# COTTON PRODUCTION, CONSRAINTS, AND RESEARCH INTERVENTIONS IN KENYA

***Dr. W. Gitonga[1] , J. M. K. Macharia[1], A. Mungai[2] , H. Njue[2] , Dr. D. K. Karanja[3] & Hesbon Olweny[2]***

### *The Cotton industry- ' Vision 2030'*

Under the Kenya Government's policy for addressing poverty 'Kenya Vision 2030', cotton has been identified as a key sub-sector with the potential to benefit 8 million people in the drier areas of the country. The Cotton Development Authority (CODA) has been set-up to co-ordinate rehabilitation of the cotton sector.

### *Cotton production; current status*

National cotton production reached a peak of 38,000 metric tonnes of seed cotton in 1984/1985. Production declined to 14,000 MT by 1995 following liberalization of the sector and withdrawal of Government from the provision of credit and inputs. The Cotton Development Authority estimates currently that there are 350,000 ha in the country suitable for cotton production, with a potential production of 50,000 tonnes annually. Until Government initiatives to encourage cotton growing began to take effect in 2006, national production stood at only 5,000 tonnes from 30,000 ha in 2005. 2008/09 production is estimated at 10,000 tonnes from 46,000ha.

Yet before liberalization, cotton was once one of Kenya's main foreign exchange earners. Under structural adjustment policies, there has been a collapse of the vertically integrated system for input supply, extension and seed cotton buying. This combined with falling world prices has resulted in thousands of cotton growers abandoning the crop.

### *Cotton Amendment Bill*

The Cotton amendment Bill of 2006 provided the legal framework for Government supported re-organization of the cotton sector. Already there has been some impact with national production rising to 9,800 tonnes in 2006 from 5,090 tonnes in 2005. However, this increase was mainly due to an increase in the number of producers (hectares under cultivation) rather than any substantial increase in productivity. Average yields remain at 400 – 600 kg/ha of seed cotton.

[1]Agricultural Research Centre, Mwea Tebere
P.O Box 298-10300, Kerugoya.
Tel, 020-2028217; 020-2028216
Fax: 020-3589054
Email- karimwea@yahoo.com

[2]Cotton Development Authority
P.O. Box 66271-00800, Westlands, Nairobi.
Tel, 254 20 4444155; 4444156; 4444253
Fax: 254 204444151; Wireless: 254 20 3530908
Email-info@cottondevelopment.co.ke

[3]CABI Africa
ICRAF Complex
United Nations Avenue, Gigiri
PO Box 633-00621
Nairobi, Kenya
Tel: +254 20 7224450
Fax:+254 20 7122150
Email-cabi@cabi.org

**Table 1. Production in number of lint in bales (185kg/bale) over the last 5 years and projection for 2010**

| Year | Production in bales |
|---|---|
| 2005 | 20,000 |
| 2006 | 50,000 |

| | |
|---|---|
| 2007 | 45,035 |
| *2008 | 27,194 |
| *2009 | 26,821 |
| **2010 | 58,000 |

***Drought affected***
***Project figures***

***Commodity Chain***
At present, the commodity chain is made up of licensed and unlicensed private traders and ginning companies buying cotton on an *ad-hoc* basis. The cotton production areas are spread across Western Central/Eastern Kenya and the Coast Province with some growers often a long way from a ginnery. They are, therefore often forced to sell to middlemen. There is no zoning or concession system, as operates in some other cotton growing countries. Despite this some ginning companies distribute inputs on credit to farmers in order to ensure adequate cotton for their ginneries. However, others do not, providing the opportunity for 'side-selling'.

***Cotton growing areas***
In Kenya, cotton is currently grown solely by small-scale farmers in Western, Nyanza, Central, Rift Valley, Eastern and Coast Provinces of Kenya. An estimated 200,000 farmers grow most of the cotton on holdings of less than one hectare. Cotton in the country is mainly grown in arid and semi arid areas where there are limited economic activities. Cotton yields in 2006 averaged 572 kg/ha of seed cotton or 191 kg/ha of lint, estimated as 23% of the potential yield.

***Is Kenyan cotton competitive?***
Studies by Ikiara & Ndirangu in 2002 and Wakhungu & Wafula in 2004, suggested that Kenyan cotton is chronically uncompetitive with examples of negative gross margins. Another study on cotton production and marketing constraints carried out in 2005 by KARI-Mwea, however, indicated that profit margins ranged from KES 1,614 to 12,520 per hectare, at buying prices of KES 20-25. Given that the average yield is only 572 kg/hectare profitability would be greatly improved even with production at 50% of the yield potential of the commercial varieties.

