Chapter 1

Introduction

Agriculture is the largest sector of economic activity in India. Agriculture which is considered as the backbone of India, not only provides food and raw materials but also employment to a very large proportion of population. Though its contribution to the overall GDP has declined from about 50 per cent in 1950-51 to lower at 15 per cent in 2010-11, the growth of agriculture and allied activities continue to be a critical factor in overall performance of Indian economy (MoA, 2012). Since agriculture forms the resource base for a number of agro-based industries and agro-services; it would be more meaningful to view agriculture not as farming alone but as a holistic value chain, which includes farming wholeselling, warehousing, processing and retailing.

Indian agriculture has undergone considerable transformations overtime. The transformations are seen in the form of changes in agrarian structure, technology interventions, cropping pattern, enterprise mix and marketing system. More emphasis has been placed on increasing agricultural production through adoption of high yielding varieties along with use of chemicals, fertilizer and pesticides. Since land availability is limited, more emphasis have been put on increasing productivity of crops. All these developments have entailed increased building up of pests and diseases which have great negative effect on productivity and hence on production. In order to control pests and disease higher amount of pesticides is used which resulted in developing insects and disease resistance and it has further led to reduction in crop yield.

At present scenario, there has been considerable increase in attention to the role of agriculture must play in order to meet the food security needs of the country. Increase in productivity is an essential component of vibrant agriculture sector. Loss in yield of any crops is due to variety of reasons. Improved pre and post harvest technologies are imperative to avoid yield losses in crops which account for a major share of harvested produce. It is also essential to ensure high income to farmers.

1.1 Status of Agricultural Economy in Gujarat

Gujarat is located in the west coast of India. The state covers an area of 196024 sq. km. which is nearly six per cent of geographical area of the country. The state of Gujarat comprises of 26 districts and 225 talukas.

Agro-climatic zones:

Gujarat is spread over seven agro-climatic zones, based on geography, climate average rainfall and the nature of soil.

1) South Hills: This consists of districts of Dangs, Navsari and Valsad with average rainfall of 1800mm/annum and deep black soil. The major crops grown are rice, sugarcane, mango and chikoo. Certain parts of the districts are heavily populated by tribal population.
2) Southern Gujarat: This comprises of districts of Surat, Tapi, Bharuch and Narmada with average rainfall of 970mm/annum, the soil is deep black, coastal alluvium and major crops are rice, tur, sugarcane and vegetables. Certain parts of these districts are dominated by tribal population.
3) Central Gujarat: This has districts of Vadodara, Anand, Kheda, Dahod and Panchmahal, with average rainfall of 750 mm/ annum, the major crops are cotton, tobacco, maize, sugarcane, rice, banana and vegetables. Anand, Kheda and Vadodara are agricultural developed districts. Areas of Dahod and Panchmahal are most backward areas.
4) North Gujarat: This consists of districts of Ahmedabad, Gandhinagar, Mehsana, Patan, Banaskantha, and Sabarkantha with average rainfall of 735mm/annum and soil is gray brown, coastal alluvium. The major crops are wheat, bajra, jowar, castor, mustard, cotton, vegetables and spices.
5) North Saurashtra: This comprises of districts of Amreli, Jamanagar, Bhavanagar, Rajkot and Surendranagar. The average rainfall is about 500mm/annum. The soil is medium black and shallow calcareous. The major crops include groundnut, cotton, tur, gram, urad, bajra and jowar.
6) South Saurashtra: The districts of Junagadh and Porbandar with average rainfall of 850 mm/annum fall under this zone. Soil is medium black and costal alluvium. The crops grown are gram, cotton, bajra and mangoes.

7) North-West area: This zone has district of Kutch with average rainfall of 300mm. This region experiences recurrent drought. Crops grown are bajra, jowar, groundnut, cotton, and date palm.

Land holding and Land utilization:

Average land holding size of the state was 2.20 hectares as per 2005-06 agricultural census which was 2.33 hectares as per the previous Agriculture census (2000-01). Thus, it has reduced slightly between this period. According to 2006-07 season and crop report, of the total 188.1 lakh reporting area of the state, 51.81 per cent was net area sown, while 13.80 per cent was barren and uncultivable land, 6.18 and 10.55 per cent were under non-agriculture uses and cultivable waste respectively. The area covered under forest was 9.75 per cent and permanent pasture and other grazing land was 4.53 per cent. Current and other fallows land was 3.43 per cent of the total reporting area. The time series data has indicated not much change in land use pattern during last two decades in the state.

Agriculture:

Agriculture in Gujarat largely depends on south-west monsoon. There are wide variations in rainfall received by different parts of the state i.e. 300mm in the western half of Kutch to 2100 mm in the southern part of Valsad districts. Rainfall pattern in the state is uneven and erratic.

The agriculture in Gujarat engaged 52 per cent of the total workforce (2001) and 15 per cent of the State Domestic Production originated from this sector in 2009-10. Twenty years ago the corresponding shares were much higher 69 (1981) and 32 (1990-91) per cent. This indicates that economy is witnessing structural transformation. Despite these changes, agriculture still remains backbone of the economy. This sector is a supplier of food, fodder and raw materials for a vast segment of industry.

