Study report : VCC - Cirad collaborative research project on irrigated cotton cultivation

Mission VietNam 12 - 17/05/2002

J-M. Lacape, B. Michel, J. Pages

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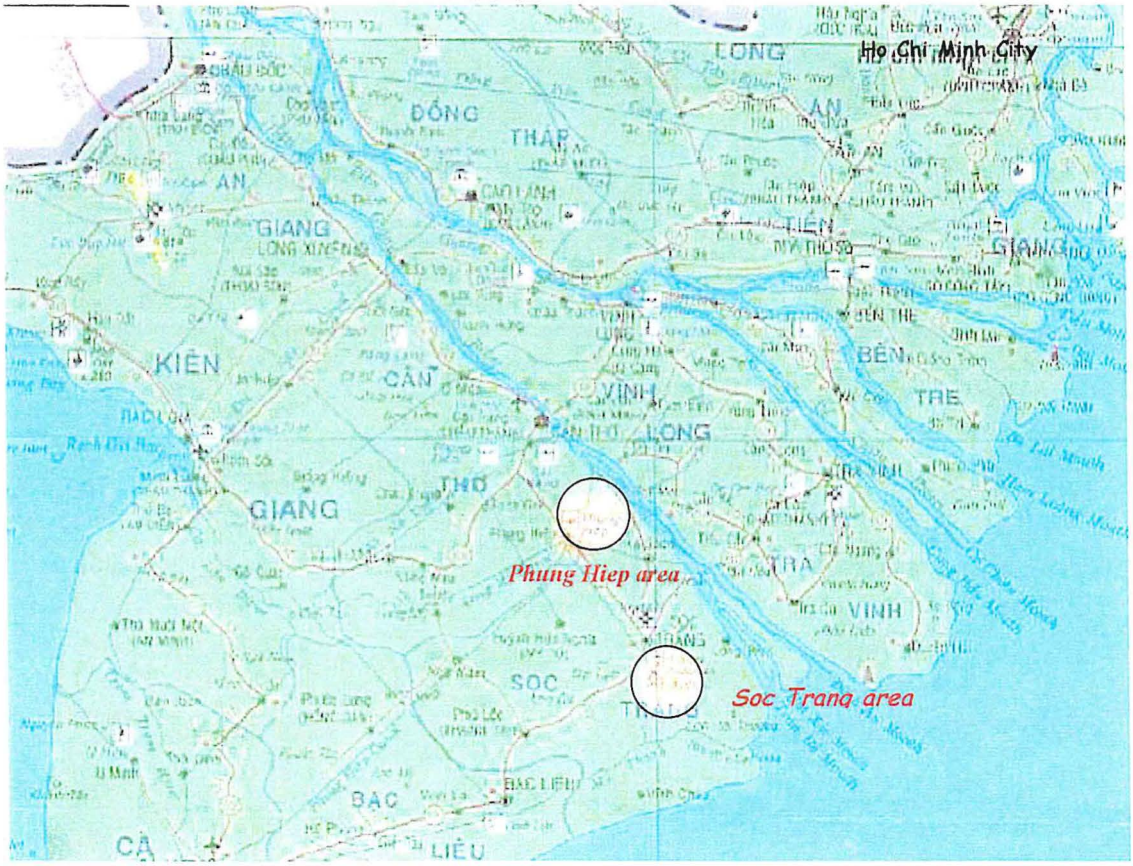
Preliminary note

The Cirad mission would like to thank Mr Nguyen Huu Binh, General Director of VCC for the kindness of his welcome as well as for the support of his institution all along its stay in Vietnam.

VCC staff from Ho Chi Minh offices as well as on the spot, in cotton fields, have been very attentive and ready to answer all the questions we might have asked.
In a rather limited duration, they managed to show us various situations all very interesting and helpful to assess the current status of irrigated cotton in Mekong delta area, and eventually to develop with them, the framework of a scientific collaboration, upon topics of mutual interest.

The mission team thanks VCC for this support and looks forwards to a fruitful partnership.

Map of the Vietnam southern area, showing visited locations



1. Mission objectives

Supported by AFD agency in Vietnam, and implemented jointly with the Vietnam Cotton Company staff and scientists, main objectives were to precise together with these last ones, the framework of a possible collaboration on irrigated cotton crop, based on the two partners' mutual expertise and fields of interest[1].

After field visits devoted to assess the current status of irrigated cotton conditions in Mekong delta, meetings and discussions had to be held in order to consider VCC development and research objectives and programmes. Eventually proposals could be elaborated and the general framework of a collaboration drawn.

2. Timetable and persons met

May 12th	Arrival at HCM City
May 13th	VCC Offices at HCM City Visits Farmers fields (Can Tho Province)
May 14th	Visits Farmers fields (Can Tho Province) Visits Farmers fields (Soc Trang Province)
May 15th	VCC Offices at HCM City with RICFC researchers
May 16th	VCC Offices at HCM City with RICFC researchers Wind-up meeting with VCC Gal Manager AFD Office in Hanoi, meeting with O.Gilard and Nguyen Thuy Anh CIRAD Office in Hanoi, meeting with RICFC Director
May 17th	Departure from HCM City

Nguyen Huu Binh	General Director, VCC
Le Quang Quyen	Director RICFC
Le Cong Nong	Vice-Director RICFC
Hoang Ngoc Binh	Vice-Director RICFC, Head Agronomy Dpt VCC (accomp.during Delta visits)
Pham Huu Nhuong	Vice-Director RICFC, Head Entomology Dpt VCC (accomp.during Delta visits)
Duong Viet Thanh	Vice-Head Agronomy Dpt VCC

[1] *It was also planned to carry out a synthesis of previous works carried out at the beginning of 80's, in order particularly to point out the major constraints identified to cotton production in the considered area. This synthesis could not be performed mainly by lack of available data.*

Nguyen Thi Thanh Binh	Head Plant Protection Division, RICFC
Ngo Trung Son	Entomologist, RICFC
Dang Minh Tam	Breeder, RICFC
Tran Thanh Dung	Agronomist, RICFC
Mai Van Hao	Entomologist
Christian Merer	Technical Councelor, French Consulate (HCM City)
Olivier Gilard	AFD Hanoï
Nguyen Thuy Anh	AFD Hanoï

3. Introduction

3.1. Presentation of VCC and RICFC

The Vietnam Cotton Company, VCC, is a state company involved in all aspects of cotton production in Vietnam, from technical research to trading and processing of cotton products, trough production of cotton seeds and provision of extension services to farmers. It is currently dealing with more than 90 % of the whole Vietnamese cotton production.
The VCC is based in Ho Chi Minh City, and has branches in all major cotton producing provinces.
Research activities, as part of the VCC, are conducted by the Research Institute for Cotton and Fiber Crops, RICFC, based in Nhaho, Ninhthuan Province. The 5 research departments of the RICFC are : Genetic and breeding, Plants protection, Agronomy, Fiber technology and Variety testing, and Field crops. Staff composition, major objectives and achievements of the different research departments are detailed in Annex 1.

3.2. Cotton production in Vietnam : present situation and forecasted evolution

Although textile industry in Vietnam has a long history and presently employs 800 000 persons, the country presently relies for 90% of its needs on imported cotton fiber.
Major features of the cotton production in Vietnam are as follows :

- Production is carried out in rain-fed conditions
- Cropping systems are diversified and intercropping is a rather frequent practice
- Seed are derived from 1st generation intraspecific *G hirsutum* hybrids

- IPM strategy is widely applied and can be considered as an exemplary success story when compared with other cotton producing countries
- « Cotton blue disease » transmitted by the Aphids in all regions, appears to be one of the most important constraint to production.

Cotton production has steadily increased in the five past seasons

Norms	Unit	1996/97	1997/98	1998/99	1999/00	2000/01
Area	Ha	10,676	11,716	19,963	17,705	23,250
Seed-cotton yield	Kgs/ha	640	940	810	990	1,100
Seed-cotton production	Tons	6,806	10,986	16,245	17,578	20,340
Fiber production	Tons	2,454	3,898	5,716	6,394	7,845
Cotton fiber imported	Tons	37,400	73,930	67,880	77,380	80,800

The production figures for the 2001-2002 season forecast 33.000 tons of seed cotton (11 300 tons of cotton fiber), produced out of 30.000 hectares. The goal of the Vietnamese Government and of the VCC is to boost cotton production in Vietnam, in order to meet at least 60% of the domestic demand by the year 2010, i.e. raise fiber production to around 80.000 tons of cotton fiber and surfaces to 115.000 hectares. Considering most recent government cotton development plans for Vietnam, these projected figures for 2010 would even reach 230.000 hectares and a production of 180.000 tons of cotton fiber.

