Homs and Hamah for grain storage.

11. Soil preparation will be carried out applying the same methodology used by the company. Alternatives to methyl bromide will be applied simultaneously with methyl bromide applications in order to have a control field. Soil samples will be analysed before and after soil treatment and three days after planting has taken place. All tests will be carried out in duplicate using each of the alternative technologies selected. During the first cultivation season the alternative technologies will be tested in relatively small areas (a half of a greenhouse). The most promising technologies will be tested at a full commercial scale in the second year.

12. The project will be coordinated by the Ministry of the Environment and implemented by UNIDO in cooperation with the local branches of the Directorate of Plant Protection of the Ministry of Agriculture. In close cooperation with local agronomists, the international experts will propose alternate technologies, design the tests to be carried out in the plots made available by each grower, and establish the analytical methods to be used for monitoring pests and diseases.

13. The expected results from project implementation are: (i) a technical and economic analysis of utilization of proposed alternatives to methyl bromide, (ii) agronomist and crop specialists fully trained in the alternative technologies used; and (iii) dissemination of the results of the demonstration project among Article 5 countries.

14. A national project coordinator (NPC) will be recruited for managing and supervising the demonstration project, including designing the tests, collecting and analyzing the data, supervising field activities and coordinating the services of project personnel. The total costs of human resources is US $371,500 including a subcontract for fumigation (US $95,000), study tours (US $18,000) and internal travel (US $6,000), representing 80 per cent of the cost of the project. The total cost of the equipment is US $72,000.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

1. The Fund Secretariat reviewed the project in the context of the Executive Committee's interim guidelines on methyl bromide projects (adopted at the 20th Meeting), the demonstration projects approved at the 22nd and 23rd Meetings of the Committee, the report of the Methyl Bromide Technical Options Committee (MBTOC), several publications on methyl bromide and in the light of the two-day meeting held in the Fund Secretariat (3-4 February) to develop a strategy and guidelines for projects in the methyl bromide sector (to be submitted for consideration of the Executive Committee at the 24th Meeting).

2. The project concept follows the Executive Committee's guidelines and is consistent with MBTOC reports.

3. The projects states that adequate care was taken by the Ministry of Environment and UNIDO to identify the most relevant crops and the climatological areas representative of Syria's ecological conditions. A number of growers/crops were also identified in each of the areas selected.

4. The Secretariat discussed with UNIDO issues regarding the use of existing equipment in the country, the cost of equipment and laboratory tests being requested, and the salaries of international and national experts.

PROJECT DOCUMENT

COUNTRY:	Syrian Arab Republic
PROJECT TITLE:	Demonstration Project - Alternatives to the use of Methyl bromide in horticulture and commodities fumigation.
SECTOR COVERED:	Horticulture and grain fumigation
ODS USE BY SECTOR:	440 mt. in 1996
PROJECT DURATION:	24 months
TOTAL PROJECT COSTS:	US$ 509,850
OVERHEADS OF IMPLEMENTING AGENCY:	US$ 66,281
PROPOSED FINANCING BY MULTILATERAL FUND:	US$ 576,131
IMPLEMENTING AGENCY:	UNIDO
COORDINATING INSTITUTION	Ministry of Environment

PROJECT IMPACT: The project has been designed in order to demonstrate proven alternatives to the use of methyl bromide as a fumigant in horticulture and in the treatment of commodities. The chosen alternatives in horticulture are steam pasteurization, non-soil cultivation, solarization, bio-fumigation, application of low doses of other pesticides and use of resistant varieties, all in combination with an integrated pest management system (IPM). The chosen alternatives in grain fumigation are phosphine in the form of gas, mixtures of phosphine and carbon dioxide and modified atmospheres. Implementation of the project will also include the preparation of a technical and economic assessment of the technologies used and the dissemination of the results through a national workshop.

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1. BACKGROUND

Approximately 12% of the entire surface of Syria is cultivated. The Syrian agricultural sector has two main components: open field crops, mainly cereals and pulses, and protected horticultural crops.

About 4 million tonnes of wheat and 1 million tonnes of barley are produced every year in the northern and eastern regions of the country. The total capacity of grain storage of Syria is about 2,5 million tonnes, but it is estimated that it will increase to 5 million tonnes within the next three years. Grains are stored for few months in bulk or bags in silos and warehouses belonging to the Government or just in open air stacks covered with plastic sheets, and usually fumigated with methyl bromide or phosphine tablets.

It is estimated that about 80,000 covered plastic houses exist in Syria, which account for total area of 4,000 hectares of land. Most of these plastic houses are located in the coastal area, within the two governorates of Tartous and Lattakia, and in the southern regions, in Swedish and Daraa governorates. Plastic houses are used for vegetable and ornamental crops, such as tomatoes, cucumber, sweet pepper, strawberries, banana, etc. In the coastal area, tomato is the most important culture, with relatively high yields (100 tonnes per hectare), but only 10% of this production is exported. Banana cultivated under plastic tunnel and tobacco seedbeds are rather frequent all over the region and represent new and expanding sectors.