Gujarat has all the odd in the field of agriculture, about 70 per cent of its agriculture is rainfed, 50 per cent of its districts are drought prone areas and 20 per cent of its area is tribal, surrounded by undulating terrain where despite good rains, crops get rained and washed away (Shelat, 2007). It has recurrent droughts where almost three years in every decade are drought years. Beside rainfall is uneven and erratic. The state is surrounded by sea on three sides. The salinity ingress is on rise affecting the productivity of crops. Despite all these constrain, Gujarat is an outstanding performer in agriculture in India.

Area, production and yield of major crops:

The details on area, production and yield of major crops of Gujarat are presented in Tables 1.1, 1.2 and 1.3. The area cultivated under foodgrains has declined continuously over period from 48.32 lakh hectares during TE 1977-1980 to 40.20 lakh hectares during TE 2007-2010. The area under superior cereals mainly of wheat has increased significantly and area under rice increased moderately. However, decrease in area under foodgrains was mainly due to reduction in area of coarse cereals like bajra and jowar drastically. Area under total pulses increased between TE 1977-80 and TE 1987-90 but subsequently it has remained stagnant in TE 1997-2000 and then declined in TE 2007-10. Growth in productivity of almost all the crops was remarkable. While production increased significantly from 42.41 lakh tonnes to 67.19 lakh tonnes during the same period. The increase in production was attributed to productivity growth as it rose to 1671 kg/ hectare from 878 kg/ hectare during above mentioned period. Similarly production of cotton and groundnut has also shown increasing trend. Increase in yield was main reason for increase in production of groundnut, while cotton production increased due to both increase in area and yield.

Table 1.1: Area under major crops: Gujarat state

(Area in 00' ha.)

Crops	TE 1977-80	TE 1987-90	TE 1997-00	TE 2007-10
Paddy	5306	5724	7350	7285
Wheat	5849	5113	6164	10811
Jowar	10926	7187	3391	1058
Bajra	14229	14367	12268	7660
Maize	2996	3511	4396	4182
Total cereals	41742	37163	34243	32199
Gram	684	789	1032	1741
Tur	1920	4056	3728	2659
Urad	627	692	1108	992
Moong	1733	1273	1735	1790
Total pulses	6574	8617	8604	8002
Total Foodgrains	48315	45780	42848	40200
Cotton	18361	10394	16269	24133
Groundnut	20817	17422	18561	18624
Total oilseeds	24766	24296	28917	28039

Note: Data for TE 2007-10 are based on final forecast reports for the year 2007-08, 2008-09 and 2009-10.
Source: GoG (Various years)

Table 1.2: Production of major crops: Gujarat State

(Production in 00' tonnes)

Crops	TE 1977-80	TE 1987-90	TE 1997-00	TE 2007-10
Paddy	6176	7294	12157	12767
Wheat	10593	10415	13838	29272
Jowar	6064	3468	2728	1786
Bajra	12604	12226	13441	10322
Maize	1743	3814	6840	5274
Total cereals	38990	38110	49636	60947
Gram	465	476	807	N.A.
Tur	980	2483	3072	2661
Urad	346	478	565	619
Moong	830	595	705	814
Total pulses	3418	4578	5676	6241
Total Foodgrains	42408	42687	55312	67194
Total cotton$^{\$}$	19928	12893	31888	75636
Groundnut	17763	15695	18972	25722
Total oilseeds	21245	23227	31911	38804

Notes: $=Cotton production in 00' Bales (170 kg per bales); N.A. = Not Available;
Data for TE 2007-10 are based on final forecast reports for the year 2007-08, 2008-09 and 2009-10.
Source: GoG (Various years)

Table 1.3: Yield of major crops in Gujarat State

(Kg. /ha.)

Crops	*TE 1977-1980*	*TE 1987-1990*	*TE 1997-2000*	TE 2007-10
Paddy	1164	1274	1654	1753
Wheat	1811	2037	2245	2708
Jowar	555	483	804	1688
Bajra	886	851	1096	1348
Maize	582	1086	1556	1261
Total cereals	934	1025	1449	1893
Gram	679	604	783	N.A.
Tur	510	612	824	1001
Urad	551	690	510	624
Moong	479	468	406	455
Total pulses	520	531	660	780
Total Foodgrains	878	932	1291	1671
Total cotton$^{\$}$	185	211	333	533
Groundnut	853	901	1022	1381
Total oilseeds	858	956	1104	1384

Notes: Data for TE 2007-10 are based on final forecast reports for the year 2007-08, 2008-09 and 2009-10;
N.A. = Not Available.
Source: GoG (Various years)

Cropping pattern:

Cropping pattern in Gujarat has changed over the years. Foodgrain crops were important in 1950s, but later on non-foodgrain crops dominated crop pattern in the state. Table 1.4 gives cropping pattern of Gujarat. Area under cereals has declined during last three decades from 39.62 per cent during TE1977-80 to 27.27 per cent during TE 2007-10. Decline was the sharpest in the last decade and can be attributed to the fall in area under coarse cereals. Area under bajra and jowar went down remarkably. Area under pulses increased upto late 90's but then declined. In the last three decades, share of oilseeds in GCA remained almost stagnant or slightly increased due to increase in share under rapeseed and mustard and castor seeds as groundnut is losing importance. Its share is falling in GCA over the period. Share of cotton has increased.

Thus, it is evident that area under foodgrains in the state is being replaced by other crops. Cash crops are gaining area/ importance in the state's agriculture, particularly oilseeds, pulses, sugarcane. Besides, spices and horticulture crops are becoming more important in the agricultural economy of Gujarat.

