CHAPTER – V

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS
This chapter summarizes the major findings of this study and also highlights the major conclusions. Certain policy recommendations/implications to reduce the cost of cultivation, improve the production and productivity and output-input ratio of both Bt and non-Bt cotton are also narrated in this chapter.

Introduction

Cotton is defined as a plant of the soft cloud-like substance that comes from shrubby plants and is used to make thread or cloth (www.yourdictionary.com). Cotton is a soft, downy substance, resembling fine wool consisting of the unicellular twisted hairs, which grow on the seeds of the cotton plant (www.brainyquote.com). Cotton is probably one of the most common fabrics we are likely to have in our home as clothing. Cotton is a natural fibre and is used in a wide variety of clothing and home furnishings. Cotton is a good strong fabric that is absorbent and easy to work with. Cotton has a tendency to wrinkle very easily, so cotton blends began to be popular (www.about.com).

Utilization of Cotton

Every part of the cotton plant can be used. Cotton is a plant that produces fibres, which are used to make clothes and other products like towels, carpets or sheets, pillows, underwear, socks, t-shirts etc. Bed sheets are usually made of cotton because of its soft feel. Clothes made out of cotton are light and comfortable (www.english-online.at). At present, people are turning back towards cotton cloths and cotton fibre is preferred over synthetic fibres. Cotton yarn is also used for knitting and crochet. Cotton is used to create the absorbent material known as terry cloth. Cotton lint is also used to create denim for jeans and many other clothing materials. Cotton is used to create banknotes and high quality art paper as well as it used in coffee filters, gunpowder and bookbinding (www.wanttoknowit.com). The
cottonseed which remains after the cotton is ginned is used to produce cottonseed oil which, after refining, can be consumed by humans like any other vegetable oil (Singh Amrik and et. al., 2014). The leftovers of extracted cotton seeds are used in making oil cake for animals. Thus, every part of cotton plant is used properly.

**Economic Importance of Cotton**

Cotton is grown in more than 100 countries all over the world and it is estimated that the crop is planted on about 2.5 per cent of the world’s arable land making it one of the most significant crop in terms of land use after food grains and soybeans. Cotton is also a heavily traded agricultural commodity with over 150 countries involved in exports or imports of cotton. More than 100 million family units are engaged directly in cotton production. When family labour hired-on farm labour and workers in ancillary services such as transportation, ginning, baling and storage are considered, total involvement in the cotton sector reaches about 350 million people. It also provides employment to millions of persons in allied industries such as agricultural inputs, machinery and equipment, cotton seed crushing and textile manufacturing. Cotton played an important role in industrial development of the 17th century and continued to play an important role today in the developing world as a major source of revenue (ICAC, 2012).

**Major Cotton Species in the World**

The four major cotton species in the world are Gossypium hirsutum, Gossypium barbadense, Gossypium arboreum and Gossypium herbaceum.

**Cotton Economy at a Glance in World**

The area under cotton across the world has declined with -5 per cent during the last four decades i.e., 1970-71 to 2009-10. However, production has increased (85 per cent) due to sharp rise in yield (99 per cent) during the same period. After introduction of Bt cotton technology, the production of cotton reached a level of 269970 hundred metric tonnes with productivity level of 756 kg./hect. in 2004-05 in the world. This increase in production was the outcome of an increase in area (357120 hundred hectares) and yield of cotton. Though during the last two decades (1990-91 to 2009-10) area under cotton declined by 8.56 per cent, the production increased by 3.02 per cent and the yield is also increased by 28.05 per cent. This increase in
production was the outcome of an increase in the yield of cotton. However, it is pertinent to note that the world’s yield of cotton was far below (only 735 kg.) as against many countries.

**Major Cotton Producing Countries in the World**

World over cotton was grown on 301830 hundred hectares with approximately more than 75 per cent of the production in developing countries during 2009-10. The total cotton production in the world was 117400 hundred metric tonnes in 1970-71 and it rapidly increased (88.84 per cent rise) to 221700 hundred metric tonnes in 2009-10. China was the largest producer of cotton in the world and contributed one-third (31.24 per cent) of the total global output in 2009-10. India and USA were other major producers and together contributed 36 per cent of the total global production in 2009-10. The countries viz., Pakistan, Brazil, Uzbekistan, Australia, Israel, Benin, Brazil, Burkina Faso, Colombia, Cote D’ivoire, Egypt, Greece, Iran, Mali, Mexico, Myanmar, Spain, Kazakhstan, Turkmenistan, Tajikistan, Zimbabwe, Turkey, Peru, Sudan, Syria, Argentina etc. also produce cotton crop. Output of cotton increased significantly in developing countries like China, India, Brazil and Pakistan during 2005-06 to 2009-10 whereas in developed countries like USA and Australia it had declined (Cotton: World Statistics, Oct, 2012).

**Country-wise Area under Cotton**

Among the major cotton growing countries in the world, India ranked first in area under cotton (34.16 per cent of the world cotton area or 103100 hundred hectares) in the world in 2009-10 and ranked second in respect of world cotton production (23.39 per cent to total world cotton production or 51850 hundred metric tonnes) after China. Thus, India’s share in world’s cotton area was highest (about 34 per cent) in 2009-10. It was followed by China (17.65 per cent), Pakistan (10.30 per cent), USA (10.10 per cent), Uzbekistan (4.36 per cent), Brazil (2.77 per cent), Turkmenistan (2.01 per cent), Argentina (1.46 per cent), both Burkina Faso and Turkey (1.39 per cent), Myanmar (1.19 per cent) and Zimbabwe (1.16 per cent).

**Country-wise Production of Cotton**

Among the major cotton producing countries in the world, China ranked first in production of cotton in the world (31.24 per cent to world cotton production or
69250 hundred metric tonnes) and India ranked second (23.39 per cent or 51850 hundred metric tonnes) in respect of cotton production in the world in 2009-10. Thus, China’s share in world’s cotton production was highest (31.24 per cent) in 2009-10, it was followed by India (23.39 per cent), USA (11.97 per cent), Pakistan (9.34 per cent), Brazil (5.39 per cent), Uzbekistan (3.83 per cent), Australia (1.75 per cent), Turkey (1.71 per cent), Turkmenistan (1.13 per cent) and Argentina (1.01 per cent).

Country-wise Yield and Yield Differentials of Cotton

The productivity of cotton in the world was 735 kg/hect. in 2009-10. Among the major cotton producing countries, the per hectare high productivity providing countries than world average were Australia (1861 kg.), Brazil (1429 kg.), China (1300 kg.), Turkey (905 kg.) and USA (871 kg.) during 2009-10, while per hectare low productivity providing countries than world average are Turkmenistan (412 kg.), India (503 kg.), Argentina (510 kg.), Uzbekistan (645 kg.) and Pakistan (666 kg.) whereas among the minor cotton producing countries in the world, the per hectare high productivity providing countries than world average were Israel (1762 kg.), Mexico (1313 kg.), Syria (1206 kg.), Greece (919 kg.), Peru (856 kg.), Egypt (785 kg.) and Colombia (756 kg.) in 2009-10, while the per hectare low productivity providing countries than world average were Zimbabwe (330 kg.), Burkina Faso (362 kg.), Spain (371 kg.), Mali (396 kg.), Sudan (403 kg.), Cote D’ivoire (432 kg.), Benin (459 kg.), Tajikistan (481 kg.), Myanmar (524 kg.), Kazakhstan (536 kg.) and Iran (629 kg.).

Yield Gap: India vis-à-vis China, USA and the World

The yield gap of cotton in India against world, China and USA was 249 kg., 294 kg., and 372 kg. respectively in 1970-71. During 1070-71 to 2009-10, the yield gap of cotton between the world and India as well as between China and India was highest (349 kg. and 884 kg. respectively) in 2002-03, while between USA and India it was 488 kg. in 2004-05. India’s cotton yield was only 503 kg. lint/hect. as against the world average cotton yield of 735 kg.lint/hect. in 2009-10. The yield gap of cotton between the world and India had declined from 249 kg lint/hect. in 1970-71 to 232 kg. lint/hect. in 2009-10. Moreover, the cotton yield gap between the world and India is decreasing after 2005-06. The per hectare yield gap of cotton in India as against China’s yield had shown increasing trend during 1970-71 to 1985-86 (294 kg. to 546
kg.). It was declined to 540 kg. in 1990-91. From the year 2002-03, the yield gap between India and China increased substantially. The gap which was 884 kg.lint/hect., in 2002-03, declined to 797 kg. lint/hect. in 2009-10. The per hectare yield gap of cotton in India as against the USA’s cotton yield marginally declined from 372 kg. in 1970-71 to 368 kg. in 2009-10.

**Indian Cotton in World Perspective**

The area under cotton in the world had declined from 317770 hundred hectares in 1970-71 to 301830 hundred hectares (-5 per cent) in 2009-10, but in India the area under cotton had significantly increased from 76050 hundred hectares to 103100 hundred hectares during this period (35.57 per cent rise). Among the major cotton growing countries in the world, India ranked first in area under cotton in the world in 2009-10 (with 34.16 per cent). The area under cotton in India was 87860 hundred hectares which contributed to 24.60 per cent of world cotton area in 2004-05, had shown an increasing trend till 2009-10 with the highest share (34.16 per cent or 103100 hundred hectares) of world cotton area. The percentage contribution of India’s cotton production was about 8 per cent in the world total cotton production in 1970-71 (with 53471 hundred bales). Afterwards it increased to 14.40 per cent, 15.30 per cent, 15.96 per cent, 17.78 per cent, 20.02 per cent, 21.02 per cent and 23.39 per cent during 2003-04, 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 and 2009-10 respectively.

**Indian Cotton Economy at a Glance**

India occupies a very prominent position in the cotton acreage and production. In India, the area under cotton and production of cotton were 76050 hundred hectares and 53471 hundred bales of 170 kgs. each in 1970-71, which increased to 103100 hundred hectares and 305000 hundred bales in 2009-10. The cotton yield which was 120 kg.lint/hect. in 1970-71, increased to 503 kg.lint/hect. in 2009-10. Thus, during the period 1970-71 to 2009-10, the production of cotton increased by about 470.40 per cent, area under cotton increased by about 35.57 per cent and yield of cotton increased by about 319.17 per cent. This increase in production was the outcome of an increase in area and yield of cotton. Despite the largest share in area and second largest share (with 24 per cent) in total world production, India ranked 57th with
respect to cotton productivity, due to multiple pest problems and the crop being grown largely on unirrigated soil (almost 65 per cent area under cotton is unirrigated) (Peshin Rajinder and et.al., 2007).

Current Status and Growth Behaviour of Cotton among the Indian States

In order to have a clear understanding regarding significance of cotton economy at the macro level, the information regarding state-wise area, production and yield of cotton were analyzed.

Cotton is cultivated in 9 states of the country, viz., Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu which accounted for nearly 99 per cent of area and 95 per cent of production during 2005-10. Maharashtra, Gujarat and Andhra Pradesh occupied first three ranks covering nearly 72 per cent area of India’s total cotton area during 2005-10.

(1) State-wise Area under Cotton

The average area under cotton in India which was 77564 hundred hectares during 1975-80 increased to 93446 hundred hectares during 2005-10 (20.48 per cent increase over the period under study). Among the cotton growing states in India, the highest area under cotton was found in Maharashtra and its percentage share remained about 31 to 37 per cent of total area under cotton during the entire study period. It was followed by Gujarat (16 to 25 per cent), Andhra Pradesh (5 to 13 per cent), Karnataka (4 to 13 per cent), Punjab (6 to 9 per cent), Madhya Pradesh (6 to 8 per cent), Haryana and Rajasthan (4 to 7 per cent), while the lowest area was found in Tamil Nadu (1 to 4 per cent) during 1975-80 to 2005-10.

(2) State-wise Production of Cotton

The production of cotton in India which was 72149 hundred bales of 170 kgs. each during 1975-80 continuously increased to 263375 hundred bales during 2005-10 (265.04 per cent rise). Among the major cotton producing states of India, the highest average production of cotton was found in Gujarat and its share was about 17 to 29 per cent in total cotton production of the country, followed by Maharashtra (about 16 to 21 per cent), Punjab (7 to 23 per cent), Andhra Pradesh (4 to 17 per cent), Madhya

~ 396 ~
and Rajasthan (4 to 8 per cent), while lesser cotton producing states were Tamil Nadu (2 to 6 per cent) and Karnataka (3 to 9 per cent) during 1975-80 to 2005-10.

(3) State-wise Yield of Cotton

The average per hectare yield of cotton at the national level was 158 kg.lint/hect. during 1975-80. It continuously increased to 479 kg.lint/hect. with 203.16 per cent rise during the study period i.e., 1975-80 to 2005-10. The maximum yield of cotton was observed in Tamil Nadu (711 kg.lint/hect.) during 2005-10, followed by Andhra Pradesh (624 kg.lint/hect.), Punjab (591 kg.lint/hect.) and Gujarat (558 kg.lint/hect.), whereas, the lowest yield were observed in Maharashtra (299 kg.lint/hect.), Karnataka (351 kg.lint/hect.), Rajasthan (421 kg.lint/hect.), Madhya Pradesh (483 kg.lint/hect.) and Haryana (493 kg.lint/hect.) during 2005-10.

Zone-wise Area, Production and Yield Differentials of Cotton

Cotton is mainly grown in three distinct agro-ecological zones viz.,

1. Northern Zone - Punjab, Haryana and Rajasthan,
2. Central Zone - Gujarat, Maharashtra and Madhya Pradesh,
3. Southern Zone - Andhra Pradesh, Karnataka and Tamil Nadu.

Within the three cotton growing zone of India, the highest area under cotton was found in Central zone and its percentage share remained about 58 to 65 per cent of total area under cotton during the entire study period (1975-80 to 2005-10). It was followed by Southern zone (18 to 21 per cent) and Northern zone (16 to 21 per cent) during 1975-80 to 2005-10. The major production of cotton was found in Central zone and its percentage share was about 40 to 57 per cent in total cotton production of the country, followed by Northern zone (17 to 39 per cent) and Southern zone (19 to 25 per cent) during the same study period. However, Northern zone had relatively higher cotton yield (33 kg. to 194 kg.) than the national average cotton yield during the entire period under study. Besides, in the case of Central zone, the average per hectare yield of cotton was relatively lower (33 kg. to 69 kg.) than national average during 1975-80 to 2005-10. In Southern zone, the average per hectare yield of cotton was relatively higher (18 kg. to 87 kg.) than the national average yield during 1985-90 to 2005-10, while it was lower than national average (12 kg.) only in 1975-80.
Bt Cotton in India

The area under Bt cotton in India which was 500 hundred hectares in 2002 continuously increased to 94000 hundred hectares in 2010, i.e., 188-fold increase over the period of time. The percentage share of area under Bt cotton in the total cotton area of India which was 0.57 per cent in 2002 sharp increased to 91.17 per cent in 2010. Among the Bt cotton growing states in India, the highest area was found in Maharashtra and its percentage share remained between 0.29 to 36 per cent of the total area under cotton during the entire study period. It was followed by Gujarat (0.11 to 18 per cent), Andhra Pradesh (0.09 to 16 per cent), Northern Region (0.68 to 13.21 per cent), Madhya Pradesh (0.02 to 7 per cent), Karnataka (0.03 to 4 per cent), Tamil Nadu (0.02 to 1.16 per cent) and Other states (0.06 to 0.09 per cent) during 2002 to 2010.

Place of Cotton in Crop Pattern of India

Since independence, crop pattern at the national as well as level has rapidly changed. At all India level, during the study periods, food grains and cereals share in gross cropped area has been declining. At all India level, the share of foodgrains in GCA was about 74 per cent during the triennium ending (TE) 1950-53 which declined to 64 per cent during TE 2005-08. Besides this, the share of area under non-foodgrain crops in GCA which was 26 per cent during TE 1950-53, significantly increased to 36 per cent during TE 2005-08. Out of GCA under non-foodgrains, cotton ranked first position in our country. Among the two superior cash crops viz., cotton and groundnut, the area under cotton occupied first position in India. Among the non-foodgrains, cotton accounted for the largest share of about 8.21 per cent during TE 1950-53 and it significantly increased to 14 per cent of GCA during TE 2005-08. Thus, cotton has remained as an important crop at all India level and throughout the four decades its share in GCA remained nearly at the same level during the study period.

Export of Indian Cotton

The share of cotton export in total agricultural exports had increased (showing 8.01 per cent) during 1970-71 to 2009-10. Except the year 2004-05, the share of the export of cotton in the total agricultural exports increased considerably during 2001-
02 to 2007-08. The share of cotton export in total agricultural exports had increased significantly during 1970-71 to 2009-10 (3.49 per cent to 11.50 per cent). Thus, cotton is an important commercial crop which contributes a significant share in our exports earnings.

Objectives and Research Methodology

Justification of the Study

Cotton is one of the world’s most important textile fibre. The share of cotton in world textile manufacturing is about 45 per cent, whereas, in India it is about 70 per cent (AICOTTON, 9th Feb., 2010). It occupies a prominent position in manufacturing and agricultural economy of the country. India is the only country where all the four cultivated species of cotton i.e., Gossypium herbaceum, Gossypium barbadense and Gossypium hirsutum are grown on fairly commercial scale in a total coverage of 10 million hectares (AICCIP, 2010). Among all the cotton growing countries, India ranked first in global scenario (about 34 per cent of the world cotton area in 2009-10) but with regard to production and consumption, it is ranked second, next to China. It contributes nearly 65 per cent of total raw material needs of textile industry in our country. About 60 million of Indian people are involved directly or indirectly in cotton production, processing, textiles and related activities of cotton (AICCIP, 2010). Gujarat is also an important cotton growing State of the country, with largest area under cotton (24.70 per cent during 2005-10) after Maharashtra (about 34 per cent during 2005-10) (Cotton World Statistics, Oct., 2012). The area under non-foodgrain crops in the State has shown an increasing trend (non-foodgrains share which was 37.71 per cent during 1950-53 increased to 70.53 per cent during 2004-07 in GCA), whereas, the area under foodgrain crops has declined during this period. Among the two superior non-foodgrain crops in Gujarat, viz., groundnut and cotton, the area under cotton occupied the first rank with 14.79 per cent of GCA during 2004-07 (Various Season and Crop Reports, Gujarat State).

