OCCASION

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

DISCLAIMER

FAIR USE POLICY

CONTACT

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

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

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

PROJECT MP/ARG/00/033 FINAL REPORT

18/08/2015

PROJECT MP/ARG/00/033 – FINAL REPORT

Table of Contents

Index of Tables

1. Executive Summary

Montreal Protocol, devoted to Ozone Depleting Substances (ODS"S) establishes restrictions regarding production, consumption and trading of ODS's. Argentina, through bill 23778, has adhered to the Montreal Protocol, implementing actions tending to protect the environment and reconvert ODS's industries, in order to the ODS's phase out in 2015.

Regarding methyl bromide, one of the Ozone Depleting Substances, during the 1997-2000 period, INTA has run a Demonstration Project (MP/ARG/97/186) of alternatives to such product for the strawberry, protected vegetable and cut flower production. Based on its results, the Argentine Government asked for a phase out project. This is the origin of Project MP/ARG/00/033, where primarily methyl bromide phase out was set for 2005. Later, when tobacco methyl bromide phase out project was approved, date was set for 2007.

In the year 2010 a revision of proposed goals of Project MP/ARG/00/033 was held, in order to review phase out, according to the agreement signed with the Montreal Protocol. For it has been a meeting between representatives of United Nations and the Ministry of Agriculture and Food, and also the National Project Coordination. As a result of that meeting it was decided to maintain project activities using the remaining budget up to 2015. As a consequence, a revision on working areas and topics was carried out and keeping and maintaining project activities and achievements with the objective of accompanying farmers to the permanent replacement of Methyl bromide.

During the course of the project, there have been some difficulties in implementing the alternatives originally proposed. There were found problems with the efficiency of Metam sodium and the implementation of the practice of steaming.

This situation demanded the validation of other alternatives. The project proceeded to evaluate chemical synthesis products along with private companies. Involved companies help to fund research trials with own economic resources.

Due to these actions, the following chemical alternatives are available today, Metam potassium, Metam ammonium, DMDS, Dichloropropene-chloropicrin. Dichloropropene-chloropicrin has been the most successfully adopted product in the greenhouse vegetable crops and strawberry industry.

It has been recently evaluated another chemical product, Methyl iodide, which has proven to be as effective as Methyl bromide. Unfortunately the manufacturer of Methyl iodide decided not to register the product in the country.

As a result of field work and research carried out by regional technical teams, project information is available about the best alternative for each geographic area. It has been considered the type of production, the efficiency of disinfection, local availability and costs of each alternative. The following are the predominate alternative adopted by region:

Solarization-Biofumigation: Salta, Jujuy, Corrientes, Mendoza, Tucumán
Synthetic chemical fumigants: Mar del Plata, Buenos Aires, Mendoza, Tucumán, Santa Fe
Steam (for disinfecting substrates): Córdoba and Buenos Aires, with a nowadays greater adoption of Solar Collectors, a new technique.

For the development of the Project, the organization consisted in a federal coordination, and nine regional teams, settled in different regions at INTA buildings, where INTA personnel and project extensionists were and are located, working directly with farming sectors, as follows,

Mar del Plata (OIT Mar del Plata)
Gran Buenos Aires (AER Gran Buenos Aires)
Santa Fe (AER Santa Fe)
Corrientes (EEA Bella Vista)
Tucumán (EEA Famaillá)
Salta-Jujuy (EEA Yuto)
Córdoba (AER Cruz del Eje)
Cuyo (EEA La Consulta)
Chaco-Formosa (EEA El Colorado)

Extension activities, such as visiting growers, lectures, demonstration and general meetings, printed material, mass media communications, etc., were used in order to accompany Methyl bromide using farmers to help them in

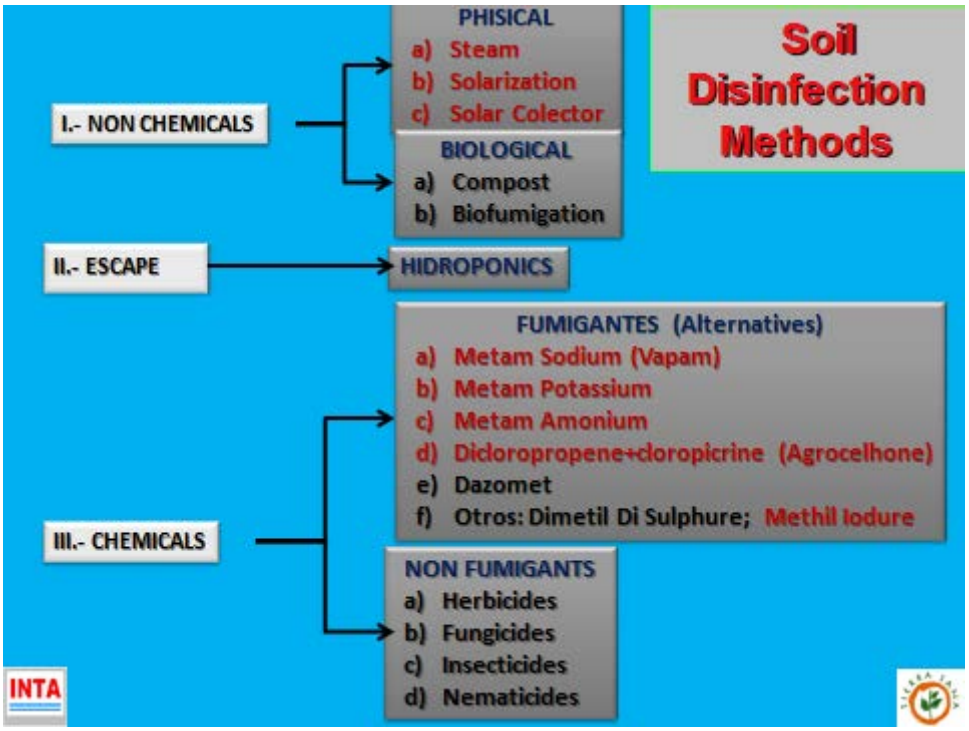
the transition and reconversion process, adapted to every particular case and land.

It can be concluded that extension, motivation, demonstration and training goals were accomplished satisfactorily.

In most of the cases, strong difficulties have been encountered in order to adopt the originally available alternatives (Metam sodium and steam). The availability of new alternatives to Methyl bromide through this Project contributed enormously to reducing the consumption.

Results of the work carried out by the Project MP/ARG/00/033 were suitable for helping farmers to phase out methyl bromide, and helped Argentina to improve ways of producing horticultural goods. It is clear that the main accomplishment of the Project is that in most of the country methyl bromide was phased out.

Table 1. Disinfection methods worked by the Project



2. Background

In the year 1999, the Executive Committee members and the implementing agencies stressed the urgent need for assistance to be provided to Article 5

countries to enable them to meet the 2002 freeze on methyl bromide. In this regard revised guidelines for methyl bromide were approved given emphasis to the need to establish investment projects.

At that time, the Executive Committee had some doubts and problems in the usefulness of methyl bromide alternative demonstration projects considering their long duration and the little impact on the ability of Parties to meet the 2002 freeze on methyl bromide consumption. They have also stressed the need to move quickly to preparation of investment projects (Decision 27/32)

By the year 1999 and 2000, the technical and, in many cases economical validation of alternatives were generally adequate and feasible for all the crops considered. In most cases, these alternatives were being introduced following demonstration projects, supplemented sometimes by additional work done in the countries by Universities, National Research Institutes or even private companies. Following the Methyl bromide guidelines, more emphasis has being given to non-chemical alternatives than chemicals alternatives. Chemical alternatives were usually conventional and based on traditional compounds, no new compounds or ingredient active have been considered during those years.

In this context of alternatives available, technical and economical feasible, approaching the 2002 freeze and considering that by 2005 all the Article 2 countries were going to reach the total phase out, some Article 5 countries embarked not only in reach the Montreal Protocol targets but to an early phase out.