**Table 2. Production and income for cotton in Kenya (2006)**

| **INDICATORS** | |
|---|---|
| Production 06/07 | 28,586 MT |
| Maximum production tonnes (year) | 38,000 (1985) |
| Average yields [seed cotton] | 400 – 600 kg/ha |
| Average cotton holding | 0.5 – 1 ha |
| Household income | KES 11,775 (US$ 157) |
| Average income/ha | KES 5,982 (US$ 79.77/ha) |

***HOW DO WE IMPROVE PRODUCTION?***

Poor yields from smallholder cotton in Africa have been a long-standing problem that has not been greatly altered by release of new varieties or by other recommendations made on the basis of research findings. There appear to be a number of problems in translating the outputs from research into the farmers' fields; farmers are consistently not taking up the recommendations.

***Ensure extension messages on ICM reach the farmer***

Extension Services (Ministry of Agriculture) and the Cotton Development Authority (CODA) have recognised the need and value of promoting Integrated Crop Management (ICM) such as through demonstration plots but have so far lacked the capacity to implement such as strategy. One constraint has been appropriate and up-to-date technical packages for crop and pest management of cotton. In addition, the national agricultural research institutions are not always fully in touch with the requirements of the ginning sector, and poor extension services mean they have difficulty reaching large numbers of farmers with technical messages. Much more should be done to foster greater public/private partnership to address the needs of all stakeholders in the value chain.

***Translating outputs from research to the farmers field***

Some of the shortcomings of moving research findings to the farmer can be addressed by expanding the on farm demonstrations (OFD) programs through farmer participatory training and promoting scientifically-based ICM systems which are appropriate and acceptable to cotton smallholders and which promote linkages among all important stakeholders both private and public. There has to be a linkage between the generation of new techniques, methodologies and their communication to the end users (the farmers).

***Importance of a consistent ICM package***

Where there is a degree of vertical integration of the commodity chain e.g. ginning companies providing agricultural inputs to cotton farmers or if a formalized system of 'contract farming' is operating, there is an opportunity to also provide improved technical services. Making inputs available to farmers has proved insufficient on its own to significantly improve yields. The missing component is a consistent ICM package that recognizes the farmers' constraints, backed by technical training support linked to a demonstration program.

