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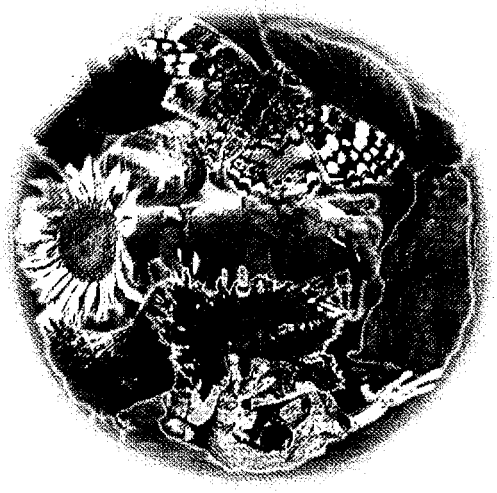
REPUBLIC OF MACEDONIA

AGENCY FOR AGRICULTURAL DEVELOPMENT

DEMONSTRATION PROJECT: ALTERNATIVES TO THE USE OF METHYL BROMIDE



UNIDO Project No. MP/MCD/98/084
Republic of Macedonia

- FINAL REPORT-
January, 2001

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UNIDO PROJECT MP/MCD/98/084
THREE ALTERNATIVES TO THE USE OF METHYL BROMIDE: NONSOIL CULTIVATION, BIOFUMIGATION AND LOW DOSE CHEMICALS IN TOBACCO AND HORTICULTURAL PRODUCTION REPUBLIC OF MACEDONIA

FINAL REPORT, January 2001

ABSTRACT

The main objective of this demonstration trial was to test the possible alternatives to the use of methyl bromide like soil-less cultivation, use of low doses chemicals and solarization/biofumigation and to prove their technical and economical feasibility. One of the projected outcomes is the training of the people that are directly involved in tobacco production. For this reason the trials have been placed in production conditions, in the largest companies that are in charge for the production and by out of the tobacco from the individual growers in the region. The agricultural policy allows company participation with sowing material, chemical, fertilizers and machines in the buy out price. The positive results of this project would create a possibility for centralized seedling production in these companies, so that the individual growers from the region may be supplied with unified and healthy planting material.

The Demonstration project "Alternatives to the use of methyl bromide" begun in February 1999 and was projected to be completed by the end of 2000. The project has been developed in two cycles. The first project year was selection of the most feasible alternative. Based on the results obtained in the first trial year and the experience from the growers that were involved in this project, for the tobacco seedling production, the Floating Tray System has been chosen for further examination, and for the vegetable production, the most feasible one was the solarization and biofumigation treatment.

Having the conclusions from the previous year as a starting point, the treatments with Dazomet and Solarization and Biofumigation were excluded from the tobacco trials, same as the treatment with soil-less cultivation from the vegetable production trials.

During the report period the trials were established in four locations for the tobacco sector: Kumanovo, Prilep, Radovis and in Krusevo. In order to disseminate the results of this technology additional contacts have been made with individual tobacco growers who were also included in this project cycle.

The second cycle of the vegetable trials commenced at the beginning of year 2000. The effectiveness of different soil sterilization treatments: biofumigation & solarization, Dazomet, Methyl Bromide and low doses of Mocab as a control treatment has been tested. The assessment of different treatments have been made by evaluation of the yield and growth dynamics of tomato and cucumbers.

The results and recommendations from the project period were made available to the Macedonian tobacco and vegetable producers, through several presentations and meetings.

INTRODUCTION

Tobacco and vegetables are economically the most important crops for the Republic of Macedonia. The existence of over 60000 families is related to the tobacco production. The acreage under tobacco varies from year to year and ranges from 20000 ha up to 30000 ha, and 40000 ha for vegetable production.
The Demonstration project: "Three alternatives to the use of methyl bromide: nonsoil cultivation, biofumigation and low dose chemicals in tobacco and horticultural production" was approved at the Twenty sixth meeting of the Executive Committee of the Multilateral Fund for Implementation of the Montreal Protocol in November 1998.
It was implemented by UNIDO and the coordinating agency is the Ozone Unite at the Ministry of the Environment. This project in the Republic of Macedonia was being carried out by the Agency of Agricultural Development, as a head office of the extension services in Macedonia. The Agency has engaged an expert team from the Faculty and Institute of Agriculture. The required analyses were made in the Nematology Department, Plant Pathology Department and Soil and Nutrition Department of the Institute of Agriculture and the Faculty of Agriculture, Hydrometeorological Department and the Institute of Tobacco.
Methyl bromide is being used for soil sterilization, 90% of it for tobacco young plants production and 10% for the greenhouse production of vegetables. The actual methyl bromide consumption, based on the exploited acreage and producers experience, seemed to be well over the officially reported figures in 1998 of around 20 t/year. The Faculty of Agriculture made a survey at the beginning of 1999 in order to determine the exact amounts. Based on the result of this survey the estimated quantities of methyl bromide spent in the Republic of Macedonia, for tobacco seedling and horticultural production, both, are 45.4 tonnes.
All objectives defined with the Terms of Reference (Project MP/MCD/98/084, Annex B) have been completed. The results of the two-year activities on deterring the most feasible alternative to the use of methyl bromide in tobacco seedling and horticultural production are presented in this report.

EXPERTS TEAM ENGAGED IN THE REPORT PERIOD

National coordinator Prof. Gjorgji Martinovski, PhD, Faculty of Agriculture, Skopje

Name	Position Title	Engagement in months
Gordana Popsimonova, Ph.D., Institute of Agriculture - Skopje	Technical supervisor	12
Metodi Milanov, Ph.D. Faculty of Agriculture, Skopje	Agroeconomist	4
Eftim Anchev, Ph.D. Faculty of Agriculture, Skopje	Agronomist	6
Simon Karajankov, Ph.D. Faculty of Agriculture, Skopje	Agronomist	6
Risto Vuchkov, Ph.D. "Agroprotekt" - Strumica	Agronomist	6

Valuable contribution to the accomplishment of the project activities also had: Dr Kiril Filipovski , Director General of the Institute for Tobacco -Prilep, Dr Slobodan Bandzo as advisor for Plant Protection at the Institute of Agriculture, Zlatko Arsov, MSc, Gjorgji Mishkovski , BSc and Romina Karajankova, BSc.

AD TUTUNSKI KOMBINAT PRILEP
- Dipl. eng. Mihail Hristovski - Deputy General Director for production and processing of tobacco.
- Dipl. eng. Gerdanovski Mile- Director of Development Department
- Dipl. Eng. Srkevski Kiril - Chief of the production sectors in Konjari village, where trial was designed.
- Zarko Vukotic, MSc - Head of the Development Department
- Dipl. Eng. Trajce Nikolovski - directly in charge for monitoring of the trials in Prilep.

AD JAKA TABAK - RADOVIS
- Dipl. Eng. Dimitrake Georgiev - General Director,
- Dipl. Eng. Aleksandar Atanasov - Deputy Director General,
- Dipl. Eng. Boris Vasilev, Head of Processing Department,
- Dipl. Eng. Blaze Donev - Head of Department for Primary Production
- Mr. Branko Tanev - directly in charge for the trials in Radovis

AD TUTUNSKI KOMBINAT - KUMANOVO:
- Mr. Todor Cuskarovski MSc, Director General
- Dipl. Eng. Miodrag Tasevski, Director for Production and Processing,
- Dipl. Eng. Ljube Mladenovski, Head of Primary Production and
- Mr. Ignjat Serafimov - Technical coordinator and directly in charge for the trials in Kumanovo.

In the second phase of the Project AD "NIKO DOAGA" - KRUSEVO participated
Dushan Trajchuleski, Director General
Saho Stefanovski, Deputy General Director
Dimitar Mihajloski, - Head of Primary Production
Dushko Dunimagleski - ccoperant

The Agency has authorized four persons to follow the project activities and to disseminate the positive outcome into the practice:
Dr Gorica Kotevska for Prilep;
Mr. Cvetanovic Tome for Kumanovo;
Mr. Sojcev Stanoja for Radovis and
Gligorov Vasil, MSc for Valandovo

FOREIGN EXPERTS ENGAGEMENT

Mr. Sanz de la Morena, (March15th - 20th .1999)
In spite of the adverse weather condition Mr. Morena's mission was completed successfully. All locations have been visited, including AK Anska reka - Valandovo. The detailed design for the trials for all four locations have been organized.

Mr. Sanz de la Morena (May 31- June 06.1999)
Mr. Morena's second visit took place during preparation for transplanting and preparation of Valandovo trials. He gave useful suggestions about the trials, especially about the floating tray system that is a completely new method for our tobacco growers. In that respect, a booklet on the principles of cultivation in floating trays has been transplanted and distributed to the people locally in charge for the trials. A detailed report about the activities in the Republic of Macedonia is submitted by Mr., Morena to UNIDO office.

Mr. Guillermo Castella (November, 1999)
Mr. Guilermo Castella visited the project cite at the end of November 1999. The past year activities were dicussed and preparations for the next period were arranged. Mr. Castella met the representatives of all participating companies, along with representatives of the Agency for Agricultural Development and the expert team, to hear their experiences and their impressions from the initial project results.

Mr. Francis Lemaire (February 21-25.2000)
Being expert on substrates, Mr. Lemaire gave useful suggestions on the choice of materials that can be used for FTS substrate mixture. He gave a lecture on substrate properties and their evaluation, at the Faculty of Agriculture. The audience consisted of the representatives from the kombinats in which the Project is carried out, Ministry of Environment, Institute of Agriculture and students from the Faculty of Agriculture.
Mr. Lemaire has discussed the possibilities of using local substrates with representatives of each of the kombinats: Kumanovo, Prilep and Radovis. Some of the local factories that are possible suppliers of substrate materials like "Partizanka" and "Crn bor" from Prilep were visited.
His recommendations were essential for the substrate preparation for the second phase of the Demonstration project.

Mr. Sanz de la Morena (April 01-07.2000)

Mr. Sanz de la Morena is well acquainted with the developments in the project area. His role was to give his aid in the sowing phase, since it was being carried out with sowing machines and different sizes of trays. His opinion was valuable in the preliminary evaluation of different numbers of alveoli and consequently their capacity.
He had visited the ongoing trial in "Anska reka" and discussed the biofumigation and solarization treatment that was chosen as most successful in the previous year trials.
The manual for the semi-automatic machine has been translated into Macedonian and multiplied for the final users - representatives of the kombinats.
Since the equipment supplied by UNIDO (additional trays and sowing machines) was still at the customs depot, during the stay of Mr. Sanz de la Morena, few samples of the trays and one manual sowing machine was taken in order to demonstrate to the participants of the Project the actual procedure of sowing. The demonstration took place at the Faculty of Agriculture in Skopje in presence of representatives of all involved kombinats.

Mr. Guillermo Castella and Mr. Rafael Sanz de la Morena (1306-17.06.2000)

Mr. Castella and Mr. Morena visited the trials in Kumanovo and the individual grower in Godivje, Krushevo, prior to transplanting. They had chance to see the difference among different treatments, as well as the difference between this and last year's results.

DISSEMINATION OF THE PROJECT RESULTS

During the reporting period, the public was several times informed about the purpose and the development of the project through the national and local TV networks. The Agency in communication with the growers found positive reactions to the project results.

A seminar was held in March, with two papers presented regarding the Project activities in the field of tobacco young plant production and alternative technologies in vegetable production. An audience of 50 people from the Agency for Development in the Agriculture, research workers and farmers from around the Country attended the Seminar.

In front of a similar auditorium, at the Faculty of Agriculture in Skopje, by the end of June 2000 a demonstration of the results achieved in the last period was provided held and an agreement was made for the future project period.

In the middle of September a documentary entitled "For Our Planet-Without Methyl Bromide", and brochure with the same title was promoted in front of a large audience and the press-representatives. The 30 minutes documentary was presented on several TV stations throughout the Republic, and the brochure has been distributed via the Agency for Agricultural Development in all regional extension services.

In the framework of the Demonstration project multimedia CD-ROM, along with a web page and a brochure for the project activities have been published. The promotion was carried out on the final Workshop, held on 08.12.2000, at the Faculty of Agriculture with over 100 representatives of all the tobacco kombinats, extension services etc.

MATERIALS AND METHODS - tobacco

The trials were placed in three different tobacco production companies through the Republic:

1. JAKA TABAK - Radovis
2. TUTUNSKI KOMBINAT - Prilep
3. TUTUNSKI KOMBINAT - Kumanovo

The irrigation water was analyzed and accordingly corrected with sulfuric acid prior to sowing with regular check-ups for EC, pH and water temperature. Some potassium permanganate was added into the water to prevent alga precipitation. No chemicals for plant protection were added.

In order not to be interfered with the experimental outcome the soil beds were covered with sterilized manure after sowing. In the regular seedling production the manure for covering is treated with Methyl Bromide.

Fertilizer used for the Floating Tray System is Soluveg (20.8.20 + oligoelements) with target concentration of 80 ppm N in the nutrient solution. The soilbeds were fertilized with basic nutrient with the autumn plowing and NPK (15.15.15) 100kg/ha prior to fine cultivation. No fertilizers were added during the cultivation, except the liquid organic manure in the Low Dozes Chemical treatment in Prilep (SKAF 1.2 ml/m^2).
In the first trial year (1999) the experimental design was completely randomized block system in three replications and following treatments:

- Control-non treated
- MeBr conventionally applied
- Basamide (Dazomet)
- Floating tray system
- Solarization/biofumigation

The size of plastic covered soil seed beds was (1m x 10m), whereas the size of seed beds with floating trays system was (1.05m x 3.05m). Alternative treatments were being compared to the control (non-treated plot) and MeBr treatment.
Description of the proposed alternatives

Soil-less cultivation - In nurseries, glasshouses and seedbeds, as well as in other cases, synthetically or naturally sterilised soil substitutes provide reliable support to prevent infestation by bacteria, fungi, nematodes and weeds. Soil-less media may be roughly divided into two classes: organic and inert. Organic media, such as peat, sawdust, straw bales, spent mushroom compost, etc., have a good cation-exchange and water-holding capacity. Inert media, such as rock wool, perlite, polyurethane, expanded clay, polystyrene, etc., have a high water-holding capacity but low cation-exchange capacity. Vermiculite is not completely inert chemically. Organic

media and some inert media can be easily sterilized with steam and re-utilized. Some inert media can also be re-extruded.
Inert soil-less media is extensively used in the Netherlands, Italy, Denmark and other countries. Cheap organic substitutes, such as sterilized grain-hulls and waste bark, are also used and are starting to be widely used in some third world countries

Low-dose chemicals - This is the use of a mixture composed of various fumigants such as methylisothiocyanate and methylisothiocyanate-generating products, e.g., metam sodium, Dazomet (the efficacy of which depends on soil preparation and moisture, climatic factors, and the application method) and halogenated hydrocarbons, e.g., 1,3-dichloropropene (which performs quite consistently for sensitive pests). Methylisothiocyanate (MITC) and MITC-generators, metam sodium (Vapam ®), Dazomet (Basamid ®), and 1,3-dichloropropene (TeloneII ®) are chemical pesticides used in tobacco and horticultural production.

Solarization plus biofumigation - this technique consists simply of heating the moist soil mixed with organic matter by covering it with a transparent plastic sheet which increases the soil temperature to a level lethal to soil pests. At the same time, the temperature reached favors the fermentation of the organic matter, generating gases, which are trapped by the plastic, and which are deadly to many microorganisms. This also reduces the time needed by solarization alone. In countries with a temperate climate this inexpensive technique, which combines solarization and bio-fumigation, was successfully tested and is now in use on a full commercial scale

The second year there were 3 replicates of pools at each site, one for each of the following 4 substrate mixtures:

- 50% Dutch peat + 50% perlite
- 50% local black peat + 50% perlite
- 2/3s Dutch peat + 1/3 perlite
- 2/3s spent mushroom compost + 1/3 perlite

Each pool contained 10 trays of each size: 209 , 264 and 338 cells, which amounts to 12 pools with a total surface close to 35 m^2. In Radovis location a tray with 589 alveoli was tested.

In all three tobacco locations the variety Prilep NS-7 that is registered from 1984, was cultivated:
Morphological characteristics: the appearance of the whole plant is cylindrical with plant height of around 90 cm. On fertile soils the height can reach up to 120 cm. The stem is relatively thin, but firm. The stem thickens is equal from the bottom to the top of the plant. The average leaf number is 50-60. In conditions of fertile soil this number can be much larger. The angle between the leaf and the steam is small and the length of internods is approximately 2 cm. In normal growing conditions, it often happens that several leaf buds (4 in average) are being formed at the same place of the plant, which is the essential difference compared to the standard variety with separated leafs, growing in a spiral pattern. The leaves are relatively small, with maximum length of 20 cm, and maximum width of 11 cm. The index is 1.8. The leaf shape is fish-like, with curled edges, medium frequent nervature.
Biological characteristics: Due to the larger number of leafs, this variety is characterized with longer vegetation period compared to the standard varieties. It takes 120-150 days from transplanting till the harvesting of the top leafs. The technological maturity is manifested by yellowing and intensive gloss of the leaf

color. Due to the strongly developed root system, and smaller number of areal roots, this variety is more tolerant to *Orobancha ssp., Phytophtora tabaci, Perenospora tabacina* Adam. The yield is relatively high. In slope terrenes the yield is 14-15 g/plant and in valleys with fertile soils the yield is 30 g/plant of oriental small leaf row material.

Technological characteristics: typical for the oriental type varieties, with easily disintegrated chlorophyll during drying and fermentation, and very good aroma.

Air and soil temperature (in the Control, Low doses chemicals and Solarisation+Biofumigation seedbeds) was recorded daily with HOBO data logger.

Biological analyses are made as required in TOR, prior to treatment, after treatment and before transplanting. The effectiveness of the treatments was estimated with quantitative analysis of the pathogens present in the soil and by the appearance of symptoms on the plants and roots. Counting for nematodes was carried out under dissecting microscope and for Fungi, Phycomicetes and Bacteriae the quantitative method for 1 g air dry soil was used with dilution of 1:10; 1:100 and 1:500. Weeds were determined and counted per square meter for each of the soilbed treatments.

The condition of the young plants were evaluated with analysis of the following parameters: percentage of germination, total plant length, stem length, root length [cm], stem diameter [mm], fresh and dry mass per plant [g]. Recorded values were processed by analysis of variance and compared both to the Control and Methyl Bromide treatment.

In open field, the following parameters were followed: acceptance rate, leaf length, leaf diameter, plant height and number of leafs per plant. Based on the measurements for fresh and dry mass per plant, the drying ratio was calculated, along with the total yield per hectare.

Leaf quality, as a row material, was evaluated as percentage of participation in three quality classes: I class (locally named as Unique1/3); II class (3^{rd} light) and III class (4^{th} light).

Chemical analysis was carried out on dry leaves for the following traits: percentage of nicotine, total nitrogen [%], nitrogen in proteins [%], proteins [%], soluble sugars [%], polyphenols [%], total reduction, ash [%], Schmooks number and polyphenolic number, for all treatments in the three locations for tobacco cultivation.

I. 1. Results from "Tutunski kombinat" - Prilep

Hectarage 7-8000 ha
Average lot size of 0.3-0.4 ha
10000 contractors
Prevailing varieties:
Oriental type: Prilep (Prilep NS72, Prilep 156, Prilep 133)
Virginia: Macedonian Virginia (MV)
Target pathogens:
Botrytis cinerea
Ryzoctonia solani
Perenospora tabaci
Melidoginae sp.

General climatic conditions in the region of Prilep (1990-2000)

Months	Average air temperature	Maximum air temperature	Minimum air temperature	Average number of days with $t^0<0^0$	Average amount of rainfalls	Average relative humidity
I	-0.1	18.7	-23.6	22.0	42.4	81.0
II	2.1	21.7	-21.9	16.8	40.4	76.0
III	5.8	31.9	-15.8	10.4	43.6	70.0
IV	10.7	29.9	-3.0	1.2	45.4	64.0
V	15.5	33.7	-0.2	-	66.8	64.0
VI	19.4	38.7	2.2	-	49.3	60.0
VII	21.7	41.5	3.6	-	35.7	56.0
VIII	21.6	39.4	5.3	-	33.4	55.0
IX	17.5	36.6	-0.7	-	37.0	62.0
X	11.7	32.3	-5.2	1.3	53.2	71.0
XI	6.5	24.6	-11.0	6.6	64.9	78.0
XII	1.9	19.7	-20.8	17.6	44.6	81.0

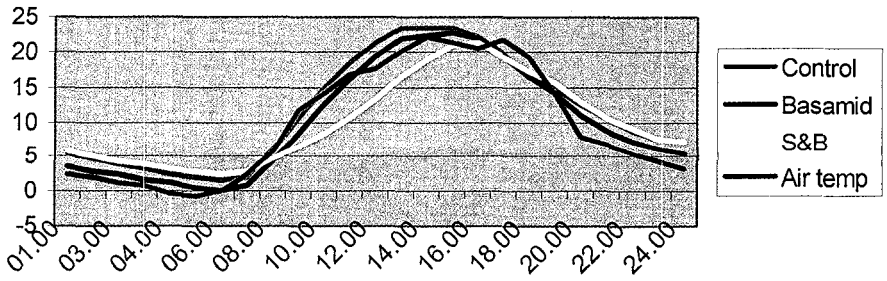
First phase results

According to the background temperature information on the region, given in the previous report, and the prevailing temperatures (Graph. 1) in the projected time of application for Dazomet it was decided to replace that treatment with combination of chemicals that are available on the local market, in low doses.

Treatments, time of application and doses are listed bellow:

Treatment	Dose	Date of application	Date of sowing
Control-non treated	-	-	17.04.1999
MeBr conventionally applied	50 g/m^2	30.10.1998	17.04.1999
Low doses chemicals:		28.04.1999	17.04.1999
Benalaxil	0.1 g/m^2		
Tiophanate	0.2 g/m^2		
SKAF (liquid organic manure)	0.12 ml/m^2		
Cytradine (iodine+citric acid)	0.06 g/m^2		
Floating tray system	-	-	17.04.1999
Solarization/biofumigation	5 kg/m^2	04.03.1999	17.04.1999

Graph 1. Daily temperature fluctuation in Prilep (04.04.1999)



The water for the nutrient solution was treated with 4 ml sulfuric acid per 100 l of water. Fertilizer was added till conductivity of 1.4 mS/cm was reached. The temperature at the time of application was 18^{0}C and the pH 5.1. The conductivity was maintained regularly with each filling of the pools. The soilbed treatments were regularly irrigated, every second day.

Regarding the health condition of the plants, there was no need for intervention, except one treatment with Vertimec (0.01%) before transplanting, because there was incandescence of Trips at the host weeds near the trial plots.

The total nematode density (Tab. 1) indicates that both soilbed alternatives to methyl bromide (low doses chemicals and solarization/biofumagation) were very efficient, beside the low temperatures prevailing in the period of young plant cultivation. The same conclusion can be reached for fungi and bacterial control (Tab. 2), except for the S&B treatment, in which the number of pathogen colonies was not reduced.

Table 1. Total nematode density per m^2- Prilep

Time of sampling	Control	Methyl Bromide	LDC	S&B
Before treatment	29650	27832	30205	28561
After sowing	37516	1736	3248	2412
Before transplanting	45382	2604	8446	2895

LDC-Low doses chemicals
S&B-Solarization+Biofumigation

Table 2. Number of colonies in 1 g of air dry soil in Prilep

Time of sampling	Control	Methyl Bromide	LDC	S&B
Fusarium sp.				
Before treatment	32	35	32	33
After sowing	30	5	4	21
Before transplanting	35	-	-	25
Alternaria sp.				
Before treatment	5	5	6	6
After sowing	7	-	3	6
Before transplanting	6	-	2	7
Phycomicetes				
Before treatment	6	7	4	6
After sowing	6	-	7	7
Before transplanting	7	-	3	8

*Saprophytic forms of Bacteria present in all samples

Table 3. Weed density per m^2 - Prilep
(three weeks after sowing)

Weeds	Control	Methyl Bromide	LDC	S&B
Amaranthus retroflexus	18	/	2	9
Chenopodium album	13	/	7	5
Cynodon dactilon	/	/	/	/
Cuscuta sp.	20%	3%	10%	5%
Graminaceae	21	/	17	11
Urtica dioica	16	/	/	/
Portulaca sativa	132	3	28	58
Trifolim sp.	41	/	12	20

The weed count also showed good results, taking into consideration all conditions. Although, all soilbed treatments performed better than the non treated plots, regarding weed control, the treatments with Dazomet and solarization with biofumigation were characterized with relatively high number of weeds per unit of area. Presence of *Cuscuta sp.*, which is difficult to be controlled, even by methyl bromide, was recorded in all treatments.

Table 4. Percentage of germination - Prilep
(one week after sowing)

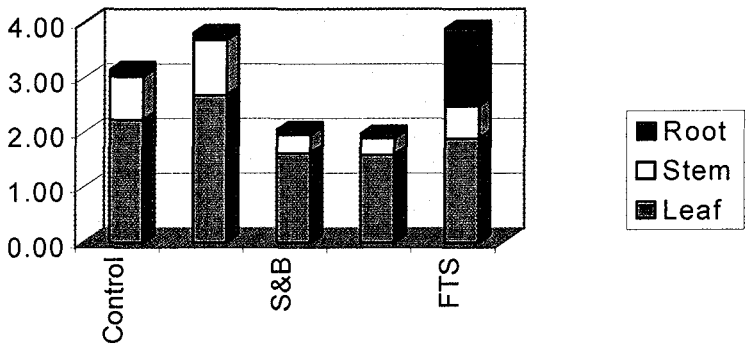
Treatments	Number of germinated plants/m^2	Expected number of plants/m^2	Percentage of germination
Control	440	1500	29.3
Methyl bromide	670	1500	44.7
Low doses chemicals	480	1500	32.0
S&B	510	1500	34.0
Floating tray system	1290	1393	92.6

Germination rate (Tab. 4) was considerably low, from 29.3% in the non-treated plots up to 95.6% in the floating tray system. It may be explained as a result of the strong wind during sowing of the trials. The plants from the floating tray system were manually thinned five days after germination into separate cells, prior to the counting for germination.