In spite of frequent drought like situations, Gujarat has remained a leading cotton producing State in the country. After introduction of Bt cotton technology in the State (2004) there was a turning point in the history of cotton production in 2007-08. The total cotton production reached to a peak level of 82757 hundred bales (170
kgs. each) in 2007-08. Between 2000-01 and 2007-08, the area, production and yield of cotton in Gujarat showed a very rapid annual growth rate of 5.96 per cent, 31.30 per cent and 25.37 per cent respectively (Gandhi V.P. and et. al., 2010; Season and Crop Report, Gujarat State).

**Objectives of the Study**

This study concentrates mainly on the following objectives:

1. To examine district–wise trend and growth pattern of area, production and yield of cotton in Gujarat during the last four decades ending 2010.
2. To find out variations in cost of cultivation of Bt and non-Bt cotton under irrigated and rainfed areas.
3. To find out the relationship between the farm size and productivity of cotton of the sample farmers and to assess the factors affecting for the variations, if any.
4. To find out output-input ratio of Bt and non-Bt cotton cultivation under irrigated and rainfed conditions of the selected sample cotton growers.
5. To suggest measures to improve cotton cultivation in Gujarat and to recommend policy implications.

**Selection of Time Periods**

The necessary data regarding area, production and yield of cotton were collected for the period from 1975-76 to 2009-10 and broadly divided into the following four periods namely:

1. Period-I (1975-76 to 1979-80) - Initial period of new seed, fertilizers, new technology and impact of hybrid varieties of cotton,
2. Period-II (1985-86 to 1989-90) - Spread of new agricultural technology and impact of hybrid varieties of cotton,
4. Period-IV (2005-06 to 2009-10) - Impact of Bt technology and open market policy.

All the districts of the State have been taken into consideration for the analysis. However, in the absence of complete time series data for the period 1970-71.
to 1999-2000 regarding the newly formed districts viz., Patan, Dahod, Anand, Narmada, Navsari and Porbandar (before bifurcation in 1997) these districts are considered as a part of Mehsana, Panchmahal, Kheda, Bharuch, Valsad and Junagadh districts respectively till 1999-2000. Though Tapi district was bifurcated from Surat district in 2008-09 it is considered as a part of Surat district for the present analysis. Thus, Mehsana and Patan districts are treated as Mehsana, Panchmahal and Dahod districts are treated as Panchmahal, Kheda and Anand districts are treated as kheda district, Bharuch and Narmada districts are treated as Bharuch district, Valsad and Navsari districts are treated as Valsad district and Junagadh and Porbandar districts are treated as Junagadh district during the years 1970-71 to 1999-2000 whereas Surat and Tapi districts are treated as Surat district during 2005-10 (Period-IV).

The districts of Gujarat have been divided in two groups i.e., (1) major cotton growing districts and (2) other cotton growing districts. The major cotton growing districts are those whose share is more than 5 per cent in GCA of the State. The major cotton growing districts in the State are Ahmedabad, Amreli, Bharuch, Bhavnagar, Gandhinagar, Jamnagar, Junagadh, Kheda, Kutch, Mehsana, Narmada, Patan, Porbandar, Rajkot, Sabarkantha, Surendranagar and Vadodara. Other cotton producing districts are Anand, Banaskantha, Dahod, Panchmahal and Surat, whose share is less than 5 per cent in area under cotton cultivation to GCA of the State, whereas, Dang, Navsari and Valsad are non-cotton growing districts, whose share is zero to GCA of the State.

Sources of Data

The present study is based on both secondary and primary data.

(a) Secondary Data

The secondary data regarding area, production and yield of cotton for the major cotton producing countries in the world, for different states of India, different districts of Gujarat and other necessary relevant information to the subject have been collected from the various published as well as unpublished sources/literatures.

(b) Primary Data

The primary data for the study were obtained by personal interview method from the selected cotton growers of the study area. The selected farmers were
personally contacted, interviewed and the required information were collected from them. Various aspects such as socio-economic profile of the sample households, their occupation, size of landholding, owned and operated land, land utilization, cropping pattern, irrigation, agricultural and non-agricultural assets, use of agricultural equipments and implements, employment in cotton cultivation, use of various inputs in cotton cultivation and its expenditure incurred on such inputs, cost of cotton cultivation, production and productivity of cotton, by-product of cotton, price of cotton, gross income, net income etc. were collected with the help of a pre designed and pre tested questionnaire.

Sampling Design

For the primary data collection, the procedure of selection of sample district, sample tehsils, sample villages and sample farmers were made in the following manner:

(i) Selection of Sample District

At the first stage, Bharuch district of Gujarat was purposively selected for the in-depth study due to the following reasons:

(1) Cotton is an important commercial as well as cash crop grown in Bharuch district. Among the different crops grown in the district cotton occupied the pivotal position in the crop pattern of the district, (2) The district had covered an average 1285 hundred hectares (about 39 per cent to GCA) of area under cotton during quinquennium 2005-10 in Gujarat. The area under cotton was increasing in this district, (3) Both Bt cotton and non-Bt cotton were grown on large scale by the farmers in this district and (4) Significant area under irrigated and unirrigated Bt and non-Bt cotton was available in the district.

(ii) Selection of Sample Tehsils

For the selection of sample tehsils, out of 8 tehsils of Bharuch district, 4 tehsils having highest area under cotton were identified. These tehsils were Bharuch, Vagra, Amod and Jambusar. With a view to include adequate sample farmers growing Bt and non-Bt cotton under irrigated and unirrigated conditions, from these identified 4 tehsils, 2 tehsils (Amod and Bharuch) having adequate area under both the irrigated
Bt and non-Bt cotton as well as unirrigated Bt and non-Bt cotton were selected purposively. Thus, at the second stage, two tehsils viz., Amod tehsil (23.12 per cent of total irrigated area under cotton and 11.53 per cent of total unirrigated area under cotton) and Bharuch tehsil (20.59 per cent of total irrigated area under cotton and 16.18 per cent of total unirrigated area under cotton) were selected purposively for an in-depth investigation. These two tehsils ranked first and second in the total area under irrigated cotton cultivation in the Bharuch district.

(iii) Selection of Sample Villages

In order to generate reliable estimates reflecting village level variability with minimum standard errors it was decided to select 5 villages from each selected tehsil. Random sampling method was used to select villages. Thus, from both the selected tehsils 10 sample villages were selected for a detailed field study. Accordingly, Matar, Nahier, Ninam, Rohad and Tanchha villages from the Amod tehsil and Amleshwar, Derol, Kasva, Kelod and Padariya villages from the Bharuch tehsil were selected for an intensive study.

(iv) Selection of Sample Cotton Growers

From each sample village, 6 Bt cotton growers comprising 1 small, 1 medium and 1 large farm size groups of irrigated Bt cotton and 1 small, 1 medium and 1 large farm size groups of unirrigated Bt cotton were selected randomly. Following a similar selection procedure, 6 non-Bt cotton\(^1\) (Desi Cotton/Non-hybrid Cotton) growers were also selected from each sample villages. Thus, from each of the selected village, 12 cotton growing farmers (6 adopting Bt cotton and 6 adopting non-Bt cotton) were selected. In this manner from 10 villages, 120 sample farmers, 60 Bt cotton growers (30 Irrigated + 30 Unirrigated) and 60 non-Bt cotton growers (30 Irrigated + 30 Unirrigated), were selected for primary data collection. Taking into account the landholdings the cotton growers were classified into 3 groups namely;

1. Small farm size group (below 02.00 hectares),
2. Medium farm size group (02.01 to 04.00 hectares) and
3. Large farm size group (above 04.00 hectares).

\(^1\) Some farmers cultivate G. Cot - 23 and GN. Cot - 25 on their farms. After completion of the ginning, farmers keep the seeds at home with some process and use them in the next season. These varieties are popularly known as Desi Cotton (Non-hybrid Cotton) in local language and farmers growing such cotton have been considered as Non-Bt Cotton growers in the present study.
Reference Year of the Field Survey

To study the “Economics of Cotton Cultivation in Gujarat - A Case Study of Bharuch District” information were collected for the agricultural year 2010-11. It was decided to take agricultural year 2011-12 as a reference year. As final harvesting of cotton crop ended around April it was decided to conduct the primary field survey during June-2011 to May-2012. Thus, for this study farm household survey was carried out for kharif season of 2011-12.

Research Tools

In the present study, the various tools and techniques are used for analysis. The analysis is largely based on the statistical and mathematical measures viz., annual average, percentage and ratio’s, per cent/percentage, average annual rate of change (per cent) and compound growth rate. The regression co-efficient least square methods were used; further, the statistical 't' test is used to test the reliability of estimated regression co-efficient. The log-linear regression model is used to examine the effects of variation in major agricultural inputs on crop yield, which is estimated for both Bt and non-Bt cotton.

Cost Concepts

The cost concepts used in the present investigation are those laid down in the comprehensive cost of cultivation scheme for principal crops of the Gujarat state. The concepts of cost viz., Cost A, Cost B and Cost C<sub>2</sub> have been used in the analysis. The inputs items included under each category of cost are indicated below:

**Cost A**

1. Value of hired human labour,
2. Value of hired bullock labour,
3. Value of owned bullock labour,
4. Value of seed (both farm produced and purchased),
5. Value of pesticides, insecticides and herbicides etc.,
6. Value of farm yard manure, oil cake, liquid fertilizers, organic fertilizers etc. (owned and purchased),
7. Value of chemical fertilizers,
8. Depreciation on farm machineries, implements, equipments, farm buildings, 
irrigation structures etc.,
9. Irrigation charges (payments made for canal water, pond water etc.),
10. Land revenue, cesses and other taxes,
11. Interest paid on crop loan,
12. Interest on working capital and
13. Miscellaneous expenses (value of other items which are used up in current 
production).

Cost B

Cost A + imputed rental value of owned landless revenue paid + imputed 
interest on owned fixed capital (excluding land).

Cost C₂

Cost B + imputed value of family labour.

After verification, the values of purchased inputs were taken into 
consideration as described by the farmers.

Income Measures

There are the returns over different cost concepts. Different income measures are 
derived using the cost concepts. These measures include farm business income, 
family labour income, net income, farm investment income etc. (Reddy Subba S. and 
et. al., 2008).

Chapter Scheme

Chapter-I focuses on an overview of world cotton economy and describes the 
Indian cotton scenario, objectives and research methodology of the study etc. 
Chapter-II depicts on reviews of literature on cotton cultivation at macro and micro 
levels. Chapter-III explains on overall cotton scenario of Gujarat - growth of 
Gujarat’s cotton, district-wise trend of area, production and productivity of irrigated, 
unirrigated and total cotton in Gujarat, compound growth rate of area, production and 
productivity of irrigated, unirrigated and total cotton in Gujarat during different 
decades, nature of variability (CV) in area, production and productivity of irrigated,
unirrigated and total cotton at the districts level as well as Gujarat as a whole. **Chapter-IV** focuses on the general socio and agro-economic conditions of the selected 120 sample cotton growers, cotton cultivation practices viz., per hectare input use pattern, cost of cultivation, production, per hectare yield, price, gross income, net income, output-input ratios of Bt and non-Bt cotton etc. It is also presents the sample farmers’ observations and perceptions regarding Bt and non-Bt cotton cultivation. **Chapter-V** summarizes the major findings of the study and also highlights the major conclusions. Certain policy recommendations/implications to reduce the cost of cultivation and improve the production, productivity and output-input ratio of cotton are also narrated in this chapter.

**Limitations of the Study**

The subject selected for a detailed study has a fairly wide scope, particularly in agricultural and manufacturing economy. But looking at the administrative and financial aspects, such as financial outlay and resources, availability of personnel time required for analysis of the field data etc., it is not possible for an individual researcher to carry out the whole area and provide justice to all aspects of cotton economy of Gujarat state. Apart from the policy issues relating to the cotton economy of Gujarat, the study is mainly limited to only Bharuch district. From this district only five villages from Amod tehsil and five villages from Bharuch tehsil have been selected for a micro study. The findings derived from the study may/may not be applied at the macro level.

**Review of Literature**

A comprehensive review of literature is a significant part of any scientific investigation. Therefore, an attempt has been made to review the research studies related to (A) Cost of cultivation of cotton, (B) Growth of area and production of cotton, (C) Yield level performance of cotton and (D) Other relevant literature reviewed for cotton crop. A brief review of such work is presented in the following paragraphs:

**[A] Cost of Cultivation of Cotton**

The studies reviewed show that the chemical fertilizers, irrigation, pesticides, human labour, rental value of own land were the major cost components in the total
cost of Bt and hybrid cotton cultivation. Among these components, the cost of human labour was found higher. The cost of fertilizers and pesticides was high due to the use of high priced agricultural inputs like fertilizers, plant protection chemicals and the farmers generally used them more than the recommended doses. The results of the studies indicate that the per hectare cost of cultivation of Bt cotton was lower than that of other hybrid varieties, but it was higher than that of non-hybrid varieties (desi varieties). The average per hectare cost of Bt seeds was more than double than the non-Bt seeds. Further, input cost was more for Bt as compared to Traditional cotton. In the case of operational cost, the Bt cotton farmers spend more than Traditional cotton. Thus, the cultivation of Bt cotton was cost intensive. In the case of hybrid cotton, the plant protection cost was higher as compared to that in Bt cotton, while the seed cost was higher in Bt cotton than non-Bt cotton. Hence, it can be concluded that the savings in pesticide costs for Bt cotton have been found more to offset the higher seed cost for Bt cotton. Besides, the average per quintal total cost of production was lower in Bt cotton than in hybrid cotton/desi cotton. Thus, Bt cotton technology was superior to hybrid cotton in terms of higher yields and lower cost of production. The results of majority of the studies show that per hectare cost of cultivation decreased with the increase in size of farms, while per quintal cost of production increased with the decline in size of farms.

[B] Growth of Area and Production of Cotton

The studies reviewed reveal that the production of cotton had increased due to improvement of the productivity of cotton. The major cause for increase in the yield of cotton was higher adoption of Bt cotton technology by the farmers. Due to the research and extension efforts the production was increased without more increase in area. Thus, the production was increased rapidly due to increased productivity. The area under cotton was increased before green revolution, but growth rate of area was negligible for this crop during post-green revolution period.

[C] Yield Level Performance of cotton

The studies reviewed indicate that for cotton, the productivity performance was poor in the 1970’s but it was relatively better in 1980’s and 1981-96. The yield level was increased considerably during 2000’s due to the adoption of Bt technology.
had played a key role in increasing the production and productivity of cotton. The majority of the studies show that productivity performance had improved but significant variation in the growth of productivity of cotton was observed. All studies reviewed show that the average yield of Bt cotton over non-Bt cotton (both hybrid and desi) was higher. Further, human labour, fertilizers, expenditure on seed and plant protection and number of irrigations were important variables for minimizing the yield gap in cotton cultivation.

[D] Other Cotton Related Review of Literature

The other studies reviewed reveal that the price of cotton and quality characteristics was closely related with each other. The staple length, staple strength, staple length uniformity, colour and fineness had significantly affected the price. The studies further reveal that a higher gross value of crop had no positive impact on IPM technology adoption in cotton. The formal IPM training, knowledge level of farmers regarding adverse impact of pesticides on environment, farm-size and gross value of crop turned out to be significant in explaining high IPM adoption score. Some studies showed that the recommended production techniques for Bt cotton were not adopted by the farmers. Moreover, a large number of farmers had described disadvantage in the seed cost of Bt cotton whereas in respect of pest incidence, pesticide need, cotton quality, staple length, yield and profitability from Bt cotton cultivation, majority of farmers were seen advantages.

Cotton Economy at a Glance in Gujarat

The area, production and yield of cotton in the State were 17450 hundred hectares, 17983 hundred bales and 175 kg.lint/hect. respectively during 1970-71 increased to 24220 hundred hectares, 82757 hundred bales and 581 kg.lint/hect. respectively during 2007-08. During the period 1970-71 to 2009-10, the production of cotton increased by about 311.58 per cent as the area under cotton increased by about 41.23 per cent, while the yield of cotton increased by about 192 per cent during above mentioned period (Various Season and Crop Reports, 1970-2010).

Thus, with this growth, Gujarat has become a number one cotton producing State in the country with about 29 per cent share to total cotton production in the country during 2005-10. The average area under cotton in Gujarat was about 23078
hundred hectares, which was about 25 per cent of the total area under cotton in the country during 2005-10. The districts that lead the cultivation of cotton in the State were Surendranagar (19 per cent of total cotton area of the State), Bhavnagar (12 per cent), Rajkot (11 per cent), Amreli (9 per cent), Ahmedabad and Vadodara (about 7 to 9 per cent) during 2005-10. The average production and productivity in Gujarat had reached 75773 hundred bales and 558 kg.lint/hect. respectively during 2005-10 (CAB and Various Season and Crop Reports). There was not much difference in area under cotton in Gujarat and Maharashtra, but in yield and production, Gujarat had far outpaced Maharashtra since 2002-03 and had the highest yield and production during 2005-10. The rapid adoption of Bt cotton in Gujarat had a major impact. Rainwater harvesting through the creation of thousands of check-dams may had also played a significant role.

