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The final report of UNIDO project MP/GEO/02/074 "Phase-Out of Methyl Bromide in Soil Fumigation sector"

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"Garemo da Analitika"
Reviewed by Mikheil Tushishvili, Ozone
Focal Point in Georgia

Background

UNIDO project MP/GEO/02/074 "Phase-Out of Methyl Bromide in Soil Fumigation sector» was approved by the Executive Committee of the Multilateral Fund at 37th meeting in July of 2002. The main objective of this project is to phasing out 12.8 tons of Methyl Bromide, which representing the entire consumption for soil fumigation.

The first implementation mission in the framework of the project took place 14-16, January 2003. Mr. Guillermo Castellá Lorenzo, Programme Manager, Montreal Protocol Branch, UNIDO visited to Tbilisi to meet with the Ozone Focal Point (OFP), members of the National Ozone Unit of the Ministry of the Environment and Natural Resources Protection of Georgia and possible sub-contractors of the project. The goal of this mission was to discuss the TORs required for the implementation of the programme. There were made a decision on a work plan for the project. The programme should be implemented in two phases: 1) Demonstrations trials and 2) The elimination of the methyl bromide for soil fumigation sector.

The contract with UNIDO was signed on April of 2003. The main activities were started from the middle of April of 2003 according the agreed Terms of Reference.

The main goals of the programme

1. Assessing Methyl Bromide use;
2. Identifying appropriate alternatives;
3. Establishing a policy framework;
4. Implement alternatives/demonstrations;
5. Encouraging stakeholders participation;
6. Awareness raising
7. Reviewing progress and further activities:

1. Assessing Methyl Bromide use

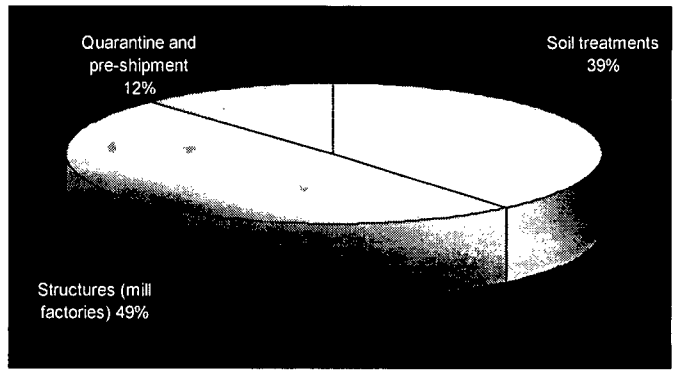
Tomato, cucumber and other vegetables are mainly grown in heated glasshouses twice a year in Georgia. It is most usual to grow cucumber or short cycle crops like dill, parsley or coriander during late spring. Tomato and cucumber production is highly intensive and is considered a high value cash crop by farmers. The major tomato and cucumber production areas are (1) Close to the capital Tbilisi, (2) Kazbegi region in the north west of the country; (3) Kutaisi region - West Georgia; (4) Agara – Central Georgia and the main concentration of plastic houses is located in the eastern Georgian region of Lagodekhi.

Table 1: Total Consumption of Methyl Bromide from 1995-2003 years in Georgia

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
Consumption (metric tones)	35	24	18	14	17.5	22	18	17.5	17

There should be underlined that 56% of the baseline consumption of Methyl bromide (12,8 tones) was used for soil fumigation sector in Georgia.
The consumption of Methyl Bromide consists of three sectors in Georgia: soil treatment, structure fumigation and quarantine/pre-shipment. The chart bellow indicates use of Methyl bromide as a fumigant by major sector from 2001 to 2003.

Chart 1: Use of Methyl bromide as a fumigant by major sector



The consumption of Methyl bromide in the soil fumigation sector gradually decreased following to the phase I (demonstration part) of the programme. The NOU of Georgia and LTD "Garemo da Analitika" consider that Methyl bromide will be totally phased out in the soil fumigation sector by 2007 after the completion of the phase II (investment component) of the programme.

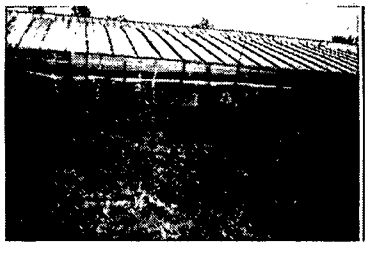
2. ***Identifying appropriate alternatives***

Preparatory work and implementation

The demonstration experiments were conducted in the main greenhouse tomato producing areas, located 1) near the capital city - Tbilisi; 2) near the town of Agara; 3) near the town of Kutaisi. Three glass greenhouses of 200 m^2 each were chosen as the experimental area. The experiments were set up a split block designee with 3 replications.

← 1) Near the capital city - Tbilisi

← 2) Near the town of Agara



← 3) Near the town of Kutaisi

Climate conditions

Georgia has a transitional climate from subtropical along the coastal regions to continental in eastern Georgia. Along the coast there are frostless winters and warm humid summers with humidity and precipitation decreasing in the mountains to the east. Along the coast average annual precipitation varies from 1,200 to 2,800 mm (47 to 110 inches) to 600 to 800 mm (24 to 31.5 inches) in the mountainous regions. Average temperature ranges are from 3 to 6 degrees Celsius (37 to 43 degrees Fahrenheit) in January to 23 to 26 degrees Celsius (73 to 79 degrees Fahrenheit) in August.

In the sight zones, **East** Georgia: 1) Near the capital city – Tbilisi, and 2) Near the town of Agara. The plains of eastern Georgia are shielded from the influence of the Black Sea by mountains of Likhi that provide a more continental climate.

1) Average temperature in Tbilisi sight is in September +20-25^{O}C, October +15-16^{O}C, November +8-12^{O}C and December -3^{O}C - +5^{O}C;
2) Average temperature in Agara sight is in September +20-22^{O}C, October +15-16^{O}C, November 0-+5^{O}C and December -4-5^{O}C.

In the sight zone, **West** Georgia: 3) Near the town of Kutaisi (the village Mukhiani). Along the Black Sea coast, from Abkhazia to the Turkish border, and in the region known as the Kolkhida Lowlands inland from the coast, the dominant subtropical climate features high humidity and heavy precipitation.

3) Average temperature in September in Kutaisi sight is about +22^{O}C, October about +15^{O}C, November +5-6 ^{O}C and December 0-+5^{O}C;

Table 2: Rainfall data (average in mm)

Months	Tbilisi	Agara	Kutaisi
September	190	260	290
October	205	225	250
November	220	300	360
December	240	345	450

History of the plot area

In Georgia tomato and other vegetables are mainly grown in heated glasshouses twice a year. During June to August, the rests of the previous planting season are being removed, and then the soil is prepared for disinfections. During August-September, the field is planted using 3-4 weeks seedlings that are either supplied by a commercial nursery (usually produced in tray soil-less) or purchased as certified seeds and produced at the farm site. Plant density is from 22,000 up to 25,000 plants/ha. The production period for the cash crop occurs between October and February, and then the land may be prepared again and planted with either tomato, cucumber or a leaf vegetable (dill, coriander or parsley).
History of plot sights:
No.1 – village Digomi (Tbilisi), farmers - Sulkhani and Tsitso Topchishvili:
2000 – Cucumber;
2001 – Cucumber;
2002 – Cucumber.

No.2 - village Agara, farmer – Goga Gongliashvili

2000 – Cucumber;
2001 – Tomato;
2002 – Tomato.