In this connection, the 30th Meeting of the Executive Committee approved the project for the phase-out of methyl bromide in strawberry, protected vegetable and cut flower production in Argentina. It was the first investment project approved for a total phase out of Methyl bromide in the horticulture sector. This project was followed by additional project for the total phase out on the tobacco approved at the 34th Executive Committee. Both projects would lead to the total elimination of methyl bromide used in Argentina for soil fumigation.

In July 2001 at the 34th Meeting of the Executive Committee approved a project for Uruguay to phase out of the use of methyl bromide as soil fumigant in Uruguay by 2005.

At the same meeting, 34th Executive Committee, approved the project to eliminate the methyl bromide used in a) in vegetable, cut flower and tobacco

production and b) Phase-out of methyl bromide for soil fumigation in strawberry production in Lebanon.

In the following meeting, at its 35th Executive Committee Meeting, it was approved a project for Costa Rica to adopt alternatives in melon, cut flowers, banana, tobacco seedbeds and nurseries, leading to total methyl bromide phase-out in the country by 2005.

The above mentioned four countries embarked in a total pashed out in the year 2001 given an international favorable environment for the elimination of the methyl bromide. The European Union had proposed for the countries members to advance in the chronogram agreed under the Montreal Protocol. Similar discussions were held in other Article 2 countries.

However, in 2003, such favorable international environment had changed. Critical uses granted to Article 2 countries were introduced in the agenda of the Meeting of the Parties, and it was used by MB importers and distributors to promote the continuation of consumption of MB in our country, discouraging some farmers from changing and making it more difficult the process of sensitization and promotion of the use of alternatives to MB.

In addition to the international atmosphere, there exist a natural and evident reluctance of MB users to change to alternatives in all sectors. The fact that MeBr cannot be replaced by one sole and equally effective alternative implies that the farmers and other stakeholders have to change their approach to production and process management.

The conjunction of these problems has been the main constraint to adoption of alternatives in our country. Also, the four countries, under the above mentioned circumstances, were forced to renegotiate the chronogram.

The Parties requested the Executive Committee to adopt a flexible approach and to adopt criteria for the prolongation of accelerated phase-out agreements when so requested by interested Parties. The Executive Committee decided to accept a renegotiated phase out schedule following an adopted criterion. (UNEP/OzL.Pro/ExCom/43/61, Decision 43/14, para. 75). Consequently the four countries in different moments renegotiated the schedule.

At its 45th Meeting, the Executive Committee approved a revised schedule for Argentina to achieve the phase-out of 192 ODP tonnes of MB representing the remaining consumption used in strawberries, flowers and protected

vegetables, on the understanding that no additional funding will be requested from the Multilateral Fund. (Annex 1 is a copy of the revised Agreement).

In addition by Decision 46/16 the 46th Ex Com. approved the revised implementation schedule for the agreement between the Government of Uruguay and the Executive Committee. (Annex 2 is a copy of the revised Agreement).

Similarly, the Forty-eighth Meeting of the Executive Committee decided to approve the request by the Government of Costa Rica to revise the methyl bromide phase-out schedule in the agreement between the Government of Costa Rica and the Executive Committee attached as Annex 3.

Finally, the 52nd Executive Committee Meeting approved for Lebanon a change on the agreed conditions (Annex 4 is the Decision 52/17 item g)

3. The situation in Argentina

Montreal Protocol, devoted to Ozone Depleting Substances (ODS"S) establishes restrictions regarding production, consumption and trading of ODS's. Argentina, through bill 23778, has adhered to the Montreal Protocol, implementing actions tending to protect the environment and reconvert ODS's industries, in order to the ODS's phase out in 2015.

Regarding methyl bromide, one of the Ozone Depleting Substances, during the 1997-2000 period, INTA has run a Demonstration Project (MP/ARG/97/186) of alternatives to such product for the strawberry, protected vegetable and cut flower production. Based on its results, the Argentine Government asked for a phase out project. This is the origin of Project MP/ARG/00/033, where primarily methyl bromide phase out was set for 2005. Later, when tobacco methyl bromide phase out project was approved, date was set for 2007.

In the year 2010 a revision of proposed goals of Project MP/ARG/00/033 was held, in order to review phase out, according to the agreement signed with the Montreal Protocol. For it has been a meeting between representatives of United Nations and the Ministry of Agriculture and Food, and also the National Project Coordination. As a result of that meeting it was decided to maintain project activities using the remaining budget up to 2015. As a consequence, a revision on working areas and topics was carried out and keeping and maintaining project activities and achievements with the objective of accompanying farmers to the permanent replacement of Methyl bromide.

During the course of the project, there have been some difficulties in implementing the alternatives originally proposed. There were found problems with the efficiency of Metam sodium and the implementation of the practice of steaming.

This situation demanded the validation of other alternatives. The project proceeded to evaluate chemical synthesis products along with private companies. Involved companies help to fund research trials with own economic resources.

Due to these actions, the following chemical alternatives are available today, Metam potassium, Metam ammonium, DMDS, Dichloropropene-chloropicrin. Dichloropropene-chloropicrin has been the most successfully adopted product in the greenhouse vegetable crops and strawberry industry.

It has been recently evaluated another chemical product, Methyl iodide, which has proven to be as effective as Methyl bromide. Unfortunately the manufacturer of Methyl iodide decided not to register the product in the country.

As a result of field work and research carried out by regional technical teams, project information is available about the best alternative for each geographic area. It has been considered the type of production, the efficiency of disinfection, local availability and costs of each alternative. The following are the predominate alternative adopted by region:

Solarization-Biofumigation: Salta, Jujuy, Corrientes, Mendoza, Tucumán
Synthetic chemical fumigants: Mar del Plata, Buenos Aires, Mendoza, Tucumán, Santa Fe
Steam (for disinfecting substrates): Córdoba and Buenos Aires

For the development of the Project, the organization consisted in a federal coordination, and nine regional teams, settled in different regions at INTA buildings, where INTA personnel and project extensionists were and are located, working directly with farming sectors, as follows,

Mar del Plata (OIT Mar del Plata)
Gran Buenos Aires (AER Gran Buenos Aires)
Santa Fe (AER Santa Fe)
Corrientes (EEA Bella Vista)

Tucumán (EEA Famaillá)
Salta-Jujuy (EEA Yuto)
Córdoba (AER Cruz del Eje)
Cuyo (EEA La Consulta)
Chaco-Formosa (EEA El Colorado)

Extension activities, such as visiting growers, lectures, demonstration and general meetings, printed material, mass media communications, etc., were used in order to accompany Methyl bromide using farmers to help them in the transition and reconversion process, adapted to every particular case and land.

In the last few years of the Project, priority working areas were determined, concentrating in the strawberry fruit production and greenhouse crop areas, stressing the work of the Regional Teams of Gran Buenos Aires, Tucumán and Santa Fé, as well as Mar del Plata and Corrientes. In the rest of the regions, efforts aim to keep and improve substitution results.

Argentina political decision was to reduce methyl bromide use, releasing some measures to diminish amount used, such as allowing only 70:30 mixes to be permitted to disinfecting soils.

It should be mentioned that from 2004 to 2007 years consumption of Methyl bromide was not depressed compared to previous years mainly due to increased acreage of both strawberry and vegetable greenhouses and resistance from some farmers to leave the habit of Methyl bromide use. Also in this period there were not yet available other commercial chemical alternatives to Methyl bromide and of similar efficiency. Fortunately, this situation was able to be reversed by the actions undertaken by the project coordination with government representatives and the work of the professionals involved in the conflict areas.

Today growers and project technical staff maintain a permanent dialogue that allows the decision-making and action together.

Overall results regarding the alternatives evaluated,

Metam sodium: does just a good initial control of fungal diseases and nematodes in soil. Therefore, must be supplemented during growth with specific fungicides and nematicides. It is suitable for soils with pathogen low pressure. It is not efficient for many weed species (Example: *Cyperus rotundus*).

Steam: The steam disinfection through "Mobile Units disinfection of soil and substrates" (UMDSS) provided by the project were not adopted in any zone. This is due to operational difficulties for the transfer and application of steam, high cost of diesel oil, low efficiency of disinfection and high time required for the disinfection process. Given this situation, the technical teams in cooperation with growers have made changes to the UMDSS.