**Bt Cotton in Gujarat**

The area under Bt cotton was only 180 hundred hectares (1.08 per cent to total cotton area) in 2002-03, thereafter, it continuously increased to 13000 hundred hectares (1.08 per cent to 53.67 per cent to total cotton area in India) in 2007-08. The production which was 16846 hundred bales of 170 kgs. each during 2001-02 increased to 77796 hundred bales during 2005-06 with a yield level of 660 kg.lint/hect. The production and yield slightly declined to 74166 hundred bales in 2006-07 having yield average of 550 kg.lint/hect. Again the production and yield of cotton increased to 82757 hundred bales of 170 kgs. each in 2007-08 having yield average of 581 kg.lint/hect. Groundnut area was replaced by cotton owing to popularization of Bt cotton and higher yield especially in Rajkot, Porbandar and Kutch districts (Singh N.B., 2009).

**Area under Prominent Hybrid/HYVs and Non-hybrid Varieties of Cotton in Gujarat**

After the approval of Bt cotton cultivation in Gujarat in 2002, the area under Hybrid-4 cotton variety rapidly declined and reached to a very low level in 2004-05 and afterwards it reached to zero level. In the total cotton area of the State, the share of non-hybrid varieties declined from 57.60 per cent in 1998-99 to 26.48 per cent in 2007-08. Besides this, the share of hybrid varieties in the total area under cotton increased from 42.40 per cent in 1998-99 to 73.52 per cent in 2007-08. This clearly
suggests that cotton farmers had shifted from non-hybrid to hybrid cotton and particularly to Bt cotton at a very fast speed.

**Gujarat’s Cotton in India**

The percentage share of area under cotton in Gujarat to the national cotton area declined from 22.95 per cent (with 17450 hundred hectares) in 1970-71 to 14.01 per cent (with 10426 hundred hectares) in 1990-91. After 1990-91, the percentage share of area under cotton of the State to the India’s cotton area significantly increased from 19.53 per cent in 2000-01 to 25.73 per cent in 2007-08. Thereafter it declined during next two years i.e., 2008-09 (25.02 per cent) and 2009-10 (23.90 per cent). The percentage share of production of cotton in Gujarat to the India’s cotton production remarkably declined from 33.63 per cent with 17983 hundred bales in 1970-71 to 8.88 per cent with only 12426 hundred bales in 2000-01. Afterwards, it increased to 32.28 per cent in 2005-06. Again it declined to 24.27 per cent in 2009-10. Thus, though the percentage share of area under cotton in Gujarat to the national cotton area was only 23.11 per cent in 2005-06, the percentage share of production of cotton was 32.28 per cent.

**Yield Gap: Gujarat vis-à-vis India**

The percentage difference between India’s cotton yield and Gujarat’s cotton yield was -45.83 per cent in 1970-71, -6.62 per cent in 1975-76, -11.83 per cent in 1980-81, -10.28 per cent in 2003-04, -11.28 per cent in 2004-05, -39.83 per cent in 2005-06, -5.57 per cent in 2006-07, -4.87 per cent in 2007-08 and -1.59 per cent in 2009-10. Per hectare yield of cotton in Gujarat (126 kg./hect) was far below as against the national average cotton yield (278 kg./hect) in 2000-01 (54.68 per cent). From the year 2005-06 the yield gap increased substantially having as high as 188 kg. lint/hect. in Gujarat against India (-39.83 per cent). In short, the Gujarat’s cotton yield was maintained above the national average of cotton yield during the whole study period (1970-71 to 2009-10), except 1985-86 to 2002-03 and 2008-09.

**Growth Pattern of Area, Production and Yield of Cotton**

During 1950-55 to 2005-10, the CGR of cotton production was marginally higher for Gujarat (4.28 per cent per annum) as compared to all India (3.72 per cent per annum). The CGR of area under cotton was 1.08 per cent for Gujarat whereas it
was only 0.61 per cent for all India level. The CGR of productivity of cotton was also marginally higher for Gujarat (3.22 per cent) as compared to all India (3.10 per cent). The post-Bt technology period (1995-2000 to 2005-10) revealed that the CGRs of area, production and productivity were significantly higher with 3.46 per cent, 8.93 per cent and 5.38 per cent respectively for Gujarat, while for all India they were only 0.36 per cent, 5.15 per cent and 4.78 per cent respectively. However, significant rise in CGR of production and yield, both for Gujarat and all India, during this period can be mainly attributed to significant rise in area under Bt cotton. It must be noted that Bt crop is highly favoured by the farmers.

**Cotton Position in Cropping Pattern of Gujarat**

The cropping pattern of the State has gradually diversified from food grain crops to non-food grain crops (Patel A.S., 2006). The low value food crops have been replaced by high value non-foodgrain crops. During the study period, the share of foodgrain crops in GCA declined significantly from 62 per cent during TE 1950-53 to 29 per cent during TE 2004-07. On the other hand, the share of non-foodgrain crops in GCA had fluctuated and increased from nearly 38 per cent to 71 per cent during the same study period. Out of the total area under total fibre crops/non-foodgrain crops in the State, cotton ranked first position. Among the two superior cash crops viz., cotton and groundnut, the area under cotton occupied first position in the State. The area under cotton had gradually increased between TE 1950-53 to TE 1970-73 (14 per cent to 19 per cent). Thereafter, its share declined to 17 per cent during TE 2000-03 and 15 per cent during TE 2004-07.

**Trend of Area under Cotton in Gujarat**

Movement towards cotton economy and the distinguished features of such movement are noteworthy. It is observed that the crop pattern, at the State and the districts level, has a significant shift from foodgrain crops to non-foodgrain crops (Patel A.S., 2006). The degree of concentration of cotton crop in various districts is measured by average percentage of GCA as well as State’s total area under cotton.

**Percentage Share of Area under Cotton to GCA among the Districts**

The proportion of GCA under cotton had declined up to 1985-90 but then it had constantly increased during 1995-2000 to 2005-10. The districts having more than
30 per cent of their GCA under cotton during 2005-10 were Surendranagar (59.56 per cent), Bhavnagar (45.38 per cent), Bharuch (38.57 per cent), Narmada (36.52 per cent), Amreli (36.27 per cent), Ahmedabad (32.74 per cent) and Vadodara (30.82 per cent). Among the cotton growing districts, the proportion of GCA under cotton increased significantly in Amreli, Bhavnagar, Jamnagar, Rajkot and Surendranagar and declined in Kheda, Kutch, Mehsana, Sabarkantha and Vadodara districts. Surendranagar district was ranked first in the proportion of GCA under cotton, which was followed by Bhavnagar and Bharuch districts. The districts which did not experience any change in their proportion were Ahmedabad, Bharuch, Gandhinagar and Junagadh.

**Percentage Share of Districts in the State’s Total Area under Cotton**

Surendranagar district was ranked first in the percentage share of area under cotton during 2005-10, followed by Bhavnagar and Rajkot districts. The percentage share of Surendranagar in total area under cotton was significantly higher during 1985-90 as compared to 1975-80 and 2005-10. Gandhinagar and Junagadh districts did not register any noticeable change in its percentage share in the total area under cotton cultivation.

**Trend of Area under Irrigated Cotton**

**Share of Area under Irrigated Cotton to Gross Irrigated Area (GIA) among the Districts**

Cotton covered the larger proportion of GIA in Amreli, Surendranagar, Bhavnagar, Rajkot, Jamnagar, Narmada and Vadodara. The proportion of cotton to GIA in these districts is more than 40 per cent. The percentage share of irrigated area under cotton to GIA continuously increased in Bhavnagar, Jamnagar and Rajkot, while it continuously decreased in Ahmedabad, Bharuch, Gandhinagar, Junagadh, Kheda, Sabarkantha, Surendranagar and Vadodara districts during 1985-90 and 1995-2000, but again it increased during 2005-10. In Amreli, Kutch and Mehsana districts, it declined during 1985-90, but then continuously increased during 1995-2000 and 2005-10.
Percentage Share of Area under Irrigated Cotton in Various Districts of the States’ Total Irrigated Area under Cotton

The percentage share of irrigated area under cotton in the States’ total irrigated area under cotton had continuously increased in Amreli and Jamnagar over the study period, while it had continuously declined in Junagadh and Mehsana districts during study period. The districts which did not experience any change in its percentage share were Bharuch and Gandhinagar, while the share of Bhavnagar and Rajkot in total irrigated area under cotton continuously increased during 1985-90 and 1995-2000 but thereafter it declined marginally during 2005-10. It continuously declined in Ahmedabad, Kheda and Sabarkantha districts during 1985-90 to 1995-2000 but again increased during 2005-10. In Surendranagar and Vadodara districts it increased during 1985-90 but continuously declined during 1995-2000 to 2005-10, while in Kutch it declined during 1985-90 than it continuously increased during 1995-2000 to 2005-10.

Percentage Share of Area under Irrigated Cotton in Total Area under Cotton in Various Districts of the State

Irrigated area under cotton had increased more than 60 per cent in total area under cotton during 2005-10 in the State. Cotton was mainly cultivated under irrigation condition in Sabarkantha and Junagadh districts from 1975-80 while in Gandhinagar, Sabarkantha, Jamnagar, Junagadh and Bhavnagar from 1985-90 and in Gandhinagar, Sabarkantha, Jamnagar, Rajkot, Amreli and Bhavnagar from 1995-2000. Out of the total area under cotton, Gandhinagar, Junagadh, Porbandar, Rajkot, Sabarkantha, Jamnagar, Kheda, Mehsana, Kutch and Bhavnagar districts had more than 70 per cent of the total cotton area under irrigation.

Area under Cotton (Irrigated and Unirrigated)

During quinquennium 1975-80, average annual area under total cotton in Gujarat was 18446 hundred hectares, which increased to 23078 hundred hectares during 2005-10 (4632 hundred hectares or 25.11 per cent). During the overall study period i.e., the 4th over the 1st period, the area under cotton increased in all districts except six districts viz., Kheda (64.09 per cent), Mehsana (62.70 per cent), Kutch (47.96 per cent), Sabarkantha (27.62 per cent), Vadodara (22.42 per cent) and Bharuch (18.71 per cent). The highest percentage rise (456.05 per cent of area) was
observed for Amreli, followed by Jamnagar (437.77 per cent) and Gandhinagar (285.87 per cent) districts. On the other hand, the highest percentage fall of the area was in Kheda (64.09 per cent) and the lowest was in case of Bharuch district (18.71 per cent).

**Area under Irrigated Cotton**

The average annual irrigated cotton area was 4834 hundred hectares in Gujarat, increased to 14066 hundred hectares during 2005-10 (9232 hundred hectares or 191 per cent rise). During the entire study period, area under irrigated cotton increased remarkably in all the major cotton producing districts except two districts viz., Kheda (-27.76 per cent) and Mehsana (-16.86 per cent) districts. The highest increase was found in Jamnagar (1198.60 per cent) district and the lowest was found in Sabarkantha district (9.22 per cent).

**Area under Unirrigated Cotton**

The average annual unirrigated area under cotton was 13613 hundred hectares during 1975-80, which declined to 9012 hundred hectares during 2005-10 (4601 hundred hectares or 54.33 per cent declined). During the entire study period, the area under unirrigated cotton decreased in all the districts of the State except Bhavnagar (4.89 per cent), Jamnagar (12.82 per cent) and Amreli (179.24 per cent). Among other districts, the highest percentage decline was found in Gandhinagar (100.00 per cent), followed by Junagadh (94.69 per cent), while the lowest percentage decline was found in Surendranagar (9.48 per cent).

**Trend of Cotton Production in Gujarat**

**Percentage Share of Districts’ Cotton Production in the State’s Total Production of Cotton**

The percentage share of cotton production had increased in Amreli, Bhavnagar, Gandhinagar, Jamnagar and Rajkot districts during the study period. Among these districts, the production of cotton had increased significantly in Rajkot (17.00 per cent), followed by Bhavnagar (15.09 per cent) and Amreli (10.24 per cent) districts during the study period whereas the percentage share of cotton production had declined in Ahmedabad, Bharuch, Junagadh, Kheda, Kutch, Mehsana,
Sabarkantha, Surendranagar and Vadodara districts during the study period. The percentage share of Amreli, Bhavnagar and Rajkot in the total cotton production of the State had increased continuously during the study period while it continuously declined in Mehsana district during the study period. In Kutch district, the percentage share of cotton production in the total production of cotton of the State had declined up to 1985-90 but then it increased continuously during 1995-2000 to 2005-10. Rajkot and Bhavnagar districts ranked first and second respectively in the percentage share of cotton production during 2005-10.

Production of Cotton (Irrigated and Unirrigated)

The average annual production of cotton in Gujarat State which was 21259 hundred bales (170 kgs. each) during 1975-80 significantly increased to 75773 hundred bales during 2005-10 (54514 hundred bales or 256.42 per cent). Between the 1st and the 2nd period, production of cotton decreased by 32.76 per cent (6964 hundred bales) in the State. Then it increased by 98.94 per cent (14144 hundred bales) between the 2nd and the 3rd period. It again increased by 166.44 per cent (28439 to 75773 hundred bales) between the 3rd and the 4th period. Over the three and a half decades, production of cotton increased more than cripple with 256.42 per cent (21259 to 75773 hundred bales) in Gujarat. Throughout the study period, cotton production remarkably increased in Amreli district (1471.12 per cent), followed by Jamnagar (1395.91 per cent) and Bhavnagar (1072.96 per cent) whereas, Sabarkantha was at the last position in increasing irrigated cotton production (10.77 per cent) in the State.

Production of Irrigated Cotton

The average annual production of irrigated cotton of the State as a whole was 12444 hundred bales during 1975-80, which sharp went down to 60637 hundred bales during 2005-10 (48193 hundred bales or 387.27 per cent). The percentage change in the entire study period shows that irrigated cotton production had gone up considerably in all the leading cotton producing districts of Gujarat. This production was found better in three districts viz., Amreli (1632.78 per cent), Jamnagar (1350.92 per cent) and Bhavnagar (1072.96 per cent) whereas, Sabarkantha was at the last position in increasing irrigated cotton production (10.77 per cent) in the State.
Production of Unirrigated Cotton

The average annual production of unirrigated cotton which was 8815 hundred bales (170 kgs. each) in during 1975-80 period declined by more than one and half fold (-47.18 per cent) during 1985-90, but remarkably increased by (119.59 per cent or 5569 hundred bales) during 1995-2000, then it further increased by 48.04 per cent (4911 hundred bales) during 2005-10. During 1985-90, only Surendranagar was major unirrigated cotton producing district. During 1995-2000, Vadodara was another major unirrigated cotton producing district and its share considerably increased but Surendranagar had remained as a dominant district. In absolute term, production of unirrigated cotton had increased by 6321 hundred bales (71.71 per cent) during the 4th over the 1st period.

Trend of Productivity of Cotton in Gujarat

Productivity of Cotton (Irrigated and Unirrigated)

The average per hectare yield of cotton was 196 kg. during 1975-80 which increased to 207 kg. during 1985-90, 304 kg. during 1995-2000 and it further increased to 558 kg. during 2005-10 in Gujarat. During the whole study period, the yield of cotton noteworthy increased in all the cotton growing districts of Gujarat. The highest yield was found in Bharuch district (328.80 per cent) as compared to earlier periods. The lowest productivity was found in Sabarkanth (21.68 per cent) during the same period.

The yield of cotton was relatively higher than State’s cotton yield in almost all the districts except Bharuch, Ahmedabad, Surendranagar, Vadodara, Kutch, Kheda and Bhavnagar districts during the first period. In the same manner, cotton yield was also higher than State’s total cotton yield in all the districts except five districts viz., Surendranagar, Ahmedabad, Bharuch, Kutch and Vadodara during 1985-90. In the third period (1995-2000) the yield of cotton was significantly higher than State’s total cotton yield in Gandhinagar, Jamnagar, Rajkot, Junagadh, Amreli, Bhavnagar and Sabarkantha while for the remaining districts it was lower. Finally, for the period 2005-10, in the case of Junagadh, Rajkot, Porbandar, Jamnagar, Bhavnagar, Kutch, Gandhinagar, Amreli and Mehsana districts the yield of cotton was relatively more
than the State’s cotton yield, while in the other remaining districts it was lower than the State’s cotton yield during the same period.

**Productivity of Irrigated Cotton**

The average annual per hectare yield of irrigated cotton was 438 kg. during 1975-80 declined to 383 kg. (55 kg. or -12.45 per cent) during 1985-90 and further increased to 513 kg. (33.96 per cent) during 1995-2000 and 733 kg. (42.77 per cent) during 2005-10. The yield of irrigated cotton increased in the State but at the district level, the yield had noteworthy increased in Rajkot and Junagadh districts in the fourth period (2005-10). During this period, yield of irrigated cotton was greater than the State’s yield in Rajkot, Junagadh, Jamnagar, Porbandar, Kutch, Bhavnagar and Patan, while in remaining districts the yield was less than the State’s yield. Rajkot was at the top (186 kg.) in irrigated cotton yield, followed by Junagadh (148 kg.), while Narmada district had the lowest cotton yield (282 kg. less than State’s yield) in this period. Finally, the yield of irrigated cotton had significantly increased in all the major cotton cultivating districts of the State (except Gandhinagar) over the study period i.e., the 4th over the 1st period. The yield of irrigated cotton increased higher in Kheda (139.09 per cent), while it was lower in Sabarkantha district (1.42 per cent).

