

**A REPORT ON THE STUDY  
TOUR OF INDIA**

**BY**

***SMALLHOLDERS COTTON REHABILITATION  
PROJECT STAFF***

|                                                          |
|----------------------------------------------------------|
| NAARI LIBRARY - NAMULONGE<br>P. O. BOX 7084, KAMPALA (U) |
| ACC. NO : .....                                          |
| CLASS NO : .....                                         |
| DATE ENTERED : .....                                     |

17TH SEPTEMBER 1995  
TO 7TH OCTOBER, 1995

## TABLE OF CONTENTS

|                                                                                                   |    |
|---------------------------------------------------------------------------------------------------|----|
| Table of Contents .....                                                                           | i  |
| Introduction .....                                                                                | 1  |
| Tour bjectives:      Research and Development .....                                               | 1  |
| Extension Planning and Management .....                                                           | 2  |
| Team Composition .....                                                                            | 3  |
| Tour Programmes .....                                                                             | 4  |
| Issues and Lessons Learnt .....                                                                   | 22 |
| Conclusion .....                                                                                  | 24 |
| Annexes:      The Problems of Aflatoxin in Human Food<br>and in Livestock and Poultry Feeds ..... | i  |
| Germplasm Collection and Colaboration with India .....                                            | ii |
| The Integrated Pest Management (IPM) Approach<br>for Control of Cotton Pests in India .....       | vi |

## **Introduction**

Uganda's cotton industry thrived well in the 1960s reaching a peak of 467,000 bales in 1969/70 season. By then cotton was the second most important export crop after coffee. Cotton accounted for about 25% of the total foreign earnings. In the 1970s, however, the country faced civil strife which led to economic decline. Cotton production progressively declined reaching its lowest ebb of about ten thousand (10,000) bales in 1987/88.

Uganda Government in its effort to revive and develop the cotton industry has sought financial assistance from IFAD/IDA to support two projects namely, the smallholders Cotton Rehabilitation project (SCRIP) and the Cotton subsector Development project (CSDP).

The general objective of the tour was to get acquainted with India's agriculture and related industries with special emphasis on cotton research and production within relevant farming systems.

The specific objectives were three-fold focusing on Research and Development; Extension Planning and Management; and Trade and Industry related to agriculture as outlined below.

### **a) Research and Development**

- (i) To study the agricultural research institutions, their organisations and respective mandates;
- (ii) To study India's research programmes, and their collaborative and coordinative arrangements;
- (iii) To identify and, where possible and appropriate, collect, promising cotton genotypes for trial and possible use in breeding programmes as a means of enriching Uganda's germplasm diversity to ultimately improve cotton quality and yields.

- (iv) To identify and acquire technical and operational information on technologies available in India for immediate synthesis and application in Uganda
- (v) To initiate and as appropriate, establish collaborative agricultural R&D arrangements between India and Uganda specially in cotton breeding and where such arrangements already exist, consolidate them.
- (vi) To enroll with relevant professional organisations and, whenever possible, collect pertinent publications.

b) Extension Planning and Management:-

- (i) To study India's agricultural extension philosophy, mandate, and organisation.
- (ii) To study India's agricultural programme development and institutional arrangements for its operationalisation.
- (iii) To acquaint with India's technology generation and transfer paradigm and areas for strengthening Uganda's Research Extension and Farmer linkages.
- (iv) To identify extension - oriented agencies and the roles of each.
- (v) Initiate and, as appropriate, establish professional and commercial links and programmes with relevant industrial and extension agencies especially in the areas of training and appropriate farm - level technologies for production and post- harvest activities.
- (vi) To study India's strategies and programmes for staff motivation toward extension service effectiveness.
- (vii) To identify operational technologies utilised in India's agriculture which can be used in Uganda with little or no modification and experimentation .

#### Team Composition:-

Six senior staff working with the Smallholders Cotton Rehabilitation project were sponsored to undertake a three weeks study tour of India so as to learn from the Indian experience about the cotton industry, and to learn more about the operationalisation of the Training and Visit (T&V) extension system, and compare experiences therein with the Unified Extension system now being adopted in Uganda; to study the Indian Cotton Research programmes with a view to identifying possible areas of collaboration/germplasm collection, to understand the Research - Extension - Farmers linkages works in India and finally to look at the general concept of rural development with emphasis on peoples participation in various developmental processes and activities. The members of the team were as follows:-

1. Mr. Jecco L.K. Isabirye, Assistant Commissioner/Project Coordinator/SCR/CSDP, Team Leader.
2. Dr. Lastus K. Serunjogi, Principal Research Officer/Cotton Breeder, Serere Research Institute.
3. Mr. Peter .E. Ochodomuge, Principal Agricultural Officer/APC/SCR/CSDP.
4. Mr. Okello Ocaya Maurice, Principal Agricultural Officer/Training/SCR/CSDP.
5. Mr. Robert Sabiti, Agricultural Economist MAAIF
6. Mr. Alexandar Geri Nyugo, Principal Agricultural Officer/SCR/CSDP.

### TOUR PROGRAMMES:-

#### DAY I 18/9/95:-

The delegation on arrival jointly reviewed the tour programme with the MANAGE staff focusing on areas of interest and developed the following strategies to enable it achieve the set objectives: \_

- (i) discussion with MANAGE Institute staff.
- (ii) discussion with Research Scientists and Extension staff and administrators
- (iii) discussion with Academic staff in the Universities
- (iv) discussion with authorities, concerned with marketing and processing of cotton
- (v) meet various categories of farmers involved in the cotton industry.

#### MEETING WITH DIRECTOR GENERAL OF MANAGE:

The team met the Director General of the Institute who gave a welcome address on behalf of the Institute. During the above meeting, the Team Leader emphasized the team's other special areas of interest which included methods used by India to:-

- (a) technologies that can be adopted immediately without further research. These technologies should be simple and relevant to the Ugandan situation and therefore extrapolatable
- (b) possible areas of collaboration i.e germ plasm collection.

He informed the Director, that, the team wishes to return with an action plan for all extrapolatable technologies observed in India.

He further informed the Director that during all discussion with persons and organisation in India, the team will focus its interest on the following points/areas.