. Number of plastic houses and estimated production for the main protected horticultural crops in the Syrian coastal area (Tartous and Lattakia governorates)

Crops	**Number of plastic houses**	**Estimated production 1997 (in metric tonnes)**
Tomatoes	23,993	120.000
Cucumber	7,363	30.000
Sweet pepper	2,215	3.500
Eggplants	1,847	6.000
Peas	686	1.000
Strawberries	601	30
Squash	402	1.600
Cut flowers and ornamental plants	210	
Banana	130	330
Nurseries (tobacco)	6	
TOTAL	**37,453**	

Cultivation of the above-mentioned crops on the same soil has led to several phytosanitary problems. Nematodes and corky-root fungi are some of the major limits to crop productivity, mainly for those cultures grown under plastic shelters. In the coastal area, pest control is achieved mainly using soil fumigation with methyl bromide and metham sodium: some growers have been also practising a sort of Integrate Pest Management strategy, that includes changing location of plastic houses and timing of planting, soil solarization, use of soil amendments and mulching.

1.1 Consumption of methyl bromide in Syria

In Syria, methyl bromide is registered for quarantine measures, commodities and soil fumigation. "Mebron" Methyl or "Soprom" are the only methyl bromide brand names used in Syria. In the last four years, the average quantity of methyl bromide consumed for sterilization of commodities and quarantine is about 239 tonnes per year. The average consumption for post-harvest treatments ranged from 62,65 tonnes in 1993, 195,39 tonnes in 1994, 365,15 tonnes in 1995 and 361 tonnes in 1996. Consumption for quarantine purpose is smaller, and accounts for only 100 Kg in 1993, 680 Kg in 1994, 644 Kg in 1995 and 566 Kg in 1996.

There is no record for the consumption of methyl bromide for soil fumigation in Syria. The best estimate of the 1996 total quantity of methyl bromide consumed in covered crops, made from direct contact with growers, dealers (shop sellers) and other operators involved in plastic houses industries, is 80 tonnes per year.

Syria has imported 300 tonnes of methyl bromide in 1997, half of which came from Belgium and the other half from France. The consumption of methyl bromide in Syria is on the rise, therefore, this demonstration project could be instrumental in reversing the upward trend.

Estimated consumption of methyl bromide for quarantine, post-harvest treatments and other applications in 1996

Area of application	**Estimated quantity used in 1996 (in metric tonnes)**
Soil treatments	80
Quarantine treatments i.e. treatments required by quarantine	0,57
Post-harvest treatments e.g. stored grains, excluding quarantine	361
Other miscellaneous treatments e.g. buildings, termite mounds	45
TOTAL	**486,57**

Summary of data/estimation of the total quantity of methyl bromide imported and consumed in Syria during 1993-1996

Year	MB imported (in metric tonnes)	Estimated consumption of MB (in metric tonnes)
1993	210	210
1994	255	255
1995	255	255
1996	400	487
Average per year	**280**	**301,75**

2. PROJECT OBJECTIVES

The **first** objective of the project is to demonstrate and disseminate the technical and economic feasibility of five alternative methods to the use of methyl bromide, i.e., solarization, bio-fumigation, non-soil cultivation techniques for seedlings, steam pasteurization and application of various mixtures of other chemicals in low doses, all in combination with the use of the newest most resistant varieties and an integrated pest management system.

The main crops targeted are: tomatoes, strawberries, tobacco, sweet pepper, banana, and cut flowers.

The **second** objective of the project is to demonstrate and disseminate the technical and economical feasibility of two alternative methods in wheat and other cereal grains fumigation. The alternatives chosen are phosphine in the form of gas and mixtures of phosphine and carbon dioxide.

3. PROJECT DESCRIPTION

3.1 Proposed Technologies in horticulture

3.1.1 Integrated Pest Management incorporating steam pasteurization

This technology is being successfully utilized by several firms in the flower sector in Colombia since 1985. It is not a single technology but a combination of two different techniques, namely:

(a) Soil pasteurization by steam, which consists of heating the soil up to 80° C, 65 cm deep, in order to inactivate nematodes and 95% of the spores of the pathogenic fungi.

(b) Integrated management of the pests (IPM). IPM makes use of all possible resources - not just chemical control - to reduce and prevent the incidence and effects of a given disease or pest. It includes crop sanitation, disease free plant material, physical and cultural controls, disease or pest resistant varieties, scouting for diseases and record keeping, sanitary barriers, segregating nurseries from production facilities, etc. IPM leads to far less usage of chemical pesticides and, according to the specialists, it is at present the only real and lasting solution to severe diseases and pests attacking many crops.

A combination of SSS and IPM for the control of pests and diseases in horticulture is a proven technology package, widely used in other countries for more than ten years. Colombian growers using this approach report annual losses of only 1-2% due to bacterial and fungal diseases, as compared to much higher losses when relying on soil pasteurization with methyl bromide only. The approach is not only environment-friendly but also economically feasible.

3.1.2 Soilless media and IPM

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

Organic media, as well as some inert media, are currently being used in the United States, Italy and Spain for tobacco seedbeds. Floating or fixed plastic trays which can easily be sterilized and re-used.