**Productivity of Unirrigated Cotton**

The average annual per hectare yield of unirrigated cotton in Gujarat was 85 kg. during 1975-80 and which went down to 62 during 1985-90 (-26.96 per cent) then it remarkably increased to 104 kg. (66.41 per cent rise) during 1995-2000. It further increased to 168 kg. or 61.78 per cent during 2005-10. The unirrigated cotton yield was quite good during 2005-10 for the Bharuch district (277 kg.). The yield rate increased noticeably during the 3rd over the 2nd period in Gujarat State. During the entire study period, i.e., 4th over the 1st period, the yield of unirrigated cotton had gone up at higher rate in Rajkot district (6161.80 per cent), followed by Jamnagar (2348.13 per cent), while it went up at lower rate in Kutch district (5.20 per cent).
Compound Growth Rate of Cotton Production in Gujarat and Contribution of Area and Yield of Cotton

Compound Growth Rate of Cotton (Irrigated and Unirrigated)

During the period 1970-71 to 2009-10, the annual rate of growth in cotton production was 3.19 per cent in Gujarat. District-wise CGR of cotton production varied between -1.87 in Kheda to 8.07 per cent in Amreli district during 1970-2010. The Amreli district reported highest CGR of production (8.07 per cent per annum) during the same period which was followed by Jamnagar with 7.40 per cent and Bhavnagar with 7 per cent per annum. The production of cotton increased at the annual growth rate of 6.10 per cent in Gandhinagar, 5.68 per cent in Rajkot, 3.96 per cent in Surendranagar, 3.42 per cent in Junagadh, 2.28 per cent in Kutch, 2.25 per cent in Bharuch, 1.63 per cent in Vadodara and 1.40 per cent in Ahmedabad district during the study period. The CGR of cotton production was negative in the districts of Kheda and Sabarkantha.

The CGR of production of cotton was as high as 23.91 per cent for the State as a whole during 2000’s. The CGR of cotton production was high during 2000’s in all districts except Bharuch (8.55 per cent). It was highly significant in the all districts (except Bharuch and Porbandar). Looking into the contribution of CGRs of area and yield in growth rate of cotton production indicate that the districts of Bhavnagar, Jamnagar and Junagadh had positive CGR of the production during all the four decades and it was mainly due to the positive growth rate of yield. It was significant during 1990’s and 2000’s. The important cotton producing district i.e., Kheda district had negative (-4.22 per cent), (-9.44 per cent), (-0.93 per cent) per annum CGRs during 70’s, 80’s and 90’s respectively and it was mainly due to negative growth rate in area. Later on it achieved positive (20.59 per cent) growth rate during 2000’s. It was mainly due to the significantly positive CGR of the area and also due to well improved growth rate of yield during 2000’s.

Compound Growth Rate of Irrigated Cotton

The production of irrigated cotton had increased significantly at the rate of 3.67 per cent per annum during 1970-71 to 2009-10 for the State. The CGR of production of irrigated cotton was negatively insignificant (-0.18 per cent and -2.58
per cent respectively) during 70’s and 80’s whereas, it was positively significant (9.70 per cent and 27.27 per cent respectively) during last two decades in the State. Among the major irrigated cotton producing districts, Amreli had reported significantly highest CGR of the irrigated cotton production with 8.44 per cent per annum, followed by Jamnagar with 7.32 per cent, Bhavnagar with 7.14 per cent, Gandhinagar with 6.07 per cent, Rajkot with 5.73 per cent, Kutch with 5.01 per cent, Surendranagar with 4.18 per cent, Junagadh with 3.83 per cent, Vadodara with 2.59 per cent, Bharuch with 2.54 per cent and Ahmedabad with 2.17 per cent per annum during the entire study period, while only three districts i.e., Kheda, Mehsana and Sabarkantha had negative growth rate of irrigated cotton production, but it was insignificant.

Over the period of time, the per annum CGR of production of irrigated cotton was significantly positive in all the major irrigated cotton producing districts, (except Kheda, Mehsana and Sabarkantha). It was mainly due to the positive CGR of area and yield of cotton. The CGR of production of irrigated cotton had been significantly positive during the entire period for the State due to the significantly positive CGR of both area and yield. During 2000s, the CGR of irrigated cotton production was highly positive due to the positively significant CGR of both area and yield for the State as a whole, but growth rate of yield contributed more to growth rate of the production in the State. The same was true for Bharuch, Bhavnagar, Mehsana, Rajkot and Vadodara districts of the State.

**Compound Growth Rate of Unirrigated Cotton**

The production of unirrigated cotton had increased significantly at the rate of 1.96 per cent per annum during 1970-71 to 2009-10 for Gujarat. The CGR of unirrigated cotton production was negative per annum in the State during 70’s (-0.58 per cent) and 80’s (-9.65 per cent), while it was significantly positive during 90’s and 2000’s (9.35 per cent and 12.51 per cent respectively). Among major unirrigated cotton producing districts, Amreli district reported significantly positive and the highest CGR of unirigated cotton production with 7.61 per cent which was followed by Bhavnagar with 7.58 per cent, Jamnagar with 5.45 per cent, Surendranagar with 5.05 per cent, Rajkot with 3.59 per cent, Bharuch with 2.13 per cent, Ahmedabad with 1.32 per cent and Vadodara with 0.25 per cent per annum during 1970-71 to 2009-10.
During 70’s and 80’s, the CGR of unirrigated cotton production was negative in Bharuch and Vadodara districts, but it became positive during next two decade viz., 90’s and 2000’s. Ahmedabad, Amreli, Bhavnagar, Jamnagar, Mehsana, Rajkot and Surendranagar districts had positive CGR of unirrigated cotton during all the decades under study except only 80’s. Among the major cotton producing districts of the State, only in Kheda district the CGR of unirrigated cotton production was negative during all the periods under study. Analyzing the contribution of CGRs of area and productivity to growth rate of production of unirrigated cotton was observed that CGR of yield contributed cent per cent to positive growth rate of production at the State level during the last decade under study (2000’s). The same observation was true for Ahmedabad, Bharuch, Mehsana, Rajkot, Surendranagar and Vadodara. The CGR of unirrigated cotton production was positive for Amreli, Bhavnagar, Jamnagar, Narmada and Sabarkantha due to the positive growth rates of both area and yield, but growth rate of yield contributed more to growth rate of the production in these districts (except Sabarkantha).

**Variability in the Area, Production and Yield of Cotton in Gujarat**

The nature of variability in area, production and productivity per hectare over the time is worth inquiring. In order to inquire in to this aspect, the estimates of coefficient of variations (CV) were carried separately for the various decades. The CV indicates the disparities or inequality among the districts.

**Variability in Area under Cotton (Irrigated and Unirrigated)**

The degree of variability measured in terms of CV worked out to 8.88 per cent in first period, 18.07 per cent in the second period, 16.30 per cent in the third period, 16.31 per cent in the fourth period and 24.40 per cent during the entire study period in Gujarat. As regards the figure of CV the variation in the major cotton growing districts was 7.19 per cent in Sabarkantha district and 43.09 per cent in Kutch district in the first period and 8.41 per cent in Vadodara and 49.65 per cent in Gandhinagar district in the second period. In the third period, the variation varied between 7.20 per cent in Vadodara district and 42.74 per cent in Amreli district, while 5.86 per cent in Vadodara and 68.91 per cent in Jamnagar district in the fourth period. The CV worked out to 14.88 per cent in Surendranagar and 103.79 per cent in Gandhinagar for the entire period under study.
Variability in Area under Irrigated Cotton

During the first to fourth period, the CV continuously increased in Gujarat. The figure of CV was 10.34 per cent in the first period, 11.94 per cent in the second period, 26.46 per cent in the third period, 36.14 per cent in the fourth period and 56.05 per cent in the entire period. In respect of major cotton growing districts, the figure of CV varied from 10.90 per cent in Vadodara district to 46.51 per cent in Sabarkantha in the first period and 11.34 per cent in Mehsana to 67.28 per cent in Jamnagar district in the second period. The CV varied from 15.40 per cent in Mehsana to 47.02 per cent in Amreli in the third period and 12.67 per cent in Vadodara district to 78.92 per cent in Ahmedabad in the fourth period, while the CV varied from 20.43 per cent in Mehsana to 132.89 per cent in Jamnagar during the entire period.

Variability in Area under Unirrigated Cotton

The CV of area under unirrigated cotton remarkably increased in the second period as compared to first period but there was decline in the third period (22.39 per cent to 11.21 per cent). Further there was a marginal decline (10.75 per cent) in the fourth period in the State as a whole. The figure of CV for the entire period was found to be 27.67 per cent. In respect of major unirrigated cotton growing districts, the figure of CV varied from 6.94 per cent in Surendranagar district to 49.02 per cent in Kutch in the first period and 8.72 per cent in Vadodara to 207.54 per cent in Gandhinagar district in the second period. The CV varied from 3.96 per cent in Vadodara to 216.02 per cent in Gandhinagar in the third period and 10.68 per cent in Bharuch to 162.18 per cent in Gandhinagar in the fourth period. For the overall period under study, the figure of CV varied from 14.83 per cent in Surendranagar to 115.49 per cent in Sabarkantha district.

Variability in Production of Cotton (Irrigated and Unirrigated)

In Gujarat, CV of production of total cotton continuously increased during 1970-71 to 2009-10 period (17.52 per cent to 52.42 per cent). Among the four period under study, the figure of CV varied from 17.52 per cent in the first period to 52.42 per cent in the fourth period in the State. For the entire period it was 74.21 per cent. In respect of main cotton producing districts of the State, the variation in CV was from 18.07 per cent in Mehsana to 50.19 per cent in Bharuch in the first period and 33.95
per cent Amreli to 82.36 per cent in Jamnagar in the second period. The figure of CV varied from 16.08 per cent in Kheda to 64.11 per cent in Amreli in the third period while 34.95 per cent in Patan to 90.27 per cent in Bharuch district in the fourth period. Lastly, the figure of CV varied in between 31.22 per cent in Mehsana and 148.05 per cent in Jamnagar district in the entire period.

**Variability in Production of Irrigated Cotton**

During the first to fourth period, CV continuously increased in the State. The CV of production of irrigated cotton significantly increased from 23.30 per cent in the first period to 32.96 per cent in the second period. Further it again increased from 37.25 per cent in the third period and 56.75 per cent in the fourth period. For the entire period, it was 90.86 per cent. As regards the figure of CV, the variation in the major irrigated cotton producing districts was from 21.84 per cent in Gandhinagar and 89.80 per cent in Ahmedabad during the 1970-71 to 1979-80, while 27.15 per cent in Mehsana and 96.11 per cent in Kutch district during the 1980-81 to 1989-90. The figure of CV was found to be varying from 22.93 per cent in Mehsana to 69.45 per cent in Kutch district in the third period and 41.04 per cent in Bharuch district to 80.30 per cent in Jamnagar in the fourth period. The figure of CV was found to be varying between 38.65 per cent in Mehsana to 156.61 per cent in Jamnagar in the entire study period.

**Variability in Production of Unirrigated Cotton**

The CV of unirrigated cotton production noteworthy increased from 19.66 per cent in the first period to 43.30 per cent in the second period. Thereafter, the figure of CV marginally declined to 42.94 per cent in the third period but it again significantly increased to 51.55 per cent in the fourth period under study. The figure of CV was found to be 52.37 per cent in the entire period. At the district level, the variation in CV was found to be varying from 27.79 per cent in Vadodara to 95.25 per cent in Jamnagar in the first period and 25.91 per cent in Vadodara to 173.92 per cent in Sabarkantha in the second period. The figure of CV varied in between 28.50 per cent in Ahmedabad district to 145.15 per cent in Rajkot in the third period and 32.21 per cent in Ahmedabad to 132.57 per cent in Bharuch district in the fourth period, whereas, in the entire period under study (1970-71 to 2009-10), the figure of CV varied from 37.27 in Vadodara to 136.95 per cent in Bharuch district.
Variability in Productivity of Cotton (Irrigated and Unirrigated)

The CV of cotton yield had increased from 14.82 per cent in the first period to 27.32 per cent in the second period. But there was a marginally declined (22.87 per cent) in the third period. Again it significantly increased (45.00 per cent) in the fourth period. The figure of CV for the entire period was found to be 51.54 per cent. As regards the figure of CV it varied from 17.15 per cent in Mehsana to 46.64 per cent in Sabarkantha in the first period and 23.50 per cent in Junagadh to 57.66 per cent in Kutch in the second period. The CV in the third period varied in between 18.56 per cent in Bharuch to 47.36 per cent in Sabarkantha district, while in the fourth period the variation was from 27.87 per cent in Mehsana district to 86.20 per cent in Bharuch. In case of the entire period the CV varied from 38.64 per cent in Ahmedabad to 85.39 per cent in Bharuch district.

Variability in Productivity of Irrigated Cotton

During the overall period under study, the CV of productivity of irrigated cotton significantly increased in the State as a whole (33.94 per cent). During the first decade, the CV was 24.15 per cent in the State as a whole. Afterwards, it increased to 28.27 per cent in the second decade. It declined to 20.50 per cent in the third period, but again significantly increased to 40.30 per cent in the fourth period. The figure of CV was found to be 33.94 per cent in the entire period. At the district level, the figure of CV varied from 27.86 per cent in Amreli district to 74.24 per cent in Kutch district in the first period, while it varied from 19.96 per cent in Mehsana to 121.15 per cent in Kutch district in the second period. The figure of CV was found to be varying between 14.28 per cent in Vadodara to 41.49 per cent in Amreli district in the third period and in the fourth period the variation was 20.72 per cent in Mehsana district to 60.89 per cent in Rajkot district. In the entire period, the variation in CV was from 33.81 per cent in Mehsana to 100.86 per cent in Kutch.

Variability in Productivity of Unirrigated Cotton

During the first to second period, CV of unirrigated cotton yield significantly increased (23.15 to 37.48 per cent) in the entire State, but it declined marginally (37.05 per cent) in the third period. Again it noticeably increased to 49.48 per cent in the fourth period in the State. The figure of CV worked out to 56.02 per cent in the
entire period. At the district level, the variation in CV of unirrigated cotton yield varied from 28.21 per cent in Vadodara to 110.78 per cent in Jamnagar in the first period and 29.45 per cent in Vadodara to 125.84 per cent in Kutch district in the second period. In the third period, the figure of CV was found to be varying from 23.31 per cent in Kheda district to 147.07 per cent in Sabarkantha district, while 30.04 per cent in Patan district to 137.61 per cent in Bharuch district in the fourth period. The CV varied from 41.36 per cent in Ahmedabad to 231.15 per cent in Sabarkantha district in the entire period.

**Highest and Lowest Yield Levels**

An attempt is made to judge the nature of variability through the data of maximum and minimum levels of per hectare productivity of cotton, both irrigated cotton and unirrigated.

**Maximum and Minimum Yield of Cotton (Irrigated and Unirrigated)**

During the first study decade (1970-71 to 1979-80), per hectare yield of total cotton was maximum (210 kg.) in 1971-72 and minimum (129 kg.) in 1972-73 in Gujarat. During this decade, the variation was about 39 per cent (81 kg.) in the State. The higher variation was observed in Surendranagar (82.35 per cent), while it was lower in Sabarkantha (25.56 per cent). For the State as a whole, during 2000-01 to 2009-10, per hectare yield of cotton was found maximum (660 kg.) in 2005-06 and minimum (126 kg.) in 2000-01. During this decade, the variation was 80.91 per cent (534 kg.) in the State. Per hectare higher yield was obtained (1173 kg.) in 2005-06 for Junagadh district and lower was obtained in 2000-01 for Rajkot district (only 66 kg.). Rajkot district registered higher variation with 94 per cent and it was lower in Mehsana district (57 per cent).

**Maximum and Minimum Yield of Irrigated Cotton**

During the first decade under study, per hectare yield of irrigated cotton was maximum (728 kg.) in 1971-72 and minimum (329 kg.) in 1974-75 in Gujarat. During this decade, the variation was about 55 per cent (398 kg.) in Gujarat State. The higher variation was observed in Kutch district (95.77 per cent), while it was lower in Amreli district (58.28 per cent). For the State as a whole, during 2000-01 to 2009-10, per hectare yield of irrigated cotton was found maximum (879 kg.) in 2005-06 and
minimum (239 kg.) in 2000-01. During this decade, the variation was 72.81 per cent (640 kg.) in Gujarat. Per hectare higher yield was obtained (1316 kg.) in 2003-04 for Jamnagar district and lower was obtained in 2000-01 for Rajkot district (only 75 kg.). Rajkot district registered higher variation with 93.71 per cent and it was lower in Kutch district (52.06 per cent).

**Maximum and Minimum Yield of Unirrigated Cotton**

During the first study decade (1970-71 to 1979-80), per hectare yield of unirrigated cotton was maximum (108 kg.) in 1977-78 and minimum (only 38 kg.) in 1972-73 in Gujarat. During this decade, the variation was about 65 per cent (70 kg.) in Gujarat. The higher variation was observed in Rajkot (99.16 per cent), while it was lower in Vadodara (62.18 per cent). For the State as a whole, during 2000-01 to 2009-10, per hectare yield of unirrigated cotton was found maximum (420 kg.) in 2005-06 and minimum (57 kg.) in 2000-01. During this decade, the variation was 86.43 per cent (363 kg.) in Gujarat. Per hectare higher yield was obtained (1579 kg.) in 2005-06 for Bharuch district and lower was obtained (15 kg.) in 2002-03 for Rajkot district. Rajkot district registered higher variation with 95.47 per cent and it was lower in Patan district (70.05 per cent).