- (i) Research Issues
- (ii) Extension matters
- (iii) Policy and Administrative/Management issues
- (iv) Research Extension - Farmer linkages in India
- (v) General observations

DAY II. 19/9/95 MANAGE: NATIONAL INSTITUTE OF AGRICULTURAL EXTENSION  
MANAGEMENT, HYDERABAD

The morning opened with a brief by the Deputy Director of MANAGE Dr. Wilson, on the background and functions of the Institute which are summarised as follows:-

- (i) Training,
- (ii) Research,
- (iii) Consultancy and
- (iv) Information Technology and documentation

MANAGE is a National Institute responsible for Extension Training and Research in India. What major objectives are to:-

- (a) orient, sensitize and teach various levels of functionaries, principles of general management in organisation.
- (b) train various levels of functionaries in broad based extension management.
- (c) update the knowledge and skills of the various functionaries in various fields related to the management of agriculture and related fields.

### Training Programmes:

MANAGE offers the following programmes for both local and international participants

- Training of Trainers
- Communication skills
- Integrated Project Planning and Management
- Extension management programme for extension staff
- Agricultural policy formulation and management
- Management courses for farmers and farm leaders.
- short courses and Workshops

MANAGE does not offer fellowships. Participants are usually sponsored by their organisations, government or other donors. Most courses in Manage are of four weeks duration. This Institute has good working relations with other National Organisations and NGOs within India. Recently it has started establishing working relationships with international organisations and governments.

The team visited various departments within MANAGE, and held meetings with the various heads of departments who briefed the team members about the set up and functions of their departments as below:-

### Extension and Communication

A:- Dr. R.K. Semanta, extension and communication specialist, summarised the sections activities as follows:

- (i) The Central Government or Union Government run Extension.
- (ii) State run Extension
- (iii) Extension by Universities within the 26 states in India

He emphasized the healthy interaction which exists between these arrangements to ensure no duplication or parallelism in the field. The technologies generated from each of the above sources are all targeted at farmers, especially the small scale farmers who comprise 55 % of the farming communities in India, each owning an average of 5-10 Acres of land. Ten percent (10%) of the farming community are large scale farmers who own an average of 50 - 100 Ac of land. These large scale farmers own about 50% of the total agricultural land of India.

While the above stated situation prevails, there is also a landless group often referred to as labourers who constitute 10 - 12% of the total population. Considering that the population of India in the 1991 census was 962 million people, the number of the landless in India is actually high and is of great concern to the Indian Government which is now drawing plans to redistribute land in the country. However, this redistribution will have to be done by each state in accordance with the existing local land policies. There is no taxation on agricultural production in India, as an incentive to farmers. The country has enough food to feed her people and food prices in the country is reasonably low.

Some major inputs like fertilizers are heavily subsidized as a further good will from Government.

A LECTURE ON INDIAN COTTON BY DR. RAO MH AGRONOMIST AND SPECIALIST AT ICAR:

Dr.Rao informed the team that cotton improvement has a long history in India starting from 1921 and culminating in 1967 when all India coordinated Cotton Improvement embarked upon Cotton Research. The main concern has been the improvement of cotton yields and quality. Cotton yields in all the states average about 252 kg/ha of lint, with some states attaining upto 350 - 420 kg/ha of lint. These yields by Ugandan standards are very high, and yet India is targeting 312 kg/ha lint as an overall average in all the states. Generally in India, annual cotton production has steadily been increasing as shown in the table below:-

### Annual Production trends of Cotton in India

(Million bales)

| <u>YEAR</u> | <u>Bales</u> |
|-------------|--------------|
| 1947        | 25           |
| 1950        | 30           |
| 1959        | 50           |
| 1982        | 84           |
| 1990s       | 135.75       |

These steady increases have ensured self sufficiency for domestic consumption and for export.

Currently in India, four (4) major species of cotton are being cultivated namely:-

- (a) *Gosypium harsutum* - medium staple
- (b) *Gosypium barbadense* - medium staple
- (c) *Gosypium harbeceum* - short staple
- (d) *Gosypium haborium* - short staple.

The first two are long to extra long staples, short maturing and very suitable for irrigation. While, the last two are short staples, which are very flaxy and late/slow maturing.

India has been able to achieve the above steady increase in yields mainly because of:-

- (i) constant crop improvement through strong breeding programmes,
- (ii) the high yielding varieties and hybrids have also covered a great extent of the country;
- (iii) government of India has also heavily invested on cotton irrigation.

These inputs by Indian Government are convincing indicators of Government's commitment in the propulsion of the cotton industry. Between 1971/72, Government for instance instituted an intensive District Cotton Programme which was later, modified to be known as Intensive cotton Development Programme. In both of these programmes/approaches, increase in cotton production through the spread of different cotton types and hybrids was the target.

These strategies were backed by the availability of

- (i) good seed
- (ii) readily available and cheap fertilizers
- (iii) a good programme on Plant Protection which included the introduction of Integrated Pest Management (IPM)

It is important to mention here that Government of India supports cotton production at all levels, including cotton research, extension and marketing.

#### VISIT TO THE NATIONAL INSTITUTE OF PLANT PROTECTION AND TRAINING/HYDERABAD - 19/9/95

Later in the day, a field visit was made to the above Institute which has the following responsibilities:-

- (i) Plant Protection activities
- (ii) Quarantine
- (iii) Locust control
- (iv) Implementation of Insecticide Act
- (v) Training (Campus and Institute Training in the States).

This Institute spends 25% of its total time on Research and 75% on training.

At this point, it is important to mention that 7 Ugandans have already benefitted from these training programmes, and two more are expected to participate in Sericulture in the near future.

Some of the notable supporting services of this Institute include:-

- (i) An elaborate IPM Laboratory with different types of pheromone traps for insect monitoring and forecast and various types of natural enemies or predators of the various pests.
- (ii) Engineering Workshop fabricating and modifying various types of implements for spraying crops e.g the modified Knapsack Sprayer with additional nozzles which ensure that during spraying the person spraying is protected.  
The team also observed and commended the work done to mount a spraying boom on bicycle wheels. The sprayer was operated by a battery which was energized by a solar pannel.

This Institute offers both diploma and short courses on IPM for both Research and Extension staff. The NPV virus to kill caterpillars is widely used in this Institute and is reported to be cheap and already commercialized.

It is reported to be safe and quite effective. Sex pheremone traps which are simple and cheap and made of polythene pieces are being produced at commercial level. This method could be adopted in Uganda. Green Lace wing as predators to devour aphids, thrips, whiteflies, meally bugs, insect eggs etc are being used also at commercial level. This one could also be adopted in Uganda.

#### Mixed Cropping in cotton:-

The use of Castor Plants and Merigold to attract insects is being researched under IPM.

### Inter cropping:

Studies in inter cropping of cotton should be stepped up in Uganda. In India, there has been a lot of research on intercropping cotton with soyabean, and black grams, and the results are promising.