Gujarat is predominantly a non-food crops economy with preponderance of groundnut, tobacco and cotton (Shah, 2002). Presently, the commercial orientation is more associated with oilseeds, paddy, wheat, sugarcane, pulses, vegetables, spices etc. A notable feature of cropping pattern changes in the recent time is the significant enhanced share of other crops occupying almost a quarter of GCA. However, due to doubling of yield the production of cereals has gone up during this period. The major vegetables grown in the state are onion, potato, brinjal, tomato, okra, etc. The state mainly produces spices like cumin, fennel and garlic. Papaya, mango, chikoo, banana, lime are the main fruits grown in Gujarat. Livestock farming and fisheries in the coastal districts are other important land-based activities in the state.

Major expansion in irrigation, water management, implementation of drip and sprinkler irrigation, providing Kisan Credit Cards and Soil Health Cards for farmers in the past years have led agriculture economy towards the inclusive growth (GoG, 2012). "Krishi Mahotsav" programme was initiated in Gujarat in 2005 with the main objective to double the income of farmers within the span of 5 years in sustainable manner. The 'Krushi Mahotsav' covered almost all the villages in the state reaching farmers with researchers, scientists and experts interacting and providing information on all aspects of agriculture.

Table 1.4: Cropping pattern of Gujarat State

(% to GCA)

Crops	TE 1977-80	TE 1987-90	TE 1997-00	TE 2007-10
Paddy	5.04	5.83	6.66	6.17
Wheat	5.55	5.20	5.58	9.16
Jowar	10.37	7.31	3.07	0.90
Bajra	13.51	14.62	11.11	6.49
Maize	2.84	3.57	3.98	3.54
Others	2.31	1.28	0.61	1.02
Total cereals	39.62	37.82	31.02	27.27
Gram	0.65	0.80	0.93	1.47
Moong	1.64	1.30	1.57	1.52
Tur	1.82	4.13	3.38	2.25
Urad	0.60	0.70	1.00	0.84
Moonth	0.96	0.55	0.46	0.34
Others	0.56	1.29	0.44	0.36
Total pulses	6.24	8.77	7.79	6.78
Total foodgrains	45.86	46.59	38.82	34.05
Sugarcane	0.78	1.33	2.19	1.76
Total species	1.26	1.45	1.74	NA
Fruits & Vegetables	1.16	1.78	2.68	NA
Cotton	17.43	10.58	14.74	20.44
Total fibers	17.53	10.69	14.80	NA
Groundnut	19.76	17.73	16.82	15.77
other oilseeds	3.75	7.00	9.38	7.98
Total oilseeds	23.51	24.73	26.20	23.75
Total fodders	8.42	11.63	11.82	NA
Drugs & Narcotics	1.49	1.77	1.73	NA
Misc. Non-food crops	0.00	0.03	0.03	NA
Food crops	49.05	51.15	45.42	NA
Non food crops	50.95	48.85	54.58	NA
Total kharif crops	84.97	81.75	79.62	NA
Total rabi crops	13.59	15.59	17.15	11.47
Total summer crops	1.44	2.66	3.23	N.A.
Gross cropped area (ha.)	*105361*	*98262*	*110383*	*118074*

Source: GoG (Various years)

Overall, Gujarat has achieved a remarkable growth in agriculture (Gulati 2009). IFPRI (International Food Policy Research Institute) points to three main sources of growth in Gujarat, viz., i) Cotton output soared, primarily driven by Bt cotton, ii) the rapid growth

of the high value segment, i.e., livestock, fruits and vegetables, iii) increase in production of wheat. Gujarat is drought prone state, with limited irrigation facility. Increased water supply from Sardar Sarovar Project, construction of check-dams and watersheds and good rainfall in last few years has helped in rapid growth of agriculture in Gujarat. Besides good infrastructure, agriculture research system and extension services to farmers contributed significantly to the development of agriculture in Gujarat.

1.2 Importance of Tur Crop in Gujarat

Among the pulses grown in India, chickpea accounts for 40-50 per cent of the total pulses production then followed by tur (15-16 per cent), black gram (10-12 per cent) and lentil (9-10 per cent).

Tur is also known as pigeon pea, arhar and red gram. India is the largest producer and consumer of tur in the world. India accounted for about 70-75 per cent of the total area and production of tur in the world. It consumes around 90 per cent of the tur produced globally and also to meet the demand, India imports tur in between 3 to 4 lakh tonnes of which 96 per cent import comes from Myanmar (Mahyco, 2011). Tur is widely grown in India. It was grown over an area of 35.23 lakh hectares with production of 26.02 lakh tonnes in TE 2007-10. Maharashtra is the largest producer of tur in the country accounted for 31 per cent of the total area followed by Karnataka (17.81%), Andhra Pradesh (12.95%), Madhya Pradesh (9.54%), Uttar Pradesh (9.35%) and Gujarat (7.54%) during TE 2007-10. Among these major growing states, Maharashtra has the highest production of tur in the country (33.40%) followed by Karnataka (13.86%), Uttar Pradesh (10.48%), Gujarat (10.22%), Madhya Pradesh (10.04%) and Andhra Pradesh (9.06%). Whereas in case of productivity among these states, it was the highest (1001 kg/ha.) in Gujarat followed by Uttar Pradesh (828 kg/ha.), Maharashtra (796 kg/ha.), Madhya Pradesh (778 kg/ha.) Karnataka (575 kg/ha.) and Andra Pradesh (516 Kg./ha.) during TE 2007-10. Details on this are given in Table 1.5.

