# Improving the Productivity of Cotton
## Research Associate Program-2010

## COUNTRY REPORT/STATEMENT- PAKISTAN

## 1. INTRODUCTION

Cotton is an important cash crop and lifeline of textile industry of Pakistan. It accounts for 8.2 per cent of the value-added in the agriculture sector and about two per cent to GDP, adds over $2.8 billion to the national economy. According to an estimates increasing one million bales in cotton production means half a per cent increase into GDP. Cotton and cotton products contribute about 10 per cent to GDP and 55 per cent to the foreign exchange earnings of the country. Taken as a whole between 30 and 40 per cent of the cotton ends up as domestic consumption of final products and the remaining is exported as raw cotton, yarn, cloth and garments.

Presently cotton crop is facing a number of constraints, including low per acre yield, high price of agriculture inputs (seeds, fertilizers, pesticides etc.) higher intensity of insects and pests attack, shortage of good quality, high-yielding, insect and pests resistant varieties of seeds, deficiency of irrigation water, lack of advance technologies, lack of awareness and agro-professionalism, and adulterations in pesticides, fertilizers and seeds. Above all natural factors like unexpected rain, drought and floods especially in southern Punjab and Sindh. The yield remains low because unfavourable weather conditions at the time of sowing affect germination causing re-sowing of crop. Increase incidence of pest attack in the early growth of the crop as well as at the time of flowering and boll formation, decrease in the number of bolls and weight and higher weed intensity.

Because of low cotton production, Pakistan annually has to import 1.5-2.0 million bales to meet expanding demand of local textile mills. Moreover, the country has been losing some 10-15 per cent of value of its cotton due to poor quality. To over come the problem one option is to increase area under cotton cultivation but presently no sizeable area under cotton farming can further be brought in the two major cotton growing provinces of Punjab and Sindh as they are already at their maximum level. Second option is to consider adopting modern cotton technologies. The technologies, that have successfully been adopted to many developed and developing countries to improve crop yields with better pests and weeds resistance crop varieties like cotton, soybean, canola, and corn etc.

## 2. COTTON PRODUCTION

### Cotton Production Target for 2009-10:

The Federal Committee on Agriculture in its 90$^{th}$ meeting held on 9$^{th}$ April 2009 in consultation with the Provincial Agriculture Departments fixed the cotton area and production targets for 2009-10 at 3.20 million hectares and 13.36 million bales, respectively. Province-wise breakup is shown/given below:

| Province | Area (Ml. ha) (Ml. acres) | Production (Ml. bales) | Yield (Kgs/ha.) |
|---|---|---|---|
| Punjab | 2.50 (6.18) | 10.00 | 680 |
| Sindh | 0.65 (1.61) | 3.25 | 850 |
| NWFP | 0.01 (0.02) | 0.01 | 170 |
| Baluchistan | 0.04 ((0.10) | 0.10 | 425 |
| **Pakistan** | **3.20 (7.91)** | **13.36** | **710** |

In the 2nd meeting of the Cotton Crop Assessment Committee held on 7th January, 2010 estimated the crop size at 12.70 million bales (Punjab: 8.40, Sindh: 4.20, NWFP: 0.01 and Baluchistan: 0.09 million bales ex-farm).

According to the reports of Pakistan Cotton Ginners Association (PCGA) issued on 05-04-2010, the national cotton output has increased by almost 12% as compared to last year. The PCGA report said that the total arrivals of cotton at ginneries all-over the country were registered at 12.689 million bales compared to the last year's 11.333 million bales, posting a surge of 11.97%. Sindh produced 4.232 million bales compared to last year's 2.994 million bales, recording a hike of 41.35%, while Punjab produced 8.457 million bales compared to last year's 8.339 million bales, with an increase of 1.41 per cent.

The FCA meeting held on 12th April 2010 has fixed production target of 14.00 million bales for Kharif season 2010-11.