The development of cotton production under irrigated conditions during the winter-spring dry season is expected to largely contribute to the increase of cotton production in Vietnam, as the targeted 230.000 hectares planned (government plan) for 2010 are equally shared between rain-fed and irrigated cotton productions.

Areas identified for promoting production of dry season cotton, are shared between the delta region of the Mekong river, also called Cuu Long (or « Nine Dragons ») delta region ; and the Central highlands and coastal regions. Within the Mekong delta, three provinces surveyed by the VCC, show greater potential for irrigated cotton production (Annex 2).

Northern mountainous areas of Vietnam have a past history in growing diploid *Gossypium arboreum* cotton, and account for around 3% of total production.

The period of the mission corresponded to the harvest period of dry season cotton.

The visits organised by the VCC involved around 10-12 locations in 2 provinces of the Mekong Delta, Can Tho and Soc Trang. According to VCC preliminary surveys in the delta region these 2 provinces have the highest potential, 8000 and 6000 hectares respectively. All the fields visited are farmers fields benefiting from a close supervision of VCC staff specially appointed in the region for the duration of the growing season. Supervision from VCC extension staff included a thorough follow-up of pest pressure, and the collection of field operations dates and details. Particular technical alternatives (density, use of growth regulators, genotype) proposed by VCC were tested in some cases, but no (except one) single-location nor multi local experimental design had been tested during this season.

4. Farmers fields visit in the Mekong delta region[2]

Field visits took place in the provinces of Can Tho (Phung Hiep area) and Soc Trang. In this area, cotton cultivation has been recently introduced and farmers did not have any prior knowledge upon this crop. First are presented the technical itineraries applied in each plot and secondary the general observations made on the pest incidence and agronomic context.

4.1. Visit report

Can Tho Province

The fields visited in the district of Phung Hiep. As a general feature this area is characterized by the soils of heavy clayish type, prone to flooding during the rainy season. As a consequence, the planting of dry season cotton can be delayed. Whatever the date of planting, availability of water does not appear as a limiting factor.

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[2] *See Annex 2 for general data on these provinces*

- farmer Duong Van Dinh.

Though no further commented by the VCC, an experimental design comparing different varieties had been set up in the vicinity by students/teachers from the University of Can Tho.

- Density trial. The trial (9 elementary plots of 10 rows of 10 m) compared 3 plant populations : 3.25, 5 and 7.5 plants per m^2 with 3 replications. Other particular operations were:
  - Direct sowing without tillage after sugar cane
  - 3 applications of Mepiquat chloride (commercial name Pix) at 50 ml/ha (30-35 days after sowing, DAS), 70 ml/ha (45-50 DAS) and 120 ml/ha (65-70 DAS)
  - 3 insecticides sprayings (additionally to the usual seed treatment using imidachloprid, aiming at controlling *Agrotis* and jassids)
  - split fertilizer application of 500 kg/ha of 18-8-8- 6S compound, as local application after emergence, and as side-dressing at flowering/ridging time

Varieties trial in farmer fields

- 0.6 hectare farmers field with new VN01-6 hybrid variety

- 0.2 hectare farmers field (preceding crop pumpkins) with hybrid variety VN15, sown Dec 25th , received fertilizer application, 1 application of Pix (50 ml/ha at 60 DAS), 1 insecticide spray against *Agrotis*, plants topped (VCC recommendation is to top the plants after 12 sympodia bear fruits), harvesting initiated 1st May. Cotton should be followed by sweet corn, then rice, before a second cotton crop.

- High-density field (120 000 plants/ha) of pure line variety CS95, with 3 Pix applications and 3 insecticide sprayings (2 against jassids and 1 against thrips)

Soc Trang Province

Several fields along the road from Phung Hiep to Soc Trang were visited. As a general feature the area is characterized by sandy-loamy soils, giving opportunity of earlier sowings than in the Can Tho Province. The choice of the location, usually near a canal or a water pond, allows for complementary irrigation. The proximity of urbanisation leads farmers to develop vegetable production system, either as a pure stand or as an intercrop with cotton. Cotton then is grown in order to provide a complementary income.

Cotton field in urban surroundings

The first farm visited shows a cotton field, twin rows intercropped with cabbages. Main observations are as follows :

- not defined hybrid variety, of high plants (1.2 to 1.4 m)
- plants are grown on ridges and irrigation is performed by means of furrows, every 4 days. Density is about 35.000 pl/ha.

- two application of pesticides (a.i. propargite and imidachlopride) have been carried out. A few *Dysdercus*, trialeurodes and cochenilles have been observed.

- an efficient weed control has been achieved through manual weeding.

harvested field (around 2 t/ha as yield) under reflowering : after Pix treatment at 65 DAS top plants bear clustered bolls

The second cotton field visited was located inside an area planted with fruit trees (mango, java apple) and eucalyptus, coconuts. It was noted there :

- a soil heavier than the previous one, allowing two successive rice cultivation, one during rainy season, and the next one grown on water stored in soil compartment after flooding,
- cotton is being cultivated as a replacement for this second rice crop,

- though a rather high pressure of *Dysdercus* damages to plants seem rather low,
- planting density is about 35.000 pl/ha

- 0.35 harvested field (sown Nov 25th), with 1 Pix application (70 DAS), average yield 2 t/ha

In both cases no damage linked to *Helicoverpa* has been reported.

4.2. General comments on pests and their control

Field visits took place at the end of the growing season. Consequently it has not been possible to collect data on the early-season and middle-season pests. According to the observation we did in the fields, the incidence of the late-season pests seems to be very low in the Mekong delta zone. The pests recorded were:

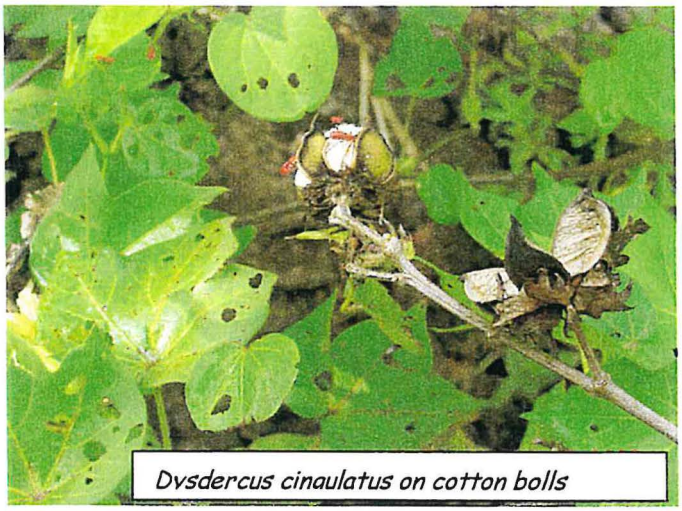
Sucking pests:

Amrasca biguttula : this Homoptera is one of the main cotton pests in South-east Asia. Most important damages are caused at the beginning of the growing season. Late attacks are generally of lower importance. Populations observed during field visits were very low.

Aphis gossypii : colonies were of no importance. The population density was very low and symptoms of attack were of no economic importance.

Aleurodicus disperses : this white fly belongs to the same family as *Bemisia tabaci*, but contrary to it, its incidence on the crop remains of no economic importance.

True bugs (Hemiptera Heteroptera) : in one field we observed the presence of *Dysdercus cingulatus* (Pyrrhocoridae) on the green and open bolls. Nevertheless, this insect was not represented by numerous individuals, and consequently its incidence on the production should be low. This bug



Dysdercus cinaulatus on cotton bolls

is a well known pest of cotton. Adults and larvae feed on the seed inside the bolls, and when the population is important, serious damage may occur.

One species of Coreidae (*Cletrini*) and Alydidae (*Riptortus*) have been observed in one field in Phung Hiep District. In this field the plant had grown again at the end of the season due to favourable weather conditions. These plants, with freshly developed organs, are attractive to the bugs.

Leaf-roller

Syllepte derogata: larvae of this Lepidoptera feed on the leaves. The level of damages was low and only a few plants were affected by this pest.

Bollworms

Helicoverpa armigera: very few larvae of this Lepidoptera have been observed in the fields, and the damage caused to the squares and the bolls was of no economic importance.

Earias vitella: only adults have been noted during the visit. The population was very low and no damage have been observed.

Pectinophora gossypiella: Only one larva was observed and the incidence of this pest was of no importance. No damage on seed-cotton was noted.

