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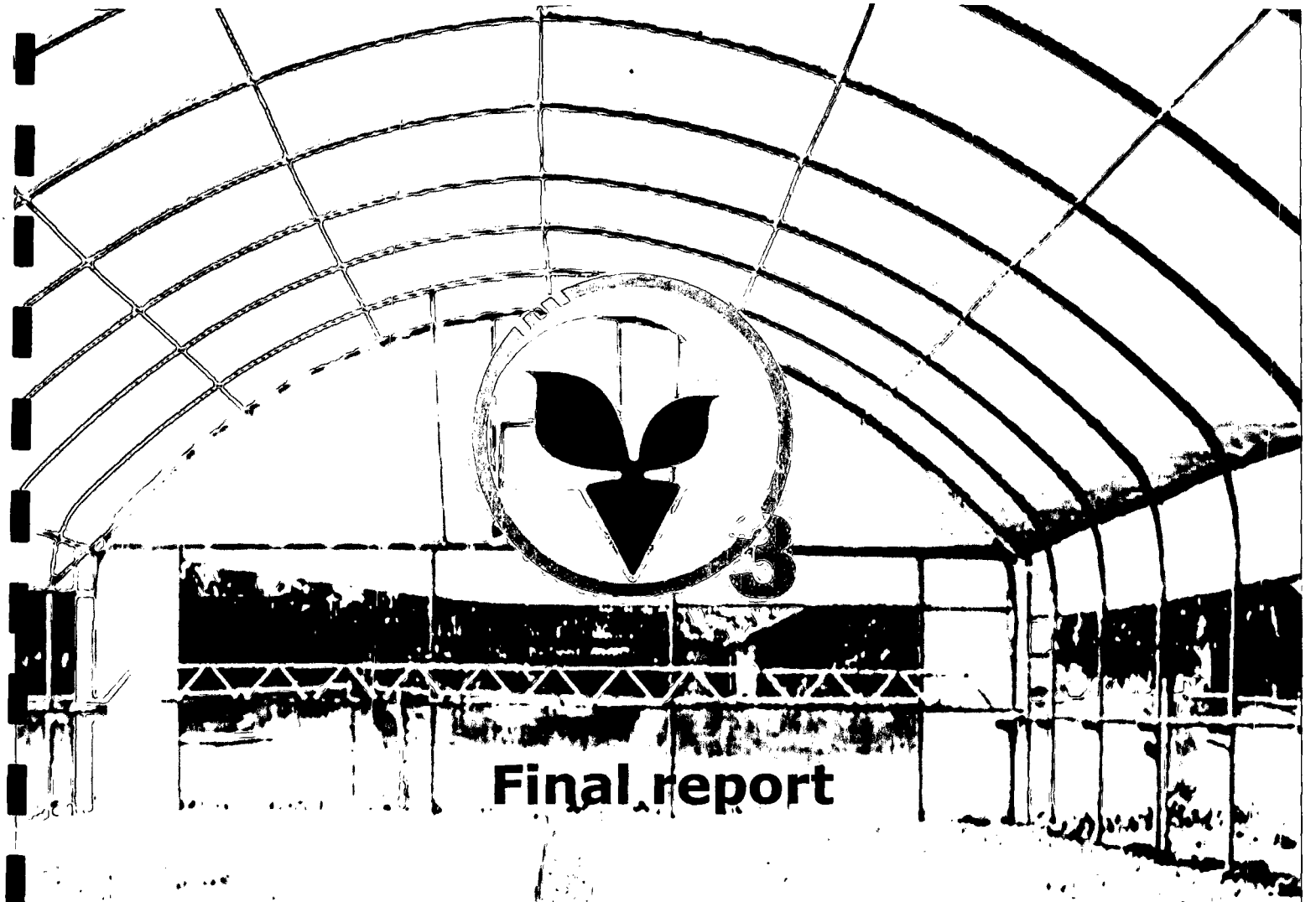

Final report

Montreal Protocol Project
"Phasing out of methyl bromide in the tobacco cultivation in Cuba."

Project No. MP/CUB/98/038

Contract UNIDO No. 99/074

Havana, Cuba

June, 1st 2003.

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1 Introduction.

The project **"Phasing out of methyl bromide in the tobacco cultivation in Cuba."** was conceived with the objective of eliminating the consumption of 48 tons ODS, that is to say 80 tons of methyl bromide that were used in 253 ha of traditional seedbed of tobacco in Havana and Pinar del Río that gave transplant for 4116 ha to cover crop tobacco plantations in Havana and Pinar del Río and Vegas Finas in a later province.

This project constitutes a clear example of a harmonic program of technological transference where science, technology and readiness of resources were complemented.

The technology transferred was the production of tobacco transplant for the system of floating tray, with organic substrate and use of biological control, in greenhouses, tunnels and micro tunnels of different dimensions.

The first step in the work plan was to guarantee the investment of the project and the necessary annual inputs.

Special emphasis were given to different training tasks and popularisation through trainings, workshops, technical advise, lectures and chats with the aid of videos, leaflet, posters, book and manuals. Those activities were carried out on the assembly of greenhouses and micro tunnels, operation of semiautomatic and manual sowing, quality and sterilization of the substrate, quality of pellet and naked seed, necessary condition for the sowing and the whole conduction of floating tray technology. The work was characterized by the participation of a great quantity of people among those are included that peasants, producers of tobacco, managers and officials of different state entities. It was spread a wide work of participative research with the producers, based on the feedback of the technological transference, as well as to give solution to the new problems that have appeared because the masification of the new technology.

During the period of the inter campaigns they were carried out tasks related with the reception and distribution of the resources of the project, assembly of greenhouses and micro tunnels, distribution of the inputs, planning of areas to benefit with the technology during the tobacco campaigns and programs of reduction of the consumption of methyl bromide in tobacco traditional seedbed.

The preservation and reparation of equipment and supplies was an additional tasks in the work plan which was important tool for the success of the project, as well as the survey of the quality of the substrate and water supply for the pools, elaboration of a norm about substrate quality, methodology of disinfections of this, scale up of two factories of substrate production, improvement of the design of the manual naked seeder, etc.

The fact of three hurricanes passed across the eastern part of Cuba, had great attention in very important moments for the production of tobacco transplant, during the campaigns of 2001-2002 and 2002-2003, in this later campaign occur two meteorological events in a period of 10 days which passed for the same area of Pinar del Río where is very wide area of tobacco production.

They were carried out periodic meetings every month with peoples belong to the all organization involved in the project and it were keep strong common interest in giving execution to the project objectives during the period since 1999 up to the 2003. Finally it was given great attention to create the bases once the project concluded it would follow the achievements of it.

The total phase out of 80 tons of methyl bromide in traditional tobacco seedbed was completed in a quick way, since in the 1999-2000 tobacco campaign the consumption decreased in 16,4%, in 2000-2001 the consumption went declining to 52.5% and in the 2001-2002 it was reaches the total elimination that has stayed in the 2002-2003 and forbidden its use in the cultivation of the tobacco in Cuba according to official resolutions.

2 Funds approved for the project by the Montreal Protocol.

The project was presented and approved in the 26 meeting of the Executive Committee of the Multilateral Fund for the Application of the Montreal Protocol, which it was develop in the Cairo, Egypt, on November 13-15, 1998.

For the execution of the project were approved the following funds:

Table 1. Funds approved for the execution of the project.

Incremental capital cost.	US $ 1 619 950.00
10% of contingency.	US $ 161 695.00
Operational incremental cost.	- US $ 105 321.00
Total project cost.	US $ 1 673 324.00
Cost-Effectiveness	US $ 39.40 / Kg ODP

The total budget was planned in the following aspects:

Table 2. Distribution of the budget planned for the execution of the project.

Budget	US $
Consultant on soilles floating tray system.	8 000
Supplying and transporting structures for greenhouse and micro tunnel.	462 583
Supplying and transporting hardware for greenhouses and micro tunnel.	140 185
Supplying and transporting polyethylene films for greenhouses and micro tunnel.	134 082
Supplying and transporting trays.	620 200
Training in greenhouses erection.	9 000
Training in the soilles system and coordination the activities.	242 900
Sub-total.	1 616 950
Contingency funds.	161 695
Incremental operating costs.	-105 321
Total project cost.	1 673 324

3 Execution of the Cuban commitment to the project implementation.

3.1 Cuban commitment to the project implementation.

On December 21, 1997 the Ministry of Agriculture (MINAGRI) sent two letters to the Technical Office of Ozone of the Ministry of Science Technology and Environment (CITMA), in those were put forward the intention and proposal of carrying out a project of alternative to the use of methyl bromide in tobacco sector, it conditioned the whole support from the MINAGRI to the implementation of the project.

The 28 of August of 1998 the project was presented and approved in the council of GEF in Cuba before their consignment to the Multilateral Fund of the Montreal Protocol.

Once concluded the whole documentation of the project, the government of Cuba through their Ministry for the Foreign Investment and the Economic Collaboration (MINVEC), communicate to the UNDP-UNIDO and to the Multilateral Fund of the Montreal Protocol, the commitments of the Cuban part, which in general are as follow:

- Once concluded successfully the execution of the project, will not be used more methyl bromide in the tobacco cultivation in Cuba.
- That the Cuban part will assume all the necessary activities for the greenhouses installation and micro tunnels. It will be assumed the construction work for the installation of the greenhouses.
- To provide the technical service for the installation and exploitation of the greenhouses, micro tunnels and other equipment's.
- To provide internal transportation of the equipment and material that will be acquired in the project.
- To assume the difference of the operational incremental costs in the form of services and supplies.

After the project was approved, an agreement was established between the UNIDO, the MINVEC and the MINAGRI on February 18th, 1999, in which the following compromises were settled:

- It is understood that all the remaining expenses of the conversion costs to substances not ODP, which are not explicitly covered by the budget of the project, they will have to be assumed by the government of Cuba.
- The government of Cuba represented by the TABACUBA-MINAGRI assumes the following responsibilities:
    a. All the necessary activities for the installation of new greenhouses and micro tunnels.
    b. The construction works of the greenhouses according to the specifications prepared by the contractor suppliers and under their supervision.
    c. Needs of technical services during the installation, commencement and use of the greenhouses and related equipment.
    d. If would be necessary, to guarantee transportation of the bought equipment from the Havana harbour to the places where they will be installed.

e. To provide all the necessary adjustments of legal documents and certificates allowing the total operation of the new floating tray system.

f. Take care of the equipment storage and in the places of the project during the installation.

g. If would be necessary to invest in supplies and / or services until a quantity of US $105 000, which is the resulting quantity of operational savings of the use of the new technology. In this case, the counterpart will have to establish a direct agreement with the contractors and suppliers of the project in order to buy the necessary supplies until the quantity before mentioned.

The TABACUBA as final user agreed that it will provide all that was mentioned above, as well as some non-specified articles in the balance of the supplies contract, which however, can be necessary to the conversion and ulterior operation of the soilles floating tray technology.

During the whole period of execution of the project it has stayed a constant interaction with the UNIDO as implementing agency also TABACUBA, Research Institute of Plant Protection (INISAV), National Centre of Plant Protection (CNSV), Research Institute of Tobacco (IIT), these previous of the MINAGRI, the Technical Office of Ozone of the CITMA and the MINVEC have participated actively in the execution of the commitments.

3.2 Execution of the Cuban commitment to the project implementation.

All the commitments by the Cuban part have been completed successfully, which could be summarize as follow:

The investment expenses and insurance assumed by TABACUBA for the implementation of the project have been around 800 000 US$ and they include the following items:

- Buys of two factories for the industrial production of substrate, civil engineering in facilities for the exploitation of these, laboratories for the quality control of the substrate, technical and material insurance for the exploitation of these.
- Buys of plastics for the reinstatement of coverings and pool of greenhouses, tunnels and micro tunnels.
- Buys of structures of micro tunnels and tunnels.
- Purchase of manual seeders.
- Buys of mechanic pruner for micro tunnels.
- Purchase of tools for the assembling greenhouses and micro tunnels and repair semi-automatic seeders.
- Accessories for semi-automatic seeders (Plate of sow).
- Transportation, storage and distribution of the all project resources.
- Expenses of the assembling greenhouses and micro tunnels and placement semi-automatic seeders.
- Purchase of equipment for the benefit of the seed for their use in the technology (sieve and equipment to determine the density of seed).

4 Objectives of work for the project implementation.

The project had the goal to extend the floating tray technology with organic substrate and use of biological control to all the cover tobacco of Havana and Pinar del Río and the Vegas Finas subject of treatment with methyl bromide in Pinar del Río, located in 7 municipalities (Figure 1 and Table 3).

Figure 1. Tobacco regions of Cuba and covered by the project.

Table 3. Areas proposed to benefit with the floating tray technology with organic substrate in Havana and Pinar del Río.

Province	Area of traditional seedbed (ha)	Area of tobacco plantation (ha)	Consumption of methyl bromide (Tons)
Havana	47.09	950.15	18
Pinar del Río	206.06	3166.35	62
Total	253.15	4116.50	80

The project was conceived to conclude its execution and consequently to reach the total phase out of methyl bromide in the sector of tobacco in a period smaller than 4 years, to reach these objectives, the work was divided in 4 components, according to the aspects that were approached.

4.1 Coordination, organisation and control of the project execution.

To prepare the work plan for the project for a 4 year-old period and to distribute a version in Spanish to those involved in Cuba and to send to UNIDO-Vienna an English version. The work plan included the following thing:

- The work plan of greenhouses and micro tunnels to be builds up and disposed for exploitation every year, the names of the beneficiaries and their localization.

- The work plan of execution of civil engineering requirements (Levelling, establishment, foundation of holes and pools).
- Plan of storage of equipments received by the supplier and their control.
- Delivery work to the places where the greenhouses, micro tunnels and other equipments will be used.
- Delivery plans of seed, substrate, *Trichoderma* and other inputs to the places where they will settle the greenhouses and micro tunnels.
- To elaborate the design of micro tunnels and of pool of greenhouses and micro tunnels.
- Monitoring and coordination of all the activities of the work plan.
- Control of the programme to eliminate the use of methyl bromide in tobacco.

4.2 Transportation, storage and control of equipment and supplies.

- To Coordinate with TABACUBA, the local transportation of the greenhouses, micro tunnels, trays and other equipments and supplies from the port of Havana City or warehouses of the suppliers until warehouses of TABACUBA and beneficiaries.
- To emit certification of each equipment received and to inform it to UNIDO.

4.3 Training on build up and exploitation of the greenhouses and micro tunnels with the soilles floating tray technology.

The program of training had the following activities:

- To Instruct before final of August 1999, with the attendance of an international consultant to a national specialists in the installation of the greenhouses (land plane, build up and fixed of structures, cover with plastic, construction of pool and fixed of the bridge and prune).
- To prepare and to publish a book of training with the purpose of training trainers in the system of soilles floating tray.
- Production of videos with the purpose of training directly the peasants in the technology of floating tray in micro tunnel.
- To prepare, publish and distribute to the peasants a leaflet describing the general aspects of the technology of floating tray in micro tunnel.
- To organize and implement before concluding the year 1999 a workshop of 1 week for 30 trainers or extension workers in the technology of floating tray. (This group will be in charge to train the producers and to offer consultantship in the direct work).
- To organize and to implement 15 workshops of 70 people's training each one, with the objective of training 1000 peasants in the implementation of the technology in micro tunnels.
- To put in operation an extension service with the purpose of giving direct attendance to all the peasants of the Cooperatives of Credits and Services (CCS) and of the Cooperatives of Agricultural Production (CPA), the Basic Units of Production Cooperatives (UBPC), and State Farms (GE), in the implementation of the technology. During this service, each peasant and production unit will be visited at least twice during the first year of setting in march the new technology and survey its execution until have concluded the project.

4.4 Progress reports of the work.

During the whole progress of the project, they would be carried out biannual balances of the march of it, besides the relative reports to the work plan and culmination of the project, according to the established commitments, these should be send in English to the UNIDO. The reports are the following:

- Initial report of work, the one that should contain the whole work plan and it should be emitted 3 months after the signature of the contract.
- Progress reports every 6 months in those will be described the activities developed and the results obtained.
- Final Report that will reflect all the activities related with the culmination of the project.

5 Coordination, organisation and control of the whole work plan activities.

The national coordination of the project was integrated by officials of the organizations and ministries involved and that they are responsible for the analysis of the progression of the work and the formalities among organisms, and specialists of the following institutions conform it:

- Ministry of Foreign Investment and Economic Collaboration (MINVEC).
  - Department of International Organisms (DOEI
  - Enterprise of International Donation (EMED)
- Ministry of Science, Technology and Environment.
  - Technical Office of Ozone (OTOZ)
- Ministry of Agriculture (MINAGRI)
  - Department of International Relationships
  - TABACUBA
  - National Centre of Plant Protection (CNSV)
  - Plant Protection Research Institute (INISAV)
  - Research Institute of Tobacco (IIT)

On the other hand, the technical team of work was integrated by specialists of the INISAV, CNSV, TABACUBA and IIT and it also was integrated it in each province by representatives of the Provincial headquarter of Tobacco and Plant Protection.

In Havana, the enterprise Lázaro Peña, has one specialist in charge at that level and 21 more in each units of production.

In Pinar del Río, the Research Station Tobacco in San Juan y Martínez disposed 3 extension specialist and each tobacco enterprise engage in a project, involved 31 specialists at that level and at the grass root level.

To develop the work, plan the national coordination group and the technical team developed monthly meetings where they settled down and checked the advance of the project's step and designated responsibilities for their execution.

The execution of the project in each place was responsibility of those involved in each case and the national technical team checked it.

They were carried out systematic visits to the 8 tobacco enterprises involved in the execution of the project in those were discussed, analysed and checked the preparations for the introduction of the new technology in the different tobacco campaigns, equally documents were elaborated that were circulated to the competent authorities about the more important aspects to be solve to achieve an appropriate advance of the project.

Equally they were carried out periodic contacts with official of the involved organisms, the UNIDO and the suppliers of the project investment.

Derived of those periodic meetings, they were organized activities related with important subjects such as control of equipment and supplies in warehouses, workshops on important thematic, control method of the project advance and the destination of the resources available.

They were carried out two audits by the CITMA to evaluate the execution of the commitments with the Montreal Protocol, as well were submitted periodic reports to the MINVEC on the execution of the project.

To give execution to the tasks that should be executed during the period of project, annual work plans were elaborated.

The tasks in question appear reflected next which were satisfactorily fulfilled.

5.1 Investment tasks with the funds of the project.

- All the terms of reference related with the contracts carried out by the UNIDO were approved, those included greenhouses and accessories, plastics, conductivity meters, trays of expanded polystyrene, blocks and arches for micro tunnels.
- Official application to the UNIDO for the purchase of new greenhouses and profiles to substitute the bars omega of the existent ones. Additionally the offers for the purchase of these supplies were processed. A periodic communication with AGROTEX was kept about aspects related with the quality of the equipment requested.

5.2 Tasks of TABACUBA.

- Transportation, storage and distribution of all the equipment and supplies so much of the direct investment of the project like of TABACUBA and periodic report on the inventory of parts and pieces of the acquired resources have been emitted.

- Established plan of necessities of manual seeders and arches purchase for micro tunnels.
- Search of offers for the acquisition of manual seeders and supplies for its.
- The substrate supply for the technology has been analysed and solved the relative problems.
- The quality control of the equipments and supplies of the project has been analysed and established methods for it's, among those were included blocks, arches, greenhouses, plastics and trays.
- The execution of delivery plan of micro tunnels, arches, blocks, greenhouses and trays were analysed.
- The distributions to the producers of the project resources during the 4 tobacco campaign were executed efficiently.
- The purchase of 2 factories of substrate production as well as their transportation to San Luis in Pinar del Río and the enterprise Lázaro Peña in Havana were carries out.
- The whole civil work of the factory of San Luis in Pinar del Río as well as operation tests and scale up have been made. In the Havana factory have been worked in the constructive design, perform the civil engineering and assembly of the factory.
- Searches of offers for the purchase of a machine for sow seed pellet was carried out.
- Samples of plastics of different types to reduce the temperature in the greenhouses were acquired.
- The production and delivery of certified seed with more than 90 % germination was guarantee.
- The systems of pesticide spray which include set of sprays and machine were bought and distributed to be use in greenhouses of Pinar del Río and Havana with 15 and 21 modules, respectively.
- The annual supplies of the technology were guaranteed.
- The appropriate quality of the substrate was guarantee and certified by the official analisis given by provincial lab of plant protection.

5.3 Tasks of the tobacco enterprises of Havana and Pinar del Río.

The activities developed in Pinar del Río and Havana by the tobacco enterprises and provincial headquarter of tobacco in a first case to give continuity to the advances of the project included the following aspects.

- Microlocalization of the greenhouses, tunnels and micro tunnels with the aid of the national project team.
- The use of wooden as alternative for the construction of pool of the greenhouses and micro tunnels where they didn't reach the concrete blocks.
- The civil engineering were made in order to levelling the soil surface and assembly of pillars of greenhouses as well as build a place which were use for sowing with semiautomatic seeder machine.
- The maintenance and reparation program of the existent facilities was executed. The 8 tobacco enterprise elaborated the necessities of resources in each campaign as well as the planning of activities to guarantee an appropriate production of transplant.
- Each campaign was made a plan of tasks for adverse conditions due by the occurrence of hurricane.

- The phytosanitary defence program were establish for the floating try technology according to the common noxious organisms in each region.
- The analyses of phytosanitary strategy for the new technology were discus in a meeting.
- Some measures for the conservation and use of *Trichoderma* were taken.
- The calibrations of the spray equipment of pesticides were carried out each campaign.
- An appropriate preparation, storage and disinfection of substrate were guarantee.
- Periodic inspections were carried out about the quality of the substrate production.
- The chronograms of sowing of floating try tobacco were prepared and developed each campaign according to the necessities. .
- Elaboration of the program of assembly new greenhouses and profiles and PVC to the all greenhouses available for the first six month of the 2004 was elaborated and executed.
- During the inter-campaigns were repair the technical travel appears in greenhouses and micro tunnels in Pinar del Río and Havana.
- The water supply for a pool was survey regarding electric conductivity, % of salts and total solids in the existent facilities and in the new ones.
- The proposal of substrate production in Pinar del Río and Havana each campaign were made.
- The semi-automatic seeders machines were putted into operation (Places, improve the technology and the valves system).

5.4 Research develop tasks.

Seed

- Production of seed of high quality for the floating tray system.
- Selection of fields for the seed production for the floating tray technology.
- Establishment of an appropriate program of selection, benefit, disinfection and certification of seed for the floating tray technology.
- Establishment of an appropriate conservation of the seed until their final destination.
- Determination of the technical-economical feasibility of the seed pelletization in Cuba.

Substrate

- Production of substrate of appropriate quality for their use in floating tray technology.
- Monitoring the chemical physical and biological quality of the substrate.
- Search of alternative sources of raw material for the substrate.
- Scale up the new factories of substrate and to standardize the production.
- Use of appropriate containers for the substrate.
- Appropriate storage of the substrate given to the producers.
- Evaluate different alternatives of the substrate sterilization (Dazomet, solarization, stem).
- Establish an appropriate manipulation of the substrate.

Water

- Determination of the electric conductivity and possible contamination of the waters sources to be used in the new technology.

Sowing machines

- Evaluation of different prototypes of manual seeders.
- Adjusts the manual seeder to achieve bigger effectiveness in the sowing.
- Use of automatic seeder of CARISOMBRA for naked seed in trays of 247 cells.
- Optimization of semi-automatic seeder in the two provinces.
- Application and evaluation a new plate of AGROTEX to improve the quality of naked seed sowing with semi-automatic seeder.

Fertilization

- Determination of the effectiveness in the nutrition on tobacco seedling in floating try of the different types of fertilizers registered in Cuba.
- Establishment a document on the management of fertilizer in a new technology.

Management of the technology

- Elaboration of a technological document that contain all the elements of the technology of floating tray.
- Looks for pruning equipment for the micro tunnels, which should be acceptable for the producers.

Phytosanitary activities

- Preparation of the pesticide spray parameters for greenhouses.
- Improve the systems of spray of the new technology.
- Evaluations of different alternative methods for controlling the phytosanitary problems in floating try system.

Others

- Search of viable alternative to reduce the temperatures inside the greenhouse during the hottest months through different cover materials and change in the design of the greenhouse.
- Elaboration of an emergency plan against hurricanes.

5.5 Plant protection tasks.

- The bases for the establishment of a daily monitoring of plant diseases in the floating try technology were created and the program of phytosanitary defence was developed rigorously.
- The special strategy to solve the disease problems in greenhouses was elaborated.

- An appropriate supply of *T. harzianun* was guaranteed, that includes the quantity need, in the appropriate time, with good quality. In order to assure the above the bio factories were advise about production of *T. harzianun* in Pinar del Rio and Havana.
- An analysis of inputs of the technology in chemical and biological pesticides in comparison with the traditional nurseries was made.

5.6 Training tasks.

- The more massive task of the training program it was related with the develop of workshops at the end and beginning of tobacco campaigns at municipal and provincial level.
- Municipal seminars were carried out before the beginning of each tobacco campaigns and at that time were organized the extension work.
- 3 videos on the technology were elaborated, that were showed in all the tobacco enterprises.
- 2 leaflets were elaborated and distributed to all the producers involved in the technology.
- The technical service was characterized by the constant check-up of the extension service and members of the technical team of the project to the units of cooperative production and individual peasants.
- A special attention was dedicated to the phytosanitary activity because in this system phytopathogens fungus development favourably which usually are in the substrate and it requires a careful treatment to avoid the losses in the cultivation.
- The team of the project in charge of the training and the technical service followed the substrate analyses very closely to detect any infestation with anyone of the noxious organisms of the tobacco in the seedbed stage.
- The technical team was added a group of specialists in biological control with which worked together in order to improve the cultivation method for *Trichoderma harzianum* production. This team checked the quality productions of the bio control *T. harzianum* as much in the field as in the bio factory. Also in several cases they were revised the steps of the technological process of the production and modifications and necessary recommendations were introduced to assure the quality of the product elaborated in this centres. On the other hand they were defined some measures in the storage, conservation and application of the bio control that can improve the technical effectiveness of the product.
- The program of phytosanitary defence was analysed for this system and studies with fungicides were carried out in order to improve the control of disease produce by pathogens fungus develop in a substrate.
- International popularisation of the project results was given to a video which was elaborated with the objective to show at national and international level the results reached in the total phase out of methyl bromide in the tobacco cultivation and the success of the approached technology as well as the use of training methods, the participation of the peasants and the women in this purpose.
- A book with the technology of floating tray was elaborated, published and distributed to all the producers.
- A norm of substrate quality for floating try in tobacco was elaborated.
- An instructive on technology of production of naked seeds for sow in floating tray was prepared.

- A training program with special emphasis in monitoring of electric conductivity and other parameters of water, fertilization, sowing and pruning were developed.
- The data picked up in the survey of the tobacco campaigns and the results were processed and analysed.

5.7 Direction and follow up tasks.

- The coordination group of the project discussed periodically with the directors of the involved enterprises, aspects related with the implementation of the project and the solution of the problems.
- Some resources were acquired for the execution of the training work with the funds of the contract INISAV with UNIDO.
- Annually the program of methyl bromide consumption was analyzed with TABACUBA and CNSV.
- Aspects related with the supplies, the quality and the dates of delivery were discussed (AGROTEX, Empresa de Instalaciones Fijas, ESCO-EDESCO).
- During the later year of the project was settled down a system of work with smaller dependence of the coordination team of it, to create the bases of pursuit the achievements of the project once concluded it. Nevertheless the control of advance of the projects was keep rigorously.
- Make an official document of prohibition of the use of the methyl bromide in tobacco was made.
- A rigorous control of the advance of the project was maintained.
- Reports to UNIDO on the march of the project were sent. .
- An application to UNIDO on international expert in substrate production was prepared.
- Two reports were presented to the Managerial Group and the Advisory Technical Council of Tobacco with the objective of giving solution to the main difficulties that were achieved, among those are included the quality of substrate and seed, what served as base for the elaboration and setting up some solutions.