**Area, Production and Yield in Pakistan**

| Season | Area (Million hectares) | Production (Million bales) | Yield (Kgs/ha) |
|---|---|---|---|
| 2000-01 | 2.927 | 10.732 | 624 |
| 2001-02 | 3.115 | 10.612 | 579 |
| 2002-03 | 2.794 | 10.211 | 622 |
| 2003-04 | 2.989 | 10.048 | 572 |
| 2004-05 | 3.192 | 14.265 | 760 |
| 2005-06 | 3.103 | 13.019 | 714 |
| 2006-07 | 3.075 | 12.856 | 711 |
| 2007-08 | 3.054 | 11.655 | 649 |
| 2008-09 | 2.820 | 11.819 | 712 |

## 3. NATIONAL AGRICULTURAL POLICY

The main objectives of the National Agricultural Policy are to ensure the implementation of the promise/commitments made with public for their prosperity, to provide the timely required inputs (seeds, fertilizer, pesticides, farm machinery and crop production/protection technology etc. to enhance the crop yields. It is also one of the main aims of the policy to formulate a national plan keeping in view the demand and supply of the crop-products produced catering the domestic need and to earn foreign exchange to facilitate all the stake holders.

## 4. MANDATE OF PCCC

The Pakistan Central Cotton Committee (PCCC) emerged as incorporated institution on the national horizon in 1948 with the objective to bring improvement in growing, marketing and manufacturing of cotton and cotton by products through an extensive programme of Research and Development (R&D) in all its conceivable aspect under the Cotton Cess Act, 1923.

For this purpose a chain of Research Institutes/Stations has been set up by PCCC all over the country to undertake research of fundamental as well as applied nature/aspect on cotton. Up till now PCCC has developed number of varieties, which are under cultivation and are being rebalanced by new varieties whenever released.

The PCCC has evolved 41 varieties (13 varieties during the last five years). A number of new varieties namely CIM-553, CIM-573, CRIS-168, CRIS-468, BH-167 are in pipeline. These varieties meet the requirement of Spinners for fineness and strength. The staple length also improved to 32 mm as per Cotton Breeding Standard's requirement.

**Cotton Breeding Standards**

| Fibre Traits | Standards |
|---|---|
| Staple Length (mm) | > 28.0 mm |
| Lint Percentage | > 37.5% |
| Micronaire (μg inch$^{-1}$) | 3.8-4.9 |
| Fibre Strength (tppsi) | 92 |
| Uniformity Ratio (%) | 48 |
| Fibre Maturity (%) | 80 |

**Source:** 53rd meeting of the Special Experts Sub-Committee of the Punjab Seed Corporation held on 06-02-2007 at PSC, Lahore.

**The adjective description to classify the cotton is as under:**

| Fibre length (mm) | |
|---|---|
| Under 20.6 | Short |
| 20.6-25.4 | Medium |
| 26.2-27.8 | Medium long |
| 28.6-33.3 | Long |

| Uniformity Index (%) | |
|---|---|
| Below 77 | Very low |
| 78 to 79 | Low |
| 80 to 82 | Average |
| 83 to 85 | High |
| Above 85 | Very high |

| Micronaire reading | |
|---|---|
| Below 3.0 | Very fine |
| 3.0 to 3.9 | Fine |
| 4.0 to 4.9 | Average |
| 5.0 to 5.9 | Coarse |
| 6.0 and above | Very coarse |

| Fibre Strength (Mpsi) | |
|---|---|
| 70 to 76 | Very low |
| 77 to 83 | Low |
| 84 to 90 | Average |
| 91 to 97 | High |
| 98 to 104 | Very high |