Tur is the main pulse crop among the all pulses grown in Gujarat. It is revealed in the cropping pattern of Gujarat that total area under pulses was 6.78 per cent of gross cropped area (GCA) in TE 2007-10. Tur, which accounted for 1.82 per cent of GCA in TE 1977-80 increased to over 4.13 per cent in TE 1987-90 but then decreased to 3.38 per cent

in TE 1997-2000 and further down to around 2.25 per cent in TE 2007-10. The decrease area under in tur cultivation has been due to shifting in area towards cotton cultivation.

Tables 1.6 and 1.7 indicate state and district-wise area and production of tur and its contribution in the total area and production of pulses and foodgrains. The contribution of tur cultivation in the total area under pulses and food grains was 29.21 and 3.97 per cent in TE 1977-80 respectively and the same rose to 47.07 and 8.86 per cent in TE 1987-90. Then afterwards share of tur in both continuously declined and it touched to 33.23 and 4.71 per cent in TE 2007-10. Similar trend was reported in tur production.

Table 1.5: Major tur producing states in India

No.	State/ UT	Area ('000 ha.)			Production ('000 Tonnes)			Yield (Kg. /ha.)		
		TE 1987-1990	TE 1997-2000	TE 2007-2010	TE 1987-1990	TE 1997-2000	TE 2007-2010	TE 1987-1990	TE 1997-2000	TE 2007-2010
1	Andhra Pradesh	340 (9.80)	382 (11.20)	456 (12.95)	64 (2.50)	127 (5.26)	236 (9.06)	189	333	516
2	Bihar	71 (2.04)	66 (1.93)	30 (0.85)	83 (3.22)	88 (3.65)	37 (1.41)	1169	1343	1219
3	Gujarat	348 (10.02)	371 (10.89)	266 (7.54)	227 (8.78)	310 (12.82)	266 (10.22)	652	835	1001
4	Haryana	43 (1.23)	30 (0.87)	28 (0.79)	42 (1.61)	33 (1.38)	31 (1.18)	975	1119	1095
5	Karnataka	481 (13.83)	468 (13.74)	627 (17.81)	181 (7.01)	203 (8.40)	361 (13.86)	377	434	575
6	Madhya Pradesh	449 (12.94)	360 (10.58)	336 (9.54)	478 (18.49)	292 (12.06)	261 (10.04)	1062	809	778
7	Maharashtra	876 (25.22)	1018 (29.86)	1092 (31.00)	615 (23.80)	677 (28.02)	869 (33.40)	702	666	796
8	Orissa	147 (4.22)	141 (4.13)	136 (3.87)	117 (4.53)	82 (3.40)	115 (4.41)	798	585	842
10	Rajasthan	24 (0.69)	32 (0.94)	18 (0.52)	15 (0.58)	28 (1.17)	12 (0.48)	623	881	676
11	Tamil Nadu	152 (4.36)	78 (2.27)	29 (0.81)	107 (4.13)	49 (2.01)	20 (0.76)	703	627	689
12	Uttar Pradesh	501 (14.43)	436 (12.79)	329 (9.35)	622 (24.07)	507 (20.99)	273 (10.48)	1240	1164	828
13	All India	3474 (100.00)	3408 (100.00)	3523 (100.00)	2582 (100.00)	2417 (100.00)	2602 (100.00)	743	709	739

Notes: Figures in parenthesis indicates percentage share in all India.
Source: GoI (various years)

Table 1.6: Major tur growing districts in Gujarat: Area

Name of District	Area in 00' hect.	% of total area under tur	% of total area under pulses of respective districts	% of total foodgrains	% of GCA
TE 1977-1980					
Vadodara	453	23.58	73.92	17.69	8.14
Bharuch	538	28.00	76.59	23.93	12.34
Valsad	83	4.32	23.83	4.79	2.56
The Dangs	27	1.41	32.93	6.80	5.41
Gandhinagar	16	0.83	35.04	4.90	2.90
Kheda	109	5.68	51.42	3.06	1.87
Mehsana	95	4.97	23.60	1.91	1.08
Panchmahals	142	7.40	23.77	3.27	2.62
Sabarkantha	97	5.07	31.70	3.93	1.98
Surat	256	13.35	57.35	11.26	6.03
Gujarat State	1920	100.00	29.21	3.97	1.82
TE 1987-1990					
Vadodara	987	24.33	84.69	31.97	17.77
Bharuch	1645	40.57	92.64	53.56	38.49
Valsad	96	2.38	28.76	5.85	2.88
The Dangs	42	1.03	43.55	9.27	7.65
Gandhinagar	5	0.13	24.62	1.80	0.86
Kheda	139	3.42	51.17	3.52	2.36
Mehsana	64	1.57	16.24	1.64	0.80
Panchmahals	232	5.72	34.05	5.01	4.45
Sabarkantha	298	7.36	35.57	9.58	6.32
Surat	457	11.27	74.31	18.91	10.29
Gujarat State	4056	100.00	47.07	8.86	4.13
TE 1997-2000					
Vadodara	930	24.94	84.59	32.73	16.35
Bharuch	959	25.72	88.14	45.60	23.22
Valsad	87	2.34	34.79	5.68	2.50
The Dangs	33	0.88	33.22	7.21	5.79
Gandhinagar	5	0.14	38.10	1.68	0.79
Kheda	190	5.10	60.51	4.28	2.91
Mehsana	51	1.36	10.24	1.52	0.57
Panchmahals	425	11.40	39.32	7.95	7.28
Sabarkantha	459	12.31	52.06	12.82	8.27
Surat	357	9.58	76.17	16.03	7.47
Gujarat State	3728	100.00	43.33	8.70	3.38
TE 2007-2010					
Vadodara	747	28.08	80.15	21.80	13.44
Bharuch	733	27.56	84.64	30.95	16.23
Valsad	44	1.65	26.19	3.82	2.88
The Dangs	39	1.47	37.86	6.00	6.78
Gandhinagar	4	0.15	5.06	0.35	0.20
Kheda	39	1.47	32.50	0.61	0.56
Mehsana	16	0.60	2.04	0.36	0.17
Panchmahals	410	15.41	35.71	5.47	6.70
Sabarkantha	222	8.35	51.63	6.07	3.87
Surat	330	12.41	61.45	9.78	5.05
Gujarat State	2660	100.00	33.23	4.71	2.25