While this project intends to use soilless media for the production of tobacco seedlings, it is worth mentioning that inert media are extensively used in the Netherlands, Italy, Denmark and other countries. Cheap organic substitutes, such as sterilized grain-hulls and waste bark, are also used. The experience gathered through years of commercial cropping of tomatoes, melons, pepper, strawberries, etc., is now very large and the use of soil alternatives is currently predominant in many countries.

The project intends to apply this technology to the production of tobacco seedlings by using:

(i) organic media available in the area, alone or in mixtures with inert media;
(ii) inert media, available in the area, at competitive prices.

Three different systems will be used: (i) suspended plastic trays, (ii) plastic trays lying on sand and (iii) floating polyurethane trays.

Finally, the re-utilization capacity of the various plastic trays will be actually tested by sterilizing them with hot water, steam or chemicals and using them again.

3.1.3 Low-dose chemicals in combination with IPM

The application of an Integrated Pest Management Programme greatly reduces the doses of mixtures of certified pesticides, nematocides, herbicides and fungicides applied. This pesticide mix has to be elaborated according to the ecology and climate of the area.

3.1.4 Solarization in combination with IPM

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

In countries with a temperate climate and marked seasons, the technique has a drawback, which is, that it blocks the use of land during the most productive periods of the western summer. However, this technique might prove to be cost-effective in the case of seedbeds.

3.1.5 Bio-fumigation combined with solarization

Fermentation of organic residues below the surface of the soil generates gases which are lethal for many microorganisms, including several nematodes. This old technique has been recently improved with the use of plastic sheets that trap the gases generated by the fermentation of organic waste.

In countries with a temperate climate, this cheap technique, which combines solarization and bio-fumigation, has been successfully tested and is now in use on a full commercial scale.

3.1.6 Use of resistant cultivars and biological control

Intensive cropping favours the susceptibility to many plant diseases such as *Fusarium* and *Verticillium* wilts. The use of resistant cultivars, which are slowly being commercially released, is the cheapest and easiest way to control soil borne pathogens.

Many resistant cultivars are now used for specific crops in industrialized countries. No fruit or vegetable nematode-resistant cultivar in the market is resistant to all nematodes. However, the use of these cultivars greatly has reduced the use of broader nematocides and it is possible to use low doses of more specific nematocides, targeting only nematodes that might cause more serious damage.

Great efforts are being made to incorporate gene resistance, to introduce biological control through seed infestation with non-pathogenic *Fusarium spp* or by inducing systemic resistance through infestation with plant growth promoting rhizobacteria.

The project will use these resistant varieties the day they are made commercially available.

3.2 Proposed alternatives in grain fumigation

There is a wide range of alternatives available for fully substituting methyl bromide in the treatment of cereals and pulses. In many cases, fumigation can be prevented by applying Integrated Pest Management (IPM) principles during crop production and storage. Any improvement in IPM techniques leads to reduced pressure on stored products and thus to a reduction in the number of times food needs to be fumigated to maintain quality. Good management, like proper planning and timing of treatment, allows also the use of other methods, even if an exposure time of one week or longer is required, as is the case with phosphine or other fumigants.

Better methods of population monitoring are also needed to facilitate integrated management of stored-product insect pests in large retail stores. Such methods should be capable of detecting insect infestations quickly and of locating the foci of infestation, so that corrective measures can be taken with minimum risk of chemical contamination.

3.2.1 Phosphine gas

Phosphine is already extensively used, principally for cereals and pulses which are usually stored in bulk. Insect resistance to phosphine is an emerging problem, particularly in developing countries, but resistant pests can, at present, be controlled using currently available phosphine-based technology in combination with an Integrated Pest Management system.

Standard fumigation techniques. The application will follow the routine procedures for sealed bulks and bags. Best results will be achieved with temperature above 15 °C and with exposure periods of at least three days. The target organisms will be stored product insects and mites (mite eggs are highly tolerant; a second treatment may be required after hatching). As insect resistances have appeared in several countries, great care will be taken to respect minimum exposure periods and to use hermetically sealed storage structures.

3.2.2 Mixtures of phosphine and carbon dioxide

The project will apply a flow-through fumigation system, which is a new technique that works with a gas distribution system (existing aeration ducts will be used). Cylinders containing phosphine in CO_2 will be used to generate the gas. This technique is effective against all kinds of stored product insects, on cereals in bulk (horizontal and vertical silos). The economic advantage of this technique is that sealing costs are reduced.

Commodities stored in bulk or bags will also be exposed to high CO_2 concentration, between 60 and 95%, at atmosphere pressure, for a minimum treatment time of 15 days. This technique does not require maintenance of the atmosphere but anyway hermetically sealed storage structure will be used.

3.3 Evaluation of alternative techniques

Basically, there are five well-proven, alternative techniques available in horticulture and three in grain fumigation.

(i) Use of a combination of various registered fumigants, the cost of which is comparatively low, but requires a waiting period before replanting. It must be integrated with an Integrated Pest Management System.