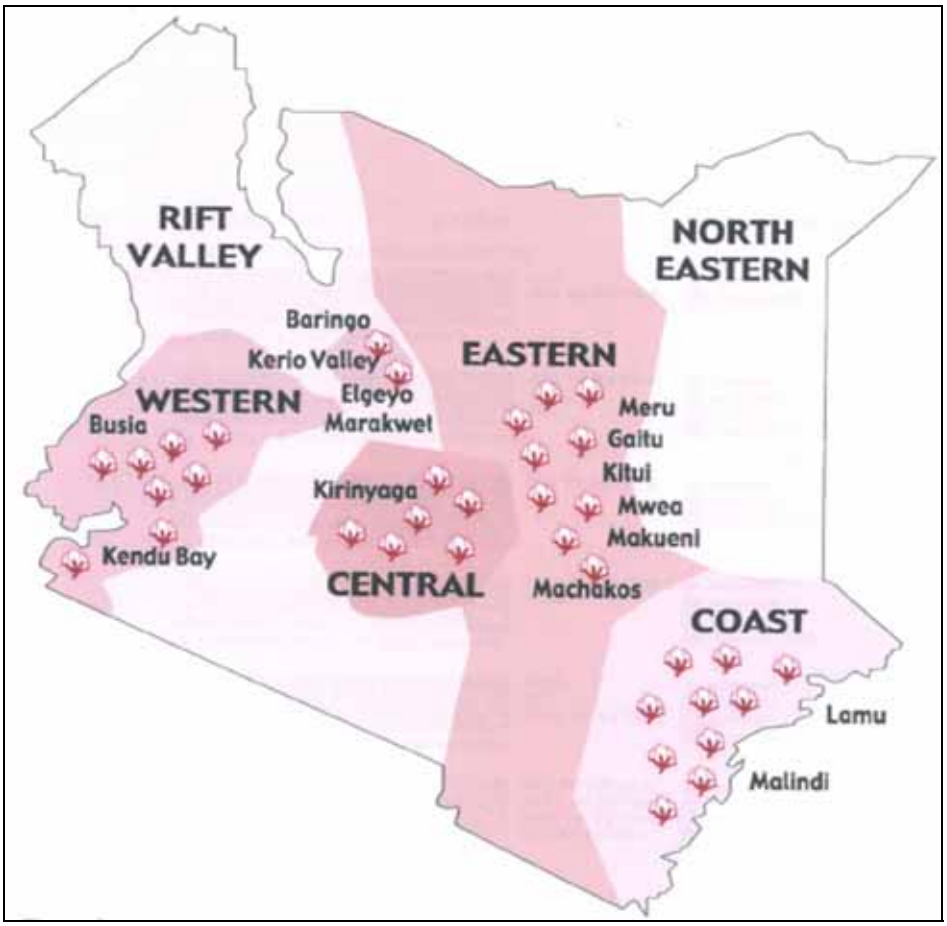



**Figure 1. Map showing the Main cotton producing areas of Kenya**

***The need for technical and institutional innovations***

Technical and institutional innovations in the cotton sector require both funding and private incentives. This is especially true in the development and multiplication of new varieties, improved pest management and updated grading systems. Achieving a mix of public and private participation by engaging all actors in a dialogue to build institutional and policy environments that encourage technological renewal, will be an additional requirement.

# CONSTRAINTS TO PRODUCTION

***Risk aversion by the private sector and farmers***

Prior to structural adjustment, production-to-market chains for agricultural commodities were integrated under the control of state or parastatal organizations that provided subsidized farm inputs, often provided advisory services, sometimes even provided credit as well as purchasing the commodity from farmers. However, under the structural adjustment reforms government support for input and output markets has been withdrawn in the expectation that private sector traders would fill the niche and develop these markets. In practice, the private sector has proved to be highly risk-averse to investing in the cotton growing enterprises linked to smallholder agriculture.

As a result farmers will reserve minimal resources in terms of fertiliser application and crop protection for cotton in preference to food crops.

***Policy issues***

There are also policy issues which impact on the already complex situation, such as price-setting for seed cotton, subsidies for inputs and access to input credit. Cotton farmers are very price sensitive but attempts to control the price can have a negative impact on the willingness of the private sector to invest in production support mechanism.

***Lack of irrigation facilities***

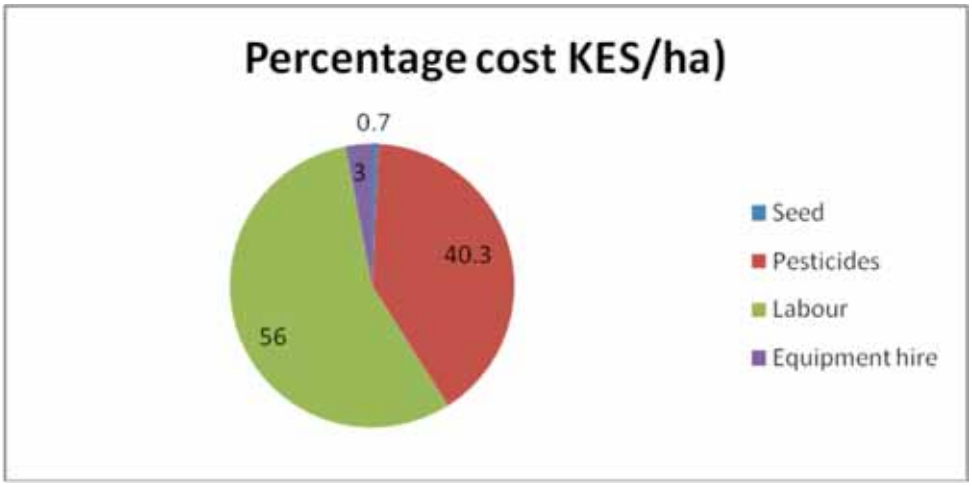
With the collapse of the Hola and Bura irrigation schemes which accounted for over 30% of cotton production in the country, cotton is mostly grown under rainfall conditions. Yields are adversely affected by unreliable rainfall. Where irrigated cotton is grown there is a lack of proper water use in irrigating cotton sometimes leading to water logging and poor crop yield.

***High input costs***

Costs associated with spraying, weeding and harvesting contributed to the high cost of production. Pesticide costs are high and can contribute upto 51.70% of the input costs. Gross margins can range from KES 1,614 to KES 12,520 per hectare.