Notes: (1) In Gujarat, sub-division and reformation of districts took place in 1997.To know correct trends we have not considered separately the sub-division of Kheda (Anand), Bharuch (Narmada), Surat (Navsari+Tapi), Panchmahals(Dahod), Mehsana(Patan) and Junagadh (Porbandar) for the TE 2007-10. (2) Data for TE 2007-10 are based on final forecast reports for the year 2007-08, 2008-09 and 2009-10. 3) *GCA of 2006-07 year.
Source: GoG (Various years)

Table 1.7: Major tur growing districts in Gujarat: Production

States	Tur production ('00 MT)	% to total tur production (state)	% of total pulses production (respective district)	% of total foodgrains
TE 1977-1980				
Vadodara	237	23.81	70.05	12.28
Bharuch	282	28.37	77.21	19.51
Valsad	42	4.19	17.76	1.91
The Dangs	14	1.37	34.17	5.00
Gandhinagar	8	0.80	24.49	2.70
Kheda	55	5.56	54.97	1.19
Mehsana	48	4.86	19.97	0.88
Panchmahals	77	7.77	18.07	2.71
Sabarkantha	51	5.12	27.47	2.37
Surat	132	13.23	56.27	5.68
Gujarat State	995	100.00	28.99	2.35
TE 1987-1990				
Vadodara	615	24.78	87.45	23.90
Bharuch	750	30.20	91.50	43.23
Valsad	60	2.43	30.99	2.58
The Dangs	26	1.03	50.33	8.81
Gandhinagar	3	0.13	33.33	0.75
Kheda	97	3.91	60.50	1.89
Mehsana	38	1.54	19.76	0.91
Panchmahals	288	11.58	53.70	7.06
Sabarkantha	209	8.43	42.93	7.24
Surat	339	13.66	83.79	13.25
Gujarat State	2483	100.00	54.25	5.82
TE 1997-2000				
Vadodara	737	23.99	88.12	23.93
Bharuch	564	18.37	89.34	32.37
Valsad	67	2.18	41.27	2.35
The Dangs	27	0.88	36.65	6.16
Gandhinagar	4	0.14	52.00	0.56
Kheda	185	6.01	68.82	2.37
Mehsana	42	1.37	16.32	0.92
Panchmahals	490	15.96	53.32	7.79
Sabarkantha	428	13.94	62.59	7.79
Surat	334	10.86	83.63	9.34
Gujarat State	3072	100.00	54.12	5.55
TE 2007-2010				
Vadodara	816	30.68	85.18	16.46
Bharuch	591	22.22	87.95	22.85
Valsad	25	0.94	22.94	1.25
The Dangs	39	1.47	44.32	5.30
Gandhinagar	4	0.15	7.84	0.15
Kheda	33	1.24	40.24	0.25
Mehsana	16	0.60	3.88	0.25
Panchmahals	561	21.09	50.50	6.19
Sabarkantha	177	6.65	61.89	2.73
Surat	320	12.03	69.72	5.37
Gujarat State	2660	100.00	42.57	2.74

Notes: (1) In Gujarat, sub-division and reformation of districts took place in 1997. To know correct trends we have not considered separately the sub-division of Kheda (Anand), Bharuch (Narmada), Surat (Navsari+Tapi), Panchmahals(Dahod), Mehsana(Patan) and Junagadh (Porbandar) for the TE 2007-10. (2) Data for TE 2007-10 are based on final forecast reports for the year 2007-08, 2008-09 and 2009-10. 3) *GCA of 2006-07 year.
Source: GoG (Various years)

However, share of tur production in the total pulses and food grains production was higher due to higher yield of tur. Like in TE 1987-90, tur accounted for 54.25 per cent in total pulses production and 5.82 per cent in the total food grains production. However, its share in total pulses and foodgrains production declined slightly in TE 1997-2000 but it contribution reduced comparatively more in TE 2007-10 but on account of high productivity, this reduction was not as much as decline in area.