6 Execution of the investment, transportation, storage and assembly of equipment and supplies.

The work plan was implemented for a 4 year-old period:

6.1 Investments carried out by the project.

Since February of 1999 and during the development of the project according to the necessities were carried out a bid process for the selection of offers of greenhouses, pruner, sowing machines, trays, arches, sickles, conductivity meters, technical service and international expert consultantship.

The first stage concerning with the elaboration and reviewing of the reference terms of most of the equipments and supplies was carried out in a very brief time, as well as the selection of suppliers according to the technical analysis carried out by the UNIDO and the staff of the project.

The second stage concerning to the different contracts were carried out by the UNIDO in Vienna, most of them were made in very brief time. The status of these contracts is shown on Table 4.

Table 4. Final status of the project contracts.

Item	Approval of RT	Number of companies bids	Approval date of the contract	Companies selected
Greenhouse, seeder, Prune and bridge.	February 25, 1999	15	May 11, 1999 Extension of the contract in 2001 and 2002	Agrotécnicas Extremeñas S.L. Cáceres, Spain
Expanded polystyrene trays	February 25, 1999	6	May 14, 1999	Empresa de Instalaciones Fijas. Villa Clara, Cuba
Black and Transparent polyethylene	May 6, 1999	18	July 16, 1999	SOLPLAST S.A. Murcia, Spain
Technical services	May 9, 1999	1	May 11, 1999	INISAV, Cuba
Concrete blocks and arches		1	Nov. 2, 1999	ESCO-EDESCON,Cuba
Conductivity meters	October 11, 1999	1	January 6, 2000	WTW, Germany
Sickle	October 11, 1999	1	April 26, 2000	Inmaher, S.L.Spain
Consultantship of expert in substrate		2	April, 2001	Dr. Francis Lemaire,France

6.2 Funds executed of the project.

Seven contracts were executed those are relative to equipment and supplies as well as technical services, besides a relative to technical attendance of an French expert in substrate (Table 5).

Table 5. Funding contracted and executed.

Item	Value of contract US$
Greenhouse, seeder, prune and bridge	706 150
Expanded polystyrene trays	477 000
Black and transparent polyethylene's	139 335
Technical services	251 000
Concrete blocks and arches	46 428
Conductivity meters	12 506
Sickle	6 851

The original contract with Agrotécnicas Extremeñas S.L. was extended two times, while the corresponding to blocks and arches with ESCO-EDESCON, Cuba was reduce.

6.3 Transportation, storage and distribution.

The Company Agrotécnicas Extremeñas, S.A. embarked a total of 17 containers since 1999 up to 2002 with greenhouses and others accessories, these were transported by TABACUBA from the Havana Port to their warehouses, the same ones according to previous agreement with the suppliers were transported directly to the warehouse Malagamba belong of Lázaro Peña in Havana and the remaining ones went to the provincial warehouse of Ovas, Pinar del Río with supplies for the municipalities San Juan y Martínez, San Luis, Pinar del Río and Consolación del Sur.

The plastics were received in 4 containers and they were taken to the central warehouse of TABACUBA in La Salud, Havana.

The expanded polystyrene trays were transported from the warehouses of the supplier in Villa Clara in Empresa Industrial de Instalaciones Fijas until the municipal tobacco enterprises and from there to the production units.

The delivery of concrete blocks stopped after the first delivery because readjustments of the contract, finally EDESCON through ESCO gives a total of 230 000 blocks in the warehouses of this enterprise in Soroa, Pinar del Río.

All the equipment and supplies were registered in the corresponding warehouses being determined that they gathered the requirements agreed in the reference terms and in agreements with the suppliers.

The later distributions of those equipments in Havana were made to production unit in the moment that the assembly team carried out this job. In Pinar del Río from the provincial tobacco warehouse, the equipment were distributed to the warehouses of the municipal tobacco enterprises, those that

proceed to delivery in the same way of Havana. This measure avoids any risk of loss of some component of the structure. The total amount of supplies of the project investment transported and stored are reflected in the table 6.

Table 6. Equipment and supplies of the project transported, stored and distributed by year.

Supplier	Item		Quantity per year				
			1999	2000	2001	2002	Total
Agrotécnicas Extremeñas S.L. Caceres-Spain	Greenhouses and accessories	m^2	9 366	34 314	6 720	3 360	53 760
		Number	11	31	12	8	62
	No. of bridge		9	33	12	8	62
	No. of prunes		6	20	12	8	46
	No. of semi-automatic		3	8			11
SOLPLAST S.A. Murcia- Spain	m^2	Transp. (3.1) m	187 000				187 000
	Plastics	Black (2.2) m	125 000				125 000
	(Wide)	Black (5.6) m	50 000				50 000
Empresa de Instalaciones Fijas.Villa Clara, Cuba	No. of expanded polystyrene trays		106 000	424 000			530 000
ESCO-EDESCON, Havana, Cuba	No. of concrete blocks		67 500	66 996	95 505		230 000
	No. of arches		11 234				11 234
WTW, Germany	No. of conductivity			21			21
Inmaher, S.L.Spain	No. of sickle			5 000			5 000

Besides the previous supplies like support to the project, TABACUBA carries out the transportation, storage and distribution with same procedure that those previous of the following resources designated to the project (Table 7).

Table 7. Equipment and supplies provide by TABACUBA and INISAV, transported, stored and distributed by year.

Item		Quantity per year				
		2000	2001	2002	2003	Total
Substrate factories				2		2
Lab. for quality control of substrate				2		2
Micro tunnels		750	850			1 600
Tunnels 8.5x 52 m		31	9			40
Spray machines and spray system for greenhouses.		21		15		36
Plastics (Wide)	Transp.(3.1m)			94 000		94 000
	Black (2.2) m			63 000		63 000
	Black (5.6) m			55 000		55 000
Manual seeders			100			100
Seed sieve			1			1
Module of tool *			8*		4*	12*
System of pruning with box and nylon cord			50			50
Electrical and gasoline pruner with nylon cord to be use in micro tunnel y tunnel*		4			9*	13
Bicycle with motor to be use for extension service al level of enterprises and plant protection *					18*	18*
Motorcycles to be use for extension service al province level *		3*	2*			5*
Car to be use in investment work*		1*				1*

* Provide with the fund of the contract UNIDO-INISAV.

6.4 Execution of the assembly of greenhouses, tunnels, micro tunnels, sowing system and substrate factories.

6.4.1 Assembly of greenhouses, tunnels and micro tunnels.

The location of the greenhouses, tunnels and micro tunnels responded to have an easy access for the transfer of transplant, flat topography or with slight slope and that the quality of the available water were adjusted to the requirements of tobacco seedling.

6.4.1.1 Assembly of greenhouses.

For the establishment of the greenhouses were carried out the following engineering tasks:

- Selection of the area
- Topographical rising of the place.
- Levelling the soil surface.
- Perforation of holes of 1 m of depth and 0.25 m of diameter.
- Build up the pillars and foundation the holes.
- Build up the metallic structures.
- Placement and tense the plastic cover.
- Placement the curtain.
- Placement the rail of the bridge.
- Placement of concrete blocks buried 5 cm for pool.
- Placement of black polyethylene for pool.

Once they received the greenhouses, they proceeded to the foundation of the pillar, using 150 kg/cm^2 of concrete, which responds to the following composition.

Table 8. Concrete composition for foundation of greenhouse pillars.

Material	% in the mixture	Part	Quantity of concrete
Cement 350	17	1	325 kg.
Washed sand or river sand.	33	2	0.44 m^3
Stone or gravel of 1.6 cm	50	3	0.74 m^3

Each orifice has a volume of 0.049 m^3; therefore the consumption by unit is the following:

Table 9. Materials consumption by orifice.

Material	Quantity
Cement 350	15.93 kg.
Washed sand or river sand.	0.0216 m^3
Stone or gravel of 1.6 cm	0.0363 m^3

Elapsed 7 days after the smelting it were proceeded to the placement of the metallic structure, placement the cover films, rolling walls and rails, alignment of concrete blocks and extends the black polyethylene as pools.

For these assembly operations in each involved tobacco enterprise was formed a brigade, which received training for an expert of the supplier company and permanent consultantship by the technical team of the project, each brigade had the following module tools: Offset wrench, drills with bits of 10-12 mm, pincers to cut wire, switchboard of work with 220 V outlet and several plugs, carrack keys, fixed wrench, flat star wrench, electrical extension of 50 m with 2 plug in the extreme, magnetised levels, flex meters, resistant cord rolls for set plastic cover, screwing machines and soil drill of 25 cm. diameter and 1.20 m. height perforation.

The material consumption for all the greenhouses is detailed next.

Table 10. Materials consumed for foundation of all greenhouses.

Material	Consumption per year (Tons)				
	1999	2000	2001	2003	Total
Cement 350	12.02	40.70	8.62	4.31	65.65
Washed sand or river sand.	16.28	55.30	11.68	5.84	83.26
Stone or gravel of 1.6 cm	27.36	92.80	19.63	9.82	139.79

6.4.1.2 Assembly of micro tunnels.

In Pinar del Río where were located the micro tunnels, the assembly was carry out in two ways, on one hand where the peasants requested that service a municipal brigade assembly these and the other way directly by the peasants.

Each micro tunnel required of the following resources:

- 27.33 m of transparent polyethylene of 3.1 m of wide and 200 galges of thickness.
- 24.65 m of black polyethylene of 2.2 m of wide and 200 galges of thickness.
- 25 Arches.
- 126 blocks of 40 x 10 x 20 cm.
- 152 trays.
- 151 m of nylon cord of 3-4 mm of diameter.
- Wires of tying.
- 2 m of rope of polyethylene of ¼ inches to fix the covering polyethylene in the ends.

The assembly of micro tunnels has the following steps.

Selection of the land for the location of the micro tunnel.

For the selection of the land was consider the following aspects:

- Near the peasant's house.
- In a ventilated place.
- With water supply and flat surface so that the movement of soil was minimum.
- Far from the animals.
- The orientation of the micro tunnel should be north-south or in the direction of the predominant winds.

Levelling the land.

This one was carries out to achieve the best building of the micro tunnel and to avoid differences in the concentration of the nutrients in the water flotation. For a correct levelling it is necessary to guarantee the same height of the water column in all the points of the pool.

An additional complication in Pinar del Río constituted the necessity of the land movement in most of the places selected for the micro tunnels.

Measurement of the micro tunnel.

The measurement consists on taking the exact dimensions of the interior borders of the micro tunnel, to do that, in the centre of the plane surface cross nylon strings tightened 1.4 m of wide and 23.61m of long to a height of 15 cm of the soil level, taking into account that the angles of the corners are of 90° or right angle, for which could help a big square or a measure of 90 cm in the short side, 120 cm in the long side and to make coincide these distances with a side of 150 cm, which is proven in the opposed side.

Placement of blocks or wood.

Once carried out the layout the next step is to place the blocks or wooden, on the taking like reference the tightened cord line and it most place on the outside. The borders of the block or wood were recovered with cloth (Cheese cloth) or another material, to avoid that the block or wood cut the black polyethylene.

Placement of the black polyethylene of the pool.

This is placed in a way that is distributed the surpluses equally to the two sides of the pool, and in the ends it is cut with 15 cm buried in the soil; for their placement it is convenient to fill the pool with water, which allows that this is without wrinkles, and later on the plastic on the external side of the block is fixed with an soil bank.

Placement of arches and of the transparent polyethylene as cover.

Each pool take 25 arches that are distributed equally approximately to 98 cm distance. These they are buried into the soil until the level of the ring.

Placement of nylon rope.

In each arch a nylon rope braided were through the ring in the surface of the soil and turn will be given by each side of the arch; finally it will be tied with a knot that allows to untie it easily.

6.4.2 Assembly of the sowing system.

The 11 semi-automatics seeders required of the establishment of appropriate place for their exploitation where maximum necessity of transplant is needed, those places are the same where several greenhouses were built closely. The main requirements have been reached in these are the following ones:

- Built a small factory where reach and appropriate productive flow and enough space to flow substrate, trays and seeds as input with full and sowed tray as output.
- Storage of small size for trays and substrate.
- Appropriate electric flowing with alternate current for motors of 220 volts.

6.4.3 Assembly of substrate factories.

During the whole period of project, the team work was studying the necessity of industrial production of substrate, because the handmade production do not guarantee adequate quality, what led the purchase of two plants of industrial production which were located in tobacco enterprises of San Luis, Pinar del Rio and San Antonio de los Baños, Havana.

The main module of factories consists on mixtures, crush and sterilize and sack the substrate used in the floating try technology, the production capacity surpasses the current needs of the technology with a daily production of 14 tons.

For its exploitation has been required the next civil engineering work:

- Warehouse for raw material for the substrate.
- Greenhouse to dry with thermal plastic for black peat or sugar cane phlegm to reduce humidity until 20% for their sieve, blend and crush.
- Laboratory for quality control of the substrate.
- Civil engineering to place the main equipment of the factory.
- Storage of substrate.
- Additionally has been carried out studies about productive flow and methods for drying the raw material.

7 Annual inputs of the technology.

Every year the inputs were growing, these were guaranteed by TABACUBA and distributed to the tobacco enterprises, producers and peasants where were executed the project.

The annual consumption is presented in the table 11 that includes as important inputs a maximum supply of 4 200 tons of substrate and 272 million seed, the others inputs are fertilizers and pesticides.

Table 11. Annual inputs of the technology for the exploitation of greenhouses, tunnels and micro tunnels.

Inputs	Annual inputs			
	1999	2000	2001	2002
Substrate (m3)	354.3	2 736	3 600	4 200
Seed (millions)	22.9	176.8	233.0	271.5
Fertilizer complete formulation (Ton)	1.6	12.7	16.3	19.0
Ammonium nitrate (ton)	0.4	3.1	4.1	4.7
Fungicides (kg)	46.9	361.4	476.5	556.0
Trichoderma (kg)	131.8	1017.7	1 339.2	1 562.4
Bio insecticide (kg)	147.0	1135.0	1493.6	1 742.6
Dazomet (kg)	102.8	793.8	1 044.5	1 218.6

8 Localization of greenhouses, tunnels and micro tunnels.

The distribution of greenhouses, tunnels and micro tunnels at the end of the project reach a total of 12 ha for the production of tobacco transplant in soilles system, which is represented by municipality in table 12.

Table 12. Area of greenhouses, tunnels and micro tunnels in exploitation for municipality.

Province	Municipality	Area of greenhouses, tunnels and micro tunnels (m^2)				
		1999	2000	2001	2002	2003
Havana	San Antonio de los Baños	1491.0	20979.0	20139.0	20139.0	20979.0
Pinar del Río	San Juan y Martínez	3111.1	16595.2	28743.5	30275.0	30275.0
	San Luis	2166.1	11705.4	25256.2	29114.0	30374.0
	Pinar del Río	1851.1	7404.2	13142.5	15960.0	16380.0
	Consolación del Sur	1011.1	8811.9	13662.3	17820.0	17820.0
	Viñales	0.0	330.5	661.1	661.1	661.1
	Guane	0.0	95.8	991.6	991.6	991.6
	Minas de Matahambre	0.0	1784.9	2446.0	2772.0	2772.0
Total		9630.4	68106.9	104442.2	117732.7	120252.7

8.1 Localization of greenhouses.

The enterprise Lázaro Peña of Havana received from the project, 25 greenhouses of them 6 single and the rest twin, in Pinar del Río province were distributed among the 4 more important tobacco enterprises a total of 37 units of which 16 are single and the rest twin (Table 13).

Table 13. Greenhouses distributed to production unit.

Municipality	Unit of production	Dimension of greenhouse (m)	Municipality	Unit of production	Dimension of greenhouse (m)
San Antonio de los Baños, Havana	UBA Palo Seco	10,5x60	San Luis	CCS Teherán	21.0x60
		10.5x40			21.0x60
	UBP Simón Bolívar	21,0x40			21.0x60
	Tumbadero	21,0x40			21.0x60
	Tumbadero	21,0x40			21.0x60
	Cdte. Pinares	21,0x40		CPA La Vigia, El Corojo	21,0x40
	Benito Juárez	21,0x40			21.0x60
	Laterita	21,0x46			10.5x 40
	Agustín Suárez	21,0x46			10.5x 40
	Las Mercedes	21,0x46		San Benito	10.5x 40
	F. Herrera	21,0x50			10.5x 40
	Las Marías	21,0x50			10.5x 40
	Primer Partido	21,0x50			10.5x 40
	Briones Montoto	21,0x50		Fabrica sustrato	10.5x40
	La Reserva	21,0x60			10.5x40
	Frank País	21,0x60			10.5x40
	Fundora	21,0x60		Sub-total	16
	Pérez Quintosa	21,0x60	P. del Río	CCS Ovas	21.0x60
	Capitán San Luis	21,0x60			10.5x40
	5 de Septiembre	21,0x60		CPA La Coloma	10.5x50
		10.5x40		Sub-total	3
		10.5x40	C.del Sur	CCS P. Golpe	10.5x50
	Ubaldo Diaz	10.5x50		CCS C. del Sur	10.5x40
		21.0x46		Sub-total	2
		10.5x40	Sub-total Pinar del Rio		37
	Sub-total	25	Total		62

Destroyed by storm and hurricane

Tabla 13a Greenhouses distributed to production unit.(cont)

Municipality	Unit of production	Dimension of greenhouse (m)
San Juan Y Martínez	UBPA Pancho Pérez	21,0x46
		21.0x60
	La Nilda	10.5x50
		21.0x60
		21.0x60
		21.0x60
	Cepellón Est. Exp.	21.0x60
		21.0x60
	UBP11 Monterrey	21.0x60
	UBP6 Mena	21.0x40
		21.0x40
		21.0x60
	CPAB. Rubino	21.0x40
	CPA 10 de Octubre	21.0x40
	CPA J. M. Marquez	10.5x40
	CPA L. Abrantes	10.5x40
	Sub-total	16

The greenhouses were used as they were received from 1999 up to the 2003, the areas in greenhouses growed in 2003, what includes the investment due to the damage of the hurricanes and local storms, in the table 14 are pointed out by municipality the areas of greenhouses under exploitation each year.

Table 14. Areas of greenhouses in exploitation during the period of the project.

Province	Municipality	Area in m^2 of greenhouses				
		1999	2000	2001	2002	2003
Havana	San Antonio de los Baños	1491	20979	20139	20139	21819
Pinar del Río	San Juan y Martínez	3045	11571	15771	15771	15771
	San Luis	2100	8400	10920	10920	12180
	Pinar del Río	1785	1785	1785	1785	2205
	Consolación del Sur	945	945	945	945	945
Total		9366	43680	49560	49560	52920

8.2 Localization of tunnels and micro tunnels.

In the 7 municipalities of Pinar del Río 1 530 micro tunnels were settling progressively in areas of small producers and peasants, additionally 40 tunnels of the pattern Carisombra were built in areas of peasants and in some units of UBPC, all of that is reflected in the table 15.

Table 15. Number of tunnels and micro tunnels in exploitation during the period of execution of the project.

Municipality	Number							
	Micro tunnels					Tunnels		
	1999	2000	2001	2002	2003	2001	2002	2003
San Juan y Martínez	1	152	232	252	252	12	14	14
San Luis	1	100	300	404	404	10	11	11
Pinar del Río	1	170	250	309	309	7	9	9
Consolación del Sur	1	238	259	431	431	2	6	6
Viñales		10	20	20	20	–	–	–
Guane		15	30	30	30	–	–	–
Minas de Matahambre		54	74	84	84	–	–	–
Total	4	739	1265	1530	1530	31	40	40

The total surface of pool for floating try in micro tunnels and tunnels at the end of the project rise to 50 493 m^2 and 17 680 m^2, respectively for a total of 6.8 ha, which is shown in table 16.

Table 16. Area of tunnels and micro tunnels in exploitation during the period of execution of the project.

Municipality	Area in m^2							
	Micro tunnels					Tunnels		
	1999	2000	2001	2002	2003	2001	2002	2003
San Juan y Martínez	66	5024	7669	8316	8316	5304	6188	6188
San Luis	66	3005	9916	13332	13332	4420	4862	4862
Pinar del Río	66	5619	8264	10197	10197	3094	3978	3978
Consolación del Sur	66	7867	11833	14223	14223	884	2652	2652
Viñales		331	661	661	661	–	–	–
Guane		496	992	992	992	–	–	–
Minas de Matahambre		1785	2446	2772	2772	–	–	–
Total	264	24427	41781	50493	50493	13702	17680	17680

9 Exploitation of the floating tray technology.

9.1 Production of transplant.

The total production of transplant at the end of the project rise to 145 million of units, given by the fact of having in exploitation a bigger quantity of facilities, as well as a better manage of the technology (Table 17).

Table 17. Production of transplant per year.

Province	Transplant produced in floating trays (Thousands)			
	1999	2000	2001	2002
Havana	3 949	22 213	31 933	36 169
Pinar del Río	24 184	68 587	109 106	109 242
Total	28 133	90 800	141 039	145 411

Nevertheless with the available facilities it could reach a production of 164 million transplants, it is necessary to highlight the following elements:

- The productivity for tray used as base of calculation in the project was of 95%, what is equal to obtain 251 for tray, however the productivity achieve was 80-85% with 211-224 plants / tray, which represent 5-10 % smaller that the one planned.
- The production in greenhouses was calculates on the base of 1191 plants / m^2, which represent 4.7 trays / m^2 and in practices, according to the pool design, in all the cases they were 4 trays / m^2, since there were necessary the conformation of central corridors and also the lost of space with the blocks of 15 cm of wide (60 cm as a total).
- The effect of local storms and the three hurricanes, one in 2001 and two in 2002 put out of service permanently two greenhouses and damaged the structures of other, therefore the production of transplant was reduce in Pinar del Río during the tobacco campaign in 2002.
- As a consequence of the high temperatures during August and September which are the beginning of the transplant campaign the production of it suffer some looses because the attack of pathogens.

9.2 Traditional seedbed substituted.

The 252.2 ha of traditional seedbed was able to reduce at 88% with the productions of transplant reached with the floating tray soilles technology, in Havana was 100% and in Pinar del Río 85 %, in the later province, this was related with the adverse effects of the two hurricanes that damage the production of transplant in the 2002 campaign. (Table 18).

Table 18. Traditional seedbed substituted.

Province	Areas of traditional seedbed substituted per year (ha)			
	1999	2000	2001	2002
Havana	4.7	26.2	37.9	47.1
Pinar del Río	37.7	106.4	167.4	175.2
Total	42.4	132.6	205.3	222.3

9.3 Open field tobacco area profit by the floating tray technology.

The transplant from the floating try technology was used to plant all the tobacco areas of Havana (950 ha) also those areas, which are under cover crops tobacco and some ''Vegas Finas'' of Pinar del Río (2 691.4 ha). It means a total area of 3 641.6 ha were benefited (Table 19).

Table 19. Areas of open field tobacco benefited.

Province	Areas of open field tobacco benefited (ha) per campaign			
	1999-2000	2000-2001	2001-2002	2002-2003
Havana	95.0	529.4	764.0	950.2
Pinar del Río	577.9	1634.6	2 571.1	2 691.4
Total	672.9	2164.0	3 335.1	3 641.6

All areas were reaches with alternative to the use of methyl bromide, of them 89% with the floating tray technology and the 11% remaining with dazomet, that was used as soil treatment in traditional seedbed (Table 20).

Table 20. Proportion of areas benefited with the floating tray technology.

Province	% of open field areas of tobacco benefited per year.			
	1999-2000	2000-2001	2001-2002	2002-2003
Havana	10.0	55.7	80.4	100.0
Pinar del Río	18.3	51.6	81.2	85.0
Total	16.3	52.6	81.0	88.5

10 Preservation and reparation program of equipment and supplies.

The program of preservation and reparation of equipment and supplies were not foreseen in the plan of work, nevertheless in the pursuit of the project it arose like a necessity to achieve an appropriate exploitation of equipment each tobacco campaign. Every year was carries out this program of all resources available, which always were develop during the inter campaign, the additional investments in plastics and equipments, plate of saw, etc were assumed by TABACUBA, the tobacco enterprises and the individual producers.

The main causes that justify this program are the following:

- Damages caused by adverse climatic conditions among those that strong winds, local storms and hurricanes are included that cause rupture of the plastics, twist of metallic structures and lost of production.
- Normal deterioration of equipment for the use. .
- Break down electric motors and other equipment that require replacement. .
- Necessity of an eradication program of the weed *Cyperus rotundus* that perforates the plastics of the pool.

10.1 The impact of the adverse climate conditions on the equipment and supplies of the project.

10.1.1 Conditions of temperature and appearance of plant diseases.

The tobacco transplant production period of 2001-2002 was characterized by high temperatures from the beginning of the campaign until its end in January, under the conditions of the greenhouses the high temperatures were stable, this led to the appearance of fungus diseases in higher levels than the previous campaigns, the incidence of species of fungus belong to the Pythium genus was observed. That genus develop well in high temperatures and more than 40°C was common inside the greenhouse, this led to have a new phytosanitary problem with the new technology and its negative consequences,

10.1.2 Local storms.

In the tobacco enterprise of Havana different local storms caused substantial lost in greenhouses of the project, the next table describe the damage in each production unit (Table 21).

Table 21. Damage produce by local storms to greenhouses in Havana province.

Production unit	Damage
Benito Juárez	Total destruction of greenhouse of 21 x 40 m.
Cap. San Luis	Destruction of 18 pillars, 9 arches and several curtain tubes of greenhouse of 21
Felipe Herrera	Distortion of pillars and of the pruning system of greenhouse of 21 x 60 m.
Las Mercedes	Rupture of plastic cover of greenhouse of 21 x 46 m
Agustín Suárez	Rupture of plastic cover of greenhouse of 21 x 46 m
Fundora	Rupture of plastic cover of greenhouse of 21 x 60 m
Las Marías	Rupture of plastic cover of greenhouse of 21 x 50 m

Of the previous affectations, the most significant was presented at the beginning of July, 2001 when a twin greenhouse of 21 x 40 m was destroyed in the UBPC Benito Juárez as consequence of a local storm with winds higher than 100 Km / hour for a period of time smaller than 10 minutes. This lost represents the whole production of this UBPC with an area of tobacco of 46.3 ha (Figure 2).