(ii) Use of steam to pasteurize the soil, which is costly, but eliminates any waiting period and can be graduated according to the intensity of the incidence of the disease. It also needs the framework of an Integrated Pest Management System.

(iii) Use of non-soil culture media, organic or inert, which has been widely adopted in non-open air cultures in Holland, where the use of methyl bromide was banned some years ago, as well as in other European countries and in the USA. It is also widely used in seedbeds, particularly tobacco seedbeds, in USA, Spain, and others.

(iv) Solarization, which is a promising technique, is effective against bacteria, but, in temperate climate countries, the temperatures reached are only effective against fungi spores during the period of maximum sun radiation. Therefore, in said countries, the land remains non-productive during a long period of time in late spring or summer, which would normally be the most productive period.

(v) A combination of bio-fumigation and solarization. This technique takes advantage of the maximum amount of gases generated by the fermentation of organic wastes by covering the surface of the soil with plastic sheets. Under favourable conditions, the increased soil temperature accelerates the exothermic fermentation of organic wastes and thus increases the release of lethal gases and the pasteurization effect of the heat generated.

(vi) Use of phosphine either alone and or mixed with carbon dioxide in grain fumigation. Of all the alternatives to methyl bromide, only phosphine is extensively used, principally for cereals and pulses which are stored in bulk. Indeed, phosphine is a rather cheap product, unduly hazardous to man and the environment (if used in a proper way), that can be easily obtained from solid formulations, available almost in every country. Insect resistance to phosphine, emerging problem, particularly in the developing countries, can be controlled using currently available phosphine based technology in combination with an Integrated Pest Management system.

(vii) Treatments with controlled or modified atmospheres based on carbon dioxide and nitrogen offer an alternative to fumigation with toxic gases for insect pest control in all durable commodities. However, these treatements, rarely reach the minumum oxygen level needed to prevent insects reproduction.

Low oxygen atmosphere, typically created by adding nitrogen to a fumigation enclosure, or by adding atmospheres generated by the combustion of propane (burner gas), require

the presence of a maximum of 1% oxygen for effective action. Therefore, stringent sealing of the enclosure and some facilities for topping up gas are required.

Carbon dioxide atmospheres typically are applied at about 60% CO_2 in air. Most species of stored product insects are completely controlled by exposures of about 15 days at this high carbon dioxide levels. The exposure time can be reduced if the treatment is combined with pressure alterations or raised temperature. Bulk and cylinder-based supplies are the only viable options if there is no locally available industrial source of carbon dioxide.

(viii) Inert dusts such as ash, amorphous hydrated silica, lime, earths, etc. are registered in some countries for treatment of grain and grain legumes against insect pests. They are particularly useful in dry conditions as a means of controlling pests resident in storage structures, and they are likely to be used more as part of an Integrated Pest Management system. Additional costs are required to clean the dusty grain from the commodities.

3.4 Project Implementation

3.4.1 Location of the Project

The project will be implemented in two different climatological regions and in three sites:

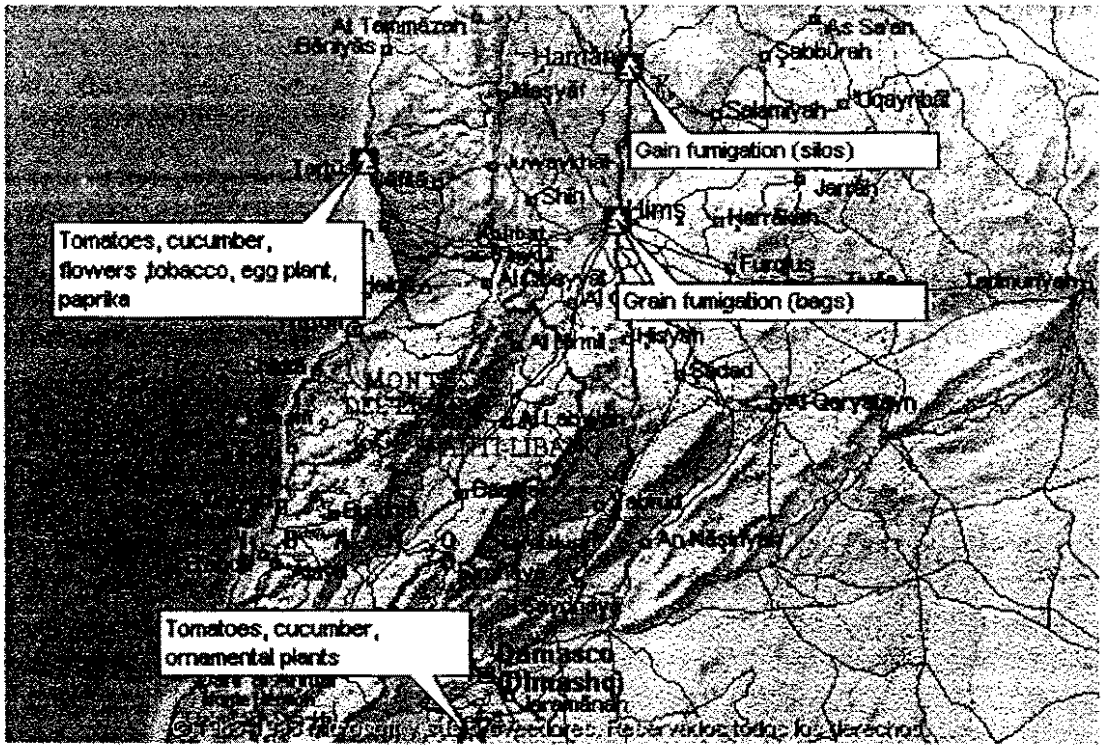
- Tartous in the relatively wet coastal area (Horticultural crops);
- Koswa in the dry area near Damascus (Horticultural crops and flowers);
- Homs and Hamah for grain storage.

