OCCASION

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

DISCLAIMER

FAIR USE POLICY

CONTACT

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

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

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

23480

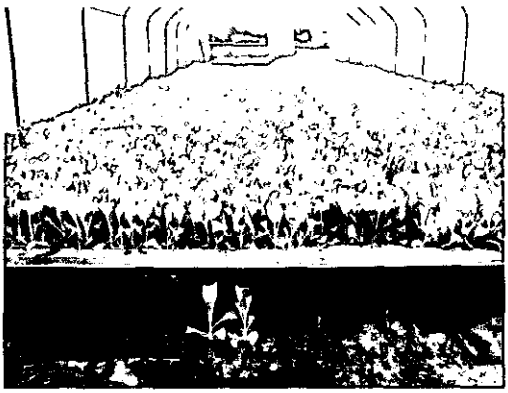
UNIDO

Contract No. 2002/164

FINAL REPORT

2002 - 2006

PHASE OUT OF METHYL BROMIDE IN PRODUCTION OF TOBACCO SEEDLINGS IN THE REPUBLIC OF CROATIA



UNIDO Project No. MP/CRO/01/215
Agresso No. 16000266

Tobacco Institute Zagreb

Zagreb 2007.

UNIDO Contract No. 2002/164
Project No. MP/CRO/01/215
Agresso No. 16000266

CONTRACT

between

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

and

TOBACCO INSTITUTE

for the provision of services relating to the

Phase out of Methyl Bromide in Production of Tobacco Seedlings

in

CROATIA

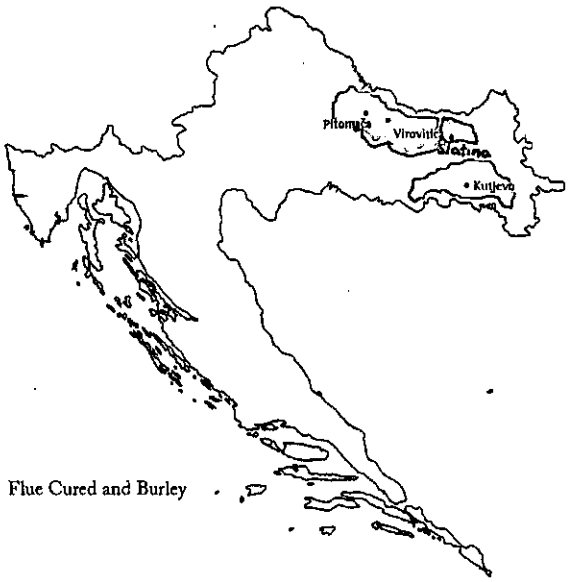
This CONTRACT is entered into between the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (hereinafter referred to as "UNIDO"), having its headquarters located at Wagramer Strasse 5, A-1220 Vienna, Austria, and TOBACCO INSTITUTE (hereinafter referred to as "the Contractor"), having its principal office located at Planinska 1, 10000 Zagreb, Croatia.

Leaf Growing Areas

Hrvatski Duhani d.d. consist of three tobacco production areas (Kutjevo, Pitomaca, Virovitica).

There are two FCV varieties produced by Croatian Tobaccos - DH17 (85%) and VaD (15%). In Burley production, there is one variety in use - BH4

100% of tobacco seedlings are produced by float - tray system. Both tobacco types are processed in Virovitica.



PROJECT No. MP/CRO/01/215

Phase out of Methyl Bromide in Production of Tobacco Seedlings in the Republic of Croatia

National expert: Ivan Turšić, PhD, Tobacco Institute Zagreb

Final Report - from 2003 to 2006 (48 months) Contract

In the Republic of Croatia from 1998 till 2000 UNIDO Demonstration Project No. MP/CRO/98/058 was conducted. The detailed report was shown on the workshop in Đurđevac, Croatia, 8-9 May 2001.

The given results point that the best alternative to the use of Methyl Bromide (MeBr) in tobacco seedling production in Croatia is floating tray system. After the application of the results given by the UNIDO Demonstration Project (MP/CRO/98/058), the reduction of MeBr usage in tobacco seedling production has started. Meanwhile, The Ministry of Agriculture of the Republic of Croatia has decided that MeBr can be used for soil disinfection in seedling production till December 31, 2005.

The changes of the tobacco growing area, quantity, import, export and value in 1000 US$ are shown in Table 1.

Table 1. Tobacco production in Croatia

Year	Area ha	Quantity t	Export t	Value 000$	Import t	Value 000$
2000	5.933	10.948	5.295	10.846	4.890	20.287
2001	5.352	10.406	5.075	8.225	3.817	19.112
2002	5.604	13.098	4.413	6.994	4.642	21.884
2003	6.108	12.959	5.306	6.867	4.219	26.403
2004	5.752	12.925	4.399	5.783	4.387	22.411
2005	5.463	10.420	6.297	9.318	4.097	18.488
2006	5.047	12.014	5.897	10.116	4.722	16.084

Significant amount of cigarettes (Table 2.) which are important for Croatian economy (partly exported to the neighboring countries also) are made of the tobacco produced in northern Croatia.

Table 2. Cigarettes market

Year	Production t	Export t	Value 000$
2000	13.780	6.115	65.212
2001	14.690	7.388	80.438
2002	15.110	7.388	90.070
2003	15.491	7.479	109.470
2004	15.374	7.521	128.308
2005	14.599	7.254	116.715

Tobacco production is evolved through cooperation with Croatian Tobacco Company which is result of joining of "Viržinija" Virovitica, "Duhanprodukt" Pitomača and "Rovita" Kutjevo and is a part of Tobacco Factory Rovinj. 2653 families are involved in this production.

Through UNIDO Project Tobacco Institute Zagreb has decreased usage of MeBr in "Hrvatski duhani" by 90 % (2003).

The substitution of MeBr with the usage of floating tray system has positive effect on ozon layer protection, prevention of Br leaching into ground water and increase of yield and quality of produced tobacco.

The farmers that are cooperating with "Duhan" Slatina, have reduced use of MeBr for more than 50 % in the year 2003. The total amount of MeBr used by "Duhan" Slatina for production of tobacco seedlings in 2002 was around 5000 kg whereas in the year 2003 it was 2300 kg. According to this reduction less plots were treated with MeBr. This can be seen if figures from year 2002 and 2003 are compared. In 2003 there were 113100 seedbeds treated with MeBr whereas in 2003 only 51100 seedbeds. The seedlings were used to plant approximately 640 ha of tobacco and the total tobacco production in 2002 was 1555 ha while in 2003 it was 1255. Although total production was smaller in 2003 compared to 2002, the applied amount of MeBr in 2003 was for production of 51 % of tobacco seedlings whereas in 2002 it was used for production of 91.3 % of tobacco seedlings. In 2003 from 245 cooperating farmers 16 have produced seedlings only by floating tray system and there were 45 farmers using only MeBr. In 2002 from 286 cooperating farmers 8 have produced seedlings only by floating tray system and there were 235 farmers using only MeBr (Table 3., Figure 1.).

Table 3. Decrease of Methyl Bromide (MeBr) usage in "Duhan" Slatina, 2000-2004

Farmers	Year			
	2000	2001	2002	2003
MeBr only	370	282	235	45
MeBr and trays	1	5	43	184
Trays only	0	0	8	16
Total	371	287	286	245

Tobacco production over the year

Tobacco production by types in 1999 - 2005 period.

YEAR	FCV (ha)	FCV (t)	BLY (ha)	BLY (t)
1999	3.769	7.247	345	720
2000	3.904	8.811	299	872
2001	3.574	7.105	404	977
2002	3.779	8.787	461	1.354
2003	4.288	9.118	534	1.462
2004	3.942	8.820	559	1.248
2005	3.777	7.290	490	925

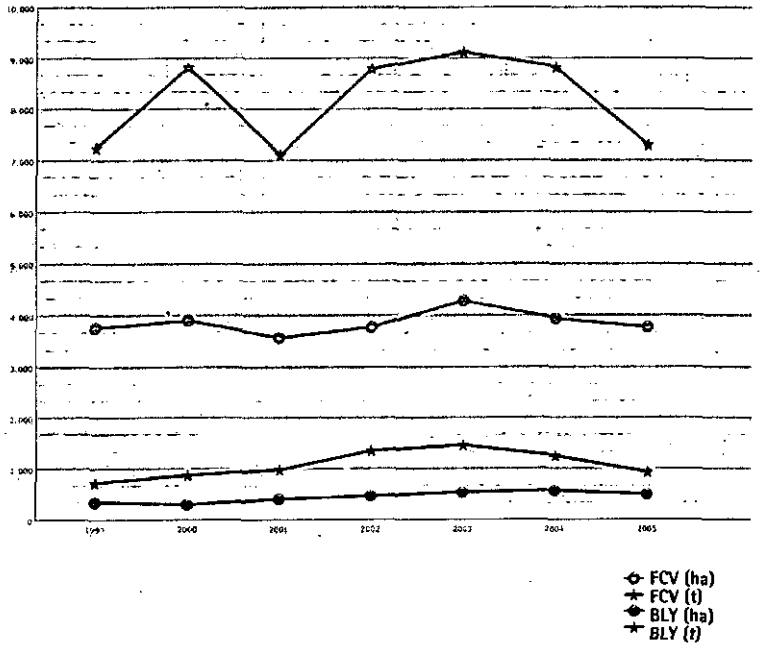


Figure 1. shows decrease of number of seedbeds treated with MeBr and hectarage of tobacco from seedbeds treated with MeBr while Figure 2. shows changes in amount of MeBr from 2000 to 2003. The usage of MeBr has been reduced from 6900 kg to 2150 kg.