**Cotton Economy at a Glance in Bharuch District**

**Socio and Agro-Economic Conditions of sample Households**

On the basis of a farm level survey of 120 sample farmers, the socio and agro-economic conditions, employment in cotton cultivation, cost of cotton cultivation, production and productivity, price, gross income, net income, farmers’ perceptions and observations etc. are discussed at length. Two tehsils namely Bharuch and Amod of Bharuch district were selected and from each selected tehsil, 60 samples of cotton growers (30 Bt and 30 non-Bt, both irrigated and unirrigated) were selected. A brief outline of the results of the survey is presented in the following paragraphs:

**Personal Characteristics of Head of the Sample Household**

**Caste Composition**

Out of 120 sample farmers, majority of the sample farmers were found from General (open) category (80.83 per cent), followed by SCs (8.33 per cent), OBCs
(7.50 per cent) and STs (3.33 per cent). None of the medium and large farmers were found from STs.

**Age Group**

The age of the farmer is an important factor to make quick decisions regarding adoption of new seeds, fertilizers, pesticides, etc. The age of the respondents ranged from 32 to 79 years. The average age of the heads of the farm households was 53 years. Among the different farm size groups, large farmers were younger (about 51 years of average age) as compared to small and medium farm households. Out of 120 sample farmers, only 7 farmers (5.83 per cent) were from the young age group, while 29 (24.17 per cent) were from the adult age group. Majority of the sample farmers (41.67 per cent) were in middle age group. However, 34 farmers (28.33 per cent) were of old age.

**Educational Status**

The formal education helps farmers to understand the consequences of new technology and therefore an attempt was made to examine the educational status of cotton growers. Out of total 120 sample respondents, 22.50 per cent had education up to primary level and 52.50 per cent had education up to secondary school and higher secondary school. Here, it may be noted that about 16.67 per cent heads had education above higher secondary school i.e., graduates and post-graduates level. Only 4.17 per cent heads were educated in technical line i.e., Diploma, ITI, etc. Out of total 120 sample respondents, only 4.17 per cent were illiterate. It may be noted here that there was no relationship between education and size of the operational holding of the sample farmers. None of the large farmers was illiterate, while 7.50 per cent and 5 per cent of the small and medium farmers were illiterate respectively.

**Occupation**

Farmer’s cultivation practices viz., modern input use, investment in irrigation facilities, storage capacity, risk bearing capacity, etc. are greatly dependent on their capability. Therefore, an attempt was made to examine the occupations of the sample farmers. Out of total 120 sample farmers, 30 per cent farmers were fully dependent on farming only, while remaining farmers (70 per cent) were engaged in other occupations along with farming. Among the different farm size groups, medium (35
per cent) and large (37.50 per cent) farm size groups were engaged only in farming because they had higher cultivated area. Small farm size group did farming with other economic activities due to less cultivated area. Majority (45 per cent) of the large farmers were engaged in farming along with animal husbandry, it was closely followed by medium farmers (40 per cent). Majority of the sample cotton growers were found to be dependent on farming along with animal husbandry as well as labour work on other farms. The main reason was that more than 22 per cent of the farmers had not obtained education above primary school and 4 per cent were illiterate and their economic condition was also poor.

Annual Income

The average annual income of the sample farmers was Rs. 2.35 lakh in the reference year. Majority (40 per cent) of the farmers’ average annual income was between Rs. 1 to 2 lakh and only 4.17 per cent farmers’ average annual income was above Rs. 6 lakh. The major sources of the income of the medium and large farmers were farming and animal husbandry. Average annual income of the large farmers was Rs. 4.20 lakh.

Personal Characteristics of Sample Households’ Family Members

Population

The sample households had a total population of 577 persons, which comprised 53.03 per cent males and 46.97 per cent females. The medium farm households were 172 (29.81 per cent), large farm households were 222 (38.47 per cent) and small farm households were 183 (31.72 per cent). Thus, the overall gender-ratio was 886 females per 1000 males.

Working Population

Out of the total population, 55.11 per cent were working members while the non-working members were 44.89 per cent. The percentage of working population was 62.84 per cent in group of small farmers, 54.07 per cent in group of medium farmers and 49.55 per cent in group of large farmers. There was negative relationship between working population and size of the operational holding of the sample farmers.
Family Size

In the case of sample Bt cotton growers, the majority of the farmers (about 52 per cent) had less than 4 family members, whereas 12 per cent of the respondents had above 7 family members and 37 per cent had 5 to 7 family members. In the case of non-Bt cotton growing sample farmers, majority of the farmers (about 47 per cent) had less than 4 family members, whereas, 10 per cent of the respondents had above 7 family members and 43 per cent had 5 to 7 family members.

Age Composition

Out of 577 family members, the highest members were of young age group between 19 to 35 years (26.52 per cent), followed by children under 18 years of age (24.26 per cent), middle age (20.80 per cent) and adult (16.46 per cent). The lowest members were of the old aged members (11.96 per cent). The number of old age group members in large farm size group was lower than other two farm size groups. Besides, the number of younger in small and medium farm size groups was higher as compared to large farm size group. The numbers of productive age group (19 to 60 years) was notable in all farm size groups.

Educational Status

Out of total 577 members, the majority (46.45 per cent) of the members had education up to secondary/higher secondary level, followed by the members who had education up to primary level (25.65 per cent), up to graduate level (10.40 per cent), up to technical level (4.16 per cent) and up to post-graduate level (1.21 per cent). The proportion of illiteracy among the members of the sample farm households was 12.13 per cent. The majority of the illiterate members were found in small farm size group (18.58 per cent), followed by medium (9.30 per cent) and large farm size group (9.01 per cent).

Occupation

Out of 577 members, 60 members (10.40 per cent) were engaged in farming only, followed by farming and animal husbandry (55 members or 9.53 per cent), only animal husbandry (47 members or 7.97 per cent), farming and farm labour (42 members or 7.28 per cent), only farm labour (31 members or 5.37 per cent). It was
observed that majority of the small farm households’ members (60.39 per cent) were found to be dependent on farming along with farm labour for their income whereas in case of medium farm holdings, 12.79 per cent were found to be dependent only on farming and 13.06 per cent were dependent on farming along with animal husbandry in case of large farm size group.

**Investment in Farm Implements and Equipments of Bt Cotton Growers**

The ownership of farm implements and equipments help in caring out of the farm operation efficiently and therefore, it is pertinent to analyze investment in farm implements and equipments owned by the sample farm households. Per household investment in traditional as well as non-traditional implements and equipments was Rs. 208556 of Bt cotton growers. Out of these, the investment in non-traditional implements and equipments was Rs. 150893 (72.35 per cent) while the investment in traditional implements was Rs. 57663 (27.65 per cent).

**(A) Investments in Traditional Farm Implements and Equipments**

Out of total investments of Rs. 57663 in traditional implements and equipments, Rs. 40917 (70.96 per cent) were invested in well/open well, Rs. 9976 (17.30 per cent) in plough, seeder, leveler, Rs. 4533 (7.86 per cent) in bullock/camel/buffalo cart and Rs. 2238 (3.88 per cent) were invested in minor implements.

**(B) Investments in Non-traditional Farm Implements and Equipments**

Out of total investment of Rs. 150893 in non-traditional implements and equipments, Rs. 81250 (53.85 per cent) were invested in tractor, Rs. 35053 (23.23 per cent) were invested in pipes, Rs. 20433 (13.54 per cent) were invested in trolley and other attachment, Rs. 4383 (2.90 per cent) were invested in electrical/submersible pump set, Rs. 4150 (2.75 per cent) were invested in oil engine with pump set, Rs. 2683 (1.78 per cent) were invested in thresher/opener. Rs. 1357 (0.90 per cent) were invested in manual spraying pump set, Rs. 1167 (0.77 per cent) were invested in diesel pump set and Rs. 417 (0.28 per cent) were invested in power operated spraying pump set. It is interesting to note that category-wise investment in farm implements and equipments were positively related with farm size groups of Bt cotton growers. More investment in implements and equipments was made by large farm group because they had large size of farms for farming.
Investment in Farm Implements and Equipments of Non-Bt Cotton Growers

Per household investment in traditional as well as non-traditional implements and equipments was Rs. 274671 of non-Bt cotton growing farmers. Out of which, the investment in non-traditional implements and equipments was Rs. 206508 (75.18 per cent) and the investment in traditional implements was Rs. 68163 (24.82 per cent).

(A) Investments in Traditional Farm Implements and Equipments

Out of total investments of Rs. 68163 in traditional implements and equipments, the highest investment worth Rs. 39133 (57.41 per cent) were in well/open well, followed by Rs. 21602 (31.69 per cent) in plough, seeder, leveler, Rs. 4867 (7.14 per cent) in bullock/camel/buffalo cart and Rs. 2561 (3.76 per cent) in minor implements.

(B) Investments in Non-traditional Farm Implements and Equipments

Out of total investments of Rs. 206508 in non-traditional implements and equipments, Rs. 149083 (72.19 per cent) were invested in tractor, Rs. 21855 (10.58 per cent) were invested in pipes for irrigation, Rs. 16933 (8.20 per cent) were invested in trolley and other attachments, Rs. 10317 (5.00 per cent) were invested in electrical/submersible pump set, Rs. 3550 (1.72 per cent) were invested in oil engine with pump set, Rs. 2137 (1.03 per cent) were invested in manual spraying pump set, Rs. 1583 (0.77 per cent) were invested in power operated spraying pump set, Rs. 583 (0.28 per cent) were invested in thresher/opener and Rs. 467 (0.23 per cent) were invested in diesel pump set. Thus, the category-wise investment in farm implements and equipments was positively related with farm size groups.

Ownership of Livestock of Bt and Non-Bt Cotton Growers

Out of total 90 animals owned by Bt cotton growers, 30 animals (33.33 per cent), 20 animals (22.22 per cent) and 40 animals (44.44 per cent) were owned by small, medium and large landholding groups respectively of Bt cotton cultivators, whereas out of total 91 animals owned by non-Bt cotton growers, 15 animals (16.48 per cent), 19 animals (20.88 per cent) and 57 animals (62.64 per cent) were owned by small, medium and large farm size groups respectively. Ownership of animals was positive related with the farm groups of non-Bt cotton growers.
Ownership of Residential Houses and Cattle Sheds of Bt Cotton Growers

On an average, per sample household value of pucca residence houses for small, medium and large farm size groups worked out to be Rs. 272418, Rs. 343286 and Rs. 393962 respectively. Similarly, the value of kutcha residence houses was highest (Rs. 199672) for large farm group, followed by medium and small farms group, whereas per farm value of mixed residence houses was worked out to Rs. 139158, Rs. 191105 and Rs. 256696 for small, medium and large categories of farm groups respectively. Thus, per sample farm investment in residential houses was positively related with the farm size groups.

The average value of pucca cattle shed worked out to Rs. 139862 and Rs. 115097 for large and medium farmers. The per farm average value of kutcha animal shed was the highest for big farmers (Rs. 24220), followed by medium (Rs. 24210) and small (Rs. 21160) farmers. The average per farmer value of mixed animal shed worked out to be Rs. 67653, Rs. 61948 and Rs. 69620 for small, medium and large farm size groups respectively.

Ownership of Residential Houses and Cattle Sheds of Non-Bt Cotton Growers

Per household average value of pucca residence houses for small, medium and large operational holding groups worked out to be Rs. 252393, Rs. 334952 and Rs. 368594 respectively. The average value of kutcha residence houses was maximum for large farm size group (Rs. 171225) and minimum for small farm size group (Rs. 117271). In the case of mixed residence houses, the average per farm value was highest for large farmers (Rs. 267583), followed by medium (Rs. 177558) farmers.

Per farm average value of pucca cattle sheds was worked out to Rs. 107557 and Rs. 125133 for medium and large farm size groups respectively whereas the average per farm value of kutcha animal sheds was worked out to Rs. 22821, Rs. 24915 and Rs. 26491 respectively for small, medium and large farm size groups. The average investment in mixed animal sheds was maximum for large farmers (Rs. 77238) and minimum for medium farmers (Rs. 63934). Thus, per farm investment in all type residence houses and cattle sheds were positively related with the farm size groups.
Land Use Pattern of Bt and Non-Bt Cotton Growers

Size of operational holding influences the cost of cultivation of crops, adoption of modern and new technology and capital investment in agriculture and hence the size of operational holding was examined. Average owned land holding was found to be 4.25 hectares per sample farm household of Bt cotton growers. It was 1.20 hectare for small farm group and 3.09 hectares for medium farm group and 8.46 hectares for large farm group. The average operational holding was 4.44 hectares per sample farmer. Net cultivated area of Bt cotton was 4.35 hectares per farmer. Area sown in more than one season was only 0.40 hectare per farmer, therefore, GCA was 4.75 hectares per farm household.

In the case of non-Bt cotton growers, per household average owned land holding was 4.06 hectares. On an average per household, figure of owned was 1.15 hectare for small farm size group, 3.10 hectares for medium farm size group and 7.94 hectares for large farm size group. The average per farmer operational holding was 4.65 hectares. Net cultivated area was 4.63 hectares. Area sown in more than one season was 0.42 hectare; hence GCA was 5.05 hectares per farmer.

Cropping Intensity of Bt and Non-Bt Cotton Growers

Cropping intensity can be measured in percentage terms in a ratio of GCA and Net Cultivated Area (NCA). Cotton is a long duration crop (130 to 200 days) and if it is sown around or after mid-June, the picking of cotton continues up to December. Hence, farmers sowing cotton on or after mid-June would not in a position to grow rabi crops on land. Hence, cropping intensity of such farmers remained at low level. The average cropping intensity of Bt cotton growers worked out to 1.14, 1.11 and 1.07 for small, medium and large farm size group respectively. In the same manner, the overall average cropping intensity of non-Bt cotton growers worked out to 1.12, 1.06 and 1.10 for small, medium and large farm size groups respectively.

Cropping Pattern of Bt and Non-Bt Cotton Growers

The prime objective of the study is to analyze the cost of cultivation of both Bt and non-Bt cotton, income, profit and yield and hence an attempt was made to examine cropping pattern adopted by sample households. For the sample farmers, foodgrain crops constituted only 35.68 per cent while non-food grain crops accounted
for 63.58 per cent of TCA. Within the non-food crops, cotton was a dominant crop accounting for 57.32 per cent of TCA, of which Bt cotton and non-Bt cotton accounted for 51.65 per cent and 5.67 per cent of TCA respectively. In the study area, cotton (Bt + non-Bt) was an important non-food crop and its relative share was 49.14 per cent of TCA for small farmers and 69.12 per cent medium farmers. For large farmers the share was 54.71 per cent of TCA in the study area. Relative share in the area under Bt cotton of TCA was 49.14 per cent for small farm size group, 67.24 per cent for medium farm size group and 46.35 per cent for large farm size group.

For the sample farmers, foodgrain crops constituted about 29 per cent of TCA, while non-food crops accounted for 70.12 per cent of TCA during the reference year 2011-12. Within the non-food crops, cotton (Bt + non-Bt) was a major crop accounting for about 63.15 per cent of TCA. Out of total cotton area, the non-Bt cotton and Bt cotton accounted for 53.07 per cent and 10.08 per cent of TCA respectively. Cotton (Bt + non-Bt) was most important non-food crop in the study area and its relative share was 92.55 per cent of TCA for small size category of farm and 66.47 per cent for medium size category of farm. For large size farmers, the share was 57.82 per cent of TCA. Relative share in the area under non-Bt cotton of TCA was 90.89 per cent for small farmers, and 60.12 per cent for medium farmers. For large farmers, the share was 45.12 per cent of TCA. Thus, the area under non-Bt cotton increased with the decrease farm size group.

**Irrigation Status of Bt and Non-Bt Cotton Growers**

Irrigation is one of the key factors for deciding type and variety of crops to be grown and use of other inputs. The share of gross irrigated area to GCA was 71.25 per cent for the Bt cotton growers whereas it was 69.24 per cent for the non-Bt cotton growers. Between the various farm-size groups under study, the difference in irrigation percentage between Bt and non-Bt cotton was found to be highest (6.99 per cent points) for large farm size group, while for small farm size group it was -4.70 per cent points and for medium farmers it was -5.75 per cent points. The share of gross irrigated area to gross cropped area was 53.08 per cent, 59.37 per cent and 79.31 per cent respectively for small, medium, large land holding groups of Bt cotton growers, whereas, they were 57.78 per cent, 65.12 per cent and 72.32 per cent for small, medium and large sample non-Bt cotton growers.
Average Cultivated Area under Bt and Non-Bt Cotton

An average area under Bt cotton was 2.34 hectares per farm, while for non-Bt cotton it was 2.39 hectares. Category-wise per household average area under Bt cotton was 0.93 hectare for small, 2.15 hectares for medium and 3.94 hectares for large farm size groups. The corresponding figure for non-Bt cotton was 1.10 hectares for small, 2.08 hectares for medium farmers and 3.98 hectares for large farm size groups. Thus, the average per farm area under non-Bt cotton was marginally higher as compared to Bt cotton for small and large farm size groups. The easy availability and low price of non-Bt cotton seed was the main reason for the said scenario.

Various Varieties of Bt and Non-Bt Cotton Grown by the Sample Farmers

Among the varieties of Bt cotton grown by the sample farmers, Rashi-2 (RCH-2), Ajit-155 and Pratik were very popular in the study area. Their share accounted for 23.74 per cent, 22.39 per cent and 12.66 per cent of total area under Bt cotton respectively for Rashi-2 (RCH-2), Ajit-155 and Pratik. Another important variety of Bt cotton viz., Vikram-5, 15 and Ankur/Arjun accounted for 8.48 per cent and 4.71 per cent of the total area under Bt cotton. Among the varieties of non-Bt cotton grown by the sample farmers, G. Cot - 23 and GN. Cot - 25 were very popular in the study area. Their share accounted for 50.91 per cent and 46.36 per cent of total area under non-Bt cotton for G. Cot - 23 and GN. Cot - 25 respectively.