Adequate care has been taken by the Ministry of Environment and the UNIDO team to identify the most relevant crops and the climatological areas representative of Syrian Arab Republic's ecological conditions. A number of growers/crops have been identified in each of the areas selected, as shown below.

CROPS, SITES AND ALTERNATIVE TECHNOLOGIES

Area	Climate	Grower	Crop	Alternatives
Tartous	Mediterra-nean. Wet	Mr. Ebrahim Hakim	Tomatoes	Soilless floating or suspended trays Low-dose chemicals Solarization Solarization Bio-fumigation Steam pasteurization IPM Resistant cultivars
		Mr.Wail Salhman	Eggplants S. Pepper	
		Mr. Mohammed Salhman	Cucumber	
		Mr. Adel Sayouh	Flowers	
		Mr. Mohammed Isa	Tobacco	
		Mr. Tannous Muawad	Banana	
Koswa	Mediterra-nean. Dry	Mr. Mohammed Abo Baker	Tomatoes Ornamental plants	
Homs		Ministry of Supply and Trade	Grains in bags	Phosphine and mixtures Inert gases
Hamah		Ministry of Supply and Trade	Grains in silos	

CROPS/PRODUCTS AND SITES



3.4.2. Methodology

For the sake of comparison, soil preparation will be carried out using the same methodology the growers use, whether for crops that require nurseries, such as tomatoes, tobacco and broccoli, or for crops that do not. When the time comes for methyl bromide to be applied, the project will apply the alternative treatment so as to have a control field.

All tests will be carried out in duplicate using each of the alternative technologies selected. During the first cultivation season the alternate technologies will be tested in relatively small surfaces usually half of a greenhouse surface. The most promising technologies will be tested at a full commercial scale in the second and third year.

The data will be processed and analysed in terms of effectiveness, productivity and cost. The monitoring phase and the collection of data will start with the soil preparation and will end after the harvest.

Soil samples will be analysed before and after soil treatment and during the entire crop cycle. Levels of pathogens and pest counts will be the indicators used in assessing the effectiveness of the treatment.

During the second cultivation season, the surface of the most successful trials will be considerably expanded to at least a full greenhouse.

3.4.3 Project Coordination

The Project will be coordinated by the Ministry of the Environment and implemented by UNIDO in cooperation with the local branches of the Directorate of Plant Protection of the Ministry of Agriculture and the Ministry of Supply and Trade. UNIDO will draw up a subcontract for the implementation of the demonstration of alternate technologies in grain fumigation. A part-time national coordinator will be recruited to interact between these local Institutions, the Government Institutions and the private sector farmers. Two part-time national agronomists will be hired to conduct the field work in cooperation with the growers and the international experts.

In close cooperation with the local agronomists, the international experts will propose the alternate technologies, design the tests to be carried out in the plots made available by each grower, and establish the analytical methods to be used for monitoring pests and diseases.

The national project coordinator will be responsible for managing and supervising the entire demonstration project. He will also be responsible for supervising field activities and coordinating the services of project personnel; collecting and consolidating the technical and economic data in the final report. He is expected to establish good working relationship with the growers, field agronomists, government authorities, experts and implementing agency officers.

Project activities will start with a study tour organized to enable the local agronomists and the Directorate of Plant Protection to become familiar with the technologies that will be used.

The services of a national agro-economist will also be subcontracted in order to establish cost comparative analysis between the alternate technologies and the existing practices using methyl bromide.

This technical and economical analysis of the alternate technologies will be published and discussed during a national workshop at the end of the project.

3.4.4 Institutional Arrangements

The Ministry of the Environment will be the coordinator and counterpart institution. Final specifications for equipment required and a work plan will be elaborated after an agreement has been reached with the Ministry of the Environment and UNIDO.

4. OUTPUTS

4.1 Outputs and Activities

OUTPUT 1: A practical technical and economic analysis, at full commercial scale, of the utilization of five alternatives to methyl bromide, namely, non-soil cultivation, steam injection, solarization, bio-fumigation and the use of various other chemicals in combination with the use of resistant cultivars and with an integrated pest management system. .