No.3 – village Mukhiani (Kutaisi), farmer – Gocha Chitaishvili
2000 – Dill;
2001 – Cucumber;
2002 – Tomato.

Disease and pest incidence

Table 3: Disease and pest incidence

	N1 Tbilisi	N2 Agara	N3 Kutaisi
1. Gryotalpa gryllotalpa	+	+	+
2. Onychiarus armatus	+	+	-
3. Agriotes obscurus	+	+	+
4. Scutigerella immaculata	+	-	+
5. Meloidogyne incognita	+	+	+
6. Verticillium albo-atrum	+	+	+
7. Fusarium oxysporum	+	+	+
8. Phiroctonia solani	+	-	-

Table43: Plant pests

	N1 Tbilisi	N2 Agara	N3 Kutaisi
1. Aphis gossypii	+	+	+
2. Tetranychus urticae	+	+	+
3. Trialeurodes vaporariorum	+	+	+
4. Trips tabaci	+	+	+

Table 5: Plant deceases

	N1 Tbilisi	N2 Agara	N3 Kutaisi
1. Botrytis cinerea	+	+	+
2. Phytophthora infestans	+	+	+
3. Oidium erysiphoides	+	+	+
4. Alternaria solani	+	+	+
5. Colletotrichum atramentrarium	+	+	+
6. Ascochyta lycopersici	+	+	+

The methyl bromide and following chemical and non-chemical alternatives were included:

A. **Solarization + Metam Sodium;**
B. **Solarization + Dazomet;**
C. **Biofumigation;**

D. Control without any treatment;
E. Methyl Bromide;

By the end of June, 20 kg of Dazomet (from BASF, Germany) and 60 liters of Metham Sodium (from UCB, Belgium) were purchased by LTD Garemo da Analitika" for a trial purpose with intention of further registration of these alternatives of Methyl Bromide. It should be underlined complicated negotiations with above mentioned companies due to the small size of Georgian market and non commercial interest in these circumstances. However, experts of "Garemo da Abnalitika" reached successes after long consultations and these chemicals were purchased to Georgia. Moreover, 100kg of Methyl Bromide were also bought for the demonstration activities.

In addition, experts of the LTD "Garemo da Analitika" procured all necessary fungicides, insecticides, fertilizers, biofumigation materials and solarization materials in time. Finally, the high qualities tomato seeds "Belle" were bought from the Dutch Seed producer Company "Bejo Zaden&Enza Zaden".

LTD "Garemo da Analitika" started negotiations with the Greece office of the company "Dow AgroSciences" in order to make a purchase of 1,3 Dichloropropene. Mr. Tityanov (a representative of the company) informed that the negotiations for supplying of small amount of this chemical had to be started at least one year before transportation (See attached letter). Furthermore, it was needed to be specified the future market for this product in Georgia. Mr. Tityanov suggested to visit Georgia for further consultations in the beginning of 2004. Moreover, Mr. Tityanov assisted to find 40 L of 1,3 Dichloropropene through the company "AMC" (Agricultural Material Company) in Jordanian. It should be also underlined that this product had not been registered in Georgia. However, the problem was that the airline companies refused to transport it for the reason that 1,3 Dichloropropene was considered as a Hazardous substance.

At the same time the LTD "Garemo da Analitika" with assistance of the NOU of Georgia started negotiations with Mr. John Busacca, Senior Research Scientist and Mr. Bruce A. Houtman, M.S. Global Regulatory Leader from Dow AgroSciences LLC in Indianapolis, USA in order to accelerate consultations for supplying this product to Georgia. Regrettably, the team had not received any responses so far. Consequently, the first demonstration activities started in Georgian greenhouses without 1,3 Dichloropropene.

Soil and water were taken before treatment from all three sights for examination. Samples were analyzed in the laboratory of the Tbilisi State University of Georgia. The results are indicated in the tables 5 and 6.

Table 5: Water Analysis

Component	Method	Sample		
		1	2	3
Hydrocarbonates, mg/L		162,8	190,0	188,0
Sulphate, mg/L	ISO 9280	35,0	36,0	34,0
Chloride, mg/L	ISO 9294	4,38	4,60	3,35
Sodium, mg/L	ISO 9964	22,4	25,3	22,4
Calcium, mg/L	ISO 6059	40,0	48,0	44,6

Magnesium, mg/L		4,78	5,51	5,70
pH	ISO 10523	8,15	8,10	8,00
Permanganate index, mg O/L	ISO 8467	7,0	8,2	7,5
Total hardness, mg eqv/L (Ca+Mg mg eqv/L)	ISO 6059	2,4	2,8	2,7

Table 6: Soil Analisis

Component	Sample		
	1	2	3
Moisture, %	4,15	4,26	4,35
Loss at heating, %	16,1	13,4	8,2
Carbonate CO2, %	5,20	1,2	7,32
Organic C, %	2,18	1,45	1,02
Humus, %	3,80	2,50	1,73
pH (water solution)	7,70	8,05	7,90
pH (KCl solution)	7,35	7,70	7,75
K2O (0,2 N HCl soluble), %	0,010	0,011	0,009
P2O5 (0,2 N HCl soluble), %	0,11	0,13	0,10
NO 3- (Water soluble), %	0,12	0,04	0,06

Samples:
No.1 – village Digomi (farmers - Sulkhani and Tsitso Topchishvili)
No.2 - village Agara (farmer – Goga Gongliashvili)
No.3 – village Mukhiani (farmer – Gocha Chitaishvili)

Mr. Mikheil Tushishvili, the National Ozone Focal Point visited all three sights in Tbilisi, Agara and Kutaisi from 24 July to 29 July of 2003. The objective of the mission was to discuss and arrange all required actions for the implementation of the demonstration trial, to visit all three sights and meet with farmers and agree on a timetable for the upcoming activities within the demonstration part of the programme. He highlighted that all three greenhouses were repaired and heating systems were modernized eventually in order to ensure the optimal temperatures for growing tomatoes under the demonstration part of the programme.

3. Establishing a policy framework;

Georgia ratified the Vienna Convention and the Montreal Protocol on 21st March 1996. The country also ratified the London, Copenhagen and Montreal Amendments in 14th June 2000.

The use of methyl bromide is already strongly regulated. Only professional applicators under contract with the methyl bromide importers are allowed to use the product. There are 3 related legal acts in place with reference to Methyl Bromide:

1. The Law of Georgia on the Protection of Plants from harmful organisms – 12, October, 1994; (Forecasting of spreading of dangerous insects. Plant Protection Service against dangerous insects)
2. The Law of Georgia on Agricultural Quarantine - 15, May, 1997; (State control on the execution of quarantine rules during the production, transportation, storage and realization of agriculture products)
3. The Law of Georgia on the Pesticides and Agricultural Chemicals - 25, November, 1998 (Regulation of import/export and consumption of pesticides on the territory of Georgia)

Following to the demonstration part of the project there should be registered alternatives of Methyl Bromide such as Metham Sodium and Dazomet

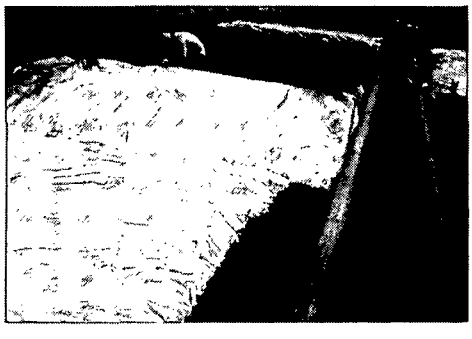
Upon termination of the project the Ministry of Environment of Georgia and Ministry of Agriculture and Food will complete above policy measures by issuing a regulation, which forbids the use of methyl bromide for soil fumigation.