Inadequate use of mechanisation, contributes significantly to high production costs.

**Figure 2 Cost distribution for various activities in the production of one hectare of cotton**




***Competition from enterprises with higher gross margins***

This is especially true within the irrigation schemes where horticultural produce and production of seed for food crops is preferred. The Bura and Hola irrigation schemes were revived two years ago and cotton production within the scheme is already of a low priority to the farmers.

***Inadequate availability of quality planting seed***
A seed bulking and certified support programme was started in 2007. However, this is currently inadequate and requires strengthening in terms of additional trained manpower and financing. Investments especially on equipment for the commercial production of seed by the private sector is also limited.

***Distribution of substandard agro-chemicals***
Substandard or entirely fake agrochemicals especially pesticides are often sold to farmers. The Pesticides Control Produce Board (PCPB) is not able to ensure that all products sold are genuine due to limited manpower.

***Lack of an updated quality assurance protocol and testing equipment***
While quality assurance procedures and standards exist, lack of more modern equipment such as High Volume instrument (HVI) means that cotton from Kenya is of unknown quality.

***Low yields***
The two varieties recommended for commercial production, HART 89M and KSA 81M have a production potential of 2,500 kg/hectare and over 4,000 kg/hectare under rainfed and irrigated conditions. This potential is however far from being achieved with the average yields being 572 kg/hectare. Lack of use of Bt cotton, mite, thrip and herbicide tolerant varieties, also contribute to low yields.


**Photograph showing of delinted seed treated with Monceren (right) and untreated fuzzy seed (left)**

# RESEARCH INTERVENTIONS

## CROP IMPROVEMENT

Revitalization of cotton industry calls for provisions of quality and high yielding cotton varieties. Maintaining genetic purity of introduced, promising and existing commercial cotton varieties is an essential practice that ensures that all varieties and cultivars are maintained over the years.

### *Acquisition of new varieties and selection of superior triats*

Acquiring new varieties, characterizing, evaluating and multiplying the seed give the breeder a vast germplasm for selection of superior varieties. This is done either through direct acquisition or selection from those already maintained at the National Genebank of Kenya (NGBK).

- ***New varieties***

  Thirty four new Deltapine lines/varieties were obtained from Monsanto in 2008 and are currently being evaluated for performance. It is expected that drought tolerant and Bt cotton lines from other countries including India and China will be acquired within the next 2 years.

- ***Selection of superior triats***

  Two varieties/lines with thrips and mite tolerant/resistant, RAVI and NGBK003084 have been tested at KARI-Mwea since 2008. Crosses with 5 high yielding lines/varieties have begun during the 2009/2010 season.

**Photograph showing thrips and mite tolerant/resistant RAVI cotton variety growing at KARI-Mwea**

### *Field rejuvenation*

Field rejuvenation of existing varieties/lines from the NGBK is carried out on a regular basis, with the objective of obtaining pre-basic seed of promising varieties. Recently acquired lines/varieties frequently used in variety trials including the 2 commercial varieties also often undergo field rejuvenation.

- **Currently 61 varieties/lines from the NGBK are being rejuvenated at KARI-Mwea.**

### *Evaluation of varieties*

Commercial suitability of cotton varieties is determined by their inherent nature; farmers need and market forces that change from time to time. In order to keep a breast with these changing needs, continuous evaluation of new varieties is required.

Under the breeding/crop improvement programme, the breeder will evaluate varieties that are economically suitable in different agro-ecological zones. These agro-ecological zones vary in terms of soil types, soil fertility, climate, culture, diseases and insect pest pressure and subsequently on yield of the different cotton cultivars.

- **34 Deltapine lines/varieties from Monsanto are being compared to the 2 commercial varieties, KSA 81M and HART 89M, under different agro ecological zones in cotton growing regions**

- **Thirteen cotton varieties were tested under various agro ecological zones for yield and fibre out turn in the 2006/7 season, with 2 varieties Scala v-1 and L142.9 having significantly higher ginning out turn than HART 89M and KSA 81M (Table 4).**