4.3. General comments on cropping systems and agricultural practices

Cropping systems observed, in spite of a rather wide diversity of situation and environment, showed good apparent results whatever cropping practices adopted : high/low density, crop rotation, varieties, water management, intercropping,...
The short duration of the mission anyway did not allow to extrapolate these observations, as only few plots have been visited and limited information on crop follow-up could be processed.

4.4. General comments on plants and breeding

During the mission, some of the farmers fields visited were planted with different varieties developed by the RICFC (hybrids VN06-1, VN15, classical

variety CS95), but no experiment comparing varieties had been set up. No time could be devoted to a visit to Nha ho research centre where most of research work is conducted. During the meeting in the VCC premises in Saigon, indications provided by the cotton breeder about its priorities and research activities for rainfed and/or irrigated cotton, were rather limited.

No particular programme has been initiated in relation to the development of genetic material for irrigated zones. Suggestion has been made to the cotton breeder that a separate pedigree selection programme could be undertaken aiming at developing improved germplasm suitable to specific constraints identified in dry-season cotton cropping system.

Due to the possibility of delayed planting (in relation with the end of flooding period) and to the prevalence of rainfalls at the time of boll split and harvest (beginning of the monsoon), a reduction of the duration of the cotton crop cycle appears as a requisite for cotton cultivation in irrigated zones. Cultural practices, like direct sowing, use of higher plant densities, control of plant growth with hormones, could be recommended for reducing the duration of the crop cycle. As regards plant material, the genotypes ideally suited for the above-mentioned types of cropping systems, should also be of a short and compact plant habit. Considering the expected high importance of jassids and thrips under irrigated conditions, attention need to be paid to the leaf hairiness of varieties. An identification of such type of genotypes, will only be possible after a thorough survey of genetic variability within the Gossypium genus germplasm available in Vietnam or in other countries .

Lastly, it has been confirmed that the Cotton Blue Disease, CBD, has gained importance in Vietnam and led to negative economic impact in all areas of rainfed cotton cultivation. Although no data is presently available as to the actual prevalence and importance of CBD in irrigated dry-season cotton fields, one may expect that the existence of populations of the aphid insect vector throughout the year, makes the CBD a potential threat for dry season cotton. Different plant material, identified as putative sources of resistance to CBD, had been imported from Africa and South America into Vietnam, and were all found susceptible after artificial transmission of the disease using infectious aphids. The only source of resistance identified so far at the RICFC, is the variety 'Nghe an' which belongs to the *G. arboreum* species. According to the pathologist of RICFC, artificial transmission using infectious aphids is presently routinely used at Nha Ho, but apparently no specific breeding programme is presently developed targeting CBD resistance.

5. Working meeting - Discussion upon Research priorities for irrigated cotton

As a first part of this meeting, RICFC scientists presented their priorities in terms of topics to be dealt with. Considering that cotton production was actually introduced in the delta region for the first time, the VCC and researchers of the RICFC could not invest in designing specific research protocols. On the contrary, and although they were not visited, experiments were held in 2001/2002 dry season in the other provinces (Central highlands and Coastal area).
Converging fields of interest between RICFC and Cirad have then been listed, as possible future themes for a co-operation.

5.1. Plant protection Department

In this field, major issues identified were :

- biology and ecology of cotton aphids, thrips and red spidermites, all pests which are considered as constraining heavily cotton cultivation. Thrips were characterized in the framework of a collaboration with Hanoi University 1.
- Biological control of these pests
- Assessment and study of insect pests resistance to chemical
- Elaboration of control measures for Cotton Blue disease, important constraint to cotton fields in Phu Hien, Binh Thuan, and Ninh Thuan.

5.2. Agronomy Department

Amongst others, activities concern :

- Elaboration of cropping system in irrigated environment : rotation, intercropping, crop succession and association
- Soil preparation : minimum tillage, no-tillage, direct sowing on living mulch, cover crop
- Water management and irrigation practices
- Cotton growth and behaviour modelling (training on "Cotons®" model)

5.3. Genetics and breeding Department

Research priorities have been presented as follows :

- Selection for early maturing characteristics and compact harvest.

- Production of varieties resistant to bollworms, aphids and Cotton blue disease
- Identification of varieties resistant to drought and salinity
- Storage over a long period of time of genes and gene bank management
- Molecular tools mastering for genome mapping.

6. Main conclusions

→ Visits of experimentation plots, located within farmers' fields and operated by farmers, under the close supervision of VCC technical staff, were mainly devoted to assess cotton crop adaptability and reaction to diverse technical alternatives : population density, type of soil preparation, pests management, varieties evaluation, use of growth regulators in the framework of intensified systems.
These alternatives have been devised from technical reference conceived on the base of VCC experience in cotton farming in other Vietnamese environmental conditions. Experimental protocol designed by VCC scientists are closely looked after by VCC staff posted in farmers' villages. As for all cotton growers, VCC has concluded an agreement with farmers hosting experiments, regarding input, technical advice, and production marketing. Moreover farmers, who have been selected on the base of sufficient land acreage as well as their open mind to progress and innovation, are covered against the risk induced by experiments, and VCC will compensate for any loss that might occur. Many observations have been recorded and should give key indications on cotton responses to test.
As a preliminary step, this approach is very promising to insure the collection of diversified information, and to help supporting cotton crop introduction. The lack of replicates and particularly the lack of multi-local evaluation of same alternatives, will arise difficulties to extrapolate the results to different situations. In the absence of an agro-environmental typology any farmer field will be specific and adapted technical guidelines not easy to define.
More generally considered, the need to quickly gather information on cotton crop behaviour, in a set of different situations, in order to define as fast as possible general recommendations to be transferred to growers, led VCC to give a reasonable priority to quick tests upon more evolved experimental protocol, which would have required more time and means.

→Research activities planned by VCC scientists cover a wide range of topics, relevant to the overall objective of developing good cotton production in irrigated areas.

These activities meets at various levels, Cirad's concerns in its contribution to cotton improvement and development.

A collaboration between Cirad and VCC may then be considered :

- on experimental protocols definition, in view of producing more general results that could be extrapolated to group of situations ;
- on precise research actions, either derived from information gathered on previous survey, or from VCC own analysis and local knowledge and expertise.

This collaboration could be implemented along at least three axis, sometimes jointly considered whenever necessary, through technical assistance, exchange on tools and methodologies, training and joint research project. The table n°1 attached, presents a synthesis of Cirad proposed involvement.

Besides these talks, VCC expressed interest in fibre technology, at laboratory level, and particularly in being associated in cross evaluation and round-test procedure. This topic has been added into Cirad projected activities, as an activity related to exchange in methodologies and tools.

6.1. Projected activities

▫ 6.1.1 Pests and crop protection

Biology and ecology of major pests - Studies of natural enemies

Aphids, jassids and thrips, probably the most important pests encountered in cotton fields, will be carefully observed in their diversity and behaviour.

→ Trapping and rearing should be implemented in order to precise populations dynamic and balances within the cotton-based ecosystem.

→ Besides, observation of natural enemies would be carried out and relationships between these two fauna and local environment and practices, should be pointed out.

Further to an increase knowledge on the crop biotic environment, this type of study would give relevant indication on the way to control cotton pests, in the framework of an integrated pest management project.

Chemical efficiency assessment

As crop chemical protection develops, pests and diseases evolve in order to adapt to this dynamic, and resistance to pesticide leads chemical firms to elaborate new molecules.

Cirad is currently carrying out research on the mechanisms underlying pests resistance to pesticides and protocols and experimental designs have been developed in this objective.

→ These technologies transferred to VCC scientists could be applied to local pests and chemical.

→ Meanwhile comparative evaluation of the most commonly encountered chemical would be engaged in order to contribute to the elaboration of cultivation guidelines.

Cotton blue disease : causal agent characterisation and plant-insect vector relationships

Introduction of resistant cultivars developed in South America proved inefficient to control this viral disease, identified as one of the constraints to cotton production in Asian countries, and more particularly in VietNam, in Ninh Thuan and Binh Thuan provinces.

→ The virus has been isolated in Hanoi University laboratories and studies are being carried out in order to more precisely characterize this pathogen.

→ As far as plant protection is concerned, there is a need to acquire more knowledge on plant-vector relationships, and linkage with environment and farming practices.

Methodologies and protocols should be shared in the overall framework of a regional project to be set up in partnership with Thailand institutions (Kasetsart University and Cotton Research Centre), as well as European ones (Gembloux University and Cirad).