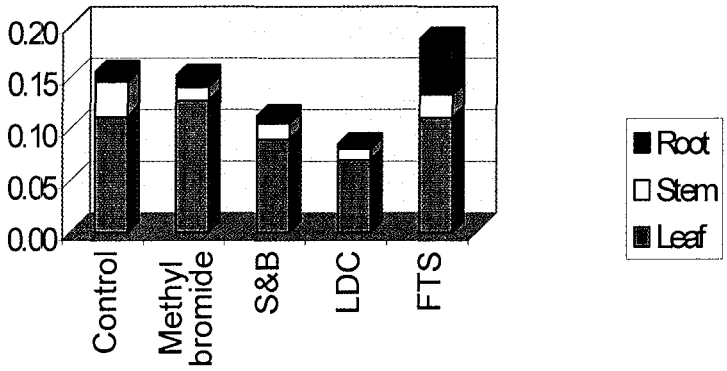
Table 5. Analysis of seedling parameters- Prilep

Plant parameters		control		treatments		
		Control C1	Methyl Bromide C2	Floating tray system	Low doses chemicals	Solarization + biofumigation
Plant length	avg	10.81	14.08	18.07	8.27	6.29
	stdev	0.92	1.19	0.73	0.34	0.20
	VK	8.53	8.43	4.04	7.16	7.22
compared to control 1		**C1**		7.26	-2.53	-4.52
compared to control 2		**C2**		3.99	-5.81	-7.79
			LSD	0.005=1.59; 0.001=2.32		
Stem length	avg	9.30	9.65	7.93	5.21	4.63
	stdev	0.14	0.15	0.73	0.38	0.33
	VK	9.27	8.59	1.48	7.29	7.06
compared to control 1		**C1**		-1.37	-4.08	-4.66
compared to control 2		**C2**		-1.72	-4.43	-5.01
			LSD	0.005=1.59; 0.001=2.32		
Root length	avg	3.09	4.10	9.80	2.53	1.96
	stdev	0.38	0.23	0.47	0.38	0.16
	VK	12.33	5.68	2.84	14.94	8.21
compared to control 1		**C1**		6.71	-0.56	-1.13
compared to control 2		**C2**		5.70	-1.57	-2.14
			LSD	0.005=0.69; 0.001=1.00		
Stem diameter	avg	3.12	3.59	3.77	3.06	3.13
	stdev	0.22	0.43	0.18	0.31	0.36
	VK	6.52	11.43	4.70	10.24	11.64
compared to control 1		**C1**		0.65	-0.06	0.01
compared to control 2		**C2**		0.18	-0.53	-0.46
			LSD	0.005=0.44; 0.001=0.64		

Graph 2. Fresh mass of tobacco young plants in Prilep [g]



Graph. 3 Dry mass of tobacco young plants in Prilep [g]



Young plants from the floating tray system gave best results, regarding analyzed plant parameters (Tab. 5). The root system was far better developed compared to the rest of the treatments; the plants were uniform, and the stem diameter satisfactory, although the plants have not been trimmed. Few trays were trimmed only week prior to transplanting, just to test the procedure and to see the possible outcome. The assumption was that due to the small size of oriental tobacco seedlings there would be no need for them to be trimmed in the future.

The poorest results were obtained in the treatment with solarization and biofumigation, closely followed by the treatment with low dose chemicals. It is obvious from the Graphs 2 and 3 that they had performed worse than the non-treated plots and methyl bromide treated both. The small portion of root mass that can be noticed in the soilbed treatments compared to the larger leaf mass, in general, does not give good perspective for acceptance in open field.

The tobacco young plants in Tutunski kombinat - Prilep were transplanted by the end of June, 1999. Two weeks after transplanting the acceptance percentage (survival rate) was recorded. The results are presented in table 6.

Table 6. Acceptance percentage
(two weeks after transplanting)

Treatments	Percentage
Control	58
Methyl bromide	65
Solarization+biofumigation	65
Floating tray system	90

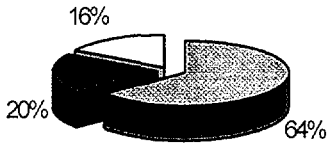
The acceptance rate was highest in the floating tray treatment (90%), due to the well developed root system, good condition of the transplants and consequently proper mechanized transplanting.
Average values for the plant parameters in open field, presented in the Table 7. It is important to be noted that the variation coefficient is lowest in FTS treatment for all plant parameters, compared to the rest of the treatments, which is one more proof for the uniformity among the plants grown in this system.

Table 7. Plant parameters in open field

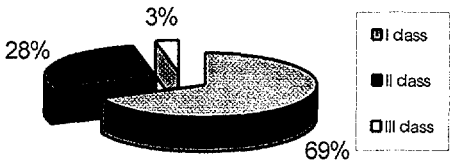
		control		treatments		
		C1	**C2**	**1**	**2**	**3**
Leaf	avrg	17.47	18.41	14.37	16.08	16.43
length [cm]	stdev	0.91	0.61	0.65	2.56	1.47
	CV	5.19	3.30	4.53	15.90	8.97
compared to control 1		**C1**		-3.10	-1.39	-1.03
compared to control 2		**C2**		-4.04	-2.34	-1.98
			LSD	**0.005=2.67; 0.001=3.88**		
Leaf	avrg	9.40	9.67	8.80	6.71	9.57
diameter [cm]	stdev	0.34	0.19	0.52	0.79	1.01
	CV	3.66	1.98	5.90	11.80	10.57
compared to control 1		**C1**		-0.60	-2.68	0.17
compared to control 2		**C2**		-0.87	-2.95	-0.10
			LSD	**0.005=2.47; 0.001=3.59**		
Plant	avrg	61.60	61.37	62.50	61.67	63.13
height [cm]	stdev	2.40	5.57	1.21	0.50	2.80
	CV	4.90	9.08	1.94	0.82	4.43
compared to control 1		**C1**		0.90	0.07	1.53
compared to control 2		**C2**		1.13	0.30	1.77
			LSD	**0.005=6.13; 0.001=8.92**		
Leafs per	avrg	35.33	34.50	37.93	34.53	34.93
plant	stdev	0.32	1.71	0.83	0.15	0.86
	VK	0.91	4.94	2.20	0.44	2.47
compared to control 1		**C1**		2.60	-0.80	-0.40
compared to control 2		**C2**		3.43	0.03	0.43
			LSD	**0.005=1.98; 0.001=2.88**		

Graph 4. Distribution of leaves from different treatments in quality classes

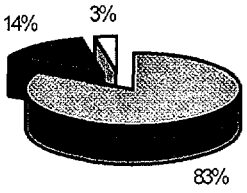
Control –non treated



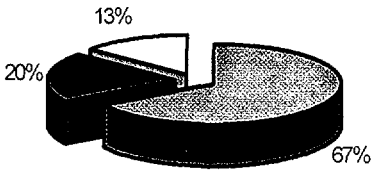
Methyl Bromide



Floating Tray System



Solarization & Biofumigation



The buy-out price for tobacco leaves, as raw material, depends on the quality class, which is determined by the leaf dimensions. From the conclusions obtained from the plant analyses it was obvious that the plants grown with FTS were given good support to exhibit the variety characteristics of Prilep NS-72. Most of the leaves belong to the first class (Unique 1/3), i.e. 83% of the total yield and only 3% to the III class. In the methyl bromide treated plants, it can be noticed that the portion of leaves that is categorized as an II quality class is larger (28%).

Table 8. Fresh and dry mass per plant [g], drying ratio and total yield [t/ha]

Treatments	Fresh mass/plant	Dry mass/plant	Drying ratio	Fresh yield/ha	Total yield
Control	84.50	17.59	4.80:1	15.20	3.16
Methyl bromide	80.50	16.45	4.89:1	14.49	2.96
S&B	77.50	16.72	4.63:1	13.95	3.01
Floating tray system	85.00	18.55	4.58:1	15.30	3.34

The drying ratio is one of the most important indicators for the yielding quality (Table 8) was recorded to be below 5, but still the FTS treatment had the lowest values for the ratio. Regarding the total yield, depending on the climatic conditions and the cultivation practices during the vegetation period, it defers from one to another treatment, with no significant difference within treatments. It should be noticed that the total yield was calculated for 180000 plants/ha with no correction for the acceptance percentage.

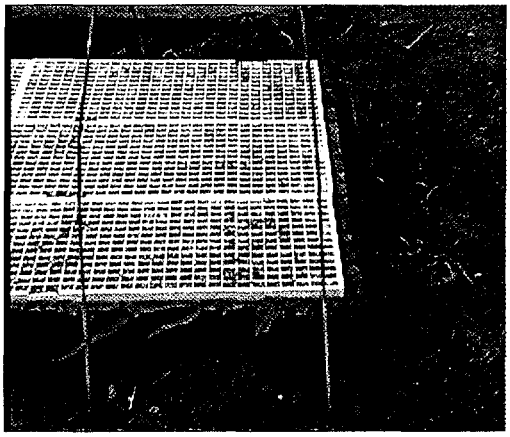
Table 9. Chemical analyses of the leaf

Treatments	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars%	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
C 1	1.59	2.82	1.19	7.45	15.46	3.53	18.99	10.77	2.08	18.59
C 2	2.40	2.14	1.76	10.98	11.72	0.70	12.42	11.73	1.07	5.64
1	1.85	2.72	1.14	7.11	19.17	2.50	21.67	9.62	2.70	11.54
2	1.22	3.54	1.03	6.48	27.69	5.67	33.36	8.99	4.27	17.00

C 1 - Non treated
C 2 - Methyl bromide
1 - Floating tray system
2 - Solarization + Biofumigation

The chemical analyses of the dry leaf indicate that the treatment with methyl bromide contained highest percentage of nicotine and the lowest values for the Schmooks number. Regarding the chemical traits the treatment with solarization and biofumigation had the best performance in all parameters.

Second phase results



The region of Prilep is in general characterized with delayed sowing periods, so that the delay with the trials did not affect much the results from the trials, compared to the common production of young plants. Sowing started at 30.04.2000. Based on the water analysis the irrigation water in the pools was corrected with 10 ml of sulfuric acid /100l of water. The initial conductivity of 1.5 mS/cm was obtained by adding 8g /l of water soluble Soluveg 20:8:20.

Table 10. Seedling parameters in relation to tray size and substrate - Prilep

Plant parameters	Tray size	Type of substrate 1	2	3	4
Root length [cm]	209	9.02	9.18	7.14	[1]10.58
	264	8.11	10.80	8.23	10.14
	338	10.15	9.67	9.56	8.12
Stem length [cm]	209	6.72	7.60	9.90	7.40
	264	8.12	8.43	10.03	9.63
	338	8.42	7.12	10.27	8.12

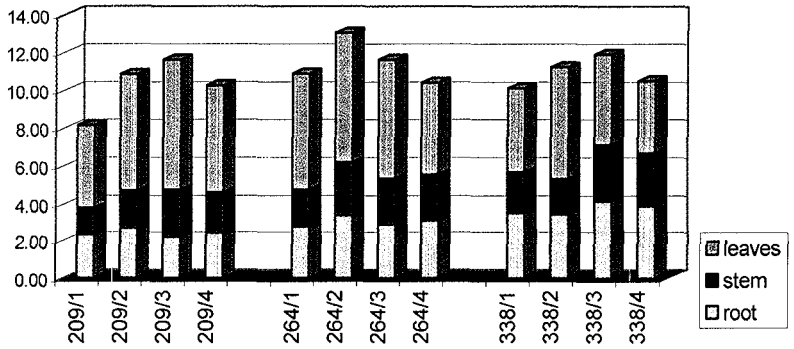
Table 10. Seedling parameters in relation to tray size and substrate - Prilep (continued)

Plant parameters	Tray size	Type of substrate 1	2	3	4
Stem diameter [mm]	**209**	4.80	5.31	[11]6.14	5.12
	264	5.01	5.80	6.08	5.64
	338	4.31	5.64	5.70	4.02
Number of leaves	**209**	6.30	5.20	6.80	6.50
	264	6.28	5.31	6.71	6.48
	338	6.40	5.40	6.00	6.80

The experimental design of 12 treatments in total, three tray sizes and four substrates was also applied in Prilep.

In order to test the germination of pelletized seeds in field conditions, one regular seedbed treated with Methyl Bromide was sown with this kind of seeds. The germination rate was equal to the one from the Floating Tray System (78%). This facts, along with the reduction caused by the sowing device (-20% approximately) should be taken into consideration when calculating the sowing rates. Commonly, for one seedbed of 10 m^2 growers use 7 g of seeds. The Floating Tray Systems offers possibility for savings in the sowing material, but the realistic amount and proper way of sowing needs to be estimated for obtaining of optimal results.

Graph 5. Green mass of different organs [g] in relation to supstrates and tray size



Regarding the plant parameters of the seedlings (table 10), measured prior to transplanting, it was noticed that there is no significant difference among treatment, in respect of the tray size or the substrate mixture. The only significantly high differences (at level of 0.001) was recorded for stem diameter in the treatment of 209 trays, with mushroom compost and perlite, compared to the Dutch peat and perlite, and in the root length between the young plants grown in Dutch peat and tuff, compared to the ones grown in Dutch peat and perlite, again in 209 trays.

The green mass analyses (graph 5.) of different organs indicates that root mass is largest in the trays of 338 size and the values for the same characteristic are lowest for the 209 trays. In general, the plants grown in local peat and perlite (2) and mushroom compost and perlite mixture (3) performed better than the rest of the substrates. The

situation was similar in the rest of the trial locations, which gives good perspectives for exploitation of locally produced mixtures on large scale.

Table 11. Acceptance percentage - planting density 180000 plants/ha
(two weeks after transplanting)

Tray size	Type of substrate mixture			
	1	2	3	4
209	93.15	93.78	94.35	93.58
264	93.14	94.67	95.12	94.23
338	93.11	94.66	94.21	94.37
Methyl bromide			70.19	

Same as in the first phase, the acceptance rate was measured three weeks after transplanting. It was recorded to be higher in the floating tray treatments, due to the well developed root system and the generally good condition of the transplants. There was no significant difference recorded among the different treatments of the FTS. In general, the percentage of acceptance was higher than 90.

Table 12. Leaf diameter [cm]

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	8.76	6.69	6.89	6.79	7.08
	stdev	1.95	1.16	0.83	1.02	0.92
	CV	3.92	1.35	1.36	1.75	1.77
	LSD		-2.07	-1.87	-1.97	-1.67
264	avrg	8.76	6.49	7.08	6.99	6.89
	stdev	1.95	1.14	0.85	1.08	0.99
	CV	3.92	1.74	1.42	2	1.65
	LSD		-2.26	-1.67	-1.77	-1.87
338	avrg	8.76	6.2	6.1	6.4	5.9
	stdev	1.95	1.13	1.24	1.25	1.11
	CV	3.92	2	1.05	0.88	1.99
	LSD		-2.56	-2.66	-2.36	-2.85
			LSD 0.001 1.12; 0.005 0.06			

Average values for the plant parameters in open field are presented in the tables 12 and 13. It is important to be noted that the variation coefficient is lowest in FTS treatment for all plant parameters, compared to the plants grown in traditional system, which is one more proof for the uniformity among the plants grown in this system.

Table 13. Leaf length [cm]

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	17.43	12.88	12.84	12.3	12.84
	stdev	1.99	1.2	0.87	1.06	0.96
	CV	5.04	2.47	2.48	2.87	2.89
	LSD		-4.55	-4.59	-5.13	-4.59
264	avrg	17.43	13.46	13.6	13.04	13.89
	stdev	1.99	1.18	0.89	1.12	1.03
	CV	5.04	2.86	2.54	3.12	2.77
	LSD		-3.97	-3.83	-4.39	-3.54

Table 13. Leaf length [cm]
(continued)

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
338	avrg	17.43	12.37	12.84	13.44	13.96
	stdev	1.99	1.17	1.28	1.29	1.15
	CV	5.04	3.12	2.17	2	3.11
	LSD		-5.06	-4.59	-3.99	-3.47
			LSD 0.001 2.13; 0.005 1.41			

Taking into consideration the fact that the smaller leaves are appreciated, the FTS treatments in Prilep had significantly better leaf quality, compared to methyl bromide treatment. The leaf length in open field was similar among the FTS treatments, but smaller than the methyl bromide treatment. It can be noticed that the variation coefficient is considerably smaller than in the control seedbed.

Table 14. Number of leaves per plant

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	33.5	41.4	40.29	40.37	39.45
	stdev	5.53	3.54	3.14	3.37	3.25
	CV	8.88	4.92	5.42	5.17	5.05
	LSD		7.9	6.79	6.87	5.95
264	avrg	33.5	42.24	41.37	43.36	42.31
	stdev	5.53	3.52	3.16	3.44	3.33
	CV	8.88	3.57	4.68	5.66	4.8
	LSD		8.74	7.88	9.86	8.81
338	avrg	33.5	39.37	39.40	40.40	41.45
	stdev	5.53	3.51	3.64	3.65	3.48
	CV	8.88	4.06	3.44	3.81	4.36
	LSD		5.88	5.91	6.91	7.96
			LSD 0.001 4.02; 0.005 2.82			

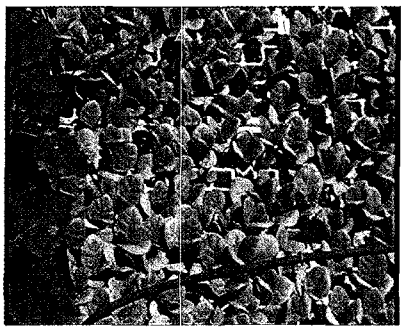
The number of leaves per plant (Table 14) is a variety characteristic. For Prilep NS-72, the tested variety, the average number is 50 leaves per plant, but due to the long drought period of over the whole summer, the number of leaves, in all treatments is relatively low. There is not significant difference between the alternative treatments and the control.

Table 15. Plant height [cm]

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	62.79	74.15	69.43	69.43	73.29
	stdev	2.05	1.25	0.92	1.11	1.01
	CV	15.3	4.8	5.2	5	4.9
	LSD		11.36	6.64	6.64	10.5
264	avrg	62.79	68.47	66.54	67.61	65.57
	stdev	2.05	1.23	0.94	1.17	1.08
	CV	15.3	3.7	4.6	5.4	4.7
	LSD		5.68	3.75	4.82	2.79

Table 15. Plant height [cm]
(continued)

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
		avrg	62.79	72.12	68.78	72.68	70.4
	338	stdev	2.05	1.22	1.33	1.34	1.2
		CV	15.3	4.1	3.6	3.9	4.3
		LSD		9.33	5.99	9.89	7.61
				LSD 0.001 5.41; 0.005 3.12			



The chemical analysis presented in table 16. There is no significant difference among treatments with different tray size and substrate mixtures, although the different color in phase of transplanting indicated that certain difference in nitrogen level could be expected. The percentage of soluble sugars is lower along with other relevant parameters, due to the fact that the last harvest was prolonged.

Table 16. Chemical analyses of the leaf

substrate mixture	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars %	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
1	1.22	2.05	1.10	7.12	16.35	2.18	18.53	13.12	2.29	18.59
2	1.17	2.07	0.89	8.14	18.19	2.02	20.21	13.58	2.23	17.02
3	1.29	2.58	1.16	7.52	15.58	2.31	17.89	14.08	2.07	19.80
4	1.20	2.70	0.92	7.67	16.22	2.50	18.77	13.72	2.11	18.64

I. 2. Results from "Jaka tabak" - Radovis

Hectcreage: 4000 ha
Average lot size of 0.3-3 ha
7000 contractors
Prevailing varieties: more than 90% are oriental: Jaka type
Target pathogens:
Pythium debarianum
Botrytis cinerea
Ryzoctonia solani
Perenospora tabaci
Melidoginae sp.

General climatic conditions in the region of Radovis (1990-2000)

Months	Average air temperature	Maximum air temperature	Minimum air temperature	Average number of days with $t^0<0^0$	Average amount of rainfalls	Average relative humidity
I	1.1	16.5	-21.0	21.0	43.8	84.0
II	3.4	20.4	-18.8	15.6	49.5	81.0
III	6.7	26.5	-14.2	8.6	47.2	74.0
IV	11.6	31.2	-4.5	1.0	36.1	68.0
V	16.6	35.5	1.0	-	53.1	69.0
VI	20.6	38.0	4.5	-	39.7	62.0
VII	23.0	41.0	6.4	-	36.3	61.0
VIII	22.6	40.1	6.5	-	22.6	60.0
IX	18.4	35.3	0.7	-	33.2	66.0
X	12.9	31.4	-6.0	0.8	49.5	73.0
XI	7.8	24.1	-9.0	5.4	64.4	71.0
XII	3.0	18.0	-15.2	16.3	45.0	84.0

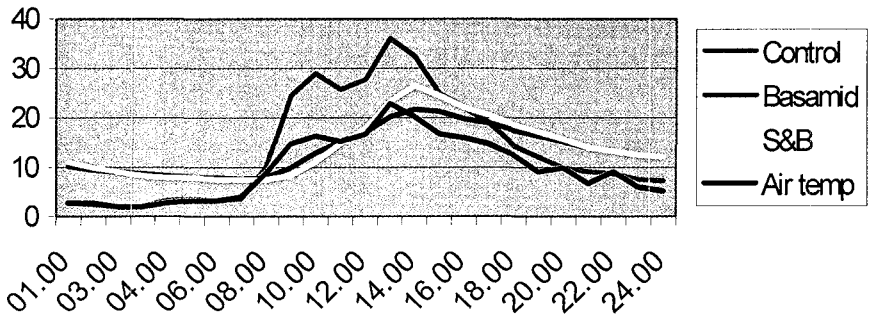
First phase results

The experiment in "Jaka tabak" - Radovis, same as in Prilep, was placed near the regular seedbeds of the kombinat, that had been sown two weeks earlier. The treatments were performed as shown bellow:

Treatment	Dose	Date of application	Date of sowing
Control-non treated	-	-	17.04.199
MeBr conventionally applied	50 g/m^2	01.03.1999	17.04.1999
Basamide (Dazomet)	50 g/m^2	11.03.1999	17.04.1999
Floating tray system	-	-	17.04.1999
Solarization/biofumigation	5 kg/m^2	09.03.1999	17.04.1999

Dazomet appeared to have high phytotoxic effect on tobacco seeds. Although the lattice test was positive, the plants did not germinate in the experimental plots. The sowing was repeated after one week, but with same negative result. This may be due to the continuously low temperatures, as illustrated on Graph 7 till the time of transplanting.

Graph 6. Daily temperature fluctuation in Radovis (04.04.1999)



Irrigation water that comes from a pump required a correction of 3 ml sulfuric acid per 100 l of water. During the vegetation one of the FTS replications was little bit retarded and yellowish. It was caused by a leakage from the pool. After adding water in this replication the situation was recovered, which means the yellow color was deficiency caused.

Table 17. Total nematode density per m^2- Radovis

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	14755	18533	17850	15211
After sowing	20310	283	42	7047
Before transplanting	22312	425	926	8809

Phytopatological analyses made for total nematode density (Tab. 17) and microbiological analyses (Tab. 18) proved the prolonged effect of Dazomet, as the number of pathogens is radically changed after application. Regarding

nematodes according the Bridge and Page rating chart the examined plants were evaluated from 0-4, (galling of the secondary roots only) with no clear distinction among treatments. Solarization and biofumigation treatment have also shown some effect on the reduction of the pathogens, compared to the non-treated plots.

Table 18. Number of colonies in 1 g of air dry soil - Radovis

Time of sampling	Control	Methyl Bromide	LDC	S&B
Fusarium sp.				
Before treatment	28	30	30	31
After sowing	28	10	12	25
Before transplanting	30	8	-	20
Alternaria sp.				
Before treatment	14	10	12	14
After sowing	17	3	-	15
Before transplanting	23	1	-	11
Phycomicetes				
Before treatment	-	4	5	6
After sowing	6	-	-	7
Before transplanting	6	-	-	6

*Saprophytic forms of Bacteria present in all samples

Table 19.Weed density per m^2 in Radovis
(three weeks after sowing)

Weeds	Control	Methyl Bromide	LDC	S&B
Amaranthus retroflexus	17	/	/	25
Chenopodium album	3	1	/	14
Cynodon dactiolon	4	/	/	7
Cuscuta sp.	8%	5%	/	10%
Graminaceae	42	/	/	93
Urtica dioica	/	/	/	/
Portulaca sativa	164	12	/	248
Trifolim sp.	/	/	/	/

The treatment with solarization and biofumigation contained extremely high number of weeds that have completely outgrown the tobacco plants. Non-treated were also weeded more compared to the two experimental cites (Tab.19). It appears that in this region, weeds are the largest problem that they are trying to solve with methyl bromide treatment. In that case any soil-less technique, Floating Tray System in particular seems to be the best alternative to the use of methyl bromide.
The percentage of germination, aside from Dazomet treatment, that did not have any plants, ranged from 20.7% in non-treated plots, followed by 26.0% in S&B treatment up to 86.9 in the Floating Tray System.

Table 20. Percentage of germination in Radovis
(one week after sowing)

Treatments	**Number of germinated plants/m^2**	**Expected number of plants/m^2**	**Percentage of germination**
Control	310	1500	20.7
Methyl bromide	890	1500	59.3
Low doses chemicals	0	1500	0.0
S&B	390	1500	26.0
Floating tray system	1210	1393	86.9

The analysis of variance of the plant parameters indicated that plants grown in the Floating Tray system were better developed, regarding plant length, stem length

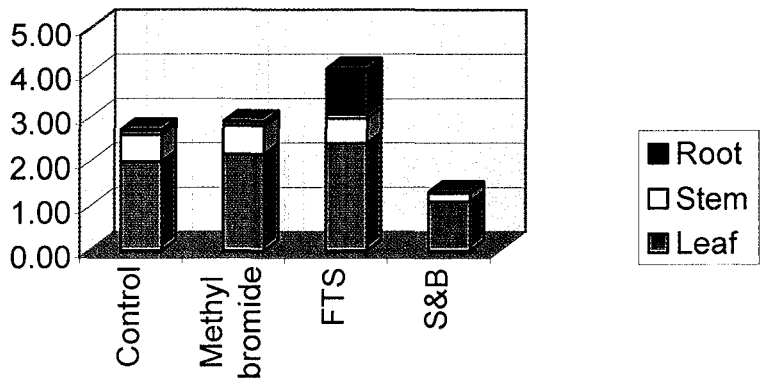
and stem diameter compared to the non-treated plots and methyl bromide treated. The stem length was shorter on account of the root length. Poorest results were obtained with the S&B treatment due to the abundance of weeds.

Table 21. Analysis of seedling parameters

Plant parameters		control	treatments		
		Control C1	**Methyl Bromide C2**	**Floating tray system**	**S&B**
Plant length	avg	10.95	12.42	15.13	7.80
	stdev	0.73	0.39	0.38	0.12
	CV	6.70	3.11	2.53	1.53
compared to control 1		**C1**		4.19	-3.14
compared to control 2		**C2**		2.72	-4.61
			LSD	**0.005=0.90; 0.001=1.36**	
Stem length	avg	7.70	7.43	4.35	5.29
	stdev	0.26	0.22	0.13	0.31
	CV	3.34	2.98	2.99	5.86
compared to control 1		**C1**		-3.35	-2.41
compared to control 2		**C2**		-3.08	-2.14
			LSD	**0.005=0.90; 0.001=1.36**	
Root length	avg	3.09	4.10	9.80	2.53
	stdev	0.38	0.23	0.47	0.38
	CV	12.33	5.68	4.84	14.94
compared to control 1		**C1**		6.71	-0.56
compared to control 2		**C2**		5.70	-1.57
			LSD	**0.005=1.41; 0.001=2.14**	
Stem diameter	avg	3.13	3.43	3.66	2.97
	stdev	0.25	0.23	0.15	0.55
	CV	7.91	6.82	4.07	18.45
compared to control 1		**C1**		0.52	-0.16
compared to control 2		**C2**		0.22	-0.46
			LSD	**0.005=0.46; 0.001=0.70**	

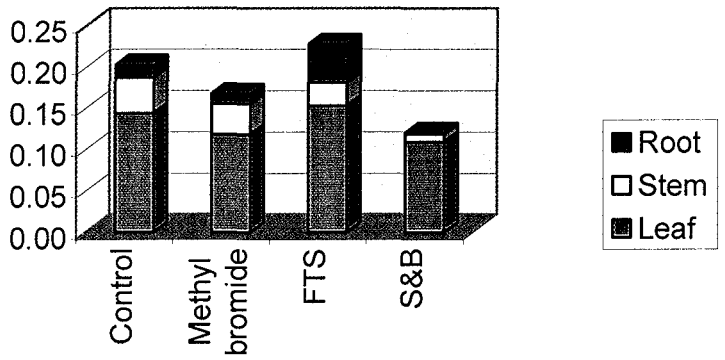
Analysis of the Dazomet treated plots is omitted, as there were no plant to be analyzed.