While some of these technologies can be extrapolated, it is however important to note that, there are differences in the major cotton pests i.e. jassids and lygus are not important pests in India. India can use smooth varieties to guard against whiteflies and Hiliothis. Some trap crops have not been tried in Uganda i.e. onions, merigold as attractants.

India meanwhile uses maize as a trap crop, and sorghum as a baricade crop. The team suggested that, under IPM the following trials be conducted:-

- (i) randon planting of maize in cotton fields as trap crops.
- (ii) Research to determine the optimum population for economic return under mixed-cropping.
- iii) The use of edible hibsicus to attract cotton stainers away from the cotton crop since beans are already known to help increase parasites that feed on cotton pests, this should be put into use and should be promoted as much to make cotton production attractive.

### Plant Protection:

The National Institute of Plant Protection and Training also has a special unit for testing equipments. At this Institute, a senior Agricultural Engineer, tests, and modifies agricultural chemical applicators. In Uganda the testing of chemical applicators has always been carried out by Biological Researchers, merely by measuring their effectiveness on crops.

No modifications are carried out.

The team therefore recommends that Agricultural Engineering Institute, when established in Uganda, should work closely with these Biological Researchers to test and modify such equipments. Engineers now being posted to Research Institutes in Uganda, should work closely with Biological Researchers to identify and recommend possible modifications.

#### The Training Programme for CPPTA

This Institute runs both short and post graduate diploma courses meant for graduates, lasting for nine (9) months of intensive training in theory and practical work.

- (i) Pesticide Formulation analysis courses lasting upto 3 months. These are meant for Researchers and technicians.
- (ii) Pesticide residue analysis course. These can last upto 33 months, and are meant for researchers, laboratory technicians and personnel working on food quality and standards.
- (iii) Advanced Plant protection courses lasting for 2 months. This is meant for both graduates and diplomates. Both theory and practicals are emphasized.

Most of these courses are sponsored by the Indian government, but also fellowships can be obtained from FAO, UNDP, World Bank etc. It is also possible to organise tailor made courses to meet the needs of the clientele.

After the visit to the workshop the team also visited the Extension and Communication Centre which is responsible for the production of visual aids used in extension training.

#### DAY III 20/9/95

#### LECTURES ON AGRICULTURAL CREDIT IN INDIA BY M.B. SALIM:-

The team learnt from the lecture that the farming community in India has access to Agricultural credit , with 50% of this credit

coming from the cooperatives. Other sources include Commercial Banks and Regional Rural Banks also known as Gramina Banks.

Loan application originate from the villages and are sent to the District Cooperative Central banks from where they are sent to the Central Cooperatives which are guided by the District Technical Committees who prepare the guidelines for awarding credit based on enterprises. These are usually called the "Credit Limit Statements", which show the amount each farmer will get based on the enterprise viability.

Experience in India as regards rural Credit is that loans awarded through the Cooperatives are much easier to recover during the sale of produce.

Loans are usually targeted at the small scale and marginal farmers. Each farmer has to sign the Declaration Statement as a commitment to ensure loan recovery.

- (a) Small scale farmers receive character loans.
- (b) Large scale farmers must first pay 25 % of the total loan applied for. The gestation period of the loan depends on the enterprise.

Credit offered as loan package alleviates rural poverty. This package is usually phased during the production season. In all, credit has contributed to poverty reduction from 51 % to 39 % in India during the period of 1977 - 1995. Where a farmer fails to pay the loans due to natural hazards, this loan will be rescheduled for the following season.

It was found that in India, loans often meant for development were misdirected, and repayment are usually difficult. It was also found out that people living below the poverty line are usually left out of the loan schemes.

The main issue here is that, there seems to be no way of assisting the poorest of the poor in society/community at the moment, until there is a complete revolution on the lending policy.

A similar situation exists in Uganda today. The question here is, how can these poor farmers be assisted through rural credit to get them out of the vicious circle of poverty?

A VISIT TO THE INTERNATIONAL CROP RESEARCH INSTITUTE FOR SEMI ARID TROPICS (ICRSAT) - 20/9/95

Later in the day, the team visited the International Crop Research Institute for Semi Arid Tropics (ICRISAT). This Institute has the following mandates.

- (i) To improve agriculture in the Semi Arid Tropics. This constitutes its Regional Mandate.
- (ii) To work on the six crops wherever they are. The six crops are, Finger millet, Pearl (Bulrush)millet, Sorghum, G/nuts, P/peas and Chick peas. This constitutes the global mandate of ICRISATI. This Institute releases improved cultivars of these crops to collaborating countries. In this senses ICRSAT serves as a gene bank. Note that the six crops are equally important in Uganda farming systems. The other services rendered by ICRISAT include resource management whereby technology generated on Soil and water conservation are disseminated.
- (iii) Information exchange. This is achieved by networking in meetings, circulation of publications and holding of training programmes. There is active collaboration between ICRISAT, the National Agricultural Research Systems and the farmers who are the end users of these technologies. While at ICRISAT, the delegation had a chance to discuss with Dr. Mehan V.K. an important problem vis Aflatoxins, which are associated with some of the major staple food crops in Asia and Africa region; e.g. Maize, G/nuts and Cotton. The presence of aflatoxins in these crops, particularly G/nuts, is affecting their exports to Europe, and also posing health hazards and death among consumers in Africa and Asia. Some European countries demand zero - levels.

Whereas in Uganda this problem was thought to be a post harvest one associated with mainly, G/nuts, the delegation learnt that this problem has many more dimensions to it than is presently known in Uganda. The team was also informed that Aflatoxins can present at pre-harvest stage in crops, milk and meat of cows, meat and gizzard of chickens.

It was confirmed that even boiling of these foods does not destroy the aflatoxins, although it could reduce their concentration.

The issue here is that, there is very little awareness in Uganda, of the dangers of aflatoxins, despite the fact that this problem was noticed way back in 1960. There is therefore need to raise awareness among our population to know that a flotoxins problem could easily wipe out the market of exportable crops like G/nuts, cotton seed and maize. Further more, people need to know that this problem starts right from the field. It is on transit and in storage. It should therefore be dealt with in its entire. Aflatoxins one caused by *Asperigillus Flavus* which is a fungus.

N.B A detail report has been compiled by Dr. L. Serunjogi

#### A VISIT TO MEKINS AGRO-PRODUCTS 20/9/95

Mekins Agro-products manufacture a wide range of agricultural machinery, implements and tools. It was established 20 years ago. This company has been exporting some agricultural tools and implements to Uganda through the Agricultural Development Project (ADP) and other countries like Ghana, Nigeria, Ivory Coast etc. The team was impressed by the work being done and in particular, the modified ox-plough with multi purpose tool bars, walking, harvesters and several other small processing equipments like hullers, hammer millers, feed mixer, wheat harvesters etc.