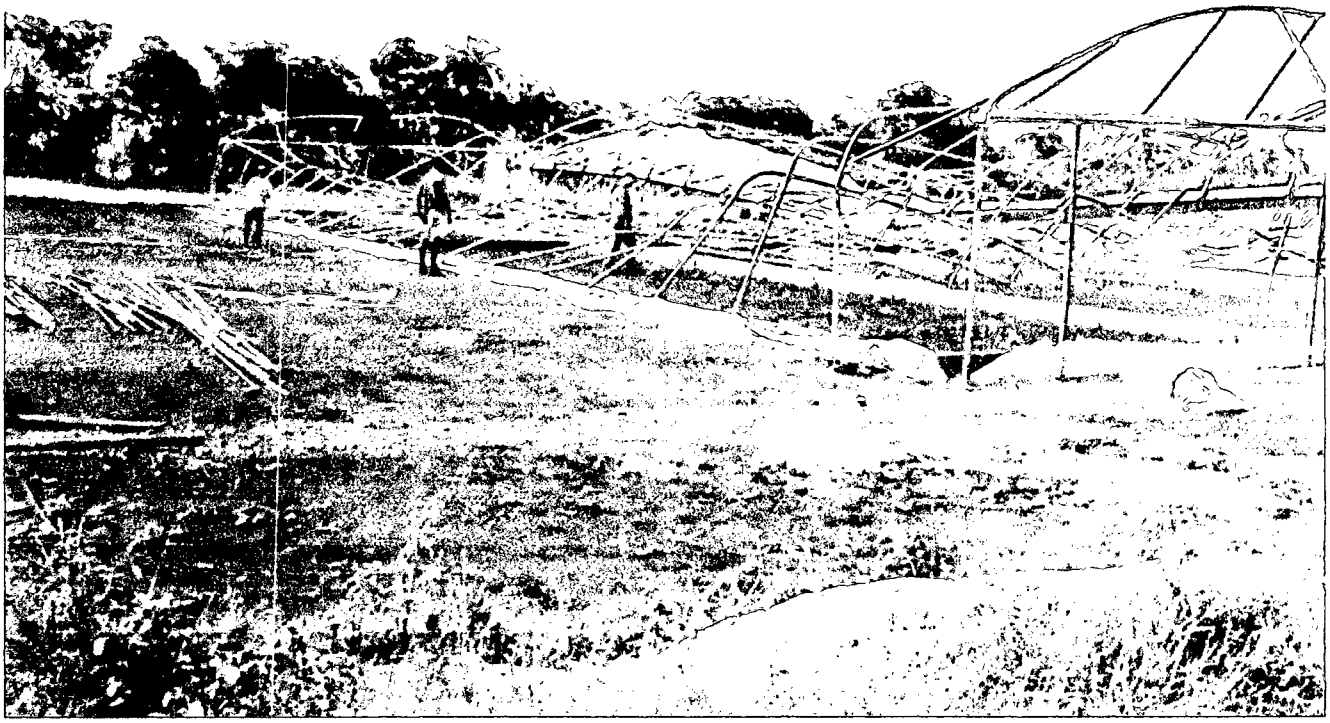


Figure 2. Twin greenhouse of 21 x 40 m destroyed in the enterprise Lázaro Peña of Havana for a local storm on July 4, 2001.

An emergent program for the purchase of the necessary resources for the reinstatement of the previous affectations was carries out in the tobacco enterprise Lázaro Peña of Havana with the objective of repairing the affectations before the beginning of the 2001-2002 campaign.

10.1.3 Impact of Hurricanes

10.1.3.1 Hurricane Michelle.

The hurricane Michelle when passed across the Havana and Pinar del Río provinces led a direct and indirect damages, the first ones as a consequence of the devastating force of its winds with gusts higher than 200 Km / hour, which destroyed metallic structures, plastics of cover and curtains, as well as disable productions of transplant.

On the other hand the negative effects were in the whole preparatory work to avoid bigger damages when break down the structures and consequently smash some plastics. Additionally were necessary the work of it dismounts and assembly again.

The hurricane Michelle caused damages in the facilities of the project in the tobacco enterprise of Havana to a twin greenhouse which was totally destroyed, 2 twin greenhouses had very severe damages with affectations in the metallic structures and polyethylene's, 2 twin greenhouse with severe damages with destruction of polyethylene's of the roof and curtains, and 6 twin greenhouse with slight damages of the polyethylene's. In Pinar del Río destructions of the roof and curtains plastics were evident in 10 greenhouse, of them 8 twin and 2 single. In general the production of transplant was affected by 10 % as a consequence of the hurricane, with losses about 17.4 million of transplant.

10.1.3.2 Hurricanes Isidore and Lily.

Last year (2002) two hurricanes passed across the more important area of tobacco of Pinar del Rio in a term of 10 days, the hurricane Isidore passed on September, 20 and Lily before recovering the devastation of the first one, those events cause serious affectations to the facilities and the production of tobacco transplant.

The main affectations caused by these hurricanes consisted on the destruction of the roof plastics of the greenhouses where were not able to remove on time the same ones and some metallic structures that received the impact of wood and other objects with the force of the winds, all of which bring about substantial injure during the period of maximum production of transplant, the lost were estimated at least in 15% of the production in Pinar del Rio.

10.2 Measures to mitigate the impact of hurricanes.

In a peculiar case of greenhouses, tunnels and micro tunnels are required an specify program of measures according to the advice reports of the civil defence to prevent or mitigate the disasters cause for the abundant and intense rains and for the winds that can reach according to the category of the hurricane which will be of values between 100 and 250 km / hour. The plan of measures has to activate with enough time to protect the plastics of greenhouses, tunnels and micro tunnels, trays and the remaining equipment of the technology.

A question that limited the repid dismounts of the plastic of the structures of greenhouses which were designed so the plastics remain fix to the structure by hold with screws and plastic hose, as a measure to facilitate its dismounts was acquired by the project the system of profile and PVC for all the greenhouses, which is assembling during the first six months of the year 2003.

10.3 Preservation and reparation of equipment.

In the tobacco enterprises of Havana and Pinar del Río provinces were developed tasks related with the reparation of greenhouses, particularly the polyethylene and frontals damaged by the wind, with respect to the semi-automatic seeder machines were designed and built local of work for the same ones, including the supply of electric current 220 volts and the necessary changes for the sowing of naked seed, Several pool of micro tunnels were readjusted the heights and replaced the polyethylene's. Additionally, in Pinar del Río was carried out a program of elimination of *Cyperus rotundus* in the area of the pool of all the facilities.

10.3.1 Havana's programme.

The preservation and reparation of facilities in exploitation in the tobacco enterprise Lázaro Peña of Havana during the inter campaigns included the following aspects:

- Made again some pool of greenhouse
- Put new polyethylene in the roof.
- Repair the greenhouse.
- Remove the corridor in the centre of the twin greenhouse.
- Design and construction a place for the semi-automatic machine.
- Calibration of the pruning system.
- Calibration the system of pesticide spray.
- Conservation of trays.
- Change 4 electric motors of the semi-automatic machine.
- Change the hold of plastics using profile and PVC for all the greenhouses.

10.3.2 Pinar del Río's programme.

The preservation and reparation work plan of greenhouses and semi-automatic machine in exploitation in the tobacco enterprises of Pinar del Río included the following aspects:

- Made again some pool of greenhouse.
- Put new polyethylene of the roof.
- Repair polyethylene of the roof.
- Put available the electric current of 220 volts for semi-automatic machine.
- Clean, preserve and paint semi-automatic machine and improve the naked seed sow with the innovation developed.
- Repair all greenhouses.
- Design and construction of the place of semi-automatic machine.
- Repair perimeter fence.
- Conservation of trays.
- Change 4 electric motors of the semi-automatic machine.
- Change the hold of plastics using profile and PVC for all the greenhouses.

The preservation and reparation of micro tunnels facilities used in the 7 tobacco enterprises of Pinar del Rio included the following aspects:

- Paint of not galvanized arches.
- Reinstatement of some perforated polyethylene of pool.
- Rectification of fixation of arches.
- Cleaning the area inside the fence.

- Rectify the levelling of micro tunnels
- Put or repair perimeter fences to micro tunnels.
- Put the post of fixation of the first arch according to the design.
- Construction of box and nylon pruner.
- Calibration of the pesticide system of spray.
- Conservation of trays.
- Eradication of *Cyperus rotundus* in pool areas.

11 Training and extension service in Pinar del Río and Havana provinces.

11.1 The trainer's selection, trainings to the trainers and workshops to make aware to the tobacco sector.

Since the tobacco campaign 1999 -2000 the activities related with the training began, with a work plan in which the main tasks to guarantee the appropriate development of the project were included.

For the successful development of the phase out of methyl bromide in the sector of the tobacco in Cuba and the diffusion and adoption of the new technology of tobacco transplant production in Pinar del Río and Havana provinces, was necessity to have a qualified people that facilitated the appropriate diffusion of the technology to the tobacco sector. For those was link a team to a project with specialists and researches related with this technology of production, plant protection, nutrition of plant and communication.

Because an appropriate structure of the extension work didn't exist in the in Pinar del Río and Havana provinces, particularly in the tobacco branch involved in the technology change; the first step was to reinforce this activity in the tobacco sector with the collaboration of Plant Protection Research Institute and Research Institute of Tobacco.

For the reinforcement of extension service were kept several important aspects among which stand out the provincial and municipality tobacco structure, the cultural, technical and professional level of the people which will be involve, their knowledge and experiences in the tobacco production, as well as their linking with the farmers and knowledge related with other disciplines. In this sense 30 technicians were selected to develop this activity from the provincial level until the territory or entity (CCS, CPA, UBPC). The number of trainers assigned by province, municipality and cooperative depended from the area of tobacco and of the number of farmers involved in the technology change (Table 22).

Table 22. Trainers selected for the training work in the Pinar del Río and Havana provinces.

Province	Municipality	Numbers of selected trainers
Pinar del Río	San Juan y Martínez	6
	San Luis	6
	Pinar del Río	5
	Consolación del Sur	5
	Minas	2
	Viñales	2
	Guane	2
Havana	San Antonio de los Baños	2

In the campaign 1999-2000 a work of awareness began directed to the directors, officials, technicians, specialists and farmers of the tobacco sector from the national, provincial, municipality, managerial and farmer levels to exchange about all the aspects related with the technology change and the elimination of methyl bromide in the tobacco cultivation. Since beginnings, informal exchanges were developed and later on meet up were planned with the different strata of the tobacco sector.

In this exchange and meeting were offered an information on the advantages and disadvantages of the methyl bromide use, the damages that caused to the layer of ozone and their consequences on the alive beings of the planet, the elimination terms for the developing countries, the advantages of our country of assume it elimination in a short time, the alternatives available and the advantages of the new technology of transplant production in floating trays with organic substrate and biological control. Workshops of sensitisation were programmed in the provincial and municipal level with the farmers in Pinar del Río and Havana provinces, where were used different materials and methods that allowed the farmers to understand the necessity and the importance of the technology change.

In both provinces, the selected trainers and peoples in charge of specify activities received several trainings. Since August 10 up to September 11 of 1999, were carried out a training on the assembly of the greenhouses that included the identification of the parts and pieces, selection of the area, levelling the land, erection of pillars, placement of the metallic structures, location of the polyethylene and other activities, which was made with the attendance of a specialist of Agrotécnicas Extremeñas (Spain), in coordination with the group of training of the project. A total of 20 technicians were trained with the assembly of a greenhouse of 10.5 x 50 m in Antonio de los Baños, Havana province and other similar in the municipality of Juan y Martínez, Pinar del Río province. The training concluded with a workshop in which participated, specialists, technicians and farmers of both enterprises and others involved in the technology change.

In 1999, the 30 trainers received several trainings, the thematic approached were: Storage and distribution of pieces, levelling the land, assembly of greenhouses and micro tunnels, conduction of the floating trays technology, use of the conductivity meters to determine the electric conductivity of the water and the manipulation of the semi-automatic seeder. The first part of the trainings was developed in a theoretical way, where specialists of the team of the project and others of the Tobacco Research Institute and of the Plant Protection Research Institute teach matters related with the new technology to introduce. Later on were carried out practice activities where the 30 trainers of both

provinces participated. In the followings campaigns and before the beginning of each tobacco campaign exchanges of experience were made of the different activities of the technology.

11.2 Elaboration of didactic materials to facilitate the learning of the new technology of production of tobacco transplant.

A book was elaborated with the participation of the team of the project, specialists of the floating trays technology and plant protection in tobacco crop. This book was given to all the trainers, specialists, technician, farmer, producer, official and directors of the tobacco sector in both provinces. The book is composed by seven chapters, as next is described:

"Technology to phase out methyl bromide. Floating trays soilles with organic substrate and biological control to produce tobacco transplant".

1. Introduction.
2. Importance of tobacco cultivation in Cuba.
3. The phase out methyl bromide in seedbeds of tobacco.
4. Traditional seedbed of tobacco.
5. Floating trays soilles with organic substrate and biological control to produce tobacco transplant.
6. The phytosanytary activities to the floating trays soilles technology.
7. The communication in the transference of the technology

In the book is described the importance of tobacco cultivation, the areas where the tobacco is cultivated in Cuba, and the main pest, diseases and weeds that affect the cultivation, as well as the methods used for its control. Also there is detailed the causes of used methyl bromide in Cuba, the methods that are used for their substitution and the necessity of eliminating it due to the damage that causes to the ozone layer and the implications that it derives to the alive beings in the planet. The methods of assembly of the tunnels and micro tunnels are also described, all the related with the substrate, seed, quality of the water, fertilizer, the production technology, the methods of substrate disinfection among them, the use of the dazomet. Another important part is it related with the use of the bio control *Trichoderma spp* for the control of soil borne diseases and the pesticides frequently use in tobacco seedbed. It is included the communication techniques appropriate for the process of the technology transfer of the floating trays with organic substrate and biological control.

The book was given to the trainers, specialists and technicians and it has been considered a valuable element for the constant consultation of the trainers and the specialists, officials and technicians linked to the activity of floating tray in tobacco.

To help the popularisation of the technology two videos were made, the first one contains the whole sequence of the assembly of the tunnels and the micro tunnels, which include the selection of the area, the levelling of land and other steps of it. The second video contains the complete development of the technology of production of transplant of tobacco by means of the floating trays technology. Both videos were finished in March of the 2000 and they were showed since April before the beginning of the campaign for the farmers training.

A third video was made with the experiences and the results achieved by the project during the 1999-2002 period. In this video some interview are included, where the importance of the execution of the project is explained from the point of view of the environmental protection and the responsibility of Cuba like member of the international community. The positive experiences are picked up which were achieved during the development of the project. It is also inserted a new version of the first and second videos that include the description of the assemblies of the tunnels and micro tunnels and the whole steps of the tobacco transplant production through floating trays technology.

In general, these videos have been used extensively for the training of the technicians, specialists and farmers in both provinces and it has been very useful as didactic method in the technology transference because they are very illustrative and those are good to wake up the interest of the farmers involved in this technology. Also these have been used for the extensive popularisation to specialists and linked technicians to the project and others, which have the chance to know the new technology, applied in Cuban tobacco.

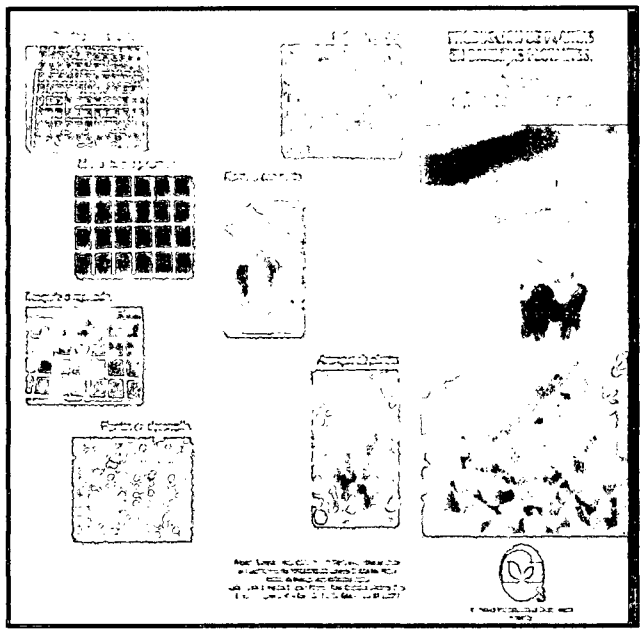
Posters were edited which basic content was related with the harmfulness from the methyl bromide to the layer of ozone and the alive beings in the planet and the necessity of its elimination. Those posters were distributed in tobacco enterprises, centres of the Ministry of Agriculture, related scientific institutions, UBPC, CCS and CPA involved in the elimination of this substance, as well as in areas which location are significant for its visualization and accessibility, that which contributed to maintain present the message of the harmfulness of methyl bromide and its urgent elimination of the tobacco areas in Cuba. In each tobacco campaign they were renewed the posters so that stayed the validity of the necessity and of the commitment of Cuba and the tobacco sector of the elimination of this biocide.

From the beginning of the project some leaflet were elaborated (Figure 3) where the methods for the assembly of the micro tunnels and the floating tray technology are described. These leaflet have been of a lot of utility for the farmers because a graphic sequence is exposed (And its detailed explanation) of the main steps of the micro tunnels assembly and the sequence of the technology, all of that are basic aspects to dominate for the farmers in the adoption of the new technology. The leaflet were made with a clear and direct language, and adequate size so that they were of easy manipulation for the farmers, as well as they were elaborated with a material that allowed a bigger durability, with possibilities of frequent and durable use. To the beginning of each tobacco campaign in the moment of the training, delivery of the leaflet were made always in order to reinforce the best understanding of the new technology.

Other media like the newspaper, the radio and the television were also used so that the information arrives to all the involved individuals and the population in general.

It was verified that the used of mass and individual communication methods allowed to obtain the proposed objectives, the tobacco farmers were plenty informed of the harmfulness of the methyl bromide, the necessity of their elimination in the tobacco sector, and the use of a viable and favourable alternative for the farmers and the environment.

A.



B.

Figure 3. Leaflets on the assembly of micro tunnels (A) and floating tray technology of tobacco transplant production (B).

11.3 Development of workshops, seminars and extension service.

About the training of the farmers in general these began since the 1999-2000 campaign, the workshops was the first activity carried out with the purpose of aware the necessary understanding of the phase out methyl bromide. To carry out this activity were programmed meeting in all the municipalities which farmers grouped according to geographical location and production forms (UBPC of the state farm, CCS and CPA for the individual and cooperative farmers).

In these workshops were used presentations with very illustrative and simple calculation, clear and concrete language was used, which the basic objective was the harmfulness of the methyl bromide, the necessity of its elimination, the available alternatives and the advantages of the floating trays technology since practical, economic and environmental point of view. In this workshops were carried out wide discuss with all the participants, where technological feasibility, economic, risk, practical and also legal aspects were approached. After the debates so much different tendencies of acceptance were observed, scepticism and rejection on the part of some producers, since most of they ignored the new technology although it was already introduced in some regions of the country.

The necessity of beginning of strong training was identified, so much from the theoretical as practical point of view, and it was evidenced, that the adoption of new technology require the develop of several learning forms, which is logical in these cases where many farmer ignored the new technology completely, in spite of its multiple advantages.

After the workshops of awareness were programmed the theoretical seminars for the explanation of the different activities of the technology. These activities were programmed with the cooperation of provincial level, municipality's enterprises, and zone of tobacco production. To program the seminar always were taken into account several aspects: The selection of the place most be near of the

residence of the farmers' (So they were not affected in their mobility and disposition of the time); an accessible place for all the farmers most be available; a date and hour should be select that it do not affected the agricultural works. In the seminar at the beginning an explanation of the technology were made and later a discussion were developed until they were not doubts in this respect.

The second phase of the learning was the days of field, those that were planned after the theoretical workshops; those were programmed and carried out on dates, places and frequencies similar to the theoretical seminars. For these days of field, per each tobacco zone were selected the appropriate farmer (generally leader) and they prepared all the resources in that place to carry out the training. First the designated trainers carried out a theoretical explanation in the place and later on a group of farmer with the trainers carried out the activities foreseen for that day of field (Figure 4). In the practical activities were developed discussion and exchanges of approaches, explanation of doubts, etc. These practices were very effective in the initial understanding of the technology. The practical work in their own property and the consultantship of the extension adviser during the campaign was essential for the success of the adoption of the technology.

Figure 4. Training on the micro tunnel assembly in the small farmer property.

Later on to the theoretical-practical workshops, the assemblies of the tunnels and micro tunnels were developed in the selected territories of both provinces. Those activities were carried out with the participation of the trainers and the farmers of each municipality. These activities were planned with all levels involve in a project. The trainings related with the floating trays technology were carried out in the Research Station of Tobacco located in San Juan y Martínez, in the case of Pinar del Río and with relation to the enterprise Lázaro Peña were carried out in the own areas with the support of the Tobacco Research Institute loacated in San Antonio de los Baños, Havana. In both cases were carried out a theoretical-practical explanation of all the works in the new technology. In general sense the thematic approached in the trainings are related next:

- Selection of area.
- Storage and distribution of pieces.

- Levelling the land.
- Assembly of greenhouses and micro tunnels.
- Preparation and disinfection the substrate.
- Sow with semi automatic and manual seeder machines.
- Establishment and conduction of the floating trays technology and use of biological control.

Before the beginning of each tobacco campaign, from the months of April - May the workshops and seminars began on the technology in all the municipalities of Pinar del Río and in the units of production of the enterprise Lázaro Peña in Havana. In the workshops were also approached aspects on the plant protection of the new technology of transplant production.

The technical team of the project together with the trainers and provincial specialists conformed a multidisciplinary team to give technical attendance to the farmers for the installation of the micro tunnels and greenhouses (Selection of areas, levelling the land and installation of structures, as well as in the operation of the sowing machines, production, handling, disinfection and storage the substrate and in the technology). From the beginning of the first tobacco campaign, they were carried out weekly visits to the areas of the UBPC, CCS and CPA where they settled the greenhouses and micro tunnels to advise the farmers during all the activities involved in the production of plants by the system of floating trays. Also the phytosanitary problems were attended as well as others related with the technology. The visits carried out during every year of execution of the project to the all facilities of the UBPC like the individual farmers, facilitated a continuous and direct contact between the producers and the technicians, which was good to detect the difficulties observed in the productive process on time, to give immediate solution or to carry out urgent investigations and in many cases, with the participation of the farmers (Participative research), that helped to give solution to some of the problems arise in the development of the technology change.

The individual visits were very positive to the farmers for the technical attendance in a more direct way. In many cases were used the leader farmer to carry out exchanges and visits to his areas on the part of the producers relate to this technology, that contributed to wake up the interest of the farmers toward the new productive process. In the table 23 is described the most important training activities developed in the technology change.

In the activities developed it was perceived that the level of formal education of the farmers' favoured the understanding of the tasks. The cultural level of the farmer contributed partly to the successful development of the technology change (70% of the farmers' has the 6to grade, 28% has secondary level and 2% are universitary). All farmer located in small areas, had the support of the family for the development of the work and they live in areas of easy access and communication, 40% of them are producer leaders.

Table 23. Training actions and technical services per municipalities.

Municipality	Seminar	Workshops	Field days	Visits to the production units
San Juan y Martínez	15	4	16	180
Pinar del Río	25	6	21	150
San Luis	27	8	24	250
Minas de Matahambre	4	2	3	51
Viñales	5	2	3	35
Guane	5	2	3	32
Consolación del Sur	17	4	18	186
San Antonio de los Baños	9	5	10	87

Due to the necessity of perfecting some parts of the technology and during the diffusion phase, special workshops were carried out with the participation of specialists, researcher and technicians with the purpose of increase the knowledge and to carry out some indispensable adjustments in some parts of the technological process (Table 24).

Table 24. Workshops on special thematic.

Thematic	Participants
Substrate	Tobacco municipalities' enterprises, officials, trainers, researchers and others interested.
Seed	Seed researchers, trainers and tobacco producers.
Sowing machine	Agrotex, tobacco producers, operators of machines, electrician installers and trainers.

The thematic of pellet seed was subject to a workshop, which was developed with the objective of, motivate the debate on all the basic requirements of the technology and the important role of the seed in this system. The approached topics were the quality of the seed used in the process of peletization, transport and storage of the seed and the relative to the sowing with pellet seed. Also, several questions with regard to the use of the pellet seed were pointed out, among them, the conductivity of the water that affects the germination of the seed; the temperature that is reached under the greenhouses and methods to attenuate their effect. Also there was analysed the requirements that it should gather the seed for their pelletization (Germination tests, thermal gradient of germination and determination of diseases, among others).

With a view to increasing the quality of the substrate, which are produce either in Pinar del Río and Havana, through the project was received the expert's in substrate Dr. Francis Lemaire. In the expert program the following aspects were included: Exchange with the specialists of the project team,

directive of TABACUBA and specialists in charge of substrate production; visits to the sources of supplies of phlegm of sugar cane compacted and black peat and the factories of substrate.

Two workshops were also made and a lecture, about production, quality and used of substrate was offer by Dr. Lemaire. The most outstanding aspects were: To characterize the black peat of Pinar del Rio and compost of phlegm of sugar cane of Havana; the adequate humidity of the substrate in the different processes, size and form of the raw material, to have a substrate with components which contribute to the elasticity and capillarity; to carry out the physical and chemical analyses in different phases of the production process; to establish a laboratory in each substrate factory, to carry out the basic analyses of quality; to adjust the production flow and disinfection.

Starting from the recommendations emitted by Dr. Lemaire a plan of measures was elaborated to eliminate these deficiencies and the elaboration of a norm of substrate production, the creation of the laboratories in the substrate factories, the realization of the necessary physical and chemical analyses to characterize the substrates and the biological tests.

With relationship to the use of conductivity meters, in each municipality were selected the technicians in charge of the water analysis to be used for the production of transplant. The selected technicians participated in three workshops programmed with regard to that subject. These specialists are responsible in each municipality of the analyses to all the sources of water supplies to floating tray technology.

At the end of each tobacco campaign, in all the 7 municipalities of Pinar del Río and San Antonio de los Baños, Havana were carried out workshops in which the reports of each municipality were debated, the successes, the difficulties and their solutions. Those were followed by the provincial workshops where the following aspects were discussed:

- Introduction
- Deficiencies in the technological process and measures taken for its solution.
- Selection and levelling the soil.
- Components and assemblies of the greenhouses.
- Composition and quality of the substrate.
- Construction of the pool and quality of the water.
- Filled of the trays.
- Quality of the seed and the sowing.
- Operation of the sowing machine.
- Fertilization.
- Pruner.
- Transfer of transplant.
- Phytosanitary problems.
- Aspects related with the training and the technical service.
- Conclusions.

These workshops were very valuable to debate the problems and the solutions among all the farmers, directive, technicians, specialists, trainers and members of the project team. The debates were always carried out with the participation of all those involved in this task, so that the agreements were solved in the possible briefer term.

During all the campaigns they were carried out surveys in the different units of production of both provinces, the results of these analyses were debated in the provincial workshops. These surveys were valid to understand some of the difficulties observed in the course of the campaign and the feasible solutions to apply in each case.

Among the aspects that showed the surveys in some places were: Certain deficiencies in the determination of the water conductivity; the use of river water, damp, and others sources of water; the presence of weed surrounded the pool, a bigger use of it semiautomatic seeder that the manual; presence of ants in some regions; the majority employment of the variety "Criollo 98"; the top period of sowing during October and November; frequent plastic of the pool perforated, among other aspects. These results allowed planning the strategies to eliminate these deficiencies in those places were detected.

12 Research and innovation come up of the technological transference.

Different questions arose during the period of technological transference, that using the established norms for the exploitation of the technology of floating tray were not possible to solve. With the experience of the producers in coordination with the technical team of the project, different studies were developed that next are described.

12.1 Greenhouse.

12.1.1 Design of greenhouse's pool.

The greenhouses received by the project it was designed a model of pool. The greenhouses of 10.5 m of wide, will have a central corridor to carry out the operations inside the structure. To both sides it is available a width of 4.51 - 4.75 m for the pool. Due to the great quantity of plants that can be manipulated at once, the pool is divided each 20-25 m according to the longitude in order to separate different production (see figure 5). The dimensions of the pool according to longitude of the greenhouse and the among of trays used are shown in Table 25.

The pool were built with concrete blocks of 40x10x20 cm, the height of 20 cm will be buried in the floor 5 cm, being to a free height of 15 cm for the filling with water and flotation of the tray.