Graph. 7 Fresh mass of tobacco young plants in Radovis [g]



The results from fresh and dry mass analysis (Graphics 7 and 8) also confirm that the largest portion of the young plants in FTS was the root system compared to the rest of the treatments. Values for fresh mass per plant ranged from 1.32571g for the Solarization +Biofumigation up to 4.09000g for the young plants from the Floating tray system. As for the dry mass, the lowest value was recorded again in the S&B treatment 0.12011g and again the highest in the FTS treatment 0.16724g.

Graph 8. Dry mass of tobacco young plants in Radovis [g]



By the end of June 1999, the young plants of all treatments were transplanted in open field. The acceptance rate, as an important indicator of the plant condition, was recorded two weeks after transplanting. In the traditional way of cultivation in that period fulfillment of empty places (failed plants) in the rows is taking place.

Table 24. Acceptance percentage
(two weeks after transplanting)

Treatments	Percentage
Control	63
Methyl bromide	70
Solarization+biofumigation	69
Floating tray system	95

Table 22. Plant parameters in open field

		control		treatments	
		C1	**C2**	**1**	**2**
Leaf length [cm]	avrg	12.20	13.18	14.27	12.27
	stdev	1.91	0.60	1.61	1.89
	CV	15.64	4.59	11.27	15.44
compared to control 1		**C1**		2.07	0.07
compared to control 2		**C2**		1.08	-0.92
		LSD		**0.005=2.83; 0.001=4.29**	
Leaf diameter [cm]	avrg	6.25	7.13	6.54	6.58
	stdev	1.78	0.22	0.70	0.25
	CV	28.53	3.15	10.75	3.82
compared to control 1		**C1**		0.29	0.32
compared to control 2		**C2**		-0.59	-0.55
		LSD		**0.005=2.62; 0.001=3.97**	

Table 22. Plant parameters in open field (continued)

		control		treatments	
		C1	**C2**	**1**	**2**
Plant height	avrg	65.80	71.03	78.97	70.93
[cm]	stdev	1.77	1.42	1.77	2.68
	CV	5.69	4.00	2.24	3.96
compared to control 1		**C1**		13.17	5.13
compared to control 2		**C2**		7.93	-0.10
			LSD	**0.005=2.29; 0.001=3.47**	
Leafs per	avrg	33.60	36.80	43.57	36.90
plant	srdev	0.53	1.51	0.85	0.30
	CV	1.57	4.11	1.95	0.81
compared to control 1		**C1**		9.97	3.30
compared to control 2		**C2**		6.77	0.10
			LSD	**0.005=1.48; 0.001=2.24**	

Prilep NS-72, the tested variety, is characterized with the average number of 50 leaves per plant, but due to the long drought period of over two months, the number of leaves was relatively low. The difference between the alternative treatments and the control in Prilep location is significantly higher, compared to the both of the controls. Regarding the quality of the elves as a raw material, it was highest in The Floating Tray System grown plants, with around 83% of the leaves belonging to the I quality class.

Graph 9. Distribution of leaves from different treatments in quality classes

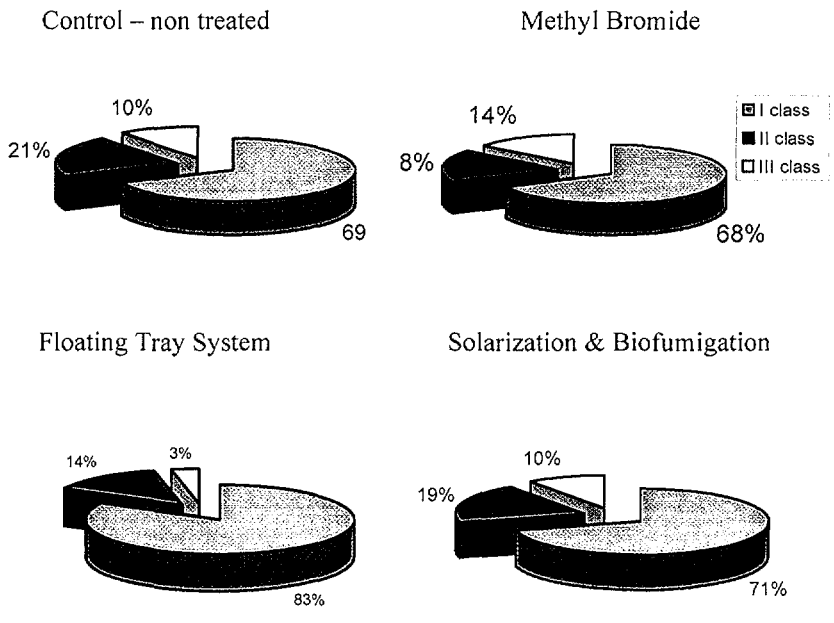


Table 23. Fresh and dry mass per plant [g], drying ratio and total yield [t/ha

Treatments	Fresh mass/plant	Dry mass/plant	Drying ratio	Fresh yield/ha	Total yield/ha
Control	105.35	21.55	4.80:1	18.96	3.95
Methyl bromide	106.00	21.60	4.90:1	19.08	3.89
S&B	113.50	24.80	4.60:1	20.34	4.42
Floating tray system	118.00	25.90	4.55:1	21.24	4.66

Regarding the total yield, there is no significant difference within treatments. It should be noticed that the total yield was calculated for 180000 plants/ha with no correction for the acceptance percentage. The drying ratio in all treatments was below 5 (Table 23), which means that less than 5kg fresh mass is required for 1kg of dry mass to be obtained.

Table 24. Chemical analysis of the leaf

Treatments	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars%	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
C 1	1.59	2.82	1.19	7.45	15.46	3.53	18.99	10.77	2.08	18.59
C 2	2.40	2.14	1.76	10.98	11.72	0.70	12.42	11.73	1.07	5.64
1	1.85	2.72	1.14	7.11	19.17	2.50	21.67	9.62	2.70	11.54
2	1.22	3.54	1.03	6.48	27.69	5.67	33.36	8.99	4.27	17.00

C 1 - Non treated
C 2 - Methyl bromide
1 - Floating tray system
2 - Solarization + Biofumigation

The chemical analysis presented in table 24 show no significant difference between treatments. Among these treatments the FTS values are the highest, and consequently the Schmooks number is higher.

Second phase results

The trial in "Jaka tabak" commenced even later than the trials in the rest of the locations, on 10.04.2000. Due to technical complications, it was decided that the pools should be in the vicinity of the company headquarters.
In the Radovish trial, one tray with 589 alveoli was included. The assumption was that this tray size would be most appropriate for cultivation of oriental young plants in Floating Tray System, with some possible alternations in the granulation of the substrate.

The capacity of a single alveolus is 11 cc, and the height of the tray 5.0 cm. It was filled with all four mixtures of substrates that are in the trial, so that plant measurements were taken for each of them. Taking into consideration the prolonged sowing date in Radovish, the young plants dimensions as overall are

smaller, compared to other experimental locations. Statistically significant difference, at a level of 0.05, was recorded for stem length in substrate mixture of local peat and perlite in 209, compared to the same substrate in 589. The plants grown in same substrate, only in 264 trays had significantly larger stem diameter than the ones grown in 589. On the other hand, the young plants grown in this single 589 tray developed larger roots (Table 25) than in the other trays and this difference in the case of Dutch peat and perlite (1) and Dutch peat and tuff (4) is significant at level of 0.05.

Table 25. Seedling parameters in relation to tray size and substrate - Radovish

Plant parameters	Tray size	Type of substrate			
		1	2	3	4
Root length [cm]	**209**	9.98	11.50	9.56	8.30
	264	10.44	11.62	9.91	10.35
	589	[209]13.17	10.67	12.70	[209]13.00
Stem length [cm]	**209**	7.65	[589]8.13	9.70	7.83
	264	5.60	6.88	5.66	8.90
	589	4.67	4.57	7.20	9.50
Stem diameter [mm]	**209**	4.62	5.70	7.08	5.36
	264	5.88	[589]6.12	6.30	4.65
	589	4.40	3.75	3.69	4.15
Number of leaves	**209**	6.20	6.70	7.00	6.40
	264	6.60	6.70	6.40	6.00
	589	5.33	5.00	5.33	5.00

The results from green mass analyses (Graph. 10) have proven that the work on 589 trays disserves further attention. Although the complete fresh mass is lowest, compared to the other tray sizes, the root fraction is larger, especially for the plants grown in mushroom compost and perlite (3) and Dutch peat and tuff (4).

Graph. 10 Green mass of different organs [g] in relation to substrates and tray size

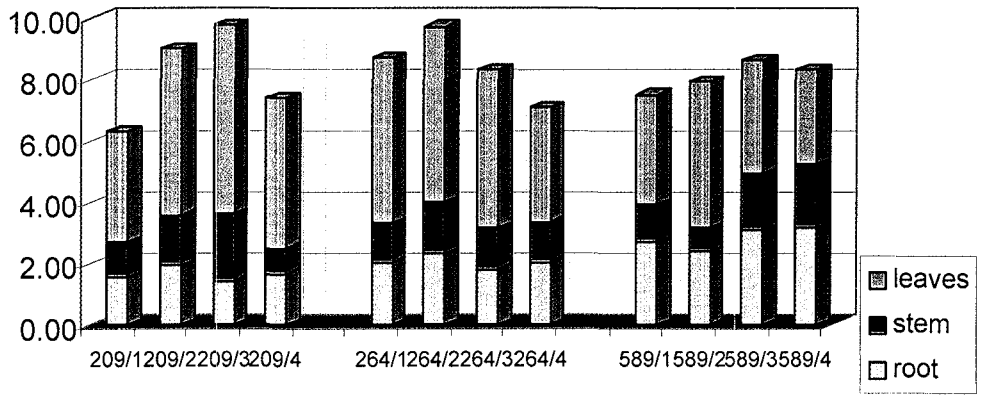


Table 26 Acceptance percentage
(two weeks after transplanting)

Tray size	Type of substrate mixture			
	1	2	3	4
209	93.20	94.20	93.68	93.45
264	94.11	94.62	93.68	94.07
589	93.57	94.10	95.00	94.38
Methyl bromide		75.71		

As expected the acceptance in open field was excellent in all 12 treatments (Table 26). In Radovish the transplantation was carried out by transplanting machine, and after two weeks the acceptance percentage was recorded, showing no difference among particular treatments. The young plants transplanted from the traditionally treated seedbed with methyl bromide had relatively high acceptance rate, but still significantly lower, compared to the treatments from the FTS.

Table 27. Leaf diameter [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	8.95	7.08	7.77	7.48	7.97
		stdev	2.92	1.35	1.36	1.75	1.77
		CV	5.11	2.09	1.32	1.36	2.04
		LSD		-1.87	-1.18	-1.48	-0.98
	264	avrg	8.95	7.58	7.48	7.38	7.68
		stdev	2.92	1.74	1.42	1.02	1.65
		CV	5.11	1.86	2.88	3.05	2.05
		LSD		-1.38	-1.48	-1.57	-1.28
	589	avrg	8.95	6.99	6.69	6.79	6.71
		stdev	2.92	2	1.05	0.88	1.99
		CV	5.11	2.22	2.05	3.04	0.92
		LSD		-1.97	-2.26	-2.16	-2.24
				LSD 0.001 1.72; 0.005 0.83			

Plant measurements in open field are presented as average values of all harvests. During the harvesting it was noticed that the lower leaves in the methyl bromide treated plants have larger leaves, where as the top ones are the smallest, and according the oriental type quality criteria, can be evaluated as I class. In the FTS treatments the size of the leaves, i.e. length and diameter are more balanced, so that larger portion of the total amount of leafs can be treated as first class. This is proven with the low variation coefficient, presented in the tables 27 and 28.

Table 28. Leaf length [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	18.84	14.06	15.84	15.84	16.84
		stdev	1.96	0.39	0.40	0.79	0.81
		CV	6.23	3.21	2.44	2.48	3.16
		LSD		-4.78	-3.00	-3.00	-2.01
	264	avrg	18.84	15.83	14.86	14.32	15.55
		stdev	1.96	0.78	0.46	1.04	1.73
		CV	6.23	2.98	4.00	4.17	3.17
		LSD		-3.02	-3.98	-4.52	-3.30
	589	avrg	18.84	14.85	14.06	15.84	17.13
		stdev	1.96	2.08	1.13	0.96	2.07
		CV	6.23	3.34	3.17	4.16	2.04
		LSD		-3.99	-4.78	-3.00	-1.71
				LSD 0.001 2.61; 0.005 1.31			

Table 29. Number of leaves per plant

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	36.1	44.3	45.7	45.2	43.21
		stdev	4.99	3.05	3.06	3.54	3.57
		CV	7.8	4.57	5.48	5.07	5.31
		LSD		8.2	9.6	9.1	7.11
	264	avrg	36.1	43	46.2	47	46.2
		stdev	4.99	3.53	3.13	3.85	3.42
		CV	7.8	5.56	4.17	3.93	3.78
		LSD		6.9	10.1	10.9	10.1
	589	avrg	36.1	47.02	48	46.78	46.98
		stdev	4.99	3.85	2.68	2.47	3.84
		CV	7.8	4.01	4.05	4.11	5.01
		LSD		10.92	11.9	10.68	10.88
				LSD 0.001 5.36; 0.005 2.71			

Plant height and the number of leaves are variety characteristic, but they also depend on the climatic conditional and the cultivation technology. In the second year of the Demonstration project it was confirmed that plants grown by the floating tray system develop more leaves, and the plants are higher and more uniform. In all treatments, significantly higher number of leaves was recorded compared to the methyl bromide treatment. The same conclusion stands for the plant height, where all differences are on significance level of 0.01.

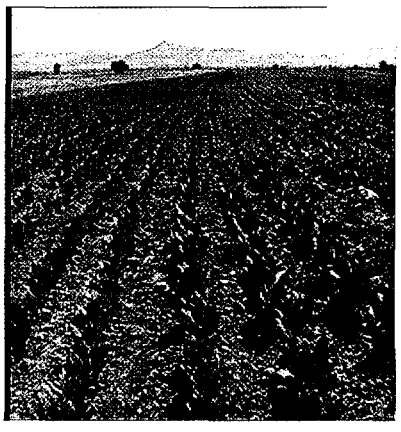


Table 30. Plant height [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	71.75	80.61	80.69	83.64	78.88
		stdev	4.04	2.47	2.48	2.87	2.89
		CV	13.92	4.75	5.69	5.27	5.51
		LSD		8.86	8.94	11.89	7.13
	264	avrg	71.75	77.58	74.83	79.70	77.74
		stdev	4.04	2.86	2.54	3.12	2.77
		CV	13.92	6.77	4.33	4.08	3.93
		LSD		5.82	3.08	7.95	5.98
	589	avrg	71.75	84.62	76.75	76.75	78.88
		stdev	4.04	3.12	2.17	2.00	3.11
		CV	13.92	4.16	4.20	4.27	5.20
		LSD		12.87	5.00	5.00	7.13
				LSD 0.001 5.02; 0.005 2.74			

The analyses of the row material chemical content indicated that the nitrogen level is balanced during the vegetation period in open field, regardless of the substrate mixture in which the young plants had been grown previously. The differences that were recorded in the leaf color until the time of transplanting. The sugar content in Radovish was relatively high, accompanied with low level of proteins, which consequently resulted in high values for the Schmooks number. (Table 31)

Table 31. Chemical analyses of the leaf

substrate mixture	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars %	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
1	1.37	2.50	1.07	6.66	14.81	4.68	19.49	13.98	2.22	24.01
2	1.25	2.58	1.01	6.42	15.15	4.52	19.67	13.21	2.35	23.80
3	1.42	2.20	1.01	6.51	14.82	4.53	19.35	13.80	2.27	23.17
4	1.30	2.47	1.10	6.33	14.78	4.27	19.05	13.58	2.33	22.80

I. 3. Results from "Tutunski kombinat" - Kumanovo

Hectarage: 205 ha
Average yield of 1-1.2t/ha
1500 contractors
Prevailing varieties:
mostly Virginia type and Burley.
Target pathogens:
Target pathogens:
Botrytis cinerea
Ryzoctonia solani
Perenospora tabaci
Melidoginae sp.

General climatic conditions in the region of Kumanovo (1990-2000)

Months	Average air temperature	Maximum air temperature	Minimum air temperature	Average number of days with $t^0<0^0$	Average amount of rainfalls	Average relative humidity
I	0.4	18.5	-24.0	21.6	37.0	87.0
II	2.8	23.2	-17.6	17.5	35.9	84.0
III	6.3	34.0	-11.5	11.2	35.4	77.0
IV	11.6	33.1	-3.5	1.3	43.3	70.0
V	16.4	33.5	-2.0	-	67.3	70.0
VI	20.3	382.0	5.5	-	56.0	63.0
VII	22.3	39.4	5.9	-	46.6	59.0
VIII	22.1	40.0	2.8	-	61.6	58.0
IX	17.8	36.2	-0.2	-	38.8	70.0
X	12.1	33.0	-4.3	-2.0	49.6	78.0
XI	7.0	22.5	-12.8	7.6	60.4	86.0
XII	21.0	22.0	-16.4	17.8	42.5	88.0

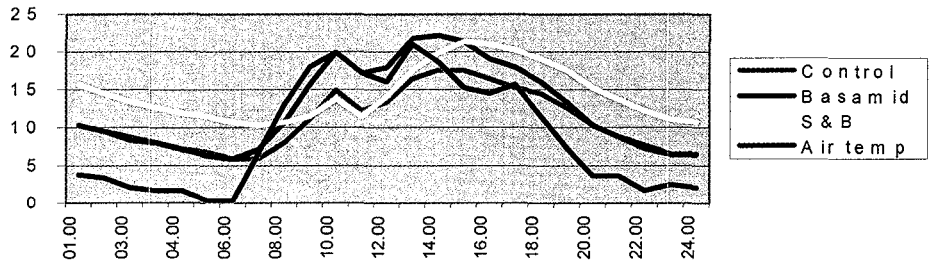
First phase results

Out of the three tobacco experimental cites the sowing in Tutunski kombinat Kumanovo was lastly performed in 1999. Alternative treatments to methyl bromide were applied as recommended in the TOR. Prior to sowing the water alkalinity in the floating tray system (FTS) pools was corrected with 14 ml of sulfuric acid per 100 l of water. The initial conductivity in the FTS after fertilization was 1.4 mS/cm, pH 5.2 and the average water temperature was 23^{0}C.
The time of application and sowing were as follows:

Treatment	Dose	Date of application	Date of sowing
Control-non treated	-	-	19.04.199
MeBr conventionally applied	50 g/m^2	04.03.1999	19.04.1999
Basamide (Dazomet)	50 g/m^2	04.03.1999	19.04.1999
Floating tray system	-	-	19.04.1999
Solarization/biofumigation	5 kg/m^2	04.03.1999	19.04.1999

Although there was relatively long period left for fumigants to be released, due to the adverse weather conditions the treatments with Dazomet and Solarization +Biofumigation did not perform well. The temperatures were below 10^{0}C most of the time, with night temperatures near 0^{0}C. To illustrate the temperature conditions (Graph. 11) daily fluctuation prior to the sowing date is presented.

Graph. 11 Daily temperature fluctuation in Kumanovo (04.04.1999)



Beside the negative effects of low temperatures, the plants were severely damaged by hail on 04.05.1999. Only the FTS plants continued to develop well. For that reasons the experiment in this cite continued and all the measurements were carried out regularly.
Among the treatments there were no evident symptoms of diseases. Regarding nematodes according the Bridge and Page rating chart the examined plants were evaluated from 0-4, (galling of the secondary roots only) with no clear distinction among treatments. Quantitative analysis was carried out in the traditional seedbeds (Table 32) that also showed relatively low density of nematodes, which may be explained by the fact that the experimental plots have not been used for several years.

Table 32. Total nematode density per m^2- Kumanovo

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	7376	8608	7819	9834
After sowing	16917	0	6529	9967
Before transplanting	20382	0	3134	6852

S&B-Solarization+Biofumigation

Table 33. Number of colonies in 1 g of air dry soil - Kumanovo

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Fusarium sp.				
Before treatment	51	49	47	56
After sowing	49	14	40	12
Before transplanting	52	-	-	10
Alternaria sp.				
Before treatment	1	1	3	1
After sowing	2	-	-	4
Before transplanting	2	-	-	4
Phycomicetes				
Before treatment	7	3	4	7
After sowing	6	1	-	6
Before transplanting	7	-	-	6

*Saprophytic forms of Bacteria present in all samples

The analyses of suspected pathogens in the soilbeds (Tab.33) prove the prolonged effect of Dazomet treatment and to some extend the treatment with solarization and biofumigation. If applied in proper time and temperatures these two alternatives may show good results in the pathogen control.
The manure that was used for the S&B treatment may not were well composted, or contained large number of weed seeds, as the weeds count (Table 34) showed largest presence of weeds in this treatment, which may also be treated as evidence of its non-toxicity.

Table 34. Weed density per m^2 - Kumanovo
(three weeks after sowing)

Weeds	Control	Methyl Bromide	LDC	S&B
Amaranthus retroflexus	9	/	/	12
Chenopodium album	8	/	/	5
Cynodon dactilon	3	/	/	/
Cuscuta sp.	20%	5%	/	35%
Graminaceae	56	/	/	78
Urtica dioica	6	/	/	/
Portulaca sativa	82	5	/	112
Trifolim sp.	4	/	/	11

The rate of germination was relatively low, from 32% in the S&B treatment where tobacco plants were outgrown by weeds, up to the FTS treatment. It should be mentioned here that although the sowing was performed by hand and there were two or three plants per cell, only one plant per cell was counted for the germination percentage assessment (Tab. 35).

Table 35. Percentage of germination - Kumanovo
(one week after sowing)

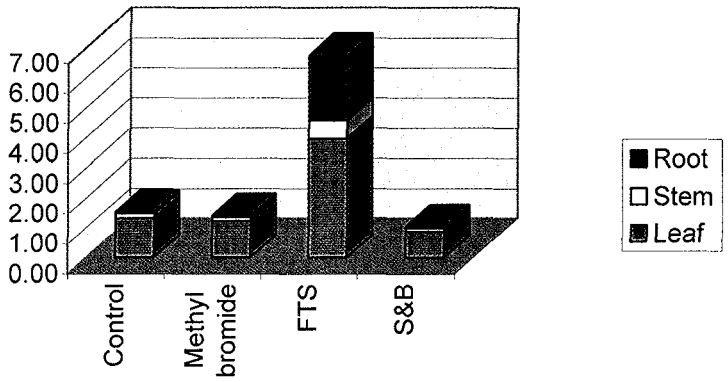
Treatments	Number of germinated plants/m^2	Expected number of plants/m^2	Percentage of germination
Control	650	1500	43.3
Methyl bromide	840	1500	56.0
Low doses chemicals	0	1500	0.0
S&B	480	1500	32.0
Floating tray system	1300	1393	93.3

Table 36. Analysis of plant seedling parameters-Kumanovo

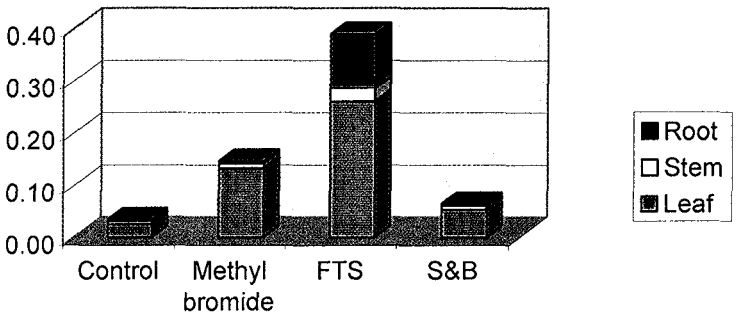
Plant parameters		control		treatments	
		Control C1	**Methyl Bromide C2**	**Floating tray system**	**S&B**
Plant length	avg	7.64	4.61	11.06	4.29
	stdev	0.59	0.15	0.22	0.17
	CV	7.67	3.31	1.95	3.92
compared to control 1		**C1**		3.43	-3.35
compared to control 2		**C2**		6.45	-0.32
			LSD	**0.005=0.67; 0.001=1.02**	
Stem length	avg	3.68	2.11	2.39	2.04
	stdev	0.19	0.16	0.09	0.26
	CV	5.05	7.39	3.86	12.56
compared to control 1		**K1**		-1.28	-1.64
compared to control 2		**K2**		0.28	-0.07
			LSD	**0.005=0.67; 0.001=1.02**	
Root length	avg	3.58	2.28	8.54	1.86
	stdev	0.10	0.12	0.12	0.06
	CV	2.71	5.31	1.42	2.96
compared to control 1		**K1**		4.96	-1.72
compared to control 2		**K2**		6.26	-0.41
			LSD	**0.005=0.15; 0.001=0.23**	
Stem diameter	avg	3.34	3.47	3.87	2.80
	stdev	0.20	0.17	0.16	0.14
	CV	5.89	5.01	2.21	4.97
compared to control 1		**K1**		0.52	-0.54
compared to control 2		**K2**		0.40	-0.67
			LSD	**0.005=0.34; 0.001=0.51**	

The seedling parameter analysis (Tab. 36) was carried out only on two alternatives, because the Dazomet treatment did not have enough plants for analysis. The values in general are very low due to the conditions mentioned above. It specially stands for the S&B treatment that has significantly lower values both from the Control and Methyl bromide treatment for all plant parameters. The young plants grown in the floating tray systems had best performance regarding the average values and lowest variation coefficient, which is a proof of the uniformity. Only in the case of plant length, the values of FTS are significantly lower. The largest portion of the total plant length is in the root system, which will provide good acceptance in open field after transplanting.

Graph. 12 Fresh mass of tobacco plants in Kumanovo



Graph. 13 Dry mass of tobacco young plants in Kumanovo



The results from fresh and dry mass analysis (Graphics 12 and 13) also confirm that the largest portion of the young plants in FTS was the root system compared to the rest of the treatments. Values for fresh mass per plant ranged from 1.01876g for the Solarization +Biofumigation up to 6.71000g for the young plants from the Floating tray system. As for the dry mass, the lowest value was recorded in the control treatment 0.03350g and again the highest in the FTS treatment 0.38942g.
The tobacco young plants were transplanted by the end of June, 1999. Two weeks after transplanting the acceptance percentage (survival rate) was recorded. The results are presented in table 37.