▫ 6.1.2 Plant breeding and genetics

Exploitation of cotton blue disease resistance, CBD, from G. arboreum 'Nghe an' variety through interspecific breeding

The primary goal of the RICFC cotton breeder should be the survey a larger genetic germplasm, as no other source of resistance apart from *G. arboreum'* 'Nghe an' has so far been identified. Meanwhile it is suggested that RICFC

approaches other cotton research institutions, including possibly Cirad for importing new accessions from wide geographical and genetic origins.
Among other Gossypium species, *G. arboreum* belongs to the secondary gene pool which includes genetic resources that require some level of manipulation to obtain fertile hybrids. An introgression of genetic factors of resistance from the *G. arboreum* variety (of poor economic and technological value), into some high yielding and high quality *G. hirsutum*, requires a particular mating design allowing interspecific diploid-tetraploid genetic recombination to occur.
A strategy has been proposed to the breeder and pathologist of RICFC to exploit the resistance from 'Nghe an' variety. Methods described in Annex 3, as pseudophyletic and aphyletic methods, for example, could be developed whereby 3 genetic materials are used: the "donor" A_2A_2 diploid *G. arboreum* species, the $A_hA_hD_hD_h$ tetraploid *G. hirsutum* "recipient" species, and a third species of the diploid D_xD_x genome, designated as "bridge" species. The proposed method requires specific techniques used in interspecific breeding, like use of colchicine for chromosome doubling, or use of phytohormones for embryo rescue or reducing premature fruit abscission.

→ Cirad proposes to share with VCC its expertise through : - training on breeding techniques, - providing seed of particular genitors if not available at Nha Ho centre, and - undertaking part of the crosses process in its greenhouses in Montpellier.

Development of a breeding program for irrigated zones

→ After having reviewed the collection of accessions available in Nha Ho research centre, Cirad cotton programme proposes to put at RICFC's disposal, seeds of complementary cotton varieties matching criteria of earliness, compact plant habit and high leaf hairiness. These accessions will then be used as genitors in crossing with the locally adapted genetic material. Further selection from these source populations may either use a pedigree method or a recurrent method.

▫ 6.1.3 Cropping techniques and agronomy

Cropping system studies : analysis and typology

In order to support the extrapolation of the results derived from experimental plots, the diversity of situations must be apprehended through farming system studies.

→ Data at farm levels, as well as environmental characteristics, will be collected in the area, following methodology based on inquiries, surveys, and sampling.

→ Typology which will be set up later on, will group situations following key parameters, so that it will be possible to address specific problems and implement technical practices in a more relevant way.

Crop modelling

Cirad's software Cotons® has been devised to simulate cotton plant growth under specific environmental conditions and agricultural practices. The use of this model can support the design of experimental protocol, giving key indications regarding data to be collected and expected results.

→ Following previous exchanges between Cirad and VCC staff on this issue, as a preliminary step the software would be put freely at VCC scientists disposal.

→ Further on, Cirad scientists should assume the training of personal in charge of its adaptation to local environmental conditions.

Cover crop and direct sowing

This topic deals with the use of a selected cover crop and the conservative tillage technique, as a means to shorten cultivation cycle, while improving water and soil fertility management, saving labour and eventually restoring ecological balance of cropping system.
It is a rather issue, based on environmental knowledge, and adaptation of direct sowing technique within local cropping system.

→ In the collaboration herein considered, links with farming system studies previously considered should be established. Expertise in botany should be mobilised in order to identify the major constraints in terms of weed pressure, as well as the more suitable cover crop to be developed, according to farmers strategy (based on labour saving, on maximum profit earning, on risk reduction,...).

→ Experiments devised to assess the suitability of cover crop should be developed and incidence on farming practices monitored.

This topic should be tackled within the framework of a regional cooperation involving together with VCC, the Vietnam Agricultural Sciences Institute, Kasetsart University (Thailand), the National Agriculture and

Forestry Research Institute (Lao Rep.). Actions have already been undertaken in these institutions, in close partnership with Cirad posted scientists.

A regional agro-ecology project is planned and VCC could eventually be part of its preparation and implementation.

▫ 6.1.4 Fibre technology laboratory

Cotton fibre technology: results validation and integration of Nha Ho laboratory into international network

In the framework of its Fibre technology and Variety Investigation Department, the RICFC in Nha Ho centre has a well-equipped fibre technology laboratory and conducts determination of both classical and HVI fibre parameters. A technologist from RICFC had a training session on HVI measurements in Montpellier in 2001.

→ Although this could not be directly discussed with the head of the technology department, Cirad proposes to provide support to the VCC/RICFC in the field of data calibration and to contribute to RICFC laboratory integration into international round tests. Such support from Cirad would mainly require the exchange (from France to Vietnam and vice versa) of cotton fibre samples jointly analysed within the 2 laboratories.

6.2. Proposed modalities of implementation

As a result of the previously described exchanges, implementation of the various interventions, should be settled in the framework of a collaboration for which modalities and duration still need to be discussed between partners.

From Cirad's perspective, proposed guidelines should be as follows :

- **duration** of the collaboration : 3 years
- **objective** : mutual exchange of expertise ; VCC capacity building ; cotton development-led scientific production ;
- **means** :
  - human resources (scientific and technical) from both partners, to be completed whenever necessary by other national Vietnamese institutions

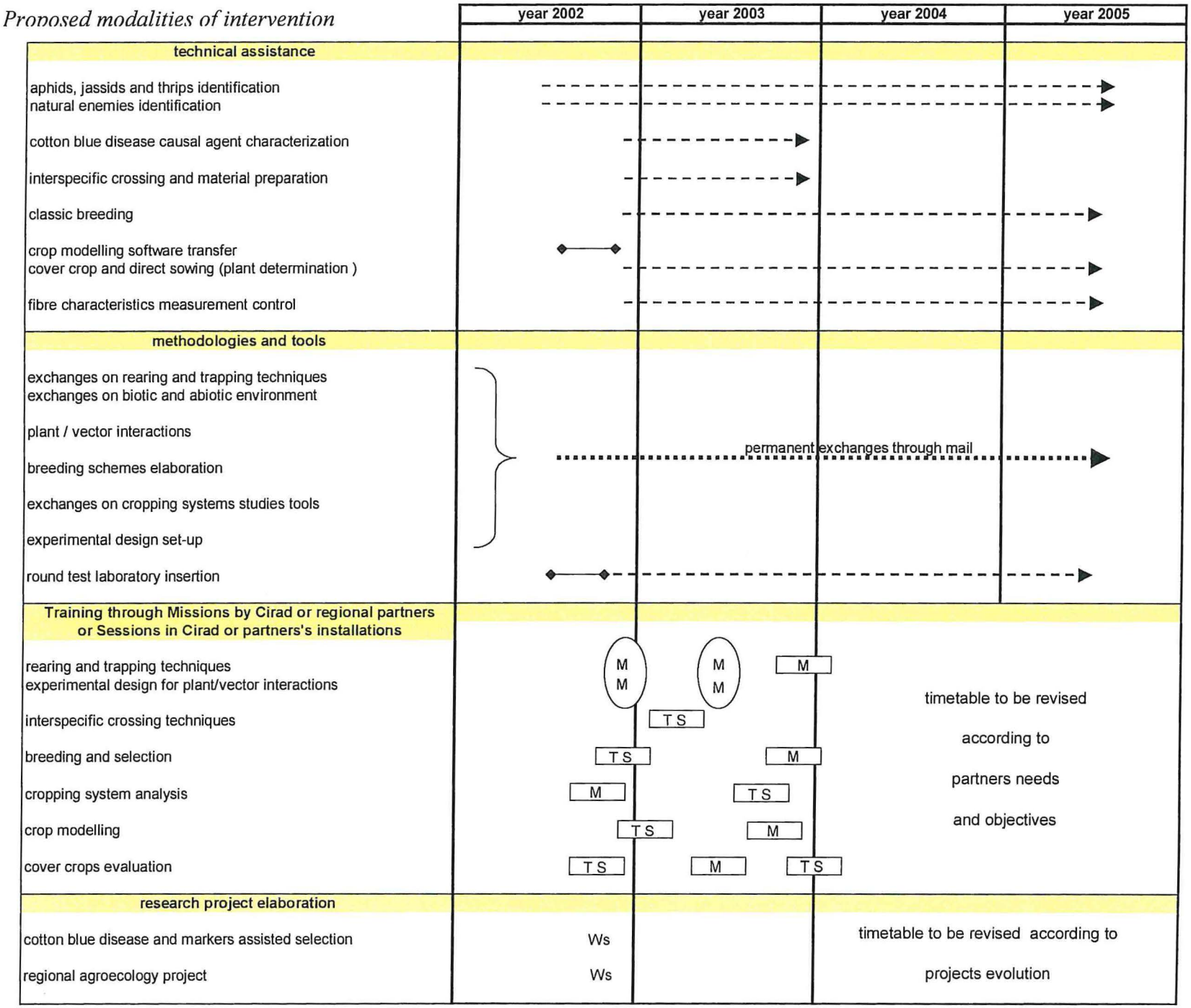
(University, national agencies) or regional ones (in the network of Cirad regional partnerships)
  - funding : to be requested to French national donors (AFD, MAE), and eventually completed by VCC and Cirad own budgets.
- **timetable** (see table 2. attached) :
  - as far as technical assistance is concerned exchanges on methodologies and tools will be carried out, on a continuous basis all along the duration of the collaboration.
  - for training support, a programme can be devised for the two first years. It will then be redefined to match the evolution of different activities and the new requirements that could be identified.