**Source:** PCCC. Quality Survey of Pakistan Cotton Crop season 2007-2008.

**The details of the some promising varieties released by PCCC**

| Variety | Year of Release | Lint %age | Staple Length (mm) | Micronaire (μg inch$^{-1}$) | Fibre Strength (tppsi) |
|---|---|---|---|---|---|
| CIM-70 | 1986 | 31.5 | 29.0 | 4.2 | 92.5 |
| CIM-109 | 1990 | 35.1 | 27.2 | 4.4 | 92.0 |
| CIM-240 | 1992 | 36.5 | 27.5 | 4.7 | 93.7 |
| CIM-1100 | 1996 | 38.0 | 29.0 | 3.9 | 94.0 |
| CIM-448 | 1996 | 38.0 | 28.5 | 4.5 | 93.8 |
| CIM-443 | 1998 | 36.7 | 27.6 | 4.9 | 96.0 |
| CIM-446 | 1998 | 36.2 | 27.0 | 4.7 | 97.4 |
| CIM-482 | 2000 | 39.2 | 28.5 | 4.5 | 98.0 |
| CIM-473 | 2002 | 39.7 | 29.6 | 4.3 | 95.2 |
| CIM-499 | 2003 | 40.2 | 29.6 | 4.4 | 97.3 |
| CIM-707 | 2004 | 38.1 | 32.2 | 4.2 | 97.5 |
| CIM-506 | 2004 | 38.5 | 28.7 | 4.5 | 98.9 |
| CIM-496 | 2004 | 41.1 | 29.7 | 4.6 | 93.5 |
| CIM-534 | 2006 | 40.1 | 29.0 | 4.5 | 97.2 |
| CRIS-9 | 1992 | 34.5 | 26.5 | 4.6 | 97.0 |
| CRIS-5A | 2001 | 35.0 | 26.8 | 4.2 | 97.5 |
| CRIS-134 | 2004 | 36.5 | 27.5 | 4.2 | 97.0 |
| CRIS-467 | 2004 | 37.0 | 27.5 | 4.7 | 97.2 |
| CRIS-121 | 2006 | 36.8 | 27.5 | 4.7 | 98.5 |
| CRIS-342 | 2010 | 38.5 | 28.4 | 4.5 | 98.5 |

Following varieties are recommended for general cultivation in the country:

CIM-496, CIM-506, CIM-499, CIM-473, CIM-707, CIM-534, MNH-786, FH-901, FH-1000, NIAB-111, NIBGE-2, BH-160, Al-Seemi 151, CRIS-9, CRIS-134, CRIS-121, CRIS-342, Sadoori, Sohni, Chandi and Sindh-1. In case of scarcity of water, cotton varieties viz., CIM-473 and FH-1000 gave better yield.

## 5. PCCC'S FOCUSED AREAS

- Development of CLCV resistant varieties.
- Evolution of long and extra long staple cotton varieties.
- Development of commercial cotton hybrids.
- Development of Bt. cotton.
- Technical support to NWFP & Baluchistan Governments for promotion of cotton cultivation.
- Strengthen technological Testing and Training Facilities to benefit textile industry.

## 6. Cotton R&D Framework

- Research planning through integrated approach.
- Linkage with national and international research institute.
- Develop high yielding, pest & virus resistant varieties.
- Emphasis on biological control, biotechnology and virology.
- Human resource development.
- Upgrade CCRI, Multan to an international level research institute.
- Promotion of cotton cultivation in Baluchistan and NWFP.
- Streamline and strengthen technology transfer mechanism.
- Facilitate National Coordinated Varietal Trials.

## 7. Other Organizations engaged in the R&D/promotion of Cotton

- Provincial Department of Agriculture.
- Pakistan Agricultural Research Council.
- National Institute of Agriculture & Biology.
- National Institute of Bio-Technology & Genetic Engineering.
- Centre of Excellence for Molecular Biology.
- Pakistan Cotton Standard Institute.
- Department of Plant Protection.
- Agriculture Universities.
- Agriculture Policy Institute.
- Multi National and Private Sector Organizations.

## 8. Proposals for Research & Development (R&D)

### 8.1. Cotton Leaf Curl Virus (CLCV)

Cotton Leaf Curl Virus (CLCV) is the major threat in Pakistan. Cotton Leaf Curl Virus (CLCV) is a major problem particularly in the Punjab. Leaf curl, a viral disease of cotton, was first noticed in Pakistan in traces in 1967, but was not considered to be significant problem till 1988 when its occurrence was observed on about 200 hectares in the Punjab. Highest production 12.8 million bales achieved in 1991-92 dropped to 8.0 million bales in 1992-93 because of CLCV. Cotton research scientists were able to develop CLCV resistant varieties and production was again geared up and sustained to 10-11 million bales. Inspite of the recommendations and management strategy developed the research scientists, the farmers continue to grow susceptible varieties which resulted in new strain of virus and all the CLCV resistant varieties developed became susceptible to this new strain of virus. Germplasm used for evolution of CLCV varieties was of narrow genetic base and also susceptible to this new strain of virus. The major focus of the research scientists should be on the CLCV to use wider base genetic germplasm for

evolution of CLCV resistant varieties to achieve proposed production of 20 million bales and to sustain the cotton production because mutation of virus is a natural phenomena and will remain threat to cotton. At present, cotton research scientists are developing CLCV resistant varieties by transferring resistance from wild species and indigenous desi cotton through inter-specific hybridization and radiation as well as by using genetic engineering technology. The CLCV research program needs to be strengthened and it should continue to develop breeding material and management strategy to face any eventual mutation in virus.