**Table 3. Characteristics of promising cotton varieties/lines at KARI-Mwea (2006/2007)**

| Variety | Bolls per plant | Days to 1st Flowering | Gining outturn % | Plant Height (cms) | Mean weight (in grams) of 1 boll from a 25 boll sample | Yield in kg/hectare |
|---|---|---|---|---|---|---|
| KSA 81M | 139 | 70.00 | 39.94 | 114.43 | 4.9 | 2,900 |
| A540 | 141 | 73.00 | 39.39 | 121.23 | 4.6 | 3,700 |
| F962 | 137 | 73.50 | 43.45 | 110.30 | 5.1 | 3,110 |
| Vered | 137 | 75.00 | 41.67 | 119.83 | 5.3 | 2,420 |
| HART89M | 141 | 74..25 | 40.30 | 122.33 | 4.6 | 3,650 |
| Pb (70) 1 | 135 | 71.75 | 39.56 | 125.30 | 4.9 | 2,760 |
| Sicala v- 1 | 130 | 71.00 | 43.73 | 108.15 | 4.6 | 2,600 |
| K3400-7 | 130 | 72.25 | 38.68 | 356.50 | 4.5 | 3,450 |
| E790 | 136 | 74.25 | 42.49 | 112.33 | 4.9 | 3,140 |
| L433.15 | 134 | 73.75 | 41.88 | 129.00 | 5.3 | 2,810 |
| Cs189+ | 134 | 70.25 | 41.86 | 112.70 | 4.5 | 2,930 |
| Ny(72) 26 | 141 | 70.50 | 41.54 | 108.08 | 4.9 | 2,930 |
| L142.9 | 136 | 72.00 | 44.17 | 19.10 | 4.8 | 3,180 |

***Production of basic, foundation and certified seed***

Production of basic and foundation seed of the two commercial varieties HART 89M and KSA 81M is carried out every season at the two KARI centres in Kibos and Mwea in order to maintain the genetic purity.

- **Production of basic and foundation seed is carried out continuously on a year to year basis. During the current 2009/2010 season, production of 100 tonnes of certified HART 89M seed has already been attained.**

**Photograph showing preparation of irrigation furrows at the revived Bura irrigation scheme**

# AGRONOMY

***Soils and application of fertilizer***

Application of fertilizers and manures to soils in cotton growing regions will depend on the soil type and extent of depletion of nutrients in specific agro ecological zones. Research on soils has been carried out extensively in the country from the sandy soils of the Coast province; acid loams (Western Province) and the heavy clays of Mwea and Kano plains. The clay loams of Bura and Hola. and the poorly developed loamy soils in Mwea, Meru, Machakos and Kitui. The sandy and loamy soils are generally low in Nitrogen (N) and phosphorous (P), while heavy clay soils tend to be low in nitrogen and high in P. Proper application of manure will in almost all cases enhance the soil water status and N, while inorganic fertiliser use is location specific and soil analysis is recommended before use.

***Tillage***

While the conventional tillage method is the use of one or two disc plough followed by harrowing, many farmers use oxen ploughs with no harrowing due to economic reasons. The use of the oxen plough usually results in the compaction of lower soil layers due to repeated shallow ploughing. Studies have shown that minimum tillage combined with controlled grazing and use of manure may be adopted in cotton farming without loss in yield.

***Water management and irrigation***

Water use to supplement rainfall especially in the very dry cotton growing areas is important for increasing yields. However, water logging is often a major problem on clay soils. Studies on drainage in western Kenya and water harvesting in central and eastern provinces of Kenya indicate that using broad bed and furrows for surface water drainage and tied ridges for water harvesting, a substantial increase in the yield is attained. Additional studies especially in irrigation schemes are required in order to improve water utilisation and yield of cotton.

Research on the use of cotton as an alternative crop in the rotational programme of the rice paddies indicates that it is suitable in enhancing the soil qualities. In addition, the yield of the cotton crop in the paddy is much better than under rainfed conditions

***Importance of correct time of planting***

Timely planting is essential to achieving high yields in cotton especially under normal rainfall conditions. A delay in planting after the optimal date results in a significant drop in yields. In addition time of planting differs according to the rainfall patterns in different cotton growing zones in Kenya. Research on planting dates indicated that proper timing was extremely important with optimal dates in mid- March for most of western Kenya, April in the coast province and mid-October for the central and eastern regions.

***Plant population and spatial arrangements***

Several plant population and spatial arrangement studies have been carried out in almost all cotton growing regions in Kenya. These studies indicate that yields remain optimal and fairly stable within the range of 33,333 to 74,074 plants per hectare. Within this range, choices of plant population will be made mainly depending on convenience of various activities such as spraying, weeding and harvesting.