Although, tur accounted for only 2.25 per cent of GCA of the state during 2007-10, it is very important crop for the districts of Vadodara and Bharuch. Area under tur increased significantly between TE 1977-80 and 1987-90. Tur was grown on 8.44 per cent of GCA of Vadodara district and 12.34 per cent of Bharuch district in TE 1997-2000. While their share in GCA was as high as 17.72 and 38.49 per cent in TE 1987-90 respectively. Then onwards, its share in GCA decreased significantly in Bharuch and was 16.23 per cent during TE 2007-10 and same was 13.44 per cent for Vadodara. Still these districts remain the major tur producing districts in the state. The share of Vadodara and Bharuch in the total area cultivated under tur in the state was 28.08 and 27.56 per cent respectively and in case of production, Vadodara contributed 30.68 per cent and Bharuch 22.22 per cent in the total production of tur in TE 2007-10. Tur was grown between 5 to 6 per cent of GCA in Dangs, Panchmahal and Surat during TE 2007-10.

Cultivation of tur has reduced over the period in the state as well as in major tur producing districts but its production has not declined as much as its area in the state. The districts of Vadodara and Bharuch recorded increased in production of tur. This shows that yield has increased substantially over the period. Average yield of tur was 518 Kg. / hectare in TE 1977-80 and it increased to 1000 Kg. / hectare in TE 2007-10 in Gujarat. Similar trend in productivity was reported in both districts.

1.3 Background of Pre and Post Harvest Losses.

At present, increased productivity is an essential component of a vibrant agricultural sector and improved pre and post-harvest technology is essential to ensure high yield and quality of products. Large quantity of crops is being lost at pre and post harvest stages. Assessment of pre-post harvest losses at the various stages of production would help to increase yield and in identifying factors responsible for such loss and the extent of lost.

Pre harvest losses:

Pre-harvest lost is mainly due to pests and disease. The estimation of crop loss due to pests and disease is a complex subject. It is difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field condition. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions.

Generally, 'Pest' is an organism that causes damage resulting economic loss to plant or animal. The expression of pest is used broadly to insects, other invertebrates like rats, birds, etc., that cause damage to crops, stored products or animal. Disease producing pathogens of plants and weeds are also referred as crop pest.

India with diversified agro-ecosystems responded spontaneously to the technologies of green revolution with introduction of several components in crop production like developing and adopting HYV, usage of high dose of chemical fertilizer, adoption of intensive crop cultivation techniques etc. These had led to development of various types of pests, resistance toward these chemicals use. The ability of some of pests to develop resistance curbs the effectiveness of many commercial chemicals. There were frequent set back to crop production, experienced in the shape of abiotic and biotic stresses during the last two decades in several food crops where intensive farm practices were adopted. In country like India, insects are dominating over other pests by acquiring character like resistance to toxic, chemicals and resurgence particularly in intense crop management of practices adopted by the farmers. In the past one and half decades, the periodical unabated explosions of aphids, whiteflies, bollworms, pod borers, defoliators, coccids, cut worms, plant happens etc., are direct damagers to crops and diseases transmitters in different regions of the country have made agriculture less remunerative and highly risk prone. It was reported that more than 500 insect and mite species are immune to one or more insecticides at present. Similarity about 150 plant pathogens such as fungus and bacteria are now shielded against fungicides. Some of the weedicides also found effective earlier failed to control weeds now-a-days.

Hence, there is need to reduce if not eliminate these losses by protecting the crops from different pests through appropriate techniques. At present day the role of crop protection in agriculture is of great important and a challenging process than before, as the

so called resistance spices should be brought under control, if it is not done, yield of crops may reduced drastically.

Post-harvest losses:

India faces large scale losses in crop production especially food crops. The losses are not merely at the farm level for a variety of reasons including non standard quality of inputs, pest and disease attacks, and lack of scientific pre harvest practices. Importantly, there is lack of awareness about post harvest technologies. After the crop is harvested, it undergoes several operations that if improperly done, may result in serious losses. Damage to grain may happen due to improper application of post harvest practices such as threshing, drying or transportation, lack of adequate storage facilities, absence of primary grading and sorting, render food unusable or cause food to rot. At the processing level, use of primitive technology, lack of modernization and inefficiency in energy use result in a huge losses. Thus there is a sizable quantitative and qualitative loss of crops during different post harvest operations like threshing, winnowing, transportation, processing, storage and marketing.

Among post harvest operations, storage is responsible for the maximum losses. In the field and during storage; the products are threatened by insects, rodents, birds and other pests. Moreover, the products may be spoiled by infection from fungi, yeasts or bacteria. Foodgrains stocks suffer quantitative and qualitative losses while in storage. The quantitative losses are generally caused by factors, such as incidence of insect infestation, rodents, birds and also due to physical changes in temperature, moisture content etc. The qualitative loss is caused by reduction in nutritive value due to the factors, such as attack of insects, pests, physical changes in the grain and chemical changes in the fats, carbohydrates, protein and also by contamination of myco toxins, besides residue etc. The storage loss/ gain is a very sensitive issue at it depends upon agro-climatic conditions. Besides post harvest technology are commodity and location specific.

Farmer store grain in bulk using different type of storage structure made from locally available materials. The major construction material for storage structures in rural area at the farmer level are mud, bamboo, stone and plant materials. Generally, they are neither rodent proof nor secure from fungal and insect attack. On an average, out of the total six per cent loss of foodgrains is in such storage structures; about half is due to rodent and rest half is due to insects and fungi. The storage at farm level includes: coal tar dram bin,

domestic hapur bin, chittor store bin, double walled polyethylene lined bamboo bin, pusa bin, and so on. The bulk storage of foodgrains is done mainly by traders, cooperatives and government agencies and grain marketing cooperatives.