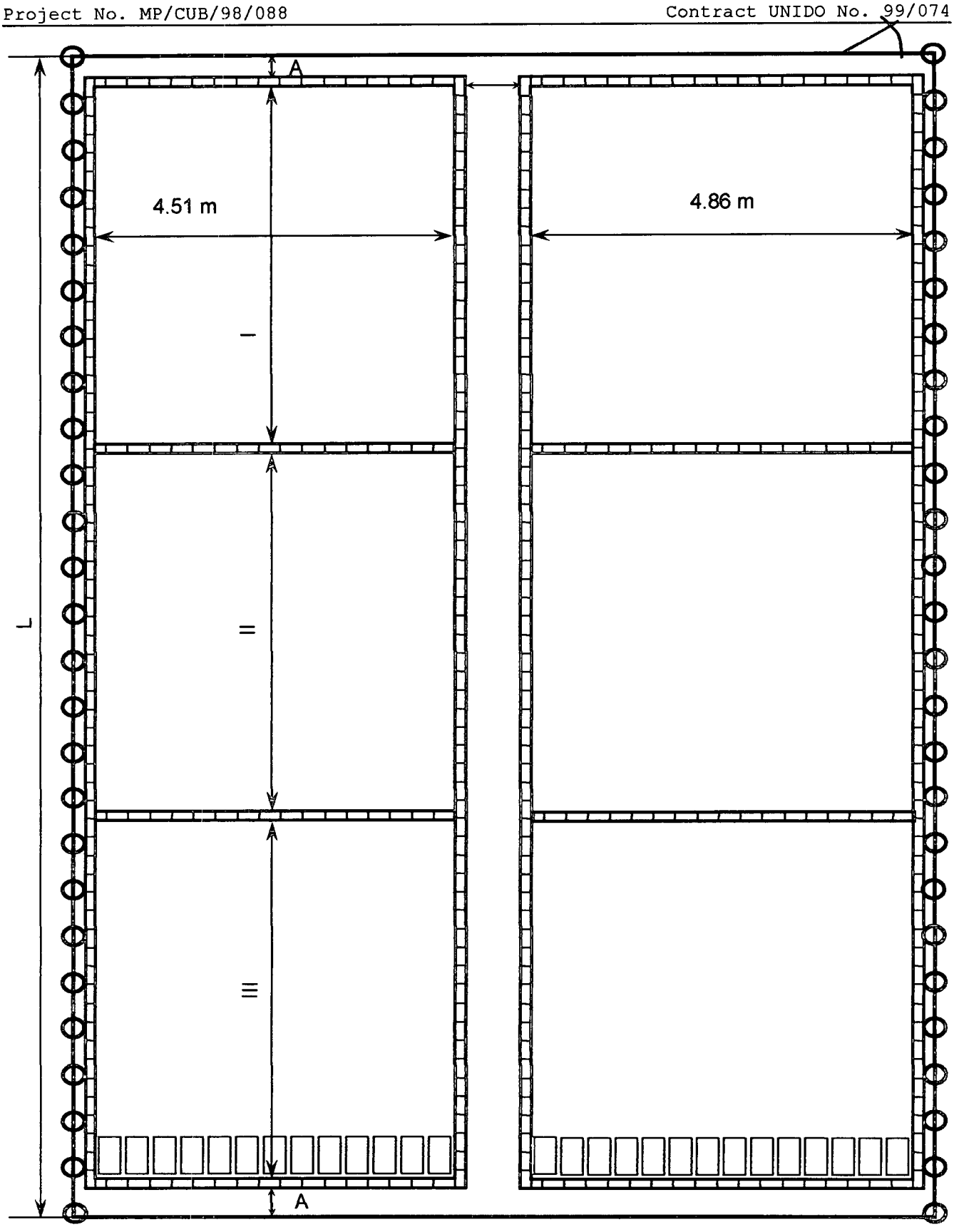


Figure 5. Design of greenhouse pool.

Table 25. Size of the pool and number of trays supported by the greenhouses.

Greenhouse's size (m)	Length of pool (m)			N° of trays along the greenhouse			Capacity of trays	Width of front corridors A (mm)
	(I)	(II)	(III)	(I)	(II)	(III)		
10.5 x 40	19.282	19.282		31	31		1674	568
21.0 x 40	19.282	19.282		31	31		3348	568
21.0 x 46	22.392	21.770		36	35		3834	769
10.5 x 50	24.258	24.258		39	39		2106	592
21.0 x 50	24.258	24.258		39	39		4212	592
10.5 x 60	19.904	19.282	19.282	32	31	31	2538	566
21.0 x 60	19.904	19.282	19.282	32	31	31	5076	566

12.1.2 Change of junction system of roof and curtain plastics.

During the last two years, the facilities of greenhouses suffered different damages due to the inclemencies of the climate for the impossibility of disassembling the plastics of the roof and curtains in a short time, which were strongly subject for an omega metallic bar with hose of PVC and auto-thread's screws.

The previous situation led to the necessity of establishing a mooring system of the polyethylene to the metallic structure with profiles and tapes of PVC, placed to pressure that can be disassembled quickly in case of necessity.

12.1.3 Reduction of temperature inside the greenhouses.

The high temperatures notably reduce the germination of the seeds of tobacco and the growth of the seedling in the floating tray technology. The responses of these to the temperatures are shown in table 26.

Under the normal conditions of the climate of Cuba, the temperatures to the beginning of the seedbed campaigns are superior to the optimum needs for the germination and the development of the tobacco seedling (Figures 6). Besides the temperatures, the heating is added during the day inside the greenhouses by the high radiations that are superior to 40 °C, during the months of August and September.

Table 26. Effect of the temperatures on the germination and development of the tobacco seedling in floating tray technology.

Stage of growth	Temperature in °C		
	Minimum	Optimal	Maximum
Germination	11	16-29	34
Initial growth	18	21-24	32
Development stage	18	21-24	35
Yellowing			40
Death			50

Due to these problems of high temperatures inside the greenhouses caused by the covering of plastic with 800 galges, different alternatives were evaluated to reduce temperatures and they are:

- Addition of zenithal ventilation each 10 m in the new structures received.
- Substitution of the frontals plastic by a net, allowing more circulation of air.
- Put an additional roof to the height of the pillars with different materials, reducing the penetration of the heat (Aluminet or cheesecloth).

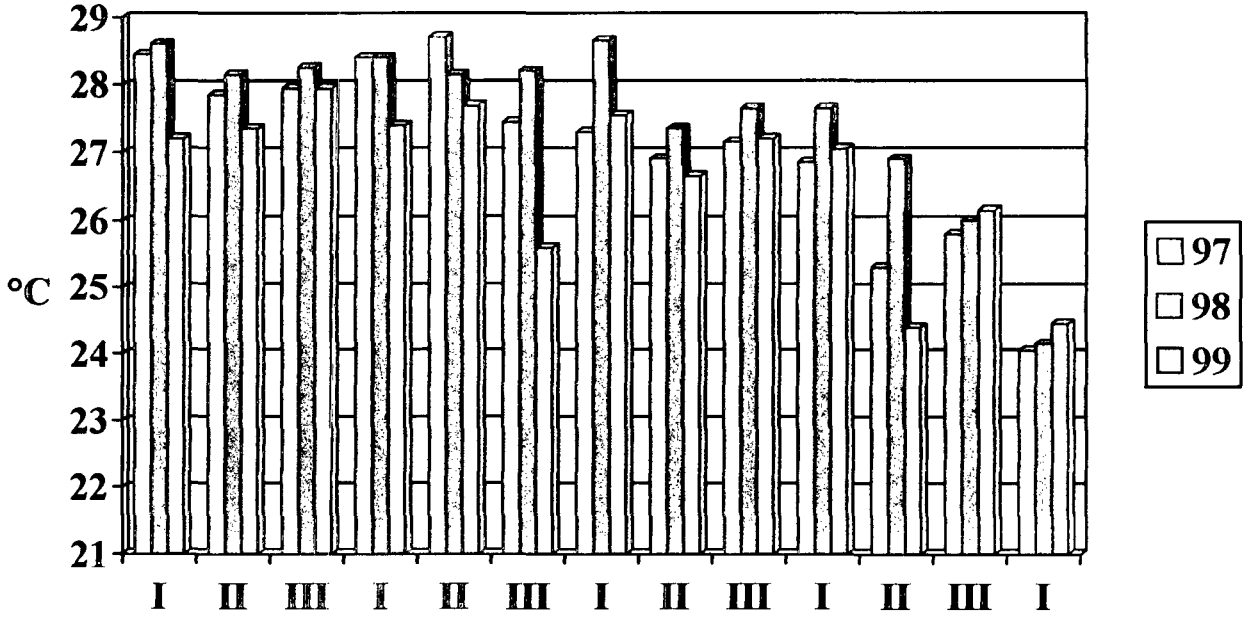


Figure 6. Tenth days average temperature in Pinar del Rio and Havana from July 1 up to November 10.

12.2 Micro tunnel.

Design of micro tunnel.

The micro tunnel has a real dimensions of 23.61 m long, 1.8 m wide and 1.0 m height. It is conformed by arches of 1.8 m wide with a height over the surface of 1.0 m and 25 cm buried at the ends. The dimensions of the arch are shown in figure 7.

The design of the micro tunnel includes the alignment of the arches each 1 m until a total of 25, secured in the soil and additionally bundles in the top of the structure.

The plastic of 3.1 m of wide is held in each arch by a nylon rope and in the ends with a knot tied to a stake. The dimensions of the micro tunnel are seen in figure 8.

The pool has an internal width of 1.4 m conformed by blocks 40x10x20 cm., the side of 20 cm of height of which 5 cm is buried, remaining 15 cm for the water and flotation of the tray.

The supplier of plastics sent the same ones, in rolls of black plastic of 2.2 m wide and 112 m long and transparent roll of 3,1 m wide and 82 m long. A roll of black plastic covers 4,5 micro tunnels and one transparent 3 units.

Total longitude: 352.744 cm.

Buried direct section: 25 cm.

Width of the arch: 180 cm.

Radius of the arch: 90 cm.

Diameter of the arch: 8mm.

Air direct section: 10 cm.

Diameter of the ring: 5 cm.

Length of the arch: 282.744 cm.

Angle of the arch: 180°

Material: Galvanized steel

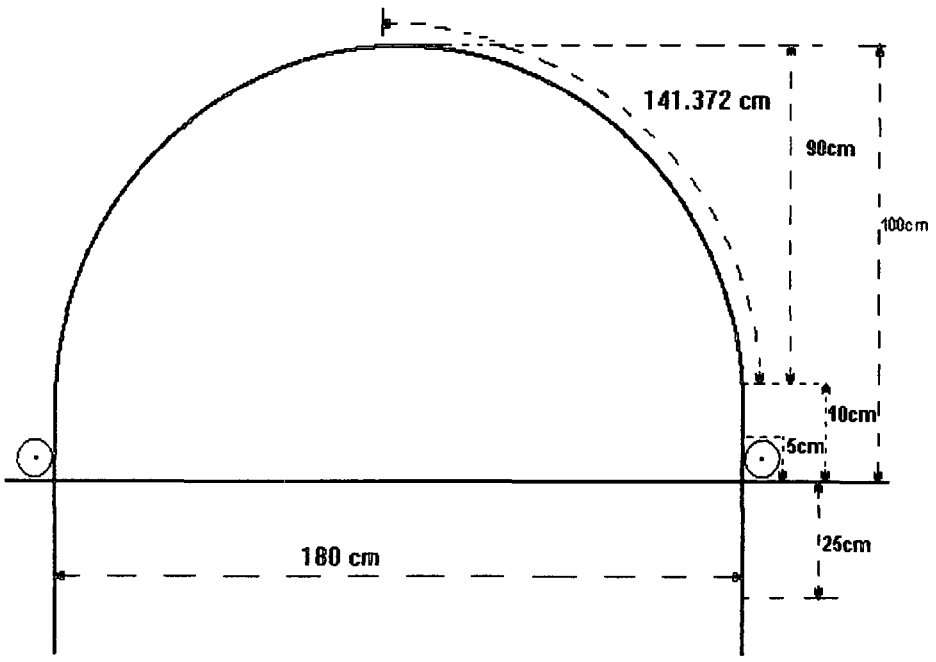
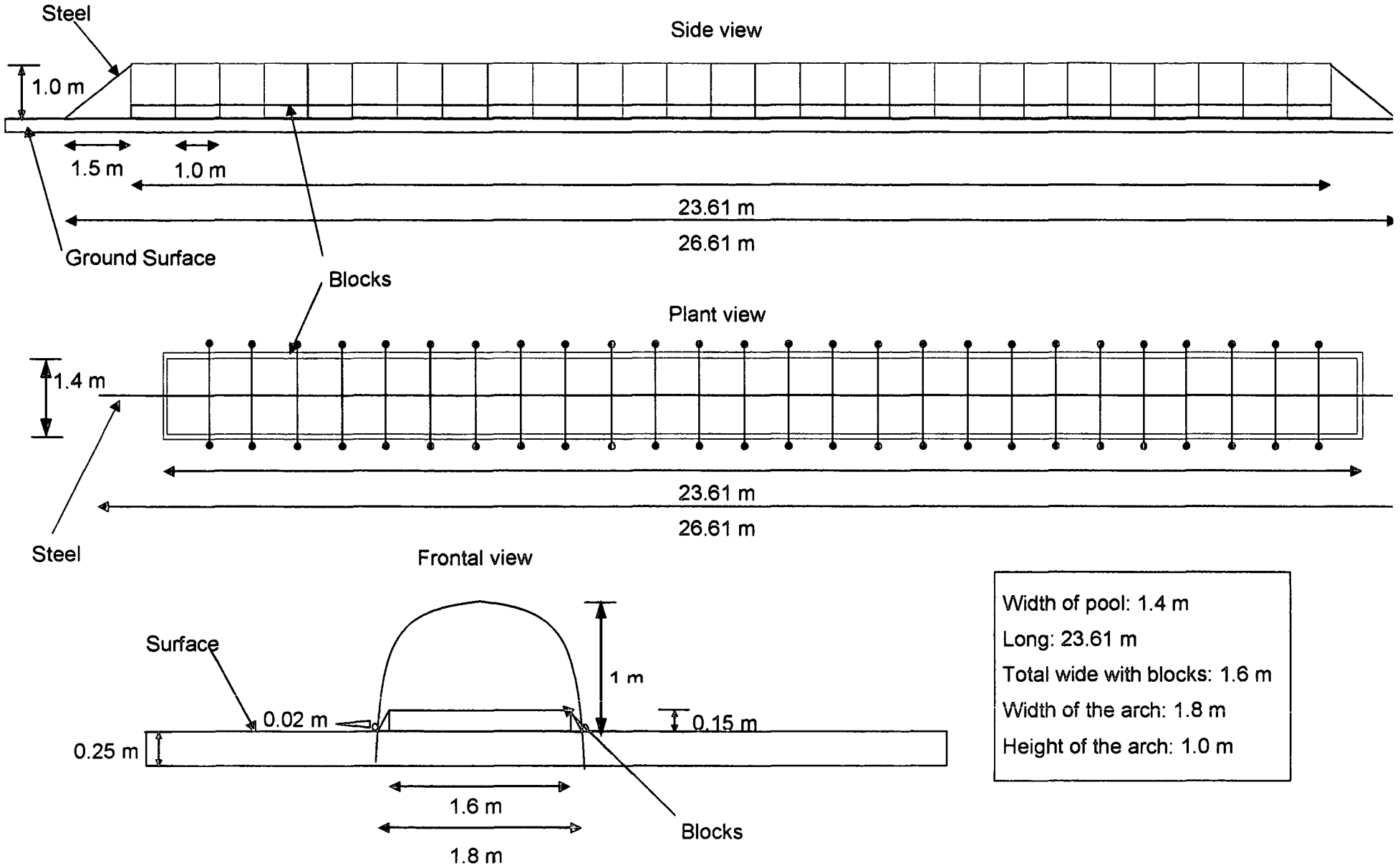


Figure 7. Arch of micro tunnel for floating trays in tobacco.

Figure 8. Design of micro tunnel for Pinar del Río.



Width of pool: 1.4 m
Long: 23.61 m
Total wide with blocks: 1.6 m
Width of the arch: 1.8 m
Height of the arch: 1.0 m

12.3 Water.

The quality of the supply water for the pool of the floating tray technology has been monitoring during the whole course of the project. This monitoring has been focused to the appropriate use of supply sources that have an acceptable level of electric conductivity, content of total solids and salinity, also to assure the minimum contamination with pathogen organisms of the tobacco.

12.3.1 Monitoring of the electric conductivity of water.

With the facilities that it offered the use of the conductivity meter model WTW LF-340, the measurations of conductivity, salinity and dissolved solids of the supply water have been monitoring in the source and once established the floating tray technology. This later one allows to know the levels of dissolved fertilizers in water and available for the plant.

Table 27. The chemical characteristics of the water used in Pinar del Río.

pH	C.E.	NH_4 mg/l	NO_3 mg/l	P mg/l	Ca mg/l	Mg mg/l	K mg/l	HCO_3 mg/l	Na mg/l
8.0	600	4	80	0	49	56	0.45	247	10

12.3.2 Monitoring of plant pathogens in water to be supply for floating try technology in Pinar del Río and Havana provinces.

The Provincial Laboratory of Plant Protection of Pinar del Río and the INISAV have been analysing in all campaigns the presence of phytophatogens in the supply water of the pool. It has been determined that all the supply sources (Damp or reservoirs, rivers and wells in Pinar del Río) have presence of ***Phytophthora nicotianae***, ***Pythium aphanidermatum*** (Edson) Fitzp ***Rhizoctonia solani***, ***Fusarium sp*** and other pathogen of the tobacco. This requires of a previous disinfection before depositing the tray in the pool of the greenhouse or micro tunnel. Different substances have been evaluated with fungicidal action, such as the copper sulphate and hypochlorite of sodium without showing adverse effects about the germination of the seed and the growth of the plant of tobacco.

12.4 Seed.

As a consequence of the massive use of the naked seed of tobacco in the technology of floating tray, became essential to change some technological aspects in the system of seed production. These, include the gathering of the capsules for the system of regulated inflorescence, to make the controlled drying of the seeds, to carry out the one thrashed with rubber rollers, to make the cleaning and selection with the adapted sieve system, to pass the seed by a density meter table to discard the less heavy ones, to make an appropriate storage and conservation of these and finally before the sowing to submerge the seeds in water.

To carry out these activities TABACUBA has developed a program of investments putting to disposition new equipment including seed sieve and density meter table.

12.5 Substrate.

12.5.1 Quality of the substrate.

In the success of the production of tobacco transplant for the floating trays technology several factors have played an important role. The substrate is one from the main elements to be considered.

In the process of massive use of the floating tray technology for the production of tobacco transplant, it has been specified that one of the questions that should be standardized is the quality of the substrate to be used.

The substrate for their use in the floating tray technology should gather the following requirements:

- High availability, the most standardize possible and the cost is compatible with the economy of the cultivation.
- Functional condition such as high porosity (more than 70%), low apparent density, relationship air / water satisfactory for the cultivation, physical, chemistry and biological stability, appropriate pH, low salinity and free of weeds, pathogens, pest and alelochemicals, as well as low fertility and of cationic exchange capacity.

The French expert's consultantship Dr. Francis Lemaire visited the project from the 7 up to 21 of May, 2001 determined that the bad quality of the substrate in Pinar del Río and Havana were due to the following causes:

- Excess of humidity in the sifted process forming conglomerate of particles with a size of 2 cm or higher.
- The use of zeolite without sifting in Havana causes the formation of a powder cover around the particles increasing the hydrophobic characteristic of the substrate.
- The lack of appropriate humidity in the substrate doesn't allow in a brief time to arrive a good humidity of it in a tray.

At the moment, the mixtures of substrate considered satisfactory to produce transplant of tobacco under the conditions of Cuba in occasions fail. This is due to problems of lack of humidity of the substrate deposited in the tray or because it is not possible to fill all the volume of the cell with the substrate. The substrate has been using without an appropriate control of the % of humidity and acceptable size of particles, which is in opposition with the fact that reducing the volume of the alveolus in the tray, the technology should be executed with more rigor.

The substrate, in a great number of cases, is deposited in the tray through the mechanism of the semiautomatic sowing machines, which implies that if the substrate is not of the best quality the filled is incorrect and consequently the problems before mentioned take place.

The importance of normalizing the characteristics of the substrate avoids the risks given by the use of a material with a big size of particles, different to the dimensions of the alveolus. For such a reason a norm was elaborated that contains the following aspects.

Title: Norms of quality of the substrate used in the technology of tobacco transplant in floating tray technology.

- Introduction.
- Physical, chemical and biological properties of the substrate for their use in floating tray technology.
- Different raw materials approved for their use in the technology of floating tray and their characteristics.
- Composition of approved substrate and condition of blended.
- The analysis methods and equipment to use for the determination of the physical, chemical and biological properties of the substrate and raw material.
    - Sampling method.
    - Analytic techniques.
        - Determination of physical properties.
        - Determination of chemical properties.
        - Determination of biological properties (Nematodes, pathogens and weeds).
        - Determination of alelochemicals residue.
    - Analysis module to carry out at the factory conditions and provincial laboratory.
- Approved methods of substrate disinfection.
    - Dazomet use.
    - Solarization.
    - Steam.
- Packed and labeled.
- Manipulation.
    - Transportation.
    - Storage.

This norm offers to those producing of substrate, to the technicians in charge of the production of transplants, to the phytosanitaries and the provincial and national instance of the TABACUBA a tool that assure the use of stable substrate with the appropriate quality.

In Cuba it has been evaluated with satisfactory results the use of black peat of San Luis (Figures 9A), compost of sugar cane phlegm of (Figures 9B), zeolite and husk of rice as raw materials mixed in different proportions.

Each raw material contributes to the different properties of the substrate, the black peat and the compost of sugar cane phlegm retain the humidity, the husk of rice retains air and the zeolite helps to moisturize.

Table 28. Chemical analysis of the black peat.

pH	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cl (%)	OM (%)
4	0.46	0.19	0.07	0.14	0.01	0.09	23.6

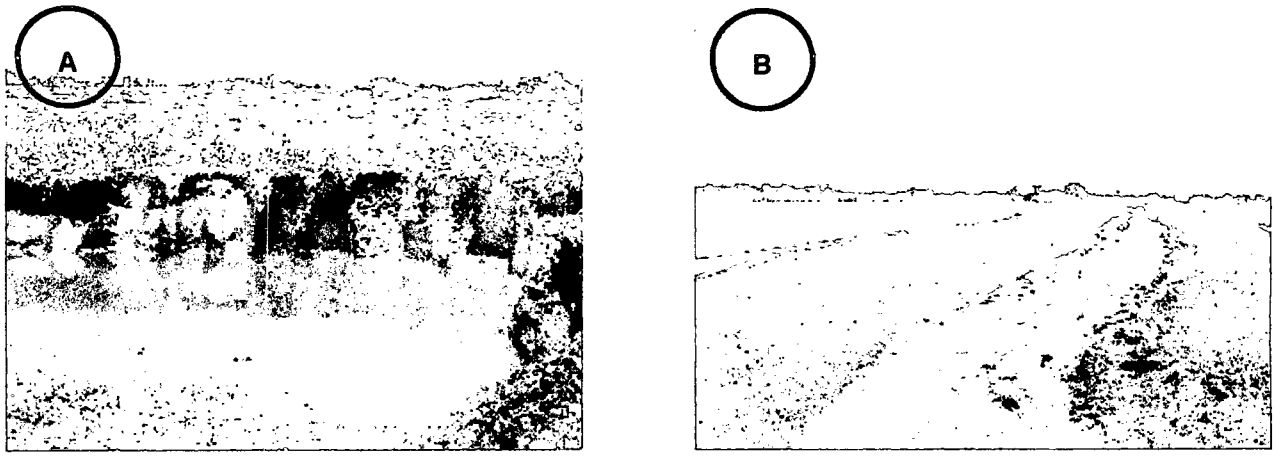


Figure 9. Black peat of San Luis (A) and phlegm of sugar cane composted in the sugar cane factory Héctor Molina, Quivican (B) as raw material for the preparation of substrate.

An appropriate substrate for the germination of the seed and growth of the seedling of tobacco should have the following characteristic:

pH (water)	5,5-6,5
Electric conductivity mS/cm	0,5-2
Capacity of cationic exchange meq/l	10 at 100
Dry density (dry weight / volume)	0.3
Humid density	0.6
Total porosity (% of volume)	>88%
Porosity of air to the pF1 (% of volume)	20-30
Capacity of retention of water to pF1 (% of volume)	55-70
Easily available water (pF1 - pF2) (% of volume)	20-30
Pathogens and viable seeds of weed	None
Toxic substances (Natural or introduced)	Total absence

12.5.1.1 Increase pH level of the substrate.

One of the aspects that required supervision is the pH of the substrate. It was carried out the following tests to increase the same.

It was carried out a first test to determine the dose of limed required by the substrate using powder of limestone from Havana. The results showed that between 5 and 7.5 g / l the pH rises at the levels recommended in tobacco 5.5 and 6.5 (Figure 10).

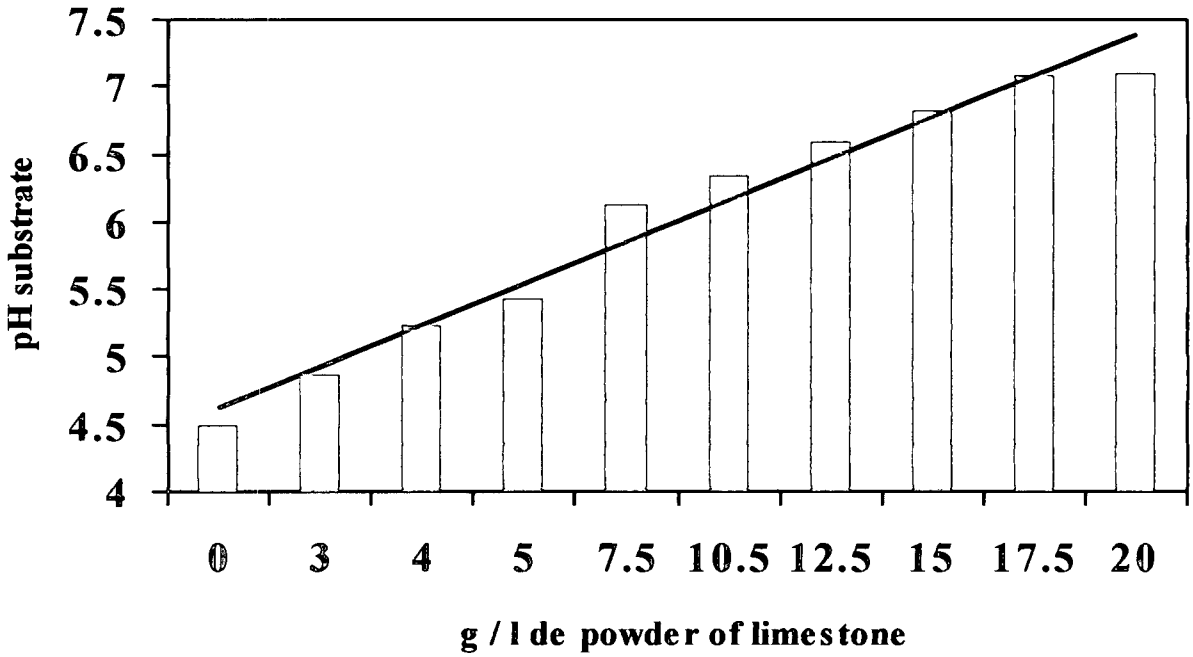
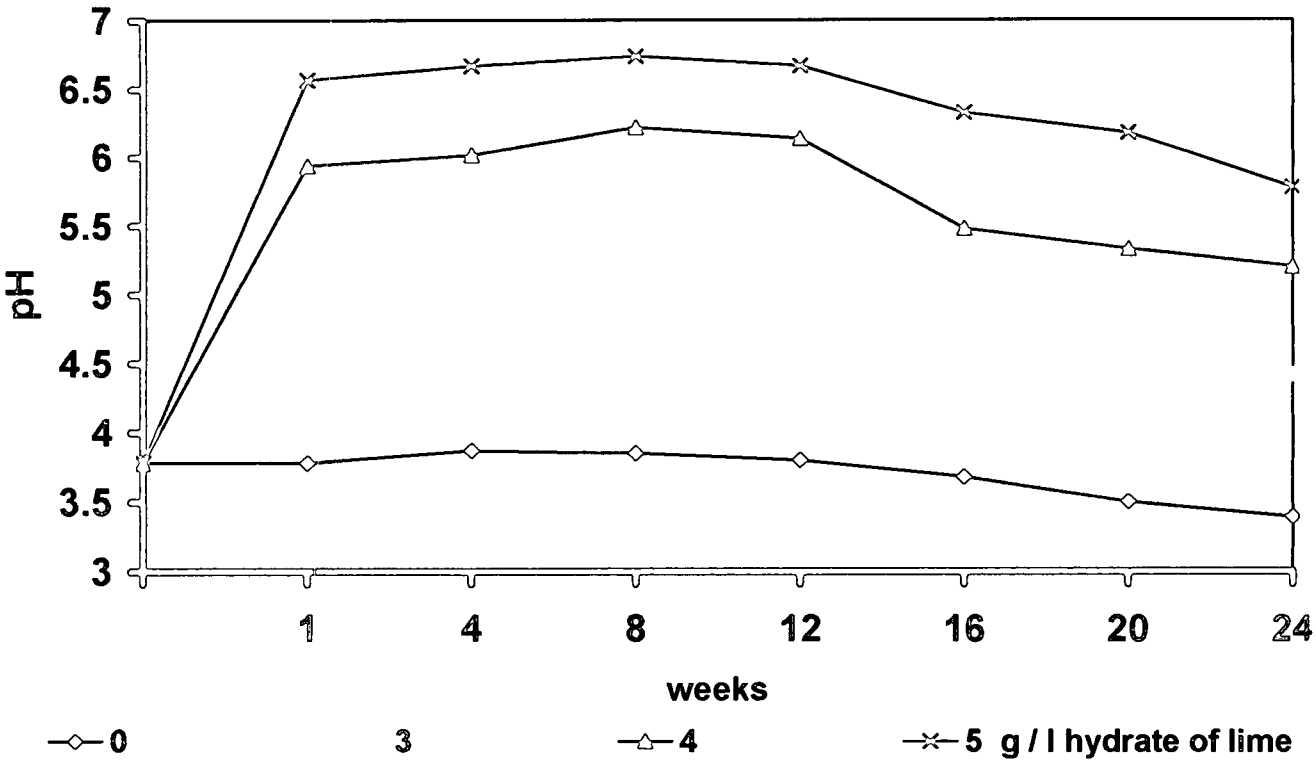


Figure 10. Effect of the limed with powder of limestone on the pH of black peat + husk of rice + zeolite.