Collaboration with this company is expected to continue, to supply the relevant agricultural tools, implements and machinery that could be used to promote cotton production, or to be used for other crops within the cotton based farming system in Uganda.

## A VISIT TO LAM, REGIONAL AGRICULTURAL RESEARCH

STATION - GUNTUR 21/9/95

The team made a visit to LAM Farm, which is a Regional Agricultural Research Station falling under the University of Andrapradesh. Technologies for cotton and chillies are developed here for dissemination to farmers. However, cotton research is the most important activity in this station. The main issues here are on cotton particularly on Integrated Pest management (IPM). This concern has come about as a result of farmers over adopting the use of chemicals for crop protection. This indiscriminate use of chemicals has led to cotton pests developing resistance to most chemicals. LAM Farm plays a big role in staff and farmer training. The major activities carried out at LAM Farm are:-

- (i) Cotton improvement through variety improvement and hybridization
- (ii) over use of pesticides leading to the heliothis developing resistance to most pesticides
- (iii) Agronomic practices related to IPM. *Gosypium harsutum* varieties were greatly improved. Uganda cotton Breeder was asked to follow up and try to obtain germplasm for further research in Uganda. This Research Institute is also promoting the use of high yielding cotton hybrids i.e. LAM H I. which is red and is resistant to heliothis. Other hybrids like H4, LPS 42; LK861 are all resistant to the whitefly.

The hybrids developed between *Gosypium harsutum* and *Gosypium barbadense* give a higher staple length (or longer staples) further. Ginning out turn (GOT) of Hybrids range from 33 - 35 %, and some go up to 39 %

It is recommended that as along term strategy, Uganda Cotton Research programme considers the development of appropriate hybrids, which are high yielding for this country. Those hybrids could then be used by the emerging commercial cotton growers.

The team also learnt that Guntur district alone, consumes 60% of the total world pesticides. This phenomenon could easily manifest in Uganda if the entry and use of chemicals are not carefully regulated. The research work at LAM form was found to rely not only on the local cotton types, but also on hybrids obtained from other countries i.e Israel. While this appears good, sustainability of such programmes may be at stake especially if they are built on a political foundation. Some scientists may also not be very cooperative in releasing their research findings.

### PEST AND DISEASE CONTROL: INDIA

Generally, pests and diseases on crops are controlled by the use of agro-chemicals or pesticides.

India as a country, relied heavily on the use of chemicals to control pests and diseases at both pre and post planting. Over time farmers have intensified the use of chemicals, above the recommended application regimes (types, rates and number of times). Farmers, particularly in Guntur believed that the more sprays they applied the more yields they would obtain.

Consequently, some pests developed resistance i.e. heliothis developed resistance to pesticides. The practice adversely affected the eco system by killing even the beneficial organisms. Reports indicate that farmers sprayed up to 25 times pre season hence aggravating loss by increasing the cost of production. Andhra Pradesh records the highest use of chemical pesticides in the world.

Andhra Pradesh State, uses 10kg/ha of active ingredient of the chemical per season in comparison to 6kg/ha in Asia. While Andhra Pradesh grows only 9% of Indian cotton, it uses 20% of all the pesticides used in India, of which 60% is used on cotton alone. Farmers also mix two or more, insecticides due to lack of knowledge, anxiety and fear to lose the cotton crop.

Research efforts are now focusing on IPM, integrating genetic resistance, biological controls, cultural practices and judicious use of chemicals. On genetic resistance selection is

undertaken for red colour pigments genotypes against Heliothis and hairlessness against whiteflies. While the former is desirable and can be extrapolated for Uganda Cotton, the latter is undesirable since we need hairy plant types to guard against jassids (Empoasca spp)

Biological control includes the use of plant attractants, barricades, predators and parasitoids to cotton pests, such as castor oil which attracts spodoptera SPP, Marigold (Tagitus rectus) which attracts Heliothis, sorghum which works as a barricade against glow worms. The population of predators such as spiders and coccinelids is enhanced by intercropping with groundnuts and grams (green and black) Parasitoids are also enhanced by inter spacing maize in the cotton field. There is however, a need to decob the maize plant at flowering stage to guard against heliothis.

Judicious use of chemicals includes bio insecticides i.e weed extractives, Bacillin thugerensis (QF) and conventional chemicals based on threshold levels as established by scouting.

#### SEASON LONG TRAINERS TRAINING PROGRAMME IN COTTON IPM

##### AT PARS - LAM GUNTUR ANDRAPRADESH 23/9/95 - 30/11/95

The team attended the above Workshop for one day and learnt the following under IPM Training in cotton:

#### 1. Chemical control

- (a) survey pest level and apply pesticides only as a last resort
- (b) use specific and safe pesticides
- (c) use pesticides carefully and sparingly to minimise environmental pollution.

#### 2. Mechanical control

- (a) Light trap
- (b) collection and demise of egg masses

- (c) use of sweep nets
- (d) perching for birds

3. Cultural control

- (a) Use healthy seeds
- (b) optimum spacing
- (c) optimum dose of fertilizers
- (d) keep fields free of weeds
- (e) proper water management
- (f) synchronised cultivation

IPM Emphasizes on

- 1- Conservation of predators and parasites of insects.
- 2- Chemical control
- 3- Grow pest tolerant varieties
- 4- Cultural control
- 5- Mechanical control

Cotton Insect Pests/Enemies

Lygus, Jassids, boll worms, whitefly.

Predators - Farmers friends

Wasp, frogs, carabid beetle, damselfly spiders, lady beetle.

Farmers friends/Predators

- 1- Lady bird beetles.  
They defend crops by feeding on pests.
- 2- Conserve beneficial insect spiders. They control crop pests
- 3- Damselfly. Helps farmers in pest control by feeding on hoppers.

- 4- Wasps. They destroy eggs and larvae of most pests of rice.

#### EXTENSION:-

The team visited and held discussions with Joint Directors of Agriculture Extension staff and farmers in several states and districts in India, with a view of learning more about operationalization of the Training and visit systems (T&V) of extension, and compare experiences therein with the Unified Extension System now being adopted in Uganda. The team learnt that Extension in India is tripartite involving state Universities, Union and state governments and the private sector. Its main function is technology transfer through training, information, demonstration, field trials, and pre-season planning workshops among other techniques.

Basically extension follows the Training and Visits (T&V) model with modifications from state to state.