Table 37 . Acceptance percentage - planting density 180000 plants/ha (two weeks after transplanting)

Treatments	Percentage
Control	61
Methyl bromide	75
Solarization+biofumigation	72
Floating tray system	93

As expected, the acceptance rate was highest in the floating tray treatment (93%), due to the well developed root system and the generally good condition of the transplants. The oriental type of tobacco is characterized with shorter plants and smaller leafs from the Virginia type. Tobacco leaves that are evaluated as first class should not be longer than 15 cm. Larger leaves loose their oriental characteristics regarding the aroma, sugar/protein ratio etc. During the vegetation period, several plant parameters were monitored, among which the leaf dimensions. The results presented in the following table are taken from the last harvest.

Table 38. Plant parameters from the last harvest

		control		treatments	
		C1	**C2**	**1**	**2**
Leaf length [cm]	avrg	17.70	15.13	14.77	14.37
	stdev	1.04	1.91	1.89	0.65
	CV	5.90	12.61	12.82	4.53
compared to control 1		**C1**		-2.93	-3.33
compared to control 2		**C2**		-0.37	-0.77
			LSD	**0.005=2.83; 0.001=4.29**	
Leaf diameter [cm]	avrg	9.56	7.72	9.38	8.96
	stdev	0.72	2.30	0.06	0.81
	CV	7.56	29.79	0.60	9.08
compared to control 1		**C1**		-0.17	-0.60
compared to control 2		**C2**		1.67	1.24
			LSD	**0.005=2.62; 0.001=3.97**	
Plant height [cm]	avrg	60.20	61.73	70.17	62.30
	stdev	2.60	3.60	1.86	1.64
	CV	6.00	5.83	2.65	2.63
compared to control 1		**C1**		9.97	2.10
compared to control 2		**C2**		8.43	0.57
			LSD	**0.005=5.02; 0.001=7.60**	
Leaves per	avrg	33.67	34.00	36.03	33.53
plant	stdev	1.03	1.06	1.19	2.03
	CV	3.05	3.11	3.31	6.06
compared to control 1		**C1**		2.37	-0.13
compared to control 2		**C2**		2.03	-0.47
			LSD	**0.005=3.15; 0.001=4.77**	

Both alternatives in Kumanovo had better leaf quality regarding the size and the diameter; the plants were taller and uniform. There was no considerable difference in the number of leaves per plant.

The leaf quality varied from 59% in the non-treated plots that were evaluated as an I quality class raw material, up to 85% for the plants that belonged to the Floating Tray System Treatment. Methyl bromide plants yielded with largest portion of leaves that were evaluated as a second class (Graph 14).

Graph 14. Distribution of leaves from different treatments in quality classes

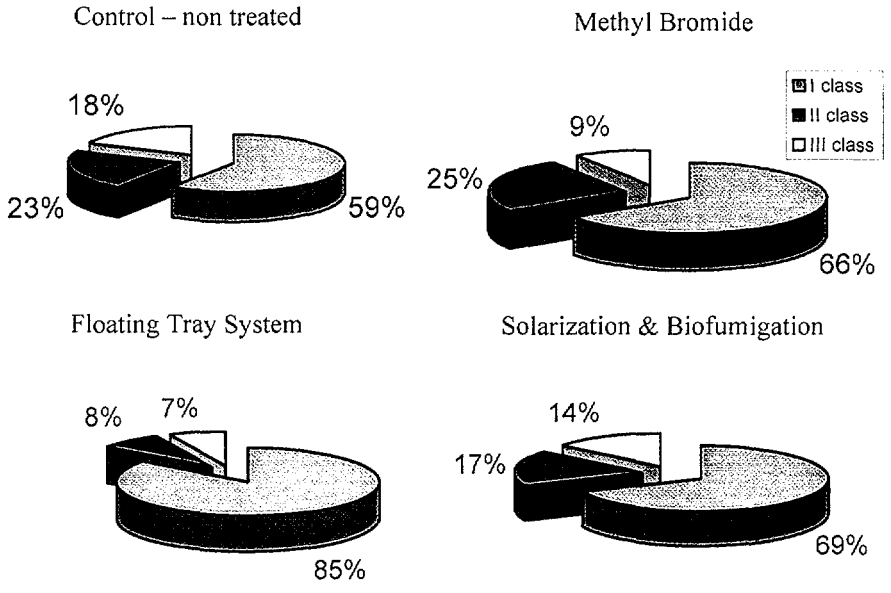


Table 39. Fresh and dry mass per plant [g], drying ratio and total yield [t/ha]

Treatments	Fresh mass/plant	Dry mass/plant	Drying ratio	Fresh yield/ha	Total yield
Control	86.05	15.65	5.50:1	15.48	2.81
Methyl bromide	79.80	15.00	5.32:1	14.36	2.69
S&B	82.40	15.32	5.37:1	14.83	2.76
Floating tray system	89.45	19.20	4.71:1	16.10	3.41

Although the pants in open field were being grown in equal conditions, which resulted in relatively even fresh mass yield per plant, the drying ratio varied considerably, from 4.71:1 for the FTS, up to 5.50:1 for the control treatment. Consequently, the total yield out of the FTS treatment was the highest (Table 39).

Table 40 Chemical analyses of the leaf

Treatments	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars%	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
C 1	1.29	2.05	0.82	5.12	7.59	2.03	9.62	13.81	1.48	21.10
C 2	1.17	2.08	0.88	5.55	8.87	2.11	10.98	12.40	1.60	19.22
1	0.89	1.43	1.16	7.25	14.47	4.84	19.3	10.21	2.00	25.06
2	1.20	2.58	1.02	6.39	6.23	1.64	7.87	13.62	0.97	20.84

C 1 - Non treated
C 2 - Methyl bromide
1 - Floating tray system
2 - Solarization + Biofumigation

Regarding the chemical analysis that were made to estimate the quality of the raw material (Tab 40) In Kumanovo location the percentage of soluble sugars is lower along with other relevant parameters, due to the fact that the last harvest was prolonged. Still, among this treatment the FTS values are the highest, and consequently the Schmooks number is higher.

Second phase results

The tobacco young plants in Kumanovo were sown on 28.04.2000. Previously the pools had been constructed, filled with water and the alkalinity was corrected with adequate amounts of sulfuric acid. After several days, when the water temperature was above 20^{0}C, 8 g/l of Soluveg 20:8:20 were added up to EC of 1.5 mS/cm. Manual seeder was used for 209 and 264 trays. The same 209 trays were used from last year. Palletized seeds were sown manually in the 338 trays. It was noticed that more than 20% of the alveoli remain empty after sowing with the manual seeder, which should be corrected in the future with finalization of the seeders. Otherwise, the sowing procedure is shorter, safer and the savings in seeds are larger compared to the traditional way of sowing.

Table 41. Seedling parameters in relation to tray size and substrate - Kumanovo

Plant parameters	Tray size	Type of substrate			
		1	2	3	4
Root length [cm]	**209**	9.45	7.90	7.53	9.10
	264	10.02	8.54	9.05	[2]12.01
	338	11.53	9.95	9.43	10.85
Stem length [cm]	**209**	8.75	13.65	17.30	13.90
	264	9.12	16.80	[11]17.35	14.18
	338	7.65	15.54	14.80	13.15
Stem diameter [mm]	**209**	4.11	5.64	[1]6.70	5.38
	264	5.27	5.95	6.17	6.95
	338	4.67	6.39	6.18	4.35
Number of leaves	**209**	6.60	8.20	8.80	8.00
	264	8.60	8.60	8.20	9.10
	338	7.10	[44]9.30	6.20	6.60

One of the conclusions from the first phase of the Demonstration project was that 209 trays would be too specious, especially for the oriental type of tobacco. For that reason 264 and 388 trays were included in the trials, with capacity of 17 and 15 cc/alveolus, respectively. As expected, there was no significant difference recorded in the plant parameters among the young plants sown in different tray size. It proves that tobacco young plants can develop in smaller capacity alveoli with same dynamics. This would result in more than 30% savings in substrates, which are considerable part of the total cost of production.

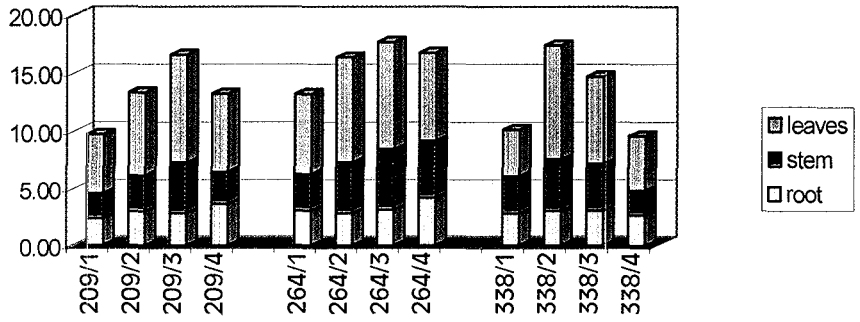
As presented in Table 41. there is difference between the plants grown in the mixture of Dutch peat and tuff; i.e. their roots are significantly longer than the roots of the young plants grown in mixture of Dutch peat and perlite. The length of the root was measured only in the mixture bulk.

In average, highest stem had the plants grown in mixture of mushroom compost and perlite in all tray sizes, but significantly higher values, at level of 0.001 were observed in the 264 trays, compared to the plants grown in Dutch peat and perlite.

Most important characteristic, beside the root length, is the stem diameter. Best values were obtained in the young tobacco plants grown in mushroom compost and perlite in all tray sizes.

Regarding the number of leaves, highest values were measured in the treatment with 338 trays filled with mixture local peat and perlite.

Graph 15. Green mass of different organs [g] in relation to substrates and tray size

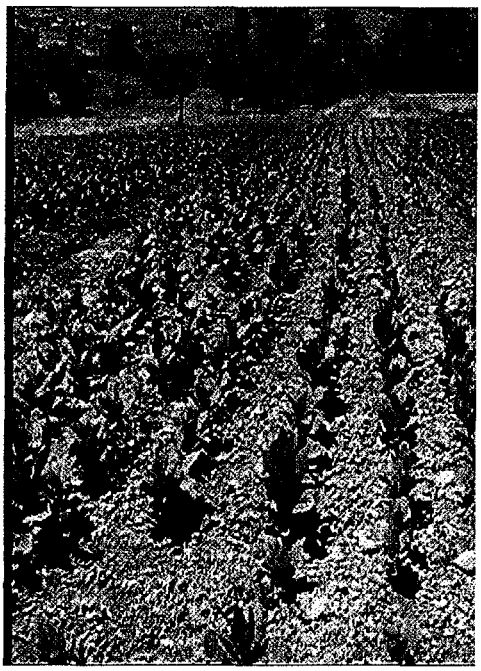


The measurements of green mass (Graph. 15) confirm the conclusion that there is no significant difference among the different tray sizes. The differences among substrates are most obvious in the 338 tray size. It can be also noticed that highest values for different organs of the young plants, regarding green mass were obtained in the treatments with mixtures made of local peat and perlite (2) and mushroom compost and perlite (3).

The measurements of green mass confirm the conclusion that there is no significant difference among the different tray sizes. The differences among substrates are most obvious in the 338 tray size. It can be also noticed that highest values for different organs of the young plants, regarding green mass were obtained in the treatments with mixtures made of local peat and perlite (2) and mushroom compost and perlite (3).

Table 42. Acceptance percentage - planting density 180000 plants/ha
(two weeks after transplanting)

Tray size	Type of substrate mixture			
	1	2	3	4
209	94.36	94.52	93.85	94.52
264	94.52	95.12	96.02	95.70
338	94.15	93.89	94.34	94.63
Methyl bromide		72.31		



Methyl bromide treated plants, after transplanting

The acceptance rate, as an important indicator of the plant condition, was recorded two weeks after transplanting. In the traditional way of cultivation, usually in that period fulfillment of empty places (failed plants) in the rows takes place. In the case of FTS grown plants, practically there was no need of this practice, as the acceptance rate was well above 90%.

The oriental type of tobacco is characterized with shorter plants and smaller leafs from the Virginia type. Tobacco leafs that are evaluated as first class, should not be longer than 15 cm. Larger leafs loose their oriental characteristics regarding the aroma, sugar/protein ratio etc. During the vegetation period, several plant parameters were monitored, among which the leaf dimensions. The results presented in the following tables (43 and 44) are taken from the last harvest.

Table 43. Leaf diameter [cm]

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	13.97	10.14	10.92	11.12	9.86
	stdev	3.72	1.57	2.22	1.33	1.98
	CV	4.77	1.86	2.82	2.22	2.55
	LSD		-3.84	-3.05	-2.85	-4.11
264	avrg	13.97	9.35	9.64	10.63	10.43
	stdev	3.72	1.25	2.36	1.45	0.95
	CV	4.77	1.86	1.95	1.95	3.26
	LSD		-4.62	-4.33	-3.35	-3.54
338	avrg	13.97	9.64	9.92	9.74	9.19
	stdev	3.72	1.75	1.40	2.97	0.88
	CV	4.77	2.85	2.56	2.16	2.07
	LSD		-4.33	-4.05	-4.23	-4.78
			LSD 0.001 1.86; 0.005 0.92			

Table 44. Leaf length [cm]

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	19.11	16.69	15.35	16.04	15.65
	stdev	3.79	1.59	2.26	1.35	2.01
	CV	5.89	2.98	3.94	3.34	3.67
	LSD		-2.43	-3.76	-3.07	-3.47
264	avrg	19.11	15.84	16.64	16.34	16.93
	stdev	3.79	1.27	2.40	1.48	0.97
	CV	5.89	2.98	3.07	3.07	4.38
	LSD		-3.27	-2.48	-2.77	-2.18
338	avrg	19.11	16.04	17.13	16.04	15.55
	stdev	3.79	1.77	3.45	3.01	0.89
	CV	5.89	3.97	3.68	3.28	3.19
	LSD		-3.07	-1.98	-3.07	-3.57
LSD 0.001 2.40; 0.005 1.22						

FTS alternatives in Kumanovo had better leaf quality regarding the size and the diameter; the plants were taller and uniform. There was no considerable difference in the number of leaves per plant. In average, the plants grown by FTS had 7-8 leaves more than the ones grown by the traditional method, i.e. treated by methyl bromide.

The difference in plant height among the floating tray system plants and ones grown in traditional system, along with the larger number of leaves per plant is, mainly, the prerequisite for higher yields.

Table 45. Number of leaves per plant

Tray size		Methyl Bromide	Type of substrate 1	2	3	4
209	avrg	32.77	40.11	39.82	37.99	40.82
	stdev	5.79	3.59	4.26	3.35	4.01
	CV	9.71	4.87	5.80	5.22	5.54
	LSD		7.34	7.05	5.22	8.05
264	avrg	32.77	41.22	40.63	39.18	41.02
	stdev	5.79	3.27	4.40	3.48	2.97
	CV	9.71	4.87	4.96	4.96	6.22
	LSD		8.45	7.86	6.41	8.25
338	avrg	32.77	38.92	39.11	38.22	38.14
	stdev	5.79	3.77	3.45	3.01	2.89
	CV	9.71	5.82	5.55	5.16	5.07
	LSD		6.15	6.34	5.45	5.37
LSD 0.001 5.12 ; 0.005 3.63						

Table 46. Plant height [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	65.77	78.72	70.85	70.85	74.78
		stdev	3.79	1.59	2.26	1.35	2.01
		CV	15.71	4.02	4.98	4.38	4.71
		LSD		12.95	5.08	5.08	9.02
	264	avrg	65.77	69.86	67.89	65.93	69.04
		stdev	3.79	1.27	2.40	1.48	0.97
		CV	15.71	4.02	4.11	4.11	5.42
		LSD		4.10	2.13	0.16	3.27
	338	avrg	65.77	71.99	71.01	73.96	71.83
		stdev	3.79	1.77	3.45	3.01	0.89
		CV	15.71	5.01	4.72	4.32	4.23
		LSD		6.22	5.24	8.19	6.06
				LSD 0.001 5.08; 0.005 2.11			

Based on the chemical analyses of the row material, the content of soluble sugars was higher compared to the rest of the trial locations, although there was no significant difference among plants grown in different substrate mixtures. The nicotine content was also in the margins of acceptability, same as the ratio of soluble sugars and proteins which gave satisfactory results, that are presented in table 47.

Table 47. Chemical analyses of the leaf

substrate mixture	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars%	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
1	1.57	2.23	1.08	7.76	13.47	3.22	16.69	15.32	1.99	19.29
2	1.49	2.60	1.04	7.02	13.89	3.52	17.41	14.81	1.97	20.24
3	1.60	2.44	1.11	6.20	10.18	3.82	14.00	13.44	1.64	21.11
4	1.52	2.18	0.98	7.11	13.69	3.94	17.69	15.48	1.92	19.81

I. 4. Dimko Dunimagloski, village Godivje - Krushevo

The Floating Tray System, as a new system for production of tobacco young plants attracted grower's attention. For that reason in the second year of the project an individual grower was included. Mr. Dimko Dunimagloski is one of the most productive cooperants of AD "Niko Doaga" from - Krushevo. He produces oriental tobacco on 0.3 ha of his own, with average yield of 1.6 t/ha.

Having in mind the fact that the oriental type of tobacco will be most probably grown in smaller capacity alveoli trays, in Mr. Dunimagloski property only two tray sizes (264 and 338) and all four substrates were tested.

At the beginning of July the experiment was repeated with all tray sizes. The plant parameters in open field have been followed along with the rest of the trial locations.

Table 48. Acceptance percentage - planting density 180000 plants/ha (two weeks after transplanting)

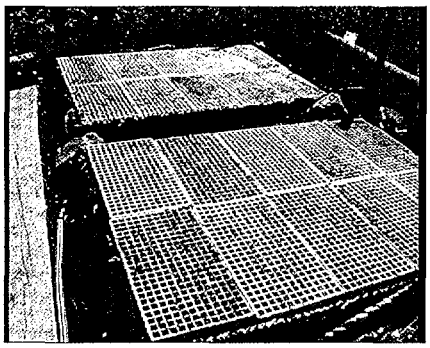
Tray size	Type of substrate mixture			
	1	2	3	4
209	92.98	93.67	92.01	93.22
264	95.12	94.3	95.55	94.23
338	94.11	94.66	94.21	95.45
Methyl bromide		77.5		

Table 49. Leaf diameter [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	11.07	9.64	9.42	9.48	7.99
		stdev	0.94	1.88	0.13	0.82	0.85
		CV	5.09	1.28	1.92	1.40	1.04
		LSD		-1.43	-1.65	-1.60	-3.08
	264	avrg	11.07	8.00	8.53	8.58	8.09
		stdev	0.94	1.65	1.44	0.85	0.86
		CV	5.09	2.14	1.18	1.44	1.74
		LSD		-3.07	-2.54	-2.49	-2.98
	338	avrg	11.07	8.18	8.45	8.49	8.08
		stdev	0.94	0.65	1.54	0.78	0.15
		CV	5.09	2.20	1.84	1.40	0.96
		LSD		-2.89	-2.62	-2.58	-2.99
				LSD 0.001 2.07; 0.005 0.98			

Table 49. Leaf length [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	19.11	16.69	15.35	16.04	15.65
		stdev	3.79	1.59	2.26	1.35	2.01
		VK	5.89	2.98	3.94	3.34	3.67
		LSD		-2.43	-3.76	-3.07	-3.47
	264	avrg	19.11	15.84	16.64	16.34	16.93
		stdev	3.79	1.27	2.40	1.48	0.97
		VK	5.89	2.98	3.07	3.07	4.38
		LSD		-3.27	-2.48	-2.77	-2.18
	338	avrg	19.11	16.04	17.13	16.04	15.55
		stdev	3.79	1.77	3.45	3.01	0.89
		VK	5.89	3.97	3.68	3.28	3.19
		LSD		-3.07	-1.98	-3.07	-3.57
				LSD 0.001 2.40; 0.005 1.22			



Mr. Dunimagleski is convinced in the advantages of the Floating Tray System compared to the standard sterilization with Methyl Bromide. He is especially satisfied with the high rate of acceptance in open field. In his opinion the decisive factor for wide adoption of this technology and replacement of the Methyl Bromide use will be the cost of the production for the Floating Tray System.

Table 50. Number of leaves per plant

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	33.47	38.12	39.04	38.36	40.35
		stdev	5.49	2.36	3.16	3.03	3.07
		VK	8.92	4.01	4.80	4.16	4.95
		LSD		4.65	5.57	4.89	6.88
	264	avrg	33.47	39.01	40.24	39.67	38.57
		stdev	5.49	4.07	3.80	3.06	3.07
		VK	8.92	7.29	5.12	5.44	5.81
		LSD		5.54	6.77	6.20	5.10
	338	avrg	33.47	39.56	40.23	41.01	39.48
		stdev	5.49	3.82	3.44	2.97	2.19
		VK	8.92	6.38	4.70	4.16	4.85
		LSD		6.09	6.76	7.54	6.01
				LSD 0.001 4.04; 0.005 2.21			

Table 51. Plant height [cm]

Tray size			Methyl Bromide	Type of substrate 1	2	3	4
	209	avrg	66.91	76.75	78.88	78.72	76.75
		stdev	3.96	1.91	0.13	0.84	0.87
		VK	14.44	2.44	3.08	2.56	3.20
		LSD		9.84	11.97	11.81	9.84
	264	avrg	66.91	79.70	81.67	74.78	78.72
		stdev	3.96	1.68	1.46	0.86	0.87
		VK	14.44	5.10	3.34	3.60	3.90
		LSD		12.79	14.76	7.87	11.81
	338	avrg	66.91	72.82	73.64	77.74	73.80
		stdev	3.96	0.66	3.60	0.79	0.15
		VK	14.44	4.36	3.00	2.56	3.12
		LSD		5.90	6.73	10.82	6.89
				LSD 0.001 6.14; 0.005 3.04			

Chemical analyses of the material that was collected from Mr. Dunimaleski's plot indicate that the quality was lower, compared to the same alternatives cultivated in the kombinat's trial fields. The nicotine level is higher than 2 in the plants from all four substrate mixtures, and the soluble sugars content is very low, which results in low Schmooks number. It should be mentioned that transplantation was carried out at the beginning of July on the only available plot was the one where traditional seedbeds had been located, i.e. the soil contained high levels of nitrogen.

Table 52. Chemical analyses of the leaf

substrate mixture	Nicotine %	Total N %	N in proteins %	Proteins %	Soluble sugars%	Polyphenols %	Total reduction	Ash %	Schmooks number	Polyphenolic number
1	2.66	3.34	1.42	8.86	6.78	2.24	9.02	15.95	0.77	24.83
2	2.57	3.47	1.58	7.90	7.11	2.18	9.22	15.81	0.90	24.71
3	2.70	3.27	1.47	7.81	8.03	2.80	10.83	14.97	1.03	23.80
4	2.52	3.50	1.39	8.40	7.03	2.31	9.34	15.17	0.83	24.13

MATERIALS AND METHODS - vegetables

The first project year (1999) the experiment was conducted in greenhouses of AD ANSKA REKA -Valandovo, with the following treatments:

- Control
- MeBr conventionally applied
- Dazomet in low doses, 50 g/m^2
- Plastic pipes, 100 cm long and 15 cm in diameter
- Solarization/biofumigation - with organic manure

The size of the plots was 3 x 6m. The alternative of soil-less technique applied in this case was represented with plastic pipes with the above mentioned dimensions, with 10 cm sand layer, on top of the soil. Alternative treatments were compared to the control (non-treated plot) and MeBr treatment. Dutch varieties that are well grown in our productive regions - Dorinda (tomatoes) and Cordoba (cucumbers) were chosen for this trial. The transplantation took place by the end of July.
Description of the proposed alternatives

Soil-less cultivation - In nurseries, glasshouses and seedbeds, as well as in other cases, synthetically or naturally sterilised soil substitutes provide reliable support to prevent infestation by bacteria, fungi, nematodes and weeds. Soil-less media may be roughly divided into two classes: organic and inert. Organic media, such as peat, sawdust, straw bales, spent mushroom compost, etc., have a good cation-exchange and water-holding capacity. Inert media, such as rock wool, perlite, polyurethane, expanded clay, polystyrene, etc., have a high water-holding capacity but low cation-exchange capacity. Vermiculite is not completely inert chemically. Organic media and some inert media can be easily sterilised with steam and re-utilised. Some inert media can also be re-extruded.
Inert soil-less media is extensively used in the Netherlands, Italy, Denmark and other countries. Cheap organic substitutes, such as sterilized grain-hulls and waste bark, are also used and are starting to be widely used in some third world countries

Low-dose chemicals - This is the use of a mixture composed of various fumigants such as methylisothiocyanate and methylisothiocyanate-generating products, e.g., metam sodium, Dazomet (the efficacy of which depends on soil preparation and moisture, climatic factors, and the application method) and halogenated hydrocarbons, e.g., 1,3-dichloropropene (which performs quite consistently for sensitive pests). Methylisothiocyanate (MITC) and MITC-generators, metam sodium (Vapam ®), Dazomet (Basamid ®), and 1,3-dichloropropene (TeloneII ®) are chemical pesticides used in tobacco and horticultural production.

Solarization plus biofumigation - is technique consists simply of heating the moist soil mixed with organic matter by covering it with a transparent plastic sheet which increases the soil temperature to a level lethal to soil pests. At the same time, the temperature reached favors the fermentation of the organic matter, generating gases, which are trapped by the plastic, and which are deadly to many microorganisms. This

also reduces the time needed by solarization alone. In countries with a temperate climate this inexpensive technique, which combines solarization and bio-fumigation, was successfully tested and is now in use on a full commercial scale

In the second growing season (2000), the soil-less cultivation treatment was excluded from the trials and the following treatments were tested on larger experimental plots, (170m^2) each, in three replications:

- Dazomet (Low dose chemicals),50 g/m^2
- Methyl Bromide,50 g/m^2
- Cow manure + straw (Solarization and Biofumigation), 5 kg/m^2
- Mocab (Control), 10 g/m^2

The cultivated varieties for this season are Monica for tomatoes and short type cucumbers Rambo. The transplanting took place at the end of January for the tomatoes and February for the cucumbers.

The tomatoes were grown up to IV cluster with the following parameters being recorded: number of fruits per cluster, average fruit mass per cluster [g], total fruit mass per cluster [g] and growth dynamics [cm] fortnightly. Planting density was 24000 plants/ha.

The cucumbers were trained on two stems with planting density of 12000 nests/ha and 2-3 seeds per nest. The following parameters being recorded: number of fruits per cluster, average fruit mass [g], total fruit mass per plant [g] and growth dynamics [cm] fortnightly.

Air and soil temperature (in the Control, Low doses chemicals and Solarisation+Biofumigation treatment) was recorded daily with HOBO data logger.

Biological analyses are made as required in TOR, prior to treatment, after treatment and before transplanting. The effectiveness of the treatments was estimated with quantitative analysis of the pathogens present in the soil and by the appearance of symptoms on the plants and roots. Counting for nematodes was carried out under dissecting microscope and for Fungi, Phycomicetes and Bacteriae the quantitative method for 1 g air dry soil was used with dilution of 1:10; 1:100 and 1:500. Weeds were determined and counted per square meter for each of the treatments.