Level of Employment in Cultivation of Bt and Non-Bt Cotton

The agricultural sector is an important source for rural employment. Human labour is mainly used in crop cultivation. The overall average per hectare employment in the study area in respect of selected samples for irrigated Bt cotton, unirrigated Bt cotton and total Bt cotton worked out to 184.25 man days (1474 hours), 148.67 man days (1189 hours) and 170.85 man days (1367 hours) respectively, whereas, for irrigated non-Bt cotton, unirrigated non-Bt cotton and total non-Bt cotton was worked out to 125.24 man days (842 hours), 93.27 man days (746 hours) and 101.37 man days (811 hours) respectively. This indicates that Bt cotton provided more employment (68.54 per cent more) than that of non-Bt cotton in the selected study area. The average per hectare employment in irrigated Bt cotton was higher (24 per cent) than that of unirrigated Bt cotton. In the same way, the average per hectare...
employment in irrigated non-Bt cotton was higher (13 per cent) than that of unirrigated non-Bt cotton.

Loan Taken by the Sample Farmers

Out of the total 120 sample farmers, 56 farmers had taken loan from various sources. All the sample farmers had taken loan from the commercial banks/co-operative societies in the study area. Out of total 56 farmers who had taken loan, 31 (55.36 per cent) were Bt cotton growers and 25 (44.64 per cent) were non-Bt cotton growers. There existed positive relationship between the amount of loan and farm size groups in the study area. An average principal amount of the sample farmers was Rs. 163181. It was Rs. 64188, Rs. 149293 and Rs. 276063 for small, medium and large farmers respectively. The average duration of loan was 2 years for all sample farmers. The average per annum rate of interest was 3.88 per cent. Out of principal amount of loan taken by the sample cotton growers, Rs. 68725 (42.12 per cent of the principal amount) were used for growing cotton crop. Out of total loan taken, 45.63 per cent, 41.43 per cent and 41.67 per cent of the principal amount were used for cotton cultivation by small, medium and large farmers respectively.

Cost of Cultivation of Bt Cotton (Irrigated and Unirrigated)

The overall average per hectare cost of cultivation (Cost C₂) of Bt cotton was Rs. 60806. It fluctuated between Rs. 57059 in respect of small farmers to Rs. 62346 in the case of large farmers. The per hectare cost of Bt cotton cultivation and farm size groups were positively related with the land holding groups. The share of Cost A in the total cost of cultivation for all size of holdings was 74.35 per cent. Among the various components of expenditure, the cost of hired human labour had occupied the first position with 18.87 per cent (Rs. 11473), followed by tractor charges (14.69 per cent), rental value of own land (13.37 per cent), irrigation charges (10.09 per cent), family human labour (10.05 per cent), chemical fertilizers (7.67 per cent), farm yard manure (7.28 per cent), seed (6.12 per cent) and pesticides charges (5.27 per cent). Thus, it could be inferred that the human labour (both hired and family), tractor charges, irrigation, chemical fertilizers, farm yard manure, seeds and pesticides were the major cost components in the Bt cotton cultivation.
Cost of Cultivation of Irrigated Bt Cotton

The per hectare cost of cultivation (Cost $C_2$) of irrigated Bt cotton ranged from Rs. 60401 in respect of small farmers to Rs. 67908 in the case of medium farmers with the overall average of Rs. 65054. The share of Cost A in the total cost of cultivation for all size holdings was 73.65 per cent. The Cost $C_2$ shows that among different components of expenditure, the cost of hired human labour occupied the first position with 19.38 per cent, followed by tractor charges (14.78 per cent), rental value of own land (14.47 per cent), family human labour (9.68 per cent), irrigation charges (9.43 per cent), chemical fertilizers (7.92 per cent), farm yard manure (6.77 per cent), seed (5.83 per cent) and pesticides (5.17 per cent). Thus, it could be inferred that the human labour, (both hired and family), tractor charges, irrigation charges, chemical fertilizers, farm yard manure, seeds, pesticides were the major cost components for the irrigated Bt cotton cultivation.

Cost of Cultivation of Unirrigated Bt Cotton

The cost of cultivation of unirrigated Bt cotton ranged from Rs. 46844 in respect of small farmers to Rs. 50819 in case of large farmers with the overall average of Rs. 48836. The share of Cost A in the total cost of cultivation for all the size of holding groups was 73.25 per cent. The data of Cost $C_2$ shows that among different components of costs, the cost of hired human labour occupied the first position with 20.22 per cent, followed by tractor charges (16.90 per cent), rental value of own land (13.36 per cent), family human labour (11.19 per cent), farm yard manure (9.10 per cent), chemical fertilizers (8.54 per cent), seed (7.47 per cent) and pesticides (6.24 per cent). Thus, it may be noted that the human labour (both hired and family), tractor charges, farm yard manure, chemical fertilizers, seed and pesticides were the main cost components for the unirrigated Bt cotton cultivation.

Cost of Cultivation of Non-Bt Cotton (Irrigated and Unirrigated)

The overall average per hectare cost of non-Bt cotton cultivation (Cost $C_2$) was Rs. 34382. It varied from Rs. 32595 for small farmers to Rs. 35321 for medium farmers. Thus, the cost of cultivation and farm size groups were positively related with the land holding groups. The share of Cost A in the total cost of cultivation for all size of holding groups was 72 per cent. Among the various components of
expenditure, the cost of tractor charges had occupied the first position with 24.01 per cent, followed by hired human labour (20.18 per cent), rental value of own land (12.99 per cent), family human labour (12.85 per cent), farm yard manure (7.79 per cent), chemical fertilizers (5.56 per cent) and irrigation charges (4.31 per cent). Thus, it could be inferred that the tractor charges, human labour both hired and family, farm yard manure, chemical fertilizers and irrigation charges were the major cost components in the non-Bt cotton cultivation.

**Cost of Cultivation of Irrigated Non-Bt Cotton**

The per hectare total cost of cultivation (Cost C2) of non-Bt cotton varied from Rs. 33593 in respect of small farmers to Rs. 37249 in case of medium farmers with the overall average of Rs. 36022. The share of Cost A in the total cost of cultivation for all the size of holdings was 71.37 per cent. Among different components of expenditure, the tractor charges occupied the first position with 23.39 per cent, followed by hired human labour (20.32 per cent), rental value on own land (14 per cent), family human labour (12.49 per cent), farm yard manure (7.40 per cent), chemical fertilizers (5.91 per cent) and irrigation charges (4.11 per cent). Thus, it could be inferred that the tractor charges, human labour charges - both hired and family, farm yard manure, chemical fertilizers and irrigation charges were the major cost components for the irrigated non-Bt cotton cultivation.

**Cost of Cultivation of Unirrigated Non-Bt Cotton**

The per hectare cost of cultivation of unirrigated non-Bt cotton ranged from Rs. 29655 in respect of small farmers to Rs. 31395 in case of large farmers with the overall average of Rs. 30772. The cost had increased with increase in farm size groups. The share of Cost A in the total cost of cultivation for all the size of holdings was 71.79 per cent. Among various components of costs, the tractor charges occupied the first position with 26.28 per cent, followed by hired human labour (20.67 per cent), family human labour (13.11 per cent), rental value of own land (12.94 per cent), farm yard manure (8.74 per cent) and chemical fertilizer (5.51 per cent). Thus, it may be noted that the tractor charges, human labour charges (hired and family), farm yard manure and chemical fertilizers were the main cost components for unirrigated non-Bt cotton cultivation in the study area.
Comparison of Cost of Cultivation between Bt Cotton and Non-Bt Cotton

The average per hectare gross cost of cultivation for Bt cotton (Rs. 60806) was more (76.85 per cent) than that for non-Bt cotton (Rs. 34382) in the study area. The overall average per hectare cost of cultivation worked out to Rs. 65054 for irrigated Bt cotton, Rs. 48836 for unirrigated Bt cotton and Rs. 60806 for total Bt cotton, while it was Rs. 36022, Rs. 30772 and Rs. 34382 for irrigated, unirrigated and total non-Bt cotton respectively. The overall average per hectare cost of cultivation for irrigated, unirrigated and total Bt cotton was higher by Rs. 65054, Rs. 48836 and Rs. 60806 respectively, an increase of 80.60 per cent, 58.70 per cent and 76.85 per cent compared to that for irrigated (Rs. 36022), unirrigated (Rs. 30772) and total non-Bt cotton (Rs. 34382) respectively. The examination of cost of cultivation data, according to land holding categories, does not reveal any definitive trend of cultivation of irrigated Bt and non-Bt cotton. However, per hectare cost of cultivation was found lowest for small size farmers in the cultivation of irrigated, unirrigated and total Bt as well as non-Bt cotton.

There were several reasons which pushed up the cost of cultivation of Bt cotton:

1. The per hectare seed cost of Bt cotton was Rs. 3722, whereas it was only Rs. 565 for non-Bt cotton. Thus, as compared to non-Bt cotton growers, average per hectare expenses incurred on seed for Bt cotton was about 558.76 per cent higher.

2. Owing to substantially higher productivity, per hectare cost of picking/harvesting operation was about 56.63 per cent higher for Bt cotton (Rs. 8192) compared to that for non-Bt cotton (Rs. 5230).

3. The cost of pesticides was much higher (524.76 per cent) for Bt cotton than that for non-Bt cotton.

Thus, it is clearly suggest that Bt technology was a cost intensive and not cost saving in cotton cultivation.

Percentage Share of Inputs in Gross Cost of Cultivation (Cost C2)

The share of seed cost in total cost was 6.12 per cent for Bt cotton which was substantially higher than that of non-Bt cotton (1.64 per cent). This was due to
abnormally high seed prices of Bt varieties as compared to that of non-Bt cotton varieties. The share of farm yard manure was observed somewhat lower for Bt cotton (7.28 per cent) as compared to that for non-Bt cotton (7.79 per cent). Though, chemical fertilizers accounts for the largest share in total cost of Bt cotton (7.67 per cent), it was only marginally higher than its share in total cost of non-Bt cotton (5.56 per cent). The share of irrigation was 10.09 per cent for Bt cotton, which was substantially higher than its share of 4.31 per cent for non-Bt cotton. Similarly, the share of pesticides cost in total cost of cultivation was 5.27 per cent for Bt cotton which was substantially higher than the share of 1.49 per cent for non-Bt cotton. As in Bt cotton, various pests, insects and diseases were generally found and the cost of pesticides was significantly more (524.76 per cent) as compared to non-Bt cotton. The non-Bt cotton did not require higher doses of chemical fertilizers, more irrigation and pesticides as Bt cotton required. On the whole, it is emerging from the analysis that the seed, chemical fertilizers, irrigation and pesticides were mainly responsible for increase in the cost of cultivation of Bt cotton.

Cost of Production, Returns and Output-Input Ratios of Bt Cotton and Non-Bt Cotton

Returns of Bt Cotton (Irrigated and Unirrigated)

The per hectare average gross returns of Bt cotton varied from Rs. 69500 in the case of small farmers to Rs. 84311 in the case of large farmers with an overall average of Rs. 81311. Thus, the gross return of Bt cotton and farm size groups were positively related with the landholding groups. The overall average per hectare farm business income, family labour income, net income and farm investment income of Bt cotton growers were Rs. 36103, Rs. 26615, Rs. 20505 and Rs. 29992 respectively. Thus, Bt cotton cultivation was profitable during the reference year in the study area.

Per unit cost of production plays an important role in determination of minimum support price. The overall average per quintal total Cost C2 of Bt cotton was worked out to be Rs. 3257 for all sample farmers. It ranged from Rs. 3544 for small farm size group to Rs. 3244 for large farm size group. The average per hectare output-input ratios over Cost A, Cost B and Cost C2 was favourable for all the farm size holding groups. The output-input ratio over Cost C2 was 1.35 for large farmers, followed by 1.32 for medium farmers and 1.22 for small farmers with the overall
average of 1.34. This indicates that on an average one rupee invested in the cultivation of Bt cotton earned Rs. 1.34. The output-input ratio over Cost $C_2$ had increased with increase in the farm size group.

**Returns of Irrigated Bt Cotton**

On an average per hectare gross returns of irrigated Bt cotton varied from Rs. 77088 for small farm size group to Rs. 98751 for medium farm size group with an overall average of Rs. 94103. The overall average per hectare farm business income, family labour income, net income and farm investment income of irrigated Bt cotton growers were Rs. 46193, Rs. 35346, Rs. 29049 and Rs. 39897 respectively. The overall average per quintal total Cost $C_2$ of irrigated Bt cotton was worked out to Rs. 3013 for all sample farmers. It was Rs. 3407 for small farmers, followed by Rs. 3005 for large farmers and Rs. 2968 for medium farmers. If the per unit cost of irrigated Bt cotton production is compared with the farm harvest price of Bt cotton received by different category of farmers it seems that it was relatively more than the cost of production. The average per hectare output-input ratio over Cost $C_2$ ranged from 1.28 on small farmers to 1.47 on large farmers, while 1.45 on medium farmers with the overall average of 1.45.

**Returns of Unirrigated Bt Cotton**

The average per hectare gross returns of unirrigated Bt cotton was Rs. 65235 for all the sample farmers. It varied from Rs. 58641 in the case of small farmers to Rs. 67232 in case of large farmers. The overall average per hectare farm business income, family labour income, net income and farm investment income of unirrigated Bt cotton growers were Rs. 29462, Rs. 21865, Rs. 16399 and Rs. 23995 respectively. The overall average per quintal total Cost $C_2$ of unirrigated Bt cotton was worked out to Rs. 3262 for all sample farmers. It ranged from Rs. 3427 for small farmers to Rs. 3298 for large farmers, while it was Rs. 3281 for medium farmers. The output-input ratios over Cost A, Cost B and Cost $C_2$ were favourable for all the farm size holding groups. The overall per hectare output-input ratio over Cost $C_2$ was 1.35 on medium farmers, followed by 1.32 on large farmers and 1.25 on small farmers with the overall average of 1.34.
Returns of Non-Bt Cotton (Irrigated and Unirrigated)

The average per hectare gross returns of non-Bt cotton was Rs. 45253 for medium size of farms group, followed by Rs. 45114 for large size of farms group and Rs. 43002 for small size of farms group with an overall average of Rs. 44668. The overall average per hectare farm business income, family labour income, net income and farm investment income of non-Bt cotton growers were Rs. 19913, Rs. 14704, Rs. 10286 and Rs. 15495 respectively. This clearly indicates that the non-Bt cotton cultivation was profitable during the reference year.

The overall average per quintal total Cost C2 of non-Bt cotton was worked out to Rs. 3041 for all sample farmers. It was Rs. 2977, Rs. 3072 and Rs. 3111 for small, medium and large size of landholding groups respectively. Thus, the relationship between per quintal cost of production (total Cost C2) of non-Bt cotton and farm size group were positively related with farm size groups. The output-input ratios over Cost A, Cost B and Cost C2 were favourable for all the farm size holding groups. The per hectare output-input ratio over Cost C2 of non-Bt cotton ranged from 1.32 on small farmers to 1.28 on both medium and large farmers with an overall average of 1.30.

Returns of Irrigated Non-Bt Cotton

The overall average per hectare gross returns of irrigated non-Bt cotton was Rs. 50435 for all the farmers as a whole. They were Rs. 46112, Rs. 49794 and Rs. 52361 respectively for small, medium and large farm size groups. The overall average per hectare farm business income, family labour income, net income and farm investment income of irrigated non-Bt cotton growers were Rs. 24726, Rs. 18911, Rs. 14413 and Rs. 20227 respectively. The overall average per quintal total Cost C2 of irrigated non-Bt cotton was worked out to Rs. 2818 for all the farmers as a whole. It was Rs. 2898 for small farm size group, followed by Rs. 2881 for medium farm size group and Rs. 2829 for large farm size group. Thus, per quintal cost of production had declined with an increase in farm size groups. The overall average per hectare output-input ratio over Cost C2 was 1.42 for large farmers, followed by 1.37 for small farmers and 1.34 for medium farmers with an overall average of 1.40.
Returns of Unirrigated Non-Bt Cotton

On an average per hectare gross returns of unirrigated non-Bt cotton was Rs. 39826 for all sample farmers. It ranged from Rs. 39229 for large farmers to Rs. 41283 for medium farmers. It is interesting to note that the average per hectare gross return was lowest (only Rs. 39229) for large farm size group. The overall average per hectare farm business income, family labour income, net income and farm investment income of unirrigated non-Bt cotton growers were Rs. 17733, Rs. 13088, Rs. 9054 and Rs. 13699 respectively. The overall average per quintal total Cost $C_2$ of unirrigated non-Bt cotton was worked out to Rs. 3055 for all the sample farmers. It ranged from Rs. 2857 in case of small farmers to Rs. 3174 in case of large farmers. The average per hectare output-input ratio over total Cost $C_2$ was 1.36 for small farmers, followed by 1.32 for medium farmers and only 1.25 for large farmers with an overall average of 1.29.