#### Agricultural Communication Centre

The multi media pilot programme being developed at MANAGE is a good innovation. The group was impressed with the Agricultural Communication Centre at Tamil Nadu Agricultural University. This centre is well equipped to handle publications and produce radio and TV programmes for farmers.

The group was informed that the centre was producing up to 15 educational video films a year. This is a commendable job.

While at India council of Agricultural Research, the head of the Agricultural Extension Programme Dr. Hemachandra stated that there was a special committee that meets every month to determine what should come out on the air. This ensures relevance and quality programmes.

Considering the above, it would be beneficial to MAAIF if the following could be considered.

- (a) Improve the editing unit of the ACC
- (b) ACC to be charged to produce at least six education/instructional video films for farmers/colleges per year.
- (c) There should be a media committee consisting of representatives from the various districts. This body will ensure that what is produced meets the need of a particular organisation of the right time. It could similarly be used for monitoring and evaluating the programmes being produced.

It is too early for MAAIF to adopt the multi media but could well improve upon the video especially the editing and need to concentrate on educational programmes while not forgetting the public relations aspect of MAAIF to bio monthly training to keep in pace with technology generations and budgetary requirements.

In Coimbatore districts of Tamil Nadu State the T&V has adopted the satellite farmer approach in which an interdisciplinary team of field staff including researchers accompanied by farmers, visit a model farm at the same time to deliver the holistic message.

The interdisciplinarity of the team and the centrality of the satellite farmers promoted a two-way learning and effective use of resources. Hence the Research - Extension Farmer Linkages are strengthened.

#### INSTITUTIONAL ARRANGEMENTS FOR EXTENSION

Extension is the responsibility of the Indian Government, but is carried out by the state extension staff, Regional Research Institutes, State Universities, Government of India Corporation, farmers organisations and commercial companies dealing in manufacturing agricultural inputs.

Release of all technology generated is the mandate of ICAR.

Staff and farmer training is carried out collaboratively by the aforesaid institutions. Annually ICAR management committees drawn from the above said parties meet to review the years work and lay new strategies. Such meetings and workshops are replicated at the lower levels. The Researchers therefore participate in technology generation and transfer directly.

### ISSUES AND LESSONS LEARNT

- i- The Cotton Industry in India has made greater advances in research, production, and related industries. All the stakeholder aspire to a common purpose and collaborate at all levels of the Industry. One such area of collaboration which highly impressed the delegation was the production of cotton seeds including hybrids by private farmers.

This type of collaboration and support to other subsectors outside the direct interests of the beneficiaries partly accounts for the advances made in the industry and should be emulated, in Uganda by all stake holders in supporting research, production and other cotton activities.

- ii- Indian Research - Extension- Farmer linkages are quite strong. Research is executed by India Government, Regional Research Institutes, the State Agricultural Universities as well as industries and private farmers, coordinated at the national level by Indian council for Agricultural Research (ICAR).

Extension is the responsibility of Government but is carried out by the State Extension Staff. Regional Research Institutes State Universities. Government of India Corporation, Farmers organisations and commercial companies dealing in manufacturing agricultural inputs. Farmers are not merely technology recipients but participate in technology generation at adaptive level and technology transfer as satellite and contact farmers. Release of all technology generated is the mandate of ICAR.

- iii- Staff and farmers training is carried out collaboratively by the aforesaid institutions. Annually ICAR Management Committee drawn from the above said parties meet to review the year's work and lay need strategies. such meetings and workshops are replicated at the lower levels. The Researchers participate in technology generation and transfer directly.
- iv- Whereas the Dean of the Faculty of Agriculture and Forestry, Makerere University, and Director General of NARO are members of the National Variety Release Committee the mandate of the Institutions they represent, do not cover their involvement in extension directly. The release of technology other than varieties is not explicitly defined. There is therefore a need to examine these areas in Uganda.
- v- Technology generation in India which had a production orientation has shifted to value added technology hence the high level of market- oriented. Research and Development (R&D).

This has been possible due to high financial and technical support by both public and private sectors. As research is a high investment undertaking there is need to explore avenues to provide requisite funding commensurate with the benefits expected from research.

- vi Follow-up action was identified in the following areas:-

- germ plasm and technology exchange between Uganda and India.
- Training in fibre testing, spinning and plant protection.
- Acquisition of cotton laboratory equipment especially the lab gins. These however were not yet patented but would be acquired along diplomatic lines.
- Mass production of documentaries

- Introduction and development of multi-media communication centre
- Sensitisation of authorities and the nation on the aflatoxin problem
- Rationalization of study tours with a view to making them more effective.
- The issue of seed multiplication and distribution was not focussed by the tour.  
This is an area which needs follow up.

### CONCLUSIONS

The team found the experiences gained in India, invaluable, commends the tour and thanks MANAGE for organising it so well.

The team requests that the issues raised be studied in Uganda and appropriate action taken when accepted.

We once again thank the Government of India, State Government and all officials and the people who helped in variously in our tour.

Abstracts annexed:

- The problem of aflatoxin in Human Food and in Livestock and Poultry Feeds.
- Germplasm collection and collaboration with India.
- Integrated Pest Management (IPM) approach for control of cotton pests in India.

Finally we thank the Government of Uganda and IFAD/IDA for facilitating this trip.

## THE PROBLEM OF AFLATOXIN IN HUMAN FOOD AND IN LIVESTOCK AND POULTRY FEEDS

Aflatoxins are poisonous compounds which cause serious disease condition, aflatoxicosis, in animal and humans on ingesting food contaminated with the toxin (Mehan *et al.*, 1991). Aflatoxins are produced in range of crop seeds such as maize *Zea mays* (L), groundnuts *Arachis hypogaea* (L), Cotton *Gossypium* spp, rice *Sativa oryzae* and soy bean by growth of strains of the fungus *Aspergillus flavus* Link ex Fries in the seeds. Aflatoxins are known to be hepatotoxic, carcinogenic and teratogenic in man and many animal species: including fish, pigs, cows. In addition, *A. flavus* produces a mycotoxin cyclopiazonic Acid (CPA) when ingested in food produce other disease symptoms in addition to aflatoxicosis (Cole 1986). Furthermore, aflatoxins change forms as they traverse through the food chain, for example aflatoxin B1 ingested in food changes to equally dangerous forms of M1 or M2 in animal or human breast milk. Deaths have been reported due to aflatoxin B1 eaten in maize.