II. Experiment On Alternatives to the Use of Methyl Bromide in Greenhouse Production in "Anska Reka "- Valandovo

Sowing of the cucumber and tomato seedlings commenced on 28.06.1999 year. It was carried out, as regularly, in pots (10 cm) with mixture of 50% send and 50% manure. The tomato cultivar Dorinda is used for the experiment and for cucumbers the cv. Cordoba.

The transplanting commenced on 31.07.1999.

The experimental plots, both for cucumbers and tomatoes were treated as follows:

Solarization/ biofumigation (5 kg manure /m^2) - 30.06.1999

Methyl Bromide (50 g/m^2) - 02.07.1999

Dazomet - (50 g/m^2) - 30.06.1999

For the soil-less system plastic tubes, 15cm in diameter were cut lengthwise and filled 2/3 with manure with 1.3 gavel sand on the top.

Water-soluble fertilizer Hortigrow has been used, with 5-50-20 formulation for better rooting, after transplanting, and 20-20-20 after flowering. The irrigation water has been analyzed (Tab 53) and adequately neutralized with nitric acid to pH of 5.8-6.0.

Table 53. Analysis of weal water in Valandovo

Macroelements (mmol/l)					
NH_4^+	K^+	Na^+	Ca^{2+}	Mg^{2+}	Si^{4+}
<0.1	0.4	0.9	1.7	1.0	0.33
NO_3^-	Cl^-	SO_4^-	HCO_3^-	$H_2PO_4^-$	
0.2	0.5	0.4	5.4	<0.01	
Microelements (µmol/l)					
Fe total	Mn^{2+}	Zn^{2+}	B^{3+}	Cu^{2+}	$Mo^{\$+}$
<0.1	0.3	<0.1	34	<0.1	<0.1

EC - 0.6 mS/cm

pH-7.5

1. Cucumbers

Soil samples were taken prior and after treatment (after transplanting) in order the effect of different treatments to be estimated. The results of the quantitative and qualitative analyses are presented in tables 54 and 55.

Table 54. Total nematode density per m^2- cucumbers

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	58018	31051	39490	63330
After treatment	212314	4542	28693	36943
During vegetation	57141	6066	10840	22480

S&B-Solarization+Biofumigation

Although the number of nematodes was relatively high in the control treatment, there were no knots on the roots noticed, except on the side roots. It can be noticed that the number of nematodes has been reduced in all treatments, as well as the number of colonies in the examined soil samples.

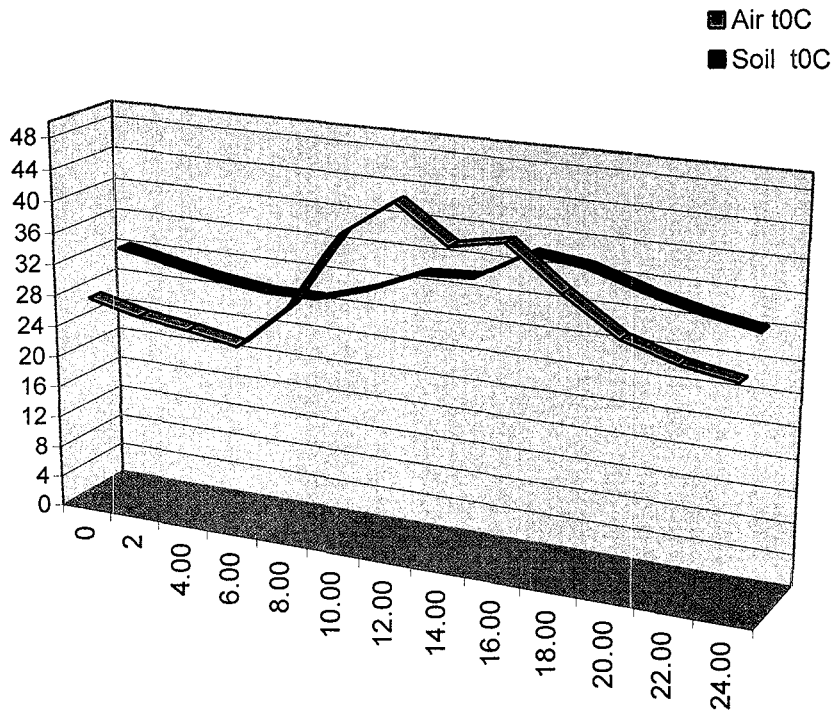
Table 55. Number of colonies in 10 g of air dry soil - cucumbers

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Fusarium sp.				
Before treatment	19	16	13	14
After treatment	16	6	6	2
During vegetation	11	13	6	32
Trichoderma sp.				
Before treatment	11	10	10	12
After treatment	10	1	7	6
During vegetation	-	5	6	6
Penicillium sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	2
During vegetation	50	3	60	10
Aspergillus sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	11	-	-	2
Alternaria sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	4	-	5	-
Phycomicetes				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	-	-	8	-

*Saprophytic forms of Bacteria present in all samples

By the method of wheat traps on soil medium, *Pythium sp.* and *Fusarium sp.* have been determined in all treatments, before and after treatment, except*for Phytophtora sp.* that was present in soil samples before treatment only.
The irrigation system for cucumber plants was independent from the one for tomatoes, so it was enabled more frequent irrigation, along with fertilization.

Graph. 16 Daily temperature fluctuations



Due to the extremely high temperatures (graph 16) in the period after transplanting most of the cucumber plants in all treatments were lost. Although the roof of the greenhouse was shaded, the irrigation enforced, and the ventilation regular, the temperature in the greenhouse was successively over 40^{0}C for several days.

As a result of the previously mentioned conditions, there were too few cucumber plants left for follow up of the plant growth and plant measurements. They were carried out in the following cropping cycle, when cucumbers are regularly grown in this region.

2. Tomatoes

Tomato, as a crop in general, is less susceptible to adverse conditions, compared to the cucumbers, so the experimental plants have survived the hot period, but there will be a strong impact on the plant development. Plant parameters have been followed till stage of IV cluster.

Table 56. Total nematode density per m^2- tomato

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	78471	40366	78471	43221
After treatment	366242	2548	28693	21736
During vegetation	220392	6066	3220	4646

S&B-Solarization+Biofumigation

Regarding the analyses of nematodes and soil born microorganisms presented in tables 56 and 57 it can be noticed that the condition, before and after the treatments is changed. Dazomet treatment seams to be more efficient compared to the solarization and biofumigation treatment, although there were not apparent symptoms on the plant roots in both treatments.

Table 57. Number of colonies in 10 g of air dry soil - tomato

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Fusarium sp.				
Before treatment	53	80	49	75
After treatment	13	-	13	8
During vegetation	9	9	1	7
Trichoderma sp.				
Before treatment	10	8	10	9
After treatment	3	4	5	2
During vegetation	-	-	1	12
Penicillium sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	43	16	63	-
Aspergillus sp.				
Before treatment	-	-	-	-
After treatment	11	-	-	-
During vegetation	9	3	-	7
Alternaria sp.				
Before treatment	-	-	-	-
After treatment	11	-	-	-
During vegetation	3	-	6	-
Phycomicetes				
Before treatment	2	2	2	2
After treatment	-	-	-	-
During vegetation	-	-	-	-

*Saprophytic forms of Bacteria present in all samples

By the method of wheat traps on soil medium, *Pythium sp.* and *Fusarium sp.* have been determined in all treatments, before and after treatment, except *for Phytophtora sp.* that was present in soil samples before treatment only.

Growers seem to be more enthusiastic about the solarization and biofumigation treatment, compared to the rest of the treatments, mainly because of the good pest control, relatively easy handling and the fertilizing aspect. The soil-less cultivation is completely new technology for the vegetable growers in this region. It also requires very good environmental control in order to give the best results. Considering the fact that this experiment was performed in actual production environment, the results were satisfactory. The tomatoes were grown up to IV cluster with the following parameters being recorded: number of fruits per cluster, average fruit mass per cluster [g], total fruit mass per cluster [g] and growth dynamics [cm] fortnightly.

Table 58 - Number of fruits per cluster

Cluster		Treatments				
		$\varnothing_1$	$\varnothing_2$	1	2	3
I	$\bar{x}$	4.75	4.13	4.97	4.83	4.75
	σ	0.14	0.52	0.13	0.27	0.24
	VK	2.85	12.53	2.55	5.64	5.16
	compared to	$\varnothing_1$		0.22	0.08	0.00
LSD: 0.05=0.45; 0.01=0.64			$\varnothing_2$	0.84	0.71	0.62
II	$\bar{x}$	5.30	4.48	5.37	5.31	5.19
	σ	0.15	0.40	0.11	0.13	0.20
	VK	2.81	8.94	1.99	2.54	3.90
	compared to	$\varnothing_1$		0.08	0.01	-0.11
LSD: 0.05=0.28; 0.01=0.39			$\varnothing_2$	0.90	0.83	0.71
III	$\bar{x}$	5.71	5.46	6.18	5.98	5.86
	σ	0.25	0.63	0.27	0.38	0.33
	VK	4.39	11.56	4.36	6.27	5.65
	compared to	$\varnothing_1$		0.48	0.28	0.16
LSD: 0.05=0.43; 0.01=0.61			$\varnothing_2$	0.72	0.53	0.41
IV	$\bar{x}$	5.02	4.43	5.10	5.11	4.78
	σ	0.53	0.16	0.49	0.32	0.46
	VK	10.53	3.54	9.56	6.24	9.61
	compared to	$\varnothing_1$		0.09	0.10	-0.23
LSD: 0.05=0.36; 0.01=0.52			$\varnothing_2$	0.67	0.68	0.35

The number of fruits was largest in the treatment with solarization and biofumigation, whereas in the soil-less treatment, it was smaller than in the both control treatments. This and the fact that the average fruit mass per cluster was largest in the same treatment contributed to the largest total fruit mass per cluster.

Table 59 Average fruit mass per cluster [g]

Cluster		Treatments				
		$\varnothing_1$	$\varnothing_2$	1	2	3
I	$\bar{x}$	92.84	102.19	119.51	98.90	96.09
	σ	2.49	12.41	1.21	2.96	9.77
	VK	2.68	12.15	1.02	2.99	10.17
	compared to	$\varnothing_1$		26.68	6.06	3.25
LSD: 0.05=12.71; 0.01=18.08			$\varnothing_2$	17.32	-3.29	-6.10
II	$\bar{x}$	97.97	119.46	127.63	112.53	96.18
	σ	4.35	6.65	3.25	4.52	0.87
	VK	4.44	5.57	2.55	4.01	0.91
	compared to	$\varnothing_1$		29.65	14.56	-1.80
LSD: 0.05=7.57; 0.01=10.77			$\varnothing_2$	8.17	-6.93	-23.28
III	$\bar{x}$	110.39	102.59	117.33	107.22	106.92
	σ	5.29	3.27	4.57	6.34	3.20
	VK	4.79	3.19	3.90	5.91	3.00
	compared to	$\varnothing_1$		6.94	-3.17	-3.47
LSD: 0.05=6.83; 0.01=9.71			$\varnothing_2$	14.73	4.62	4.33
IV	$\bar{x}$	116.77	111.06	119.58	114.25	114.59
	σ	7.78	5.35	9.70	9.64	6.92
	VK	6.67	4.82	8.11	8.44	6.04
	compared to	$\varnothing_1$		2.81	-2.51	-2.18
LSD: 0.05=13.22; 0.01=18.80			$\varnothing_2$	8.52	3.19	3.52

Table 60- Total fruit mass per cluster [g]

Cluster		Treatments				
		$\varnothing_1$	$\varnothing_2$	1	2	3
I	$\bar{x}$	453.43	417.94	560.06	519.62	451.28
	σ	44.35	36.35	31.18	39.96	54.17
	VK	9.78	8.70	5.57	7.69	12.00
compared to	$\varnothing_1$			106.63	66.19	-2.15
LSD: 0.05=34.93; 0.01=49.69	$\varnothing_2$			142.11	101.67	33.34
II	$\bar{x}$	573.65	493.68	689.91	612.46	525.68
	σ	67.79	34.34	25.18	15.32	46.60
	VK	11.82	6.96	3.65	2.50	8.86
compared to	$\varnothing_1$			116.26	38.81	-47.96
LSD: 0.05=47.93; 0.01=68.18	$\varnothing_2$			196.23	118.78	32.01
III	$\bar{x}$	633.35	574.58	730.56	670.24	623.36
	σ	56.39	35.66	45.98	40.06	35.31
	VK	8.90	6.21	6.29	5.98	5.66
compared to	$\varnothing_1$			97.21	36.88	-9.99
LSD: 0.05=43.73; 0.01=62.19	$\varnothing_2$			155.98	95.66	48.78
IV	$\bar{x}$	554.32	477.78	608.63	561.09	549.55
	σ	47.25	22.63	86.55	61.22	69.43
	VK	8.52	4.74	14.22	10.91	12.63
compared to	$\varnothing_1$			54.31	6.77	-4.77
LSD: 0.05=75.96; 0.01=108.04	$\varnothing_2$			130.85	83.31	71.77

The greenhouse production in this region and in the rest of the greenhouses throughout the Republic is endangered by the soilborn diseases, due to the intensive production of limited number of crops. Soil-less cultivation offers a solution for that problem by restricting the source of the pathogens from the root zone. For this purpose an individual fertirrigation system has been constructed with a standard nutrient regime for tomato and cucumbers on soil-less depending on the water quality. Regarding the plant appearance and performance there was no significant difference in the traits that have been recorded. With more frequent fertirigation, as required in high temperatures during summer cultivation, the results might have been better compared to the other alternatives. Still, the cost of production, for the time being would not allow this type of production in large scale.

Table 61- Growth dynamics [cm]

No of days from sowing		Treatments				
		$\varnothing_1$	$\varnothing_2$	1	2	3
75	$\bar{x}$	12.40	10.04	22.57	15.14	12.95
	σ	1.72	2.27	2.40	1.23	1.97
	VK	13.83	22.63	10.64	8.14	15.21
	compared to	$\varnothing_1$		10.17	2.74	0.55
LSD: 0.05=2.29; 0.01=3.26;		$\varnothing_2$		12.53	5.10	2.91
90	***0.001=4.71*** $\bar{x}$	20.62	17.85	33.16	26.10	22.85
	σ	2.58	2.37	2.70	2.94	2.58
	VK	12.51	13.29	8.14	11.26	11.29
	compared to	$\varnothing_1$		12.54	5.48	2.23
LSD: 0.05=1.45; 0.01=2.06;		$\varnothing_2$		15.31	8.25	5.01
105	***0.001=2.98*** $\bar{x}$	52.18	41.32	66.14	58.16	52.98
	σ	56.34	45.68	70.78	63.14	58.18
	VK	50.14	39.42	64.60	52.60	51.16
	compared to	$\varnothing_1$		13.96	5.98	0.80
LSD: 0.05=2.32; 0.01=3.30;		$\varnothing_2$		24.82	16.84	11.66
120	***0.001=4.77*** $\bar{x}$	73.76	64.93	92.91	81.99	80.50
	σ	4.84	1.71	8.27	6.53	4.37
	VK	6.57	2.64	8.91	7.96	5.43
	compared to	$\varnothing_1$		19.15	8.23	6.74
LSD: 0.05=5.00; 0.01=7.11;		$\varnothing_2$		27.97	17.05	15.57
135	***0.001=10.25*** $\bar{x}$	94.17	84.03	119.96	99.28	93.71
	σ	5.18	5.28	2.53	4.08	6.51
	VK	5.50	6.28	2.11	4.11	6.95
	compared to	$\varnothing_1$		25.79	5.11	-0.46
LSD: 0.05=3.81; 0.01=5.42;		$\varnothing_2$		35.93	15.25	9.68
150	***0.001=7.84*** $\bar{x}$	120.41	103.80	139.41	123.42	124.70
	σ	2.78	4.06	4.07	3.63	5.64
	VK	2.31	3.91	2.92	2.94	4.52
	compared to	$\varnothing_1$		19.01	3.01	4.29
LSD: 0.05=4.22; 0.01=6.00;		$\varnothing_2$		35.61	19.62	20.90
0.001=8.69						

The progress in growth was measured every two weeks, and it can be noticed from the figures presented in Table 61, that the smallest plants have been measured in the non-treated variant, whereas the tallest ones were the tomato plants cultivated under solarization and biofumigation treatment.

$\varnothing_1$ – Methyl bromide
$\varnothing_2$ – Control
1 – Solarization +biofumigation
2 – Soil-less cultivation
3 – Dazomet

The second phase trials in Valandovo commenced on 06.01.2000.

1. Cucumbers

For the observed cucumber plants, soil samples were taken prior and after treatment (after transplanting) aiming to determine the exact effect of the different treatments. The results of the quantitative and qualitative analyses are presented in tables 62 and 63.

Table 62. Total nematode density per m^2- cucumbers

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	64212	58712	61236	63520
After treatment	8427	6595	4434	3255
During vegetation	9276	7843	8721	5515

S&B-Solarization+Biofumigation

The number of nematodes was relatively high in the soil taken from the control treatment, yet there were no knots on the roots noticed except for the side roots where they were visible. From the stated results, it can be noticed that the total nematode density per m^2 as well as the number of colonies in 10 g of air dry soil has been reduced in the examined soil samples in all treatments.

Table 63. Number of colonies in 10 g of air dry soil - cucumbers

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Fusarium sp.				
Before treatment	35	39	46	35
After treatment	13	10	8	7
During vegetation	14	10	12	18
Trichoderma sp.				
Before treatment	13	11	12	16
After treatment	9	7	4	8
During vegetation	5	9	8	9
Penicillium sp.				
Before treatment	29	28	25	32
After treatment	5	20	12	18
During vegetation	21	15	17	22
Aspergillus sp.				
Before treatment	9	10	12	-
After treatment	-	4	8	-
During vegetation	5	8	7	-
Alternaria sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	-	-	-	-
Phycomicetes				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	-	-	-	-

*Saprophytic forms of Bacteria present in all samples

By the method of wheat traps on soil medium, *Pythium sp.* and *Fusarium sp.* have been determined in all treatments, before and after treatment, except*for Phytophtora sp.* that was present in soil samples before treatment only.
The irrigation system for cucumber plants was completely independent from the one for tomatoes, therefore a more frequent irrigation, along with fertilization were enabled.

Table 64 - Number of fruits per plant

	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	18.03	21.54	20.47	22.12
σ	1.24	1.32	0.99	1.13
VK	5.54	6.31	5.22	4.13
compared to	$\varnothing_1$	3.51	2.44	4.09
LSD: 0.05=0.32; 0.01=0.68				

The number of fruits was higher at all treatments, compared to the control. The statistical analysis showed that the difference between each treatment and the control variant is significantly higher for all tested levels.

Table 65 Average fruit mass per plant [g]

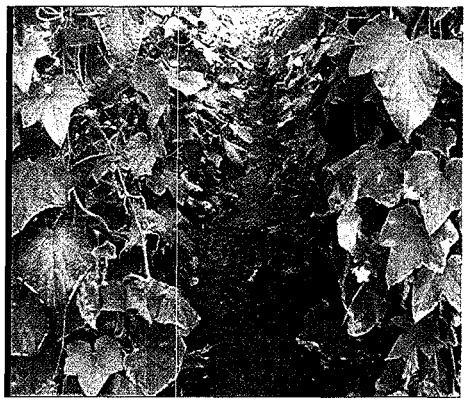
	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	275.54	312.34	305.65	322.17
σ	10.24	8.97	5.33	8.08
VK	9.81	7.16	6.99	5.38
compared to	$\varnothing_1$	36.80	30.11	46.63
LSD: 0.05=25.03; 0.01=29.87				

The average fruit mass per plant shows significantly better results for all treatments compared to the control. With the statistical analysis the differences between each treatment and the control variant were determined to be significantly higher at the level of 0.001 for the solarization and biofumigation treatment, and for the treatment with methyl bromide. The Dazomet treatment showed a significant difference at the level of 0.01.

Table 66 - Total fruit mass per plant [g]

	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	4967.98	6727.80	6256.65	7126.40
σ	5.52	3.18	2.17	4.39
VK	8.27	5.53	6.66	4.47
compared to	$\varnothing_1$	1759.82	1288.67	2158.42
LSD: 0.05=1275.03; 0.01=1749.89				

Consequently to the above analyzed characteristics, the total fruit mass per plant is higher at all treatments compared to the control. With the difference of 2158 g compared to the control variant, the solarization and biofumigation treatment, as well as the treatment with methyl bromide (1760 g more than the control) showed significantly higher yield for the level of 0.01. The treatment with Dazomet showed significant differences only for the level of 0.05.



Solarization &biofumigation treatment

Control (Mocab)

Table 67- Growth dynamics [cm]

No of days from transplanting		Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
5	$\bar{x}$	23.22	29.87	28.79	31.24
	σ	3.46	5.89	4.22	3.74
	VK	11.15	10.92	7.79	9.34
	compared to	$\varnothing_1$	6.65	5.57	8.02
LSD: 0.05=2.05; 0.01=2.86					
20	$\bar{x}$	52.12	60.41	59.42	65.84
	σ	3.58	3.27	5.61	4.59
	VK	7.78	4.56	4.77	6.32
	compared to	$\varnothing_1$	8.29	7.3	13.72
LSD: 0.05=4.32; 0.01=6.28					
35	$\bar{x}$	70.34	86.67	84.22	83.31
	σ	3.23	4.22	4.78	3.59
	VK	7.89	5.32	5.55	4.98
	compared to	$\varnothing_1$	16.33	13.88	12.97
LSD: 0.05=10.12; 0.01=11.05					
50	$\bar{x}$	90.37	112.04	108.67	110.26
	σ	5.59	4.72	3.61	3.99
	VK	10.28	6.81	7.36	4.29
	compared to	$\varnothing_1$	21.67	18.3	19.89
LSD: 0.05=10.23; 0.01=13.15					
65	$\bar{x}$	114.29	129.81	130.64	132.61
	σ	2.91	3.64	3.88	2.01
	VK	5.50	4.46	3.06	2.99
	compared to	$\varnothing_1$	15.52	16.35	18.32
LSD: 0.05=9.87; 0.01=14.07					
80	$\bar{x}$	133.93	147.72	153.38	150.39
	σ	5.67	6.97	8.12	6.38
	VK	12.13	9.88	6.38	7.47
	compared to	$\varnothing_1$	13.79	19.45	16.46
LSD: 0.05=8.77; 0.01=11.22					
95	$\bar{x}$	156.66	169.91	172.38	174.44
	σ	5.55	5.69	6.31	5.81
	VK	9.37	8.78	6.97	7.44
	compared to	$\varnothing_1$	13.25	15.72	17.78
LSD: 0.05=9.76; 0.01=13.34					

The progress in growth for all treatments was measured every two weeks. Figures presented in the Table 67 show a much stronger growth at all treatments compared to the control. A significant faster growth at the treatment with solarization and biofumigation is calculated even for the level of 0.001 at almost all measuring dates. The statistical analyses for the other two treatments resulted with significant differences on lower levels, in most cases only at the level of 0.05.

2. Tomatoes

Table 68. Total nematode density per m^2- tomato

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Before treatment	79848	55213	59824	62384
After treatment	155487	3359	6686	8900
During vegetation	25763	6422	7727	9132

S&B-Solarization+Biofumigation

Regarding the analyses of nematodes and soil born microorganisms presented in tables 68 and 69 it can be noticed that there is a change related to the type of treatment. Dazomet, Methyl Bromide and the solarization and biofumigation treatment seem to be close in their effect on nematodes, although there were no visible symptoms on the plants' roots in all treatments.

Table 69. Number of colonies in 10 g of air dry soil – tomato

Time of sampling	Control	Methyl Bromide	Dazomet	S&B
Fusarium sp.				
Before treatment	29	49	43	33
After treatment	15	20	28	17
During vegetation	17	29	19	12
Trichoderma sp.				
Before treatment	23	21	30	26
After treatment	12	17	14	14
During vegetation	15	19	18	15
Penicillium sp.				
Before treatment	-	-	-	-
After treatment	-	-	-	-
During vegetation	15	36	25	37
Aspergillus sp.				
Before treatment	15	-	10	9
After treatment	11	2	5	3
During vegetation	7	3	4	7
Alternaria sp.				
Before treatment	7	3	-	-
After treatment	-	-	-	-
During vegetation	5	-	-	4

*Saprophytic forms of Bacteria present in all samples

By the method of wheat traps on soil medium, *Pythium sp.* and *Fusarium sp.* have been determined in all treatments, before and after treatment, except *for Phytophtora sp.* that was present in soil samples only before the treatment.

Table 70 - Number of fruits per plant (up to the 5th cluster)

	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	27.54	31.05	29.74	30.60
σ	0.17	0.22	0.20	0.44
VK	3.24	4.21	3.15	3.27
compared to	$\varnothing_1$	3.51	2.20	3.06
LSD: 0.05=0.42; 0.01=0.72				

The number of fruits was higher at all treatments, compared to the control. The statistical analysis showed that the difference between each treatment and the control variant is significantly higher even at the level of 0.001.

Table 71 Average fruit mass per plant [g]

	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	102.34	110.65	105.73	114.55
σ	12.54	4.75	6.39	7.12
VK	10.87	6.66	7.02	8.92
compared to	$\varnothing_1$	8.31	3.39	12.21
LSD: 0.05=5.92; 0.01=8.76				

The average fruit mass per plant, as for the previous feature, shows somewhat better results at the treatments compared to the control. With the statistical analysis the differences between each treatment and the control variant were determined to be significantly higher at the level of 0.001 for the solarization and biofumigation treatment, whereas for the treatment with methyl bromide, the average fruit mass per plant is higher compared to the control variant only at the level of 0.05. The Dazomet treatment, although resulted with slightly bigger fruits than those obtained from the control variant, was not supported by a significant difference at any level.

Table 72- Total fruit mass per plant [g] up to the 5th cluster

	Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
$\bar{x}$	2818.44	3435.68	3144.41	3505.23
σ	9.34	5.27	8.78	6.37
VK	15.62	9.82	10.14	11.37
compared to	$\varnothing_1$	617.24	325.97	686.79
LSD: 0.05=255.05; 0.01=298.86				

Consequently to the above analyzed characteristics, the total fruit mass per plant observed up to the 5th cluster is higher at all treatments compared to the control. With an average difference of 686 g compared to the control variant, the solarization and biofumigation treatment showed significant higher yield for the level of 0.001. With a slightly smaller difference, but still the same level of significance in differences was the treatment with methyl bromide, whereas for the treatment with Dazomet, significant differences were found for the level of 0.01.