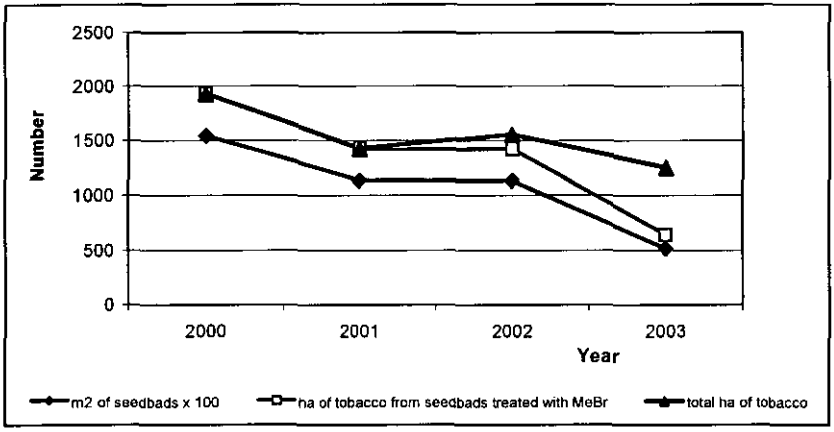


Figure 1. Number of seedbed surface for tobacco seedlings treated with MeBr and of tobacco surface. Production in cooperation with "Duhan", Slatina.

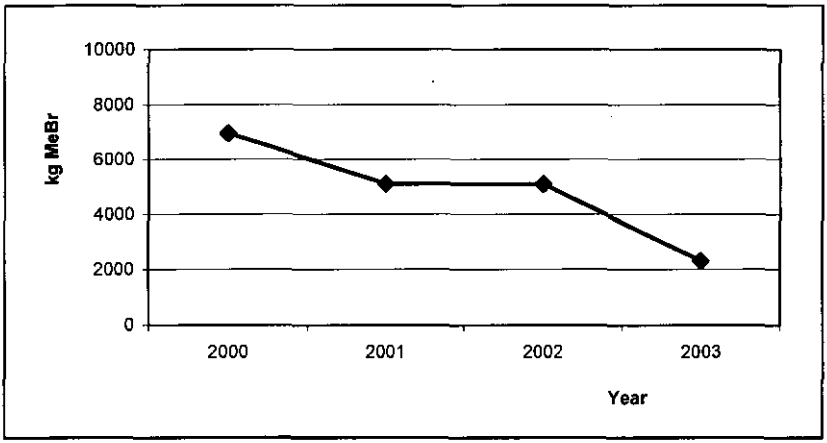


Figure 2. Amount of MeBr used for treatment of seedbeds for production of tobacco seedlings - production in cooperation with "Duhan", Slatina.

In the year 2001, several workshops were organised where experts introced floating tray system to farmers. This has resulted in decrease of MeBr usage in year 2002/2003 (Figure 3.).

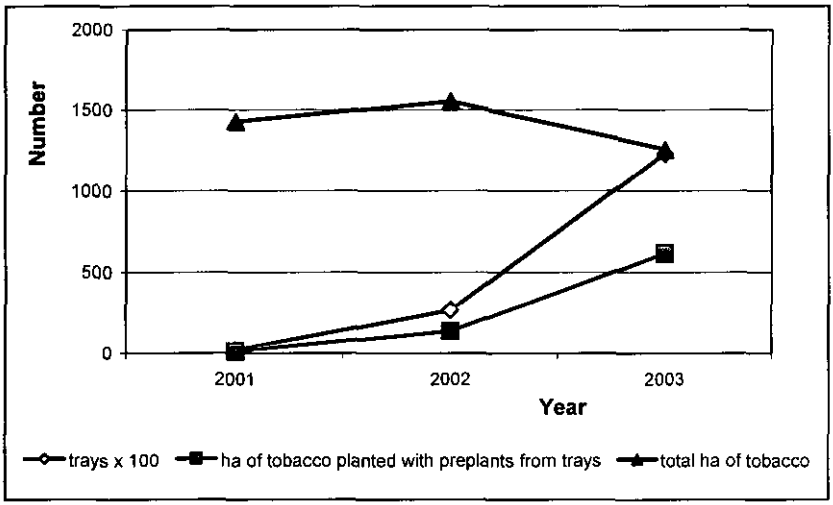


Figure 3. Number of trays and estimated ha of tobacco fields planted with seedlings – production in cooperation with "Duhan", Slatina.

In year 2003, a number of farmers involved in seedling production with MeBr only, was significantly reduced (Figure 4.). Most of the farmers were still producing the seedlings in both conventional way and floating tray system. In floating tray system, trays produced by two Croatian companies from Zagreb (OKIPOR and PLASTFORM) were used.

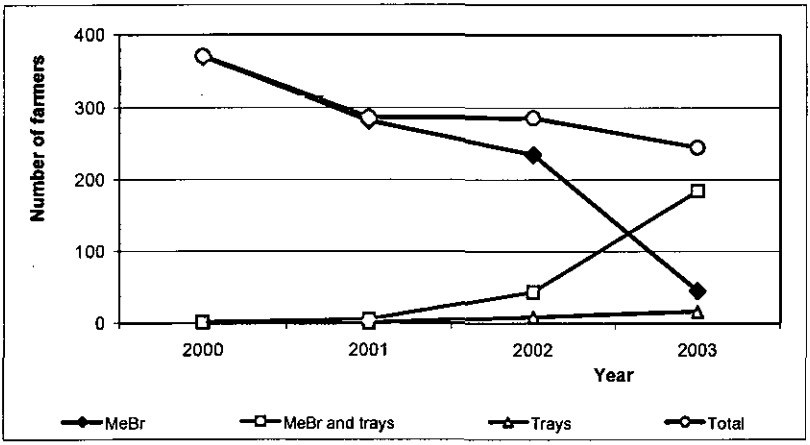
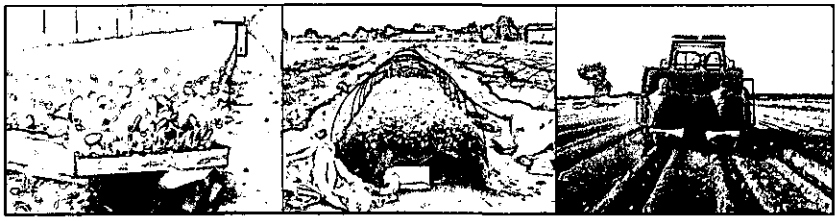


Figure 4. Farmers and methods used for production of tobacco seedlings - production in cooperation with "Duhan", Slatina.

The advantage of production of tobacco seedlings by floating tray system has been exceptionally well in the year 2003 because it was a very dry season and seedlings after planting were accepted better than those from the plots treated with MeBr.
Part of the money received by UNIDO was used for leaflets and manuals, which had significant impact, together with the workshops, on good result in demonstration part of the project. In the next period, a production of domestic substrate which was, up till today, imported from Germany.

With our help, a part of the producers applied this new technology in vegetable seedling production (paprika, tomato).



Tobacco seedlings | Paprika | Tobacco transplanting

In the second year (2004) the activity was focused on provision of automatic seeding machines for sowing of the peleted seeds. According to the decision of UNIDO, three sowing

machines (Virovitica, Kutjevo and Slatina) and two planting machines (Virovitica and Slatina) were imported from Italy.

During December, January and February the seminars for the technologists in cooperatives were conducted and with distribution of pamphlets and instructions for the production of seedlings by new technology (floating tray system), new cognitions and results of the demonstrative part of the project were propagated to farmers via technologists (6 from Virovitica, 5 from Slatina, 3 from Kutjevo).

Seeding machines for the tobacco seed got by UNIDO and with little adjustment can be used for vegetable sowing in special trays, that shows general-purpose use of seeding machines because along with tobacco, farmers produce vegetables as well (paprika, tomato). During February and after the decision of UNIDO, OKIPOR from Zagreb has delivered 200,000 trays to the tobacco producers. Though, according to plan, it was predicted 315,000 trays, but due to dollars value drop, lesser number has been delivered (203,000).

This year tobacco seed is peleted in Holland because experiences and researches till now showed better quality from SAREA (Austria). Trays were delivered by OKIPOR Company, with 209 cells and density of 28-30 kg/m^3.