4. ***Implement alternatives/demonstrations; 5. Encouraging stakeholders participation;***
6. ***Awareness raising***

The first experiment was conducted in the village Digomi (farmers - Sulkhani and Tsitso Topchishvili). The total area of greenhouse was 255 m^2. The experiment was set up a split block designee with 3 replications.
The treatment of the soil was started at 19-20 July, 2003. The plan was developed according to the approved TOR for the project. The soil was prepared as for seedling and then watered for MB 20% of whole capacity, for D and MS 60-70% of whole capacity for the period of 10 days. The samples for analyses of the soil were taken on 3 August, 2003 before a treatment. The soil was tested within of the total area of the greenhouse in six places by diagonal 0,5X0,5m^2. The following soil-born pest was identified:

1. Gryllotalpa gryllotalpa - 0,6 for 1m^2;
2. Agriotes obscurus - 0,3 for 1m^2;
3. Scutigerella immaculata – 0,1 for 1m^2;
4. Onychiarus armatus – 0,07 for 1m^2.

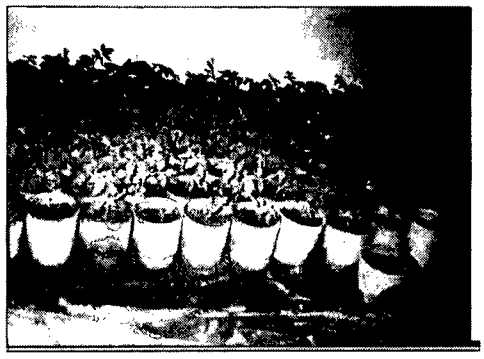
Photo: Fumigation process in Digomi



The team started fumigation of the soil at 5 August of 2003. The soil was treated with Dazomet - 60 gr. for 1m^2, Met. Br – 50-60 gr. for 1m^2; MS – 120 mlg for 1m^2 (MS was used by the spray to the soil with immediate incorporation by hoe) as well as Biofumigation – organic manure in combination with solarisation. The treated area was covered for Biofumigation treatment by black plastic sheet while for MB, D and MS the treated area was covered by white plastic coversheet. The coversheets were removed after 4 days due to the temperature of the soil was 25^{0}C as well as the temperature outside of greenhouse was 38^{0}C. The soil was incorporated once again by farmers for ventilation of the soil. Simultaneously, farmers undertook the test on phitotoxicity by green salad and radish. The test showed that replanting of seedlings could be done.

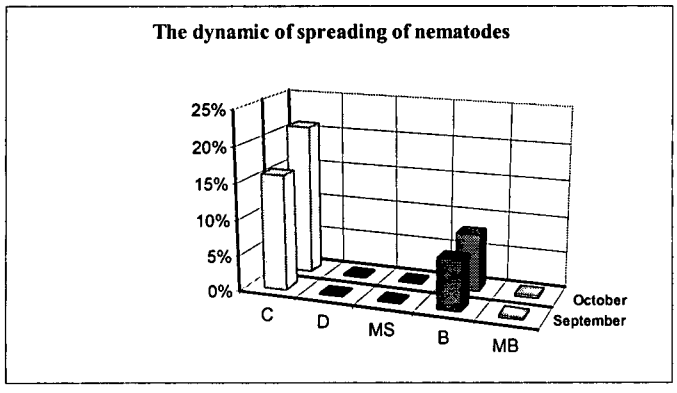
The soil was fertilised by Triple Supper phosphate (46% of P_2O_5) 25gr/m^2, K (49% of K_2O) 20gr/m^2 and N (NH_4NO_3) 10gr/m^2. Afterwards, the greenhouse was aired and farmers started assessment of conditions of soil-borne pathogens. Monitors reported that mainly soil-borne pathogens (Gryllotalpa gryllotalpa, Agriotes obscurus etc.) were killed within applications of MS, D and MB. Besides, the application of Biofumigation plus solarization was not so successful and

Photo: Seedlings for Digomi sight



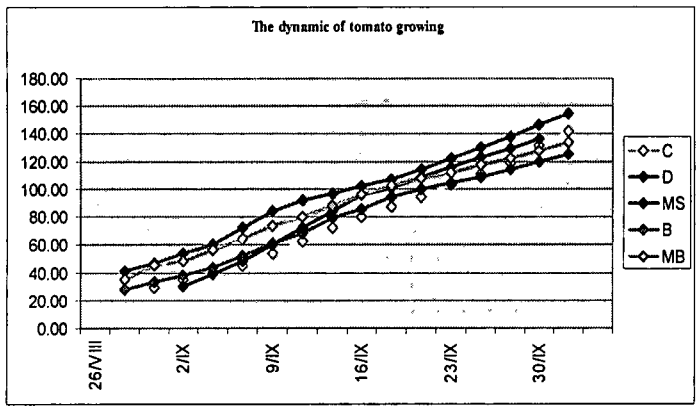
pathogens were decreased merely by 25-30%. Furthermore, pathogens remained for Control at the same level. Seedlings were visually tested for nematodes before replanting. There was not identified damage of roots and as a consequence farmers replanted seedlings at 14-15 August, 2003. Experts had been continued nematodes monitoring of plants throughout whole demonstration period. (See the diagram N1). It should be noted that only area treated by Dazomet small phitotoxicity of seedlings was observed.

Diagram N1. The diagram shows the dynamic of spreading of nematodes.



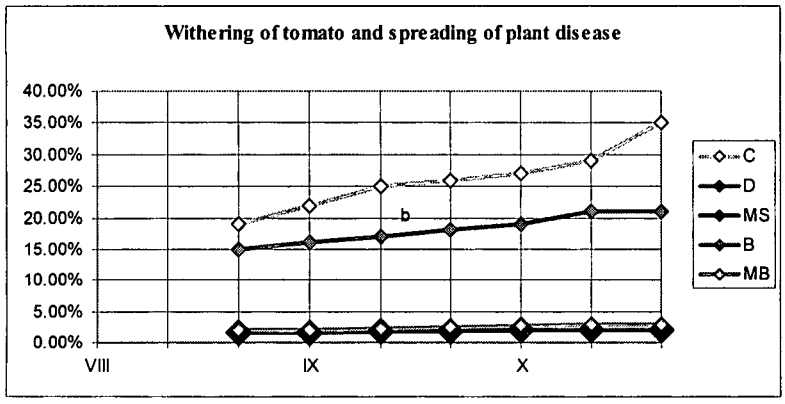
C	16%	21%
D	0.20%	0.20%
MS	0.20%	0.20%
B	7%	8%
MB	0.30%	0.40%

Diagram N2. The diagram shows the dynamic of tomato growing in Digomi.



*Sick plants were replanted three times in Control Area

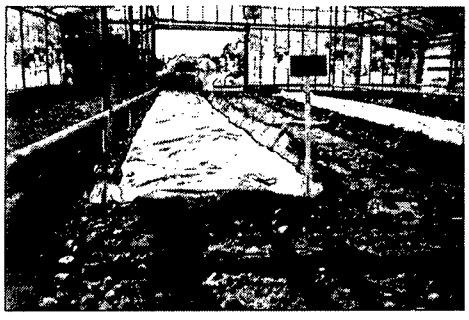
Diagram N3. Withering of tomato and spreading of plant disease in Digomi.