It is now known that the crop seeds are infected with the fungi at all the stages of production and post harvesting processing. Dry growing conditions for example make groundnuts and maize prone to entry of fungus in the pods and cobs respectively (Blaney, 1985). More contamination can occur during delayed harvest of crops. Seeds become more susceptible when moisture level goes below 30%. Contamination also occurs during slow drying, under storage and transportation. Moisture content, temperature, proper aeration, storage pest should be watched at the stages of storage and transportation.

There is therefore need to take timely action in Uganda to look at and arrest the severity of the aflatoxin problems using a cross section of the following:

- Surveying on home made and market food to assess the extent of contamination at hand.
- Research into control of pre and post harvest contamination including the breeding of varieties with resistance to the fungus and food processing technologies for decontaminating food stuffs.
- Setting up of Government Regulations on acceptable levels of aflatoxin in foods and feeds.
- Making the Uganda population aware of the dangers of the toxins in the popular food stuffs like g. nuts and maize and the realisation that the fungus and toxin are not denatured or killed by high temperatures at cooking. Roasting of groundnuts is known to reduce its activity.

### Reference

Mehan V.K., McDonald, Haravu L.J and Jayanthi S. (1991). The Groundnut Aflatoxin Problem Review and Literature Database. ICRISAT.

## GERMPLASM COLLECTION AND COLLABORATION WITH INDIA

Cotton germplasm of interest for use in the Uganda breeding programme were collected. The genetic attributes of interest are; earliness to maturity, large boll size, resistance to pests and diseases, good fiber quality, high ginning percentage and tolerance to drought. Table A shows germplasm collected during the tour.

Further more germplasm was identified for future collection coupled with further collaboration with India as shown in Table B.

Table A. COTTON GERMPLASM COLLECTED DURING THE STUDY TOUR OF INDIA BY SCRP GROUP

| TYPE OF COLLECTION     | SOURCE                                                                   | DESCRIPTION, ATTRIBUTES OR POTENTIAL                                                                                                                                                                                                                               |
|------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A. VARIETIES</b>    |                                                                          |                                                                                                                                                                                                                                                                    |
| 1. MCU 5 VT            | Kakatiya Agro: Industries Cotton Association Prum Guntur 7 Andra Pradesh | MCU material stem from selections made at Madras from Cambodian cotton acquired from Uganda in 1901 - MCU 5 VT is a <i>G. hirsutum</i> with resistance to verticillium wilt and has long staple > 30mm. Much needed in Uganda research program for vt. resistance. |
| 2. MCU 10              | Cotton Breeding Station, University of Agriculture Coimbatore            | Gama rays mutant, resistant to bacterial blight (b.b). Early maturing (150 days under rainfed conditions in India)                                                                                                                                                 |
| 3. Pusa 8 - 6          | Indian Agricultural Research Institute (IARI) Pussar New Delhi - 12      | Early maturity <i>G hirsutum</i> , large bolled resistant to b.b and jassids.                                                                                                                                                                                      |
| <b>B. LINES</b>        |                                                                          |                                                                                                                                                                                                                                                                    |
| 4. Brown tinted cotton | Cotton Breeding Station, University of Agriculture Coimbatore            | A collection for future uses in development of naturally coloured cottons as a departure from use of synthetic dyes.                                                                                                                                               |
| 5. Male sterile A line | Cotton Breeding Station, University of Agriculture Coimbatore            | <i>G hirsutum</i> for use in development of hybrids.                                                                                                                                                                                                               |
| 6. Maintainer B line   | Cotton Breeding Station, University of Agriculture Coimbatore            | <i>G hirsutum</i> for use in development of hybrids.                                                                                                                                                                                                               |
| 7. Restorer line       | Cotton Breeding Station, University of Agriculture Coimbatore            | <i>G hirsutum</i> for use in development of hybrids.                                                                                                                                                                                                               |

| TYPE OF COLLECTION                                            | SOURCE                                                                    | DESCRIPTION, ATTRIBUTES OR POTENTIAL                                                                                                                               |
|---------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C. HYBRIDS                                                    |                                                                           |                                                                                                                                                                    |
| 8. Savitha                                                    | Kakatiya Agro Industries Cotton Association Prum Guntur 7 A.P.            | Commercial hand crossed intrahirsutum hybrid - (irrigated conditions), for selection purposes out of segregating genotypes.                                        |
| 9. Prima restorer X male sterile                              | Cotton breeding station University of Agriculture Coimbatore              | Segregating material for source of <i>G barbadense</i> fertility restoration attributes.                                                                           |
| 10. Pusa HB 15                                                | IARI, Pussar New Delhi - 12                                               | Selection from segregations.                                                                                                                                       |
| 11. Six hybrids<br>S 7120, N41, P5, P13,<br>PS - 8 and PS - 9 | Pravarahan Priv. Seed Co. Bhuthpur -<br>509382 Mahabubnagar Andra Pradesh | Hand crossed intrahirsutum hybrids under testing.<br>For testing in Uganda on a collaborative basis and selection of desired genotypes in segregating pupulations. |

Table B

**PLANNED GERMPLASM COLLECTION AND FURTHER COLLABORATION WITH INDIA**

| VARIETY                         | ATTRIBUTES                                                                                  |
|---------------------------------|---------------------------------------------------------------------------------------------|
| MCU 3                           | With gunness gene at crown for imparting resistance to pests.                               |
| Red pigmented genotypes         | <b>G. hirsutum</b> for tolerance to bollworms.                                              |
| SH 131                          | <b>G. hirsutum</b> , early maturing.                                                        |
| LRA 5166                        | <b>G. hirsutum</b> , drought tolerant and adaptable to different agro. climatic conditions. |
| L 389                           | <b>G. hirsutum</b> , resistant to b.b                                                       |
| LRK 516                         | <b>G. hirsutum</b> , to cloudy weaker and tolerant to drought                               |
| Hopicala, Reba B 50 & ALIPPO 40 | for high G.O.T                                                                              |

Main requests for germplasm will be directed to:

Director, Central Institute for Cotton Research Post Bag No. 125, G.P.O Wagpor 440

Other contacts will be: Prof. K. S. Jehangir  
Dept of Cotton  
School of Genetics  
T.N.A.U  
Coimbatore - 3

Dr. V. P. Singh  
Sr. Scientist (Cotton)  
Genetic Division  
IARI New Delhi - 12

Further collaboration is planned with the Directorate of seed certification, Coimbatore 641013, Tamil Nadu on aspects of developing varietal descriptors and techniques of field inspection for ensuring genetic purity.