ACTIVITIES	MONTH OF COMPLETION	RESPONSIBLE PARTY
Equipment: purchase, delivery & installation as per annex A	3	UNIDO
Preparation of IPM programme.	3	11-01
Application of soilless technologies using at least three different locally available media and three systems at full commercial scale	24	11-02
Application of low doses of chemicals at full commercial scale	24	11-01
Application of the solarization technology at full commercial scale.	24	11-03
Application of steam pasteurization techniques at full commercial scale.	24	11-04
Application of IPM principles, at full commercial scale, and its monitoring throughout entire demonstration project.	24	11-01
Application of bio-fumigation at full commercial scale.	24	11-05
Replication of the tests on a full-scale commercial basis.	24	11-01,11-02, 11-03,11-01, 11-05
Preparation of technical/economic analysis of the results.	24	11-01, 17-04

OUTPUT 2: A practical technical and economic analysis, at full commercial scale, of the utilization of two alternatives to methyl bromide in commodities fumigation, namely, phosphine and mixtures of phosphine and carbon dioxide.		
ACTIVITIES	**MONTH OF COMPLETION**	**RESPONSIBLE PARTY**
Application of phosphine in controlled conditions and monitoring of pest survival rates	24	UNIDO and Subcontractor
Application of mixtures of phosphine and carbon dioxide in controlled conditions and monitoring of pest survival rates	24	UNIDO and Subcontractor
On-the-job training in these techniques	24	Subcontractor

OUTPUT 3: At least two agronomists and six growers fully trained in the technologies implemented during the course of the demonstration project.		
ACTIVITIES	**MONTH OF COMPLETION**	**RESPONSIBLE PARTY**
Two-week study tour	3	UNIDO
On-the-job training on IPM	24	11-01
On-the-job training in soilless cultivation	24	11-02
On-the-job training in solarization	24	11-03
On-the-job training in bio-fumigation	24	11-05
On-the-job training in steam sterilisation	24	11-04
On-the-job training in commodities fumigation	24	Subcontractor

OUTPUT 4: Dissemination of the results of the demonstration project among qualified representatives of the local farmers		
ACTIVITIES	**MONTH OF COMPLETION**	**RESPONSIBLE PARTY**
Preparation of a publication with the results of the project experiences	24	UNIDO
Editing and distribution of 200 copies of the report	24	UNIDO
Organization of a three-day workshop to make a presentation of the results to 20 qualified specialists from ten Article 5.	24	UNIDO/M.E.

4.2 Project Implementation

The project will be coordinated by the Ministry of the Environment and implemented by UNIDO in close cooperation with the Directorate of Plant Protection of the Ministry of Agriculture. Final specifications for the equipment and work plan can only be elaborated after an agreement of the project proposal has been reached with the Ministry of the Environment and the collaborative Institutions.

As implementing agency, UNIDO has the necessary experience and capabilities for the successful implementation of projects at the enterprise level. Upon approval by the Multilateral Fund for the Implementation of the Montreal Protocol (MFMP), the project budget will be transferred to UNIDO. The corresponding project allotment document will then be issued by UNIDO's Finance Section. Any substantive or financial deviation will be subject to approval by the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol.

4.3 Milestones

PROJECT MILESTONES

YEAR	ONE				TWO			
QUARTER	1	2	3	4	1	2	3	4
1. Equipment, purchase & installation	✖							
2. Preparation of the work plan	✖							
3. Execution of the small scale field tests		✖	✖	✖	✖			
4. Selection of the most promising alternatives					✖	✖		
5. Execution of the full scale demonstration field trials					✖	✖	✖	✖
6. Execution of the demonstrative fumigations			✖	✖	✖			
7. Study tour	✖	✖						
8. On-the-job training	✖	✖	✖	✖	✖	✖		
9. Technical and economical analysis					✖	✖	✖	
10. Preparation of publication						✖	✖	
11. Editing and distribution of publication							✖	✖
12. Workshop								✖

5. PROJECT COSTS (in US$)

Total project costs are as follows:

TOTAL INCREMENTAL COSTS	457,500
Contingency allowance (10%)	45,750
TOTAL PROJECT COSTS	503,250
Overhead Costs (13%)	65,423
FUNDING FROM THE MULTILATERAL FUND REQUESTED	**568,673**

6. PRE-REQUISITES

In accordance with the rules and regulations of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, project funds will cover only incremental capital costs related to the project. All other expenses, particularly those related to civil and construction works, provision of additional equipment, machinery, tools, services, instrumentation, etc., will have to be covered by the counterpart.

Therefore, prior to the start of the implementation of the project, a memorandum of understanding has to be prepared and approved by the project/government authorities concerned and UNIDO. The memorandum will specify all responsibilities of the counterpart and will be considered as an integral part of the project document

ANNEX A

PRELIMINARY EQUIPMENT SPECIFICATIONS

Preliminary equipment specifications and breakdown of costs are as follows:

BUDGET LINE	DESCRIPTION	TOTAL COST(in US$)
42-00	One compact steam boiler, with a capacity of 400 kg/h of steam at 10 Bar, complete with fittings and a 500 l/h water softening system	25,000
42-00	Two mobile platforms, one for the boiler and the other for the fuel tank and the water softening system	3,000
42-00	100 m of flexible pipe for steam, at 10 Bar, and 60 m of flexible diffusion pipes, plus fittings, connecting devices, filters, waterproof electrical connections, etc.	4,000
42-00	One 10,000-litre, steel-plated tank, to store fuel	1,000
41-00	Auxiliary equipment, consisting of tents, 85-cm bulb thermometers, polyethylene, latex paint, trays, substrates, small irrigation systems, chemicals, carbon dioxide, propane, seeds,	16,000
41-00	Four hundred analysis of soils, nematodes, fungi and other plant pathogens	12,000
	TOTAL	**61,000**