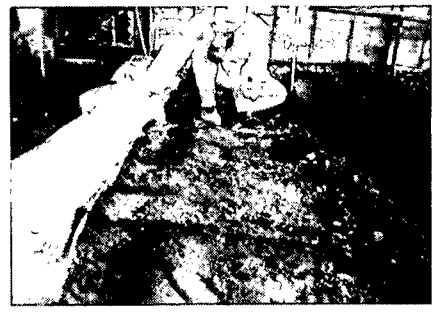


Photos: Fumigation process in Agara

The same treatment of the soil was carried out in the second and third greenhouses in Agara and Kutaisi. This work was executed from 17 to 22 of September, 2003. Results were almost the same according to monitor's reports. Soil-borne pathogens (Gryllotalpa gryllotalpa, Agriotes obscurus etc.) were killed within applications of MS, D and MB. As experiments had showed the application of Biofumigation plus solarization had not been achieved admirable results in all three sights and pathogens were decreased only on 20-30%.

Photos: Fumigation process in Kutaisi





Photos: The meeting in Agara sight

The National Ozone Unit of Georgia in cooperation with LTD "Garemo da Analitika" organised filed visit of the high level officials and experts from the Ministry of Environment of Georgia to Agara's experiential sight:

1. Ms. Nino Chkhobadze, the Minister, The Ministry of Environment of Georgia;
2. Mr. Zurab Tavartkiladze, the First Deputy Minister, The Ministry of Environment of Georgia;
3. Mr. Guillermo Castella Lorenzo, Programme Manager, Montreal Protocol Branch, UNIDO;
4. Mr. Tamaz Budagashvili, the Head of the Main Department of Air Protection, the Ministry of Environment of Georgia

5. Mr. Mikheil Tushishvili, the National Ozone Focal Point;
6. Ms. Nino Tkhilava, the Head of Department of emission Control and management;
7. Ms. Marina Shvangiradze, the Expert of Climate Change agency of Georgia;
8. Dr. Koba Khutsishvili, the Director of LTD "Garemo da Analitika";
9. Mr. Robert Revia, the Manager of LTD "Garemo da Analitika";
10. Farmers: Goga and Lado Gongliashvili

The meeting was held in the demonstration sight in Agara at 25 October of 2003. The Minister highlighted the necessity to provide farmers with relevant information on alternatives available for controlling pests as well as familiarizing them with the Montreal Protocol requirements and Georgia's obligations in phasing out of Methyl bromide as an Ozone Depleting Substance. She underscored the essential role of UNIDO programme for enabling of the country to start early Methyl Bromide phasing out process as well as a promotion of alternative chemicals and methods. In addition, the Minister emphasised the significance role of these particular farmers for the environmental protection since the greenhouse heating system was operated on underground sulphur hot water resulting zero emission to the Air.

The National Ozone Focal Point underlined that all activities had been going in compliance with agreed timetable. He expressed that the NOU of Georgia and LTD "Garemo da Analitika" would widely disseminate the information about effective alternatives of Methyl Bromide according to the achieved results of the demonstrations.

Mr. Guillermo Castella Lorenzo highlighted that the next steps would be essential for country in order to promote the adoption of accepted alternatives of Methyl bromide. He also call attention to farmers actively participate in upcoming workshops and it would help to raise awareness about availability of effective alternatives to Methyl Bromide.

The second trial was executed in a greenhouse with area 400m^2 in the village Agara. The heating system of this greenhouse is unique in view of the fact that it running on underground sulphur hot water. The temperature of water could be +90^{0}C at the surface of the ground.

The soil was tested before treatment within of the total area of the greenhouse in eight places by diagonal 0,5X0, 5m2 with depth 25-30 centimetre. Following soil-born pests were identified:

- ✓ *Gryllotalpa gryllotalpa* - 1,5 for 1m^2;
- ✓ *Agriotes obscurus* - 2,75 for 1m^2;
- ✓ *Scutigerella immaculata* – 0,75 for 1m^2;

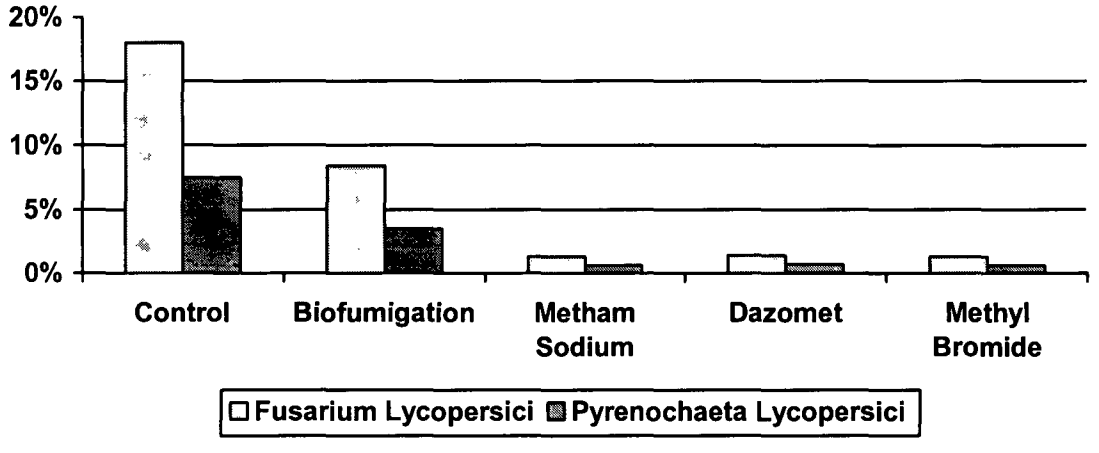
The team regularly monitored a treated soil and obtained following results: there were practically not identified the soil pathogens in the areas treated by MBr, MS and Dazomet. Farmers and experts were not fully satisfied with parts treated by manure (biofumigation). The amount of soil borne pathogens decreased no more than 15-20%. In Control where plots had prepared in the usual way and remained untreated the quantity of soil borne pathogens just reduced on 3-5%.

The soil was fertilised with different substitutes such as Triple supper phosphate – 200 kg/ha and Potassium 150 kg/ha. It should be underlined that seeds (Monroe) had been purchased from the company Enza Zaden (The Nederland)

There were identified soil borne pathogens on 15th day after the planting.

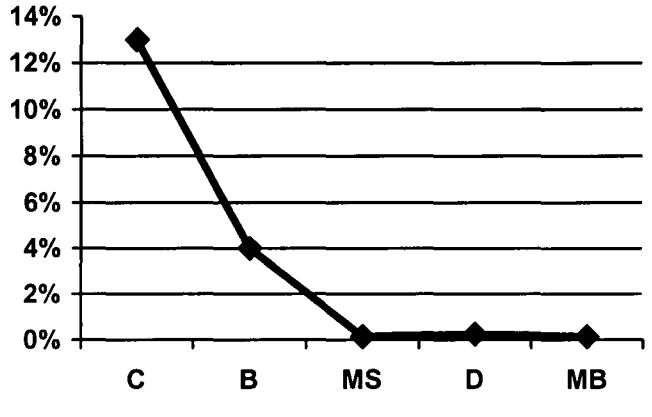
Diagram N4: Quantity of soil borne pathogens

Soil borne pathogens	Control	Biofumigation	Metham Sodium	Dazomet	Methyl Bromide
Fusarium Lycopersici	18%	8,4%	1,3%	1,4%	1,3%
Pyrenochaeta Lycopersici	7,5%	3,5%	0,6%	0,7%	0,6%



One of the major soil-borne pathogen had been identified a type of Nematode – *Meloidogyne incognita*. Subsequent to the treatment experts had been continued nematodes monitoring of plants throughout whole demonstration period.