Table 73- Growth dynamics [cm]

No of days from transplanting		Treatments $\varnothing_1$	Methyl Bromide	Dazomet	S & B
5	$\bar{x}$	16.77	20.47	18.79	16.37
	σ	5.46	4.89	3.22	4.78
	VK	10.12	11.98	8.79	12.31
	compared to	$\varnothing_1$	3.7	2.02	-0.4
LSD: 0.05=2.05; 0.01=2.86					
20	$\bar{x}$	25.36	34.71	32.16	29.98
	σ	4.59	4.77	3.12	6.58
	VK	8.88	5.67	7.16	8.92
	compared to	$\varnothing_1$	9.35	6.8	4.62
LSD: 0.05=4.32; 0.01=6.28					
35	$\bar{x}$	44.32	50.28	49.87	47.63
	σ	5.58	6.24	3.87	3.99
	VK	5.32	7.78	7.72	6.91
	compared to	$\varnothing_1$	5.96	5.55	3.31
LSD: 0.05=3.12; 0.01=5.03					
50	$\bar{x}$	62.87	68.81	62.22	65.54
	σ	7.36	5.23	4.31	6.03
	VK	9.88	5.72	6.91	5.46
	compared to	$\varnothing_1$	5.94	-0.65	2.67
LSD: 0.05=2.24; 0.01=3.08					
65	$\bar{x}$	78.85	85.33	81.17	84.78
	σ	3.61	5.33	4.89	3.98
	VK	10.02	5.81	7.24	5.99
	compared to	$\varnothing_1$	6.48	2.32	5.93
LSD: 0.05=3.61; 0.01=4.27					
80	$\bar{x}$	91.15	104.24	99.98	103.37
	σ	3.55	4.12	4.37	5.06
	VK	8.65	7.72	6.39	6.91
	compared to	$\varnothing_1$	13.09	8.83	12.22
LSD: 0.05=4.98; 0.01=6.31					
95	$\bar{x}$	108.75	122.32	117.24	120.69
	σ	5.81	3.08	2.99	2.14
	VK	8.86	2.37	3.64	3.02
	compared to	$\varnothing_1$	13.57	8.49	11.94
LSD: 0.05=5.12; 0.01=7.24					

The progress in growth was measured every two weeks. Figures presented in Table 73 show a more or less balanced growth at all treatments, with a slight faster growth at the treatment with methyl bromide as well as for the plants grown on soil treated with solarization and biofumigation. The growth was slowest at the control variant, with significant differences between the control and all other treatments for all measuring dates, at the level of 0.05.

III. Economical analyses of the proposed alternatives

The assumptions that were included in the economic calculation of the costs in the first and second year trials of the Demonstration project "Alternatives to the use of Methyl Bromide", are adjusted according to the obtained results and required economic parameters to be presented. The following analysis is based upon updated transplant and crop cost calculations. Also, the yields and buy-out prices are added to the crop budget calculations in order to get the income per capacity unit, and respectively the gross margin or profit.

In this view, all calculations are based on the exchange rate of 1 USD = 64 MKD.

A) Economic analysis of the tobacco production

In the first year of trials undertaken within the framework of this project, the objective was to assess the alternative technologies to the use of methyl bromide in tobacco production, and therefore to make a selection of the most appropriate and applicable production technology that will be further analyzed in the second year. Besides having similar pesticide effects to the methyl bromide and prospects for good yielding and successful growing in Macedonian production conditions, the selected production technology also ought to be cost effective and economically justified.

It is important to mention that the price per unit used in the crop calculations is the price that the tobacco grower gets i.e. the buy-out price. In this regard, the Government of the Republic of Macedonia guaranties the buy-out prices to the growers. That means that the tobacco kombinates are obliged to pay the Government set price to the growers. The buy-out price in 1999 set by the Government amounted 120 MKD per 1 kg raw material (1.88 USD).

According to the results from the field trials and the conducted growers survey, the assumptions for oriental type of tobacco are corrected as follows: In order to plant 1 ha of tobacco, 200 m^2 of seedlings in traditional seedbeds should be produced. Around 160,000 plants are planted on 1 ha, plus 12% for replanting losses, amounting in total 180,000.

In the tables below, the alternatives to the use of methyl bromide are compared in the three trial sites: Tutunski kombinat Kumanovo, Tutunski kombinat Prilep and Jaka Tabak Radovis. The following parameters were considered for comparing purposes and analysis:

- Costs per hectare of open field oriental tobacco production;
- Average yield per hectare from in the three experimental location;
- Buy-out price of tobacco as declared by the Government;
- Gross income (the yield times the buy-out price); and
- Calculation of the gross profit per alternative technology.

Table 74. Comparison of the alternatives to the use of methyl bromide in tobacco production, first year trial, calculated for 1 ha open field production in Tutunski kombinat Kumanovo

Production technology	Seedling costs	Total costs (USD)	Average yield in kg per ha	Buy-out price per kg (USD)	Gross income (USD)	Gross profit (USD)
Control	357.00	2,339.00	1,525.55	1.88	2,868.03	529.03
Methyl bromide	402.00	2,384.00	1,795.58	1.88	3,375.69	991.69
Low doses chemicals	397.00	2,379.00	1,802.25	1.88	3,388.23	1,009.23
S + B	382.00	2,364.00	1,768.61	1.88	3,324.99	960.99
Floating trays	340.00	2,257.00	2,483.10	1.88	4,668.23	2,411.23

Table 75. Comparison of the alternatives to the use of methyl bromide in tobacco production, first year trial, calculated for 1 ha open field production in Tutunski kombinat Prilep

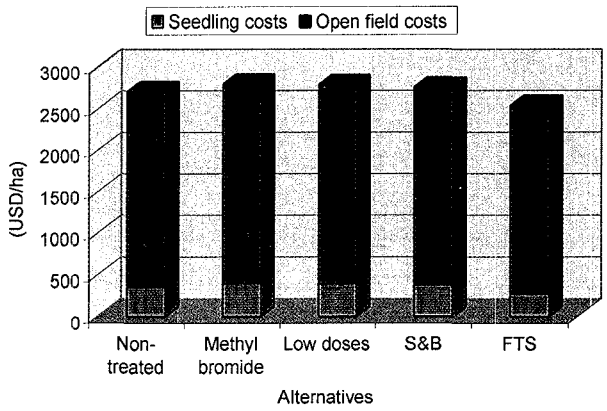
Production technology	Seedling costs	Total costs (USD)	Average yield in kg per ha	Buy-out price per kg (USD)	Gross income (USD)	Gross profit (USD)
Control	357.00	2,339.00	1,630.90	1.88	3,066.09	727.09
Methyl bromide	402.00	2,384.00	1,712.10	1.88	3,218.75	834.75
Low doses chemicals	397.00	2,379.00	1,735.50	1.88	3,262.74	883.74
S + B	382.00	2,364.00	1,741.22	1.88	3,273.49	909.49
FTS	340.00	2,257.00	2,563.20	1.88	4,818.82	2,561.82

Table 76. Comparison of the alternatives to the use of methyl bromide in tobacco production, first year trial, calculated for 1 ha open field production in Jaka Tabak Radovis

Production technology	Seedling costs	Total costs (USD)	Average yield in kg per ha	Buy-out price per kg (USD)	Gross income (USD)	Gross profit (USD)
Control	357.00	2,339.00	1814.7	1.88	3,411.64	1,072.64
Methyl bromide	402.00	2,384.00	2023.4	1.88	3,803.99	1,419.99
Low doses chemicals	397.00	2,379.00	1948.52	1.88	3,663.22	1,284.22
S + B	382.00	2,364.00	2179.24	1.88	4,096.97	1,732.97
FTS	275.00	2,322.00	3337.1	1.88	6,273.75	3,951.75

The costs of seedling production and other production costs are taken as average from all three locations and in principle vary from 10-20%, having the floating trays alternative as the most cost efficient. The costs of production of seedlings (presented in Appendix A) i.e. young plants present approximately 15% of the total production costs (presented in Appendix B), provided that in the floating trays system that percentage is somewhat higher due to the relatively high initial investment.

Graph 17 Comparison of average costs per ha



Having an identical buy-out price set at 1.88 USD, the income per hectare in the experimental fields varies significantly from 2,868.03 (control alternative in Kumanovo) to 6,273.75 USD (floating trays system in Radovis) per hectare. In this context, it is important to emphasize that due to climatic advantages, the yields were the highest in all treatments in Radovis, which resulted in higher gross income and profits in this trial area. In summary, the most profitable production technology, according to the trails conducted within the this project on three experimental sites in 1999, the floating trays alternative demonstrates highest incomes and consequently it is the recommendable alternative from the economic point of view. The most expensive alternative is the production with methyl bromide treatments, mostly due to the high official price of this pesticide.

As it was concluded in the first project year that the floating trays system of producing seedlings is by far the most appropriate and the most cost effective one, in the second project year the focus was laid upon this system, aiming to analyze its possibilities and yielding in more details. For this purpose, four types of seedling trays were tested, using four different media. The seedling trays differed with regard to the seedling density - from 209 to 589 seedling alveoli per tray. The media are explained in the experiment part of this report, however here it is important to remark that the substrate I and IV are imported, whilst II and III are of local origin.

The table below shows the results obtained from the trials, thus giving 16 different combinations of trays and media (detailed analyses presented in Appendix C), to be compared through the values measured for the cost of one seedling; the cost of $1m^2$ of the floating trays system (construction of the seedbeds, materials used for the construction, labor etc.); and the calculated cost of seedlings needed for 1 ha of open field plantation (i.e. approximately 180,000 seedlings).

Table 77. Costs of seedlings (per unit and per capacity production) and costs of floating trays system (m^2) in four different trays and media (in USD)

Combination of tray size and substrate mixture	Costs for 1 seedling	Costs for $1m^2$ of FTS	Costs for seedlings for 1 ha open field production
209/I	0.0034	3.77	617.00
209/II	0.0022	2.42	396.36
209/III	0.0026	2.66	435.05
209/IV	0.0038	4.17	681.87

Table 77. Costs of seedlings (per unit and per capacity production) and costs of floating trays system (m^2) in four different trays and media (in USD)-continued

Combination of tray size and substrate mixture	Costs for 1 seedling	Costs for 1m^2 of FTS	Costs for seedlings for 1 ha open field production
264/I	0.0038	3.75	675.10
264/II	0.0024	2.44	438.36
264/III	0.0026	2.64	475.00
264/IV	0.0041	4.15	746.50
338/I	0.0024	3.11	430.24
338/II	0.0018	2.40	332.12
338/III	0.0022	2.86	395.72
338/IV	0.0032	4.14	573.70
589/I	0.0017	3.39	305.50
589/II	0.0011	2.19	197.13
589/III	0.0018	2.39	214.80
589/IV	0.0018	3.68	330.90

The costs per unit (1 seedling) and the costs per seedlings required for 1 ha of plantation provide ground for comparing the suitability of the group of trays for this production. In this view, it can be clearly seen from the table that the 589 trays offer the least expensive seedlings, followed by the 338 alternative. The cost of 1 seedling in the 589 trays ranges from 0.0011-0.0018 USD, which is three to four times lower than the costs in the other alternatives. From the values shown in the costs of 1m^2 of FTS, it can be interpreted that in general media II and III (the local substrates) offer the lowest cost, which reflects into obtaining cheaper seedlings.

B) Economic analysis of the vegetable production

Tomatoes

The alternatives to the use of methyl bromide were also tested in the production of vegetables (detailed analyses presented in Appendix D). In the case of tomatoes, the lowest costs were achieved in the control alternative, and the production with using methyl bromide as pesticide has proved to be the most expensive one. However, if the average yield is looked up, it is obvious that the Solarisation and Biofumigation system is by far the highest with 126 tons of tomato per hectare, while the control system is the lowest with only 101 tons/hectare. Having an identical buy-out price, the Solarisation and Biofumigation system brings highest gross income and highest gross profit (66,486 USD), which makes this alternative to be the most economically justified.

Table 78 Costs of production, yielding and gross profit of tomato in the alternatives to the use of methyl bromide

Production technology	Total costs (USD)	Average yield in kg per ha	Buy-out price per kg (USD)	Gross income (USD)	Gross profit (USD)
Control	58,350.00	101,400.00	1.00	101,400.00	43,050.00
Methyl bromide	65,280.00	114,000.00	1.00	114,000.00	48,720.00
Low doses chemicals	62,148.00	113,000.00	1.00	113,000.00	50,852.00
S + B	59,514.00	126,000.00	1.00	126,000.00	66,486.00
Soil-less cultivation	65,804.00	120,000.00	1.00	120,000.00	54,196.00

Cucumbers

The second vegetable crop that was included in the trials is the cucumber (detailed analyses presented in Appendix E). The cucumber was cultivated using the same alternatives to the use of methyl bromide as in tobacco and tomatoes. This crop demonstrated similar results to the tomato, having again the Solarisation and Biofumigation system as the most economically justified option, with relatively low costs and the highest yield of 235.6 tons/hectare. It resulted into a possibility for a gross profit of 99,844 USD, which is almost double than the control system.

Table 79. Costs of production, yielding and gross profit of cucumber in the alternatives to the use of methyl bromide

Production technology	Total costs (USD)	Average yield in kg per ha	Buy-out price per kg (USD)	Gross income (USD)	Gross profit (USD)
Control	39,023.00	158,800.00	0.60	95,280.00	56,257.00
Methyl bromide	42,248.00	202,000.00	0.60	121,200.00	78,952.00
Low doses chemicals	42,972.00	222,200.00	0.60	133,320.00	90,348.00
S + B	41,516.00	235,600.00	0.60	141,360.00	99,844.00
Soil-less cultivation	48,994.00	220,000.00	0.60	132,000.00	83,006.00

CONCLUSIONS

Three alternatives to the use of methyl bromide for tobacco young plants and vegetable production have been tested: soil-less cultivation (floating trays system); low doses chemicals (Dazomet); and solarization + biofumigation. This is the first trial with oriental type of tobacco in the field. Out of the results obtained in respect of the plant condition and plant protection, the following general aspects may be underlined:

- Dazomet treatment exhibits high toxicity and can be hardly used in weather conditions that prevail in the pre-treatment period.
- The treatment with solarization and biofumigation performed poorly, due to the bad weed control. The reason may be the questionable manure quality, which will remain problem for the future.
- Floating tray system plants had the best root system and general appearance, and performed best compared both to the non-treated control and methyl bromide treatment.
- Regarding the vegetable production in the greenhouses of "Anska reka" the treatment with solarization and biofumigation was the most promising one.

In the second phase of the project, following conclusions and recommendations were achieved:

- In all tested treatments the germination percentage for the pelletized seed was lower than the one reported from laboratory tests. In average for all locations the germination rate was below 75%.
- During the process of sowing with manual seeders there is a certain loss (at least 20%) which has to be taken into consideration for calculation of the sowing rates.
- Regarding the plant parameters of different organs and the young plant condition in general the best results have been obtained in the mixtures that contained locally supplied substrates.
- The acceptance rate in open field in all four locations was recorded to be above 90%, and there was no significant difference between different treatments of the Floating Tray System.
- The floating tray system plants in open field had better performance in respect of all measured plant parameters compared to the methyl bromide treatment, such as plant height, leaf length and diameter and number of leaves per plant.
- Taking into consideration the fact that there was no significant difference in respect of the tray size treatments, after transplanting trays with smaller alveolus capacity can be used for production of young plants for oriental type of tobacco.
- The trials in the greenhouses of Valandovo have justified the results from the first phase of the Demonstration project; i.e. best results for soil sterilization tomatoes and cucumbers have been obtained with biofumigation and solarization treatment.

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APPENDIX A

COST OF PRODUCTION OF TOBACCO SEEDLINGS

Non treated

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
weeding	55	55	55	55	55	55	55	55	55	55	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Water	2	2	2	2	2	2	2	2	2	2	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Miscellaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**387**	**342**	**362**	**342**	**362**	**367**	**362**	**342**	**362**	**342**	***3570***

Methyl bromide

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Water	2	2	2	2	2	2	2	2	2	2	
Methyil bromide	100	100	100	100	100	100	100	100	100	100	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Misceallaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**432**	**387**	**407**	**387**	**407**	**412**	**407**	**387**	**407**	**387**	***4020***

Solarization + Biofumigation

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
weeding	55	55	55	55	55	55	55	55	55	55	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Manure	25	25	25	25	25	25	25	25	25	25	
Water	2	2	2	2	2	2	2	2	2	2	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Misceallaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**412**	**367**	**387**	**367**	**387**	**392**	**387**	**367**	**387**	**367**	***3820***

Floating Tray System

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
black plastic	20		20		20		20		20		
seedbed building	100										
seedling trays	750										
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	130	130	130	130	130	130	130	130	130	130	
Labour											
sowing	10	10	10	10	10	10	10	10	10	10	
other	10	10	10	10	10	10	10	10	10	10	
Compost + perlit	10	10	10	10	10	10	10	10	10	10	
Water	1	1	1	1	1	1	1	1	1	1	
Fertilizers	2	2	2	2	2	2	2	2	2	2	
Pesticides											
Misceallaneous	2	2	2	2	2	2	2	2	2	2	
TOTAL	**1080**	**165**	**205**	**165**	**205**	**190**	**205**	**165**	**205**	**165**	***2750***

APPENDIX B

COST OF PRODUCTION OF TOBACCO IN OPEN FIELD

Non treated - control

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
weeding	55	55	55	55	55	55	55	55	55	55	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
transplantation	50	50	50	50	50	50	50	50	50	50	
filling of failed plants	16	16	16	16	16	16	16	16	16	16	
digging	268	268	268	268	268	268	268	268	268	268	
spraying	27	27	27	27	27	27	27	27	27	27	
irrigation	13	13	13	13	13	13	13	13	13	13	
harvesting and handling	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	
manipulation	268	268	268	268	268	268	268	268	268	268	
other	10	10	10	10	10	10	10	10	10	10	
Manure	20	20	20	20	20	20	20	20	20	20	
Water	2	2	2	2	2	2	2	2	2	2	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Misceallaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**2369**	**2324**	**2344**	**2324**	**2344**	**2349**	**2344**	**2324**	**2344**	**2324**	***23390***

Methyl bromide

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
transplantation	50	50	50	50	50	50	50	50	50	50	
filling of failed plants	16	16	16	16	16	16	16	16	16	16	
digging	268	268	268	268	268	268	268	268	268	268	
spraying	27	27	27	27	27	27	27	27	27	27	
irrigation	13	13	13	13	13	13	13	13	13	13	
harvesting and handling	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	
manipulation	268	268	268	268	268	268	268	268	268	268	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Water	2	2	2	2	2	2	2	2	2	2	
Methyil bromide	100	100	100	100	100	100	100	100	100	100	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Misceallaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**2414**	**2369**	**2389**	**2369**	**2389**	**2394**	**2389**	**2369**	**2389**	**2369**	***23840***

Low doses chemicals

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
weeding	15	15	15	15	15	15	15	15	15	15	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
transplantation	50	50	50	50	50	50	50	50	50	50	
filling of failed plants	16	16	16	16	16	16	16	16	16	16	
digging	268	268	268	268	268	268	268	268	268	268	
spraying	27	27	27	27	27	27	27	27	27	27	
irrigation	13	13	13	13	13	13	13	13	13	13	
harvesting and handling	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	
manipulation	268	268	268	268	268	268	268	268	268	268	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Water	2	2	2	2	2	2	2	2	2	2	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides	80	80	80	80	80	80	80	80	80	80	
Misceallaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**2409**	**2364**	**2384**	**2364**	**2384**	**2389**	**2384**	**2364**	**2384**	**2364**	***23790***

Solarization + Biofumigation

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	150	150	150	150	150	150	150	150	150	150	
Labour											
sowing	20	20	20	20	20	20	20	20	20	20	
weeding	55	55	55	55	55	55	55	55	55	55	
spraying	55	55	55	55	55	55	55	55	55	55	
repicking	20	20	20	20	20	20	20	20	20	20	
transplantation	50	50	50	50	50	50	50	50	50	50	
filling of failed plants	16	16	16	16	16	16	16	16	16	16	
digging	268	268	268	268	268	268	268	268	268	268	
spraying	27	27	27	27	27	27	27	27	27	27	
irrigation	13	13	13	13	13	13	13	13	13	13	
harvesting and handling	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	
manipulation	268	268	268	268	268	268	268	268	268	268	
other	10	10	10	10	10	10	10	10	10	10	
Compost	20	20	20	20	20	20	20	20	20	20	
Manure	25	25	25	25	25	25	25	25	25	25	
Water	2	2	2	2	2	2	2	2	2	2	
Fertilizers	5	5	5	5	5	5	5	5	5	5	
Pesticides											
Miscellaneous	5	5	5	5	5	5	5	5	5	5	
TOTAL	**2394**	**2349**	**2369**	**2349**	**2369**	**2374**	**2369**	**2349**	**2369**	**2349**	***23640***

Floating Tray System

	1	2	3	4	5	6	7	8	9	10	
Capital expenditure											
plastic sheets	20		20		20		20		20		
metal arches	25					25					
black plastic	20		20		20		20		20		
seedbed building	100										
seedling trays	750										
Recurent expenditure											
Preparations and daily procedures											
Tobacco seed (row)	130	130	130	130	130	130	130	130	130	130	
Labour											
sowing	10	10	10	10	10	10	10	10	10	10	
transplantation	50	50	50	50	50	50	50	50	50	50	
filling of failed plants	16	16	16	16	16	16	16	16	16	16	
digging	268	268	268	268	268	268	268	268	268	268	
spraying	27	27	27	27	27	27	27	27	27	27	
irrigation	13	13	13	13	13	13	13	13	13	13	
harvesting and handling	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	
manipulation	268	268	268	268	268	268	268	268	268	268	
other	10	10	10	10	10	10	10	10	10	10	
Compost + perlit	10	10	10	10	10	10	10	10	10	10	
Water	1	1	1	1	1	1	1	1	1	1	
Fertilizers	2	2	2	2	2	2	2	2	2	2	
Pesticides											
Misceallaneous	2	2	2	2	2	2	2	2	2	2	
TOTAL	**3062**	**2147**	**2187**	**2147**	**2187**	**2172**	**2187**	**2147**	**2187**	**2147**	***22570***

APPENDIX C

COST OF PRODUCTION FOR DIFFERENT FTS TREATMENTS

Cost of production for young plants per m^2 for 209 trays with Dutch substrate and Perlite

			Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	Years of exploatation										
Capital costs								1	2	3	4	5	6	7	8	9	10	
Lumber and nails			$1m^3$		18000	45	0.69	0.71										
Manual seeder			1 piece				60.00											
Arches			1 kg			6.5	0.10	0.10										
Transparent polyethilene			($1kg/8m^2$)		110	14	0.22	0.22										
Black polyethilene			($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile													0.22					
	6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14										
Trays	/209					292.5	4.50	4.50					0.14					
Recurent costs																		
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Dutch peat+perlite			1 m^3		6100	171	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	
Labor costs					w/h	Total	USD											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02		6.4		0.13	12.90	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
Filling oof the trays	0.05		6.4		0.32	32.26	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	
Pozitioning of the trays	0.01		6.4		0.06	6.45	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	Total:
								9.02	3.12	3.12	3.12	3.12	3.70	3.12	3.12	3.12	3.12	*37.70*

Average cost of production for $1m^2$ of 209 trays is 3.77 USD, or 0.0034 per transplant

Cost of production for young plants per m2 for 209 trays with Compost and Perlite																	
		Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	Years of exploatation										
							1	2	3	4	5	6	7	8	9	10	
Capital costs																	
Lumber and nails		$1m^3$		18000	45	0.69	0.71										
Manual seeder		1 piece				60.00											
Arches		1 kg			0.2	0.10	0.10										
Transparent polyethilene		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Black polyethilene		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile																	
	6 m width	($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14					
Trays	/209				292.5	4.50	4.50										
Recurent costs																	
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Compost+perlite		1 m^3		3064	86	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	
Labor costs				w/h	Total	USD											
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02	6.4		0.13	12.90	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
Filling oof the trays	0.05	6.4		0.32	32.26	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	
Pozitioning of the trays	0.01	6.4		0.06	6.45	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
							7.67	1.77	1.77	1.77	1.77	2.35	1.77	1.77	1.78	1.78	*24.22*

Average cost of production for $1m^2$ of 209 trays is 2.42 USD, or 0.0022 per transplant

Cost of production for young plants per m2 for 209 trays with Local peat and Perlite																	
	Unit			*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	Years of exploatation										
							1	2	3	4	5	6	7	8	9	10	
Capital costs																	
Lumber and nails	$1m^3$			18000	45	0.69	0.71										
Manual seeder	1 piece					60.00											
Arches	1 kg				0.2	0.10	0.10										
Transparent polyethilene																	
1.9 x 4m	($1kg/8m^2$)			110	14	0.22	0.22					0.22					
Black polyethilene																	
	($1kg/8m^2$)			110	14	0.22	0.22					0.22					
Agrile																	
6 m width	($55m^2/kg$, $18g/m^2$)			490	9	0.14	0.14					0.14					
Trays /209					292.5	4.50	4.50										
Recurent costs																	
Fertilizer	1 kg			60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed	1 kg			46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization	1 kg			60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Local peat+perlite	$1 m^3$			3600	101	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	
Labor costs				w/h	Total	USD											
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02	6.4		0.13	12.90	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
Filling oof the trays	0.05	6.4		0.32	32.26	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	
Pozitioning of the trays	0.01	6.4		0.06	6.45	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
							7.91	2.01	2.01	2.01	2.01	2.59	2.01	2.01	2.01	2.01	*26.59*

Average cost of production for $1m^2$ of 209 trays is 2.66 USD or 0.0026 USD per plant

Cost of production for young plants per m2 for 209 trays with Dutch peat and Tuff

						Years of exploatation									
	Unit	*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*		1	2	3	4	5	6	7	8	9	10
Capital costs															
Lumber and nails	$1m^3$	18000	45	0.69		0.71									
Manual seeder	1 piece			60.00											
Arches	1 kg		0.2	0.10		0.10									
Transparent polyethilene															
1.9 x 4m	($1kg/8m^2$)	110	14	0.22		0.22									
Black polyethilene											0.22				
	($1kg/8m^2$)	110	14	0.22		0.22					0.22				
Agrile															
6 m width	($55m^2/kg$, $18g/m^2$)	490	9	0.14		0.14					0.14				
Trays /209			292.5	4.50		4.50									
Recurent costs															
Fertilizer	1 kg	60	4.2	0.06		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed	1 kg	46620	6	0.09		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization	1 kg	60000	4	0.06		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+Tuff	$1 m^3$	3064	196	3.11		3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Labor costs		working hours	Total	USD											
Preparation of bays bottom (plowing and leveling)		0.20	20.16	0.031		0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen		0.03	3.02	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting		0.15	15.12	0.023		0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing	0.02 6.4	0.13	12.90	0.020		0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Filling oof the trays	0.05 6.4	0.32	32.26	0.050		0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Pozitioning of the trays	0.01 6.4	0.06	6.45	0.010		0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Maintenance of the nitrient solution		0.20	20.16	0.031		0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays		0.05	5.04	0.008		0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays		0.03	3.02	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays		0.05	5.04	0.008		0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
						9.42	3.52	3.52	3.52	3.52	4.10	3.52	3.52	3.52	3.52

Average cost of production for $1m^2$ of 209 trays is 4.17 USD or 0.0038 USD per transplant

41.67

Cost of production for young plants per m2 for 264 trays with Dutch substrate and Perlite

			Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	Years of exploatation										
Capital costs								1	2	3	4	5	6	7	8	9	10	
Lumber and nails			$1m^3$		18000	45	0.69	0.71										
Manual seeder			1 piece				60.00											
Arches			1 kg			0.2	0.10	0.10										
Transparent polyethilene																		
1.9 x 4m			($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Black polyethilene																		
			($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile																		
6 m width			($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14					
Trays /264						292.5	4.50	4.50										
Recurent costs																		
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Dutch peat+perlite			$1 m^3$		6100	171	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	
Labor costs					w/h	Total	USD											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02		4.8		0.10	9.68	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	
Filling oof the trays	0.05		4.8		0.24	24.19	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	
Pozitioning of the trays	0.01		4.8		0.05	4.84	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	Total:
								9.00	3.10	3.10	3.10	3.10	3.68	3.10	3.10	3.10	3.10	*37.51*

Average cost of production for $1m^2$ of 264 trays is 3.75 USD or 0.0038 USD per plant

Cost of production for young plants per m2 for 264 trays with Compost and Perlite

		Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	Years of exploatation										
							1	2	3	4	5	6	7	8	9	10	
Capital costs																	
Lumber and nails		$1m^3$		18000	45	0.69	0.71										
Manual seeder		1 piece				60.00											
Arches		1 kg			0.2	0.10	0.10										
Transparent polyethilene																	
1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Black polyethilene																	
		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile																	
6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14					
Trays /264					292.5	4.50	4.50										
Recurent costs																	
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Compost+perlite		$1 m^3$		3064	86	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.70	
Labor costs				working hours	Total												
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02	4.8		0.10	9.68	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	
Filling oof the trays	0.05	4.8		0.24	24.19	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	
Pozitioning of the trays	0.01	4.8		0.05	4.84	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
							7.65	1.75	1.75	1.75	1.75	2.33	1.75	1.75	1.76	2.09	*24.35*

Average cost of production for $1m^2$ of 264 trays is 2.44 USD or 0.0024 USD per plant

Cost of production for young plants per m2 for 264 trays with Local peat and Perlite																					
		Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	**Years of exploatation**														
							1	2	3	4	5	6	7	8	9	10					
Capital costs																					
Lumber and nails		$1m^3$		18000	45	0.69	0.71														
Manual seeder		1 piece				60.00															
Arches		1 kg			0.2	0.10	0.10														
Transparent polyethilene																					
1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22									
Black polyethilene																					
		($1kg/8m^2$)		110	14	0.22	0.22					0.22									
Agrile																					
6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14									
Trays /264					292.5	4.50	4.50														
Recurent costs																					
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06					
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09					
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06					
Supstrate mixture -Local peat+perlite		1 m^3		3600	101	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60					
Labor costs				w/h	Total																
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031					
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005					
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023					
Sowing	0.02	4.8		0.10	9.68	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015					
Filling oof the trays	0.05	4.8		0.24	24.19	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037					
Pozitioning of the trays	0.01	4.8		0.05	4.84	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007					
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031					
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008					
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005					
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008					
							7.89	1.99	1.99	1.99	1.99	2.57	1.99	1.99	1.99	1.99					***26.39***

Average cost of production for $1m^2$ of 264 trays is 2.64 USD or 0.0026 USD per plant

Cost of production for young plants per m2 for 264 trays with Dutch peat and Tuff

			Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation									
								1	2	3	4	5	6	7	8	9	10
Capital costs																	
Lumber and nails			$1m^3$		18000	45	0.69	0.71									
Manual seeder			1 piece				60.00										
Arches			1 kg			0.2	0.10	0.10									
Transparent polyethilene																	
1.9 x 4m			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																	
			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																	
6 m width			($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays /264						292.5	4.50	4.50									
Recurent costs																	
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+Tuff			1 m^3		3064	196	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
		Labor costs			w/h	Total											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing		0.02		4.8	0.10	9.68	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Filling oof the trays		0.05		4.8	0.24	24.19	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
Pozitioning of the trays		0.01		4.8	0.05	4.84	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
								9.40	3.50	3.50	3.50	3.50	4.08	3.50	3.50	3.50	3.50

41.47

Average cost of production for $1m^2$ of 264 trays is 4.15 USD or 0.0041 USD per plant

Cost of production for young plants per m^2 for 338 trays with Dutch substrate and Perlite																	
	Unit		*Price in denars*	*for m^2*	*Unit Price USD/m^2*	Years of exploatation											
						1	2	3	4	5	6	7	8	9	10		
Capital costs																	
Lumber and nails	$1m^3$		18000	45	0.69	0.69											
Manual seeder	1 piece				60.00												
Arches	1 kg			0.2	0.10	0.10											
Transparent polyethilene																	
1.9 x 4m	($1kg/8m^2$)		110	14	0.22	0.22					0.22						
Black polyethilene																	
	($1kg/8m^2$)		110	14	0.22	0.22					0.22						
Agrile																	
6 m width	($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14						
Trays /338				292.5	4.50	4.50											
Recurent costs																	
Fertilizer	1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
Seed	1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09		
Paletization	1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
Supstrate mixture -Dutch peat+perlite	1 m^3		6100	135	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08		
Labor costs			w/h														
Preparation of bays bottom (plowing and leveling)			0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031		
Fixing of the black polyethilen			0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005		
Wooden frames mounting			0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023		
Sowing	0.02	4.5	0.09	9.07	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014		
Filling of the trays	0.05	4.5	0.23	22.68	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035		
Pozitioning of the trays	0.01	4.5	0.05	4.54	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007		
Maintenance of the nutrient solution			0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031		
Daily maintenance of the bays			0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008		
Washing and sterilization of trays			0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005		
Demounting of the bays			0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	Total	
						8.34	2.46	2.46	2.46	2.46	3.04	2.46	2.46	2.46	2.46		*31.07*

Average cost of production for $1m^2$ of 338 trays is 3.11 USD or 0.0024 USD per plant

Cost of production for young plants per m^2 for 338 trays with Compost and Perlite

			Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation 1	2	3	4	5	6	7	8	9	10
Capital costs																	
Lumber and nails			$1m^3$		18000	45	0.69	0.71									
Manual seeder			1 piece				60.00										
Arches			1 kg			0.2	0.10	0.10									
Transparent polyethilene																	
1.9 x 4m			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																	
			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																	
6 m width			($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays /338						292.5	4.50	4.50									
Recurent costs																	
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+perlite			$1 m^3$		3064	86	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37
		Labor costs			w/h	Total											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing		0.02		4.5	0.09	9.07	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Filling oof the trays		0.05		4.5	0.23	22.68	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Pozitioning of the trays		0.01		4.5	0.05	4.54	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
								7.65	1.75	1.75	1.75	1.75	2.33	1.75	1.75	1.75	1.75	***23.99***

Average cost of production for $1m^2$ of 338 trays is 2.40 USD or 0.0018 USD per plant

Cost of production for young plants per m2 for 338 trays with Local peat and Perlite																	
		Unit		*Price in denars*	*Price for m^2*	*Unit Price USD/m^2*	**Years of exploatation**										
							1	2	3	4	5	6	7	8	9	10	
Capital costs																	
Lumber and nails		$1m^3$		18000	45	0.69	0.71										
Manual seeder		1 piece				60.00											
Arches		1 kg			0.2	0.10	0.10										
Transparent polyethilene																	
1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Black polyethilene																	
		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile																	
6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14					
Trays /338					292.5	4.50	4.50										
Recurent costs																	
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Local peat+perlite		$1 m^3$		3600	101	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	2.71	2.71	
Labor costs				w/h	Total	USD											
Preparation of bays bottom																	
(plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02	4.5		0.09	9.07	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	
Filling oof the trays	0.05	4.5		0.23	22.68	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	
Pozitioning of the trays	0.01	4.5		0.05	4.54	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
							7.89	1.99	1.99	1.99	1.99	2.57	1.99	1.99	3.10	3.10	*28.58*

Average cost of production for $1m^2$ of 338 trays is 2.86 USD or 0.0022 USD per plant

Cost of production for young plants per m^2 for 338 trays with Dutch peat and Tuff

			Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation									
								1	2	3	4	5	6	7	8	9	10
Capital costs																	
Lumber and nails			$1m^3$		18000	45	0.69	0.71									
Manual seeder			1 piece				60.00										
Arches			1 kg			0.2	0.10	0.10									
Transparent polyethilene																	
1.9 x 4m			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																	
			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																	
6 m width			($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays /338						292.5	4.50	4.50									
Recurent costs																	
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+Tuff			$1 m^3$		3064	196	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Labor costs					w/h	Total											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing	0.02		4.5		0.09	9.07	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Filling oof the trays	0.05		4.5		0.23	22.68	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Pozitioning of the trays	0.01		4.5		0.05	4.54	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
								9.40	3.50	3.50	3.50	3.50	4.08	3.50	3.50	3.49	3.49

Average cost of production for $1m^2$ of 338 trays is 4.14 USD or 0.0032 USD per plant

41.43

Cost of production for young plants per m^2 for 589 trays with Dutch substrate and Perlite

		Unit		Price in denars	for m^2	Unit Price USD/m^2	Years of exploatation 1	2	3	4	5	6	7	8	9	10	
Capital costs																	
Lumber and nails		$1m^3$		18000	45	0.69	0.69										
Manual seeder		1 piece				60.00											
Arches		1 kg			0.2	0.10	0.10										
Transparent polyethilene																	
1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Black polyethilene		($1kg/8m^2$)		110	14	0.22	0.22					0.22					
Agrile																	
6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14					
Trays /589						4.44	4.44										
Recurent costs																	
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Supstrate mixture -Dutch peat+perlite		1 m^3		6100	149	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	
Labor costs				w/h													
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	
Sowing	0.02	3.7		0.07	7.46	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	
Filling of the trays	0.05	3.7		0.19	18.65	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	
Pozitioning of the trays	0.01	3.7		0.04	3.73	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	
Maintenance of the nutrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	Total
							8.57	2.75	2.75	2.75	2.75	3.33	2.75	2.75	2.75	2.75	***33.94***

Average cost of production for $1m^2$ of 589 trays is 3.39 USD or 0.0017 USD per plant

Cost of production for young plants per m^2 for 589 trays with Compost and Perlite

			Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation									
								1	2	3	4	5	6	7	8	9	10
Capital costs																	
Lumber and nails			$1m^3$		18000	45	0.69	0.71									
Manual seeder			1 piece				60.00										
Arches			1 kg			0.2	0.10	0.10									
Transparent polyethilene																	
	1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																	
			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																	
	6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays	/589					292.5	4.44	4.44									
Recurent costs																	
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+perlite			$1 m^3$		3064	74	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
	Labor costs				w/h	Total											
Preparation of bays bottom (plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing		0.02		3.7	0.07	7.46	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Filling oof the trays		0.05		3.7	0.19	18.65	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Pozitioning of the trays		0.01		3.7	0.04	3.73	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
								7.39	1.55	1.55	1.55	1.55	2.13	1.55	1.55	1.54	1.54	***21.90***

Average cost of production for $1m^2$ of 589 trays is 2.19 USD or 0.0011 USD per plant

Cost of production for young plants per m2 for 589 trays with Local peat and Perlite

			Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation									
								1	2	3	4	5	6	7	8	9	10
Capital costs																	
Lumber and nails			$1m^3$		18000	45	0.69	0.71									
Manual seeder			1 piece				60.00										
Arches			1 kg			0.2	0.10	0.10									
Transparent polyethilene																	
1.9 x 4m			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																	
			($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																	
6 m width			($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays /589						292.5	4.44	4.44									
Recurent costs																	
Fertilizer			1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed			1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization			1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Local peat+perlite			$1 m^3$		3600	90.5	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37
Labor costs					w/h	Total	USD										
Preparation of bays bottom																	
(plowing and leveling)					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting					0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing	0.02		3.7		0.07	7.46	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Filling oof the trays	0.05		3.7		0.19	18.65	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Pozitioning of the trays	0.01		3.7		0.04	3.73	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Maintenance of the nitrient solution					0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays					0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays					0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
								7.59	1.74	1.74	1.74	1.74	2.32	1.74	1.74	1.74	1.74

23.87

Average cost of production for $1m^2$ of 589 trays is 2.39 USD or 0.0018 USD per plant

Cost of production for young plants per m^2 for 589 trays with Dutch peat and Tuff

		Unit		Price in denars	Price for m^2	Unit Price USD/m^2	Years of exploatation									
							1	2	3	4	5	6	7	8	9	10
Capital costs																
Lumber and nails		$1m^3$		18000	45	0.69	0.71									
Manual seeder		1 piece				60.00										
Arches		1 kg			0.2	0.10	0.10									
Transparent polyethilene																
1.9 x 4m		($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Black polyethilene																
		($1kg/8m^2$)		110	14	0.22	0.22					0.22				
Agrile																
6 m width		($55m^2/kg$, $18g/m^2$)		490	9	0.14	0.14					0.14				
Trays /589					292.5	4.44	4.44									
Recurent costs																
Fertilizer		1 kg		60	4.2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Seed		1 kg		46620	6	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Paletization		1 kg		60000	4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Supstrate mixture -Compost+Tuff		$1 m^3$		3064	168	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66
Labor costs				w/h	Total											
Preparation of bays bottom (plowing and leveling)				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Fixing of the black polyethilen				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Wooden frames mounting				0.15	15.12	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Sowing	0.02	3.7		0.07	7.46	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Filling oof the trays	0.05	3.7		0.19	18.65	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Pozitioning of the trays	0.01	3.7		0.04	3.73	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Maintenance of the nitrient solution				0.20	20.16	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Daily maintenance of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Washing and sterilization of trays				0.03	3.02	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Demounting of the bays				0.05	5.04	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
							8.88	3.03	3.03	3.03	3.03	3.61	3.03	3.03	3.03	3.03

36.77

Average cost of production for $1m^2$ of 589 trays is 3.68 USD or 0.0018 USD per plant

APPENDIX D

COST OF PRODUCTION FOR TOMATO

Control (tomatoes)

	1	2	3	4	5	6	
Recurent expanditure							
Hybrid seed	3002.01	3002.01	3002.01	3002.01	3002.01	3002.01	
Manure	5351.17	5351.17	5351.17	5351.17	5351.17	5351.17	
Peat moss	925.22	925.22	925.22	925.22	925.22	925.22	
Gardine	267.56	267.56	267.56	267.56	267.56	267.56	
NPK	899.00	899.00	899.00	899.00	899.00	899.00	
Amonium nitrat	963.21	963.21	963.21	963.21	963.21	963.21	
Cristaline	1141.94	1141.94	1141.94	1141.94	1141.94	1141.94	
Wooden trays	5893.30	5893.30	5893.30	5893.30	5893.30	5893.30	
Support wire	428.09	428.09	428.09	428.09	428.09	428.09	
Ditan	36.39	36.39	36.39	36.39	36.39	36.39	
Sandofan	52.86	52.86	52.86	52.86	52.86	52.86	
Benomil	77.06	77.06	77.06	77.06	77.06	77.06	
Enovit	17.12	17.12	17.12	17.12	17.12	17.12	
Lanate	156.87	156.87	156.87	156.87	156.87	156.87	
Decis	71.17	71.17	71.17	71.17	71.17	71.17	
Difonat	356.76	356.76	356.76	356.76	356.76	356.76	
Vaydat	428.12	428.12	428.12	428.12	428.12	428.12	
Crude oil	20548.49	20548.49	20548.49	20548.49	20548.49	20548.49	
Fuel	1284.28	1284.28	1284.28	1284.28	1284.28	1284.28	
Total (A)	41900.62	41900.62	41900.62	41900.62	41900.62	41900.62	41900.62
Labour							
Loading of mixture	50.17	50.17	50.17	50.17	50.17	50.17	
Sowing and filling of trays	20.07	20.07	20.07	20.07	20.07	20.07	
Digging under the heating tubes	321.07	321.07	321.07	321.07	321.07	321.07	
Treatment for soil desinfection	13.38	13.38	13.38	13.38	13.38	13.38	
Superficial desinfection with Mocab	15.05	15.05	15.05	15.05	15.05	15.05	
Treatment with fertilizers	20.07	20.07	20.07	20.07	20.07	20.07	
Treatment with manure	387.96	387.96	387.96	387.96	387.96	387.96	
Filling of the pots with mixture	334.45	334.45	334.45	334.45	334.45	334.45	
Cultivation of the young plants	301.00	301.00	301.00	301.00	301.00	301.00	
Filling the trays with young plants	167.22	167.22	167.22	167.22	167.22	167.22	
Collecting of the empty pots	40.13	40.13	40.13	40.13	40.13	40.13	
Distribution of the young plants	334.45	334.45	334.45	334.45	334.45	334.45	
Irrigation (x26)	387.96	387.96	387.96	387.96	387.96	387.96	
Cleaning of the pathway after transplanting	40.13	40.13	40.13	40.13	40.13	40.13	
Fine digging (x3)	555.18	555.18	555.18	555.18	555.18	555.18	
Support wiering	387.96	387.96	387.96	387.96	387.96	387.96	
Spraying (x15)	535.12	535.12	535.12	535.12	535.12	535.12	
Removal of the side shoots	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Weeding	388.29	388.29	388.29	388.29	388.29	388.29	
Treatment with tomatine (x3)	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Defoliation	260.87	260.87	260.87	260.87	260.87	260.87	
Harvesting and packaging	4347.83	4347.83	4347.83	4347.83	4347.83	4347.83	
Loading and unloading of the trays	133.44	133.44	133.44	133.44	133.44	133.44	
Loading of the tracks	217.73	217.73	217.73	217.73	217.73	217.73	
Cutting and removal of the plants	67.22	67.22	67.22	67.22	67.22	67.22	
Total (B)	11400.33	11400.33	11400.33	11400.33	11400.33	11400.33	11400.33
Services							
Plowing	735.79	735.79	735.79	735.79	735.79	735.79	
Dusting	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93	
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=16,452

Grand total = 58,350

With obtained yield of 10.14 kg/sqm the cost of production for 1 kg of tomato is 0.58 USD

Methyl bromide (tomatoes) Appendix D

	1	2	3	4	5	6	
Durable goods							
Plastic sheets	2508			2508			
Recurent expanditure							
Hybrid seed	3002.01	3002.01	3002.01	3002.01	3002.01	3002.01	
Manure	5351.17	5351.17	5351.17	5351.17	5351.17	5351.17	
Peat moss	925.22	925.22	925.22	925.22	925.22	925.22	
Gardine	267.56	267.56	267.56	267.56	267.56	267.56	
NPK	899.00	899.00	899.00	899.00	899.00	899.00	
Amonium nitrat	963.21	963.21	963.21	963.21	963.21	963.21	
Cristaline	1141.94	1141.94	1141.94	1141.94	1141.94	1141.94	
Wooden trays	5893.30	5893.30	5893.30	5893.30	5893.30	5893.30	
Support wire	428.09	428.09	428.09	428.09	428.09	428.09	
Methyl bromide	7000.00	7000.00	7000.00	7000.00	7000.00	7000.00	
Fingicide	313.04	313.04	313.04	313.04	313.04	313.04	
Insecticide	401.34	401.34	401.34	401.34	401.34	401.34	
Acaricide	401.34	401.34	401.34	401.34	401.34	401.34	
Decis	71.17	71.17	71.17	71.17	71.17	71.17	
Difonat	356.76	356.76	356.76	356.76	356.76	356.76	
Vaydat	428.12	428.12	428.12	428.12	428.12	428.12	
Crude oil	20548.49	20548.49	20548.49	20548.49	20548.49	20548.49	
Fuel	1284.28	1284.28	1284.28	1284.28	1284.28	1284.28	
Total (A)	**52184.03**	**49676.03**	**49676.03**	**52184.03**	**49676.03**	**49676.03**	**50512.03**
Labour							
Loading of mixture	50.17	50.17	50.17	50.17	50.17	50.17	
Sowing and filling of trays	20.07	20.07	20.07	20.07	20.07	20.07	
Treatment with manure	387.96	387.96	387.96	387.96	387.96	387.96	
Filling of the pots with mixture	334.45	334.45	334.45	334.45	334.45	334.45	
Cultivation of the young plants	301.00	301.00	301.00	301.00	301.00	301.00	
Filling the trays with young plants	167.22	167.22	167.22	167.22	167.22	167.22	
Collecting of the empty pots	40.13	40.13	40.13	40.13	40.13	40.13	
Distribution of the young plants	334.45	334.45	334.45	334.45	334.45	334.45	
Irrigation (x26)	387.96	387.96	387.96	387.96	387.96	387.96	
Cleaning of the pathway after transplanting	40.13	40.13	40.13	40.13	40.13	40.13	
Fine digging (x3)	555.18	555.18	555.18	555.18	555.18	555.18	
Support wiering	387.96	387.96	387.96	387.96	387.96	387.96	
Removal of the side shoots	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Treatment with tomatine (x3)	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Defoliation	260.87	260.87	260.87	260.87	260.87	260.87	
Harvesting and packaging	4347.83	4347.83	4347.83	4347.83	4347.83	4347.83	
Loading and unloading of the trays	133.44	133.44	133.44	133.44	133.44	133.44	
Loading of the tracks	217.73	217.73	217.73	217.73	217.73	217.73	
Cutting and removal of the plants	67.22	67.22	67.22	67.22	67.22	67.22	
Total (B)	**10107.36**	**10107.36**	**10107.36**	**10107.36**	**10107.36**	**10107.36**	**10107.36**
Services							
Plowing	735.79	735.79	735.79	735.79	735.79	735.79	
Dusting	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93	
Total (C)	**1253.64**	**1253.64**	**1253.64**	**1253.64**	**1253.64**	**1253.64**	**1253.64**

(B+C)+30% overheads=14,692

Grand total = 65,281

With otained yield of 11.4 kg/sqm the cost of production for 1 kg of tomato is 0.57 USD

Dazomet (tomatoes) Appendix D

	1	2	3	4	5	6	
Durable goods							
Plastic sheets	2508			2508			
Recurent expanditure							
Hybrid seed	3002.01	3002.01	3002.01	3002.01	3002.01	3002.01	
Manure	5351.17	5351.17	5351.17	5351.17	5351.17	5351.17	
Peat moss	925.22	925.22	925.22	925.22	925.22	925.22	
Gardine	267.56	267.56	267.56	267.56	267.56	267.56	
NPK	899.00	899.00	899.00	899.00	899.00	899.00	
Amonium nitrat	963.21	963.21	963.21	963.21	963.21	963.21	
Wooden trays	5893.30	5893.30	5893.30	5893.30	5893.30	5893.30	
Support wire	428.09	428.09	428.09	428.09	428.09	428.09	
Basamide	4280.00	4280.00	4280.00	4280.00	4280.00	4280.00	
Fingicide	313.04	313.04	313.04	313.04	313.04	313.04	
Insecticide	401.34	401.34	401.34	401.34	401.34	401.34	
Acaricide	401.34	401.34	401.34	401.34	401.34	401.34	
Decis	71.17	71.17	71.17	71.17	71.17	71.17	
Difonat	356.76	356.76	356.76	356.76	356.76	356.76	
Crude oil	20548.49	20548.49	20548.49	20548.49	20548.49	20548.49	
Fuel	1284.28	1284.28	1284.28	1284.28	1284.28	1284.28	
Total (A)	47893.98	45385.98	45385.98	47893.98	45385.98	45385.98	46221.98
Labour							
Loading of mixture	50.17	50.17	50.17	50.17	50.17	50.17	
Sowing and filling of trays	20.07	20.07	20.07	20.07	20.07	20.07	
Digging under the heating tubes	321.07	321.07	321.07	321.07	321.07	321.07	
Treatment for soil desinfection	13.38	13.38	13.38	13.38	13.38	13.38	
Treatment with fertilizers	20.07	20.07	20.07	20.07	20.07	20.07	
Treatment with manure	387.96	387.96	387.96	387.96	387.96	387.96	
Filling of the pots with mixture	334.45	334.45	334.45	334.45	334.45	334.45	
Cultivation of the young plants	301.00	301.00	301.00	301.00	301.00	301.00	
Filling the trays with young plants	167.22	167.22	167.22	167.22	167.22	167.22	
Collecting of the empty pots	40.13	40.13	40.13	40.13	40.13	40.13	
Distribution of the young plants	334.45	334.45	334.45	334.45	334.45	334.45	
Irrigation (x26)	387.96	387.96	387.96	387.96	387.96	387.96	
Cleaning of the pathway after transplanting	40.13	40.13	40.13	40.13	40.13	40.13	
Fine digging (x3)	555.18	555.18	555.18	555.18	555.18	555.18	
Support wiering	387.96	387.96	387.96	387.96	387.96	387.96	
Spraying (x15)	535.12	535.12	535.12	535.12	535.12	535.12	
Removal of the side shoots	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Treatment with tomatine (x3)	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Defoliation	260.87	260.87	260.87	260.87	260.87	260.87	
Harvesting and packaging	4347.83	4347.83	4347.83	4347.83	4347.83	4347.83	
Loading and unloading of the trays	133.44	133.44	133.44	133.44	133.44	133.44	
Loading of the tracks	217.73	217.73	217.73	217.73	217.73	217.73	
Cutting and removal of the plants	67.22	67.22	67.22	67.22	67.22	67.22	
Total (B)	10996.99	10996.99	10996.99	10996.99	10996.99	10996.99	10996.99
Services							
Plowing	735.79	735.79	735.79	735.79	735.79	735.79	
Dusting	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93	
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=15,923.00

Grand total = 62,148

With obtained yield of 11.3 kg/sqm the cost of production for 1 kg of tomato is 0.55 USD

Solarization +biofumigation (tomatoes)

	1	2	3	4	5	6	
Durable goods							
Plastic sheets	2508			2508			
Recurent expanditure							
Hybrid seed	3002.01	3002.01	3002.01	3002.01	3002.01	3002.01	
Manure	5351.17	5351.17	5351.17	5351.17	5351.17	5351.17	
Fresh manure	1664.00	1664.00	1664.00	1664.00	1664.00	1664.00	
Peat moss	925.22	925.22	925.22	925.22	925.22	925.22	
Gardine	267.56	267.56	267.56	267.56	267.56	267.56	
NPK	899.00	899.00	899.00	899.00	899.00	899.00	
Amonium nitrat	963.21	963.21	963.21	963.21	963.21	963.21	
Wooden trays	5893.30	5893.30	5893.30	5893.30	5893.30	5893.30	
Support wire	428.09	428.09	428.09	428.09	428.09	428.09	
Fingicide	313.04	313.04	313.04	313.04	313.04	313.04	
Insecticide	401.34	401.34	401.34	401.34	401.34	401.34	
Acaricide	401.34	401.34	401.34	401.34	401.34	401.34	
Decis	71.17	71.17	71.17	71.17	71.17	71.17	
Difonat	356.76	356.76	356.76	356.76	356.76	356.76	
Crude oil	20548.49	20548.49	20548.49	20548.49	20548.49	20548.49	
Fuel	1284.28	1284.28	1284.28	1284.28	1284.28	1284.28	
Total (A)	45277.98	42769.98	42769.98	45277.98	42769.98	42769.98	43605.98
Labour							
Loading of mixture	50.17	50.17	50.17	50.17	50.17	50.17	
Sowing and filling of trays	20.07	20.07	20.07	20.07	20.07	20.07	
Digging under the heating tubes	321.07	321.07	321.07	321.07	321.07	321.07	
Treatment with fertilizers	20.07	20.07	20.07	20.07	20.07	20.07	
Treatment with manure	387.96	387.96	387.96	387.96	387.96	387.96	
Filling of the pots with mixture	334.45	334.45	334.45	334.45	334.45	334.45	
Cultivation of the young plants	301.00	301.00	301.00	301.00	301.00	301.00	
Filling the trays with young plants	167.22	167.22	167.22	167.22	167.22	167.22	
Collecting of the empty pots	40.13	40.13	40.13	40.13	40.13	40.13	
Distribution of the young plants	334.45	334.45	334.45	334.45	334.45	334.45	
Irrigation (x26)	387.96	387.96	387.96	387.96	387.96	387.96	
Cleaning of the pathway after transplanting	40.13	40.13	40.13	40.13	40.13	40.13	
Fine digging (x3)	555.18	555.18	555.18	555.18	555.18	555.18	
Support wiering	387.96	387.96	387.96	387.96	387.96	387.96	
Spraying (x15)	535.12	535.12	535.12	535.12	535.12	535.12	
Removal of the side shoots	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Treatment with tomatine (x3)	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Defoliation	260.87	260.87	260.87	260.87	260.87	260.87	
Harvesting and packaging	4347.83	4347.83	4347.83	4347.83	4347.83	4347.83	
Loading and unloading of the trays	133.44	133.44	133.44	133.44	133.44	133.44	
Loading of the tracks	217.73	217.73	217.73	217.73	217.73	217.73	
Cutting and removal of the plants	67.22	67.22	67.22	67.22	67.22	67.22	
Total (B)	10983.61	10983.61	10983.61	10983.61	10983.61	10983.61	10983.61
Services							
Plowing	735.79	735.79	735.79	735.79	735.79	735.79	
Dusting	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93	
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=15908.00