Due to Tobacco Institute and Institute for plant protection's efficacy, all knowledge in the seedling production and information are spreading fast and are applied on small farmers through big companies, so that Croatian Tobacco Company 100 % excluded MeBr from use.

It is known that MeBr in Croatia got a licence for use till 31.12.2005 whereby Croatia too followed a decree passed by EU, in whose membership Croatia will be admitted soon. It is important to emphasis that in neighbouring countries researches for initiation of the alternative to MeBr are practiced, in order to prevent incontrollable import, especially from Bosnia where we're incorporated as experts to help them in initiation of new technologies and application of our knowledge from demonstrative part of the project was carried out from 1999-2001.

Tobacco Institute's experiences and researches from 2003 showed that application of solarization during summer can also be an alternative to MeBr. At the moment, there are researches with methane sodium in soil disinfection for tobacco seedlings as an alternative to MeBr. Due to Tobacco Institute and Cooperative's efficacy, all knowledge is applied on small farmers who produce tobacco. This production is strictly controlled because tobacco seed is distributed via a contract with big companies. That year, there was no import of MeBr at all in soil disinfection. The application was sporadic in soil disinfection (10%) and it was from previous supplies. Sowing of pelted seed was completed till March 12th and after seven days of sprouting, trays were set in pools. That year (2004), farmers alone were making green houses, with the help of the companies. Water depth in green house is reduced from 15 cm to 12 cm. The use of pesticides (Previcur, Rovral, Rydomil and Confidor) and fertilizers in water are reduced in that way, therefore the production is more economical.

It is necessary to purchase a quantity of conductometers (EC meter) provided from UNIDO, in order to use water and fertilizers size in it well, in proportion NPK (2-1-2) with addition of minimal necessarily quantities of pesticides. In every green house there is a thermometer for measuring air and water temperature (alongside the emphatically instructions) and for the need for ventilation if temperature rises during the day, and especially during sunny days, above 28 °C.

From the beginning till April 20th clipping of seedlings began in order to equalize their growth and development. In 2004, two big companies appointed 5800 ha of tobacco and the seedling production was mainly carried out in floating tray system. 174,000 m^2 of green houses were set, and average size of a green house was about 125 m^2.

It should be emphasized that realization of Phase Out Project goes beyond expectations according to substitution of MeBr with new technology (floating tray system),

but in further Tobacco Institute and Ministry's efficacy should be emphasized the production of better trays and their use for many years and after that the recycling of damaged trays in order to protect the environment completely. The accent will be on further operation in the Project as well as the possibility for the ecologically acceptable trays production for this technology of tobacco seedlings production.

In 2004, "Croatian Tobacco" (Virovitica, Pitomača, Kutjevo) which operates in Tobacco Factory Rovinj Company, produced the seedlings 100 % without MeBr and "Duhan" Slatina about 80 % of the seedling production. In further operation with farmers and via seminars and workshops, it is required to try to improve disinfection of trays and prolong their use for many years, so that damaged trays could be collected and recycled by the producer and later on used in construction industry and so on.

In experimental research in the second part of 2004, the effect of the new technology of seedling production on tobacco yield and quality will be researched. We have presented our results at Symposiums and workshop in Habana, Cuba and at Congress in Kyoto, Japan (see attached). Furthermore, during the summer and autumn, other possibilities to be used as an alternative to MeBr such as solarization, biofumigation, usage of methane sodium in soil disinfection will be investigated. Possibility of tray disinfection with steam in drier (buck curing) will also be investigated. Training of technologists, which will teach the farmers, will be continued.

In 2004, 92 % of the seedlings (127 004.160 seedlings) which are planted on 5 291.84 ha, has been produced with float tray system. Trays from the Croatian company OKIPOR, Zagreb, which has produced 607.675 trays, have been used. With UNIDO's help the same company gave us 170.000 trays.

In 2004, 5752 ha of tobacco has been planted in Croatia (90 % virginia type). Progression of tobacco production in the last three years is shown in Table 4.

Table 4. Tobacco production in Croatia, 2002-2004

Year	Area ha	Yield t	Export t	Value 000 $	Import t	Value 000$
2002	5.604	13.098	4.413	6.994	4.642	21.884
2003	6.108	12.959	5.306	6.867	4.219	26.403
2004	5.752	12.925	4.399	5.783	4.387	22.411

During this period the education of engineers and technicians from Cooperative Croatian Tobacco is continued. Cooperative Croatian Tobacco is made of three companies; "Viržinija" Virovitica, "Duhanprodukt" Pitomača and "Rovita" Kutjevo.

Special attention is paid to the company "Duhan", Slatina, which had a lesser progress in the application of new technology, as well as some mistakes (bigger water EC, appearance of alga in the water, insufficient ventilation of green houses), which resulted in ruination of one part of the tobacco seedlings.

On the experimental field of the Tobacco Institute Zagreb in Pitomača, 4 seminars were held during June and July, in which participated 23-28 technologists. Farmers' seedlings production in 2004 is analysed and manuals and leaflets are distributed in order to correct some mistakes and draw attention to the importance of observance to the necessary discipline. For the next vegetation period, with the help of UNIDO, special conductometers will be provided for observing water EC and high quality fertilization as well as protection of plants.

Since we have noticed more improvisations in manufacturing the green houses (insufficient ventilation) on "Duhan" Slatina's farms, a new experimental green house and a micro-tunnel for smaller producers who plant burley on smaller areas (0.3-0.5 ha), was made during summer.

Tobacco transplantation

"Tobacco Field Day" was held during the summer months, where a demonstrational test was made with tobacco seedlings grown with float tray system and those grown in conventional way. Measurements proved that by growing float tray tobacco seedlings, the plants were better by 37 % from the conventional way of production with MeBr, especially in a very arid zone in 2004, whereas tobacco in Croatia is produced without irrigation. On the seminars it was concluded that despite the presence of Cooperative technicians in the production, there are still insufficiencies. Furthermore it is noticed that 25 % of farmers use the trays only once (which makes the seedlings production much more expensive) although they are been told that they can use the trays a couple of years with the necessary cleaning and disinfection.

"Tobacco Field Day", October 10, 2004

After the seminar with the head technologists in October 2004, members of Cooperative who sow the trays and organise the production agreed that in 2005 they will distribute the trays only when the farmers collect, disinfect and return old trays. That way, the application of new technology will be ecologically acceptable.

After the visit of UNIDO expert Mr. Valerio Alejandro, in order to supervise UNIDO Phase Out Project in Croatia, we were told that the trays which are produced in Croatia should be much denser and stronger in order to use them many times. After disinfection during which we will educate technicians and farmers in the next year, much cheaper production of seedlings and ecologically acceptable handling the trays will be possible.

Experiments with production of new types of trays as well as education of farmers dealing the cleaning and disinfection of the trays are going on in other countries where UNIDO projects are in process. The results of UNIDO project were presented on CORESTA Congress in October 2004 in Kyoto (paper in attachment).

The raw tobacco production, cigarette production as well as import and export were nearly the same as previous year. The tobacco growing surfaces were slightly decreased, which was compensated with higher yield. This higher yield is a result of application of new technology from UNIDO Project in tobacco seedling production.

The tobacco primary production is evolved through cooperation with company which is result of joining of "Virginija" Virovitica, "Duhanprodukt" Pitomača and "Rovita" Kutjevo and is a part of Tobacco Factory Rovinj. 2128 families are involved in this production (2005). During this period there were 16 training seminars with engineers in Pitomača (4), Virovitica (8), Slatina (6) and Kutjevo (5). After these workshops, the knowledge was passed to technicians working with farmers on application of new technology financed by UNIDO. National experts Dr. Sc. Darka Hamel and Dr. Sc. Ivan Turšić, Tobacco Institute Zagreb supervise the mountings of low and high tunnels. During the activities in this period we have received useful suggestions and expert advices from UNIDO expert Mr. Rafael Sanz de la Morena. 80 books and 2000 leaflets were printed and distributed to technicians and farmers to support them in seedling production. In years 2004 and 2005 there was no MeBr import in Croatia. With the use of the MeBr imported earlier, seedlings were produced on only 8.7 % of surfaces, mostly on farms of small producers that produce burley type of tobacco, with average surface of 0.4 ha.

In year 2005, 875.000 trays (produced in Croatia by companies OKIPOR and PLASFORM) were used. With knowledge from workshops in Brazil, Hungary, Macedonia and Cuba and in contacts with UNIDO experts (Rafael Sanz and Mr. Valeiro Alejandro) as well as through UNIDO reports, we have managed to improve the tray quality. With increased density of the trays, it is possible to use them for more years.

During this period, we have managed to reduce the costs in this production by lowering the water level in the pools (suggested by Rafael Sanz) from 14-15 cm to 10-12 cm, which were enough for high quality seedlings production. In this way the usage of fertilizer and pesticides was reduced for 18 %.

In the tobacco seedling production, the used trays will be cleaned and sterilized for further usage. We have gained very useful knowledge in this process on study tour in Spain, organized by Mr. Rafael Sanz, held from May 23 till May 28 2005. On this study tour we have seen the production of tobacco and vegetable seedlings as well as planting of seedlings in the field (in the attachment), along with other useful knowledge applicable in Croatia. The representatives of every cooperative from Croatia have participated in this Study Tour, and Tobacco Institute organized the trip.