Diagram N5. The diagram shows the dynamic of spreading of nematodes



C	13%
B	4%
MS	0.15%
D	0.25%
MB	0.15%

During the vegetation were identified following diseases/pests: *Trialeurodes vaporariorum, Aphis gossipi, A. fabae, Aculus Lycopersici, Phytophtora parasitica, Alternaria solani, Cladosporium fulvum*

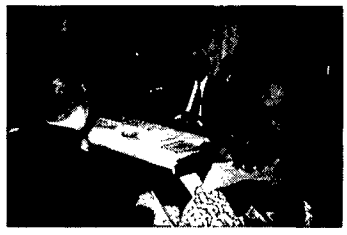
The following actions were implemented against above mentioned diseases/viruses:

- Cuproxat 0,4%;
- Iteral 0,04% + Aktara 0,02%;
- Ridomil gold 0,25% + Aktara 0,02%.

Subsequent to these actions phytosanytary conditions was satisfactory and fully controlled by experts.

Photos: The workshop organised in Digomi

The first and second workshops under the demonstration part of the programme were organised in the village Digomi (Tbilisi sight) at 9 December of 2003 and Agara sight at 17 January of 2004.



Photos: The workshop organised in Agara

The main goal of the workshops was to increase awareness of farmers on Met.Br. control measures under the Montreal Protocol as well as to demonstrate achieved results with reference to alternative techniques and chemicals that are available at this moment. Each workshop was break down into two sessions. Session (1) was the field visit to the greenhouse using alternatives to methyl bromide with demonstrations to show how various alternatives work. Session (2) focused on Met.Br alternatives for soil fumigation sector with incorporation of Integrated Pest Management System (Attachment N1). List of speakers is indicated bellow:

1. Mr. Mikheil Tushishvili, The National Focal Point for the Vienna Convention and the Montreal Protocol;
2. Dr. Koba Khutsishvili, the Director of "Garemo da Analitika" LTD
3. Dr. Zurab Loladze, the IPM specialist
4. Mr. Levan Kometiani, the expert of "Agrotechniques" LTD
5. Ms. Marina Gvinepadze, the Head of the Registration Department of Plant Protection Service of the Ministry of Agriculture and Food of Georgia

There were 34 participants in Digomi workshop and 15 participants in Agara workshop (Attachment N2).

The following documents and papers were distributed during the sessions:

- The agenda of the workshop;
- Information papers on Met.Br, Dazomet and Metham Sodium as well as Met.Br alternative technics;
- The OzonAction newsletter in Russian Language (N45) edited by the NOU of Georgia;
- UNEP DTIE report on the demonstration project in the East Europe.

Mr. Mikheil Tushishvili, the National Focal Point for the Vienna Convention and the Montreal Protocol gave the brief statement summarising activities of the National Ozone Unit of Georgia under the Montreal Protocol particularly on Met.Br activities. He stated that these specific workshops provided an opportunity to exchange information about alternatives and develop strategies with the intention of moving forward from the demonstration part to investment components of the programme.

Dr. Koba Khutsishvili made a statement that LTD "Garemo da Analitika" was pleased to host these workshops. He also underlined the essential role of different stakeholders with regard to Met.Br phase out activities in Georgia and described activities of LTD "Garemo da Analitika" concerning experimental trials in Digomi and Agara. Dr. Khutsishvili stressed the attention of participants that Metham Sodium and Dazomet gave good results reducing the incident of nematodes as well as improving fruit production. These chemicals could be adopted as alternatives of Met.Br for soil fumigation sector in Georgia.
Dr. Zurab Loladze gave further explanation on achieved results under the programme with reference to treatments with Dazomet and Metham Sodium combined with an Integrated Pest Management programme, performed well in terms of pest control, fruit production and quality and could be envisaged as feasible alternatives for Methyl bromide. He reported that Biofumigation (manure) in combination with solarisation did not reach expected results but this method should be additionally explored next year.
Mr. Levan Kometiani introduced advantages of Drip Irrigation System for Greenhouses.
Finally, Ms. Marina Gvinepadze, the Head of the Registration Department of Plant Protection Service of the Ministry of Agriculture and Food of Georgia introduced policy and legislation framework for introduction and registration of Met.Br. alternatives in Georgia. She summarised requirements of several legislative acts such as *The Law of Georgia on the Protection of Plants from harmful organisms* – 12, October, 1994; *The Law of Georgia on Agricultural Quarantine* - 15, May, 1997; *The Law of Georgia on the Pesticides and Agricultural Chemicals* - 25, November, 1998.

The most significant conclusions from two sights (Digomi and Agara) were following: (1) these chemicals (Metham Sodium and Dazomet) were successfully tested and showed effectiveness in controlling the major soil-borne pests and diseases. (2) Biofumigation was not exposed very strong results. It should be further considered a type of organic material used with some adjustments on dosages depending on the region and the cycle. Biofumigation should be further tested in combination with solarisation and it was done in Kutaisi site. The team expected to obtain these results by the end of February of 2004. (3) These workshops showed great interest of farmers with reference to the efficiency of new alternatives of Met.Br, the difference between Met.Br and alternative treatments calling attention to possible technical and economic advantages as well as introduction and combination of fumigation with IPM system.

The third demonstration plot for the examination of methyl bromide alternatives in soil fumigation sector was selected in West Georgia. A total size of the selected greenhouse was 300 m^2. The owner of this greenhouse had been the farmer – Mr. Gocha Chitaishvili. The team selected tomato as a crop for testing new alternatives for Methyl Bromide.
History of the plot sight was following:
A number of years – 150 m^2 was cucumber and 150 m^2 was a leaf vegetable (dill, coriander or parsley).
Activities had been started in this experimental plot at the end of August, 2003. The soil was ploughed and harrowed at 28-29 August. The soil was prepared for fumigation through watering of plots for MB 20% of whole capacity, for D and MS 60-70% of whole capacity for the period of 10-15 days. Samples for testing of the soil were taken at 18 September, 2003 before the treatment. The soil was tested within of the total area of the greenhouse in eight places by diagonal 0,5X0,5m^2. The following soil-born pests were identified:

- ✓ Gryllotalpa gryllotalpa - 2,25 for 1m^2;
- ✓ Agriotes obscurus – 1,5 for 1 m^2
- ✓ Scutigerella immaculata – 1 for 1m^2;
- ✓ Onychiarus armatus – 3,25 for 1m^2;

The team started fumigation of the soil at 21 September of 2003. The soil was treated with the first option Met. Br – 50 gr. for 1m^2 under the cover sheet. The second option was selected Metham

sodium - 120 mlg for $1m^2$ (MS was used by the spray to the soil with immediate incorporation by hoe). The third one was Dazomet - 60 gr. for $1m^2$ and it was messed up with the soil on the depth of 15-20 sm as well as the treated soil was covered by the special sheet. The fourth choice was Biofumigation the way through incorporation of manure – 10-12 kg for each block and the treated soil was covered by black plastic sheet. Finally, Control option was used without any treatment. The greenhouse was locked for 15 days after the soil treatment.
The greenhouse was opened at 5 October, 2004 and plastic sheets were removed. The soil was tested once more within of the total area of the greenhouse at 10 October, 2004.
Three plots treated by Met.Br, Dazomet and Metham Sodium were almost free from pests. In case of Biofumigation the following soil-born pests were identified:

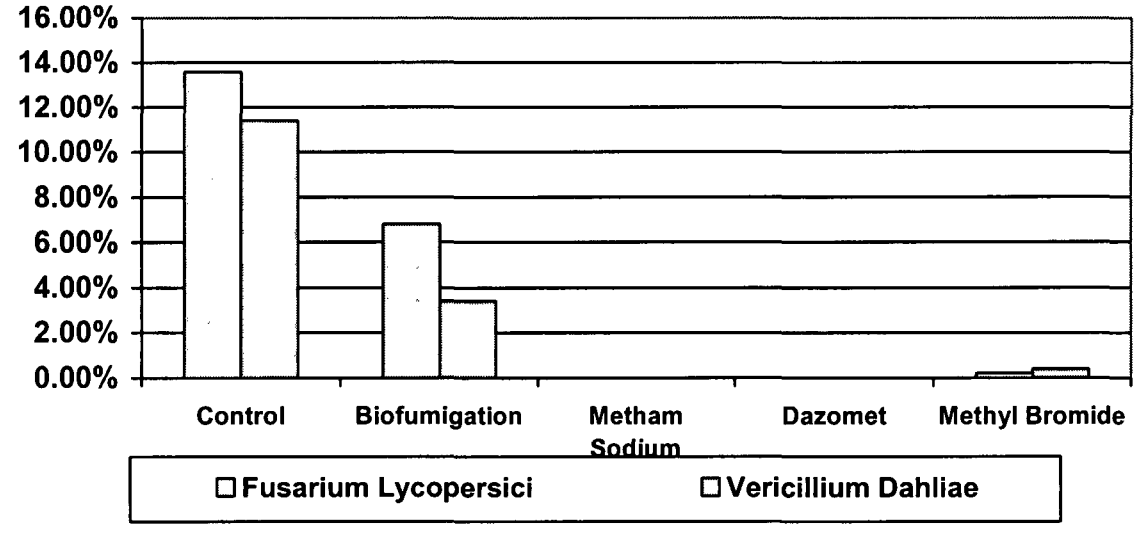
- ✓ Gryllotalpa gryllotalpa - 1,8 for $1m^2$;
- ✓ Agriotes obscurus – 0,4 for 1 m^2
- ✓ Scutigerella immaculata – 0,2 for $1m^2$;
- ✓ Onychiarus armatus – 2,7 for $1m^2$;

At the same time, farmers undertook the test on phytotoxicity by green salad and radish. The test showed that replanting of seedlings could be done.

There were identified soil borne pathogens after planting.

Diagram N6: Quantity of soil borne pathogens

Soil borne pathogens	Control	Biofumigation	Metham Sodium	Dazomet	Methyl Bromide
Fusarium Lycopersici	13,6%	6,8%	0	0	0,4%
Verticillium Dahliae	11,4%	3,4%	0	0	0,2%



In addition, the team tested the soil on a contamination of nematodes such as Meloidogyne incognita. The IMP specialist proposed the testing system based on 4 level scores:
1 score - 5% of total quantity of plants sicked by Nematoda.
2 score - 10-15%
3 score - 15-30%

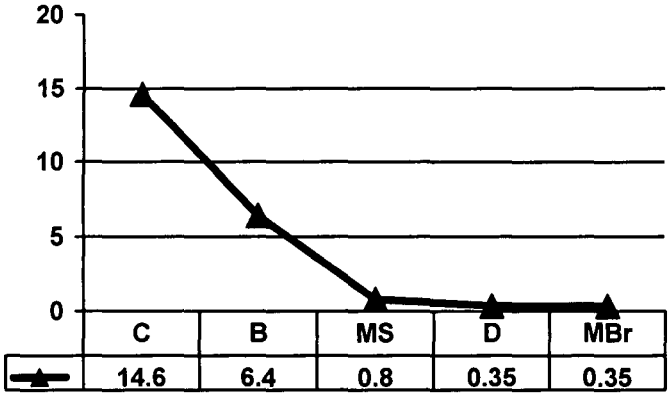
4 score - 30% and more

The average damage of plants was calculated using the following method (P):

P = (a + b X 2 + c X 3 +d X 4) : N

N – taken samples for testing (the total amount of recorded plants)
a – the total quantity of plants damaged within 1 score;
b – the total quantity of plants damaged within 2 score;
c – the total quantity of plants damaged within 3 score;
d – the total quantity of plants damaged within 4 score;

Obtained results are indicated in the Diagram N7



The team had continued a monitoring of plants during the vegetation period. Farmers and IPM specialist had measured a size of plants for the period of 40 days after replanting of seedlings (once per 5 days). The heights of plants were almost similar in MS, D and Met. Br plots area in comparison with Control plot (more for 5-6 %).
The team identified following diseases for duration of the vegetation such as *Trialeurodes vaporariorum, Neomyzus circumflexus, Alphis gossypi, Phytophtora infestans, Alternaria slani, Phoma destructiva.*
The following actions were implemented against above mentioned diseases:

- Cuproxat 0,5%;
- Iteral 0,06% + Aktara 0,02%;
- Ridomil gold 0,25% + Aktara 0,02%;
- Carate 0,04%

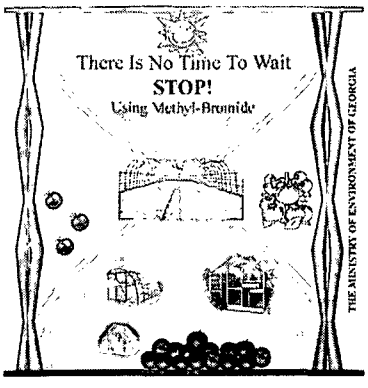
The Third (concluding) Workshop on Alternatives to Methyl Bromide in the Soil Fumigation Sector in Georgia was organized by United Nations Industrial Development Organization (UNIDO),

"Garemo da Analitika" LTD and The National Ozone Unit of the Ministry of Environment and Natural Recourses Protection of Georgia in cooperation with Kutaisi Technical University Kutaisi at 3 February, 2004. This workshop was the final one under the first phase of UNIDO programme "Phase out of Methyl Bromide in the soil fumigation sector". (The Agenda and List of participants are attached to this report).

The main objective of the workshop was to provide farmers and other stakeholders with relevant information on alternatives of Methyl bromide in the soil fumigation sector as well as the information with reference to the programme implementation and achieved results from all three sits.

The workshop was divided for two sessions. The field visit to the greenhouse using alternatives to methyl bromide was organised as the morning session. Subsequently, the meeting continued the work at the conference Hall of Kutaisi Technical University as the afternoon session.
The workshop attended 55 participants from the NOU of Georgia, LTD "Garemo da Analitika", the Ministry of Environment of Georgia, Ministry of Economy, Industry and Trade, LTD "Agrotechniques", Ministry of Agriculture and Food of Georgia, the Parliament of Georgia, Kutaisi Technical University as well as private enterprises and farmers.