The main modification was turning the units just for disinfecting substrates, modifying basically the system to use natural gas as fuel, and a fixed system for steam injection. For the disinfection of soil, some effectiveness was reached when combined the mobile UMDSS with Móvil-Vap (Mobile Steaming). The UMDSS boiler generates steam that is injected into the soil through the Movil-Vap. The Movil-Vap was developed by an Argentine farmer, is a mobile rake with metal spikes through which steam is conducted and penetrates the soil.

Chemicals and non-chemicals with higher degree of adoption and/or effectiveness,

Dichloropropene-chloropicrin (Agrocelhone) achieved as effectively as Methyl bromide in controlling fungal diseases and nematodes, both in the initial control and around the strawberry crop cycle and greenhouse crops (tomato, pepper, etc.)
The adoption was not of great magnitude in the first season 2009/2010 because it was not available commercially at the time of disinfection. Along with its availability the cost per square meter is similar to Methyl bromide and requires more time between application and transplanting of the crop, which implies, in most situations, a 20 day waiting time, compared to 8 days of Methyl bromide.

Methyl iodide was recently evaluated. Results were very satisfactory because it showed high effectiveness in achieving control of pathogens, as well as weeds.

Solarization and Biofumigation: they have been massively adopted by growers of vegetables in greenhouses in the northern part of the country, due to favorable environmental conditions of high temperature and radiation, and high effectiveness.

Solar collector, a very simple and efficient device for disinfection of substrates, very useful for nurseries, especially for small growers.
It was developed in Brazil by Rachel Ghini and Walter Bettiol, of Embrapa, and it was introduced by the Project in Argentina. It controls soil pathogens, as well

as weeds. It uses sun energy to heat tubes where substrate is inside, and reaches, within a daylight period, pasteurization temperatures.
It consists in a wooden box, 1 m x 1,5 m x 0,3 m, with a metal insulated inside, and 6 black painted metal tubes or pipes, covered with a transparent plastic film.
Main operatory considerations are the humidity of the soil or substrate (it must not be wet), and the angle or slope (local latitude + 10°).
When well used, efficiency in controlling pests, diseases and weeds is close to 100%.

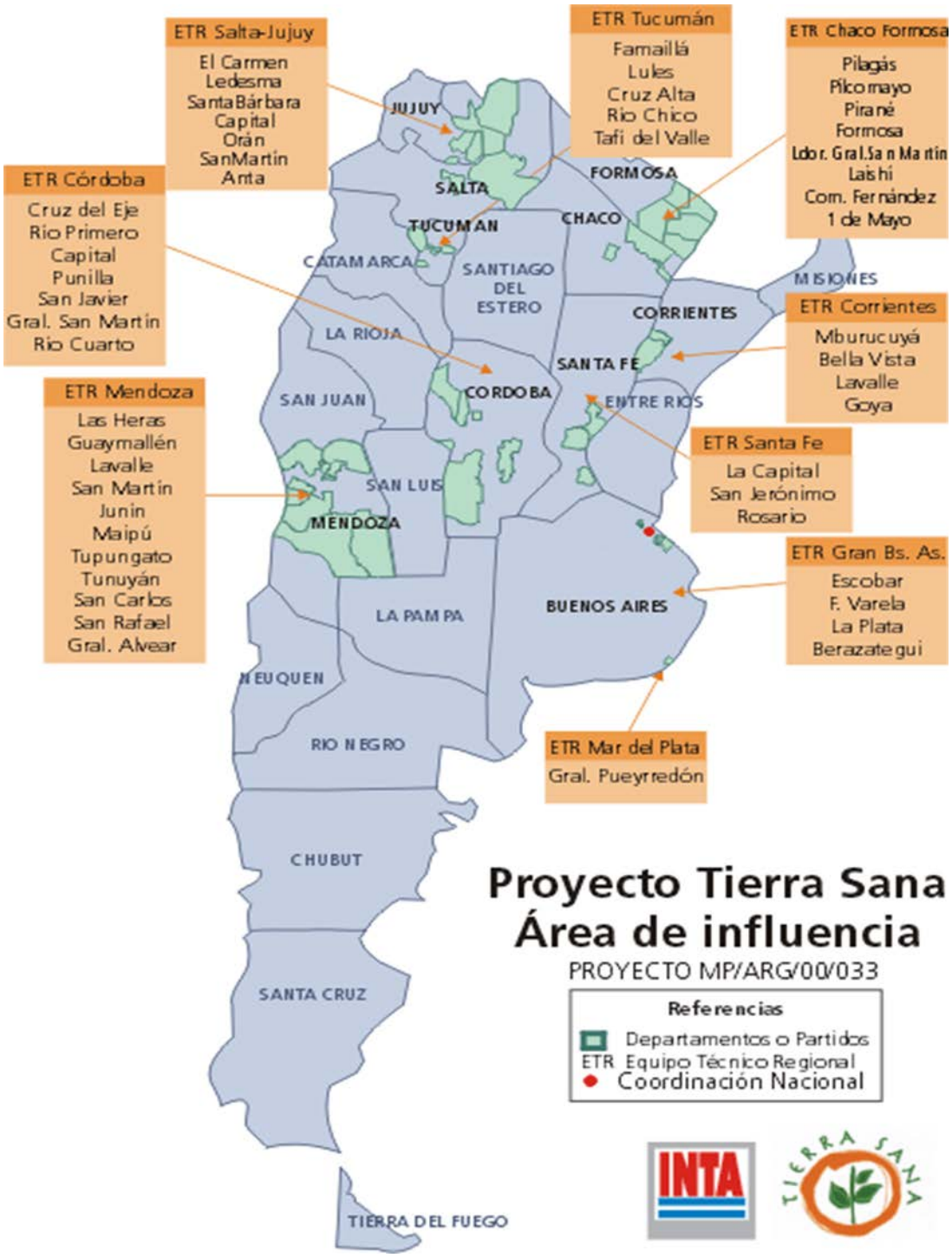
In general, it can be stated that

Extension, motivation, demonstration and training goals were accomplished satisfactorily.

In most of the cases, strong difficulties have been encountered in order to adopt the originally available alternatives (Metam sodium and steam). The availability of new alternatives to Methyl bromide contributed to reducing the consumption.

4. A brief description of the different Project working areas

Table 2. Map of Argentine provinces showing areas where the Project made activities



4.1. Córdoba

In this region, vegetable, cut flower, ornamental and nursery production are the main cultures involved. Along the project, growers shifted to the alternatives, with good results.

There some problems, at the very early stages of the Project. It must be stated that the return to the use of methyl bromide was due to the very erratic results obtained with metam sodium

4.2. Mar del Plata

In the Mar del Plata area growers fairly quickly shifted to the use of the 70/30 mixture, which has shown much better results for the strawberry and greenhouse crops than the traditional 98/2. For the total methyl bromide used for the greenhouse crops, 70% was devoted to tomato crops, and the even to pepper crops.

Some good results were obtained with the use of boilers in the early years, where around 2.000 m2 were treated with steam, 90% was for substrate treatment.

And, on the other hand, metam sodium treatment area diminished in a 30% regarding previous years, due to the instable results obtained. Although there is interest at the farmer level in substitution of methyl bromide, the erratic results of metam sodium did not allow its adoption as a replacement of methyl bromide.

4.3. Mendoza

The main methyl bromide user in the area is the strawberry sector, for both nursery and fruit production. It was replaced by alternatives.

Steam treatment is very limited due to fuel and labor costs, being more expensive than methyl bromide. It is mainly used for substrate disinfection.

Solarization is not very useful due to timing, because the season where it can be performed matches with the main cropping time.

Soiless production, using farmer organic substrate, yields good results. Unfortunately its use is very limited due to lack of standardization and economic price of substrates. The same situation occurs with biofumigation.

Regarding alternatives, metam sodium was resisted due to its lack of consistency.