Further activities are focused on the investigation of influence of seedlings produced with float-system technique on yield and quality of tobacco. Also, the introduction of this technology in paprika seedling production is in process although MeBr was never used in paprika seedlings production in Croatia because it is allowed only in tobacco seedlings production until December 31 2005.

The rest of the Phase Out Project was focused on substitution of substrate from import with one produced in Croatia, as well as on possibility of production of ecologically acceptable trays for the seedling production.

Phase Out Project of MeBr in Production of Tobacco Seedlings is successfully developing, the UNIDO experts, who are monitoring this project and the substitution of MeBr in the seedling production, rated.

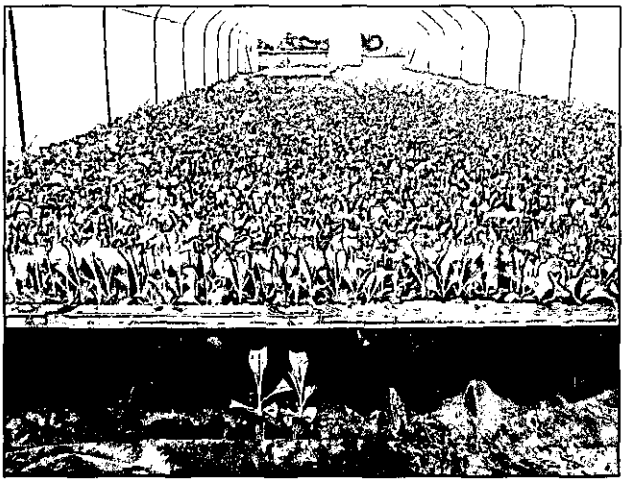
With specification and spending of authorised sources by UNIDO, we have visited Spain, where Mr. Rafael Sanz de la Morena, the UNIDO expert, has recieved us. He has acquainted us with all the details dealing the substitution of MeBr with the new technology of the production of tobacco seedlings and vegetables (paprika, tomato, etc.).
Representatives of all the cooperations from Croatia have participated (Croatian Tobacco, Virginia, Duhanprodukt, DUHAN Slatina, ROVITA and Tobacco Institute Zagreb, which organised the tour as one of the leading initiators of this project).

All that Mr. Rafael Sanz has shown us was very interesting, people in Spain are very hospitable as well. Growing areas of tobacco (Navalmoral) and vegetables (Almeria) were very useful and applicable to our process of substitution of MeBr floating tray system in the seedlings production. We were especially impressed with the rational production and handling the trays during their disinfection, which is the issue we still have to work on in our conditions. We acquired all the neccessary informations which are going to help us and our farmers.

Sources for our tour authorised by UNIDO were very effectively used. Acquired experiences are going to be applied by our tecnologists who participate in the project.

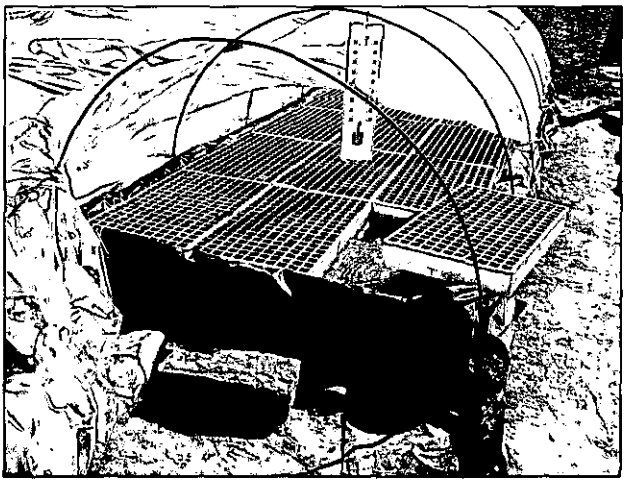
The activity in 2005 has begun with organizing of seminars and workshops with technicians and engineers who are directly involved in tobacco production in Croatian Tobacco (Viržinija, ROVITA and DUHAN Slatina cooperatives). By decision of Ministry of Agriculture, Forestry and Water Management, the application of MeBr in tobacco seedlings production had the license for use till December 31 2005. Till that date it has been used only for soil disinfection, so it has been prohibited for other purposes in Croatia. As the year 2005 was the last year in which this pesticide had license for use, all activity was focused on application of alternative technologies.

By UNIDO research methodology, the best alternative to MeBr has shown to be float-tray system. All tobacco seedlings in year 2005 were produced whit this technology. In Croatia, 95 % of tobacco seedlings production belongs to the flue-cured tobacco (bright Virginia). The smallest farms have 5 ha of this production but there are some producers which produce tobacco on 30, 50 and 100 ha. They are mostly produce tobacco seedlings in greenhouses.



Traditional way of flue-cured tobacco production (float-tray system)

Smaller producers of burley type tobacco produce their own seedlings in small greenhouses (10-20 m^2 tunnels) for 0.3-0.5 ha of tobacco.



Burley type tobacco seedlings production in Croatia

In year 2005, about 965.000 trays (produced in Croatia also last years by companies PLASTFORM and OKIPOR) were used in tobacco seedlings production. According to the suggestion of Mr. G. Castella Lorenzo from *UNIDO*, the density and induration of trays was increased. That resulted in easier and better disinfection of trays and possibility of using trays in the next years. Also, this made the trays production cheaper.

Via seminars in which engineers from cooperatives Croatian Tobacco (Viržinija Virovitica, ROVITA Kutjevo and DUHAN Slatina) participated, the education of tobacco farmers was held. The trays density has increased on 28 g and trays hole was reduced on about 16 cm^3. In this way we are trying to rationalize the production. Actually, the tray substrate for this production is still imported from Germany. Also, the depth of water in pools has been reduced from 13-15 cm to 10-12 cm that has resulted in reduction of pesticide and fertilizer use.

Quality seedlings were produced which affected the growth and development of tobacco plants in the field. It has also affected the higher yield and quality of tobacco. Higher yields of dry tobacco leaves and value of production per hectare have been achieved.

During the summer the activity of application of Phase out UNIDO Project No. MP/CRO/01/215 is continued. At some farmers, despite of all effort, demonstration research and its application, we have noticed some mistakes in seedlings production. The most common mistake is the use of improper water and, sometimes, the application of indissoluble fertilizer. Because of that, in the autumn period workshops have been organized to show the farmers the importance of EC and pH measurement in water. For that purpose, 50 COMBO pH/EC/TDS/°C testers were bought. As they were delivered in October, their practical use will be applied in the next vegetation period.

In 2006 (when the application of UNIDO Phase out Project MP/CRO/01/215 finishes) it is expected to solve all the mistakes which are nevertheless sporadic.

The application of new project financed by Ministry of Science, Education and Sports is in process. The goal of this project is to produce ecologically degradable trays, with new

technology. Momentarily the order of greenhouse and tunnels nylon for 2006 vegetation season is also in process.

The Tobacco Field Days, October 2005, Virovitica, Croatia

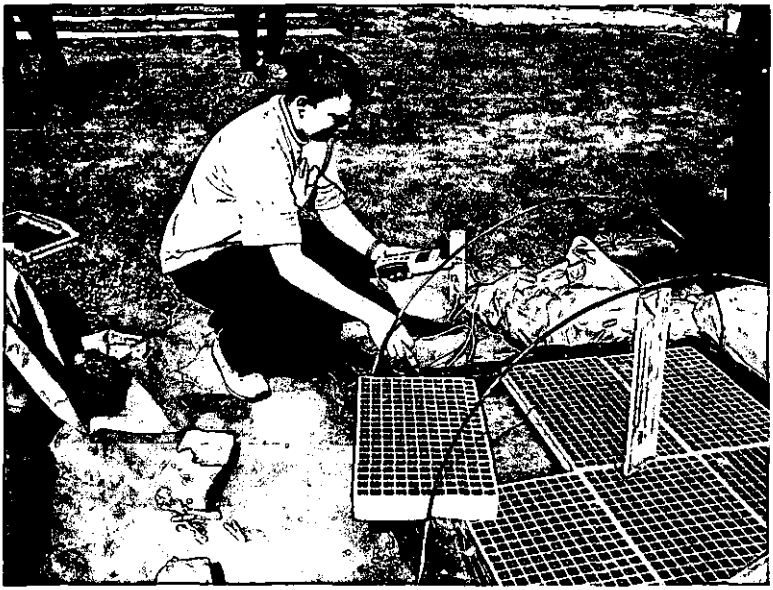
In year 2005 tobacco was planted on 5463 hectares on 1905 farms which produced 10 420 t of tobacco. In the next year the production was planned on the same level. In the last year, there was no import of MeBe and all reserves in Croatia were spend. Therefore, import of MeBr from neighbouring countries, where it is still used for soil desinfection, is completely prohibited.