### 8.2. Mealy bug of Cotton

Mealy bug is a new pest on cotton in Pakistan. CABI SA had conducted 15 year survey of scale insects and mealy bugs in Pakistan but this complex of species of *Phenacocus* was never recorded before 2005. Recently, the mealy bug has gained a prime importance. This insect is highly polyphagous. It has attacked not only cotton but it has engulfed almost whole agriculture of Pakistan and needs to be addressed on top priority. Its infestation has been observed on about 160 plants by CCRI, Multan during last three years. It has caused a huge economic loss to cotton crop during last three years. Therefore, this pest needs to be addressed on priority as it has impacted on whole agricultural flora.

This was first detected damaging cotton and other plants at agriculture research farm Vehari in 2005. It has now been recorded by CCRI on vegetables (tomato, egg plant, okra etc), field crops (chili, tobacco, wheat, fruits, etc), ornamental plants, weeds, fodders and is serious threat to agriculture of Pakistan. According to the present study by FAST National University reveals that this insect is responsible for ruining an estimated 3.1 million bale of cotton. Further more farmers have to bear additional costs Rs.1500 per acre for its control with insecticides. In most of cases the pesticides were in effective in controlling it on cotton.

#### 8.2.i. Biological studies of Mealy bug

The biological studies indicate that mealy bug breeding pattern changes with the season in a year. For example in winter, the mealy bug started laying eggs with out forming pouch attached to the body, while in summer they form pouches which are attached to their body. In laboratory it has been found that the unmated females laid eggs with out any pouch where as the mated females laid eggs/nymphs in a pouch attached with the body. The mealy bugs have been found breeding almost through out the year in Sindh where as in Punjab, where winters are cold, its breeding slowed down. Over wintering behaviors has also been studied. At Multan, its over-wintering second and third instar nymphs were found in the roots of sunflower, and crumpled leaves of sunflower and *Anthorium* sp. There may be more over wintering sites which need to be studied and detected.

### 8.2.ii. Identification of natural enemies associated with the Mealy bug

Twelve species of predators were recorded associated with the mealy bug in Pakistan. These include Coccinellids (*Brumus suturalis*, *Scymnus cocclvora*, *Scymnus* sp., *Nephus* sp., *Menochilus sexmaculatus*, *Coccinella septempunctata*, *Hyperaspis* spp. (2)}. Neuropteran {*Chrysoperla* sp., Ceccidomyd {an unidentified sp.) and hemipteran {unidentified spp. (2)} by CCRI Multan, AARI Faisalabad, ARI Tandojam and CABI SA. Some of these predators such as *Brumus suturalis*, *Scymnus coccivora* were promising as they were density dependent and their population fluctuated along with the host mealy bug. *Chrysoperla* sp. was also recorded in large numbers associated with mealy bug on some plants like Cotton, Sunflower and Abutilon. Besides predators, two species of parasitoids were also reared occasionally from the mealy bug.

### 8.2.iii. Introduction of exotic predators

*Cryptoleamus montrouizeiri* known as mealy bug destroyer has been imported by CABI SA from California. This species which is of Australian origin has been introduced in over 50 countries for controlling mealy bug. Its colony has been well established in the laboratory at Multan. Its both larvae and adults feed on all development stages of the mealy bug. It has high biotic potential and feeding rate. Techniques are being developed for its mass production and release in the field for studies on its role for controlling mealy bug in different climates of cotton growing areas of Pakistan. Studies are required for identifying the requirements of the predator necessary for its acclimatization and breeding in harsh summer and winter climates of Pakistan. This has also been supplied to AARI Faisalabad, CCRI Multan, ARI Tandojam and NIAB Faisalabad for mass production at their centers.