4.4. Santa Fe

Strawberry fruit cultures, which are Coronda main production, shifted to alternatives. This production was a high demander of methyl bromide, representing almost 99% of provincial consumption. Due to the bad results obtained with metam sodium, and the null efficiency of field steam disinfection,

only metam ammonium and 1,3 D+Pic are used, and, at a lower stage, metam potassium.

Good results with alternatives have been reached in the Rosario and Green Belt of Santa Fe. Substitution was based mainly in chemical alternatives.

Steam disinfection was mainly devoted to substrates, using a grate system. The plaque system is considered as unusable for being very difficult to work, and very costly (for the time, labor and fuel costs).

4.5. Salta-Jujuy

Due to Project work, fairly quickly there has been a methyl bromide consumption phase out. It is due to the good results obtained through solarization, and for some cases metam sodium and a mix of agrochemicals, according to specific situation.

Solarization is, by far, the most adapted technique. It is highly effective in the region, controlling most of the pests and weeds, and very adaptable to production timing, because it is used when no crop is set.

Agrochemicals used as complements are fungicides (captan, carbendazim, propamocarb, alumminiun phosetil, metalaxyl) and nematicides (etoprop, carbofuran, aldicarb, fenamifos, Mon), obtaining very good results.

4.6. Tucumán

This area is, according to market conditions, the first or second strawberry fruit production area of the country (the other one is Coronda). Metam sodium adoption was very bad, due to the very erratic results obtained.

For greenhouse crops, metam sodium has also shown low efficiency for nematode control, being this property the main barrier to its use. The main alternative is 1,3 D + Pic.

4.7. Gran Buenos Aires

In the Greater Buenos Aires area, soil disinfection is mainly devoted to greenhouse tomato and pepper crops, and at a lower rate to eggplants, lettuce, spinach, ornamentals, cut flowers and substrates.

The main practice here, due to the types of farms (small size) and growers, is disinfecting soils just according to needs.

The alternatives are all available here, namely metam sodium (new formulation), metam potassium, metam ammonium, 1,3 dichloropropene-

clhoropicrin, and solarization. The best results were obtained with 1,3 dichloropropene-chloropicrin.

Regarding physical methods, solarization is good but not appropiate due to seasonal timing and steam is good for substrate disinfection. Steam soil disinfection has almost no acceptance due to its high cost, and awkwardness for using it.

The main difficult to methyl bromide phase out is the easyness of its use, highly adapted to management practices, and the dual crop type of production. There were a couple of cases where 1,3 dichloropropene-chloropicrin has shown bad results.

4.8. Corrientes

Very bad results were obtained with metam sodium, especially for greenhouse crops. In the strawberry crops metam sodium was not accepted by the growers due to the erratic results.

For greenhouse pepper and tomato crops, there was a dramatic acreage increase due to a better economical situation of the country. Project activities yielded in the increased use of solarization, and a combination of metam sodium and solarization under certain specific conditions, allowing good disinfection results.

Regarding steam disinfection, usage is almost null, based on the fuel cost of the operation, and the lack of practicity for box (plaque) use, where labor and conditions make this method very thorny.

5. Activities carried out by Regional Teams. Brief description

5.1. ETR Córdoba

Referent: Ing. Agr. Eduardo Orecchia

Project personnel: Ing. Agr. Evangelina Matoff

Visits to groups of growers devoted to nursery production, as well as cut flower and vegetable producers, located at Cordoba Green Belt and other parts of the province (Cosquín, Cruz del Eje, Toledo, Monte Cristo, etc).

Meetings and Field Days for cut flower and vegetable greenhouse growers in the Green Belt area, as well as with horticulturalists, university students and

faculty, agrochemical representatives, grower´s associations, nursery holders, as well as Asociación de Productores Hortícolas del Cinturón Verde de Córdoba.

Lecturing in Seminars, such as “Substrates, new materials for plantlet production” and participation in fairs, such as “Second Farm and Nursery Expo of the Center of Argentina”.

Dissemination of printed material, such as leaflets, showing the alternatives to methyl bromide, as well as articles on the same topic were written for the Horticultural Bulletin every three months.

Lectures were given to the Regional Council of INTA to involve the maximum authorities of the Institution regarding methyl bromide phase out.

Demonstration lots for new alternatives, including the new ones, and some biological controllers, the influence of speedling size in disease predisposition, herbicide management, and steam disinfection.

Development, jointly with the National Coordination, of the Solar Collector for substrate disinfection. It is a widely used technology nowadays.

5.2. ETR Mar del Plata

Referent: Ing. Agr. Alfredo Szczesny

Project personnel: Ing. Agr. Enrique G. A. Adlercreutz

Demonstration lots. Several demonstration lots were set in every single campaign. They were used for showing nematode and fungus control, for both greenhouse and strawberry crops.

Training activities and meetings. Included field days on demonstration lots for growers and horticulturalists, and training courses for horticulturalists, such as: Mechanized irrigation, Use of Liquid Petroleum Gas for steam machines (joint with YPF Petroleum, Vegetable Grower´s Coop and INTA), meetings with horticulturalists of private companies in order to improve and coordinate use of alternatives for substrate and soil disinfections.

Other extension activities. It included Methyl bromide alternatives demonstration lots tours for horticulturalists and growers, press articles on Ozone Hole, activities of Project MP/ARG/00/033, and use of alternatives, lectures for farmers showing alternatives and the work done by the Project, meetings for consulting horticulturalists showing results and use of alternatives to methyl bromide, with emphasis in fungus and nematode control for greenhouse and strawberry crops, lectures and meetings held for Cambio Rural growers on costs and implementation of alternatives, as well as lectures and

meetings on metam sodium application and possibilities of its use, visits to cut flower, greenhouse and strawberry growers to promote use of alternatives. Promotions of the use of metam sodium at a lower price in order to incentive its use at the beginning of the project, (Price reduction negotiated by the National Coordination in order to promote its use), as well as lectures on the Project and the alternatives for College and University students, and production of leaflets approaching specific area problems.

5.3. ETR Mendoza

Referent: Ing. Agr. M. Sc. Gabriel, Ernesto L.

Project personnel: Ing. Agr. Soto, Pablo, Ing. Agr. Ciani, Cecilia

Visits realized to cut flower, nursery and greenhouse growers to promote alternatives to methyl bromide, and setting demonstration lots with alternatives, evaluation of demonstration lots where metam sodium, metam potassium and metam ammonium set in Mendoza (San Carlos) y Chubut (Travelín).

Strawberry nursery demonstration lot set in Neuquén (Plottier), using methyl bromide (70/30), metam sodium, metam ammonium, metam potassium, 1,3-dichloropropene+chloropicrin and dimethyl-disulphate.

5.4. ETR Santa Fe

Referent: Ing. Agr. Eduardo Scaglia

Project personnel: Ing. Agr. María del Huerto Sordo, Ing. Agr. Rodolfo Grasso, Ing Agr Ariel Belavi

Demonstration lots. Many demonstration lots were set every single year, where metam ammonium, metam potassium, metam sodium (new formulation), 1,3-dichloropropene+chloropicrin, steam and solarization were shown and evaluated. They were used to show the alternatives to other growers.

Other extension activities, such as visits paid to farmers in order to show the different alternatives evaluated, visits and tours to demonstration lots realized with Government officers of the Province and Nation, meetings and tours offered to companies providers of methyl bromide alternatives, lectures given to school, college and university students on Project activities and methyl bromide alternatives, meetings with growers of abroad, field days on alternatives, Movil-vap steam injection, and how to use 1,3-dichloropropene+chloropicrin, ,meetings for growers and horticulturalists on

use and results of alternatives to methyl bromide, participation in fairs, such as Expogaray, update of costs of alternatives for different situations.

5.5. ETR Salta-Jujuy

Referent: Ing. Agr. Víctor Mollinedo

Demonstration lots. Several demonstration plots were set every year, in order to show and evaluate efficiency of alternatives. Most of them were devoted to solarization, both for greenhouse production and field production, with excellent results. Good results were also obtained when substrates were disinfected.