The other tests consisted on using two samples of the substrate that was elaborated in the plant of the tobacco enterprise Lázaro Peña, in San Antonio de los Baños, Havana, based on black peat 70% + husk of rice 25% + zeolita 5% and as limed material hydrate of lime and limestone in dose of 3, 4 and 5g / l of substrate, to determine the pH in KCl systematically according to the potentiometer method.

The limed action of the hydrate of lime was bigger and quicker than the limestone powder. The pH of the substrate increased with the increments in the doses of the materials, the most appropriate dose is 4 g / l of hydrate of lime that since the first week and during for a long period of time remains the pH in the appropriate levels for the seedling of tobacco. Before applying a new limed material it should be carried out a preliminary study on their behavior in the material that wants to change (Figure 11).



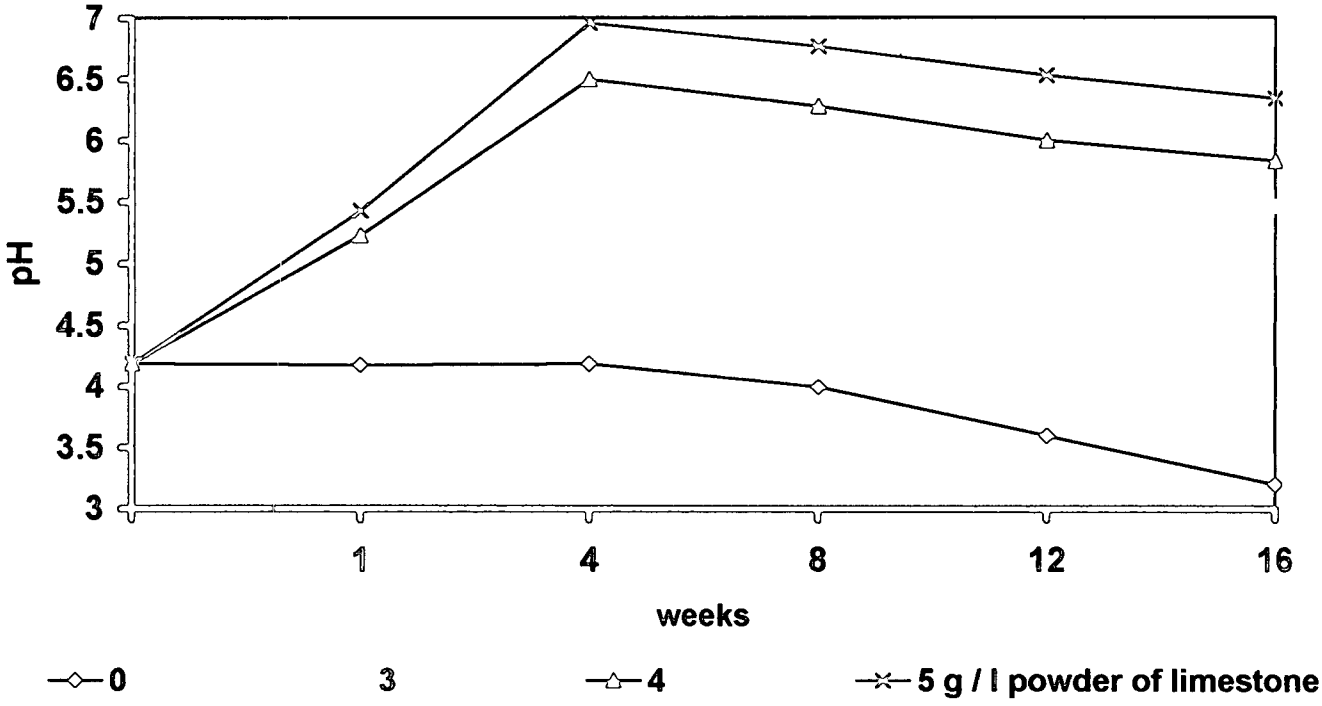


Figure 11. Effect of levels of limed on the pH of the substrate.

12.5.2 Selection of mixtures of black peat as substrate.

12.5.2.1 Physical characteristics of the substrates studied.

In the Figure 12 the grain size is observed in the different studied mixtures expressed by the percentage of distribution of particles. The mixtures of black peat + husk of rice in the proportions of 80% + 20% and 70% + 30% presented the biggest percentages in the range from 5 to 2 mm with closer values to 50%. These mixtures, also obtained near 25% of their particles in the range from 2 to 1 mm.

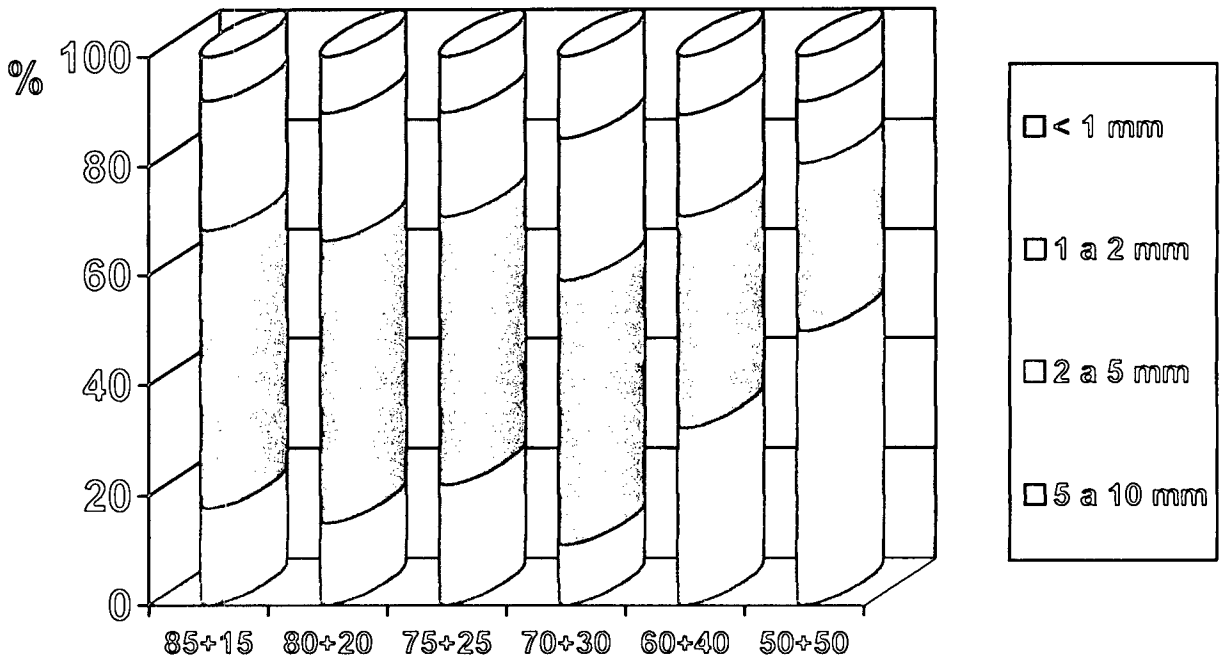


Figure 12.Distribution of the percentage of particles size in different mixtures of black peat + husk of rice.

The mixtures of 60% + 40% and 50% + 50% presented the biggest percentages of the particles in the range from 10 to 5 mm, the increment of the proportions of husk of rice in the mixtures increased the percentages of these particles substantially. This could be related with the percentages of germination of the seeds.

The mixtures with less than 25% of husk of rice obtained near 25% of their particles in the range from 1 to 2 mm.

These results influence decisively in the apparent density and the porosity of the mixtures.

In the Table 29, the behavior of different physical characteristics were observed in the mixtures studied. The percentages of humidity and the apparent density were diminishing as the percentages of husk of rice were increased, in an inverse way the porosity.

Table 29. Physical characteristics of the mixtures studied.

Variants	Humidity %	Apparent density g / cm^3	Porosity %
85% black peat + 15% husk of rice	15.86	0.380	87.65
80% black peat + 20% husk of rice	15.35	0.380	87.65
75% black peat + 25% husk of rice	15.20	0.379	88.86
70% black peat + 30% husk of rice	15.10	0.370	89.14
60% black peat + 40% husk of rice	14.30	0.315	91.67
50% black peat + 50% husk of rice	11.28	0.260	91.92

The apparent density of the mixtures of 80% + 20% and 70% + 30% have values of 0.380 and 0.370 g / cm^3 which are adequated for the tobacco in floating trays.

The porosity in the mixtures of 80% + 20% and 70% + 30% behaved in the range of 87 - 89% and in the rest of the variants were superior to 91.6%.

12.5.2.2 Chemical characteristics of the substrates studied.

In table 30, the chemical characteristics of the mixtures are observed, take into account that the husk of rice doesn't contribute chemical elements to the substrate and yes physical, it was carried out a process of reduction of the chemical elements analysed in function of the decrease of percent of the black peat in the mixtures.

Table 30. Chemical characteristics of the mixtures studied.

Variants	pH	O. M.%	N %	P %	K %	Ca.%	Mg. %	Cl %
100% black peat	4	23.60	0.46	0.20	0.070	0.140	0.010	0.090
80% black peat* + 20% husk of rice	5.5-6.5	18.88	0.37	0.15	0.048	0.112	0.008	0.072
70% black peat* + 30% husk of rice	5.5-6.5	16.52	0.32	0.13	0.049	0.098	0.007	0.063
60% black peat* + 40% husk of rice	5.5-6.5	14.16	0.28	0.11	0.042	0.084	0.006	0.054
50% black peat* + 50% husk of rice	5.5-6.5	11.80	0.23	0.09	0.035	0.070	0.005	0.045

* pH of the black peat in the mixtures was corrected with hydrate of lime to reason of 5 g / l

The content of organic matter in the black peat was of 23.60% and it was diminishing, as the rest of the elements, in the same proportion that the husk of rice was increased. The nitrogen, fundamental element in the growth of the plants presented values of 0.46% in the black peat, this value is relatively high. The rest of the presented chemical elements are within the appropriate ranges.

12.5.2.3 Effect of different substrates on the germination of the tobacco seed.

The effect of the mixtures of black peat and husk of rice in the germination of the seeds is show in figure 13, it bears to a substantial increment of the germination in the variants with less than 30% of husk of rice.

In the mixtures where the proportions of husk of rice are increased above 30%, only values smaller than 60% were reached of seeds germinated by trays.

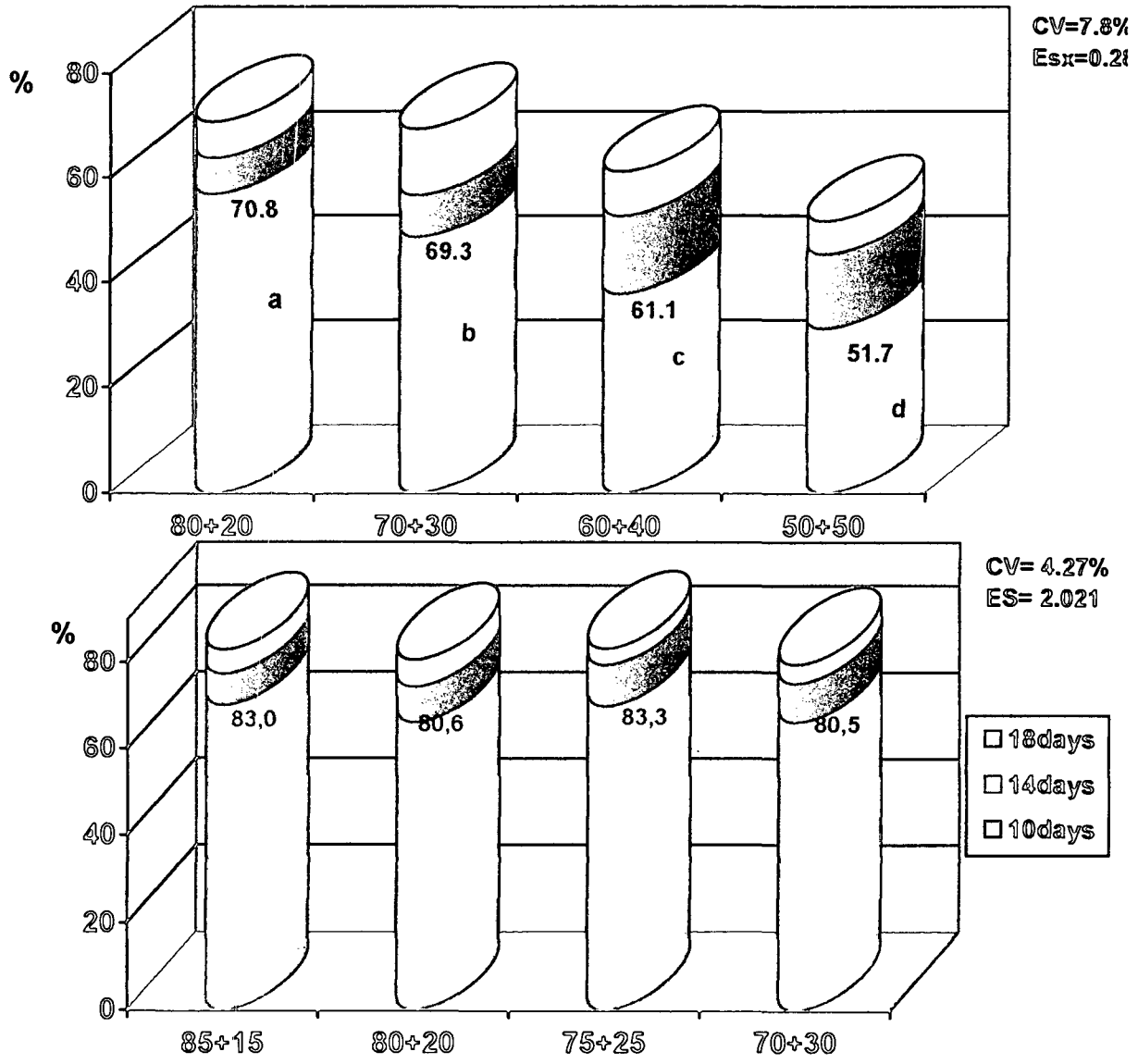


Figure 13.Germination of seeds in two experiments with different mixtures of black peat and husk of rice.

12.5.2.4 Results of the mixtures studied in some biological parameters of tobacco seedling.

In Table 31, the influence of the different mixtures is shown in the growth and weight of the seedling, where is observed significant statistical differences.

The mixture of 80% black peat + 20% husk of rice reached a value of 12.4 cm of height showing differences with the rest of the mixtures. The diameter of the stem, the green mass and dries weight of the seedling did not shows statistical differences. However a tendency is observed by increasing the green mass and dries weight in the variants containing bigger quantity of husk of rice in the mixture (40 and 50%).

Table 31. Influences of the mixtures of black peat and husk of rice in some biological parameters of tobacco seedling.

Experiment	Black peat (%)	Husk of rice (%)	Plant height (cm)	Stem diameter (cm)	Green mass of seedling (g)	Dry weight of seedling (g)
1	80	20	12.4 a	0.34 a	3.43 a	0.23 a
	70	30	11.4 b	0.35 a	3.65 a	0.25 a
	60	40	9.9 c	0.34 a	3.78 a	0.26 a
	50	50	9.6 c	0.34 a	3.77 a	0.26 a
	CV %		5.52	3.58	11.55	11.07
	ES +/-		0.149	0.0031	0.149	0.001
2	85	15	11.82 a	0.28 a	2.89 a	0.23 a
	80	20	10.73 b	0.27 a	2.45 b	0.23 a
	75	25	11.02 b	0.27 a	2.44 b	0.25 a
	70	30	11.21 b	0.26 b	2.64 ab	0.26 a
	CV %		4.32	4.23	5.44	9.87
	ES x +/-		0.094	0.0029	0.0501	0.0083

12.5.2.5 Nutrients concentration of tobacco transplants growing in different substrate studied.

The influence of the mixtures studied in the concentration of nutrients is shown in the table 32, where it is observed that for the analysed elements don't exist substantial variations between the mixtures.

Table 32. Concentration of nutrients of the different mixtures studied.

Variants	N %	P %	K %	Ca %	Mg %
80% black peat + 20% husk of rice	3.57	0.50	4.25	1.98	0.62
70% black peat + 30% husk of rice	3.66	0.56	4.51	1.93	0.54
60% black peat + 40% husk of rice	3.51	0.54	4.18	1.94	0.61
50% black peat + 50% husk of rice	3.67	0.53	4.93	2.00	0.61

12.5.2.6 Effect of the mixtures in the percentages of useful transplant per trays.

In the Figure 14, the percentages of useful seedling are observed per trays in the different mixture studied. The mixture of 80% + 20% presented the highest value (79,7%) with statistical differences with the rest of the other variants. The mixtures of 60% + 40% and 50% + 50% presented significant differences among them and they reached the smallest absolute values. These results were in agreement with the percentages of germination of the seeds and with the physical and chemical characteristics of the studied mixtures.

The black peat and husk of rice can be used as materials for the making of substrate for floating tray taking into account their physical and chemical characteristics. The ranges of 85% + 15% and 70% + 30% of black peat + husk of rice, respectively, as well as any intermediate proportion inside this range provide the physical and chemical characteristics to produce a seedling of quality.

12.5.3 Substrate factories for industrial production.

Taking into account the above mentioned, it was conceived the purchase and exploitation of 2 factories of substrate production. These plants have a capacity of 14 tons for labour cycle, which guarantees the whole production demand required by the technology of floating tray in the country. In the assembly process and setting in march of the same ones some difficulties those have been confronted which have solved properly, such as: The assembly and setting in march of laboratory of quality control, the necessity of the previous drying of the raw material until a level of 20%, the previous storage of the raw material during the dry period, the necessity of a previous sifted to eliminate rude objects that damage the trituration mechanism and blended. In the figure 15 an outline is shown of the factories and in the next two the industrial process of it (Figures 16 and 17).

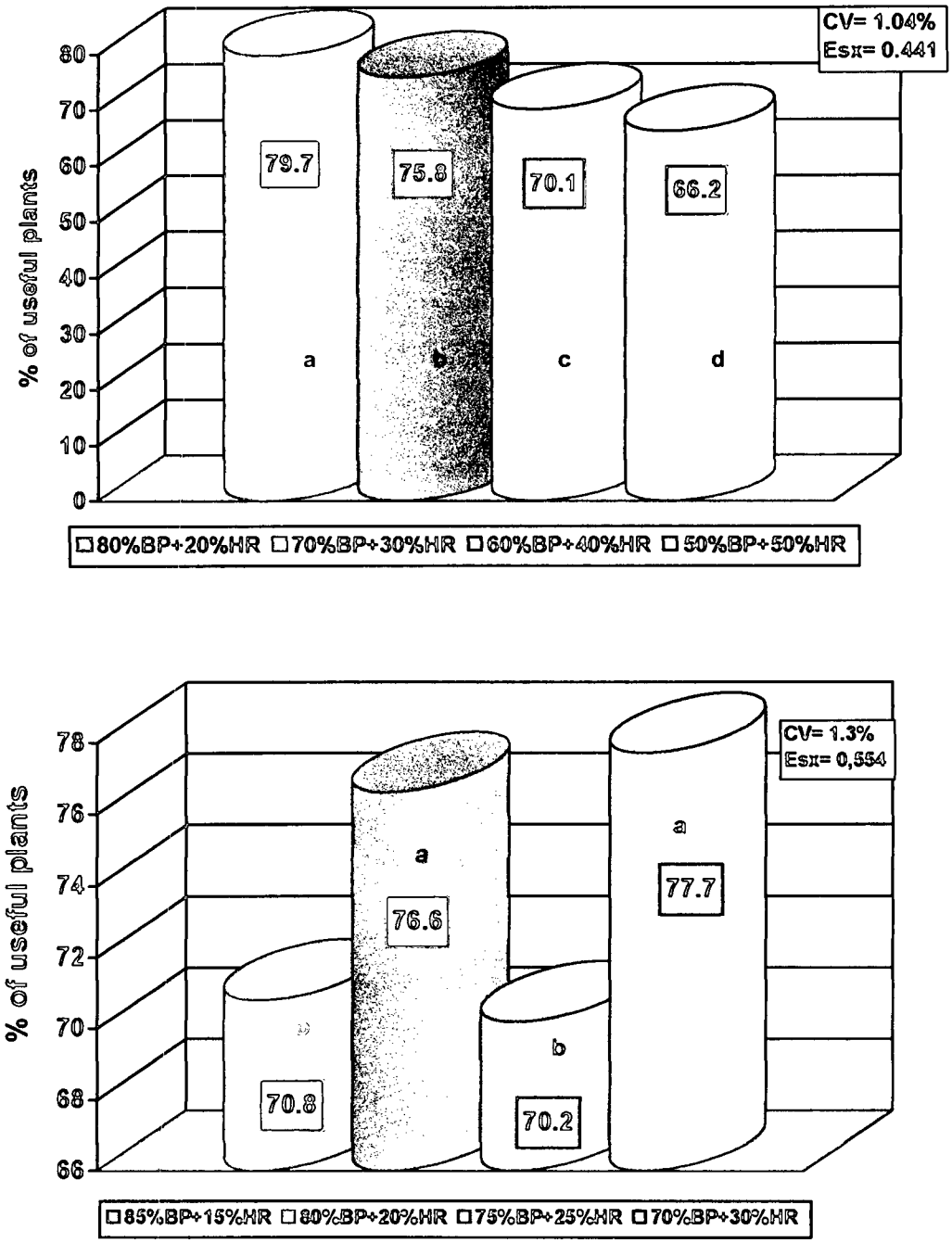


Figure 14. Effect of the mixtures in the percentages of useful transplant of tobacco per tray in two experiments.

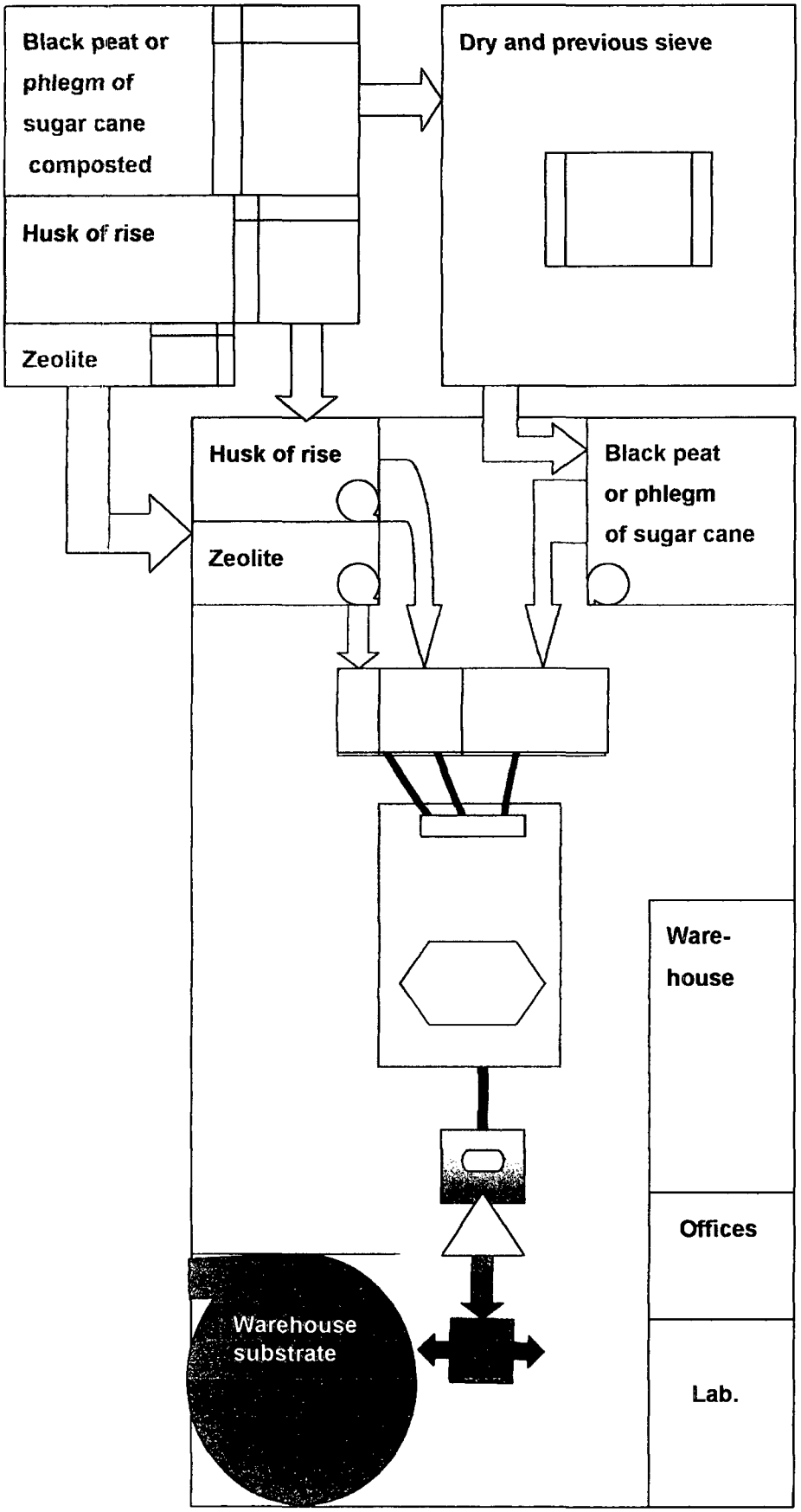


Figure 15. Scheme of production process of the substrate factory.