Picking-wise Break-up of Productivity and Maturity Period of Bt and Non-Bt Cotton

The average gap between sowing and first harvesting of Bt cotton (maturity period) was 149 days for all sample Bt cotton growers, which was 144 days for small, 153 days for medium and 151 days for large farm size group. On an average, about 92 per cent Bt cotton was harvested at the end of fifth picking in the selected study area. In the case of non-Bt cotton, the average gap between sowing and first harvesting of non-Bt cotton (maturity period) was 165 days for all sample non-Bt cotton growers, which was 164 days for small, 169 days for medium and 164 days for large farm size group. On an average, about 96 per cent non-Bt cotton was harvested at the end of fourth picking in the selected study area.

Yield Difference between Bt and Non-Bt Cotton (Irrigated and Unirrigated)

The overall average per hectare yield of Bt cotton and non-Bt cotton (irrigated and unirrigated) was 18.67 quintals and 11.31 quintals respectively in the selected study area. Thus, the average per hectare yield of Bt cotton was substantially higher (65.11 per cent more) than non-Bt cotton. This clearly shows the positive impact of qualitative seeds in enhancing yield of Bt cotton. The farm size group-wise variations in yield level of both varieties of cotton were found insignificant. Per hectare yield of Bt cotton was 19.22 quintals for large farmers, followed by medium farmers (18.77
quintals) and small farmers (16.10 quintals). Thus, it was positively related with farm size groups. In case of non-Bt cotton, per hectare yield was 11.50 quintals for medium farmers, followed by 11.30 quintals for large farmers and 10.95 quintals for small farmers. The overall average per hectare yield gap between Bt and non-Bt cotton was 7.36 quintals (65.11 per cent) for all the sample farmers. It was 7.91 quintals (70 per cent) for large farm size groups, followed by 7.27 quintals (63.23 per cent) for medium farm size group and 5.15 quintals (47.02 per cent) for small farm size group.

**Yield Gap between Irrigated Bt and Non-Bt Cotton**

The overall average per hectare yield level of irrigated Bt and irrigated non-Bt cotton was 21.59 quintals and 12.78 quintals respectively. The farm size-wise data shows that the per hectare yield of irrigated Bt cotton was 22.88 quintals for medium farmers, followed by large farmers (21.93 quintals) and small farmers (17.73 quintals). In case of irrigated non-Bt cotton, per hectare yield was 13.05 quintals for large farmers, followed by 12.93 quintals for medium farmers and 11.59 quintals for small farmers. Thus, per hectare yield of irrigated non-Bt cotton had increased with an increase in farm size group. The overall average yield gap between irrigated Bt and irrigated non-Bt cotton was 8.81 quintals (68.91 per cent) for all the sample cotton growers in the study area. It was 6.14 quintals (52.98 per cent), 9.95 quintals (76.95 per cent) and 8.88 quintals (68.05 per cent) for small, medium and large farm size groups respectively.

**Yield Gap between Unirrigated Bt and Non-Bt Cotton**

The overall average per hectare yield level of unirrigated Bt and unirrigated non-Bt cotton was 14.97 quintals and 10.07 quintals respectively. The per hectare yield of unirrigated Bt cotton was 13.67 quintals for small farms group, 14.75 quintals for medium farms group and 15.41 quintals for large farms group. Thus, it was positively related with farm size groups whereas the per hectare yield of unirrigated non-Bt cotton was highest (10.38 quintals) for small farmers, followed by 10.27 quintals for medium farmers and 9.89 quintals for large farmers. Thus, it was inversely related with farm size groups. The overall average per hectare yield gap between unirrigated Bt and unirrigated non-Bt cotton was 4.90 quintals (48.63 per cent) for the all sample farmers. It had increased with an increase in farm size groups. The overall average per hectare yield was 3.29 quintals (31.70 per cent) for small
farmers, 4.48 quintals (43.62 per cent) for medium farmers and 5.52 quintals (55.81 per cent) for large farmers.

**Realized and Expected Yield of Bt Cotton**

The average per hectare yield of Bt cotton realized by all the sample farmers was 18.67 quintals, while the per hectare expected yield was 18.64 quintals for all the sample farmers. Thus, the variation of 0.12 per cent was found between realized and expected Bt cotton yields. The average per hectare yield of irrigated Bt cotton realized by the sample farmers was 21.59 quintals as against 18.28 quintals of expected yield. Hence, the variation of 18.14 per cent was found between realized and expected yield of irrigated Bt cotton in the study area. In case of unirrigated Bt cotton, the average per hectare yield realized by the sample farmers was only 14.97 quintals as against 19.11 quintals of expected yield and hence the variation of 21.66 per cent was found between realized and expected yield of unirrigated Bt cotton.

**Realized and Expected Yield of Non-Bt Cotton**

The average per hectare realized yield of non-Bt cotton was only 11.31 quintals as against 12.62 quintals of expected yield. Thus, the variation of 10.44 per cent was found between per hectare realized yield and expected yield. In the case of irrigated non-Bt cotton, the average per hectare yield realized by the sample farmers was only 12.78 quintals as against 13.78 quintals of expected yield and hence, the variation of 7.27 per cent was found between realized and expected yield of irrigated non-Bt cotton. The average per hectare yield of unirrigated non-Bt cotton realized by the sample farmers was 10.07 quintals, while per hectare expected yield was 11.46 quintals. Therefore, the percentage difference between realized and expected yield of unirrigated non-Bt cotton was found 12.13.

**Price Realization of Bt cotton and Non-Bt cotton Growers**

Bt cotton was found relatively cleaner and better in colour and hence in respect of quality, Bt cotton has slight edge over non-Bt cotton. Thus, the overall performance of price realization of Bt cotton was better than that for non-Bt cotton. The overall average per quintal price realized for Bt cotton was Rs. 4296 as against Rs. 3862 for conventional non-Bt cotton. Examination of price data across different farm categories shows that the average per quintal price realized of Bt cotton for all the three categories

~ 444 ~
of farmers was found to be higher than that for corresponding categories of non-Bt cotton. Across farm sizes, no significant difference was observed in average price realized for non-Bt cotton. However, in respect of Bt cotton, small farmers realized lowest price worth Rs. 4250/qtl., wherein large farmers realized highest price worth Rs. 4328/qtl.

**Yield Variations in Bt and Non-Bt Cotton**

The CV for Bt cotton was found significantly more (24.11 per cent) as compared to 16.32 per cent for non-Bt cotton. In addition, the yield range of Bt cotton was 11.18 to 24.99 qtls./hect., whereas for non-Bt cotton, it was 7.95 to 16.78 qtls./hect. The higher CV and higher range of variability clearly suggests slightly higher inter-farm yield variability for Bt cotton. This result does not support the claim that Bt cotton has less inter-farm variations and more stability in yield as compared to non-Bt cotton.

**By-Product of Bt Cotton and Non-Bt Cotton**

The average per hectare by-product of Bt cotton was 30.11 quintals for all Bt cotton growing sample farmers in the study area. It was 28.79 quintals, 30.71 quintals and 30.83 quintals for small, medium and large farms group respectively. The average per hectare value of by-product was worked out to Rs. 1116 for all sample farmers. It varied from Rs. 1074 for small farmers to Rs. 1153 for large farmers, while it was Rs. 1120 for medium farmers.

An average per hectare by-product of non-Bt cotton was 26.80 quintals. It was the 28.36 quintals for large farm size group, followed by 26.70 quintals for medium farm size group and 25.34 quintals for small farm size group. The average per hectare value of by-product was Rs. 1002. It was Rs. 963, Rs. 993 and Rs. 1049 for small, medium and large farm size groups respectively.

**Price Receipt in Relation to MSP and Cost \(C_2\) of Bt and Non-Bt Cotton**

Among the many factors, the selling price of crop was found to be a very important variable for the farmers. In this context, the comparison of cotton price received by the sample farmers, (both Bt and non-Bt cotton), minimum support price (MSP) and Cost \(C_2\) was made. The market price of Bt cotton and non-Bt cotton
received by the sample farmers was higher (30.18 per cent for Bt cotton and 37.93 per cent for non-Bt cotton) than minimum support price which helped farmers to get reasonable gains. The market price of both cotton varieties (Bt and non-Bt) received by sample farmers was also higher (31.90 per cent and 27 per cent for Bt and non-Bt respectively) than Cost C2. The variation between market price and Cost C2 was more (about 5 per cent) for Bt cotton than that for non-Bt cotton. On the other hand, the variation between market price and MSP was more (nearly 8 per cent) for non-Bt cotton than that for Bt cotton. About 18.33 per cent and 23.33 per cent sample farmers received low price than MSP for Bt and non-Bt cotton respectively.

**Regression Results**

An attempt is made to examine the effects of variation in major agricultural inputs on crop yield with the help of a log-linear regression model which is estimated for both Bt and non-Bt cotton. The regression model is stated with a log-linear functional form due to the fact that the agricultural production function is usually assumed to follow a Cobb-Douglas type that requires a log-linear transformation for estimation of input co-efficients. Thus, the estimable equation is as follows:

\[ Y = a x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5} x_6^{b_6} x_7^{b_7} x_8^{b_8} x_9^{b_9} e^u \]  \hspace{1cm} \ldots \ldots (1)

After making log transformation equation (1) becomes;

\[ \log Y = \log A + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 \\
+ b_7 \log x_7 + b_8 \log x_8 + b_9 \log x_9 + u \]  \hspace{1cm} \ldots \ldots (2)

Where,

- \( Y \) = Productivity of cotton (in Quintal/Hect.),
- \( x_1 \) = Seeds (in kgs.),
- \( x_2 \) = Farm yard manure (in Quintals),
- \( x_3 \) = Chemical fertilizers (in kgs.),
- \( x_4 \) = Irrigation (in Hours),
- \( x_5 \) = Pesticides (in Rs.),
- \( x_6 \) = Area under cotton (in Hectare),
- \( x_7 \) = Farm improvement expenditures (in Rs.),
- \( x_8 \) = Education of the farmers (in Years),
- \( x_9 \) = Experience of the farmers (in Years),

~ 446 ~
A = Constant term,
\( u \) = Error term,
\( b_i \) = Regression co-efficients.

The above log-linear regression model is used to find out the contribution of each factor to productivity of both the cotton varieties. The results are presented in the following paragraphs:

**Bt Cotton**

The multiple co-efficient of determination (\( R^2 \)) turned out to be significant which confirms that included variables explained about 99 per cent variation in the productivity of Bt cotton. The co-efficients of seeds, FYM and irrigation were found positive and significant at 1 per cent for Bt cotton, which indicate that quantity of seeds, FYM and hours of irrigation were the most important variable determining the productivity level of Bt cotton. It indicates that with 1 per cent increase in use of seeds, FYM and irrigation in cultivation of Bt cotton, productivity would go up by 4.33 per cent, 3.42 per cent and 5.50 per cent respectively. Co-efficient for chemical fertilizers was found negative and significant at 5 per cent for Bt cotton, while for pesticides it was found positive and significant at 5 per cent for Bt cotton. The productivity level of Bt cotton will increase with increase in quantities of pesticides. The co-efficient of farm improvement expenditures was found positive and significant at 10 per cent for Bt cotton, whereas the co-efficients of area under cotton, education and experience were found to have non-significant relationship with productivity of Bt cotton. As expected, among the various factors, irrigation turned out to be the most significant factor (highest co-efficient value) in increasing the productivity of Bt cotton. However, the chemical fertilizer was found to be significant but had negatively influenced the productivity of Bt cotton. The farmers had applied more chemical fertilizers than the recommended doses of fertilizer in order to generate more output which was resulted in decrease in productivity of Bt cotton.

**Non-Bt Cotton**

It is also observed that the multiple co-efficient of determination (\( R^2 \)) turned out to be significant which confirms that included variables explained 1 per cent variation in the productivity of non-Bt cotton. The co-efficients of FYM, chemical...
fertilizers and irrigation were found positive and significant at 1 per cent for non-Bt cotton, which indicate that quantity of FYM, chemical fertilizers and irrigation were the most important variable determining the productivity level of non-Bt cotton. It indicates that with 1 per cent increase in use of FYM, chemical fertilizers and irrigation in cultivation of non-Bt cotton, productivity would go up by 7.13 per cent, 0.58 per cent and 3.98 per cent respectively. The co-efficient for pesticides and farmers’ experience were found positive and significant at 10 per cent for non-Bt cotton. The co-efficients of seeds, area under cotton, farm improvement expenditures and education were found to have non-significant relationship with productivity of non-Bt cotton. Among the various factors, FYM turned out to be the most significant factor (highest co-efficient value) in increasing the productivity of non-Bt cotton.

Farmers’ Perception on Advantages/Disadvantages of Bt vis-à-vis Non-Bt Cotton

Various opinions and problems associated with Bt cotton cultivation were collected from all Bt cotton growing sample households. The selected Bt growers were no major differences observed with respect to the adequate availability of seeds, need of labour, need of chemical fertilizers, harvesting cost, marketing of cotton, easy sell of cotton production and suitability for late sowing etc. Five major disadvantages expressed by the sample households were availability of Bt seeds at reasonable price, pest/insect problems, need of pesticides, need of irrigation and price realization of Bt cotton. On the other hand, the sample farmers of Bharuch district expressed that the major nine advantages of Bt cotton over non-Bt cotton varieties were the quality of Bt seeds, better/improved yield level, down to by-product output level, per bigha higher profit, better quality of Bt cotton production, good staple length, better line-cottonseed ratio, suitable for early sowing and per plant higher formation of bolls etc.

Sample Farmers’ Observations and Perceptions Regarding Bt and Non-Bt Cotton Cultivation

The sample farmers’ observations and perceptions regarding Bt and non-Bt cotton cultivation are narrated in the following part:

1. Out of total 60 Bt growers, 51.67 per cent (31 farmers) of the total had reported that they had cultivated Bt cotton to get early recovery of investment, 20 per cent had responded that they had cultivated Bt cotton to obtain high production and
productivity and get more returns, 13.33 per cent had responded that it was suitable for land, climate and environment, 10 per cent had responded that it was easy to sell it in the market and 5 per cent had responded that Bt cotton is good pest resistance. In the case of non-Bt cotton, out of total 60 sample farmers, 36.67 per cent (22 farmers) had responded that they had cultivated non-Bt cotton because it had low cost of cultivation due to less diseases and pests in crop and less requirement of labourers and irrigation, 23.33 per cent had responded that it was suitable for land, climate and environment, 20 per cent had responded that crop rotation was required to maintain fertility of land, 11.67 per cent had responded that it was less risky than Bt cotton and 8.33 per cent had responded that it was easy to sell it in the market.

2. Out of total 60 Bt cotton growers, 18.33 per cent had opined that they were recommended to cultivate Bt cotton by seed dealers/agents, followed by leading farmers (15 per cent).

3. Of the total sample farmers of Bt and non-Bt cotton, 85 per cent of Bt and 75 per cent of non-Bt growers were not satisfied with their per bigha productivity of cotton. The major reasons were (i) excess rainfall which affected the growth of crop, (ii) damage of plants due to water logging, (iii) heavy weeding problem, (iv) problems of pests, insects and diseases and (v) non-availability of irrigation at initial stage.

4. There were various types of risks and problems observed by the selected sample farmers while they cultivated Bt cotton in the study area. Out of total sample Bt growers, 20 per cent had faced the problem of crop pests, insects and diseases and bad effect on human bodies while spraying pesticides on plant, 16.67 per cent had had faced the problem of uncertainty of rain, 15 per cent had observed non-availability of water for irrigation at proper time and uncertainty of canal water for irrigation, 13.33 per cent had observed environmental risks, 11.66 per cent had faced failure of crop due to excessive rain, 10 per cent had observed nuisance of wild animals, 10 per cent had faced the problem of price reduction and 3.33 per cent had faced the problem of cyclone.
5. All the sample Bt and non-Bt cotton growing farm households had ‘black/deep black soil’ under cotton cultivation which was found most suitable for the cotton crop.

6. Majority of Bt growers (about 27 per cent farmers) had reported that they had received the information regarding latest variety of Bt cotton seed from private seed dealers/traders, followed by local producers/seed traders (17 per cent), fellow farmers/friends/relatives (12 per cent).

7. All the selected sample Bt growers had reported that they had need to buy Bt cotton seed every year and the price of Bt cotton seeds was more than affordable price.

8. About 82 per cent farmers (49 farmers) had used home produced seeds for non-Bt cotton cultivation (non-hybrid cotton).

9. Majority of the sample farmers of Bt and non-Bt cotton (58 per cent and 55 per cent respectively) had obtained the fertilizers from co-operative societies for the cultivation of cotton. It was followed by local traders/private traders (13 per cent and 22 per cent respectively of Bt and non-Bt growers).

10. The farmers had mainly used farm yard manure and chemical fertilizers in the study area. Out of total sample farmers, the highest percentage of the farmers (52 per cent of Bt and 58 per cent of non-Bt cotton) had used Urea in cotton cultivation, followed by DAP (30 per cent of Bt cotton and 22 per cent of non-Bt cotton).

11. About 47 per cent of Bt and 39 per cent of non-Bt cotton growers had opined that the fertilizer rates were very high and burdensome for them.

12. Out of total sample Bt and non-Bt growers, only 12 per cent and 18 per cent of the total Bt cotton and non-Bt cotton growers respectively were aware about different doses of fertilizers to be used during the entire season.

~ 450 ~
13. Out of total Bt and non-Bt cotton growers, about 33 per cent and 28 per cent of the Bt and non-Bt cotton growers respectively had faced the problem when they purchased the fertilizers. The major problems were scarcity and shortage of fertilizers during high demand stage, non-availability of fertilizers in co-operative societies, high prices of fertilizers, requirement of advance booking to purchase fertilizers.