Other extension activities. Many visits paid to farmers in order to show the different alternatives evaluated, visits and tour to demonstration lots realized with horticulturalists and farmers of different areas, lectures given to school, college and university students on Project activities and methyl bromide alternatives, meetings with growers of abroad, field days on alternatives such as solarization, and how to use alternatives, meetings for growers and horticulturalists on use and results of alternatives to methyl bromide, participation in fairs, such as INTA Expone and Frutar, development of the Manual of Solarization, and a video on the topic, production of leaflets approaching specific area problems, participation in radio programs, production of publications on solarization and soil disinfection topics.

5.6. ETR Tucumán

Referent: Ing. Agr. Ana María Borquez

Project personnel: Ing. Agr. Juan José Agüero

Demonstration lots. For fruit strawberry production, several demonstration plots were set every year, in conjunction with the Provincial Experimental Station of Obispo Colombres, showing 1,3-dichloropropene+chloropicrin, (drip and injection), metam sodium, metam ammonium, and solarization. For vegetable greenhouse production, demonstration plots on metam sodium, metam ammonium, metam potassium, 1,3 dichloropropane+chloropicrin and solarizarion were also set every year.

Other extension activities. Included visits paid to farmers in order to show the different alternatives evaluated, visits and tours to demonstration lots realized with horticulturalists and farmers of different areas, lectures given to school, college and university students on Project activities and methyl bromide alternatives, meetings for growers and horticulturalists on use and results of alternatives to methyl bromide, participation in fairs, such as INTA Expone, field

days on demonstration lots, participation in radio and TV programs, field days on strawberry production.

5.7. ETR Gran Buenos Aires

Referent: Ing. Agr. Oscar Régulo Martinez Quintana

Greenhouse production:

Project personnel: Ing. Agr. Pablo Delmazzo, Ing. Agr. Juan José Giaccio, Ing Agr Paula Amoia

Cut flowers:

Referent: Ing. Agr. Roberto Fernandez

Project personnel: Ing. Agr. Pablo Frangi, Marisol Cuellas,

Demonstration lots. Many demonstration lots were set, showing metam potassium, metam sodium, metam ammonium, DMDS and 1,3-dichloropropene+chloropicrine. Trials were set in order to evaluate other alternatives to control nematodes, fungi and weeds.

Other extension activities included visits paid to farmers in order to show the different alternatives evaluated, visits and tours to demonstration lots realized with horticulturalists, provincial and nation governmental officers, and farmers of different areas, lectures given to school, college and university students on Project activities and methyl bromide alternatives, meetings with growers of abroad, field days on alternatives, meetings for growers and horticulturalists on use and results of alternatives to methyl bromide, participation in fairs, such as INTA Expone and Frutar, development of a Boiler management handbook, production of leaflets approaching specific area problems, participation in radio programs, production of publications on disinfection topics. training of boiler managers in order to provide them with up to date information on boiler use.

5.8. ETR Corrientes

Referent: Ing. Agr. Antonio Ishikawa

Project personnel: Ing. Agr. José E. Pacce – Ing. Agr. Walter Navarro

Demonstration lots. Several demonstration lots were set per year, in the Lavalle and Bella Vista area, for tomato and strawberry crops, where alternatives to methyl bromide were shown, and also steam was also shown.

Other extension activities included visits paid to farmers in order to show the different alternatives evaluated, visits and tours to demonstration lots realized

with horticulturalists, provincial and nation governmental officials, and farmers of different areas, lectures given to school, college and university students on Project activities and methyl bromide alternatives, participation in fairs, such as INTA Expone and Frutar, production of leaflets approaching specific area problems, production of publications on disinfection topics.

6. Summary of Argentina's research on the effectiveness of alternatives for greenhouse, cut flower and strawberry productions

The main pests are nematodes (*Meloydogine, Nacobbus*), *Fusarium, Phytophthora, Cynodon spp.. Cyperus rotundus* and *Cynodon dactylon* are the most significant weeds. The most prevalent soil diseases are *Rhizoctonia sp, Sclerotinia sp* and *Phytophthora sp.*

Two projects investigating alternatives to methyl bromide were carried out by Argentina, with UNIDO as implementation agency, and INTA (Federal Institute for Agricultural Technology) as local agency. During 1997-2000 INTA ran a Demonstration Project (MP/ARG/97/186) of metam sodium and steam as alternatives for the strawberry, protected vegetable and cut flower production. Based on its results, Argentina asked for a phase out project funding. This is the origin of Project MP/ARG/00/033, where methyl bromide phase-out was to be accomplished by the use of metam sodium and steam.

However, inconsistent results at field level were observed with these alternatives, so the Project researched several other alternatives. INTA's research has enabled many growers in Argentina to utilize alternatives.

Metam sodium did not work properly to control neither the nematode population nor the diseases in tomato and pepper greenhouses, and in strawberry production.

Steam disinfection was not effective and too costly leading to almost null adoption in the horticultural sector. The problems were increased fuel costs, very slow treatment times, and the technical and operational difficulties related to applying steam to the soil with the mobile steam units delivered by the Project which were incompatible with greenhouse structures characterized by many internal poles.

Due to this situation, the need to test and identify other alternatives was necessary. Intensive farm-level research was conducted to obtain and evaluate chemicals and non-chemicals alternatives to obtain information and evaluate the effectiveness of these potential alternatives by the end-users.

Grower´s associations have been actively involved with INTA and other institutions on MB alternatives projects since 2000. The Project, in conjunction with growers actively worked with Midas field trials in Argentina. Being a new molecule it takes not less than three years to obtain the approval to register the product. Then, trials were initiated, INTA personnel and growers worked with the manufacturer and regulatory agencies to facilitate registration of the compound in Argentina. After three seasons of extensive testing the manufacturer indicated that registration in Argentina would not be pursued and MI is not registered in Argentina. So, considerable effort was expended on this avenue which was then closed due to commercial reasons.

Steam and solarization were and are being tested in cooperation with growers and solarization has been implemented where possible in northern districts. Grafting for tomato has been utilized for disease resistance but has not been effective in areas of high nematode infestation. In warmer, dryer growing regions various combinations of solarization, 1,3-D/chloropicrin and metam sodium are being used.

Also, some trials on 1,3-D +Pic are being conducted to determine if there is a way to increase efficacy and reduce replanting interval. Grafting trials continue to develop disease resistance, but nematode resistance has not yet been achieved

7. Summary of results of alternatives

7.1. Chemicals

a. **1,3 Dichloropropene + Chloropicrina**. The most likely alternative has seemed to be 1,3 D + Pic (1,3 Dichloropropene + Chloropicrine = trade name Agrocelhone), and so considerable research and trials have focused on its use. Registration was achieved, and is sold in Argentina for the last three years.
b. **DMDS.** This product was very good for nematode control, **but it is not in the market**
c. **Metam sodium**. A product with erratic results, and not very viable in some areas of Argentina, especially with heavy wet soils, and when salty water is available. For example, in the Coronda (Province of Santa Fe) area, after heavy rains and floods in the area, irrigation water turned salty, with a high pH, where disinfection was a failure, causing very severe crop losses.

Despite several years of winter treatments trials with metam results on heavy clay soil and low temperatures have shown at best very poor results.

d. Metam Ammonium. It works very well in other areas of Argentina. Same as metam sodium. Very important disinfection product used widely in Coronda (Santa Fe)

e. Metam Potassium. It works very well in the Northern area of Argentina, with higher temperatures and light soils. Same as metam sodium. Very important disinfection product used widely in Coronda (Santa Fe)

f. Iodomethane (methyl iodide) (Midas) gave excellent results, but **the manufacturer company decided not to register the product.**

g. Dazomet. Trials show poor results, mainly in fungus control. In addition, the long preplant interval is incompatible with the production systems involved in tomato and pepper, and strawberry for the conditions above mentioned. Also, price is not competitive.