In order to implement the previous collaboration, it is proposed to set up a small joint **coordination unit**, which would oversee the development of activities, evaluate results, propose new orientations and contribute to develop new projects. This unit could meet once every year in Vietnam, before the beginning of cotton cultivation period.

Table 1. *Projected Cirad intervention within the framework of a partnership with Vietnam Cotton Company upon irrigated cotton systems. Synthesis*

Topic	Technical assistance	Methodologies and tools	Training	Joint research project
Plant protection				
Biology and ecology of aphids, jassids, thrips	Identification	Rearing techniques Trapping techniques Climatic environment characterisation Population transfer within ecosystem	Local by CIRAD scientists Local by CIRAD scientists	
Natural enemies	Identification	Rearing techniques Population transfer within ecosystem	Local by Cirad scientists	
Chemical efficiency assessment		Assessment techniques for systemic products Experimental design Products differential evaluation		
Cotton blue disease: plant – insect vector relationships		Plant / vector interaction experimentation	Local by Cirad scientists	
Genetics				
Interspecific crossing for transfer of cotton blue disease resistance	Crossing and material preparation in Montpellier laboratories		Crossing techniques in CIRAD laboratories	Marker Assisted Selection for resistance to CBD, development of a regional project (VCC, Cirad, Gembloux, Kasetsart Univ.)
Classic breeding for early maturing, compact harvest and hairy varieties	Delivery of potentially adapted material by Cirad laboratories	Breeding schemes		
Agronomy				
Cropping systems analysis		Cropping system studies On-farm surveys Data processing and typology	Local by Cirad scientists	
Crop modelling	COTONS software transfer	Data collection to set up local parameters	Local by Cirad scientists or in Cirad laboratories in France	
Cover crop and direct sowing	Botany	Experimental design for cover crop evaluation	Within Vietnam or at regional scale with Lao and Thailand	Regional agro-ecology project (FSP VN/ Laos) PCP Cirad
Fibre technology				
Cross evaluation and round test collaboration	Fibres sample analysis	Insertion in round-test procedure		

***Table 2**. Proposed modalities of intervention*



M : missions by CIRAD scientists T S : training sessions W s : regional projects preparation workshops

Annex 1 : VCC presentation and research programmes (VCC documents)

1- Research institute for cotton and fiber crops (RICFC)

1- HISTORICAL BACKGROUND

Research Institute for Cotton and Fiber Crops (RICFC) is the unique institute for cotton research and other crops in Central Southern part of Vietnam. Before liberation, in 1956, its name was Center of Agriculture-Forestry-Domestic Animal. Then, in 1964, it became National Centre for Research and Training Agricultural. After liberation, in 1975, it was renamed Nhaho Agricultural Centre. January 26, 1977, founded Agricultural Technical Centre in Central Southern part signed by Minister of the Ministry of Agriculture and Rural Development. ON 19th March 1982, it was named Cotton Research Centre belongs to Vietnam Cotton Company. And now, it is Research Institute for Cotton and Fiber Crops (RICFC).

RICFC is located at Nhaho village, Ninhson district, Ninhthuan province, on the right of National road 27th (Phanrang town to Dalat city). It is 14 km away from Phanrang town to the West.

The number of staffs now is 186 persons include : 11 PhD, 3 M.Sc, 59 B.Sc, 36 technicians and 77 workers. The cultivated land for experiments and seed production is 110 ha.

2- FUNCTION OF RICFC

- Basic investigation, carry out the experiments of agricultural techniques on cotton and other crops.
- Training staffs, technical workers for stations, for cotton growers and farmers.
- Collection, maintenance and evaluation of cotton, grape and other crops germplasm.
- Research on genetics and cotton breeding
- Research on entomology, pathology, weeds and integrated pest management on cotton and other crops.
- Research on plant physiology, soils, water management, fertilizers, crop season and agronomical practices on cotton and other crops.
- Research on cotton fibre technology.
- Research on economy of cotton and fibre crops.
- Collection and supply the advanced techniques and information for extension technology and training staffs.
- Transfer advanced technology to farmers in cotton regions of Vietnam.
- International cooperation in scientific research fields, education and training of researchers.

3- ORGANIZATION

Director Board of RICFC

Director	**Ph.D Le Quang Quyen**
Vice Directors	**B. Sc Cu Xuan Toan**
	Ph.D Hoang Ngoc Binh
	Ph.D Ngo Trung Son
	Ph.D Le Cong Nong
	Ph.D Nguyen Minh Tuyen

- 5 research departments : Genetic and breeding, Plant Protection Agronomy, Fiber technology and Investigation varieties, Department of Field Crops.
- 2 Research stations in Southeastern region (Ho Chi Minh city) and Central Highland (Buon Ma Thuot City).
- Production and Experimentation Center (Nhaho-Ninhthuan prov.).
- 3 Functional departments : Scientific and Transfer Technology, Financial and Accounting Administration and Personnel Office.

4- SCIENTIFIC RESEARCH POTENTIALS

Genetic and Breeding Department

Comprises of 12 staffs : 1 Phd, 1 M.Sc, 5 B.Sc, 1 doing post graduated and 4 technicians. This division comprises of 3 research groups with following duties :

- Collection and introduction of new varieties. Maintenance and evaluation the cotton germplasm over 1.600 entries to supply good materials for breeding purposes
- Breeding new varieties with high yield, high ginning out turn, good fibre qualities, resistance to insect and disease and high adaptability to difference regions.
- Research heredity an important economical characteristics on cotton.
- Research heterosis on cotton.
- Research on using CMS and GMS lines to produce hybrid seed.

Plant Protection Department

Comprises of 9 staffs : 3 PhD, 4B.Sc, and 2 technicians. This division has 2 research Groups and 2 laboratories with tasks :

- Research on entomology.
- Research and producing bio-insecticides such as NPV, Divicin, etc.
- Research on plant pathology.
- Research pest resistant management.
- Research Integrated Pest Management (IPM).

Agronomy Department

Comprises of 9 staffs : 1 Ph.D, 7 B.Sc, 1 technician with following duty of research on :

- Methods and techniques of cultural practices.
- Effects and doses of fertilizers.
- Cotton physiology, plant regulators for cotton and other crops.
- Analysing the soil characteristics to serve for research works of soil science and agro-chemistry.
- Biotechnology : the tissue culture experiments to serve research works on cotton and other fruit crops.
- Weed control.

Fiber Technology and Investigation Varieties Department

Have 6 staffs : 1 Ph.D, 4 B.Sc, 2 technicians with tasks :

- Testing adaptability of new varieties on cotton and fiber crops growing regions :
- Research on methods to improve of cotton fiber quality.
- Analyzing of cotton fiber samples
- Research on the effect of genotype, environment (climate, weather, soil, locality, season, practices, picking, stores and ginning) and interaction between genotype and environment.
- Testing seed properties for cotton breeding program and other purposes
- Responsibility for fiber manager, adviser, consultant and umpires for Vietnam Cotton Company (VCC).
- Cooperating with : Vietnam textile garment research institute, Cotton companies, and international cooperation.

Department of Field crops

Comprises of 6 staffs : 4 B.Sc and 2 technicians with following studies on :

- Food crops : rice, corn, and beans.
- Sugar cane.
- Fiber crops : sisal, jute, and mulberry
- Fruit trees : grape, longan, cactus, mango etc..