At 31st December 2005, Ministry of Agriculture has prohibited the use of MeBr in Croatia. During October 2005 (12 Oct) UNIDO decided granted funds for 50 pH/EC/TDS tester devices with particular reagents. The tester devices were bought over the firm "Hebe" from Split, Croatia. Afterwards, in cooperation with national expert Darka Hamel, PhD, the workshops were organized in the tobacco (virginia and burley type) growing area. These E.C. showed to be very effective. The translation of the tester device instruction manual has been made and given to technologists in "Croatian tobacco" (Pitomača, Virovitica and Kutjevo) and DUHAN (Slatina). The trainings of technologists for E.C. tester device ussage has been made during December and January. Based on their measurements, they have checked the water quality (pH and E.C.) on every tobacco farm. On 17 % of farms out of 1905 the higher content of salt has been measured and farmers were sugested to use the waterwors-water and not from well. The water hardness (E.C. > 1500 µS/cm) on these farms caused the increased development of algas. The equipment purhcased by UNIDO was very useful.

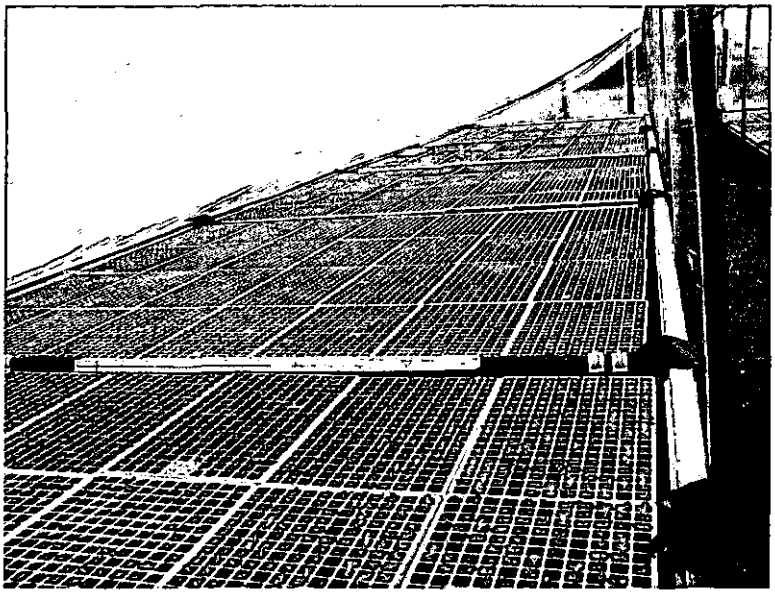
In the year 2006 all tobacco seedlings are produced without the usage of MeBr. With previous production expirience and with instructions from UNIDO experts, the more quality and cheaper seedlings were produced.

In year 2006 the farms which produce vegetable seedling (paprika, tomatos) has also started to use this technology. The water level in pools has been reduced from 15 cm to 12 or even 10 cm which resulted the significant reduction in fertilizers and pesticides use and in reduction of production costs for our tobacco farmers.

Although the quality of trays has been increased, it was decided to produce harder trays so they can be used more that two years. In cooperation with Ministry of Science, we are working on a project to produce so called ecologically produced trays. The purchase of anti dropping and diffusing plastic sheets 9 meters wide is currently in procces. Through the training workshop, we have also noticed the need to mix the supstrate with vermiculite, perlite or similar material to improve the water and air regime in seedlings rhizosphere.



EC measurment



Tobacco germination (March 2006)

The activity related on fourth progress report begun with tobacco seedlings transplantation to the field at the beginning of May. In year 2006 flue-cured tobacco was planted on 5047 hectares on 779 farms. Burley type tobacco was planted on 343 hectares on 689 farms (Table 5.). These farms have produced 11000 tons of virginia and 1014 tons of burley tobacco.

Table 5. Tobacco production in Croatia, 2006.

		Virginia	Burley
Croatian Tobaccos			
Hectares		3967	343
Farmers		594	689
Trays		640000	46500
Greenhouses		1172	780
AGRODUHAN Slatina			
Hectares		1080	
Farmers		185	
Trays		150000	
Greenhouses:	cooperants	285	
	farms	15	

In year 2006 all tobacco seedlings in Croatia are produced without the usage of MeBr. With previous production experience and with instructions from UNIDO experts, the more quality and cheaper seedlings were produced.

During the transplantation in summer, especially in June and July, there was very small amount of precipitation with very high temperatures. In spite, seedlings of very good quality were produced and successfully transplanted into the field (Picture 1 and 2). This resulted in very good yield and quality of tobacco.

The sorts of tobacco grown by Croatian Tobaccos Company in the year 2006 had prolonged vegetation period so the frost has destroyed one or two last yield. The tobacco was topped on the beginning of flowering (Picture 3) and treated with pesticides against the growth of suckers. Because of that, maturity on time and good yield of high quality tobacco is possible (Picture 4). This was shown by chemical analysis of dry leaf in laboratory of Tobacco Institute.

In this half-year period a lot of effort was made in finding a way of taking care of damaged and used trays with goal of environment protection. The factories that produce trays took used trays for new ones. The new trays are sterile and safe for usage. Of course, it is more economic to use trays for more times. They can be used three to five times (Brazil, Argentina, Zimbabwe etc.). The used trays were not clean so we had to disinfect them with sodium hypochlorite solution. If there were some diseases noticed at some farmers, we have sterilized the trays in dryers with water steam for 30 minutes on 70-80 °C. With team of experts in the cooperatives, we have trained the farmers and pointed out the possible mistakes.

Our experience gained with great help of UNIDO during the demonstration period (1999-2001) as well as during the Phase out period (2003-) we have also applied in Bosnia and Herzegovina where the use of MeBr in soil disinfections was also successfully ended. The project was smoothly provided. Farmers accepted new technology very well. It is important to mention that technicians and other experts will continue to give advices to farmers regarding tobacco growing using floating tray system.

During the duration of the project good cooperation was with the national expert from Institute for Plant Protection Dr. Sc. Darka Hamel. Knowledge and experience of Mr. Rafael Sanz was important, especially in the beginning of the project. Fruitful help was obtained from Mr. Siahmed and Guillermo Castellá Lorenzo from UNIDO.

Thank you for good cooperation and if you ever will need our help in future we hope to be available to give our best in some other project.

Dr. Sc. Ivan Turšić

National expert

Tobacco Institute Zagreb
Svetošimunska 25
10 000 Zagreb
Croatia

E-mail: itursic@agr.hr

Results of UNIDO projects are presented in following Papers from symposiums, workshops and congresses:

1. Turšić,,I.,,Radulović, V., Hamel, D. 1999. Float system as an alternative means of tobacco seedlings production in Croatia. 19TH Symposium of tobacco. Ohrid, Macedonia, Proceedings, pp. 23-24.

2. Turšić, I. 2000. Hidroponski način proizvodnje presadnica duhana. Sažeci, 36. znanstvenog skupa hrvatskih agronoma, Opatija, str. 205-206.

3. Hamel, D. 2000. Results of the alternatives project in the Republic of Croatia. Workshop on the alternatives to the use of Methyl Bromide in the tobacco sector. Joinville, Brasil, 11-12 April.

4. Hamel, D., Turšić, I. 2001. Zamjena za Methyl Bromide pri uzgoju duhana. 45. seminar iz zaštite bilja. Opatija. Glasilo biljne zaštite, str. 52-53.

5. Radulović, V. 2001. Iskustva proizvođača korištenjem plutajućeg sustava s ekonomskim osvrtom. UNIDO workshop, Đurđevac, 8-9 May.

6. Turšić, I., Hamel, D., Mesić, H., Čavlek, M., Bašić, F. 2000'. Ekološki prihvatljiva proizvodnja presadnica duhana. EKOI, Plitvička jezera, Sažeci, str. 3-38.

7. Turšić, I., Hamel, D., Radulović, V. 2002. Alternatives to the use of Methyl Bromide in tobacco production in Croatia. 20th Tobacco Symposium, Ohrid, 2002.

8. Turšić, I., Hamel, D., Mesić, H., Sanz, R., Radulović, V. 2004. Phase out of Methyl Bromide in production of tobacco seedlings in Croatia. Conf. Inter. De Alternatives of Bromuro of Metilo. La Habana, Cuba, 24-28 May, 2004.

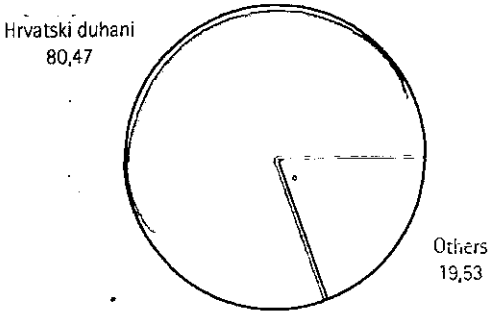
9. Turšić, I., Hamel, D., Mesić, H., Sanz, R., Radulović, V. 2004. Ecologically acceptable production of tobacco seedlings in Croatia. Coresta Congress 2004, Kyoto, Japan.