The following documents and papers were distributed throughout sessions:



- The agenda of the workshop;
- Information papers on Met.Br, Dazomet and Metham Sodium as well as Met.Br alternative technics;
- The OzonAction newsletter in Russian Language (N45) edited by the NOU of Georgia;
- UNEP DTIE report on the demonstration project in the East Europe translated into Georgian by the NOU of Georgia;
- UNEP Sourcebook of technologies for protecting the Ozone Layer: Alternatives to Methyl Bromide translated into Georgian by the NOU of Georgia;
- A poster with regard to phase out of Methyl Bromide developed by the NOU of Georgia.

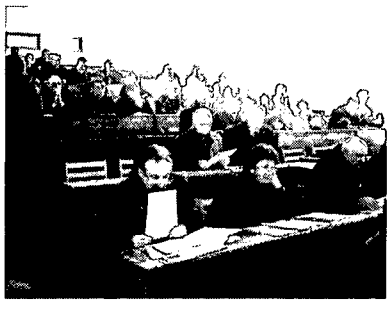
Participants were able to observe case studies during the field visit and learnt about techniques for using of alternatives to Met. Br. Mr. Gocha Chitaishvili, the farmer (the owner of the selected greenhouse) provided information with reference to gained experiences to solve problems of pests or pathogens. He emphasized the essential need for farmers to improve crop management practice as well as to be acquainted with the concept of Integrated Pest Management system.

Mr. Zaal Lomtadze, the Deputy Minister of the Ministry of Environment of Georgia, opened the afternoon session. He highlighted the need to phase out Met.Br, and the need for the country to meet obligations under the Montreal Protocol. Mr. Lomtadze thanked the NOU of Georgia for setting the network of different stakeholders involved in the implementation of the project such as the NOU of Georgia, the Ministries of Environment and Agriculture of Georgia, Plant Protection Service, LTD "Garemo da Analitika" (private sector), Kutaisi Technical University and farmers.

Mr. Guillermo Castellá Lorenzo, Programme Manager, Multilateral Environmental Branch, UNIDO attended at the workshop and gave the presentation on "the importance of training and demonstrations in the introduction of alternatives to MB". He presented a brief overview of Met.Br. phase out requirements under the Montreal Protocol. The presentation provided a background information with regard to UNIDO activities (implementation of demonstration projects in 26 countries) for phasing out Met.Br. around the world. Mr. Lorenzo gave an information relating to

alternative technologies such as steaming systems and equipment, solarisation combining with biofumigation, Metham Sodium using irrigation system, Metham Sodium using spading machine, non soil cultivation etc.

Mr. Mikheil Tushishvili, the National Ozone Focal Point presented the work of the NOU of Georgia with reference to the phase out of Met.Br. He highlighted that NOU of Georgia had started activities in 2000 with gathering of information on consumption patterns from the baseline period to the present as well as profiles of crops/commodities where methyl bromide had been used or might be used sometime in the future and regions in the country where methyl bromide had been used (including for quarantine and pre-shipment uses). Mr. Tushishvili emphasised the crucial role of the staff of UNIDO for the development and implementation of this project. He presented principle components of the project and essential role of awareness-raising activities of the NOU of Georgia including translation and dissemination of training materials on alternatives to Met.Br., articles in the newspapers and magazines, advertising clip (Methyl bromide phase-out in Georgia), TV program for adults and Web-page "Methyl Bromide Alternatives in Georgia" (http://www.airdept.ge).



Dr. Koba Khutsishvili, the director of LTD "Garemo da Analitika" introduced Met. Br phase-out program which had been implemented following a strict schedule. The program started in the year 2003 with a pilot demonstration project in 3 locations, where MB consumption had been high and that represents a strategic points to cover all the country. He highlighted also following subjects: the efficiency of new alternatives such as Dazomet, Metham Sodium and Biofumigation, the technology of using these alternatives, the economic advantage of using alternatives to Met.Br. and IPM general principals.

Mr. Zurab Loladze, the IPM specialist, underlined that IPM had been implemented together with the alternatives proposed. He presented achieved results from Kutaisi sight and evaluated these results in comparison with previous two from Tbilisi and Agara sits.

Mr. Levan Kometiani, the expert of "Agrotechniques" LTD, introduced the Drip Irrigation System for Greenhouses. He gave the explanation on the subject of Drip irrigation as the process of applying the right amount of water slowly and evenly to the root zones of plants. This could keep the level of moisture in the soil within the optimum range for healthy growth and minimum stress. He presented also several advantages of Drip irrigation system such as (1) pinpoint water placement - drip irrigation could allow to pinpoint water placement and adjust delivery rates to the changing needs of each plant. (2) Saving time. Timers could be installed to ensure that watering was done at the right time and in the desired amount. (3) High quality of crops - the slow, regular, uniform application of water and nutrients results in even growth and ripening with consistent quality.

Mr. Zurab Lipartia, the Head of Plant Protection Service, the Ministry of Agriculture and Food of Georgia gave the explanation on policy and legislation procedures for introduction and registration of Met.Br. alternatives in Georgia.

6. *Reviewing progress and further activities:*

The trials with alternatives of Methyl Bromide under the first phase of UNIDO project MP/GEO/02/074 "Phase-Out of Methyl Bromide in Soil Fumigation sector" was completed and shown acceptable results. These alternatives should be adopted by farmers from different regions of Georgia during the investment part of the programme. These alternatives (Metham Sodium and Dazomet) in combination with IPM will give the ability to farmers to produce tomatoes and other vegetables with the same efficiency.
The team identified five regions for phase out component where the use of Methyl Bromide in soil fumigation sector is high:

1. Tbilisi (the village Digomi);
2. Kareli (the village Agara and other neighbour rural community);
3. West Georgia (Kutaisi region and other neighbour rural community);
4. East Georgia (Lagodekhi);
5. Kazbegi region.

There were organised 5 field visits of experts of LTD "Garemo da Analitika" and the National Ozone Focal Point with the intention of the dissemination of obtained results as well as the identification of farmers wishing to participate in the phase out component of the programme. The first visits were managed to West Georgia (Kutaisi region and other neighbour rural community). The city of Kutaisi and several villages were visited throughout the missions such as Mukhiani, Parckhanakhanebi, Geguti and Tkachiri. The team delivered five lectures in each place for farmers so as to provide sufficient information regarding (1) ozone layer protection and ozone depleting substances (CFCs, Halons and Methyl Bromide), (2) achievements, impacts and challenges of Methyl Bromide related activities, (3) the implementation of UNIDO project and verified alternatives of Methyl Bromide in the soil fumigation sector, (4) phase out component of UNIDO programme.
It should be underlined that the lectures were provided up to 200 (!) farmers in this region with a view to develop the scope and design the phase out programme. There were selected 18 farmers based on the high consumption of Methyl Bromide as well as the willingness to introduce alternatives of Methyl Bromide in combination with IPM.