ANNEX B

PRELIMINARY TERMS OF REFERENCE FOR THE SUBCONTRACT

The subcontractor is expected to provide the following services or inputs:

1. A qualitative and quantitative analysis of the insect population in all of its stages of development infesting the the grain to be fumigated

2. The complete protocol for sampling according to the AOCC procedures or equivalent

3. Conduct three fumigations in a 10.000 mt silo located in Hamah (Syria) using two different technologies namely: phosphine in the form of gas and mixtures of phosphine and carbon dioxide. The fumigation will be conducted using the subcontractor's own equipment and safety devices.

4. Conduct three fumigations of a lot of approximately 320 mt of wheat packed in bags in a warehouse located in Homs (Syria) using two different technologies: phosphine in the form of gas and mixtures of phosphine and carbon dioxide. The fumigation will be conducted using the subcontractor's own equipment and safety devices. The subcontractor will provide the flexible tents or containers needed to perform safely the fumigation

5. A qualitative and quantitative analysis of the insect population in all of its stages of development infesting the the grain , immediately after fumigation, after seven days and after three months of such fumigation. This analysis should be compared with the evolution of the insects population in wheat fumigated with methyl bromide.

6. Prepare a technical and economical analysis of the three technologies tested.

7. All demonstration expenses including the transport of equipment, experts, etc will be at subcontractor's charge.

ANNEX C

PROJECT BUDGET

BUDGET LINE	DESCRIPTION	W/M	US$
11-01	Consultant in Integrated Pest Management	5	75,000
11-02	Consultant in soilless cultivation	1.5	22,500
11-03	Consultant in pest control by solarization of soil	1.5	22,500
11-04	Consultant in soil steam pasteurisation	1.5	22,500
11-05	Consultant in bio-fumigation	2	30,000
15-00	Internal travel		6,000
17-01	National Coordinator	24	36,000
17-02	Part time agronomist (Tartous)	24	24,000
17-03	Part time agronomist (Koswa)	24	24,000
17-04	Agroeconomist	4	8,000
21-00	Subcontract for fumigation as per Annex B		90,000
32-00	Study tour for three participants		18,000
35-01	Workshop		18,000
41-00	Expendable equipment per Annex A		28,000
42-00	Non expendable equipment as per Annex A		33,000
	Subtotal		457,500
51.00	Contingencies (10%)		45,750
	TOTAL PROJECT COSTS		**503,250**
	Overhead costs		65,423
	TOTAL PROJECT BUDGET		**568,673**

ANNEX D

JOB DESCRIPTIONS

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/11-01

Post title:	Consultant, specialist in Integrated Pest Management
Duration:	Five months in four split missions
Date required:	1998
Duty station:	Damascus, with travel to Tartous, Homs, Hamah and Koswa (Syrian Arab Republic)
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties:	The Consultant is expected to:

1. Prepare a detailed project work plan

2. Coordinate the whole demonstration programme in cooperation with the national and international experts and the National Institutions.

3. Prepare an IPM programme for implementation in combination with the five alternative methods chosen

4. Design, implement, monitor and coordinate the demonstration programmes for soilless cultivation, steam sterilisation, bio-fumigation and solarization technologies prepared by the other international consultants.

5. Design and monitor the implementation of the demonstration tests on small and full-scale commercial basis.

6. Design and execute a practical training programme on IPM directed to the National Counterparts.

7. Review the draft document with the technical and economic data resulting from the demonstration cases of the alternative technologies.

8. Prepare a succinct mission report.

Qualifications: University degree in agriculture or related field, with experience in Integrated Pest Management.

Language requirements: English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/11-02

Post title:	Consultant, specialist in soilless cultivation techniques with organic and inert media
Duration:	One and a half months in two split missions
Date required:	1998 onwards
Duty station:	Tartous and Koswa (Syrian Arab Republic)
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties:	In cooperation with the expert on IPM, the Consultant is expected to:

1. Examine the availability of organic and inert media in the area, as well as its cost effectiveness.

2. Design, implement and monitor a programme to demonstrate the use of soilless media in combination with IPM as an alternative to the use of methyl bromide.

3. Design and monitor the implementation of the demonstration tests on a small and full-scale commercial basis.

4. Design and execute a practical training programme on soilless cultivation methods and the re-utilization of the media directed to the National Counterparts.

6. Review the draft document with the technical and economic data resulting from the demonstration cases of the alternative technologies.