2006 Leaf Production

Croatian 2006 Crop (Projection)
FLUE CURED AND BURLEY TOBACCOS.

2006 Crop Hrvatski Duhani d.d. Field Operations

	FCV	BLY
Contracted Ha	3,870	343
Contracted growers	595	705
Average production per grower (tons)	14,87	1,44
Average production per grower (Ha)	6,50	0,48
2006 crop green production (tons)	8,852	1,014



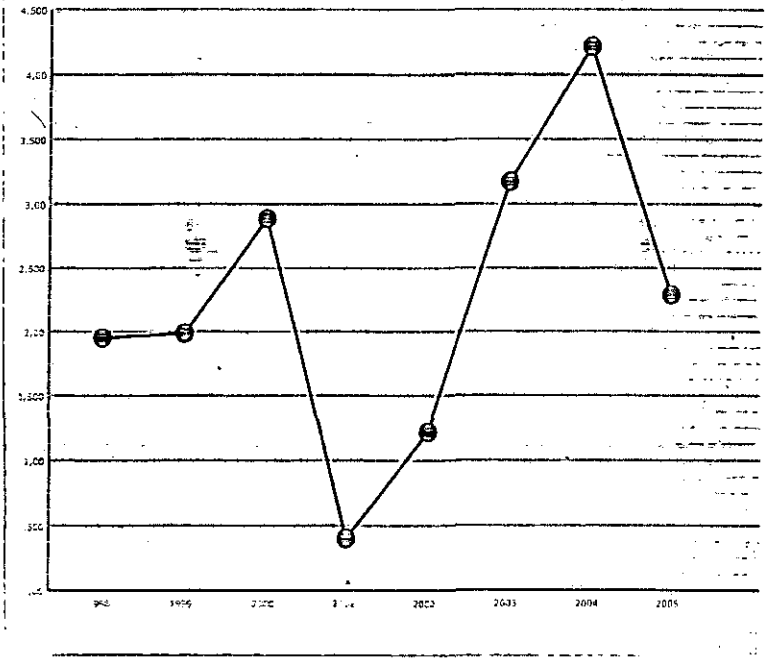
Total FCV Production .....11,000 tons
HRVATSKI DUHANI FCV Production..... 8,852 tons

Total BLY Production .....1,014 tons
HRVATSKI DUHANI BLY Production .....1,014 tons

Croatian Tobacco Export

Croatian tobaccos are sold on the local market and abroad.

	Crop (YEAR)							
	1998.	1999.	2000.	2001.	2002.	2003.	2004.	2005.
Export (tones)	1,950	1,984	2,886	40	1,216	3,170	4,214.	2,287



ECOLOGICALLY ACCEPTABLE PRODUCTION OF TOBACCO SEEDLINGS IN CROATIA*

I.Turšić[1], Darka Hamcl[2], Hana Mesić[3], R.Sanz[4], V.Radulović[5]

[1]Tobacco Institute Zagreb, e-mail: tursic@usa.net
[2]Institute for Plant Protection in Agriculture and Forestry of Republic Croatia
[3]Ministry of Environmental Protection and Physical Planning
[4]UNIDO
[5]Tobacco Slatina Company

ABSTRACT

Production of tobacco seedlings regularly involves application of methyl bromide for soil disinfections. According to the Montreal Protocol, methyl bromide is on the list of ozone depleting substances. A decision has been brought to ban its application following a set schedule, viz. by year 2005 in developed countries and by 2015 in developing countries. The producers of tobacco seedlings use about 30 tones of methyl bromide in Croatia per year - almost entirely. These individual producers organize their production as subcontractors through the Croatian Tobacco, "Duhan" Slatina and the Tobacco Institute. Aimed to study the alternative methods to methyl bromide, two-year research methodology has been developed with the help of UNIDO and its specialists, has included this trials, besides control treatments (Ø and methyl bromide), also application of Dazomet, biofumigation and the floating tray system for growing of tobacco.

After two years of investigation, better quality seedlings were obtained by the floating tray system than by other methods. This growing method requires 2 - 3 times less space. The seedlings are uniform, have a better-developed root system and develop much better after being transplanted into the field.

Planting of such seedlings resulted in higher yields and better quality of dried leaves along with maximal protection of the environment and ozone layer. This method of seedling production requires efficient producer education and special equipment. Dazomet (Basamid) efficiently controls weeds but may be phytotoxic to tobacco, particularly at low temperatures, which regularly occur in the spring. Application of solarization / biofumigation towards the end of September was not efficient either, also due to low night temperatures and re-emergence and development of weeds during tobacco germination.

Key words: tobacco seedlings, methyl bromide, Dazomet, biofumigation, solarization, floating tray system

1. INTRODUCTION

Tobacco is economically important plant in Croatia (Budin et al., 1994). The main type of tobacco in Croatia is Virginia of flue-cured tobacco, which is grown on about 6000 hectares in northern Croatia (Turšić et. al., 1999). In this region, around 2000 farmers are involved in the tobacco production. The average size of the family farm is 3 - 5 hectares. They produce about 12 000 tones of dry leaves of tobacco per year.

* CORESTA Congress 2004, Kyoto, Japan

Methyl bromide has been used in Croatia for more then forty years, in control of pest insects, nematodes, weeds and soil pathogens in tobacco transplant production (Bužančić, 1996). Methyl bromide is not manufactured in Croatia, and is therefore imported mainly from the USA and Israel, which accounted for a total import around 30 tones.

The experiments have been started to find the best suitable treatment in seedbeds between solarization plus biofumigation and floating tray system (non soil cultivation) all in combination with an integrated pest management program to improve the conventional way of production of plants in seedbeds treated with methyl bromide.

2. METHODS AND MATERIALS

The testing alternatives are solarization plus biofumigation and non-soil cultivation, all in combination with an integrated pest management program. A blank control and methyl bromide fumigation is also used as comparison.

The experiments were conducted in seedbeds of 10 m^2 covered with plastic sheet and floating tray beds of 9.52 m^2 (10.35×0.92).

There were five treatments in the experiments:

1. Control
2. Methyl bromide applied in the conventional way (45.5 g/m^2)
3. Dazomet (Basamid - 50 g/m^2)
4. Floating tray system
5. Solarization / biofumigation

Traditional treatment of seedbed with methyl bromide

This is a traditional system, where methyl bromide at a rate 45.5 g/m^2 is applied over the well-prepared soil in seedbed. The soil is covered with a plastic sheet for duration of seven days. Thereafter, the plastic sheet is removed and showing starts using 1 g of seeds / seedbed 10 m^2.

Treatment of seedbed with Dazomet (Basamid)

Dazomet, fumigant, was used in seedling nurseries and applied to the well prepared soil in the seedbed at the beginning of September at a rate of 50 g/m^2 Basamid and incorporated up to 20 cm deep in the soil.

Bio-fumigated seedbed

Seedbed for biofumigation was prepared at the end of September. Fresh sheep manure in the dose of 5 kg/m^2 was added and incorporated up to 20 cm deep in the seedbed soil. After the sheep manure application, the seedbed was covered with plastic sheet until the sowing date.

Floating tray system

In the expanded polystyrene trays (0.516 × 0.303 × 0.059 m) with 209 cells commercial substrate or experimental mixtures was poured, the seeds were sown and trays were placed to float on a water surface. The measures of the pool were 0.92 × 10.35 m. Water was filled till the depth of 0.12 m. The bottom of the pool was covered with the double black plastic sheet. The electro conductivity (EC) of the water was measured before pouring in the pools.

1200 l of water was poured in the pools which dimensions were 0.92 m ×10.35 m × 0.15 m and 1.2 l of fertilizer N-P-K-Mg (10-5-10-2) + microelements, 10 ppm of Ridomil, 10 ppm of Previcur and 10 ppm of Mythos were added.

Pools with water and trays were covered with thermo selective Lutrasil sheet.

At the same time, thermometers for air and water measurements were placed in the plastic house and for measuring of air and soil temperature outside plastic house.

Potassium permanganate solution was used in the water to prevent alga development.

The seedlings were clipped two times. Before transplanting, all tobacco was sprayed with Ridomil.

3. RESULTS

3.1. Chemical alternatives

Dazomet (Basamid), a chemical soil sterilizer used in seedling nurseries, is a technically feasible chemical alternative to methyl bromide. It is effective against nematodes and weeds, with the advantage of being non-persistent in the environment and is not to be an ozone depleting substance. However, in conducting the trials, some phytotoxicity on plants was detected. At Tobacco Institute, the area treated with Dazomet resulted in lower seed germination. On average, 380 tobacco seedlings / m^2 in the first year and 115 tobacco seedlings in the second year (Table 1) have developed in the treated bed.

Dazomet (Basamid in dose of 50 g/m^2) was incorporated in the soil and covered with plastics on the end of September.