Thus, infusion of new technologies, better practices, coordination and investment in infrastructure from food production to consumption are critical for reducing food losses and waste at post harvest stages.

1.4 Need for the Study

As per the available data, the crop losses caused by pests and diseases are huge. But, the knowledge on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the different process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of selected tur/arhar crop in Gujarat. For the pre harvest losses, generally animal pests (insects, mites, rodents, snails and birds), plant pathogens (bacteria, fungi, virus and nematodes) and weeds which are collectively called as pests and diseases is followed in the present study. For estimating post harvest losses, there is a need to establish the extent of losses during storage under different agro climatic conditions of states. Causes of storage losses include sprouting, transpiration, respiration, rot due to mould and bacteria and attack by insects. Sprouting, transpiration and respiration are physiological activities that depend on the storage environment (mainly temperature and relative humidity). These physiological changes affect the internal composition of the grains and result in destruction of edible material and changes in nutritional quality. But it would be difficult to measure the loss due to physiological changes at the farm level. Nevertheless, an attempt would be made to estimate such losses based on the visual observations and according to farmers' estimates.

With this in view, the Directorate of Economics & Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India entrusted Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat state to undertake this study for Gujarat state with the objectives mentioned below.

1.5 Objectives of the Study

The following are the specific objectives of the study:

1. To estimate the physical and financial losses caused by pests and diseases in tur at farm level.
2. To examine the measures of pests and disease management to reduce the crop loss due to pests and diseases at farm level.
3. To arrive at post harvest losses in tur under different agro climatic conditions.
4. To identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase national productivity.

Framework of the study

This study makes an attempt to assess the pre and post harvest losses of tur crop in the Gujarat state. The study was coordinated by Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore. The survey proposal, instruments, guidelines, tabulation and chapter scheme, technical inputs and guidance, etc for the study was provided by the Coordinating Agency.

1.6 Data Base and Methodology

The sampling design used in the study for selection of study districts, blocks, villages and sample farmers along with methodology used for collection and analysis of data is as given below.

Sampling design

The study is based on the both primary as well as secondary data. The primary data were collected for agriculture year 2011-12 (July to June). The selection of sample districts, sample blocks, sample villages, sample farmers were made in the following manner:

i) Selection of sample districts: As per sampling design provided by the coordinating centre, it was decided to select two districts from Gujarat state for tur crop. The selected districts must be the major producing districts of the study crops and should represent the different agro-climatic regions of the state.

On the basis of the area under selected crops and keeping in mind with considering different agro climatic zones, two districts namely 1) Vadodara and 2) Bharuch were selected studying tur crop in Gujarat state. District-wise data on area under tur is given in Table 1.8 for Gujarat.

The data shows in Gujarat state that first two districts having highest area under tur are Bharuch and Vadodara.

ii) Selection of sample blocks: From each selected districts, one major tur producing block was selected purposively. As per available data of area under tur crop, Bharuch and Karjan blocks were selected for Bharuch and Vadodara districts respectively.

Table 1.8: District-wise area under tur crop in Gujarat state

(Area in 00' ha.)

No.	Name of District	*TE 1977-1980*	*TE 1987-1990*	*TE 1997-2000*	*TE 2007-2010*
1	Ahemdabad	44	38	45	15
2	Banaskantha	60	45	54	26
3	Vadodara	453	987	930	747
4	Bharuch	538	1645	959	733
5	Valsad	83	96	87	44
6	The Dangs	27	42	33	39
7	Gandhinagar	16	5	5	4
8	Kheda	109	139	190	39
9	Mehsana	95	64	51	16
10	Panchmahals	142	232	425	410
11	Sabarkantha	97	298	459	222
12	Surat	256	457	357	330
13	Amreli	0	0	6	6
14	Bhavnagar	0	3	13	7
15	Jamnagar	0	0	58	6
16	Junagadh	0	0	33	11
17	Kutch	0	0	1	0
18	Rajkot	0	2	19	5
19	Surendranagar	0	2	2	0
20	Gujarat State	1920	4056	3728	2660

Notes:1) In Gujarat, sub-division and reformation of districts took place in 1997.To know correct trends we have not considered separately the sub-division of Kheda (Anand), Bharuch (Narmada), Surat (Navsari+Tapi), Panchmahals(Dahod), Mehsana(Patan) and Junagadh (Porbandar) for the TE 2007-10.
2) Data for TE 2007-10 are based on final forecast reports for the year 2007-08,2008-09 and 2009-10.
3) *GCA of 2006-07 year.
Source: GoG (Various years)

iii) Selection of villages: From each selected block, two sample villages using distance criteria from market/mandi were selected purposively. From each selected block, two villages one nearby the market/mandi centre and one far off from the market centre were selected for canvassing the questionnaire. On the basis of discussion with Taluka Development Officers and Extension Officials of agriculture of selected blocks, two sample

villages were selected from each selected block. The number of villages selected from each blocks also varied keeping in view the availability of adequate number of sample farmers growing selected crop. The list of selected villages from each districts/blocks and category-wise number of sample farmers selected for study is given in Table 1.9.

iv) Selection of farmers: From each selected village, total 30 samples farmers growing tur crop were selected at random. The selected farmers were of different farm size categories i.e. marginal (< 2.50 acres), small (2.51 to 5.00 acres.), medium (5.01 to 10.00 acres) and large (>10.01 acres) and representing different social strata such as SCs, STs, OBCs and General castes. Thus, from each selected district, total 60 sample farmers were selected at random for study. Altogether, 120 sample households were selected for primary survey of the study. The village-wise and farm size-wise distribution of sample farmers is presented in Table 1.9.