Southern Research Station

Comprise of 10 staffs : 1 Ph.D, 9 B.Sc., , with following duties to :

- Research and carry out scientific experiments in provinces of Southern Vietnam.
- Transfer technology to farmers

Central Highland Research Station

Comprises of 13 staffs : 1 Ph.D., 1 M.Sc., 9 B.Sc and 3 technicians, with duties are :

- Research and carry out scientific experiments in Daclac, Gialai, Binhdinh, Phuyen, Quangngai and Guangnam provinces.
- Transfer technology to farmers in the above regions.

Production and Experiment Center

Comprises of 82 staffs : 2 B.Sc. and 80 technician workers with following duties :

- Organization to multiply the new seeds.
- Seed production : cotton hybrids, rice, corn, grape and beans to provide for different regions.
- Processing of cottonseed and pre-processing cotton fiber.

Scientific and technology transfer division

- Management the research program of RICFC.
- Transfer advanced technologies

- Cooperation and training

Library

The library of RICFC comprises of :

- 950 books and journals in Vietnamese.
- 420 books and journals in English
- 1.100 books and journals in Russian
- 130 books and journals in French
- Books and journals in Chinese

5- ACHIEVEMENTS

Cotton Variety

- Cotton varieties released :
  - Normal cultivars : THI,TH2, MCU9, TM1, D16-2, LRA 5166, C118
  - Hybrids : VN20, L18, VN35, etc...
- Complete the procedure of hybrid seed production with lower price than imported seed to 60-70%. Nowadays, RICFC can the supply enough cotton hybrid seed for cotton growing regions in Vietnam.

Plant Protection on cotton

The advanced techniques have been applied to cotton production are :

- Use bio-insecticides NPV, Ha Divicin to control bollworm (*H. armigera*), *Spodoptera exigua* on cotton, onion and beans.
- Building up and applying successfully the IPM system on cotton to reduce number of insecticide application from 15-20 times to 1-3 times/cotton season.
- Estimated the dynamics of pests and their natural enemies on cotton regions in Ninhthuan, Daclac and Dongnai.
- Methods of controlling cotton diseases as blue disease, seedling disease, boll rot and leaf blight diseases.
- Research on seed treatment with Gaucho to protect cotton plant free from aphids and jassid to 70-80 days after sowing.
- Investigation of pests and diseases on grape and the effective control methods to produce the safe product.

Agronomy

- Recommendation of the optimum sowing time for all cotton regions.
- Builts up and applied the intercropping systems with cotton and cultural packages for cotton and other crops as soybean, mungbean , corn with high economical effectiveness.
- Determined the optimum doses, method of fertilizer application for cotton.
- Establishment of the land using and agro-chemistry map for RICFC and for Ninhthuan province.
- Successful study on production and utilization of microelement fertilizer : VCC and plant growth regulators for cotton and other crops.

Other field crops

- Research on grape, varieties released : NH. 01-48, propagation and grafting new grape fruit to production in Ninhthuan province.
- Evaluation and maintenance of over 60 germplasm of grape.
- Released new rice varieties to Central southern part as IR84-23, IR50404, IR205, TH.6, OM269-65, IR620-32, etc...
- Application intensive farming method of rice production to increase yield potential for Ninhthuan province.
- Building up guideline for hybrid seed production in the region, sugar cane and other crops.
- On other fruit tree : cactus, mango, longan, custard-apple, apple, orange.
- Research on sisal, agave, and jute.

Seed production

RICFC produces annually 20-30 tons of cotton hybrid seeds, 800-1000 tons rice, 200 tons of maize to supply different regions in Vietnam.

2- Plant protection division

1- PLANT PROTECTION DIVISION

1. Research staff

Total : 9 members.
Ph.D : 3 (1 entomologist, 2 plant pathologists).
B.Sc. : 4 (3 entomologists, 1 plant pathologist).
Technicians : 2

2. Laboratories : 2 (Entomology and Plant Pathology).

2.1 ***Entomology laboratory***

- Refrigerator (2)
- Oven (1)
- Binocular (1)

2.2 ***Plant Pathology Laboratory***

- Refrigerator (1)
- Incubator (1)
- Autoclave (1)
- Microscopes (2)
- Oven (1)
- Microtome (1)
- Balance (1)
- Centrifuge (2) with 10.000 and 5.000 RPM.
- Simple wood culture chamber (1)

3. Research subjects

3.1 ***Entomology Laboratory*** (4 researchers and 1 technician)

- Cotton insect pests, their natural enemies and their dynamic in cotton-grown regions of Vietnam
- Biology and ecology of main insect pests and their natural enemies.
- Production technique and technology of major biological agents and their application in fields.
- Chemical insecticides efficacy and their application.
- Management of american bollworm resistance to insecticides.
- Cotton varietal resistance to jassid and american bollworm.
- Development and improvement of cotton IPM Programme in Vietnam.

3.2 ***Plant pathology laboratory*** (3 researchers and 1 technician).

- Cotton diseases : blue disease, false mildew, Rhizoctonia leaf spot and boll rot, bacterial blight, seedling damping-off (distribution, symptoms, losses, causal agent, host range, epidemiology, infection reservoirs, isolation ...).
- Cotton varietal resistance to diseases.
- Control measures.
- Development and improvement of disease control aspects, which associated with cotton IPM Programme in Vietnam.

4. The studies have done

- Biology of insect pests : american bollworm, lesser armyworm, jassid, and some aspects of cotton aphid, pink bollworm.
- Biology of natural ennemies : Thrichogramma sp., predator stink bug (*Eocanthecona furcellata*).
- The number of species and dynamics of insect pests and their natural enemies in Dong Nai, Ninh Thuan, Dak Lak : 171 insects species and spiders are found in cotton fields ; main insect pests are american bollworm, lesser armyworm, semi-looper, pink bollworm, spiny bollworm, jassid, cotton aphid, thrips red mite ; more than a half of them are beneficial ; there are many parasitoids.
- Production technique and technology of NPV-Ha, NPV-Se, *Trichogramma*, technique of rearing *Eocanthecona furcellata* and their application.
- Blue disease : symptoms, losses, distribution, vector and transmission, host range and infection reservoirs, some of control measures.
- Rhizoctonia leaf spot and boll rot, false mildew : symptoms, damage, distribution, causal agent and some aspects on infection inoculums control measures.
- IPM programme applied in cotton production : 1) Resistant varieties to jassid, bacterial blight ; 2) Cultural practices : Compact sowing time, field sanitation, rotation, intercrop with beans and/or maize, PIX and KNO_3 application ...3) Biological practices : conservation and augmentation of natural enemies, use of bio-agents such as NPV, Bt ; 4) Chemical practices : non-chemical application before 70-80 days after sowing, 1-2 sprays for jassid of american bollworm at late season, 1-2 sprays for diseases at early and late season.

5. Orientations in next years

5.1 Entomology laboratory

- Biology and ecology of pink bollworm, cotton aphid, jassid, thrip, redmite and distribution in cotton grown regions.
- Incidence of sucking insects to quality of cotton lint and measures to overcome
- Rearing technique and production technology of some main enemies of cotton insect pests.
- Chemical insecticides efficacy and their application for major insect pests.
- Continue studying american bollworm resistance to insecticides.
- Evaluate new cotton varieties on resistance to jassid and american bollworm.
- Continue developing and improving of cotton IPM Programme in Vietnam.

5.2 Plant Pathology laboratory

- Study on seedling damping-off: losses, its distribution, causal agent, infection inoculums, control.
- Study late season diseases (false mildew, Rhizoctonia leaf spot and boll rot, other boll rots...) : losses, their distributions, causal agents, infection inoculums, control.
- Study on causal agent of Blue disease.
- Cotton varietal resistance to diseases, especially blue diseases.
- Improve efficacy of control measures for cotton diseases
- Continue developing and improving of disease control aspects, which associated with cotton IPM Programme of Vietnam.

5.3 Other tasks : Studies on grapevine

- Main insects : Thrips and lesser armyworm
- Main diseases : Downy mildew, Powdery mildew, Bunch rot (Diplodia), Anthracnose, and Rust.
- Control measures (the most important because nowadays farmers use 25-60 chemical sprays for insects and diseases on grapevine).

6. Needs

6.1 Training and education

- Training and biotechnology
  - Methodology in studying viruses, bacteria, fungi and nematodes that cause diseases of cotton and insect pests.
- Cotton entomology and pathology

6.2 Equipments

- Shaker
- Environmental chamber (for research work on insects, spiders).
- Dew chamber (for research work on plant diseases).
- Polarizing microscope with camera.
- Camera for scientific pictures with extreme close-up distance (for insects and diseases).
- Thermohygrograph
- Water bath.
- Tissue embedding console system.