# THE INTEGRATED PEST MANAGEMENT (IPM) APPROACH FOR CONTROL OF COTTON PESTS IN INDIA

## Introduction

Cotton is the India's principal commercial crop. Cotton is grown in seven states on approximately 7 million ha with an average lint yield of 300 kg/ha to produce about 14 million bales<sup>1</sup> annually. There are, however, severe constraints to productivity arising from insect pests, diseases, nematodes, rodents and weeds leading to yield losses of 15-20% in spite of use of pesticides. In their anxiety to minimise losses due to pests, the farmers reverted to excessive use of chemical pesticides, where cotton consumed over 56% of the 50,000 tonnes of insecticides used in India annually. The indiscriminate use of insecticides and synthetic pyrethroids in particular resulted in, *inter alia*, undesirable ecological changes of:

- Development of resistance to pesticides as exhibited by bollworms
- Inducing resurgence of pests for example of either whitefly *Bemisia tabaci* or Aphids *Aphis gossypii* in a given niche.
- Destruction of natural enemies such as parasites and predators of cotton pests.
- Affecting species dynamics leading to insects considered of little importance to attain pest status.
- Contamination of the food chain and the environment.

On realisation of the dangers due to chemical use, an IPM approach was initiated in 1970. Advances have been made in this area including commercialisation of the IPM technology and vigorous training of extension staff and farmers on the use of new IPM technologies. This has led to notable reduction on the amount of chemicals now used on cotton in India.

Uganda is faced with similar pest problems on cotton. Research results in Uganda show yield losses for lint or seed cotton of 50% and above in trials grown without insecticide application. Chemicals, yet, are expensive to the farmers. Further, with even the little use of chemicals in Uganda (in comparison to India) of synthetic pyrethroids, organophosphates and, carbamates new problems have already been noted. There is concern of failure to control some key pests by some chemicals resulting most likely from insect resistance built over continuous use of similar chemicals over a long period. There are also reports of increased damage by what were formerly minor pests, notably mites and aphids. Investigations into the use of IPM techniques are novel, initiated in 1993 under the SCRP and therefore yet in rudimentary stages. The study tour group therefore put much emphasis in studying the development of, achievements and application of the Indian IPM approach with the objectives listed below.

---

1

A bale is 170 Kg of lint

## **SPECIFIC OBJECTIVES ON IPM DURING THE STUDY TOUR.**

The study tour group had the following objectives while looking at the IPM concept in India.

- To identify the cotton pests common to both India and Uganda and those unique to either country and compare the conventional methods for the control.
- To acquaint knowledge on methodology, progress and achievements on IPM technology development in India since 1970.
- To identify IPM research methodology/material hitherto not utilised in Uganda for enrichment of the Uganda IPM programme.
- To evaluate the economic and environmental protection benefits (impact) realised in India through use of IPM technology.
- To identify IPM technology perfected in India which could be recommended for synthesis or immediate use in Uganda.
- To search into areas of collaboration in research, training and commercialisation of IPM to farmers level between India and Uganda.

## **Strategy**

The groups visited:

- (a) cotton research centres under its Central Institute for cotton Research (CICR). established by the Indian Council of Agricultural Research (ICAR)
  - (b) Cotton Research Stations under Agricultural Universities
  - (c) State Agricultural Extension Services
  - (d) National Plant Protection Training Institute (NPPTI) and
  - (e) Farmers.
- Information was acquired through discussions, lectures, publications, and participation in seminars.

## The cotton Pests in India

The Northern, Central and Southern cotton zones in India have in general similar major pests as shown Table 1. The pest are here grouped under the modes of damage to cotton.

Table 1: The major cotton pests in India

| Group of pests       | Name of pest                                                                                                                                                                             | Remarks                                                                                                                                                                                                                             |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sucking pests        | Jassids <i>Amarasca devastans</i><br><br>Aphids <i>Aphis gossypii</i><br><br>Thrips <i>Thrips tabaci</i><br><br>Whitefly <i>Bemisia tabaci</i>                                           | Sucking pests appear in early vegetative phase of the crop. Thrips only encountered in Northern Zone. Insects in this group are a problem in Uganda cotton. Note: Lygus and stainers the major pests in Uganda are not so in India. |
| Leaf feeding Insects | Semi loopers: <i>Anomis flava</i> , <i>Acontia graellissii</i> , and <i>Trachae nitidula</i><br><br>Leaf roller <i>Sylepta derogata</i><br><br>Tobacco leafworm <i>Spodoptera litura</i> | <i>S. litura</i> sometimes bores in the reproductive parts of the plants. This group is not of importance in Uganda.                                                                                                                |
| Bollworms            | Spotted bollworm <i>Earias Vittella</i><br><br>Pink bollworm <i>Pectinophora gossypiella</i><br><br>American bollworm <i>Helicoverpa armigera</i>                                        | The three genera of bollworms are key pests in both India and Uganda though the species may differ in the two cases. The American bollworm is the most serious of the three in both countries.                                      |

## The Integrated Pest Management Approach.

Basing on the Indian experience, the IPM technique could be defined as a broad ecological approach aiming at best mix of all known pest control measures (biotic and abiotic methods) for the suppression of the injurious pests i.e. keeping the pest population below Economic Threshold level (ETL). The major components in the IPM can be summarised under cultural, mechanical, biological and chemical methods of pest control for increasing cotton yields with least adverse impact on the total environment. Table 2 summarises the use of these approaches in control of the pests in general. Details are given for control methods of the key pests in India where use of chemicals have escalated the pest population/resistance i.e. Bollworms and whitefly. Recommendations for possible inclusions into the Uganda programmes are also outlined in the Table.