7.2. Strategies for using less chemicals

h. VIF and TIF. Both products are fairly new, and depend on the imports of some raw material not produced in Argentina. Due to difficulties in importing products to the country, it is not widely used and promoted.

i. IPM. Integrated Pest Management is a practice that is widely studied and extended to growers. Results are not as good as desire, due to costs (pesticides very specific are more expensive than others) and the need of a higher knowledge of pest cycles, where some growers lack willingness of learning and applying the management practices.

7.3. Non chemicals

a. **Solarization.** It works very well on warmer climates. In fact, it is widely used in the Northern East and West of Argentina, during very hot summers, under greenhouse and as small open field treatment as well. It did not work in Central areas, such as La Plata and Mar del Plata, due to climatic conditions, and because the solarization period overlaps the key production period

b. **Biofumigation**. Same considerations. Solarization and biofumigation are being used where possible to replace methyl bromide.

c. **Steam**. Although it is very good to pasteurize and even sterilize substrates, its use is restricted to nurseries where substrates are used. Soil disinfestation did not produced adequate results. First, to carry the heat deep in the soil takes time and is very costly. Secondly, it depends on the soil preparation, and – a very important aspect – the humidity of the soil and its temperature are key factors. The buffer capacity of the soil is a key determinant of the success of the treatment. Another consideration is the cost of the treatment where gas oil (diesel) is used. Costs of the oil products increased notably and made steam disinfestation unviable. The only one

that is fairly successful is when natural gas is used. Unfortunately, natural gas is not available in farming areas of Argentina. The potential to use steam treatment was also researched. Although there were some positive results, actual practical application has been limited due to very slow treatment times and lack of suitable equipment for steam treatment that would work in current greenhouse structures characterized by many internal poles.

d. **Non soil use**. It was successfully proven in Argentina. Unfortunately, under the nowadays economic and social conditions, is not feasible in Argentina.
e. **Solar collector**. It is very successful in Argentina, mainly in central and northern areas. It is very appropriate for disinfecting substrates in the nursery industry.

7.4. Other research in progress

f. Grafting. Grafting is fairly new in Argentina. Although some efforts have been made in order to study and develop this procedure. Some research has been made years ago by the JICA (Japanese International Cooperation Agency), but the lack of vegetable rootstocks in the country detained the proceeding of it. Nowadays some imported rootstocks are being under study, and some native materials are also analyzed. These studies are carried out by INTA (Project personnel) and some universities.

g. **Beneficial organisms.** Studies are carried out in order to determine the ability of some fungi and bacteria to prevent the infection of pathogens, as well as with some symbiotic characteristics. Most of them are native strains. These studies are carried out by INTA (Project personnel) and some universities, mainly La Plata and Luján. Mostly were carried out using native strains of *Trichoderma virens* and *Azospirillum brasilense*
h. **Biotechnology.** Some research is under way in order to incorporate genes for resistant to some diseases and pests. It is in an early stage. Carried out by INTA and Universities.

8. Demographical and general characteristics of areas where main difficulties have arisen for methyl bromide phase out

Buenos Aires City is the Capital of Argentina. Buenos Aires and surrounding area population is about 12 - 14 million people

La Plata is the Capital of the Province of Buenos Aires and is 65 km from Buenos Aires**. La Plata City Green Belt** is located 60 kilometers south east of Buenos Aires. This production area provides Buenos Aires and La Plata cities with all kind of vegetables: green leaves year round and vegetable fruits from November to May. This area is located in La Plata county, Buenos Aires

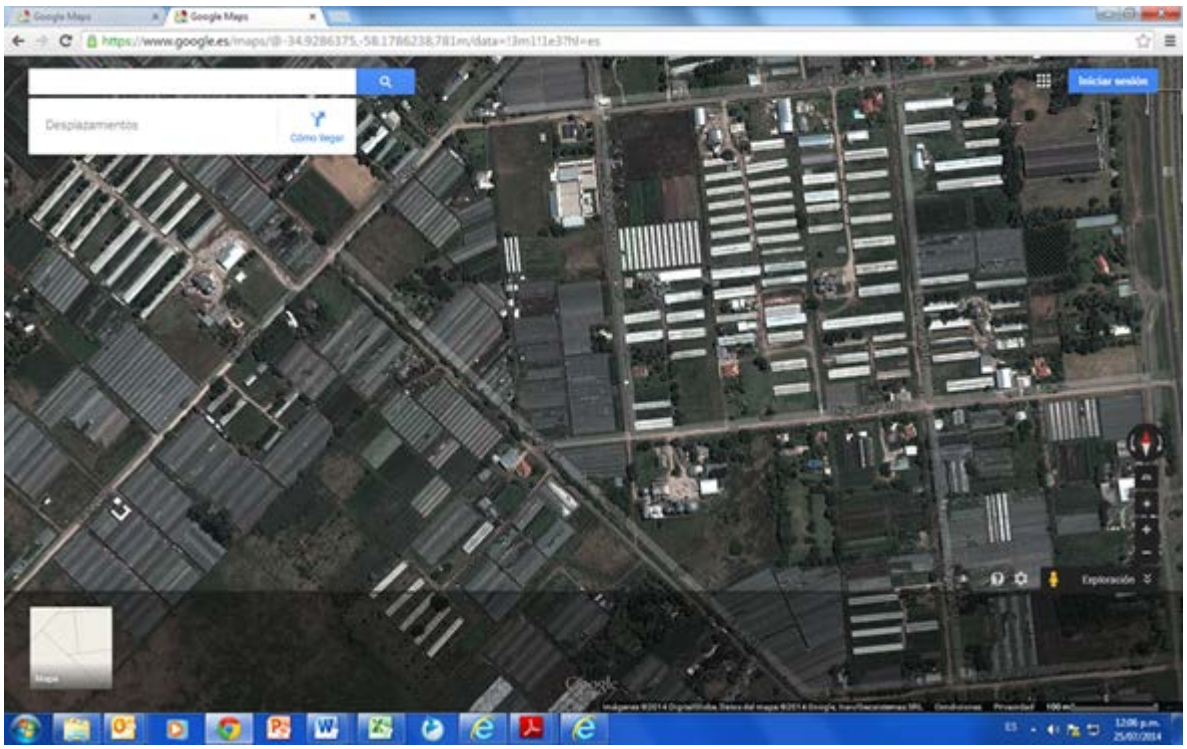
province. Its geographic coordinates are 34°58'55.68"S 58° 3'49.48"W. Recent estimates show that 70% of vegetables consumed in Buenos Aires come from La Plata, produced by some 4.000 growers.

Out of the total area under horticultural crops 64% of horticultural farms are smaller than 10 hectares representing 18% of the total surface area, 10% are between 30 and 100 ha (32% of the area), and only 2,4% have more than 100 ha (25% of the total area under horticultural crops). This area has been characterized in recent years by its dynamism in terms of crop diversity and increased acreage. Refer to picture to see the area covered with greenhouses in La Plata County. When the Project began, the covered area was less than 10% of nowadays.

There is an interesting historical reason why the soils of the Buenos Aires green belt are different than in the rest of Argentina. Metropolitan La Plata was the provider of brick for the building of the cities years ago; making the brick removed the good “black” loamy soils, leaving the lower layers, where clay is the main mineral component.

Table 3. Area covered with greenhouses in La Plata County.

Satellite image of El Peligro área (La Plata County) December 2006



Mar del Plata is the second largest city in Buenos Aires Province and the most important summer resort city in the country. These three cities account for

almost 50% of the total population of the country. These are obvious reasons why tomato and pepper growers are concentrated in these areas. Most of the growers of La Plata and Mar del Plata devote to tomato/ pepper production around the year.

The Green Belt of Mar del Plata City (General Pueyrredón County extending to neighboring counties) is a strip of 25 km bordering this city. It includes locations such as San Francisco, Laguna de los Padres, San Carlos, Batan and Valle Hermoso. In this region, some 500 growers cultivate about 10,000 hectares and 80% of them have less than 15 ha; 13% have between 15- 50 ha and only 7% have more than 50 ha. The production from this region is not only for the local are of influence (Atlantic Coast and surrounding towns) but also supplies many other areas around the country.