3- Agronomy department : some problems to discuss with Cirad

1. ACTIVE CAPABILITY, FUNCTIONS AND TASKS OF AGRONOMY DEPARTMENT

Comprises of 9 staffs : 1 Ph.D, 1 M.Sc, 7 B.Sc (1 doing post graduated) having two laboratories : Soil chemistry and tissue culture labs, with following duties :

- Study on characteristics of cotton soils.
- Study on methods and techniques of cotton tissue culture.
- Study on effects and doses of fertilizers for cotton.
- Study to produce and use fertilizer, stimulants for cotton and other crops.
- Analysing the soil characteristics to serve for research works of soil science and agro-chemistry.
- Study on cotton physiology
- Carrying out the tissue culture experiments to serve research works on cotton and other fruit crops.

2. RESEARCH SITUATION

Agronomy department now has 2 laboratories :

- Agro-chemical lab
- Cultural tissue lab

* Agrochemical lab

- *Equipments had* :
  - 1 spectrometer analyse Potassium, Sodium, Litium
  - 1 old photometer at 1970s
  - 1 Hanla pH meter of Portugal
  - 1 German dryer 2 phases – 3 phases
  - 1 damaged shaker
  - 1 vacuum dryer

Analyse physiological and bio-chemical norms of soils as : Ph, N, P, K total and available ... Analysing of soil capacity, soil density and micro elements aren't carried out due to lack in equipments.

- *Equipments need*
  - 1 set Keldal unit analysing N
  - 1 spectrometer to analyse phosphorous and micro elements
  - 1 nutrious photometer
  - 1 set of automatic pipet
  - 1 pH meter
  - 1 automatic standard pipet a set
  - 1 vacuum cleaner
  - 1 shaker

* Tissue culture labs :

- 1 double chamber for tissue culture (Vietnam product)

- 1 Russian autoclave 100 litre (old)

- *Equipment need*
+ 1 culture tissue chamber
+ 1 autoclave
+ 1 depth refrigerator
+ 1 artificial light system and 1 air conditioner
+ Low velocity shaker
+ 1 set of tissue culture kits
+ 1 pH meter
+ 1 analyse balance 210g type

* Physiological research

Equipment had
+ 1 area meter
Equipment need
+ 1 net assimilation rate machine
+ 1 Chlorophyll content in leaf

3. RESEARCH RESULTS IN VIETNAM

3.1 Photosynthesis of cotton

Leaf area index (LAI) of cotton

Research results on leaf area index (LAI) of cotton shown that, from sowing time to 50 days after sowing (DAS) cotton leaf area increases slowly. Expansion of canopy cover and LAI is slow 0,73-0,95. From 60-100 DAS, leaf area index and canopy cover reach maximum at 100 DAS (LAI is 4,35-4,57 corresponding to CS95 and VN15 cotton varieties). The period at 110-150 DAS, leaf area decreases quickly LAI is about 1,07-1,16. Hybrid VN15 is dominant over pure cotton CS95 in the expansion and development of leaf area. The question is to make suitable conditions for cotton to reach early maximum leaf area and maintain leaf longevity is necessary to increase fruit setting and yield.

Net assimilation rate (NAR) of cotton

Net assimilation rate of cotton varieties is high in the period from sowing date to 50 DAS. Net assimilation rate reaches 9.8-10.8 $gm^{-2}d^{-1}$. From 60 DAS onwards NAR reduces gradually remain 8.0-8.4 $gm^{-2}d^{-1}$. To 130 DAS is 0.4-1.5 $gm^{-2}d^{-1}$. Owing to leaf became old, so the photosynthesis is reduced.

3.2 Dry matter accumulation of cotton

Dynamics of dry matter accumulation to vegetative organs

Dry matter accumulation to main stem increases continuously in growing duration. The ration get highest at late season occupies 29.8-30.,1 % in comparison to total weigh of dry matter accumulated to vegetative organs. Dry matter accumulation to main stem can be divided to 3 stages : from sowing to 50 DAS , accumulation is slow under 10 gm^{-2}, from 60 to 100 DAS dry matter accumulation increases fast : from 100 DAS onwards is stable and reached 100 gm^{-2}

Dry matter weigh accumulated to branches occupy the biggest part in comparison to main stem and leaves. At harvesting time, the ration is 54.5 % - 57,1 % in comparison to total dry matter accumulated to vegetative organs. Dry matter weigh to branches reach 250 gm^{-2} – 262 gm^{-2}.

Dry matter accumulation to cotton leaves increase from sowing time to 100 DAS, maintain stable at 110 DAS and reduce fast at late season. Dry weigh at 90-100 DAS reached 240-280 gm^{-2}. From 110 to 150 DAS, the ration reduced to 13. %.

Dry matter accumulation to reproductive organs (squares, flowers, fruits)

Cotton squares appear early at 4-8 leaves stage and last about 25-37 days. The process of dry matter accumulation increases from 40-100 DAS and reduce to late crop season.

Dry matter accumulation to flowers is same to squares. It increases from 50-100 DAS and reduces at late season. Especially, at 70-100 DAS, cotton is in full blooming ; the dry matter accumulation reaches highest.

Cotton sets fruits at 50 DAS onwards. Dry matter weight accumulated to fruits increased fast and occupied almost total dry matter. At 70-100 DAS, dry matter weigh occupied approximately 100 % total dry matter of reproductive organs.

3.3 Fruit setting ration of cotton

Fruit setting ration of fruiting sites P

Setting ratio of fruiting sites on vertical direction from main stem to outside, there are 4 position P1, P2, P3, P4 determines almost number of setting fruits. Positions P1 occupied 53 %, following is P2 reached 44,7 % ; position P3 is 27,9 % : and P4 is 18,6 %. Positions P5 11,6 %, and P6 is 13,7 % ; P7 9,1 %. Average ratio of positions are 32,7 %, so, about 67,3 %, remaining ratio is still unused. The capacity of increase the yield is very large.

Fruit setting ratio of vegetative and fruiting branches

On vegetative branches fruit setting ratio is about 26 %. Total squares on vegetative branches of a plant is 45,6. Total number of fruits is 11,9 bolls (about 26%). Total square of fruiting sites on reproductive branches is 80.2 ; number of bolls is 26,3 (32,7 %). On a cotton total number of square is 125,8. Total number of bolls on a plant is 38,2. So fruiting ratio of a cotton only reaches 30,4 % . in order to get high yield, it is very important to increase fruit setting ration by many agricultural practices.

The contribution to yield of vegetative and fruiting branches

In cotton variety VN15, the seed cotton weight of reproductive branches is 93,46 g/plant, of vegetative branches is 44,5 g/plant. In pure cotton variety CS95 branches is 70.66 g/plant, of vegetative branches is 44,21 g/plant. So, in VN15 variety, seed cotton weigh of fruiting branches occupies 68,47 %. In CS95 variety is 61,14 %, the remaining are belonging to vegetative branches.

3.4 Studies on the effectiveness of PIX spraying to growth and cotton yield

Studies on influence of plant density, dose and time application of PIX to yield in cotton Growing region indicated that : at the density 4-5 plants m^{-2} united with 3 times of PIX application : first time at the dose of 50 ml PIX ha^{-1} at 35-40 DAS, second time at the dose of 50 ml PIX ha^{-1} at 50-55 DAS and last time at the dose of 100 ml PIX ha^{-1} at 65-70 DAS ; seed cotton yield increased 20-25 % in comparison to check grow at 2.5 plants m^{-2} and increased 10-20 % yield higher than check grown at density 4-5 plants m^{-2} without PIX application.

Application of PIX and KNO_3 at the end of growing season can increase ability of tolerance to cotton jassids and maintain leaf longevity.

3.5 Studies on the application of plant growth regulators for cotton production

Plant growth regulators such as : KE, a-NAA and GA3 were sprayed on leaf canopy at periods 70, 75, 80, 85 and 90 DAS. Use 300 litres of water ha^{-1} . The results shown that, spray a-NAA at the dose 20-25 ppm can increase average yiels 8-10 %. Spraying GA3 at the dose 5 ppm can increase yield 10-15 %. Spraying KE at the dose 20-30 ppm increased yield 3-10 % in comparison to the checks.

3.6 Studies on spraying foliar fertilizers and micro elements for cotton

Research on foliar fertilizers

Some of foliar fertilizers were studied and applied for cotton as : $MgSO_4$, Komix, Foliar fertilizer of China, VCC of RICFC, Bayfolan of German and Multi-K of Israel. The results shown that, these foliar fertilizers can increase number of bolls $plant^{-1}$, boll number m^{-2} and seed cotton yield than the checks. Especially, spray VCC increased seed cotton yield 13,2-14,05 %.