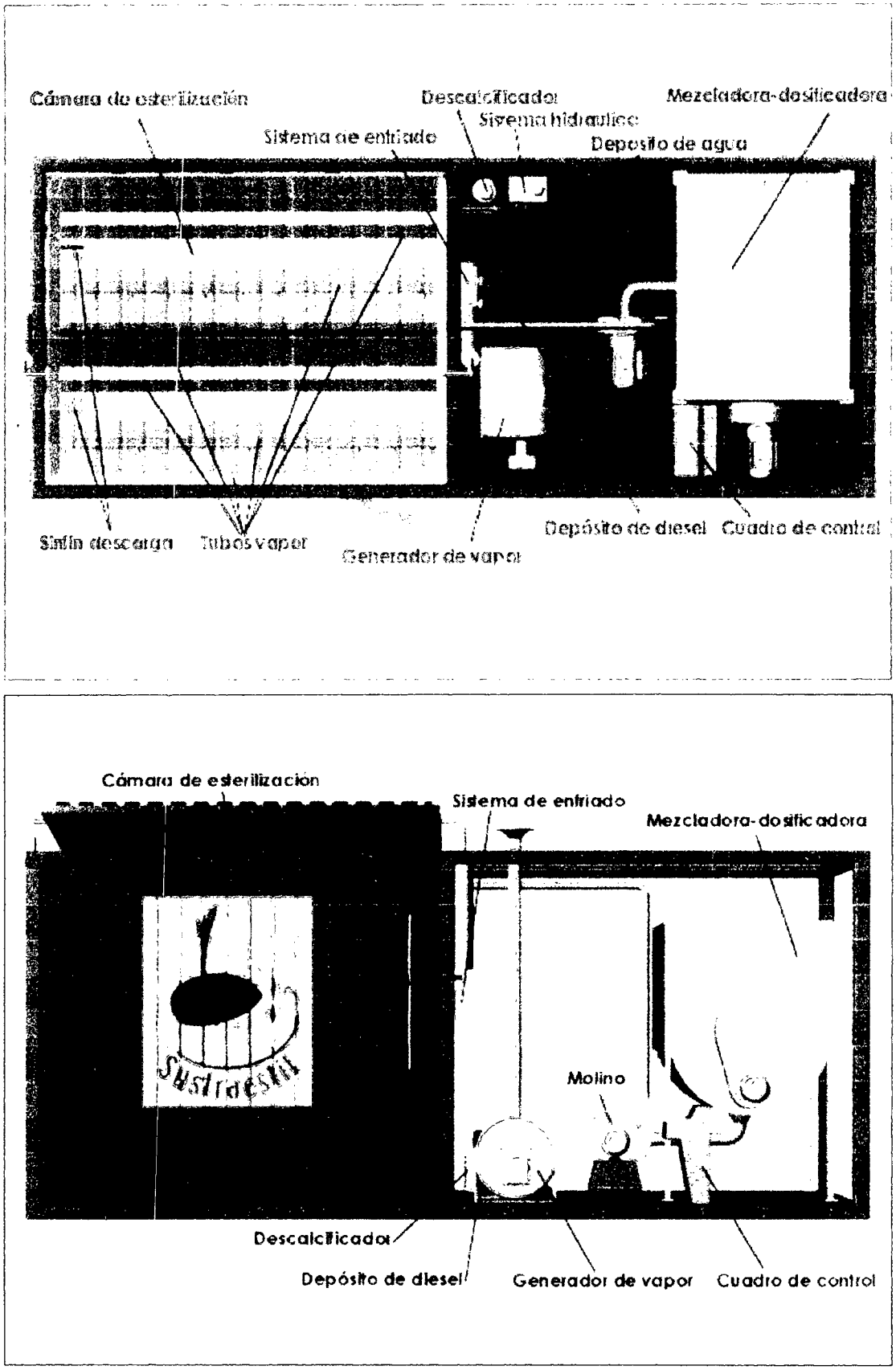


Figure 16. Design of the substrate factory. Plane and frontal view

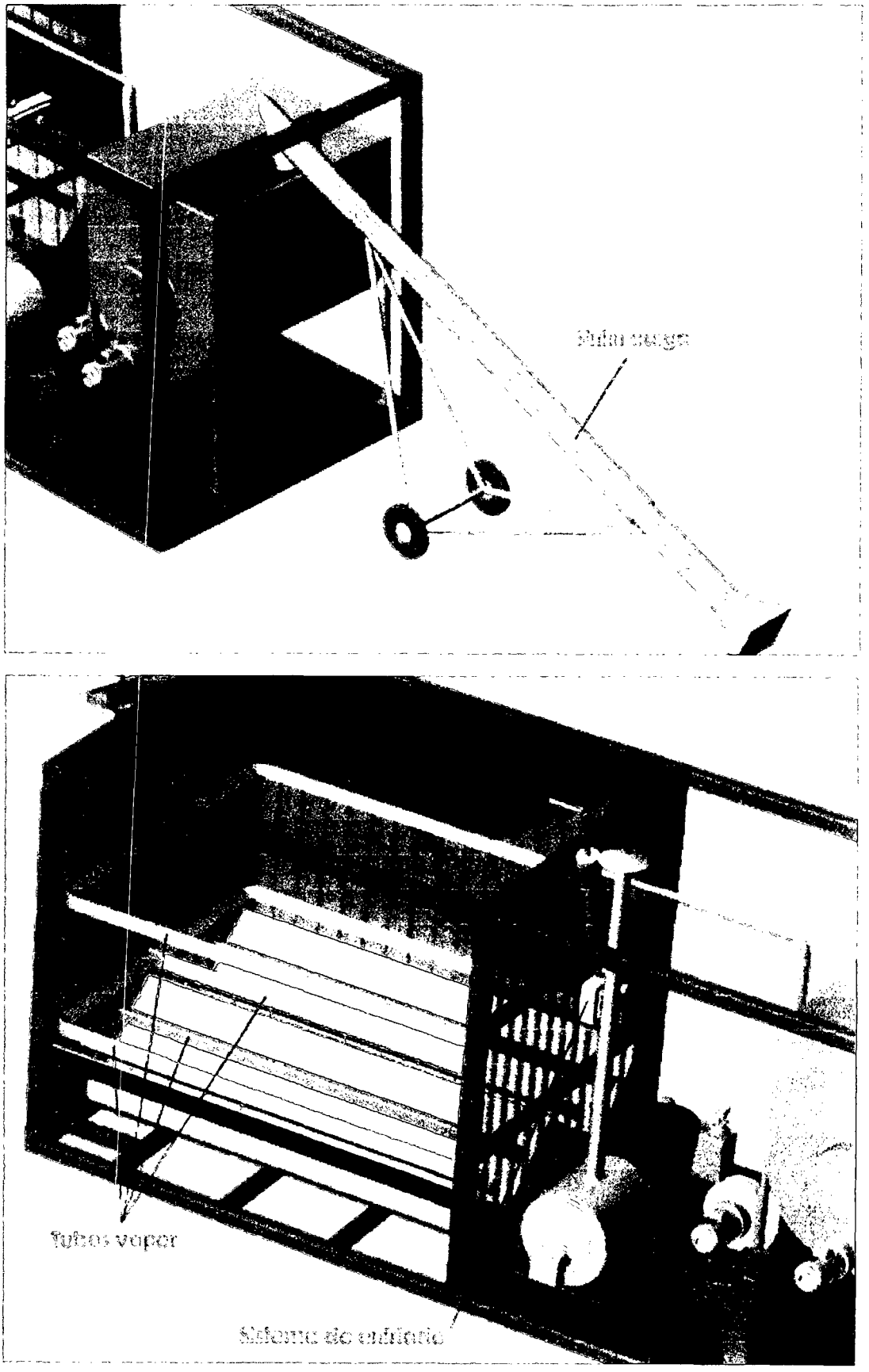


Figure 17. Design of the substrate factory. Filled and sterilization

12.6 Fertilization.

12.6.1 Complete formulations of fertilizers.

During the first tobacco campaign the granulated fertilizer was used, starting from second (2000-2001) in the Havana it was recommended to fertilize with soluble formula 20-8-20 to reason of 0.5 g / l after the germination and to the 21-25 days to add 0.12 g / l of ammonium nitrate. In Pinar del Río the first fertilization is the same but the second are carried out with the complete formula before mentioned, to reason of 0.5 g / l according to the volume of water that was replaced in the pool.

During the period of plants production, a yellowing process took place in the seedling, for that reason it was decided to carry out a group of essay comparing different formulas of fertilizers in the system of floating tray.

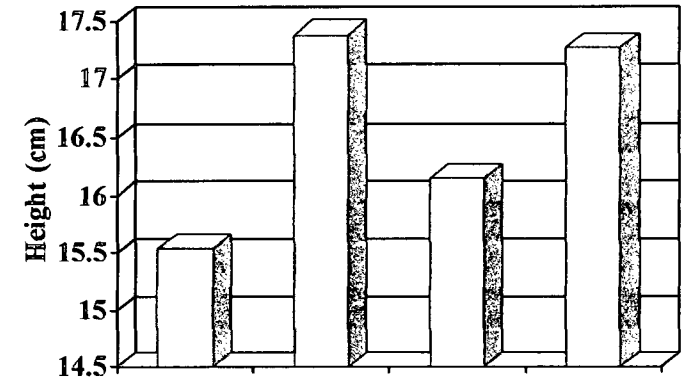
The comparison in the first experiment between the granulate and soluble formula led to better results with the complete formula with low level of phosphorus and high in potassium (Table 33).

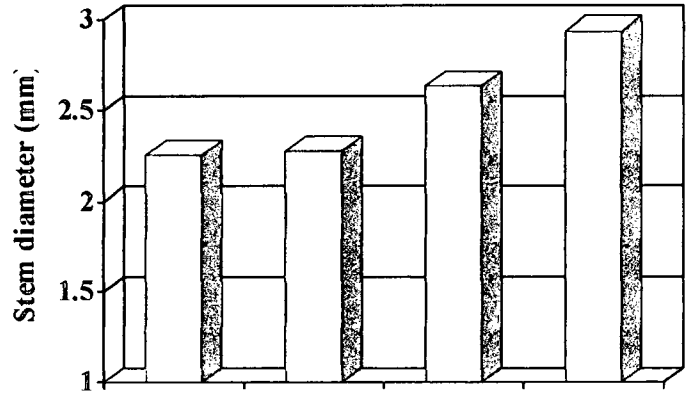
Table 33. Comparison of the growth and development of tobacco seedling of floating tray technology with two formulas of fertilizer and limed at the 42 days of the sow.

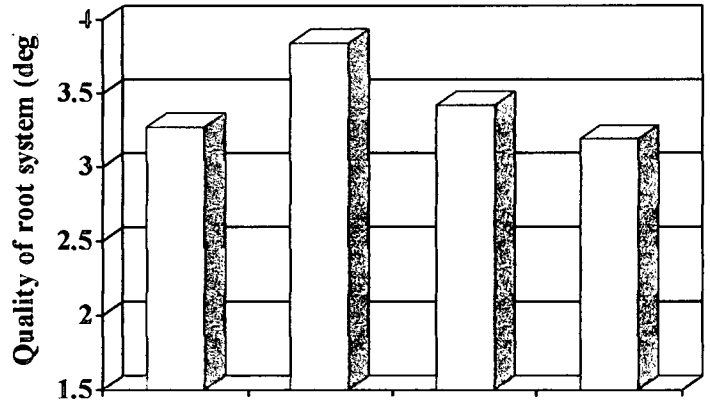
Variant*		Height of the plant (cm)	Diameter of the stem (mm)	Quality of root system	Dry weigh of the aerial part (g)
Without limed	Granulated 20-5-30	8.03	2.77	4.3	0.35
	Soluble 20-8-20	5.27	3.4	3.9	0.35
5 g / l powder of limestone	Granulated 20-5-30	11.43	3.31	4.6	0.48
	Soluble 20-8-20	4.57	2.51	2.6	0.25
6 g / l powder of limestone	Granulated 20-5-30	5.43	2.54	4.5	0.28
	Soluble 20-8-20	5.63	2.99	2.9	0.23
Average	Granulated 20-5-30	8.30	2.87	4.5	0.37
	Soluble 20-8-20	5.16	2.96	3.1	0.28

* In all the cases were used 0.5 g / l of the complete formulation.

In the second test, as it is shown in the figure 18, the best results were obtained when the granulated formula is applied to 0.5 g / l in two occasions and not to the lost water as it was made in the campaign 2000-2001,leading to a new orientation of the fertilization.







20-8-20 (0.5 total +0.5 lost water*)	20-8-20 (0.5 total +0.5 total)	20-8-20 (0.5 total +0.12 ammonium nitrate	20-5-30 (0.5 total +0.5 total)

(Dose in g / l of fertilizers.)

Figure 18. Comparison between different combinations of fertilizer in floating tray technology of tobacco.

12.6.2 Effect of different nitrogen levels in some biological parameters of the seedling in floating tray.

12.6.2.1 Seeds germination.

The influence of the different nitrogen levels in the germination of the seeds is presented in the figure 19, where it is observed that all the studied variants presented superior germination percentages to 70%, to the 18 days after the sow. The germination to the 10 and 14 days after the sow was similar in all the variants.

These results demonstrate that the nitrogen doses studied do not affect the germination due to the possible accumulation of salts in the surface of the substrate.

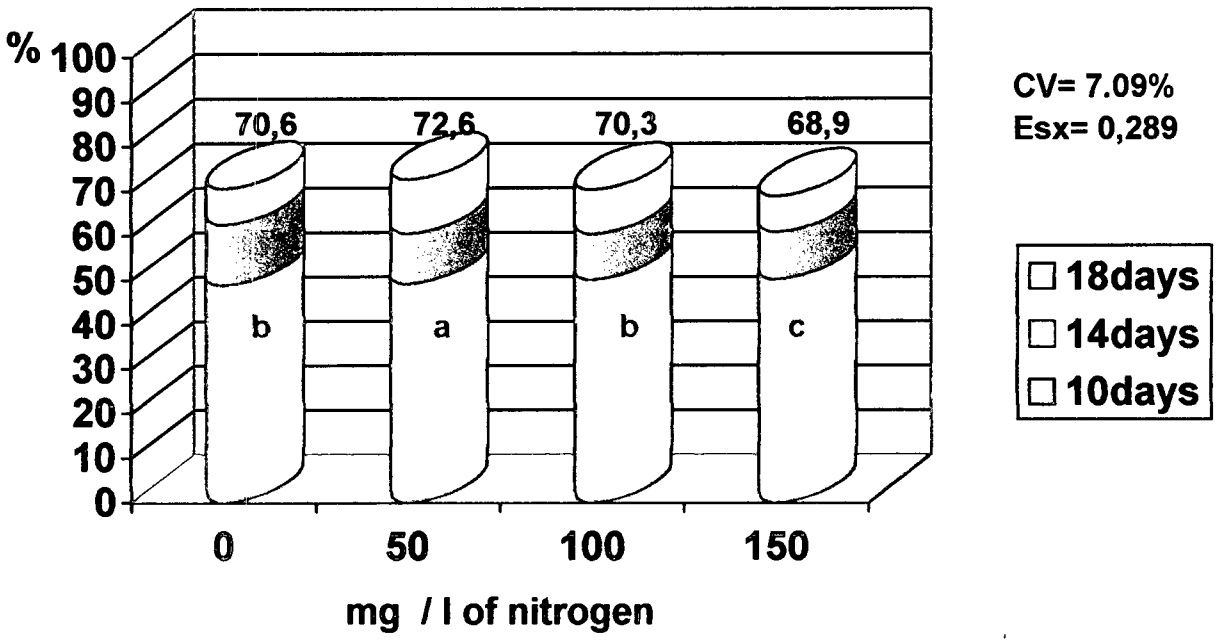


Figure 19. Effect of the nitrogen doses in the germination of the seeds.

12.6.2.2 Effect of different nitrogen dose in some biological parameters of tobacco seedling.

In table 34, the influence of the nitrogen doses studied in the height, the diameter of the stem, green mass and dries weight of the seedling are presented.

The height of the seedling was increased from the dose 0 mg / l until 150 mg / l of nitrogen . The last one presented significant differences with all the studied doses and it reached a value of 15.26 cm, among all the other doses significant differences were also presented.

The diameter of the stem is increased in a significant way from 0 until 150 mg / l of nitrogen being achieved a value of 0.33 cm, in the same way happens with the green mass with a maximum value of 4.36 g with the dose of 150 mg / l.

The dries weight increased significantly from 0 until 100 mg / l and 150 mg / l; significant statistical differences were not observed for values of 0.26 and 0.30 g.

Table 34. Influences of the nitrogen dose in some biological parameters of tobacco seedling.

Nitrogen dose in mg / l	Height of plants (cm)	Diameter of stem (cm)	Green mass of seedling (g)	Dry weight of seedling (g)
0	2.68 d	0.22 b	1.18 d	0.20 b
50	6.67 c	0.24 c	2.03 c	0.21 b
100	10.77 b	0.29 b	2.84 b	0.30 a
150	15.26 a	0.33 a	4.36 a	0.26 a
CV %	4.32	4.23	5.44	9.87
ESx	0.094	0.0029	0.050	0.0083

12.6.2.3 Effect of the nitrogen doses in the percentages of useful transplant per tray.

In the figure 20, the percentages of useful transplant per tray are exposed in the different doses studied. The dose of 100 mg / l achieved the biggest value with significant differences with the rest of the doses. Between the variants of 50 and 150 mg / l statistical differences were not observed. When nitrogen was not applied , the percentage of useful seedling for trays was not superior to 20%.

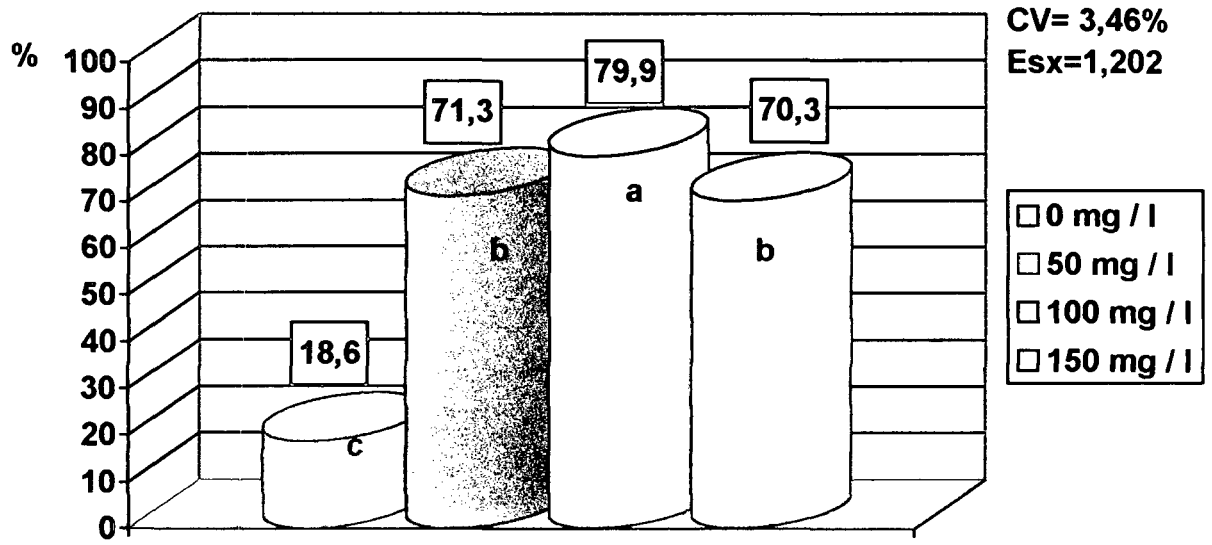


Figure 20. Effect of the nitrogen doses in the percentages of useful transplant per tray.

This fundamental indicator gives the measure of the productivity of the system and taking implicit the rest biological parameters. The germination and the concentration of chemical elements in the seedling demonstrate that with the dose of 100 mg / l of nitrogen, the most appropriate seedling is obtained for the transplant.

The increase of the nitrogen doses increased the height, the diameter of the stem, the green mass and dries weight of the seedling significantly. The seedlings of more quality in the biological parameters and the percentages of useful transplant per trays was achieved with the dose of 100 mg / l of nitrogen.

12.7 Sowing machine.

12.7.1 Semi-automatic sowing machine.

12.7.1.1 Operation of the semiautomatic sowing machine.

The semiautomatic sowing machine is designed to carry out the whole sowing process of the tray of expanded polystyrene with pellet and naked seed. Their high efficiency guarantees a minimum productivity of 4 trays per minute what represents 1680 trays in 7 working hours.

The sowing machine is composed by three parts that are coupled for the operation of the whole system (Figure 21).

The first part is formed by the feeding mechanisms, filled and brushing of the tray and the box of switches.

The second part is formed by the press mechanisms of the substrate in the tray and spray of solutions.

The third part this formed by the sowing system of pellet or naked seeds, including the motor-sucker, the deposits of seeds and the box of the conductors.

Additionally a plastic hose coupled to the motor-sucker by air pressure, allows the cleaning of the sowing machine.

12.7.1.2 Innovations for the naked seed sow with the semi-automatic sowing machine.

To sow the naked seed, it was innovated to the sow mechanism, the connection of the air of the motor-sucker , so after the suction to the plate to retain the seed, it is blown inverse to clean the holes. This avoids the stops that are made when not having a uniform size of seed and lack of cleaning. The results are very satisfactory, since with an appropriate calibration of opening of the keys, not more than 2-3 seeds by alveolus are achieved.

It has been evaluating different plate qualities for the sowing of naked seed with this machine. The most appropriate was the sent by the supplier of the machine, with 50% of the alveolus with 1 seed and with possibility of minimum take of and sow seedling, since overpopulation is not reached by alveolus as in previous cases. The results are shown in Figure 22.

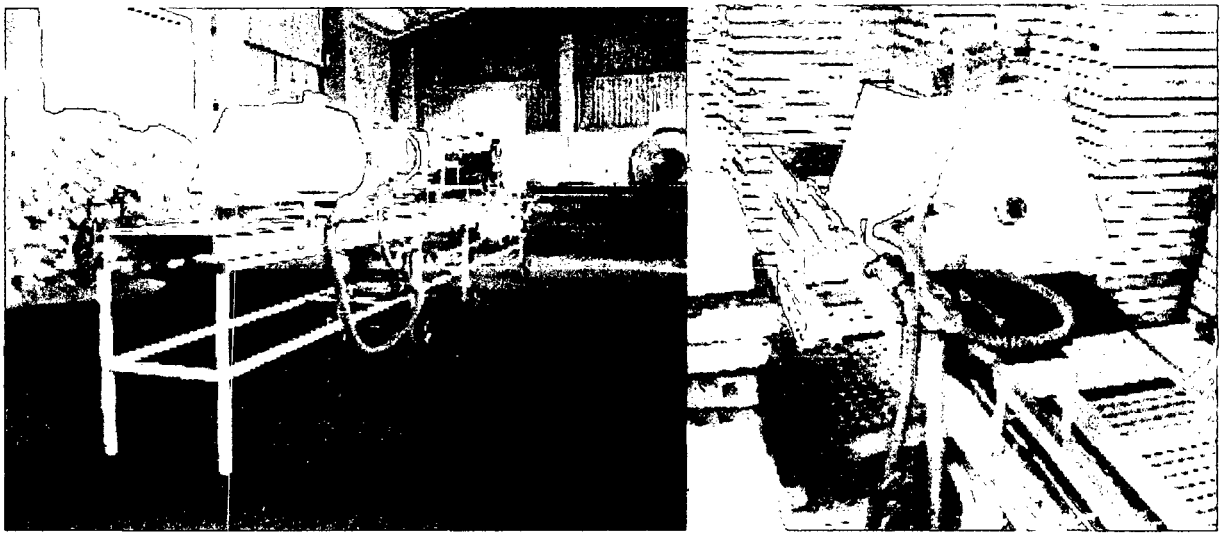


Figure 21. Semi-automatic sowing machine and innovation for naked seed.

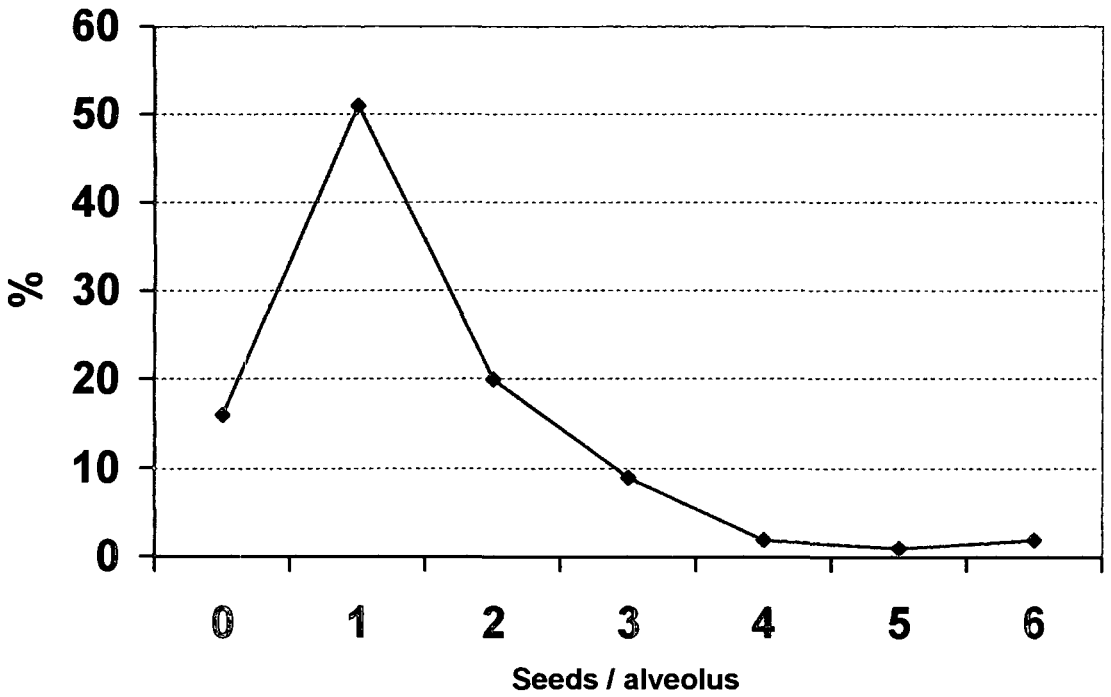


Figure 22. Evaluation of the Agrotex plate for sow of naked seed with the semi-automatic sowing machine.

12.7.2 Manuals sowing.

In Cuba, it has been evaluated successfully several types of manual sowing machines, adequate for sowing at small scale in micro-tunnels (Figures 23).

12.7.2.1 Manual sowing of pellets.

For to the sowing of pellets seed three prototypes are available with satisfactory results.

- Creole Model. Consistent in a deposit of seed with three plates of steel of which the mean one is mobile and the pellet is bring by graveness through a conduits until the alveolus. The efficiency of this machine is superior to 96% of sowed alveolus, although it can thrash some between the plates.
- Spanish Model (Agrotex). It is based on a system of two steel plates, the second is mobile, the rest of the structure is similar to the Creole Model with the difference that is slighter and handier. It has more than 98% of efficiency in the sow.
- Model of Brazil. It is an implement very simple and handy. It is based on a box of slight base with a mobile plate of nylon, both have the coincidence holes. Under normal conditions they can give good yields, although when the temperature increases the nylon plate stretches out and some pellets are caught between them.