To control the pests following pesticides have been recommended to control the mealy bug. 1) Chlorpyriphos 40 EC (1000 ml/acre) 2) Imidacloprid 200 SL (250 ml/acres) 3) Methidathion 40 EC (400 ml/acre) 4) Acetamiprid 20 SP (150 gram/acre) 5) Methomyl 40 SP (300 gram/acre) and 6) Carbaryl 85 SP (500 gram/acre).

### 8.2.iv. Specific objectives of the studies are as under:

- The main aims of the studies are to developing and implementing short and long term studies.
- Protection of natural resources and their utilization in short term and long term management of mealy bug on cotton.
- Exploration and introduction of exotic natural enemies for control of mealy bug.
- Achieve sustainability in production of cotton crop.
- Establishment model farms for other to follow the good agriculture practices in minimizing insecticides use, capacity building of farmers' community, extension workers, researchers in ecological pest management.

- Identification of the cotton mealy bug parasitoid complex using molecular markers/PCR primers.
- Develop and integrate options such as bio-pesticides and entomopathogenic nematodes with biological control for controlling pests on cotton crop.

The knowledge generated on management of mealy bug and other pests on cotton will be disseminated through workshops, seminars, farmer gatherings, electronic media, Farmers' Field School Approach to create awareness among the researchers, extension workers and the farmers.

### 8.3. Bt. Cotton

Bt. cotton varieties are required to be got tested for checking the presence of Bt. gene, type of protein expressed and level of expression of gene product through gene specific Polymerase Chain Reaction (PCR). Approval of National Bio safety Commission (NBC) is essentially required before conducting field trial or any activity related to genetically Modified Organisms (GMO's) under Pakistan Environmental Protection Act 1997 and the National Bio Safely Rules 2005.

Implementation of bio-safety rules and regulation is the pre-requisite to gain the advantage from this technology without this commercial cultivation of transgenic plants will not be possible. Rules/Regulations may provide opportunities to the multinational agencies to have joint ventures in biotechnology with the PCCC and other related organizations which would further share this technology with other cotton research institutions. This approach will create a healthy competition among the multinational agencies and local Biotech institutions in the country.

A number of Bt. cotton varieties have been screened under National Coordinated Bt. Trial under the management of PCCC for their adaptability. Out of these, 12 strains namely, Neelum 121, FH-113, IR-1524, IR-3701, CEMB-01, CEMB-02, MG-6, Sitara-008, Ali Akbar-703, Ali Akbar-802, GN-2085 and GN-31, 09 varieties were approved by the Punjab Seed Council recently, conditionally for the cultivation in the country.

### 8.3.i. Recent Development

A memorandum of understanding (MoU) was signed between Monsanto Company and the Government of Pakistan which provides frame-work to continue discussions focused on introducing Bt. Cotton in Pakistan. It is believed that bio-technology is a tool that can help to increase the productivity of Pakistan agriculture. The government has introduced 'Breeders Right Bill 2010' and expects parliament to approve it in the next session. The government has also introduced amendments in 'Plant Protection Act 1976' and 'Pesticide Act 2010' in the parliament that would further protect foreign investment in Pakistan.

## 9. Projects for Cotton R&D

- A project titled "National Programme to Strengthen Transgenic Cotton R&D in Pakistan is going to be launched. This project will streamline the production, cultivation and regulating the transgenic cotton in the country.
- MINFA has also taken initiative to establish a new world class Cotton R&D Institute at Rahim Yar Khan. This area is hub of the cotton production in the cotton belt.
- Up-gradation of CCRI, Multan is in operation. The project for up-gradation of CCRI, Sakrand is in progress.
- The Cotton Maximization & National IPM Programs are also in progress.

## 10. Cotton Vision and its Action

To enhance the cotton production, Ministry of Food and Agriculture has prepared a long term Cotton Vision for sustained growth in cotton sector and the possible improvement in the quality of raw cotton with following envisaged targets by 2015.

| | |
|---|---|
| 1. Cotton Production | 20.70 Million bales |
| 2. Cotton Yield/hectare | 1,060 Kgs |
| 3. Mill Consumption of Cotton | 20.10 Million Bales |
| 4. Exportable Cotton Surplus | 0.60 Million Bales |
| 5. Improved Yarn Recovery Rate through Clean/contamination free cotton Production | 92% (from current average of 84%) |

The Ministry of Food & Agriculture (MINFA) has identified and intimated to all the stakeholders (Growers, Ginners, Textile Mills, Exporters and Government agencies) responsibilities on their part to be pursued for attaining and envisaged production target.