Table 1 Number of tobacco seedlings and weeds per m^2 on plots disinfested with soil fumigants and control, 2000-2001

Treatments	Number of tobacco seedlings / m^2		Number of weeds / m^2	
	2000	2001	2000	2001
Control	156	193	203	215
Dazomet	310	269	1	3
Methyl bromide	*496*	*530*	*3*	*2*

The plot treated with methyl bromide, in the season 2000-2001 compared to Dazomet, produced on average more seedlings per plot, between 496 and 530 seedlings / m^2.

Dazomet controlled most of the weeds very successfully. On average, only 2 weeds / m^2 were observed in the treated plot.

Treatment with 50 g of Dazomet / m^2 perfectly controlled weeds, however also in this year there was phytotoxicity and the number of seedlings was reduced.

3.2. Seedbeds with no treatment (control)

Large number of weeds developed in the area in seedbeds without treatment (control), reducing tobacco seedlings development significantly. A large number of weeds (203-215/m^2) that initially developed in seedbeds, impaired seed germination, and reduced the number of seedlings available for transplantation. In seedbeds there was no weed control, and the large number of weeds developed totally reducing seedling development.

Weed density was very high at control and tobacco plants had a small stem, and it was impossible to use planting machine.

Table 2. Height of plants, length of roots and stem diameter

	Height of plants (cm)	Roots (cm)	Stem diameter (mm)
Control	6.3	4.4	2.6
Dazomet	14.1	5.1	4.1
Methyl bromide	16.4	6.3	3.8

3.3. Biofumigation

Fresh sheep manure in dose of 5 kg / m^2 was added at the beginning of September on the plots. Weed control was very poor. Tobacco seedlings (170 / m^2) developed high narrow leaves and density was reduced. Weed density was very high and tobacco seedlings had a small stem. They developed more in width than in height and because of this, it was impossible to use planting machine.

In our opinion, manure for such type of disinfections should be applied earlier, when higher temperatures could be achieved under plastic (Oštrec, 1993).

3.4. Floating tray system

Floating tray system produced the most uniform seedlings, and the highest percentage of useful seedlings, compared to the other treatments (Hamel, 2000, Nicolas, 1999, Smith, 1999, Turšić, 2000, Sanz, 2001).

The tobacco substrate imported from Germany was mixed with 30 % of perlite.

Table 3 Number of sown seeds, sprouted plants and plants for planting (m^2) as well as length of plants and roots, 2000/2001.

Treatments	No. of sown seeds (m^2)	No. of sprouted plants (m^2)	No. of plants for planting (m^2)	Length of plants (cm)	Length of roots (cm)
Control	1300	860	175	6.3	4.4
MeBr	1300	1010	513	16.4	6.3
Basamid	1300	650	290	14.1	5.1
Float system	1339	1203	1003	17.2	7.1
Biofumigation	1300	680	170	10.1	5.1

The best developed seedlings were the one that were grown in floating trays and the substrate was for tobacco. Faster sprouting and better development of seedlings was if tobacco substrate was mixed with vermiculite and perlite (Sanz, 2001; Turšić et al 1999).

The seedling stress caused by transplantation from the seedbed to the field was less pronounced in the floating system, compared to the other alternatives tested. This fact is due to the portion of substrate that remains adhered to the roots, protecting them against the water stress that normally occurs after transplanting, especially in 2000 because it was dry and warm soil during May.

Through UNIDO Project, Tobacco Institute Zagreb has decreased usage of methyl bromide in "Croatian tobacco" by 95 %.

The substitution of methyl bromide with the usage of floating tray system has positive effect on ozone layer protection, prevention of Br leaching into ground water and increase of yield and quality of produced tobacco in Croatia.

4. CONCLUSIONS

1. The results of the two years experiment have shown that in our pedoclimatic conditions, seedlings of good quality can be produced on the plots where methyl bromide was used or with floating tray system as an alternative for the methyl bromide.
2. Seedlings produced on the floating tray system were equally developed and of equal quality. The acceptance, growing and development of such plants in the field were better.
3. Tobacco yield obtained of seedlings from floating tray system was higher and quality was better compared with the tobacco obtained from seedlings grown on plots treated with methyl bromide in the second year of investigation.
4. The cost of one seedling produced in the floating tray system is slightly higher compared to the usual production on plots treated with methyl bromide.

Pursuant to the directive of the Ministry of Agriculture, use of CH_3Br in Croatia is allowed in tobacco seedling production until December 31, 2005.

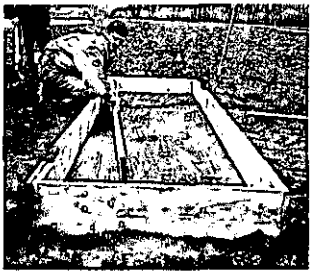
5. REFERENCES

1. Budin, T., Kraljičković, J. 1994. Costs of tobacco production on the small family farms. Annual report. 19:55-63.
2. Bužančić, A. 1996. Production of tobacco seedlings without methyl bromide. Annual report. 21:123-126.
3. Hamel, D. 2000. Results of the MB alternatives project in the Republic of Croatia and discussion. Workshop on the alternatives to the use methyl bromide in the tobacco sector. Joinville, Brazil, 11-12 April.
4. Nicolas, C. 1999. Alternative transplant production technologies. Joint meeting of the Coresta. Agronomy & Phytopatology groups. Suzhou, China.
5. Oštrec, Lj. 1993. Solar heating (Solarization) of soil for control of nematodes and weeds. Fragmenta et hebologica. 21(1):31-44.
6. Sanz, R. 2001. Experiments in tobacco seedlings production in Spain. Methyl bromide alternatives for tobacco seedlings production. UNIDO Workshops, Đurđevac, Croatia, 8-9 May.
7. Smith, D.W. 1999. Transplant production in the float system. Tobacco Information. North Carolina State University. 14-32.
8. Turšić, I., Radulović, V., Hamel, D. 1999. Float system as an alternative means of tobacco seedlings production in Croatia. 19th Symposium on tobacco. Ohrid, Macedonia. 23-24.
9. Turšić, I. 2000. Floating tray system of tobacco seedlings production. 36th Symposium of Croatian agronomists, Opatija, 22-25 February.
10. Turšić, I., Hamel D., Mesić H., Sanz R., Radulović V. 2004. Phase out of methyl bromide in production of tobacco seedlings in Croatia. Conf. Inter. de Alternativas of Bromuro de Metilo. La Habana, Cuba, 24 - 28 May.

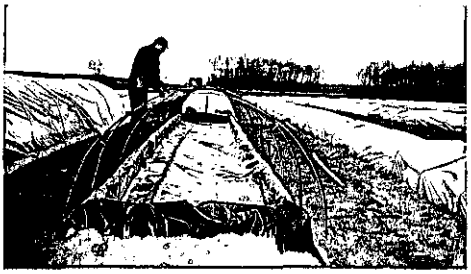
ACKNOWLEDGEMENT:
We are grateful to Mr. Rafael Sanz (UNIDO) for his expert support to our project.

Ivan Turšić
Tobacco Institute Zagreb
Svetošimunska 25, 10000 Zagreb, Croatia
E-mail: itursic@agr.hr

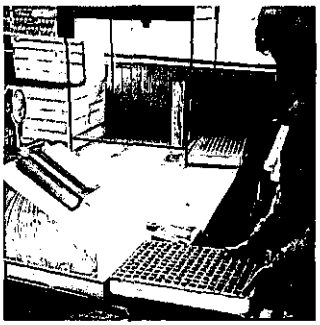
PLUTAJUĆI SUSTAV PRI PROIZVODNJI PRESADNICA DUHANA



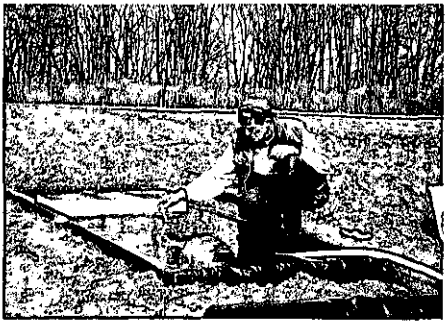
1. Iskopati bazen s ravnim dnom obrubljen s daskama ili opekom, a veličina ovisi o broju potrebnih biljaka za sadnju.



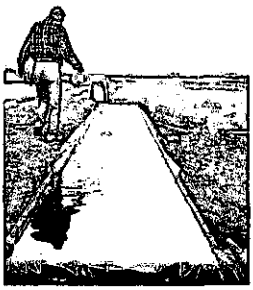
2. Ravno dno prekriti dvostrukom crnom folijom.



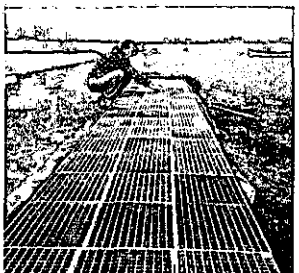
4. Plitice napuniti supstratom za duhan (bez hraniva) koji je mješavina supstrata (pH 5,8 - 6,3) i perlita (30%).