12.7.2.2 Manual sowing of naked seed.

The situation of the manual sowing machine was solved for naked seed starting from the development of a Cuban prototype that picks up a seed and deposits it in the alveolus. During this period the model was improved, since with a single operation is carried out the simultaneous sow of all the alveolus of each tray.

The model of manual sowing machine of naked seed has as principle an deposit of seed of which is extracted from 1 to 3 seeds with a specially designed palette that through a spin movement the seed is deposited in the alveolus of the tray; in this case, it is extremely important that the palette has the appropriate dimensions to extract the minimum of seed at once.

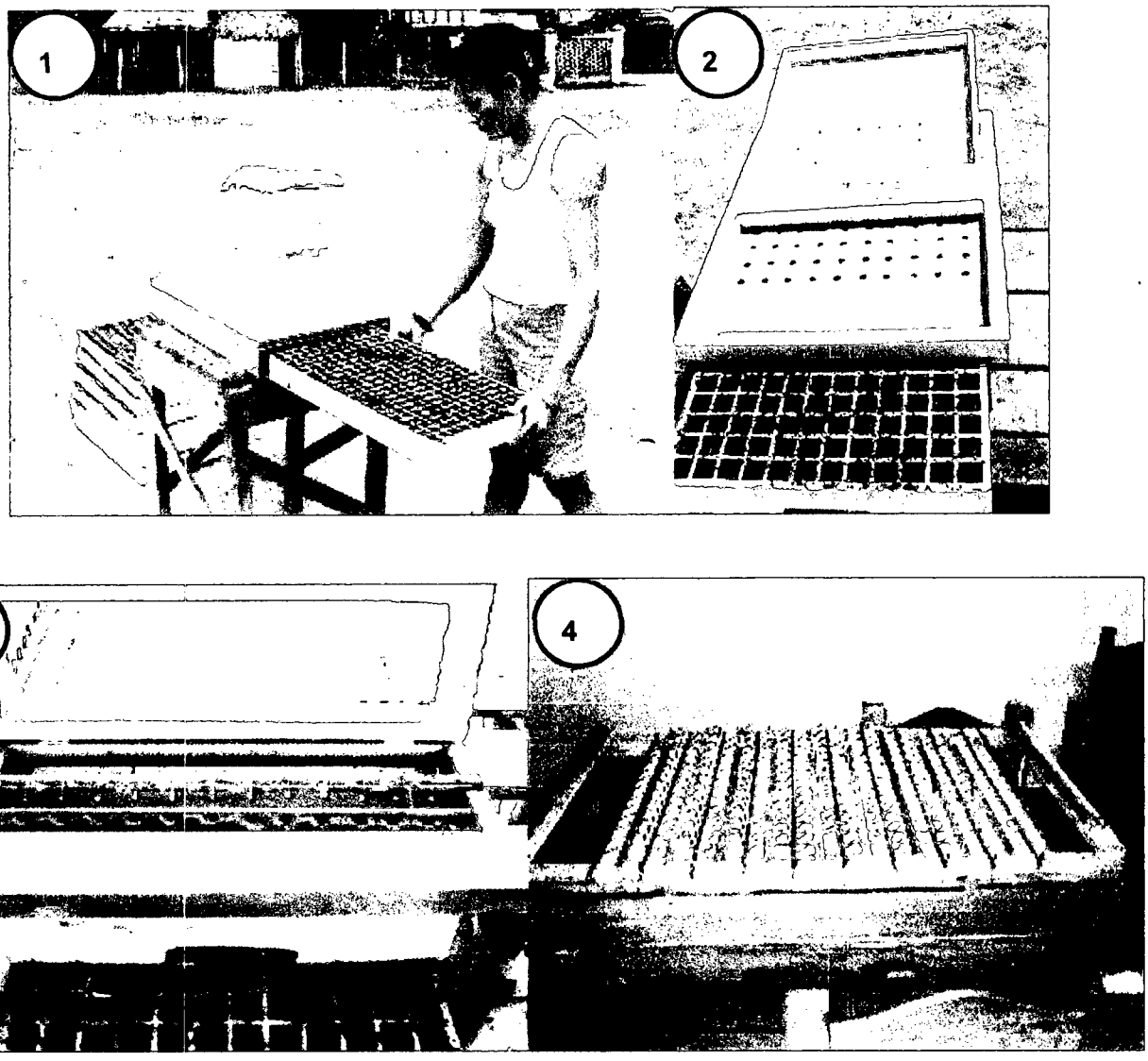


Figure 23. Manual sowing machines: 1 - Spanish of pellet seed 2 - Brazilian of pellet seed. 3 - Taguasco-1 of naked seed 4 - Taguasco-2 of naked seed.

The model manual sowing machine Taguasco 2 are a sophisticated design with capacity of carrying out the sow of all the cells or alveolus of the tray with 264 alveolus at once, the results of the effectiveness are shown in the following Table (Table 35).

Table 35. Effectiveness in sow of tobacco with the Cuban model of manual sowing machine of naked seed Taguasco 2.

No. of Seeds	No. of alveolus in each test											Statistical values
	1	2	3	4	5	6	7	8	9	10	Total	
1	9	10	10	6	9	9	6	10	8	8	85	**μ = 1.43**
2	4	3	3	4	3	4	6	3	1	3	34	**n = 130**
3	0	0	0	3	1	0	1	0	4	2	11	**σn =0.64**

12.8 Pruning system.

During the period of development of the project different alternatives have been evaluated to carry out the prune in micro tunnels. The nylon cord pruner have been the most efficient equally electric or gasoline among the different alternative evaluated. The use of the sickle has not been satisfactory and the box and nylon cord tighten is an alternative where it is not possible to make available the first two. In the greenhouses, from the beginning has settled down with efficiency the pruning system coupled to the bridge (Figure 24).

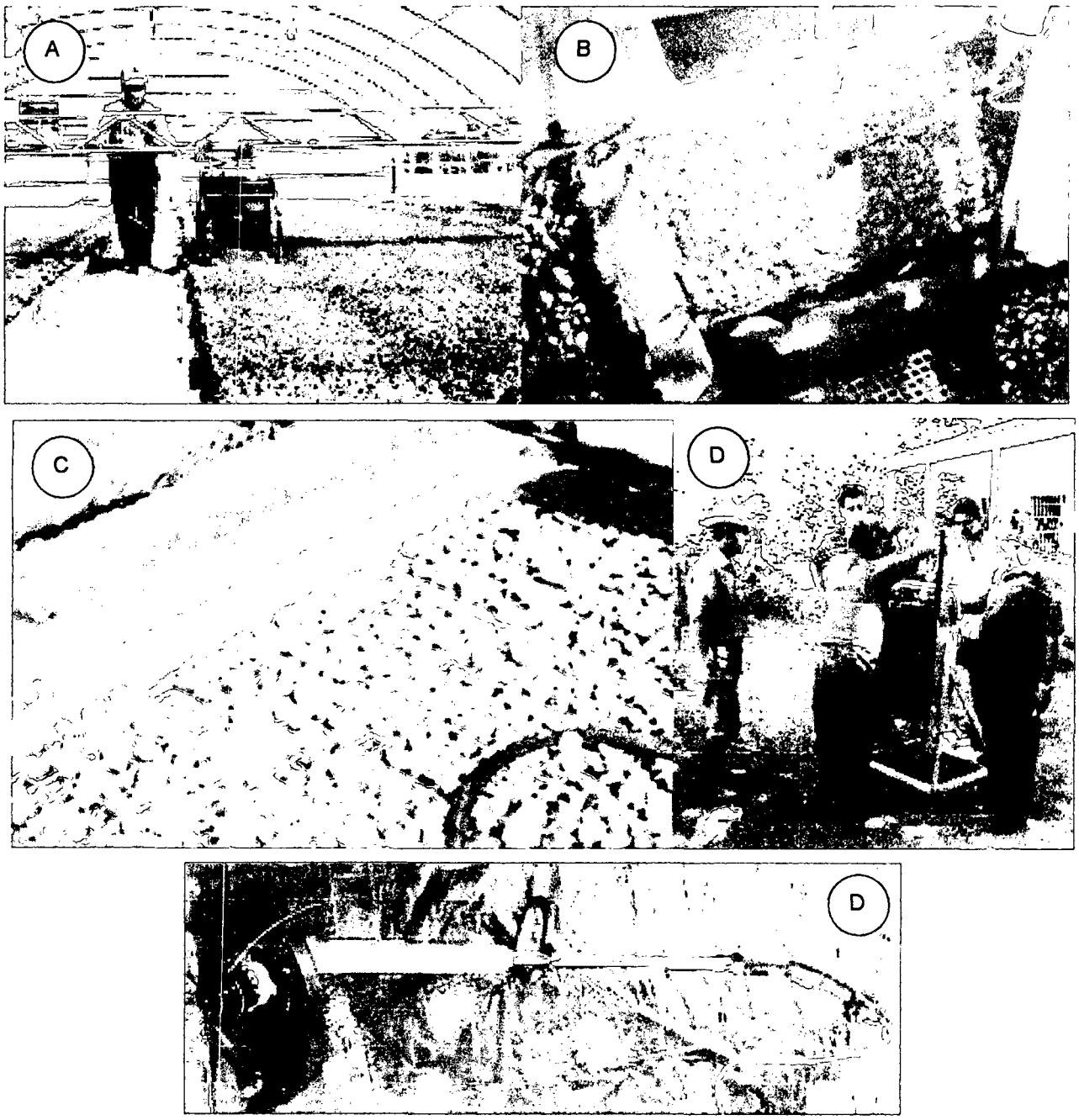


Figure 24. Differents equipment evaluated to prune the seedling of tobacco in floating tray. A- Pruning system in greenhouses B-Gasoline nylon cord pruner C- sickle D- Box and nylon cord tighten E-Electric nylon cord pruner

12.9 Plant protection.

In tobacco traditional seedbed of Cuba the most important soil borne disease is caused by ***P. nicotianae***, which is epidemic since 1985 in seedbed of some regions of the country, especially in Pinar del Río and Havana provinces. It is an disease that affects the roots and basal parts of the stem essentially.

However with the mass use of the floating tray with organic substrate system of tobacco transplant production, it has left observing a change in the composition of species that attack the seedling of tobacco with increment the damping-off, caused essentially by the fungus ***Phythium spp***. This disease can impact if the measures control, such as correct disinfections of the substrate and source of supply of water free of contaminations, are not completed properly, also it is possible to detect affectations in very specific places for the species of fungus ***Rhizoctonia solani*** and ***Fusarium spp***. For the before mentioned, a group of investigations have been carried out to clarify the causes of some damages observed in tobacco seedling under the new technology.

12.9.1 Monitoring of incidence of *Pythium aphanidermatum* (Edson) Fitzp and others diseases in tobacco growing in floating tray.

An inventory of the main phytosanitary problems in the production of tobacco transplant through floating trays system was carried out, for which were made sample of substrate and tobacco seedlings and an survey was made about detected problems.

Problems caused by non infectious pathologies were detected that at first time look like if were caused by fungus but a meticulous analysis showed that they were related with physiologic disorders of the plants due to pH problems and nutrition, the symptoms has being characterized by yellowing and necrosis of the seedling (Figure 25 and 26).

The main phytosanitary problem in the production of tobacco transplant for the of floating trays system in Pinar del Río and Havana provinces were the incidence of diseases cause by pathogens fungus of the soil, which were detected with more frequency the genus ***Pythium***, followed by ***Rhizoctonia*** and ***Fusarium***, also were presented occasionally ***Phytophthora*** as well as the genus ***Aspergillus, Curvularia*** and ***Rhizopus*** (Table 36 and 37).

The species more frequently isolated was ***Pythium aphanidermatum*** (Edson) Fitzp, follow in a second order ***Rhizoctonia solani*** and ***Fusarium sp***.

It is necessary to guarantee the disinfection of the substrate and achieve an appropriate manipulation of it, before the filled of the trays, as well as to maintain an adequate manage of pest to avoid the risk of contamination of the pool and the losses of tobacco plants in the system of floating trays.

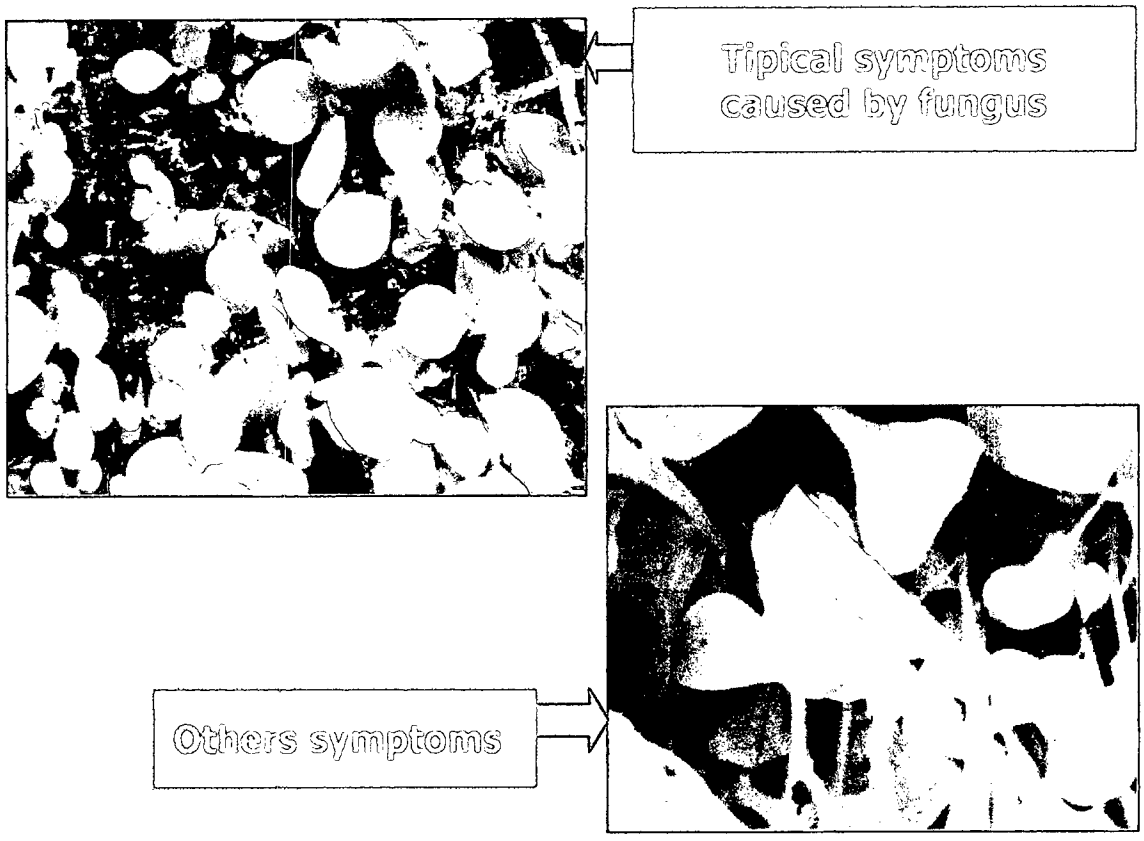


Figure 25. Symptoms detected in seedling of tobacco on the floating trays system in Pinar del Rio and Havana.

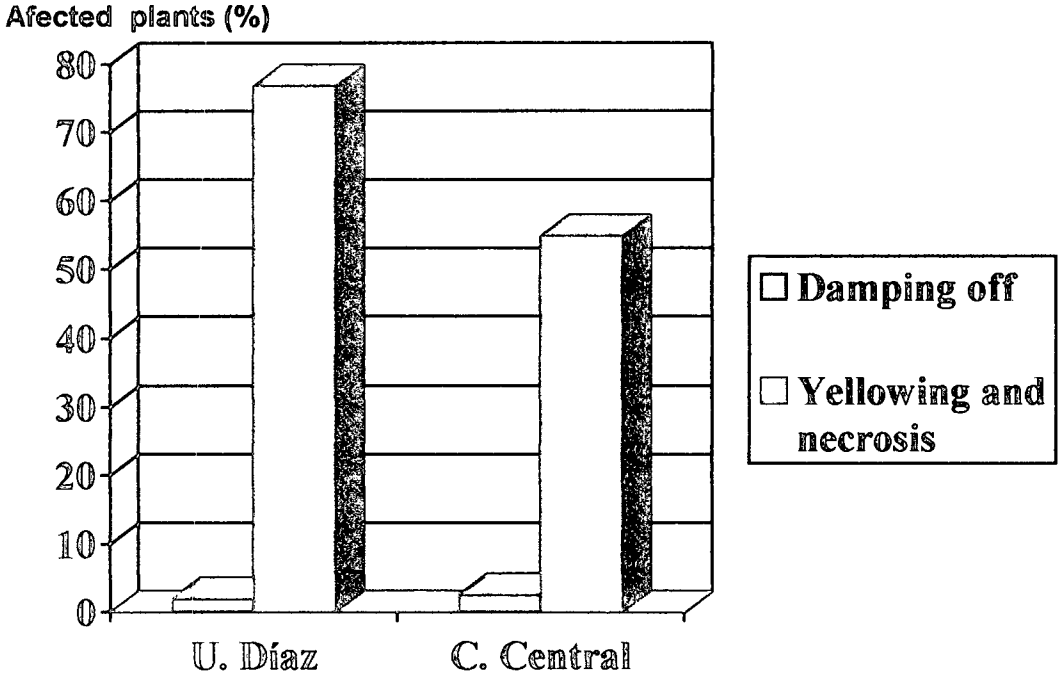


Figure 26. Incidence of symptoms in seedling of tobacco in greenhouse of the enterprise Lazaro Peña, Havana.

Table 36. Incidence of pathogens fungus in floating tray technology of the main tobacco enterprises during 2000-2001 campaigns.

Sample	Production unit	Tobacco variety	Result
San Juan y Martínez			
815	CCS "V Congreso"	Criollo-98	R. solani
821	UBPC # 5	Habana-2000	***Pythium sp.***
843	CCS "V Congreso"	Criollo-98	***R. solani***
861	CCS Osmary Arenado		***Pythium sp.*** ***R. solani***
823	Cepellón CPA "Hermanos Saínz"	Habana-2000	***Pythium sp.***
825	Cepellón Vivero	Criollo-98	***Pythium sp.***
826	Cepellón "Bienvenido Rubio"		***Fusarium sp.*** ***Pythium sp.***
830	CPA "10 de Octubre"		***Fusarium sp.*** ***Pythium sp.***
831	Cepellón "La Nilda"		***Pythium***
836	Cepellón "Salvador Carvajal"		***Pythium sp.***
837	Cepellón UBPC # 4		***Pythium sp.*** ***R. solani*** ***Fusarium sp.***
1042	Cepellón "La Nilda"		***P. tabacina***
12	CPA "10 de Octubre"		***Pythium sp.***
San Luis			
822	CCS "Jesús Menéndez".	Criollo-98	***Pythium sp.***
850	CCS "José A. Labrador".		***R. solani*** ***P. nicotianae***
865	CCS "Giraldo Valdés".		***R. solani***
829	Batería # 1 San Benito"		***Pythium sp.*** ***R. solani***
849			***P. nicotianae***
856	Cepellón "La Vigía".		***Pythium*** sp.
864	Cepellón "La Esperanza".		R. solani
13	Bartolo Zona #4		***Pythium*** sp.

Table 36a. Incidence of fungus pathogens in floating tray technology of the main tobacco enterprises during 2000-2001 campaigns. (Cont)

Sample	Production unit	Tobacco variety	Result
Havana			
1	UBPC Agustín Suárez	Criollo-98	***F. solani***
3			***Curvularia sp.***
4			***Aspergillus sp.***
6			***Aspergillus sp.***
7			***A. niger***
8			***F. solani***
9			***Rhyzopus sp.***
10	Felipe	S-98	***F. solani***
13	Herrera	Criollo-98	***F. solani***

Table 37. Main phytosanitary problems reported by the farmers of the Pinar del Río province. Campaign 2000-2001.

Municipality	Zone	Farmer	Tobacco variety	Phytosanitary problems
San Juan y Martínez	Río Seco	-	Criollo-98	-
		-		***Pythium sp.*** ***Spodoptera sp.***
		-		***Pythium sp.***
		-		-
	El Pinto	-		***Fusarium sp.*** ***Pythium sp.***
	Hoyo Mena	Salvador C.		***Pythium sp.***
	Valle	Francisco P.		***Rhizoctonia sp.***
		Silvina B.		***Rhizoctonia sp.***
Pinar del Río	Cotorra	Celestino Porra	*Criollo-98*	-
		Roberto Robaina		***Pythium sp.***
		Manuel Falcón		***Pythium sp.***
	San Juan	Rosario Cabrera	Habana-92	-
		Felipe Hernández	Habana-92	***Pythium sp.***

Table 37a. Main phytosanitary problems reported by the farmers of the Pinar del Río province. Campaign 2000-2001. (Cont)

Municipality	Zone	Farmer	Tobacco variety	Phytosanitary problems
Guane	-	Eulogio Serrano	Criollo-98	-
	-	Silverio Díaz		-
	-	Eduardo Gutiérrez		-
	-	José Pérez León		-
	-	Roberto Fernández		-
San Luis	3	Eulalio Pérez	Criollo-98	-
		Benigno Brejo		-
	-	-		-
	-	-		***Pythium sp.*** ***R. solani***
	-	-		***R. solani***
Consolación del Sur	Puerta Golpe	Candelario E.	Criollo-98	-
		Rodolfo M.	Habana-92	-
	Piloto	Segundo M.	Criollo-98	-
		Raumel A.	Criollo-98	-
		Feliz Suárez	Criollo-98	-

12.9.2 Biological aspects of *Pythium aphanidermatum* (Edson) Fitzp and pathogenic effect over varieties of tobacco.

The main parameters for the development of ***Pythium aphanidermatum*** were determined and its pathogenic effect on different varieties of tobacco.

P. aphanidermatum develop well in a range of temperature from 20 to 40 °C , with an optimum near of 40 °C. The minimum threshold is below 10 °C and the maximum threshold is located above 40 °C (Figure 27).

For the development of the pathogen the adequate pH is 5, to pH 3 do not grow and at 7 to 9 it's develop is significantly smaller (Figure 28).

The optimum humidity of the substrate for the development of the pathogen is 100% of the capacity of water retention, where it causes the biggest percentage of plants mortality. With 80 and 70% of

capacity of water retention, the infection of the pathogen to the plants is very low with values of 50 and 37.5% of mortality, respectively (Figure 29).

For future studies with the species ***P. Aphanidermatum*** the appropriate parameter are the temperature of 40 °C, the pH 5 and the humidity of the substrate 100 % of capacity of water retention, that guarantees the best conditions of develop and growth of the fungi.

The tobacco varieties Criollo 98, Corojo, Habana 2000 and Habana 92 are susceptible to the attack of ***P. aphanidermatum***, but the variety Habana 92 is less affected than the others. (Figure 30).

It is necessary to continue studies on the species ***Pythium aphanidermatum*** about the ecology, epidemiology and control in the production of tobacco transplants in floating trays soilles.

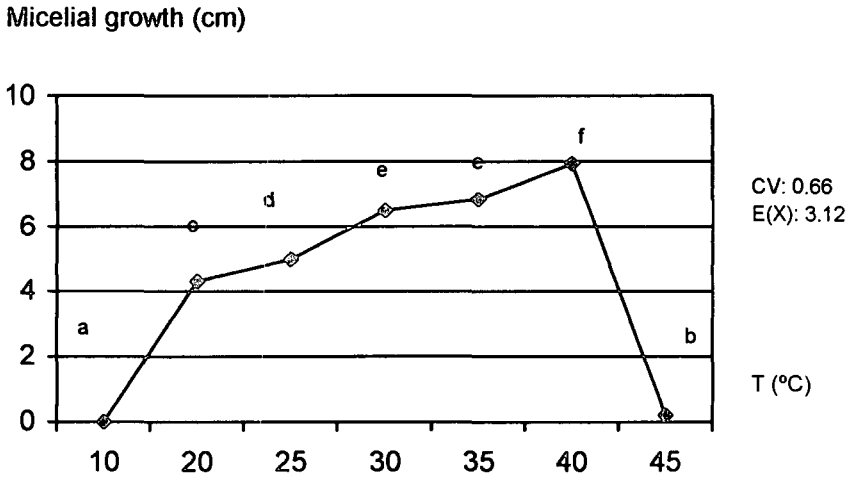


Figure 27. Influences of the temperature in the mycelia growth of *Pythium aphanidermatum*

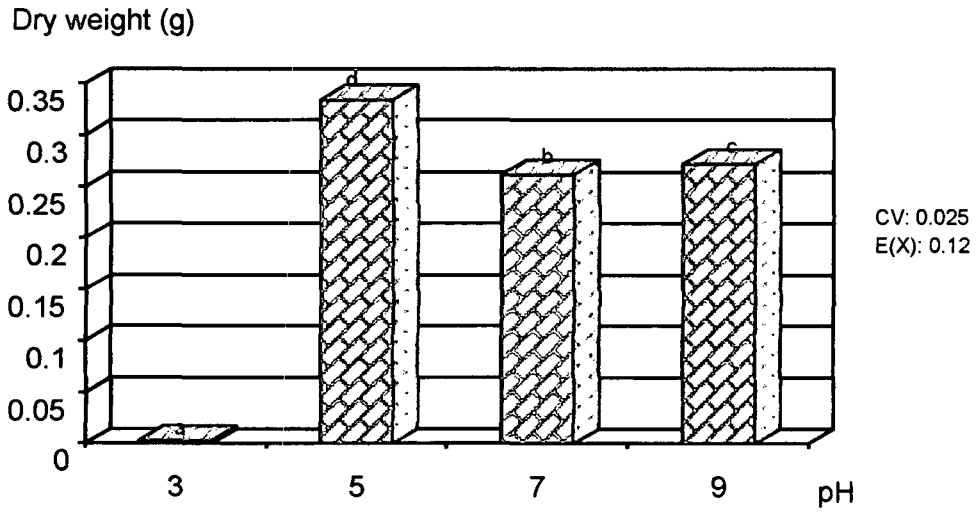


Figure 28. Influence of the pH in the development of *Pythium aphanidermatum*.

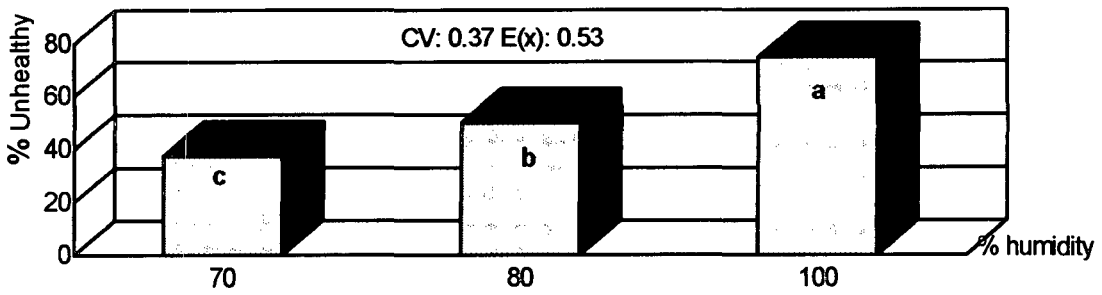


Figure 29. Influence of the substrate humidity in pathogenicity of *Pythium aphanidermatum*.