***Ratooning of cotton***

In the current cotton growing recommendations for Kenya cotton stalks are supposed to be uprooted and burnt at the end of every harvest. Cutting and burning of old cotton stalks is carried out in order to reduce the incidence of pests such as pink bollworm, spiny bollworm, seed bugs, cotton stainers and diseases from one season to the next. However, growing of ratoon cotton is a common practice in eastern and coastal areas of Kenya. Ratoon cotton is what sprouts from a cotton stalk has been cut.

Results from studies on the ratooning of cotton indicate that this has no negative effect on fibre yield and quality. However, there are increased levels of mealybugs and bollworms after two continuous growing seasons.

***Intercropping with food crops***

Intercropping cotton with grain legumes and other food crops is a common practice in many cotton growing regions. Studies indicate that intercropping gives a higher combined monetary return than from pure stands as are the land equivalent ratios. However, shade effects of maize and other cereals reduce yields significantly compared to grain legumes. This means that the combined monetary returns from intercropping legumes with cotton are better than that for maize (sorghum) and cotton. Legume/cotton intercrops are recommended at specific spacing and spatial arrangements for different agro-ecological zones.

**Photograph shows a cotton Stainer (Dysdercus spp), feeding on cotton seed in a mature boll**

# CROP PROTECTION

***Use of pesticides on cotton***

The majority of cotton farmers in Kenya spray their cotton fields using various synthetic pesticides to alleviate pest damage. The number of sprays varies with the pest incidence or what the farmers can afford to buy.

Though these pesticides protect crops and enhance yields, some have adverse effects on human health, wildlife, beneficial insects and biodiversity. Such negative effects arise from direct exposure, spray drift, washing clothes used during spraying, poor pesticide storage at homes, limited use of protective clothing's and poor disposal of empty pesticide containers. In addition, pest resistance due to improper use of pesticides and natural build up of resistance in insect populations continues to be a major challenge.

***Other methods of pest control***

Control of cotton pests may be carried out using cultural methods such as intercropping, crop rotation, and destruction of cotton plants immediately after harvest. The use of resistant cotton cultivars, timely removal of pest host weeds, use of trap crops are additional methods. Plant extracts/botanicals, biological control agents and the use of biological control agents and biopesticides (including Bt cotton) are methods used in pest control.

***Weed control***

While weed control in Kenya is mainly carried out manually, herbicides are more efficient in terms of cost and timely weed control. The development of cotton varieties with herbicide tolerance is set to see an increase in the use of herbicides.

***Use of plant extracts***

Field evaluation tests on the efficacy of selected botanical pesticides against arthropod pests of cotton and their natural enemies have been undertaken at KARI-Mwea over the last 4 years with encouraging results. Tobacco leaf powder consistently outperformed pesticides commonly used in the control of aphids and cotton stainers, without affecting the natural enemy populations.

Ageratum leaf powder was very effective against spider mites without having any adverse effects to natural enemies.
Studies are now set to narrow down to formulating and refining application methodologies and determining the exact active ingredients.

**Photograph shows high population cotton Stainer (Dysdercus spp) on cotton plant**

***Field evaluation of transgenic Bt-cotton***
Various field evaluation trials have been carried out on Bt cotton. These tests determined that;

- Transgenic Bt-cotton varieties DP 448 B and DP 404 BG effectively controlled the populations of the African Bollworm and the Cotton Semi-looper

- Transgenic Bt-cotton varieties had no significant effect on the populations of the non-target cotton pests including the aphids, red spider mites and stainers.

- Transgenic Bt-cotton varieties DP 448 B and DP 404 BG have no negative effect on the beneficial arthropods in the cotton ecosystem, but rather enhance their population growth in the absence of pesticides which have a negative impact on the populations.

- Pollen-mediated gene flow can occur between transgenic Bt-cotton and the non- transgenic local commercial cotton variety HART 89 M. Manual crossing of Bt and non-Bt cotton showed that they are compatible and out-crossing between these varieties is possible.

- Natural gene flow does occur and may be caused by wind, insect pollinators and mechanical means.

**Photograph of the African Bollworm, *Helicoverpa armigera* larvae**

***Evaluation of pesticides for purposes of registration***

Evaluation trials for synthetic pesticides have been successfully carried out over more than 10 years and the results used in recommending suitable pesticides for use in cotton production.

Efficacy trials will continue to be done for chemical companies with a view to ensuring that all products that are registered for use on the cotton crop are effective against major cotton pests. It is also envisaged that laboratory based tests will be carried out for products already being sold to farmers so that counterfeit products are eliminated from the market.