Spraying Multi-K 2% increased 15,63 % and the yield was highest in comparison to other foliar fertilizers.

Studies on effectiveness of micro elemals and Humat natri for foliar application

Spraying Chelate Zinc, Chelate Fe-Zn can increase the yield 0,64-1,51 q ha^{-1} to check (2,28-5,22 %). Application of Humat Natri at dose 0,03 % increased the yield to 15,96 % to check.

4. ORIENTATIONS FOR RESEARCHES IN THE YEAR 2001-2010

4.1 Cotton physiology

- Relations of leaf area index (LAI), optimum leaf area index (LAI.opt.), leaf area duration (LAD) of populations and cotton yield.
- Improvement of net assimilation ration (NAR) and economic ration (harvesting ratio) of cotton
- Physiology of nutrition and reasonable fertilizer applications for cotton.
- Application of plant growth regulators and foliar fertilizer for cotton.
- Capacity of drought and salt tolerance of cotton.

4.2 **Research on agricultural practices for cotton cropping systems in rainfed and irrigated** conditions in Winter-Spring crop season.

4.3 **Research on agricultural practices for cotton growing in different soil preparation : zero,** minimum and other methods of tillage in cotton growing regions in Winter-Spring crop season in the system of 2 rice crops a year.

4.4 **Research on agricultural practices to shorten growth duration, concentrate harvest, avoid late** rainfall in rainfed conditions (rainy season) and early rainfall in irrigated condition of Winter-Spring crop (dry season).

4.5 **Methods to increases emergent capacity of cotton seed, method to improve drought tolerance** at young seedling and at the end of growing season.

4.6 Methods to maintain, plants density in the field in unstable rainfed conditions.

4.7 **Methods of weed control for cotton in integrated weed management (IWM) system for** cotton growing in different soil preparation : zero, minimum and other methods of tillage in cotton growing regions.

4.8 **Research on application and production of bio-synthetic organic fertilizer, foliar fertilizer** and plant growth regulators for cotton

5. TRAINING

Training of staffs in short term and long term duration on cotton agronomy, physiology in foreign countries as China, Egypt, Israel, Australia...

Annex 2 : General data on irrigated cotton areas of the Mekong delta

- Angiang province

Cultivated area in 2001 - 2002 : 100 ha (estimated potential at 2010 : 3.000 ha)
Soils major characteristics : average pH : 5.1 to 5.2 - average soil conductivity < 1.1 mS/cm
Climatic parameters (period 1995 - 1999) : temperature ranging from 25.7 to 28.5 °C, 1.557 mm rainfall per year

- Can Tho province

Cultivated area in 2001 - 2002 : 40 ha (estimated potential at 2010 : 8.000 ha)
Soils major characteristics : average pH : 5 - soil conductivity < 1.1 mS/cm
Climatic parameters (period 1995 - 1999) : temperature ranging from 25.3 to 28.3 °C, 1.864 mm rainfall per year
Average cotton yield (2000) : 2.48 t/ha (providing a profit of 8.554 thousand VND /ha, compared to 566 thousand VND for rice)

- Soc Trang province

Cultivated area in 2001 - 2002 : 62 ha (estimated potential at 2010 : 6.000 ha)
Soils major characteristics : average pH : 5.6 to 6 - average soil conductivity < 0.5 mS/cm
Climatic parameters (period 1995 - 1999) : temperature ranging from 25.4 to 28.3 °C, 2.139 mm rainfall per year

Annex 3 : Breeding for resistance to Cotton Blue Disease

Introduction

The only source of resistance to cotton blue disease, CBD, so far identified in Vietnam is the 'Nghe an' cultivar belonging to the diploid *G. arboreum* species.
The survey of a large germplasm did not allow so far for any other interesting source of resistance to be isolated. Although such survey need to be carried on within a larger genetic variability, the exploitation of the 'Nghe an' resistance for improving the cultivated tetraploid *G. hirsutum* cotton necessitates the definition of a particular interspecific breeding programme.

The present note provides an indicative strategy whereby 3 separate, though concomitant, studies should be undertaken. The use of DNA molecular markers and marker-assisted selection, is proposed as a means for tagging and following *G. arboreum* CBD resistance alleles, in segregating populations.

Genetic components of the resistance of G. arboreum

The genetic components of the resistance of 'Nghe an' need to be estimated through a classical Mendelian inheritance study. A susceptible *G. arboreum* cultivar will be crossed by the resistant 'Nghe an':

Resistant 'Nghe an' *G arboreum* x Susceptible 'cultivar xx' *G arboreum*
↓
F1
↓
F2

Nota: all crosses to be realized according to (female x male) design

Studying the segregation pattern of the resistance to CBD (preferably both under natural and artificial transmission) in the F2 population (minimal number of F2 plants to be determined), will provide valuable information of the genetic determinism of the resistance : level of dominance, number of genes, etc...
The genetic complexity of the inheritance of CBD resistance conferred by the 'Nghe an' cultivar will partially condition the feasibility of the breeding method further described.

Introgressive marker-assisted breeding for CBD resistance through pseudophyletic method

Different stable hexaploid stocks already developed in Belgium at the University of Gembloux will be made available to this project. These hexaploid originate from colchicine chromosome doubling of triploid stocks, while the initial cross involved tetraploid *G. hirsutum* $A_hA_hD_hD_h$ and either of 4 different D_xD_x diploid species.

The proposed mating design aims at creating a trispecific tetraploid synthetic hybrid (through the crossing of the hexaploid by the diploid A_2A_2 *G. arboreum*) in which genetic recombination

between the A_2 chromosomes of *G. arboreum* and the A_h chromosomes of *G.hirsutum* will be favored. The D_x genome serves as a "bridge" genome.

A_2A_2 *G. arboreum* (Nghe an) x $A_hA_hD_hD_hD_xD_x$ hexaploid hybrid
↓
$A_2A_hD_xD_h$ trispecific tetraploid hybrid
↓
selfing and backcrosses to *G. hirsutum*

The trispecific hybrid, as well as the populations obtained after selfing (S1) and backcrossing (BC1) are then evaluated for their behaviour against CBD infestation (phenotypic evaluation). The same generations can also be genotyped using DNA markers. The choice of markers is based both on their position on the cotton genetic map (coverage), and for their ability to reveal molecular polymorphism between donor and recipient species. The identification of DNA molecular markers linked to genes or quantitative resistance loci (QRL), will allow for their use in the further introgressive breeding (marker-assisted selection) to be undertaken in the successive backcross generations.

Remark: four different "bridge" D_xD_x diploid species, including *G. raimondii* (D_5D_5), *G. harknessii* ($D_{2\text{-}2}D_{2\text{-}2}$), *G. aridum* ($D_4D_4$) and *G.thurberi* ($D_1D_1$), will be used.

Isolation and marker tagging of CBD resistance genetic components through aphyletic method

The method aims at creating a series of aneuploid (unbalanced chromosomal number) genetic stocks constituted of *G. hirsutum* and *G.arboreum* chromosomes. Among aneuploids stocks, the monosomic addition lines, with 52 *G. hirsutum* chromosomes and 1 additional *G..arboreum* chromosome, are the most stable and their development most feasible. Developing a series of addition lines, possibly for each of the 13 possible chromosomes of *.G arboreum*, will be useful for the localization and assignation of genes or QRL linked to CBD resistance.

A_2A_2 *G. arboreum* (Nghe an) x $A_hA_hD_hD_h$ *G. hirsutum*
↓
$A_2A_hD_h$ triploid (mostly sterile)
↓
colchicine doubling
↓
$A_2A_2A_hA_hD_hD_h$ hexaploid x $A_hA_hD_hD_h$ *G. hirsutum*
↓
$A_hA_hD_hD_h$ + 0-13 chromosomes A_2 (aneuploid)
↓
backcrosses to *G. hirsutum*

Although *G. arboreum x G. hirsutum* triploid is expected to be mostly sterile, direct backcross to *G. hirsutum* will be attempted as to exploit possible introgression at triploid stage.
More confidently and after chromosome doubling using colchicine of triploid plant, the introgression at hexaploid stage, will be preferred. The hexaploid as well as putative addition

lines will be tested for resistance to CBD, and the most interesting material will be selfed and backcrossed to *G. hirsutum* to allow for genetic recombination. DNA molecular markers, and more specifically chromosome-assigned markers having polymorphic alleles in parental stocks, will be useful for confirming the chromosomal content of aneuploids stocks as well as for tagging possible QRL in backcross generations.