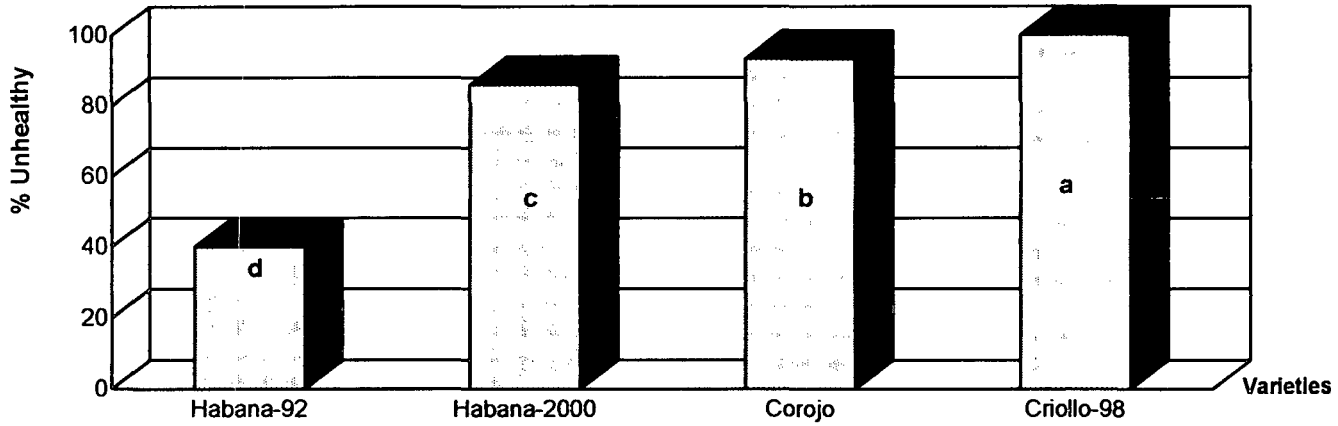


Figure 30. Pathogenicity *of Pythium aphanidermatum* on different varieties of tobacco.

12.9.3 Effectiveness of the bio control *Trichoderma against Pythium aphanidermatum* (Edson) Fitzp and its compatibility with fungicides.

The effectiveness of strains of ***Trichoderma*** was determined in the control of ***P. aphanidermatum*** and its compatibility with chemical products that are applied for the phytosanitary control in floating tray system.

P. aphanidermatum compete for the substrate with the isolations of ***Trichoderma***, but the hyper parasite invaded the mycelia of the pathogen (Table 38).

The strains of ***Trichoderma*** A-53 and A-34 were the most promissory for their high degree of antagonism and parasitism. The fungicides dimethomorph, Mancozeb, propamocarb and azoxystrobin do not inhibit the growth of the ***Trichoderma*** strains. (Table 39).

It is recommended to use the strains of ***Trichoderma*** A-53 and A-34 for the control of ***P. aphanidermatum*** in the floating tray system.

The application of the fungicides dimethomorph (Acrobat), Mancozeb, propamocarb (Previcur) and azoxystrobin (Amistar) can be made with the strains of ***Trichoderma*** selected.

Table 38. Vitro test of dual growth of the different strains of *Trichoderma* against *P. aphanidermatum* to the second day result.

Strains of ***Trichoderma***	Growth of the ***Trichoderma*** colonies (cm) against ***P. aphanidermatum***
A-34	4.64
A-53	4.78
Av	2.88

12.9.4 Desinfection of substrate for use in tobacco seedbed in floating tray.

According to the results obtained in the different experiment carried out, there were obtained that dazomet (Basamid 98%, granulated) applied to dose of 300 g / m^3 for black peat and 400 g / m^3 for phlegm of sugar cane composted eliminates weeds and phytopathogens fungus which attack the tobacco during the stage of seedling in floating tray technology (Table 40, 41, 42, 43 and 44).

For the best result of the treatment, the mixtures of dazomet with the two substrates will maintain a humidity higher than 50 % and to cover the substrate with transparent plastic for a minimum term of three days, so that the gases product of the decomposition can be liberated and act in the disinfectation.

After three days of the treatment with dazomet will proceed to carry out the aeration of the substrate, so that the residuals of gases will be release. Later to this operation it is obligatory a test of germination with lettuce to check that it is not gas residuals into the substrate.

With the results obtained of the different experiments carried out a methodology for the substrates disinfection with dazomet was prepared and used, as much for the substrate prepare with phlegm of sugar cane composted as for black peat.

Table 39. The effect of fungicides on radial growth and percentage of inhibition of three strains of *Trichoderma harzianum* to the 3 days of incubation.

Conc. mg a. i./ l	Dimethomorph			Mancozeb			Propamocarb		
	Growth (mm)	Inhib. (%)	Toxic.	Growth (mm)	Inhib. (%)	Toxic.	Growth (mm)	Inhib. (%)	Toxic.
Strain A-34									
0.00	90	0		90	0		90	0	
0.01	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
0.10	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
0.50	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
1.00	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
5.00	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
10.00	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
100.00	70	23	Innoc.	84	6	Innoc.	90	0	Innoc.
Strain A-53									
0.00	90	0		90	0		90	0	
0.01	90	0	Innoc.	90	0	Innoc.	90	0	Innoc.
0.10	75	16	Innoc.	90	0	Innoc.	90	0	Innoc.
0.50	76	15	Innoc.	90	0	Innoc.	90	0	Innoc.
1.00	81	10	Innoc.	90	0	Innoc.	90	0	Innoc.
5.00	85	6	Innoc.	90	0	Innoc.	90	0	Innoc.
10.00	87	3	Innoc.	90	0	Innoc.	90	0	Innoc.
100.00	68	24	Innoc.	86	6	Innoc.	90	0	Innoc.
Strain AV									
0.00	67	0					90	0	
0.01	65	3	Innoc.				90	0	Innoc.
0.10	59	13	Innoc.				68	25	Innoc.
0.50	61	10	Innoc.				65	28	Innoc.
1.00	61	9	Innoc.				62	28	Innoc.
5.00	61	9	Innoc.				68	24	Innoc.
10.00	59	13	Innoc.				66	27	Innoc.
100.00	51	24	Innoc.				69	23	Innoc.

*The strains A-53 showed identical results with azoxystrobin than to propamocarb. Innoc. - Innocuous

Table 40. Effectiveness on weed of dazomet (Basamid 98 %) applied in substrate with black peat. Tobacco enterprise Lázaro Peña , Havana.

Dose of dazomet (g CP / m^3)	Weeds					
	O.sativa	*C.rotundus*	*C.elegans*	*B.pilosa*	Annuals grass weed	Total
0	10	5	4	10	10	39
200	4	2	4	-	1	11
300	1	1	-	-	-	2
400	-	-	-	-	-	0

Table 41. Effectiveness on weed of dazomet (Basamid 98 %) applied in substrate with black peat. San Juan y Martínez, Pinar del Río.

Dose de dazomet (g CP / m^3)	Weeds					
	O.sativa	*C.rotundus*	*C.elegans*	Dicotil.	Annuals grass weed	Total
0	23	87	3	11	6	130
200	9			10		19
300	7					7

Table 42. Effectiveness on weed of dazomet (Basamid 98 %) applied in substrate with phlegm of sugar cane composted. Tobacco enterprise Lázaro Peña , Havana.

Dose of dazomet (g CP / m^3)	Weeds					
	O.sativa	*C.rotundus*	*E. heterophylla*	*B.pilosa*	Annuals grass weed	Total
0	15	2	6	64	4	91
200*	10		3		3	16
200**	7	1	1		3	12
300*	2		3			5*
300**	4		2			6*
400*	1		3			4*
400**	3		2		1	6*

(*) bag (**) bulk

Table 43. Effectiveness on weed of dazomet (Basamid 98 %) applied in substrate with black peat. INISAV.

Dose de dazomet (g CP / m^3)	Weeds					
	O.sativa	***C. rotundus***	***C. elegans***	Annuals grass weed	D. Annuals	Total
0	23	67	3	6		99
200*		35		1	6	42
200**	9				10	19
300*	7			8		15
300**	7				2	9

(*) bag (**) bulk

Table 44. Effectiveness on phytopathogens fungus of dazomet (Basamid 98 %) applied in substrate with phlegm of sugar cane composted and black peat.

Dose de dazomet (g CP / m^3)	INISAV		San Juan y Martínez
	Phlegm of sugar cane composted	Black peat	Black peat
0	100 % *Pythium sp.*	100 %*Pythium spp*	*Aspergillus spp*
200(*)		0	No observed
200(**)	33 % *Pythium sp.*	0	No observed
300(*)		0	No observed
300(**)	83%*Fusarium sp.*	0	No observed
400(*)			
400(**)			

(*) bag (**) bulk

12.10 Micorriza vesicular arbuscular.

It is broadly accepted that the micorrizas fungi when inoculating them establish a mutually advantageous simbiotic association, improving in the plants the absorption of nutrients such as N, P, K, Ca, Mg, S, Cu, Zn, B and others, it increases the taking of water for the plants and it provides protection against pest and disease of the roots. In consequence with the above-mentioned is increased the growth and development of the plants and increases the yields, the use and costs of the fertilizers and pesticides diminish.

Under laboratory conditions satisfactory results have been obtained for the combat of ***P. nicotianae***. Investigations began under production conditions for the use of this fungi, the first test showed that the application to the surface of the tray, improves the quality of the root system and the growth of the seedling notably (Figures 31).

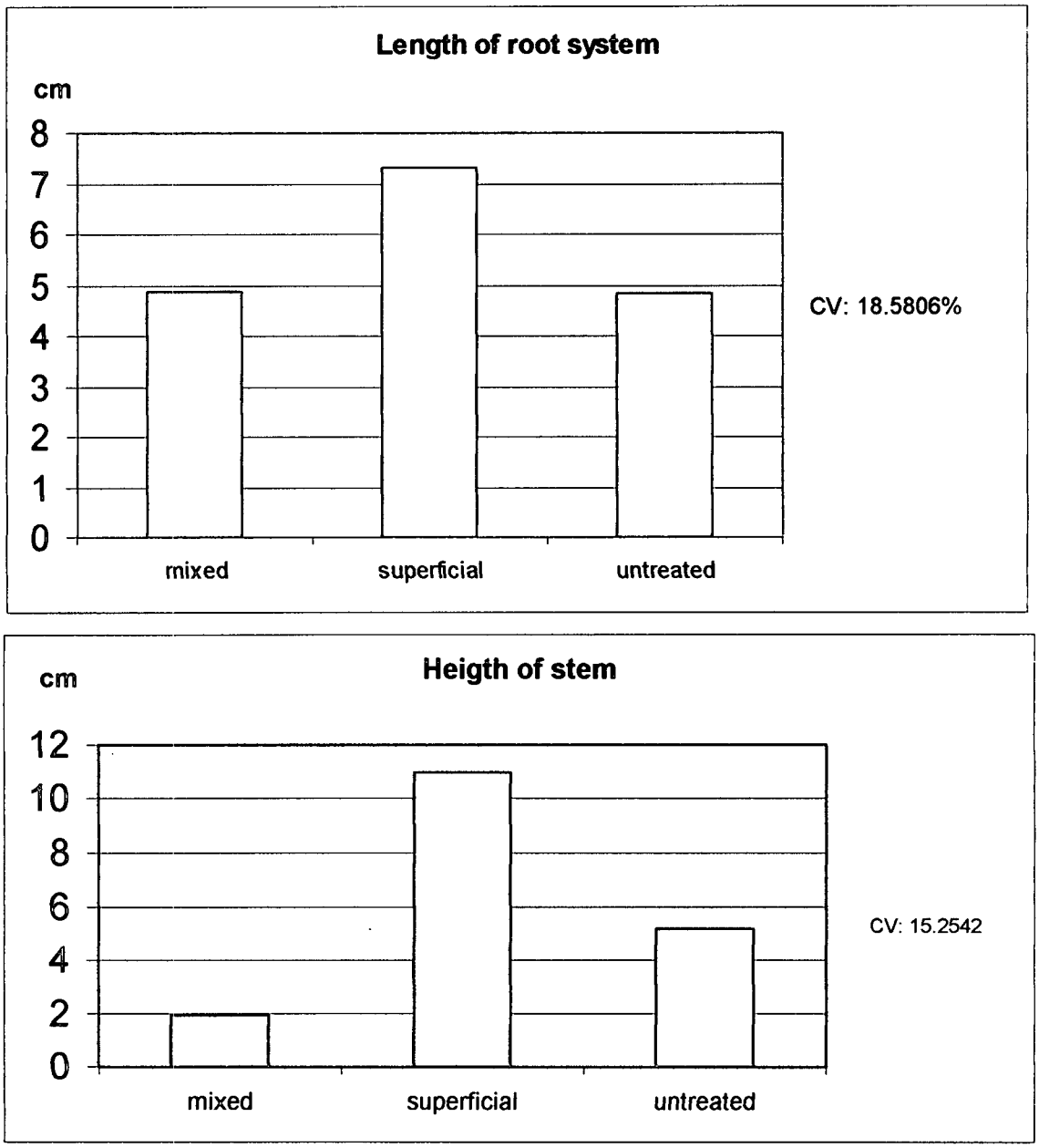


Figure 31. Micorriza (Emocic) evaluated in tobacco seedbed in floating tray. San Antonio de los Baños, 2002.

13 Total phase out of methyl bromide and national regulations derived.

13.1 Total phase out of methyl bromide in the tobacco cultivation.

In the tobacco campaign 1999-2000 was reduced the consumption from 80 tons to 66.9 tons, what it represent 16.4%. Of 253.15 ha of traditional seedbed tried with methyl bromide in 1998, 16.7% were eliminated.

In the year 2000, starting from the balance of the available quantities of methyl bromide in the warehouses for the tobacco cultivation, it was approved not to import more this substance for the tobacco cultivation, which represented an important decision of the DGSV with a view to giving execution to the project.

In the tobacco campaign 2000-20001 were released of the consumption of methyl bromide the municipalities of Consolación del Sur, Minas de Matahambre, Viñales and Guane in the province of Pinar del Río and in general the consumption decreased in 52.5%, which mean the elimination of 42 tons.

In the 2001-2002 tobacco campaign the program of methyl bromide elimination was completed successfully, since starting from the 2001 the product has not been used in traditional seedbed of tobacco, that which is shown in the figure 32.

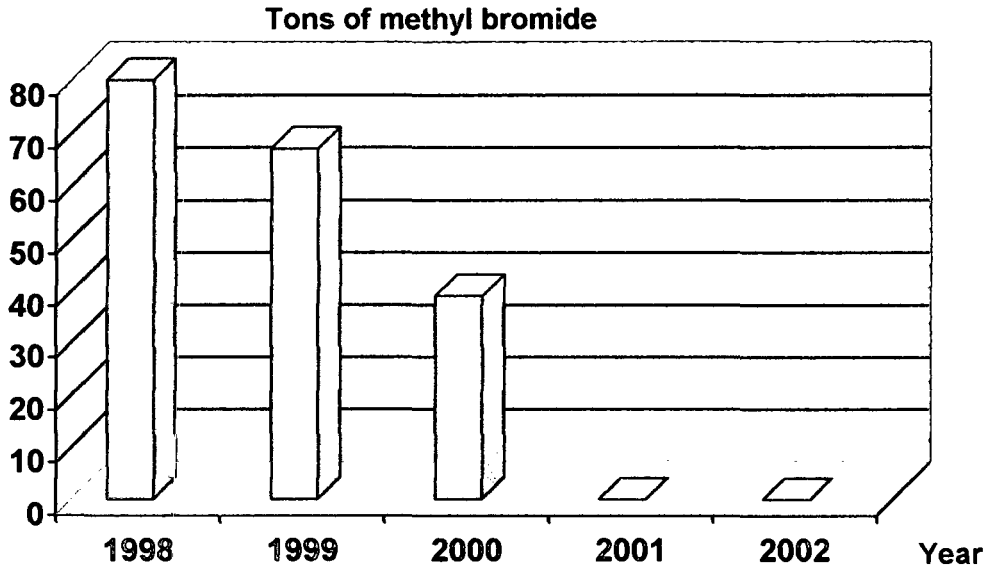


Figure 32. Consumption of methyl bromide in traditional seedbed of tobacco from the beginning of the project up to the 2002.

The consumption of methyl bromide for municipality enterprise of tobacco from the beginning of the project until its total elimination is summarized next (Table 45).

Table 45. Consumption of methyl bromide for tobacco municipality from 1998 up to the 2002.

Province	Municipality enterprise of tobacco	Consumption of methyl bromide in traditional seedbed (Tons).				
		1998	1999	2000	2001	2002
Havana	San Antonio de los	18.00	16.20	8.00	0	0
Pinar del Río	San Juan y Martínez	30.82	26.45	15.00	0	0
	San Luis	24.17	20.75	13.00	0	0
	Pinar del Río	4.08	3.50	2.00	0	0
	Consolación del Sur	0.67	0.00	0.00	0	0
	Minas de Matahambre	2.17	0.00	0.00	0	0
	Guane	0.03	0.00	0.00	0	0
	Viñales	0.06	0.00	0.00	0	0
Total		80.00	66.90	38.00	0	0

13.2 National regulations with regard to the use of methyl bromide in tobacco.

Take into consideration the premise contemplated in the document of the project where it was pointed out that once finished it successfully, no more methyl bromide will be used in the cultivation of tobacco in Cuba, the following measures settled down.

- In the official register of authorized pesticides was excludes the methyl bromide in tobacco.
- Methyl bromide has not been imported any more for the cultivation of tobacco since the tobacco campaign 2000-2001.
- The Agency of Environment has not granted environmental license to import methyl bromide for use in tobacco, it agency which belong to the Ministry of Science, Technology and Environment has the right to control the importation of methyl bromide according to resolutions No. 65/99 and 59/2000 that it regulates the imports and exports of ODP starting from January 1st, 2002, published in the Official Gazette.
- The Ministry of Science Technology and Environment has elaborated a resolution of importation and use of methyl bromide that excludes its use in the tobacco cultivation.
- Like alternative to the use of methyl bromide, moreover the soil sterilizes dicloropropeno + chloropicrin and dazomet have been evaluated and registered in traditional tobacco seedbeds.
- The Centre of Inspection and Control of the Environment (CICA) of the Ministry of Science Technology and Environment is in charge to give execution to the commitments pointed out, through the control of the implementation of the resolutions emitted and to dictate the pertinent measures.

14 Ecological, economical and social impacts of the floating try technology.

14.1 Ecological impact.

Some aspects very important of the floating tray technology in tobacco transplant production are the substantial reduction of the consumption of water, chemical and biological pesticides, fertilizers and fuel, in the figure 33 is shown the analysis of this items, which is based on the production of same quantity of plants in both tecnology. In all the cases the consumption decreases more than 67%, particularly important to the environment is the reduction of the consumption of chemical pesticides among them methyl bromide that is eliminated completely.

Likewise the necessary area for the production of same quantity of transplant decreases in 84 %, also this floating tray soilles tecnology allow the use of soil of low category for the agricultural production. The area release of traditional seedbed have been used for the agricultural productions of tobacco plantation and others crops.

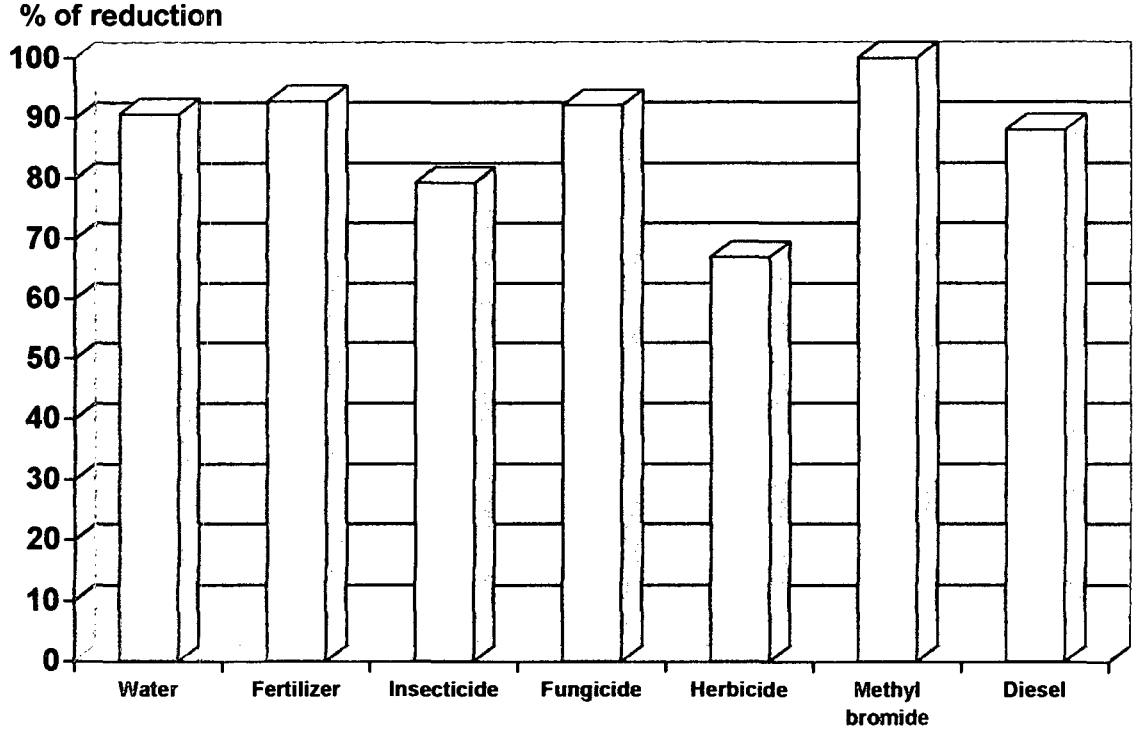


Figure 33. Reduction of the consumption of agrochemicals, water and diesel with the floating tray soilles technology regarding to the traditional seedbed.

14.2 Economical impact.

The floating tray soilles tecnology, from the beginning of its transfer to the producers has shown the economic advantage, because of the smaller production costs reached than the traditional seedbed. In the table 46 an analysis of production costs is shown, where the currency inputs are calculate on the base to produce the necessary transplant for 1 ha of open field tobacco plantation, including 12 % more to assure the replant of field. The main elements of costs of the new technology are the substrate, the salary and the paying-off the investment, this later only like a calculation base, since the producer has not to assume this expense. With respect to the substrate for the coming tobacco campaign this item could decrease notably its price and consequently to reduce the cost of production

with the new technology, the other important expense is the necessity to carry out extraction of plants from the alveolus and replant some seedling due to the sowing with naked seed, nevertheless these problems, the production costs decrease regarding to the traditional seedbed in 113.05 US$, what represents 17% less.

The smallest production cost take a look at the whole project in which 3 641.6 ha of tobacco crop were used tranplanted which came from the floating tray technology, it represents a saving of 411 683 US $ in the last year.

Table 46. Production cost to obtain transplant for 1 ha of tobacco plantation with floating try technology.

Annual input	Cost US$ /ha	
	Traditional seedbed	Floating try soilles technology
Substrate (m^3)	-	157.300
Seed (gr)	0.740	0.088
Water (m^3)	11.747	1.088
Fertilizer complete formulation (kg)	19.778	1.408
Nitrogen fertilizer (kg)	0.005	0.131
Pesticides (kg)	11.730	2.484
Basamid (gr)	11.070	1.254
Formol	-	0.613
Diesel	19.540	3.088
Salary	388.350	185.460
Others materials	127.86	-
Investment paving-off (m^2)	-	135.128
Indirect expenses	59.081	48.804
Total	649.901	536.846
Cost / thousand of transplant	15.667	12.942
Reduction of costs of transplant per 1 ha of open field tobacco plantation.		-113.055
% of costs reduction		17.4

14.3 Social impact

The massive introduction of the floating tray technology has bome better work conditions for the production of transplant. In many cases the selection of traditional seedbed requires to go away the peasant's areas and the production is carried out with an additional cost, however with the possibility of the micro tunnel near to the farmer house, all the actions of the family work are conditioned, on the other hand a source of acceptable employment has been created for women, since a great part of the operations of the technology they can develop easily (Figure 34).

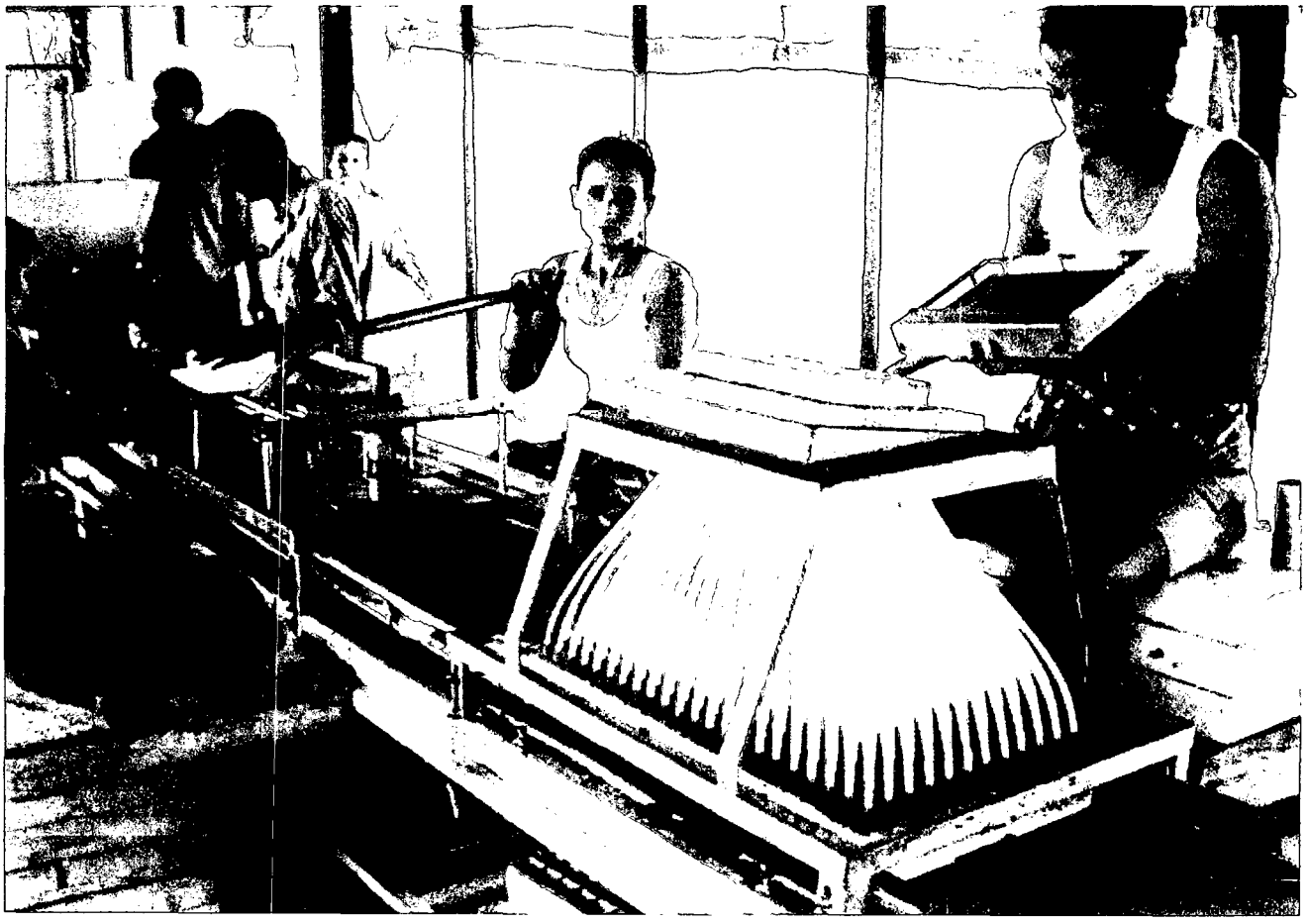


Figure 34. Incorporation of the women to the process of tobacco transplants production through floating tray technology.