Table 1.9: List of selected districts, blocks, villages and category-wise sample households in Gujarat

State	Districts	Blocks	Villages	MF	SF	MDF	LF	Total
Gujarat state	Bharuch	Bharuch	1.Dahegam	3	5	10	11	29
			2.Bhadbhut	6	6	5	14	31
	Vadodara	Karjan	3.Miyagam	6	6	6	12	30
			4.Mantroj	5	7	4	14	30
Grand Total				**20**	**24**	**25**	**51**	**120**

Notes: MF=Marginal Farmers (< 2.50 acres), SF= Small Farmers (2.51 to 5.00 acres), MDF=Medium Farmers (5.01 to 10.00 acres) and LF=Large Farmers (>10.01 acres)

Methods of primary data collection:

The primary survey instrument was prepared and finalized by Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore after consultation with associated AERCs. The season wise primary data were collected by recall method from the selected sample households by interviewing the decision makers or head of the households. Quantitative/ qualitative information was collected in the schedule on various related aspects such as demographic profile, landholding, season wise cropping pattern, pre and post harvest losses and pest, diseases problems of selected crops and different chemical and biological methods adapted to control pests and diseases. The quantified data on pre and post harvest losses during the crop, process of harvesting, collection, threshing, transportation and storage were collected from the sample farmers. Opinions of farmers were collected on various aspects such as details of biological methods adopted and nature and physical structure, cost, storage pest

controls measures, maintenance of storage structure. Suggestions with respect to minimize pre and post harvest losses of selected crops were also obtained. In addition to household schedule, a pest and diseases of local and HYV/hybrid variety was also administered to capture the data to know and to study the crop losses of both variety.

In addition to field survey, other related important information and data were also collected through personal discussion with District Agriculture Officials, Taluka Development Officers and Officials of State Agriculture and State's different agencies like KVK, Agriculture Universities and research centre of selected crop. In addition to the primary data collected from the farmers, discussed and compiled the crop loss estimates (if any) for pre and post harvest losses with concerned district offices of the Department of Agriculture of state government. The reference year for primary survey was agricultural year 2011-12 (July to June).

Secondary data collection

The secondary data required for the study were collected from the various government departments such as Directorate of Agriculture, GoG, Directorate of Economics and Statistics of Gujarat state and Central/ States government publications and websites. District-wise data on area under selected crop was collected from above mentioned sources. Block-wise data on area under selected crops were collected from district level officials like District Agriculture Officials, District Statistical Officials, etc.

Analytical framework

The main objective of the study is to examine the physical and financial losses caused during pre and post harvest of tur crop. To study the measures of pests and disease management, the crop loss due to pest and disease at farm level was collected and analyzed. The data on post harvest losses of selected crop was also analyzed. To identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase national productivity were analyzed.

The crop production constraints particularly infestation by pests and diseases, and losses caused by them was worked out based on the estimates provided by the farmers. As not only pests and diseases cause crop damage, there are also other bio-economic factors like soil fertility, water scarcity, poor seed quality, high input costs and low output prices result in consider financial loss to farmers. Thus, data on these bio-economic variables were also collected from the farmers. The post harvest losses during the process of harvesting,

collection and threshing, transportation and storage be quantified based on the estimates provided by the farmers. Storage material used by the farmers is generally mud, bamboo, stone, plant materials etc. It is essential to identify the structure of storage at the farmers' level and enumerate the losses occurring in the process of storage at the farmer level.

Qualitative questions were put to farmers on various aspects such as constraints faced in the cultivation of reference crop, details of biological and other measures to control pests and diseases, advice for pest and diseases management, nature of storage structure, physical condition of storage structure, cost and maintenance of storage structure and storage pest and control measures were also analyzed.

Suggestions with respect to problems faced by farmers and how to minimize pre and post harvest losses with regard to reference crop production were also obtained from the respondents. In addition to field survey, information on current major problems of selected crop, production losses at various stages and the possible solutions to eliminate it were also collected through personal discussion with District Agriculture Officials, Taluka Development Officers (TDO) and Officials of State Agriculture Universities, Research centre and State Agriculture Department.

1.7 Organization of Report

The present study report is divided into six chapters including this introductory chapter. The trend and growth of area, production and productivity of selected crop using secondary data for study has been presented in chapter two. Chapter three presents socio-economic characteristics of sample households, status of production of selected crop, irrigation, cropping pattern and crop productivity, marketed surplus and value of output by farmers. The chapter four presents pre harvest losses of reference crop due to different pest and diseases, different methods of pests and diseases control adopted by sample farmers and household suggestions to minimize the losses. Chapter five provides post harvest losses of reference crop and qualitative and quantitative aspects of storage and their pests control measures adopted by the sample households. Last chapter provides conclusion and policy recommendations.