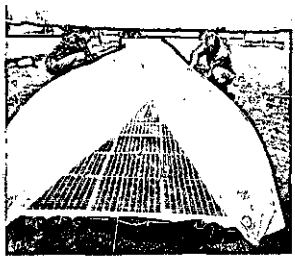
3. Provjeriti kakvoću vode (300-1000 microS/cm) i napuniti bazen (12-15 cm) te pustiti da se zagrije nekoliko dana.



5. U bazen s vodom prije stavljanja plitica dodati tekuće ili vodotopivo mineralno gnojivo u omjeru 2:1:2. Dodaje se 100 ppm dušika (1 ppm= 1g/1000 l ili 1ml/1000 l), 50 ppm fosfora i 100 ppm kalija uz dodatak svih ostalih biogenih elemenata. Dodati potrebne fungicide (10 ppm Previcura, 10 ppm Rovrala i 10 ppm Ridomila).

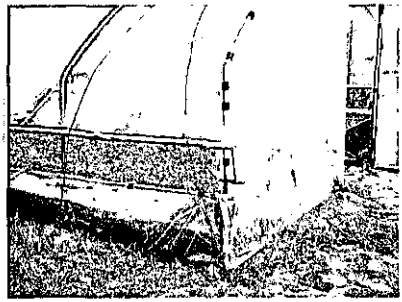


6. Plitice s posijanim piliranim sjemenom dobro posložiti da plutaju na vodi.



7. Bazen s plitičama pokriti lutrasil i polietilenskom folijom.

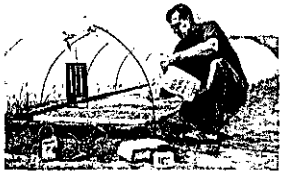
8. Dva puta tjedno kontrolirati dubinu vode u bazenima te je dodavati po potrebi. Nakon mjerenja EC vode dodavati mineralno gnojivo i održavati razinu NPK (100 ppm:50 ppm: 100ppm).

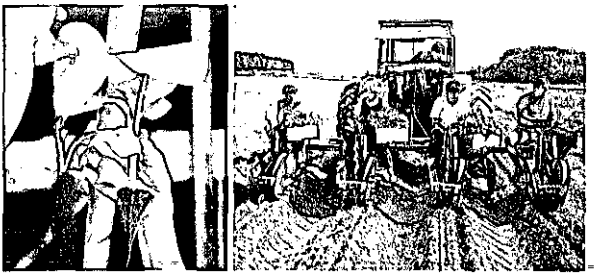


9. Kod povišenih temperatura (optimum oko 25 °C) prozračivati tunele ili plastenike.

10. Prvo šišanje vrhova listova (1/3) obaviti kad su biljke visoke 5 cm s čistim kosilicama. Po potrebi šišanje ponoviti nekoliko puta (3-5). Tijekom šišanja paziti da se ne ošteti vegetacijski vrh.

11. Prema potrebi za kontrolu rasta algi dodaje se kalijev Permanganat (0,1 - 1mg/l vode). Ne smije se koristiti bakreni sulfat.





12. Za sadnju 1 ha duhana potrebno je 25-30 m² površine bazena.

PRIPREMA I TISAK: I.T.-GRAF, ZAGREB

Duhanski institut Zagreb, Planinska 1
Tel/faks: 01/24 41 088 (Dr. Ivan Turšić)

EKOLOŠKI PRIHVATLJIVA PROIZVODNJA PRESADNICA DUHANA

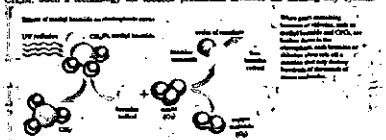
ECOLOGICALLY ACCEPTABLE PRODUCTION OF TOBACCO SEEDLINGS

I. Turšić[1], Darka Hamel[2], Hana Mesić[3], M. Čavlek[4], F. Bašić[5]

[1]Duhanski institut Zagreb, [2]Zavod za zaštitu bilja u poljoprivredi i šumarstvu Republike Hrvatske
[3]Ministarstvo zaštite okoliša i prostornog uređenja, [4]Ministarstvo znanosti i tehnologije Republike Hrvatske
[5]Agronomski fakultet Sveučilišta u Zagrebu

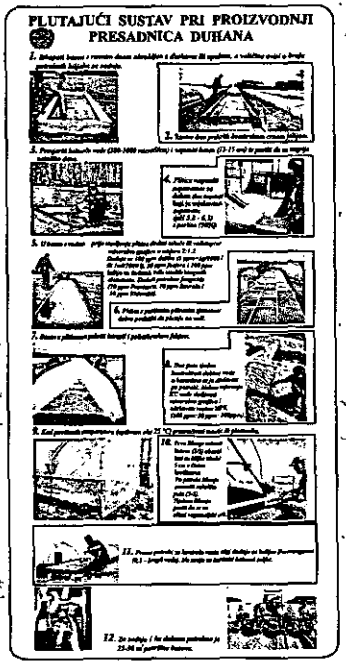
ABSTRACT

Methyl bromide (CH_3Br) is used in soil fumigation to control pests, weeds and diseases in the production of seedlings of vegetables, flowers, tobacco etc. in the world. In Croatia, use of methyl bromide was approved in 1965 only for soil fumigation in the productions of tobacco seedlings. According to the Montreal Protocol CH_3Br is on the list of ozone depleting substances. Hence, its use is allowed only until 2005 in developed countries, and until 2015 in developing countries, with certain restrictions upon its application. In EU, use of CH_3Br was banned in 2001. Pursuant to the directive of the Ministry of Agriculture, use of CH_3Br in Croatia is allowed in the tobacco seedling production until 31 December 2005. This prompted research into new seedling production technologies without CH_3Br in order to prevent its adverse effect on the ozone layer, as well as to avoid leaching of bromium salts into groundwater. Research was started by the tobacco institute in 1987 and was intensified with the support of UNIDO in 1999 and of the Ministry of Science and Technology in 2001. In the next three-year period, tobacco producers will produce seedlings without applying CH_3Br. Such a technology for tobacco production involves the floating-tray system.



UVOD

Sjeme duhana je vrlo sitno. Jedan gram sjemena sadrži oko 10 000 - 14 000 sjemenki. Zato se u proizvodnji duhana prvo proizvode presadnice koje se zatim presađuju u polje. Presadnice se proizvode u tljoduna (10×1 m) pokrivene plastičnom folijom. Sjetva sjemena u tljelu obavlja se sredinom ožujka, a proizvedene presadnice se presađuju u polje sredinom svibnja. Do sada su se presadnica duhana tradicionalno proizvodile sijetvom pripremljenog sjemena (1 g / 10 m^2) na prethodno pripremljeno i desinficirano tlo s metil bromidom. 1991. godine metil bromid je uvršten u II. popis Montrealskog protokola kao tvar koja oštećuje ozonski omotač. 2001. godine, u Europskoj zajednici prestao se koristiti metil bromid. Odlukom Ministarstva poljoprivrede u Hrvatskoj CH_3Br ima dozvolu za uporabu do 31. prosinca 2005. godine. Kako bi se provelo postupno ukidanje korištenja CH_3Br u zemljama u razvoju, multilateralni fond Montrealskog protokola putem četiri provedbene agencije (UNIDO, UNEP, UNDP i Svjetska banka) pruža stručnu i novčanu pomoć. Međunarodna organizacija UNIDO je povjerila ta aktivnost Ministarstvu zaštite okoliša i prostornog uređenja uz novčanu potporu preko projekta MP/CRO/98/058. Pokusna istraživanja od 1999. -2001. u sjevernoj Hrvatskoj proveli su Duhanski institut Zagreb i Zavod za zaštitu bilja u poljoprivredi i šumarstva. Najbolja moguća zamjena za CH_3Br u istraživanjima bio je plutajući sustav u proizvodnji presadnica (floating-tray system) čija se primjena značajno proširila i u proizvodnji duhana. U sklopu je izvedbeni dio UNIDO projekta (Phase-out project) koji je povjeren Duhanskom institutu Zagreb.



Cvat duhanpa
(Nicotiana tabacum)

Tradicionalni način proizvodnje presadnica duhana

ZAKLJUČI

1. Presadnice duhana uzgojene plutajućim sustavom imale su bolji prirast, rast i razvoj nakon presađivanja, te dale veći prinos i bolju kvalitetu lista nego presadnice uzgojene na tradicionalan način.
2. Novom tehnologijom uzgoja presadnica smanjena je potrebna površina lijehova s 60 - 80 m^2 na 25-30 m^2 potrebnih za sadnju 1 ha.
3. Uzgojem presadnica duhana plutajućim sustavom isključena je mogućnost oštećivanja ozonskog omotača i ispiranja bromida u podzemne vode.

Presadnice poprše uzgojene plutajućim sustavom (Pitomača 2002.)

Authors address:
Dr. Ivan Turšić
viši zn. sur.

Tobacco Institute Zagreb
Planinska 1, 10 000 Zagreb
e-mail: tursic@usa.net

EKOI 2002
Plitvička jezera
22-25. listopad, 2002.

UNIDO

DUHANSKI INSTITUT ZAGREB