Lules is an early strawberry production region, located in the Province of Tucumán, in the North West area of the country. Contrary to Buenos Aires and Mar del Plata, this is a mountainous area, with a heavy rainy season occurring at the same time of strawberry planting. Soils are lighter than in Buenos Aires and Mar del Plata, suitable for strawberry production.

Growers of this area have the right soils, labor, logistic services and the needed infrastructure for harvest and post-harvest care of strawberry fruit, prepared for export and domestic market. Lules is, along with Coronda area in the Province of Santa Fe, the most important strawberry fruit production areas of Argentina.

Also, for the Province of Tucumán, the strawberry fruit production in Lules is very important, due to its contribution to social and economic welfare. These aspects are further explained in the next section.

8.1. Socio-economic and economic aspects of these regions

The 2005 Buenos Aires Green Belt census showed the total greenhouse area of 1,700 ha was composed of about 29,000 individual greenhouses, where almost 18,000 corresponded to La Plata area.

Around 4,000 growers were censed, and more than 30 % were settled in La Plata. Fifty percent were owners, and almost 50% were renting the land. Today satellite photographs show that more than 3,500 ha are covered by greenhouses, with the same trend.

Regarding the Mar del Plata area, today´s county best estimates show around 500 farmers, 600 ha of wooden greenhouses and around 10,000 ha of field

horticultural crops. 70% of the farms are 10 ha or less, and 18% between 10 and 30 ha. Most farms are run by the grower and his family (family farms).

One of the important characteristics of our horticultural areas is the very strong shift in the ethnicity of growers involved, a change that took place in the last few years. Sixty years ago, farms belonged to Argentinian growers of Italian, Spanish and Portuguese descent. Today, more than 60% of farms are run by Bolivian immigrants. In Buenos Aires, the shift has been greater than 70%. This trend, intensively noted in Buenos Aires Green Belt and Mar del Plata, is not much observed in Lules. Today more than 70% of the growers are immigrants, carrying their own traditions and knowledge. Refer to the map showing the concentration of immigrant farmers in these regions.

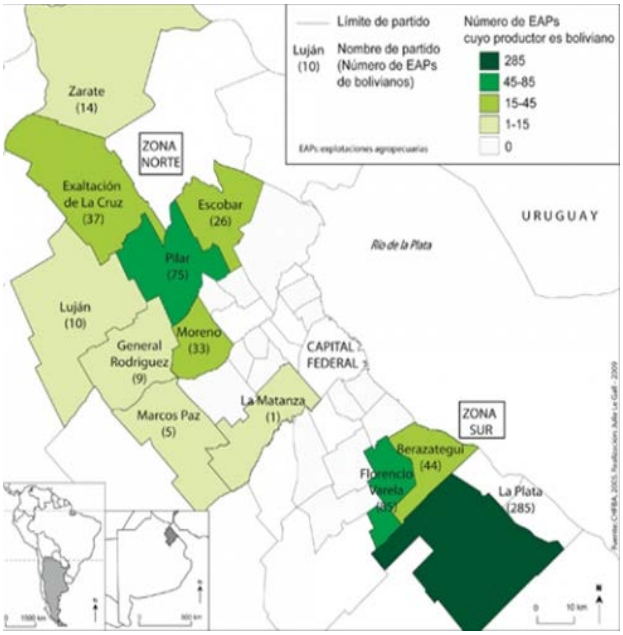
Immigrants begin by "renting" the land from a farmer, paying with a percentage of the production. In that land the main labor is provided by the new grower and his family, and eventually they bring some close relatives to work with them in order to earn some money that let them grow economically. And, of course, because they have to buy the agrochemicals, they use the most safe and efficient (it does not means the best practice) way of growing crops in order for them to ensure their earnings. The cycle follows by buying a small piece of land, when possible, and then repeating the cycle but as owners, renting it to some other growers, of the same origin. The next step on the social ladder is to be owner of more land, and later on, to own a market shop.

We highlight the very important point that vegetable production supplying the main cities of Argentina is based on the immigrant's work. If this production is to be disrupted, a social and economic problem would arise.

Considering the difficulties that immigrant growers have when using unfamiliar alternatives, and, additionally, if they are forced to use alternatives that are not effective, the foreseen consequences would be reduced grower income, which would result in significant social disruption, and – secondly – the high probability of an increased cost of fruits and vegetables to consumers, due to either the scarcity of produce or the need to rely on imports.

From November to May La Plata and Mar del Plata areas supply about 70% of fresh vegetables the country require. In order not to disrupt the food security and the supply of products to more than 28 million citizens as well, as the need to ensure grower financials, and the need to prevent significant social problems, Argentina has nominated a low amount of MB.

Table 4. Concentration of Bolivian immigrant farmers around Buenos Aires



8.2. Structure of greenhouses contributing to problems using alternatives

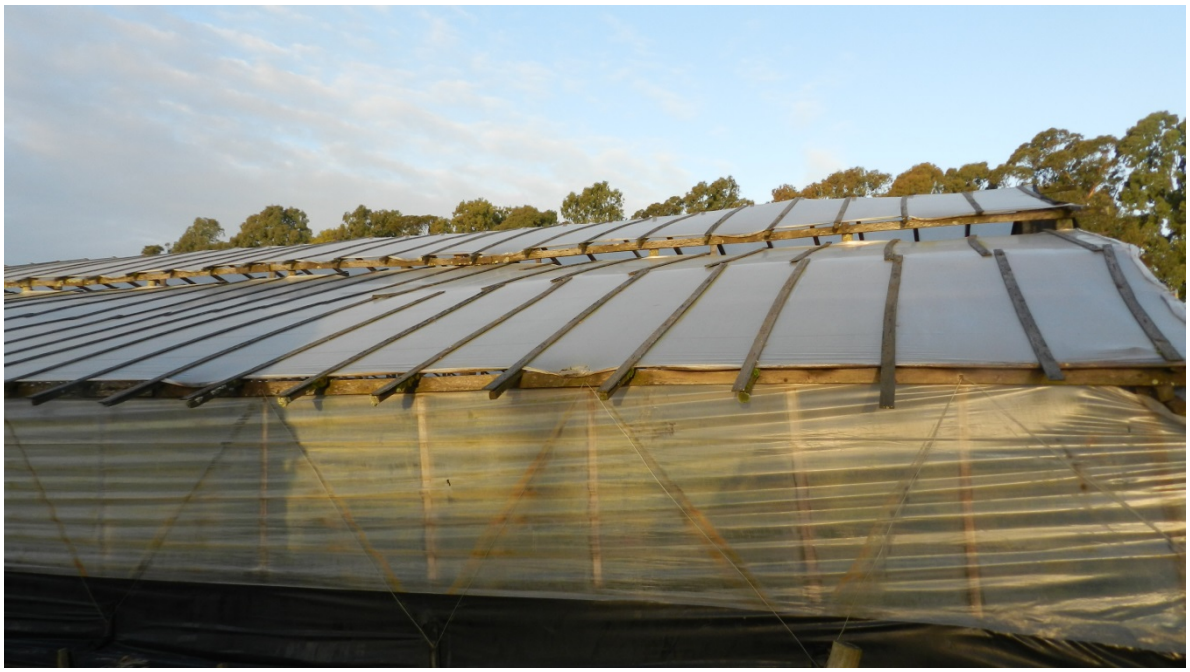
The 2005 Buenos Aires Green Belt census showed the total greenhouse area of 1,700 ha was composed of about 29,000 individual greenhouses, where almost 18,000 corresponded to La Plata area. All greenhouses were built using wood pole structure. Please refer to pictures to see the interior structure of these greenhouses.

Due to the cost of the materials to build a greenhouse, the great majority are wooden made, with small aisles to work and apply products, and areas where fumigants are difficult to handle.

Fumigant application is conducted as drip. The common cultural practice is tilling, laying plastic and drip hoses, fumigate, and then open the holes for planting, leaving some time for clearing the balance of the fumigant in the air.