### 10.1. Cotton Production Projection by 2015

The highest production 12.821 Million bales was achieved in 1991-92 and its was dropped to 8 Million bales in 1993-94 because of many reasons i.e. abnormal weather, resurgence of pests and particularly of cotton leaf curl virus. The production was again geared up and sustained from 10 Million bales to 11 Million bales by the evolution of CLCV resistant varieties. In 2004-05 the highest production (14.6 Million bales) was achieved. Keeping in view the production scenario of the previous years, the projection of cotton production by 2015 is proposed 20 Million bales. This is great challenge to the cotton scientists, agriculture extension functionaries and farmers to produce 20 Million bales by 2015.

## 10.2. Strategy for increasing yield per hectare

The proposed task of 20 million bales by 2015 is possible by continues endeavors in research for evolution of high yielding varieties and development of adoptable package of technology to increase the yield per unit area. There is a wide yield gap between the progressive and non-progressive growers and this gap needs to be narrowed to the maximum level. Measures suggested to increase the yield per unit area are:

## 10.3. Improvement of Soil Health

i. Soil health is the major issue not only in cotton production but also in other crops production. The productivity of the cultivated area is deteriorating by salinity, alkalinity, water logging and due to less organic matter in the soil than the required level. Measures available so far have to be adopted to arrest further deterioration of the soil productivity due to mentioned factors.

ii. Establishment of Soil, Water and Plant Testing Laboratories at tehsil level and provision of Mobile Soil and water Testing Laboratory for Advisory Services to the farmers.

iii. Use soil amendments (Gypsum) for reclamation of saline and sodic soils. The gypsum may be provided regularly to the growers of affected areas on subsidized rate.

iv. Installation of efficient drainage system in water logged area and in areas which are expected to be water logged in the near future.

v. Maintenance of organic matter in the soil by curing and preserving farm yard manure properly and by making compost from farm crops residues. Burial of the crops residues into the soil and by use of bio-fertilizer.

## 10.4. Leveling of Fields

Leveling of fields will improve the soil productivity in many ways as well as efficient use of irrigation water. Equipments for macro-leveling (scrapers, rear and front tractor blades etc.) and for precision leveling (laser leveler) may be provided at tehsil level on subsidized prices as well as on rent.

## 10.5. Farm Machinery

Awareness of the farmers for efficient use and maintenance of farm machinery will have great impact in production. Training of farmers by agriculture graduates should be a regular feature in collaboration with agriculture extension staff and field functionaries.

## 10.6. Plant Population

Plant population to harvest a good yield recommended by the researchers is 23000 plants per acre but at present the plant population is not being maintained at the suggested/recommended level. Farmers are to be educated to maintain this recommended level of plant population. This is the most easiest, economical and practicable remedy to increase the yield per unit area. Efficient use of farm machinery and adaptation of cultivation on bed and furrow technology will assist in achieving the desired plant population.

## 10.7. Weed Management

Losses of yield due to weeds ranged from 30-60% by depriving the crop from nutrition, water and sunlight etc. Weeds also aggravate the insect pest problems by providing the shelter and favourable habitat to the cotton pests. Available weed control measures, cultural and chemicals have to be adopted timely and wisely for good weed management.

## 10.8. Irrigation Management

Cotton plant does not drink the water but it sips the water. Available water management practices have to be adopted for efficient use of limited quantity of irrigation water available. Lining of water courses will check the losses of water through seepage and holes made by the rodents etc.

## 10.9. Nutrition Management

Fertility and productivity of the soils is decreasing due to intensive cropping and use of imbalance fertilizer. The farmers are to be educated to use balanced fertilizer on the basis of soil testing.