7. Prepare a succinct mission report.

Qualifications:	University degree in agriculture or related field, with large experience in soilless cultivation techniques.
Language requirements:	English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/11-03

Post title:	Consultant, specialist in pest control by solarization of soil
Duration:	One and a half months in two split missions
Date required:	1998
Duty station:	Tartous and Koswa (Syrian Arab Republic)
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties	In cooperation with the expert on IPM, the Consultant is expected to: 1. Design, implement and monitor a programme to demonstrate the solarization technique in combination with IPM as an alternative to the use of methyl bromide. 2. Design and monitor the implementation of the demonstration tests at small and full scale. 3. Design and execute a practical training programme on solarization methods to control soil pests directed to the National Counterparts. 4. Review the draft document with the technical and economic data resulting from the demonstration cases of the alternative technologies. 5. Prepare a succinct mission report.
Qualifications:	University degree in agriculture or related field, with large experience in pest control by solarization.
Language requirements:	English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/11-04

Post title:	Consultant, specialist in soil steam pasteurisation
Duration:	One and a half months in two split missions
Date required:	1998 onwards
Duty station:	Tartous and Koswa (Syrian Arab Republic)
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties:	In cooperation with the expert on IPM, the Consultant is expected to: 1. Design, implement and monitor a programme to demonstrate the use of steam injection in combination with IPM as an alternative to the use of methyl bromide. 2. Design and monitor the implementation of the demonstration tests on a small and full-scale commercial basis. 3. Design and execute a practical training programme on steam pasteurization directed to the National Counterparts. 6. Review the draft document with the technical and economic data resulting from the demonstration cases of the alternative technologies. 7. Prepare a succinct mission report.
Qualifications:	University degree in agriculture or related field, with large experience in soilless cultivation techniques.
Language requirements:	English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/11-05

Post title:	Consultant, specialist in bio-fumigation
Duration:	Two months
Date required:	1998
Duty station:	Tartous and Koswa (Syrian Arab Republic)
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties	In cooperation with the expert on IPM, the Consultant is expected to: 1. Design, implement and monitor a programme to demonstrate the use of bio-fumigation techniques in combination with IPM as an alternative to the use of methyl bromide. 2. Design and monitor the implementation of the demonstration tests on a small and full-scale commercial basis. 3. Design and execute a practical training programme on bio-fumigation directed to the National Counterparts. 4. Review the draft document with the technical and economic data resulting from the demonstration cases of the alternative technologies. 5. Prepare a succinct mission report.
Qualifications:	University degree in agriculture or related field, with large experience in bio-fumigation techniques
Language requirements:	English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/17-01

Post title:	National Project Coordinator
Duration:	Two years (part time)
Date required:	1998
Duty station:	Damascus, with travel inside the country
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries.
Duties:	The National Expert is expected to:

1. Interact between UNIDO, Government Institutions (Ministry of Environment and Ministry of Agriculture), local Institutions (local branches of the Directorate of Plant Protection) and the private sector farmers.

2. Execute and coordinate the entire demonstration programme in cooperation with the two local agronomists and the international experts.

3. Coordinate and arrange the administrative aspects concerning equipment, project personnel, etc. in order to have the project implemented within the established time.

4. Participate in the training programmes.

5. Supervise the field activities and coordinate the services of project personnel.

6. Prepare a comprehensive document with the technical and economic data resulting from all the demonstration cases of the alternative technologies.

7. Organize and conduct a national workshop where a presentation of the results will be made.

Qualifications:	University degree, with large experience in project management.
Language requirements:	Arabic and English

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/17-02 and 17-03

Post title:	National Expert, Agronomist
Duration:	Two years (part time)
Date required:	1998
Duty station:	17-02: Tartous 17-03: Koswa
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries
Duties:	The National Expert is expected to: 1. Implement the demonstration programmes in his/her area assigned, making the necessary practical arrangements for a smooth execution. 2. Control the execution of the demonstration programme according to the protocol established for each test and be responsible for sample collection and analysis. 3. Record, keep and evaluate all data related to the demonstration tests. 4. Cooperate in the preparation of a comprehensive document with the technical and economic data resulting from the demonstration cases of the alternative technologies. 5. Cooperate in the organization of a national workshop where a presentation of the results will be made.
Qualifications:	Agro-technologist, with large experience in horticulture.
Language requirements:	Arabic and English

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

US/SYRIA/98/XXX/17-05

Post title:	National Expert, Agro-economist
Duration:	Four months
Date required:	1999
Duty station:	Damascus, with travel inside the country
Purpose of project:	To demonstrate the technical and economical feasibility of five alternative methods to the use of methyl bromide as a fumigant in horticulture, i.e., solarization, non-soil cultivation techniques, steam sterilisation, bio-fumigation and application of various mixtures of other chemicals in low doses, all in combination with an IPM programme, and to disseminate the results among qualified specialists from Article 5 countries
Duties:	The National Expert is expected to: 1. Prepare a study of the real cost of each of the alternative methods chosen, as compared to the real cost of using methyl bromide, based on the demonstration programme being executed 2. Cooperate in the preparation of a comprehensive document with the technical and economic data resulting from the demonstration cases of the alternative technologies. 3. Participate in the national workshop.
Qualifications:	University degree in agricultural economics. Experience in horticulture is desirable.
Language requirements:	Arabic and English