Table 5. Photos of internal greenhouse structure

Pictures show the typical greenhouses in the La Plata and Mar del Plata areas, soil preparation for disinfecting and planting, and labor used. Please note the number of posts or poles, the space between rows, and the ways beds are built.



9. The replacement and phase out of methyl bromide in Argentina

It must be strongly stated that Argentine Government took measures to diminish the use of methyl bromide in the country. For example, it was banned the use of cans to disinfect the soil (Regulation 77/2006, Ministry of Agriculture and Food), and also it was prohibited the use of any other formulation than 70:30 to disinfect soil.

Efforts made by the Project MP/ARG/00/033 gave good results, so far. Research on different types and combination of alternatives was carried out by project personnel, including accompanying the official registration process to facilitate it, and give growers the chance of using a variety of them. Unfortunately, due to commercial reasons, some alternatives are not available in the market, or they do not have a strong marketing campaign.

Also a very hard extension process was carried out, through many different ways, which led to the knowledge of the methyl bromide problem and the alternatives available to many growers.

Some products of the work of the Project personnel are the following manuals, available on the web and print. (http://anterior.inta.gov.ar/tierrasana/index.htm). Please note that titles are a comprehensive translation to English.

Manual for alternative chemical product disinfection

Manual for steam disinfection

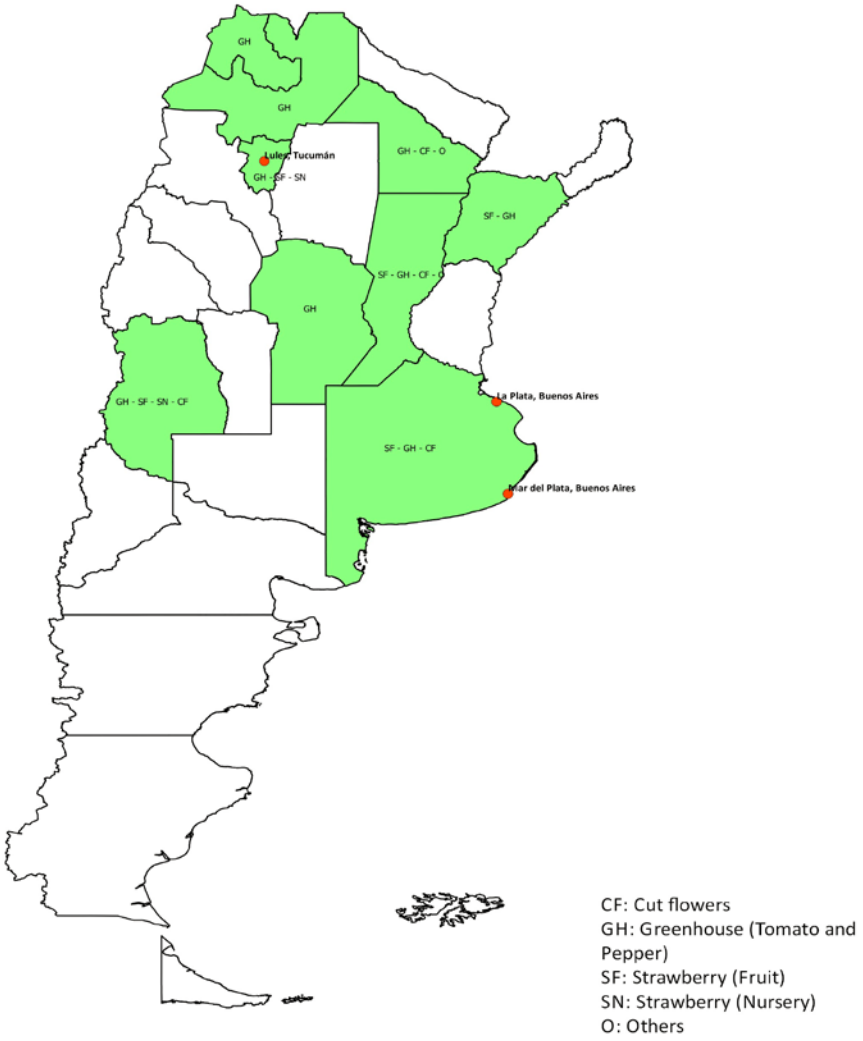
Manual for solarization and biofumigation

Manual for nematode control

Also leaflets, brochures and several extension articles and material were produced.

In summary, methyl bromide was phased out of most of the country, pending more research on very specific areas, where Critical Uses are asked.
In the following map it is shown green areas where methyl bromide was eliminated and their main crops, and the red dots are the areas where more work has to be done in order to phase out.

Table 6. Map of Argentine provinces showing the three regions where CUN MB is requested



10. Conclusion

In order to overview the Project and its achievements, it is outstanding to consider the efforts made (and currently on) in researching for alternatives to methyl bromide. A very good horticulturists group was consolidated, and actively working in searching alternatives and improving horticultural practice methods.

It is critical to consider the shift in the farmer´s type and culture that has occurred in the last few years, where a new type of grower emerged, coping with more that 70% of the horticultural produce in Argentina. This new type of grower

arrived with a different culture, and there is a need of reaching it with a new extension approach.

It is outstanding to notice the good results achieved in the use of alternatives in most of the country, due to the good work of Project personnel, sometimes not being accompanied by local actors.

It must be stressed the efforts - made and ongoing - in capacity building of new farmers to shift to alternatives and adequate them in difficult cases,

It is a condition for Project personnel and INTA authorities the need to help farmers with difficulties in order to avoid an economic disruption with foreseen social consequences.

Within the Project, it is clearly understood the need to solve some technical problems during 2015-2016 in critical areas.

As a result of the work done by the Project, in Argentina it was understood and taken by local, regional and federal authorities, the willingness of the country to attach to Good Management Practices and diminish the use of pesticides as much as possible.

It can be concluded that

Results of the work carried out by the Project MP/ARG/00/033 were suitable for helping farmers to phase out methyl bromide, and helped Argentina to improve ways of producing horticultural goods. It is clear that the main accomplishment of the Project is that in most of the country methyl bromide was phased out.

Also, this project led to a “new” approach of horticultural production, which consists on a horticultural crop management for every single situation, with horticulturists prepared and trained in extension methods, both from the governmental and private sector, in order to accomplish better management practices, a much better care of people and the environment, and a good differentiation of the products and produce.

It involves an INTEGRATED SYSTEM MANAGEMENT, which includes

- A rational use of agrochemicals
- Escape techniques, such as hydroponics
- Biosolarization
- Biofumigation
- Grafted plants
- Beneficial microorganisms
- Biotechnology

Although the results accomplished, the emerging situation of the horticultural production in Argentina implies new challenges.

One of the new challenges is the incorporation of the good management practices in the new type of growers occurred in the last few year, understanding their culture and their needs, in order to get as a result a good quality and quantity food.

On the other hand, unfortunately there was a failure in the use of alternatives under very specific situations, i.e strawberry in Lules (Tucumán), tomato in La Plata (Buenos Aires) and tomato and strawberry in Mar del Plata (Buenos Aires). Due to climatic and soil conditions (winter and wet conditions), alternatives did not show the expected results, and the Argentine Government, in order not to disrupt economical production, have asked Critical Uses for 2015 and 2016.

Efforts are put on ongoing research focused on different soil preparation dates, previous to rainfall period, as for Lules, or advancing them, as for Mar del Plata.

Also different approaches in culture technology are under study, such as adjusting planting dates, the use of different plastic mulches, product injection instead of dripping, etc.

Experiments on new rootstalks are under way, with preliminary results promising for controlling *Nacobbus spp.*

It is also expected to have in the market VIF and TIF products in the near future.

On the other hand, there are advances in the use of other alternatives, such as new molecules, or different forms of current products, in order to solve the problems presented with 1,3 D + Pic

It is expected to have results to solve current situations very soon. It must be pointed out that all these developments are carried out by Project personnel, which was trained during the execution of Project MP/ARG/00/033.

It is important to stress that grafting is considered a very promising alternative. Efforts have been made in order to receive training and the best technology available to have this technology in the market soon.