The table 7: West Georgia (Kutaisi region and the villages Mukhiani, Parckhanakhanebi, Geguti and Tkachiri);

The name and surname	The plot history	The total area treated by MB (m^2)	The heating system	The village
1. Tevdoradze Elgudga	Tomato	400 + 400	No (plastic greenhouse)	Parckhanakhanebi
2. Tevdoradze Ameri	Tomato Cucumber	400+200+200+200	No (plastic greenhouse)	Parckhanakhanebi
3. Kharabadze Vasili	Tomato Cucumber	200+200+400+350	No (plastic greenhouse)	Parckhanakhanebi
4. Kublashvili Gocha	Tomato Cucumber Herbs	(T+C) 700+600+500; 300+300+300 (Herbs);	No (plastic greenhouse)	Parckhanakhanebi
5. Kvernadze Nodar	Tomato	500+400	No (glass greenhouse)	Parckhanakhanebi
6. Chitaishvili Gocha	Tomato	500	Yes (Coal and Heavy oil)	Mukhiani

7. Chitaishvili Omari	Tomato	400+400+300	No (plastic greenhouse)	Mukhiani
8. Chitaishvili Murtazi	Tomato	400+500	No (glass greenhouse)	Mukhiani
9. Berdzenadze Rolandi	Tomato	540	Yes	Mukhiani
10. Mamadeishvili Amiran	Tomato	600	No (plastic greenhouse)	Tkachiri
11. Mitsenko Sasha	Tomato	600	Yes	Tkachiri
12. Gagishidze Mamuka	Tomato	550	No (glass greenhouse)	Tkachiri
13. Bidireishvili Demeri	Tomato	500	No (glass greenhouse)	Tkachiri
14. Iashvili Tariel	Tomato	300	No (glass greenhouse)	Tkachiri
15. Ashvetia Armaz	Tomato	425	No (glass greenhouse)	Tkachiri
16. Gabunia Malkhaz	Tomato Cucumber	500+500	No (glass greenhouse)	Geguti
17. Tsikiridze Misha	Tomato Cucumber Herbs-winter	450+300	No (glass greenhouse)	Geguti
18. Namchevadze Temur	Tomato Cucumber	660X5	Yes (gas)	Kutaisi

The next field visit was organised to Kareli (the village Agara and other neighbour rural community). The most significant investigation from this region was that the team identified the consumption of Methyl Bromide in the field of nursery (fruit trees) and flowers. There was made a decision to introduce Metham Sodium and Dazomet in this field as well. The team delivered lectures in three villages such as Kareli, Agara and Bredza. In total, experts visited about 50 farmers and selected 10 candidates for participation in the programme.

The table82: Kareli (Agara and Bredza)

The name and surname	The plot history	The total area treated by MB (m^2)	The heating system	The village
1. Mzekalashvili Akaki	Tomato Cucumber	250	No	Kareli
2. Kochishvili Besarion	Flowers	200	Yes (Coal and Heavy oil)	Bredza
3. Gongliashvili Goga	Tomato Cucumber	1000	Yes (Underground sulphur water)	Agara
4. Barbakadze Gogi	Nursery (apple, peach etc trees)	1000	No	Kareli
5. Barbakadze Zura	Nursery (fruit trees)	1000	No	Kareli
6. Gongliashvili Vaja	Nursery (fruit trees)	1000	No	Kareli

7. Barbakadze David	Nursery (fruit trees)	1000	No	Kareli
8. Bordishvili Merabi	Flowers	170	Yes (Coal and Heavy oil)	Bredza
9. Gelashvili George	Flowers	200	Yes (Coal and Heavy oil)	Bredza
10. Shubitidze Valerian	Flowers	170	Yes (Coal and Heavy oil)	Bredza

The third visit was arranged to the village Digomi close to the city of Tbilisi. The lectures were delivered throughout two meetings organised by LTD "Garemo da Analitika" in cooperation with the National Ozone Unit of Georgia. The main crops had been tomato and cucumber throughout many years. Experts visited around 60 farmers out of them 15 were selected to participate in the programme.

The table 9: Tbilisi (the village Digomi)

The name and surname	The plot history	The total area treated by MB (m^2)	The heating system	The village
1.Kotorashvili Vano	Tomato Cucumber	300	Yes (Coal and wood)	Digomi
2. Topchishvili Tsitso	Tomato Cucumber	800+800+800	Yes	Digomi
3. Topchishvili Ketevan	Tomato Cucumber	300	Yes	Digomi
4. Khelashvili ramazi	Tomato Cucumber	200	Yes	Digomi
5. Genebashvili Tamaz	Tomato Cucumber	400	Yes	Digomi
6. Genebashvili Irakli	Tomato Cucumber	300+300	No	Digomi
7. Gileri Suliko	Tomato Cucumber	400+400	Yes	Digomi
8. Khositashvili Koba	Tomato Cucumber	400	Yes	Digomi
9. Tatiashvili Vaja	Tomato Cucumber	400+300	No	Digomi
10. Chakhtauri Rezo	Tomato Cucumber	400+400	No	Digomi
11. Songulashvili Rezo	Tomato Cucumber	300+300	Yes	Digomi
12. Songulashvili Vano	Tomato Cucumber	400+400	No	Digomi
13. Pankvacashvili Beso	Tomato Cucumber	300	Yes	Digomi
14. Pankvacashvili Sandro	Tomato Cucumber	400+350	No	Digomi
15.Chaduneli Ramaz	Tomato Cucumber	300+300	No	Digomi

The fourth visit was organised at East Georgia (Lagodekhi) on Tuesday 17 August, 2004. There was delivered lecters and experts identified following potential participants for phase II of the programme

The table 10: East Georgia (Lagodekhi)

The name and surname	The plot history	The total area treated by MB (m^2)	The heating system	The village
1. Tsartsidze Eldar	Cucumber	240 + 240+240	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
2. Kusiani Ketevan	Cucumber, Herbs	2500	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
3. Bakhturidze Zurab	Cucumber	2400	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
4. Bakhturidze Nugzar	Cucumber	2400	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
5. Togonidze Kishvard	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
6. Chkhitunidze Kverin	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
7. Kukhiani Tariel	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
8. Shubitidze Zaza	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
9. Bakhturidze Petre	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
10. Shukakidze Gela	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
11. Darbaidze Temur	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
12. Kimadze Malkhaz	Cucumber	1500	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
13. Sulaberidze Murman	Cucumber	3200	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
14. Kharshiladze Vepkhia	Cucumber	1200	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
15. Djokhadze Avto	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
16. Djokhadze Simon	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
17. Tkemaladze Tamaz	Cucumber	800	No (plastic greenhouse)	Lagodekhi, the village Ulianovka
18. Chkhitunidze Valerian	Cucumber	1000	No (plastic greenhouse)	Lagodekhi, the village Ulianovka

The final field visit was set to Kazbegi region under the phase I of the programme. There was organised small meeting with farmers and disseminated information about the project and alternatives of Methyl Bromide.

The table 11: Kazbegi region

The name and surname	The plot history	The total area treated by MB (m^2)	The heating system	The village
1. Tsiklauri Iuri	Cucumber	300	Yes (gaz)	The village Tkarsheti
2. Maisuradze Vardo	Cucumber	300 +140	Yes (gaz)	The village Tkarsheti
3. Avsajanashvili Kakha	Cucumber	300	Yes (gaz)	The village Tkarsheti
4. Tsiklauri Omar	Cucumber	300	Yes (gaz)	The village Tkarsheti
5. Maisuradze Nodar	Cucumber	250	Yes (gaz)	The village Tkarsheti
6. Maisuradze Genadi	Cucumber	350	Yes (gaz)	The village Kederi
7. Tsiklauri Bejan	Cucumber	250	Yes (gaz)	The village Kederi
8. Chkareuli Gela	Cucumber	400	Yes (gaz)	The village Vardisubani
9. Geladze Dzia	Cucumber	300	Yes (gaz)	The village Garbani
10. Khelelidze Shota	Cucumber	300	Yes (gaz)	The village Arsha

The team developed a brochure in Georgian language on the subject of achieved results under the first phase of the progarmme. Three copies of the brochure are attached to this final report.