## 10.10. Pest Management

Cotton crop is more vulnerable to insect pest attack. The major loss in yield is due to improper control measures of insect pests. More education of the farmers has to be focused on integrated insect pest management. It is suggested that pesticides should be applied as a last resort when pest population reach at threshold level. The ETLs worked out and recommended are as under:

| Insect Pests | Economic Threshold Level |
|---|---|
| Jassid | 1 Adult or Nymph per leaf |
| Whitefly | Adults/Nymphs or both 5/leaf |
| Thrips | 8-10/leaf |
| Mite | Spray on visible damage |
| Aphid | Spray on visible damage on top terminals |
| Spotted bollworm | 3 larvae/25 plants |
| Pink bollworm | a) Before boll formation presence or absence of insect pest on the basis of Rosette flower.<br><br>b) Infestation in bolls should be determined by dissecting the susceptible bolls (14-28 days old, which can easily be pressed between index fingure and thumb, 5% damage or presence of larvae in boll. |
| *Helicoverpa armigera* | 5 brown eggs or 3 larvae or collectively both 5/25 plants |
| Armyworm | Localized treatment where found |

### 10.11. Availability of Inputs

Availability of timely quality inputs (seed, fertilizer, pesticide, diesel & electricity) be made available at the door-steps of the growers as per their requirement.

### 10.12. Agricultural Credits

Agriculture loans from all financial institutions (public & private) at nominal interest (at par of industrial level) be provided at the door step of the farmers to their requirements.

### 10.13. Transfer of Technology

Cotton production technology developed so far has not reached effectively to the non-progressive growers. More attention has to be focused to transfer this technology to the doorsteps of the growers particularly to small growers (82%) the major producers of the country's production. Whenever there is abnormal weather or any calamity, small farmers are not able to cope up these and consequently there is drastic decrease of production. Following measures have to be adopted for efficient transfer of technology at the door steps of the growers.

a) Exclusive agriculture television channel (PTV or private) for farmers' education, agriculture news and weather forecast.
b) Growers education and training by researcher and extension workers.
c) Yield competition and award for the farmers for adoption of recommended technology.
d) Practical demonstrations at the farmers' field.

e) Farmers Field School (FFS) for capacity building of the growers.
f) All stake holders in cotton may be persuaded for transfer of technology to the growers directly or in directly.
g) Use of print media.
h) Holding regular seminars and exhibitions at tehsil level.
i) There should be regular refresher courses on cotton production and protection for the provincial extension staff by the cotton research institute/sections.
j) Master trainers should be trained for updating their technical know how so that they can train further extension functionaries in cotton production/protection technology.
k) Private pesticide sector should also be persuaded to undertake special promotional activities in collaboration with cotton research institute/sections/extension workers for creating awareness among the small farmers.
l) Farmers should also be trained at the grass root levels for cotton production and protection in their own fields.
m) Private pesticide sector should be pursued to assist and provide pest scouting services to the farmers.
n) The concept of providing private consultancy and advisory services for cotton production/protection to the growers is introduced in the country.

- **In order to ensure significant improvement in cotton production and its quality in the country beside investing on cotton R&D following measures also need focused attention:**

- Cultivation of sugarcane in potential cotton production areas should be banned completely.
- Provincial governments should strictly enforce various provisions of the Cotton Control Act in order to discourage cultivation of unscrupulous cotton varieties and varietal mixture as well as to promote proper making on the cotton bales.
- Provincial Agriculture Departments may pursue and convince the growing community to:

  a) Bring more area under cotton crop
  b) Only certified seeds of recommended varieties to be used for sowing purpose.
  c) Seed supplied by any un-authorized agency should not be used
  d) Optimum plant population to be ensured
  e) Pest scouting to be carried out regularly for assessing the need of applying pesticides
  f) Specific pesticides for target insect pests to be used

- Ministry of Textiles Industry may make concerted efforts to implement the Cotton Standardization Ordinance in letter and spirit in collaboration with the Provincial governments as well as the private sector stake holders to address the quality issues, particularly the contamination problem.

- Organic cotton production is yet another important area being encouraged particularly in the province of Baluchistan. Measures should be taken to provide appropriate varieties and the technology to the growers for the purpose. At the same time, the Provincial Governments are being encouraged to take the growers and buyers of organic cotton as well as the internationally acceptable certification agencies on board for a collaborative efforts leading to successful intervention.

- Cotton zoning was in vogue during the early years after the country came into being, but it was subsequently neglected thereby resulting in various production and quality problems. Hence, this system needs to be re-introduced in the larger interest of the cotton economy.

- Electronic media may be used for quick technology transfer among the growing community.