TABLE 2: THE IPM APPROACH FOR PEST CONTROL IN COTTON IN INDIA

| THE IPM METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                           | APPLICATION AND REMARKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>A CULTURAL PRACTICES</b></p> <p>(i) Field selection, seedbed preparation</p> <p>(ii) Destruction of cotton residues and avoid ratooning</p> <p>(iii) Destruction or crushing of unwanted seeds</p> <p>(iv) Removal of weeds</p> <p>(v) Timely and synchronous sowing in blockfarms</p> <p>(vi) Use intercropping system</p> <p>(vii) Use of trap or barrier crops around cotton</p> <p>(viii) Control of vegetative growth through proper agronomical packages</p> | <p>Field selection based on proper crop rotation with non host crops and where possible soil testing to ensure optimal soil fertility. Early ploughing to suppress weeds which shelter cotton pests</p> <p>Observe or "a cotton period" or a closed season in a year to reduce insect cycle.</p> <p>To be done before the season. Build up of cotton stainers in Uganda is attributed to seeds left at stores, or farm houses/courtyard</p> <p>Weeds harbour pests e.g <i>H. armigera</i> in thornapple <i>Datura stramonium</i> and whitefly in <i>Abutilon spp</i></p> <p>Staggered planting induces pest migration from old to young cottons perpetuating insect cycle in the area.</p> <p>Cotton in India is interplanted with, green grams, black grams, onions cowpeas, soybean or groundnuts. The mixtures are known to divert pests e.g <i>H armigera</i> away from cotton and multiplication of pest predators while improving farmers' income. Recommended for Uganda.</p> <p>Okra against <i>H amigera</i>, castor <i>Ricinus communis</i> of other broad leaved plants to trap <i>Lepidoptera</i> spp, the ornamental African marigold (Kawunyira) to attract several insect spp, sorghum to trap glow worms. (but heads may be removed to avoid <i>Lygus</i> pest).</p> <p>Spacing, fertilizers and water management check against excessive plant growth which is conducive to pests. De-topping at 14-15 nodal stage at 110 days) practical in India. Recommended at 90 days in Uganda.</p> |
| <p><b>B. MECHANICAL PRACTICES</b></p> <p>i) Hand picking of pests</p> <p>ii) Trapping of adult pests</p>                                                                                                                                                                                                                                                                                                                                                                 | <p>Hand pick bollworms, caterpillars and clip off leaves and floral bodies infested with eggs.</p> <p>Yellow sticky traps for whiteflies, pheromone traps for <i>Heliothis</i>. The traps also help in field scouting done at 3-5 day interval for determining pest dynamics and ETLs. The ETLs for whiteflies is when adult pests density exceeds 8-10 per leaf of with more than 20 nymphs per leaf. ETL for <i>Heliothis</i> is 10% damaged fruiting points or 5% damaged bolls or 10 larvae on every 100 plants</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| THE IPM METHOD                                                                                                                                                                                                                                                 | APPLICATION AND REMARKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>C. BIOLOGICAL PRACTICES</b></p> <p>(i) Conservation of crop defenders<br/>i.e insect parasites and predators</p> <p>(ii) Augmentation of Biofauna<br/>multiplication and release of<br/>predator and parasitic cultures</p> <p>(iii) Bio-insecticide</p> | <ul style="list-style-type: none"> <li>- Green Lace <i>Crysoppa spp</i> Larva predate on soft bodied sucking pests i.e aphids, whitefly, thrips and on eggs and first instar of <i>Heliothis</i>.<br/>Population increased by intercropping described in A</li> <li>- Ladybird beetles <i>Coccinelids spp</i>: adults and larvae feed on <i>Heliothis</i> and soft body insects. Increase action by interplanting with groundnuts.</li> <li>- Spiders against aphids. Increase by interplanting with grounds.</li> <li>- Other predators are: <i>Staphylinids</i>, predatory wasps, surface bugs and predator bird perchers with nests put at strategic points in the fields.</li> </ul> <p>The use of predators and parasites described below is recommended for trying adoption in Uganda</p> <ul style="list-style-type: none"> <li>- Lacewings <i>Crysoppa spp</i>: They are made to lay eggs which hatch in 2-3 days.<br/>They can be supplied by Bio-Control Research Laboratory Nagar Bangalore 560032 and released as eggs or 1st instar larvae at a rate of 50,000/ha at a 15 day interval</li> <li>- Ladybird beetles: Several spp. can be supplied by the same lab.</li> <li>- <i>Trichogramma spp</i> There are minute wasps which parasite on eggs of pests. They are multiplied on cards containing eggs of <i>Corcyra cephalonica</i> a storage rice pest. The <i>Tricho</i> cards are cut and stuck on cotton plants after the appearance of bollworms or at 40 days after sowing at a rate of 150,000 parasites/ha every week for 6 weeks. The above Lab can supply the <i>Tricho</i> Cards.</li> <li>- NPV: Nuclear Polyhedrosis Virus is a species specific disease of <i>Helicoverpa armigera</i> and <i>Spodoptera litura</i>. The NPV can be mixed with water and sprayed to cotton. It infects the caterpillars while feeding. Caterpillars die in 2-5 days hanging upside down. Dead caterpillars can be crushed and re-used for more sprays mixed with jaggery an insect attractant and Teepol (soap) for reducing surface tension (spread). Application is done in evening since NPV is degraded by Ultra violet rays.</li> </ul> |

| THE IPM METHOD          | APPLICATION AND REMARKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (iv) Genetic Resistance | <ul style="list-style-type: none"> <li>- B.t. - <i>Bacillus thuringiensis</i> a bacterial solution is sprayed against bollworms whose larva shrink in size turning black. A commercial solution (Dipel) is available with 1 liter/ha costing 1,000 rupees.</li> <li>- Neem Seed Extracts: Extracts of neem <i>Azadirachta indica</i> seeds are repellants and thus antifeedants to pests. Five Kg of seed powder is soaked in water overnight and made to 100lts and sprayed to cotton in evening - since the extract is degraded by sunlight. Spraying done at 7-10 day intervals starting at early vegetative stage.</li> </ul> <p>Efforts are underway to incorporate genetic resistance/tolerance to major pests. These include traits of antibiosis namely: high gossypol content and red plant pigmentation against bollworms and B.t gene incorporated thru genetic engineering. Antixenotic traits selected for resistance include glabrescence (lack of hairiness) against whitefly and bollworms. (Uganda selects for hairiness against jassids), nectariless, fregobracts okra leaf and thick boll cuticle against bollworms. Germplasm collection for Uganda should focus towards these traits.</p> |
| D. CHEMICAL CONTROL     | <p>As a consequence of developing the IPM technique on cotton, the use of chemicals has been reduced. Where used, it is done judiciously with the following guidelines:</p> <ul style="list-style-type: none"> <li>- Chemical use to be based on ETL report</li> <li>- Avoid mixing two or more insecticides</li> <li>- Avoid repeated application of same pesticide</li> <li>- Avoid using resurgence causing insecticides</li> <li>- Avoid insecticides inducing vegetative growth</li> <li>- Restuct use of pyrethroids</li> <li>- Use proper spray equipments.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## CONCLUSION

The procedures of the IPM technique on cotton is summarised in a Flow Chart attached. The breeding for genetic resistance not included in chart should fall under the other methods of suppressing the pest damage. In that way the IPM technique is assisting in

- conservation of the ecosystem
- maintainance of the species dynamics
- less pollution to the environment
- good cotton yields at less cost without much chemicals.

Training of Uganda scientists would be teenable at the National Plant Protection Training Institute Hyderabad where among others a 3 months Advanced Plant Protection course is offered emphasizing IPM approach.

# INTEGRATED INSECT MANAGEMENT SYSTEM FOR COTTON