Grand total = 59,514

With obtained yield of 12.6 kg/sqm the cost of production for 1 kg of tomato is 0.47 USD

Soilless cultivation (tomatoes) Appendix D

	1	2	3	4	5	6	
Durable goods							
Plastic sheets	2508			2508			
Plastic tubes	4785					4785	
Perlite	712		712		712		
Gravel	804			804			
Peat moss	6056		6056		6056		
Recurent expanditure	3002.01	3002.01	3002.01	3002.01	3002.01	3002.01	
Hybrid seed	5351.17	5351.17	5351.17	5351.17	5351.17	5351.17	
Manure	1664.00	1664.00	1664.00	1664.00	1664.00	1664.00	
Fresh manure	925.22	925.22	925.22	925.22	925.22	925.22	
Peat moss	267.56	267.56	267.56	267.56	267.56	267.56	
Gardine	899.00	899.00	899.00	899.00	899.00	899.00	
NPK	963.21	963.21	963.21	963.21	963.21	963.21	
Amonium nitrat	1141.94	1141.94	1141.94	1141.94	1141.94	1141.94	
Cristaline	5893.30	5893.30	5893.30	5893.30	5893.30	5893.30	
Wooden trays	428.09	428.09	428.09	428.09	428.09	428.09	
Support wire	313.04	313.04	313.04	313.04	313.04	313.04	
Fingicide	401.34	401.34	401.34	401.34	401.34	401.34	
Insecticide	401.34	401.34	401.34	401.34	401.34	401.34	
Acaricide	71.17	71.17	71.17	71.17	71.17	71.17	
Decis	356.76	356.76	356.76	356.76	356.76	356.76	
Difonat	428.12	428.12	428.12	428.12	428.12	428.12	
Vaydat	20548.49	20548.49	20548.49	20548.49	20548.49	20548.49	
Crude oil	1284.28	1284.28	1284.28	1284.28	1284.28	1284.28	
Fuel	59205.03	44340.03	51108.03	47652.03	51108.03	49125.03	50423.03
Total (A)							
Labour	50.17	50.17	50.17	50.17	50.17	50.17	
Loading of mixture	20.07	20.07	20.07	20.07	20.07	20.07	
Sowing and filling of trays	321.07	321.07	321.07	321.07	321.07	321.07	
Treatment with fertilizers	387.96	387.96	387.96	387.96	387.96	387.96	
Treatment with manure	334.45	334.45	334.45	334.45	334.45	334.45	
Filling of the pots with mixture	301.00	301.00	301.00	301.00	301.00	301.00	
Cultivation of the young plants	167.22	167.22	167.22	167.22	167.22	167.22	
Filling the trays with young plants	40.13	40.13	40.13	40.13	40.13	40.13	
Collecting of the empty pots	334.45	334.45	334.45	334.45	334.45	334.45	
Distribution of the young plants	387.96	387.96	387.96	387.96	387.96	387.96	
Irrigation (x26)	40.13	40.13	40.13	40.13	40.13	40.13	
Cleaning of the pathway after transpla	555.18	555.18	555.18	555.18	555.18	555.18	
Support wiering	535.12	535.12	535.12	535.12	535.12	535.12	
Spraying (x15)	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Removal of the side shoots	1036.79	1036.79	1036.79	1036.79	1036.79	1036.79	
Treatment with tomatine (x3)	260.87	260.87	260.87	260.87	260.87	260.87	
Defoliation	4347.83	4347.83	4347.83	4347.83	4347.83	4347.83	
Harvesting and packaging	133.44	133.44	133.44	133.44	133.44	133.44	
Loading and unloading of the trays	217.73	217.73	217.73	217.73	217.73	217.73	
Loading of the tracks	67.22	67.22	67.22	67.22	67.22	67.22	
Cutting and removal of the plants	10575.59	10575.59	10575.59	10575.59	10575.59	10575.59	10575.59
Total (B)							
Services	735.79	735.79	735.79	735.79	735.79	735.79	
Plowing	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64
Total (C)							

(B+C)+30% overheads=15,377

Grand total = 65,801

With expected yield of 12 kg/sqm the cost of production for 1 kg of tomato is 0.54 USD

APPENDIX E

COST OF PRODUCTION FOR CUCUMBERS

	1	2	3	4	5	6
Recurent expanditure						
Hybrid seed	3703.78	3703.78	3703.78	3703.78	3703.78	3703.78
Manure	2777.78	2777.78	2777.78	2777.78	2777.78	2777.78
Strow	6.89	6.89	6.89	6.89	6.89	6.89
Hydratic gypsum	59.28	59.28	59.28	59.28	59.28	59.28
Gardine	666.67	666.67	666.67	666.67	666.67	666.67
Magnesium sulphate	370.00	370.00	370.00	370.00	370.00	370.00
Potassium amonium nitrate	666.67	666.67	666.67	666.67	666.67	666.67
Fe chelate	111.11	111.11	111.11	111.11	111.11	111.11
Boxes	10.50	10.50	10.50	10.50	10.50	10.50
Support wire	628.06	628.06	628.06	628.06	628.06	628.06
Bailetane	18.50	18.50	18.50	18.50	18.50	18.50
Captane	90.00	90.00	90.00	90.00	90.00	90.00
Aliete	118.58	118.58	118.58	118.58	118.58	118.58
Sandofan	82.22	82.22	82.22	82.22	82.22	82.22
Benomile	444.67	444.67	444.67	444.67	444.67	444.67
Tilt	94.44	94.44	94.44	94.44	94.44	94.44
Lanate	101.75	101.75	101.75	101.75	101.75	101.75
Decis	148.33	148.33	148.33	148.33	148.33	148.33
Mitak	80.00	80.00	80.00	80.00	80.00	80.00
Folimate	288.89	288.89	288.89	288.89	288.89	288.89
Apolo	66.67	66.67	66.67	66.67	66.67	66.67
Nissuron	122.22	122.22	122.22	122.22	122.22	122.22
Diphonate	222.22	222.22	222.22	222.22	222.22	222.22
Formaline	370.56	370.56	370.56	370.56	370.56	370.56
Crude oil	12388.89	12388.89	12388.89	12388.89	12388.89	12388.89
Fuel	1155.56	1155.56	1155.56	1155.56	1155.56	1155.56
Total (A)	24794.22	24794.22	24794.22	24794.22	24794.22	24794.22
Labour						
Loading of mixture	19.91	19.91	19.91	19.91	19.91	19.91
Digging under the heating tubes (x2)	226.13	226.13	226.13	226.13	226.13	226.13
Manual correction of the furrows	68.74	68.74	68.74	68.74	68.74	68.74
Loading and reloading of straw cubes	205.27	205.27	205.27	205.27	205.27	205.27
Distribution of straw cubes	410.55	410.55	410.55	410.55	410.55	410.55
Watering of straw cubes (x6)	616.30	616.30	616.30	616.30	616.30	616.30
Distribution of fertillizer	30.34	30.34	30.34	30.34	30.34	30.34
Digging-in of the straw cubes	90.07	90.07	90.07	90.07	90.07	90.07
Sowing and filling of the pots	137.48	137.48	137.48	137.48	137.48	137.48
Cultivattion of young plants	118.52	118.52	118.52	118.52	118.52	118.52
Treatment of the straw cubes	123.26	123.26	123.26	123.26	123.26	123.26
Distribution of the young plants	9.48	9.48	9.48	9.48	9.48	9.48
Transplanting	54.99	54.99	54.99	54.99	54.99	54.99
Support wiering	118.52	118.52	118.52	118.52	118.52	118.52
Spraying (x26)	137.48	137.48	137.48	137.48	137.48	137.48
Pincing (x22)	493.04	493.04	493.04	493.04	493.04	493.04
Harvesting and packaging	3024.59	3024.59	3024.59	3024.59	3024.59	3024.59
Weeding (x6)	2844.44	2844.44	2844.44	2844.44	2844.44	2844.44
Defoliation	137.48	137.48	137.48	137.48	137.48	137.48
Cutting and removal of the plants	824.89	824.89	824.89	824.89	824.89	824.89
Total (B)	9691.50	9691.50	9691.50	9691.50	9691.50	9691.50
Services						
Plowing	735.79	735.79	735.79	735.79	735.79	735.79
Dusting	258.93	258.93	258.93	258.93	258.93	258.93
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=14,229

Grand total = 39,023

With obtained yield of 15.88 kg/sqm the cost of production for 1 kg of cucumbers is 0.25 USD

Methyl bromide (cucumbers)

	1	2	3	4	5	6
Durable goods						
Plastic sheets	2508			2508		
Recurent expanditure						
Hybrid seed	3703.78	3703.78	3703.78	3703.78	3703.78	3703.78
Manure	2777.78	2777.78	2777.78	2777.78	2777.78	2777.78
Strow	6.89	6.89	6.89	6.89	6.89	6.89
Hydratic gypsum	59.28	59.28	59.28	59.28	59.28	59.28
Gardine	666.67	666.67	666.67	666.67	666.67	666.67
Magnesium sulphate	370.00	370.00	370.00	370.00	370.00	370.00
Potassium amonium nitrate	666.67	666.67	666.67	666.67	666.67	666.67
Fe chelate	111.11	111.11	111.11	111.11	111.11	111.11
Boxes	10.50	10.50	10.50	10.50	10.50	10.50
Support wire	628.06	628.06	628.06	628.06	628.06	628.06
Bailetane	18.50	18.50	18.50	18.50	18.50	18.50
Captane	90.00	90.00	90.00	90.00	90.00	90.00
Aliete	118.58	118.58	118.58	118.58	118.58	118.58
Sandofan	82.22	82.22	82.22	82.22	82.22	82.22
Benomile	444.67	444.67	444.67	444.67	444.67	444.67
Methyl bromide	7000.00	7000.00	7000.00	7000.00	7000.00	7000.00
Lanate	101.75	101.75	101.75	101.75	101.75	101.75
Decis	148.33	148.33	148.33	148.33	148.33	148.33
Mitak	80.00	80.00	80.00	80.00	80.00	80.00
Folimate	288.89	288.89	288.89	288.89	288.89	288.89
Apolo	66.67	66.67	66.67	66.67	66.67	66.67
Nissuron	122.22	122.22	122.22	122.22	122.22	122.22
Diphonate	222.22	222.22	222.22	222.22	222.22	222.22
Formaline	370.56	370.56	370.56	370.56	370.56	370.56
Crude oil	12388.89	12388.89	12388.89	12388.89	12388.89	12388.89
Fuel	1155.56	1155.56	1155.56	1155.56	1155.56	1155.56
Total (A)	34207.77	31699.77	31699.77	31699.77	31699.77	31699.77
Labour						
Loading of mixture	19.91	19.91	19.91	19.91	19.91	19.91
Digging under the heating tubes (x2)	226.13	226.13	226.13	226.13	226.13	226.13
Manual correction of the furrows	68.74	68.74	68.74	68.74	68.74	68.74
Loading and reloading of straw cubes	205.27	205.27	205.27	205.27	205.27	205.27
Distribution of straw cubes	410.55	410.55	410.55	410.55	410.55	410.55
Watering of straw cubes (x6)	616.30	616.30	616.30	616.30	616.30	616.30
Distribution of fertillizer	30.34	30.34	30.34	30.34	30.34	30.34
Digging-in of the straw cubes	90.07	90.07	90.07	90.07	90.07	90.07
Sowing and filling of the pots	137.48	137.48	137.48	137.48	137.48	137.48
Cultivattion of young plants	118.52	118.52	118.52	118.52	118.52	118.52
Treatment of the straw cubes	123.26	123.26	123.26	123.26	123.26	123.26
Distribution of the young plants	9.48	9.48	9.48	9.48	9.48	9.48
Transplanting	54.99	54.99	54.99	54.99	54.99	54.99
Support wiering	118.52	118.52	118.52	118.52	118.52	118.52
Spraying (x26)	137.48	137.48	137.48	137.48	137.48	137.48
Pincing (x22)	493.04	493.04	493.04	493.04	493.04	493.04
Harvesting and packaging	3024.59	3024.59	3024.59	3024.59	3024.59	3024.59
Defoliation	137.48	137.48	137.48	137.48	137.48	137.48
Cutting and removal of the plants	824.89	824.89	824.89	824.89	824.89	824.89
Total (B)	6847.05	6847.05	6847.05	6847.05	6847.05	6847.05
Services						
Plowing	735.79	735.79	735.79	735.79	735.79	735.79
Dusting	258.93	258.93	258.93	258.93	258.93	258.93
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=10,530

Grand total = 42,2480

With obtained yield of 20.02 kg/sqm the cost of production for 1 kg of ccucmbers is 0.21 USD

Dazomet (cucumbers)

	1	2	3	4	5	6	
Durable goods							
Plastic sheets	2508			2508			
Recurent expanditure							
Hybrid seed	3703.78	3703.78	3703.78	3703.78	3703.78	3703.78	
Manure	2777.78	2777.78	2777.78	2777.78	2777.78	2777.78	
Strow	6.89	6.89	6.89	6.89	6.89	6.89	
Hydratic gypsum	59.28	59.28	59.28	59.28	59.28	59.28	
Gardine	666.67	666.67	666.67	666.67	666.67	666.67	
Magnesium sulphate	370.00	370.00	370.00	370.00	370.00	370.00	
Potassium amonium nitrate	666.67	666.67	666.67	666.67	666.67	666.67	
Fe chelate	111.11	111.11	111.11	111.11	111.11	111.11	
Boxes	10.50	10.50	10.50	10.50	10.50	10.50	
Support wire	628.06	628.06	628.06	628.06	628.06	628.06	
Bailetane	18.50	18.50	18.50	18.50	18.50	18.50	
Captane	90.00	90.00	90.00	90.00	90.00	90.00	
Aliete	118.58	118.58	118.58	118.58	118.58	118.58	
Sandofan	82.22	82.22	82.22	82.22	82.22	82.22	
Benomile	444.67	444.67	444.67	444.67	444.67	444.67	
Tilt	94.44	94.44	94.44	94.44	94.44	94.44	
Lanate	101.75	101.75	101.75	101.75	101.75	101.75	
Decis	148.33	148.33	148.33	148.33	148.33	148.33	
Mitak	80.00	80.00	80.00	80.00	80.00	80.00	
Folimate	288.89	288.89	288.89	288.89	288.89	288.89	
Apolo	66.67	66.67	66.67	66.67	66.67	66.67	
Nissuron	122.22	122.22	122.22	122.22	122.22	122.22	
Diphonate	222.22	222.22	222.22	222.22	222.22	222.22	
Basamide	3113.33	3113.33	3113.33	3113.33	3113.33	3113.33	
Formaline	370.56	370.56	370.56	370.56	370.56	370.56	
Crude oil	12388.89	12388.89	12388.89	12388.89	12388.89	12388.89	
Fuel	1155.56	1155.56	1155.56	1155.56	1155.56	1155.56	
Total (A)	30415.55	27907.55	27907.55	30415.55	27907.55	27907.55	28743.55
Labour							
Loading of mixture	19.91	19.91	19.91	19.91	19.91	19.91	
Digging under the heating tubes (x2)	226.13	226.13	226.13	226.13	226.13	226.13	
Manual correction of the furrows	68.74	68.74	68.74	68.74	68.74	68.74	
Loading and reloading of straw cubes	205.27	205.27	205.27	205.27	205.27	205.27	
Distribution of straw cubes	410.55	410.55	410.55	410.55	410.55	410.55	
Watering of straw cubes (x6)	616.30	616.30	616.30	616.30	616.30	616.30	
Distribution of fertillizer	30.34	30.34	30.34	30.34	30.34	30.34	
Digging-in of the straw cubes	90.07	90.07	90.07	90.07	90.07	90.07	
Sowing and filling of the pots	137.48	137.48	137.48	137.48	137.48	137.48	
Cultivattion of young plants	118.52	118.52	118.52	118.52	118.52	118.52	
Treatment of the straw cubes	123.26	123.26	123.26	123.26	123.26	123.26	
Distribution of the young plants	9.48	9.48	9.48	9.48	9.48	9.48	
Transplanting	54.99	54.99	54.99	54.99	54.99	54.99	
Support wiering	118.52	118.52	118.52	118.52	118.52	118.52	
Spraying (x26)	137.48	137.48	137.48	137.48	137.48	137.48	
Pincing (x22)	493.04	493.04	493.04	493.04	493.04	493.04	
Harvesting and packaging	3024.59	3024.59	3024.59	3024.59	3024.59	3024.59	
Weeding (x6)	2844.44	2844.44	2844.44	2844.44	2844.44	2844.44	
Defoliation	137.48	137.48	137.48	137.48	137.48	137.48	
Cutting and removal of the plants	824.89	824.89	824.89	824.89	824.89	824.89	
Total (B)	9691.50	9691.50	9691.50	9691.50	9691.50	9691.50	9691.50
Services							
Plowing	735.79	735.79	735.79	735.79	735.79	735.79	
Dusting	258.93	258.93	258.93	258.93	258.93	258.93	
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93	
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=14,228

Grand total = 42,972

With obtained yield of 22.22 kg/sqm the cost of production for 1 kg of cucumbers is 0.19 USD

Solarization +biofumigation (cucumbers)

	1	2	3	4	5	6
Durable goods						
Plastic sheets	2508			2508		
Recurent expanditure						
Hybrid seed	3703.78	3703.78	3703.78	3703.78	3703.78	3703.78
Manure	2777.78	2777.78	2777.78	2777.78	2777.78	2777.78
Fresh manure	1664.00	1664.00	1664.00	1664.00	1664.00	1664.00
Hydratic gypsum	59.28	59.28	59.28	59.28	59.28	59.28
Gardine	666.67	666.67	666.67	666.67	666.67	666.67
Magnesium sulphate	370.00	370.00	370.00	370.00	370.00	370.00
Potassium amonium nitrate	666.67	666.67	666.67	666.67	666.67	666.67
Fe chelate	111.11	111.11	111.11	111.11	111.11	111.11
Boxes	10.50	10.50	10.50	10.50	10.50	10.50
Support wire	628.06	628.06	628.06	628.06	628.06	628.06
Bailetane	18.50	18.50	18.50	18.50	18.50	18.50
Captane	90.00	90.00	90.00	90.00	90.00	90.00
Aliete	118.58	118.58	118.58	118.58	118.58	118.58
Sandofan	82.22	82.22	82.22	82.22	82.22	82.22
Benomile	444.67	444.67	444.67	444.67	444.67	444.67
Tilt	94.44	94.44	94.44	94.44	94.44	94.44
Lanate	101.75	101.75	101.75	101.75	101.75	101.75
Decis	148.33	148.33	148.33	148.33	148.33	148.33
Mitak	80.00	80.00	80.00	80.00	80.00	80.00
Folimate	288.89	288.89	288.89	288.89	288.89	288.89
Apolo	66.67	66.67	66.67	66.67	66.67	66.67
Nissuron	122.22	122.22	122.22	122.22	122.22	122.22
Diphonate	222.22	222.22	222.22	222.22	222.22	222.22
Formaline	370.56	370.56	370.56	370.56	370.56	370.56
Crude oil	12388.89	12388.89	12388.89	12388.89	12388.89	12388.89
Fuel	1155.56	1155.56	1155.56	1155.56	1155.56	1155.56
Total (A)	28959.33	26451.33	26451.33	28959.33	26451.33	26451.33
Labour						
Loading of mixture	19.91	19.91	19.91	19.91	19.91	19.91
Digging under the heating tubes (x2)	226.13	226.13	226.13	226.13	226.13	226.13
Manual correction of the furrows	68.74	68.74	68.74	68.74	68.74	68.74
Loading and reloading of straw cubes	205.27	205.27	205.27	205.27	205.27	205.27
Distribution of straw cubes	410.55	410.55	410.55	410.55	410.55	410.55
Watering of straw cubes (x6)	616.30	616.30	616.30	616.30	616.30	616.30
Distribution of fertillizer	30.34	30.34	30.34	30.34	30.34	30.34
Digging-in of the straw cubes	90.07	90.07	90.07	90.07	90.07	90.07
Sowing and filling of the pots	137.48	137.48	137.48	137.48	137.48	137.48
Cultivattion of young plants	118.52	118.52	118.52	118.52	118.52	118.52
Treatment of the straw cubes	123.26	123.26	123.26	123.26	123.26	123.26
Distribution of the young plants	9.48	9.48	9.48	9.48	9.48	9.48
Transplanting	54.99	54.99	54.99	54.99	54.99	54.99
Support wiering	118.52	118.52	118.52	118.52	118.52	118.52
Spraying (x26)	137.48	137.48	137.48	137.48	137.48	137.48
Pincing (x22)	493.04	493.04	493.04	493.04	493.04	493.04
Harvesting and packaging	3024.59	3024.59	3024.59	3024.59	3024.59	3024.59
Weeding (x6)	2844.44	2844.44	2844.44	2844.44	2844.44	2844.44
Defoliation	137.48	137.48	137.48	137.48	137.48	137.48
Cutting and removal of the plants	824.89	824.89	824.89	824.89	824.89	824.89
Total (B)	9691.50	9691.50	9691.50	9691.50	9691.50	9691.50
Services						
Plowing	735.79	735.79	735.79	735.79	735.79	735.79
Dusting	258.93	258.93	258.93	258.93	258.93	258.93
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=14,229

Grand total = 41,516

With obtained yield of 23.56 kg/sqm the cost of production for 1 kg of cucumbers is 0.18 USD

Soilless cultivation (cucumbers)

	1	2	3	4	5	6
Durable goods						
Plastic sheets	2508			2508		
Plastic tubes	4785					4785
Perlite	712		712		712	
Gravel	804			804		
Peat moss	6056		6056		6056	
Recurent expanditure						
Hybrid seed	3703.78	3703.78	3703.78	3703.78	3703.78	3703.78
Soluble fertilizer	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00
Strow	6.89	6.89	6.89	6.89	6.89	6.89
Hydratic gypsum	59.28	59.28	59.28	59.28	59.28	59.28
Gardine	666.67	666.67	666.67	666.67	666.67	666.67
Magnesium sulphate	370.00	370.00	370.00	370.00	370.00	370.00
Potassium amonium nitrate	666.67	666.67	666.67	666.67	666.67	666.67
Fe chelate	111.11	111.11	111.11	111.11	111.11	111.11
Boxes	10.50	10.50	10.50	10.50	10.50	10.50
Support wire	628.06	628.06	628.06	628.06	628.06	628.06
Bailetane	18.50	18.50	18.50	18.50	18.50	18.50
Captane	90.00	90.00	90.00	90.00	90.00	90.00
Aliete	118.58	118.58	118.58	118.58	118.58	118.58
Sandofan	82.22	82.22	82.22	82.22	82.22	82.22
Benomile	444.67	444.67	444.67	444.67	444.67	444.67
Methyl bromide	7000.00	7000.00	7000.00	7000.00	7000.00	7000.00
Lanate	101.75	101.75	101.75	101.75	101.75	101.75
Decis	148.33	148.33	148.33	148.33	148.33	148.33
Mitak	80.00	80.00	80.00	80.00	80.00	80.00
Folimate	288.89	288.89	288.89	288.89	288.89	288.89
Apolo	66.67	66.67	66.67	66.67	66.67	66.67
Nissuron	122.22	122.22	122.22	122.22	122.22	122.22
Diphonate	222.22	222.22	222.22	222.22	222.22	222.22
Formaline	370.56	370.56	370.56	370.56	370.56	370.56
Crude oil	12388.89	12388.89	12388.89	12388.89	12388.89	12388.89
Fuel	1155.56	1155.56	1155.56	1155.56	1155.56	1155.56
Total (A)	48786.99	33921.99	40689.99	37233.99	40689.99	38706.99
Labour						
Loading of mixture	19.91	19.91	19.91	19.91	19.91	19.91
Digging under the heating tubes (x2)	226.13	226.13	226.13	226.13	226.13	226.13
Loading and reloading of straw cubes	205.27	205.27	205.27	205.27	205.27	205.27
Distribution of fertillizer	30.34	30.34	30.34	30.34	30.34	30.34
Sowing and filling of the pots	137.48	137.48	137.48	137.48	137.48	137.48
Cultivattion of young plants	118.52	118.52	118.52	118.52	118.52	118.52
Treatment of the straw cubes	123.26	123.26	123.26	123.26	123.26	123.26
Distribution of the young plants	9.48	9.48	9.48	9.48	9.48	9.48
Transplanting	54.99	54.99	54.99	54.99	54.99	54.99
Support wiering	118.52	118.52	118.52	118.52	118.52	118.52
Spraying (x26)	137.48	137.48	137.48	137.48	137.48	137.48
Pincing (x22)	493.04	493.04	493.04	493.04	493.04	493.04
Harvesting and packaging	3024.59	3024.59	3024.59	3024.59	3024.59	3024.59
Defoliation	137.48	137.48	137.48	137.48	137.48	137.48
Cutting and removal of the plants	824.89	824.89	824.89	824.89	824.89	824.89
Total (B)	5661.39	5661.39	5661.39	5661.39	5661.39	5661.39
Services						
Plowing	735.79	735.79	735.79	735.79	735.79	735.79
Dusting	258.93	258.93	258.93	258.93	258.93	258.93
Transportation of the manure	258.93	258.93	258.93	258.93	258.93	258.93
Total (C)	1253.64	1253.64	1253.64	1253.64	1253.64	1253.64

(B+C)+30% overheads=8,989

Grand total = 48,994

With expected yield of 22 kg/sqm the cost of production for 1 kg of ccucmbers is 0.23 USD