14. In this study 30 irrigated Bt cotton and 30 irrigated non-Bt cotton sample farmers were selected. Out of total 30 irrigated Bt cotton growers, canal water was the main source of irrigation (47 per cent), followed by well irrigation (40 per cent), tube well irrigation (7 per cent), bore well irrigation (3 per cent) and pond irrigation (3 per cent) whereas in the case of 30 irrigated non-Bt cotton growers, the well water was the main source of irrigation for about 15 farmers (50 per cent), followed by canal irrigation (40 per cent) and tube well irrigation (10 per cent).

15. Canal was observed to be the main source of water for irrigation for the majority of the Bt cotton growing sample farmers. Due to untimely and irregular availability of canal water, particularly in Bt cotton cultivation, crop yield was adversely affected.

16. Of the total irrigated sample farmers of Bt and non-Bt cotton, the highest percentage of the sample farmers (77 per cent and 70 per cent of Bt and non-Bt growers respectively) did not get water easily for irrigation. The major reasons were (i) non-availability of water at initial stage, (ii) irregular supply of water, (iii) irregular and insufficient supply of electricity, (iii) non-availability of canal water in time and (v) non-availability of well, canal and pond irrigation facilities at nearby places.

17. All the sample Bt growers (60 farmers or 100 per cent) had observed diseases/pests in Bt cotton crop. In case of non-Bt growers, out of 60 farmers, 35 farmers or 58 per cent had observed diseases/pests in non-Bt cotton crop.
18. Out of total 60 sample farmers of Bt cotton, as high as 53 farmers (88 per cent) believed that Bt cotton was not more pest resistant than non-Bt cotton.

19. Cotton is a labour intensive commercial crop. Thus, labour is an important input in the cultivation of cotton, however, the difficulties were found in obtaining labourers, particularly during harvesting period for both the varieties of cotton. In the study area, the per day labour rates, varied between Rs. 70 to Rs. 200.

20. About 88 per cent and 75 per cent of the Bt and non-Bt cotton respondents respectively did not classify the cotton production as per the quality of product. The reasons for not classify cotton were (i) same price for all types cotton were given by the traders, (ii) the cost for classifying and storage of crop was high and (iii) private traders did not put emphasis for classified crop.

21. The majority of the Bt and non-Bt cotton growers (91.67 per cent and 90 per cent respectively) had sold their cotton production immediately after harvest. Requirement of money, fear of reduction in price of cotton, insufficient storage capacity, risk of fire were the major reasons for the immediate sale of cotton after harvest.

22. All the sample Bt and non-Bt cotton cultivating farmers (100 per cent) had sold their cotton produce to the private traders/buyers in the village itself.

23. The large number of selected of Bt and non-Bt cotton growers (60 per cent of Bt and 55 per cent of non-Bt) had faced the problem while selling their cotton production viz., (i) inadequate and lower price of cotton which determined by the local traders, (ii) lack of scientific method of price determination, (iii) lack of proper price as per the quality of production, (iv) lack of bargaining power, (v) no proper technique of assessing quality of cotton production, (vi) lack of knowledge regarding prevailing cotton prices, (vii) non-existence of APMC and CCI’s centres at nearby places, (viii) sometimes price prevailed less than MSP, (ix) lack of organized efforts by cotton growers to get remunerative price and (x) creation of organization by private traders and they had offered low price for cotton output to exploit the farmers etc.
24. It may be noted here that majority of the sample farmers (58 farmers or 96.67 per cent of Bt growers and 56 farmers or 93.33 per cent of non-Bt growers) were not satisfied with present systems of marketing of cotton crop. They were unanimously in their view that undue pressure was exercised by traders relating to price.

25. Out of total 60 sample farmers of Bt cotton, 20 per cent of the sample farmers had received the information regarding the price of Bt cotton from newspapers/magazines, followed by traders/agencies (18 per cent), relatives/friends/neighbours (17 per cent), advanced farmer (17 per cent), gramsevak (12 per cent), radio (8 per cent) and television/internet (8 per cent). On the other hand, out of total 60 non-Bt cotton growers, 23 per cent of the sample farmers had got the information regarding the price of non-Bt cotton from newspapers/magazines, followed by traders/agencies (20 per cent), relatives/friends/neighbours (15 per cent), advanced farmer (13 per cent), gramsevak (10 per cent), radio (10 per cent) and television/internet (8 per cent).

26. Of the total Bt and non-Bt cotton growing sample farmers, 18 per cent Bt cotton and 23 per cent non-Bt cotton growers had not realized the prices of cotton higher than MSP in the study villages.

27. Majority of the sample farmers (56 farmers or 93.33 per cent of Bt growers and 57 farmers or 95 per cent of non-Bt growers) were not satisfied with the per quintal price of Bt and non-Bt cotton which they realized in the reference year. This was because of the fact that farmers did not get the remunerative price and it was too less than the expected price. Further, (i) the cotton price was insufficient to cover even the cost of cultivation as the price of agricultural inputs viz., seeds, pesticides, fertilizers, irrigation, labourers wages had increased rapidly leading the cost of cotton cultivation is very high, (ii) government had not made any intervention to stabilize prices of cotton and (iii) MSP which was decided after the selling of cotton production was very less compared to the expectations of the farmers.
28. About 42 per cent of Bt growers and 32 per cent of non-Bt growers had opined that their financial condition were improved due to cotton cultivation and they able to maintain household consumption expenditures and their savings were also increased.

29. Out of total 60 sample Bt cotton cultivators, only 8 farmers (13.33 per cent) had opined that they had observed adverse effect of Bt cotton on environment.

**Policy Recommendations**

In the absence of certain strategic measures the trend as noted above would weaken the overall economy of cotton cultivation in Gujarat. Among the cash crops, cultivation of cotton has been facing some serious difficulties. The study shows that the performance of Bt cotton is better compared to non-Bt cotton. For improvement of strategic cultivation of the cotton and strengthening the cotton economy of the State, the following policy recommendations are made on the basis of review of literature and observations of the macro as well as micro level studies related to Bt and non-Bt cotton cultivation:

1. In some cases, farmers were cheated by traders by providing spurious seeds under Bt label which, in fact, did not contain the Bt gene. Improved cotton seed is needed by the cotton growers. The Ministry of Agriculture and seed producing companies should develop a policy to accelerate adaptive research on imported varieties, whether by private, public or public-private partnerships. Sale of unapproved varieties and uncertified seed should be restricted. Moreover, some farmers had reported that Bt cotton seed was not available in time. Since sowing of seed at right time is necessary to increase the productivity of any crop, the establishment of village-based seed banks to provide the seeds of improved varieties on time is a basic necessity.

2. The government should develop efficient scientific techniques for preparing the high quality certified seeds of Bt cotton at subsidized rate.

3. According to sample farmers, the seed price of approved Bt varieties are very high and hence majority of poor farmers find it difficult to purchase. It was suggested
that the price of Bt cotton seeds should be reduced. The government must take up this issue with the concerned seed companies on a priority basis (Shah V.D., 2007). This can be done in two ways. First, as a short-term measure, direct subsidy may be granted for Bt cotton seeds for a specific period of time. Second, as a long-term measure, the role of public sector should be expanded in transgenic cotton seed production by activating research and development activities. Alternatively, in view of high profit realized by the Bt cotton farmers, adequate credit through institutional agencies can also be given to meet this cost. Unless adequate arrangements are made to reduce the seed price of Bt cotton varieties, the cultivation of Bt cotton may not spread beyond the rich and irrigated farmers (Narayanamoorthy A. and et. al., 2011).

4. In the field level survey, majority of the sample farmers had described some difficulties and problems to obtain irrigation viz., non-availability of water at initial stage, irregular supply of water, irregular and insufficient supply of electricity, non-availability of canal water in time, micro irrigation canals were not working properly, lack of resources for irrigation, problem of salty water, non-availability of well, canal and pond irrigation facilities at nearby places, high pipeline cost etc. Due to untimely and irregular availability of canal water, crop yield was adversely affected. Therefore, the provision of regular irrigation is to be made at the time of requirement during cotton season. This can be attained through proper planning of irrigation development and its distribution network. This strategy would help stabilizing the yield per hectare. In addition, the government should give top priority to develop irrigation facilities in its plan and policies in order to revitalize Indian agricultural technology. Various kinds of subsidies should be given to the farmers in various forms to develop medium and minor irrigation schemes.

5. It should provide sufficient electricity supply to the farmers for irrigation in every village. There should be a provision of electricity supply for minimum 12 hours a day on regular basis. Electricity generation should be accelerated to cope up with the increasing demand of electricity supply for both irrigation and other agricultural purposes.
6. Rain water harvesting system for irrigation should be developed as rainy water is good for crop as it is without salt and the cost of irrigation is also low. Proper rainfall water storage system should be developed in every village. The government should provide subsidy to the famers to recharge the wells, digging of deeper well and excavation of new wells. The needed loan should be provided at the concessional rate. Government should help to construct small check dam for water conservation and water conserved in such dam and it should be used only for agricultural purposes.

7. The problem of water scarcity is a major issue not only in Gujarat but also all over India. Hence, there is a need to intensify research on draught resistance/tolerant variety of cotton for efficient utilization of water even in situation where less water is available.

8. Sprinkler/drip irrigation system should be provided at high rate of subsidy and should be provided loan for the same to the farmers because it is too costly for marginal and small farmers. This will be helpful to inspire farmers to use more sprinkler/drip irrigation system. Sprinkler/drip irrigation system is helpful in many ways such as less weeding is required, labour cost can be saved, it requires low electricity and water is also saved, moisture is maintained in land, salt content can be reduced etc. Due to all these factors, cost of production can be reduced and farmers could get expected output of the crop. For the use of sprinkler/drip irrigation system, government provides HDPE pipes at subsidiary rate to the farmers which are not enough as compared to their cultivable land area. Therefore, the government should formulate liberal policy for sprinkler/drip irrigation system.

9. The field level survey reveals that the farmers had applied more chemical fertilizers in Bt cotton than the recommended doses of fertilizer in order to get more output but it had resulted in decrease in productivity of Bt cotton. Therefore, the government should establish the soil testing laboratory at village level or block level or district level. It can be helpful to train, advice and educate farmers regarding fertilizers practices to be followed in Bt cotton.
10. The field level survey reveals that some Bt growers were found using more pesticides than the required doses. Due to fear of bollworm attack, farmers have a tendency to spray pesticides as a precautionary measure, even though it is not required. This tendency of farmers not only increases the use of pesticides but also increases the cost of cultivation of Bt cotton. Therefore, the farmers should be trained to use pesticides properly to control pests and diseases of the crop. In addition, pesticides producing companies should provide effective pesticides and insecticides to the farmers at an affordable price.

11. The MSP should be decided on the basis of inflation rate at an early stage because prices of various agricultural inputs are very high and hence the cost of cultivation is increased. In comparison with international level Indian MSP of cotton is very low. Further, the MSP should be decided before crop sowing as it is helpful for the farmers to decide that which crop can be grown in next season.

12. Due to the scarcity money on hand, inadequate storage facilities, lack of market information, unavailability of co-operative marketing society etc. the farmers are compelled to sell their production to the middlemen and private traders and hence they do not get proper price of their product. It is, therefore, suggested that the government should provide the storage facilities to farmers at cheapest rate by constructing storehouse/warehouse/godowns at the village level to store the products. Along with this, farmers should be encouraged to form their co-operative societies so that they could be relieved from the clutches of the middlemen and private traders.

13. It is necessary to improve the economic position of farmers and induce them to enhance cotton production by adopting new technology. The big gap between the farmers’ price and retailers’ price should be reduced for enhancing returns to the cotton growers.

14. Traders create their own organization and create monopoly and hence the farmers get low price. Therefore, suitable policy should be framed for the farmers to get the remunerative price of their agricultural products. It is suggested that an
organization of farmers should be created and the market prices of the agricultural crops should be decided by the farmers' organization.

15. The government’s purchase centres should be established and government’s agent should be appointed in such centres as during the present era, in almost every village, the co-operative societies are collapsed due to large scale of corruption and some CCI's centres are also closed. More numbers of the purchase centres of CCI should be established at village level and they should give the priority to the farmers’ output at the time of picking and give remunerative price to the farmers. Moreover, the government should take initiatives to open organized markets i.e., Cotton Gin, Market Yard, APMC, VCCS (Village Cotton Co-operative Society), various CCI centres, etc. and farmers should be involved while determines market price.

16. Government should establish the regulated market for the crop selling, at least at block level or at district level and interfere in the market to abolish market mechanism and price decision for cotton crop and should take proper preventive actions to reduce exploitation of farmers. The APMC can play an important role in marketing of agricultural products. Some important services may be provided to the farmers through such market committees. The responsibilities of regulated market committees should be enlarged and they may be assigned the work of providing storage and transport facilities to farmers of the surrounding areas. This policy would be more beneficial to small and marginal farmers (Takle S.R. and et. al., 2007).

17. Efficient techniques for cotton marketing should be developed which could be helpful to the farmers in inflationary situations. These techniques would enhance the bargaining power of the farmers so that farmers will get attractive price.

18. The government should formulate proper import-export policy as in absence of proper policy, the farmers are compelled to sell their cotton output at low price in local market. Further, the government should give permit for more duration to export cotton.
19. Government has to formulate new marketing policies to cope with the challenges of new markets with special focus to streamline the role of middlemen and introduce regulations, which bind the limits of margins. Small growers may be included in the market committees. Government may encourage direct linkages between growers and business institutions to increase the profit margins for the cotton growers.

20. Most of the agricultural markets in India are in the private sector. In this sector, there is more possibility of creation of artificial scarcity, speculation and other malpractices to obtain the maximum monetary gain. Such practices result in erratic fluctuations in agricultural prices. Government should have control on the purchase and sale of agricultural products by private traders. The government can exercise this control by adopting several measures such as issuing the licenses, declaration of stock by traders, statutory limit on stock, maintenance of proper account of their purchase and sale transactions and its submission periodically etc. Existing rules for controlling the transactions of private traders need to be strictly and effectively implemented (Takle S.R. and et. al., 2007).

21. As per the field level survey the private traders do not give the cotton price as per its quality and grade. The price is similar for both type of quality i.e., good or bad quality and hence the farmers are not enthusiastic to classify the cotton output. Therefore, the government should interfere in local market for the price determination of cotton as per the quality of output and for the implementation of pricing strategy of cotton.

22. Subsidy should be given on price of diesel, high quality seeds, chemical fertilizers, pesticides, irrigation etc. to the resource poor farmers. The government should also immediately provide subsidy to the farmers to purchase farm implements and equipments. The government should also provide PVC pipes for irrigation at subsidized rate as per the requirement of farmers. All kinds of incentives should be given to the farmers in the form of subsidies in cash or kind through various government and quasi-government agencies.

23. Adequate supply of various farm inputs such as improved seeds, chemical fertilizers, plant protection chemicals, irrigation, electricity and farm equipment
and machinery etc. should be provided in time which will be helpful to the farmers to adopt scientific farming methods. The adequate and timely supply of such inputs is a basic necessity to increase the yields availed from the crop under study. In order to make the agricultural inputs available in time and in adequate quantity, the government and private agencies should open various distribution centres. The supply of diesel for agricultural purposes should be rationalised and the farmers should be assured to get it when needed.

24. The government should encourage the farmers to adopt the technique of organic farming in cotton cultivation as it will be helpful to produce good quality of cotton and provide high price to the cotton growers.

25. The effective measures, on continuous basis, are needed to be taken to educate farmers about the correct and scientific methods of using various farm inputs. Various workshops, seminars and training programmes should be organized by the Agricultural University or by the various Cotton Research Centres to provide the information on various aspects regarding cotton cultivation i.e., latest techniques of cotton farming, proper use of different kinds of farm inputs viz., seeds, pesticides, insecticides, weedicides, irrigation, fertilizers etc. and create information cell for the awareness of better techniques of cotton cultivation (particularly Bt cotton) to the farmers.

26. The new techniques for harvesting/picking of cotton should be developed to reduce the labour cost.

27. Proper industrial policy should be framed for balancing labour supply between agriculture and industrial sectors.

28. Proper drainage system on farm land should be developed to prevent the crop in the case of heavy rainfall so that farmers would not have to face the water logging problem.

29. The forest department should help the farmers to reduce the troubles of wild animal viz., pig, monkey etc. on farm.
30. Majority of farmers are not fully aware about the practices to be followed for cultivating Bt cotton. Therefore, cultural practices such as method and time of sowing, crop density and geometry, crop species and varieties, method and time of fertilizer application, mulching, inter-cropping, method and time of irrigation should be applied according to requirement.

31. Research and extension expenditure, per farmer, is significantly related to agricultural development but the current level of investment is inadequate in most of the developing countries. Therefore, research and extension investment needs to be increased to enhance the development and transfer of new agricultural technology. Increased expenditure is needed to provide adequate transportation, housing, programme costs and remunerative salaries. By providing the adequate salaries, competent research and extension personnel can be recruited and retained (Bahal Ram, 2004).

32. There are various types of risks and problems associated with the farmers while they cultivate cotton. The US has enacted the Agricultural Risk Protection Act, which aims to strengthen the safety net of the agricultural producers. The Indian Government can also introduce such comprehensive policies which, at the end of the day, assure the farmers some returns (Rao Janardhana N., 2005).

33. Agricultural infrastructure facilities such as weighing, drying, cleaning, processing, grading, storage, market intelligence, roads, means of telecommunications viz., telephone and mobiles phone etc. should be provided as per the requirements of the farmers.

34. Where irrigation facilities are easily available, traditional cotton varieties should be shifted to Bt cotton varieties.

35. Improvement and maintenance of soil’s physical condition ensures better soil productivity. Therefore, green manure should be practiced to improve the physical condition of the soil.