CHAPTER - III
PROFILE OF KARNATAKA STATE

3.1. A Glimpse of the State

Karnataka is one of the four southern states of India. With the reorganization of states, the modern state of Karnataka came into existence during 1956 with the incorporation of districts from Bombay, Hyderabad, Madras States and Coorg within the existing Mysore State. Mysore state was made up of ten districts, Bangalore, Kolar, Tumkur, Mandya, Mysore, Hassan, Chikmagalur (Kadur), Shimoga and Chitradurga; Bellary had been transferred from Madras State to Mysore in 1953, when the new state of Andhra Pradesh was created out of Madras's northern districts. Kodagu became a district, and Dakshina Kannada (South Kanara) district was transferred from Madras State, North Kanara, Dharwad, Belgaum District, and Bijapur District from Bombay State, and Bidar District, Gulbarga District, and Raichur District from Hyderabad State. Mysore was renamed as Karnataka on the first day of November, 1973**.**

In 1989, Bangalore Rural district was split from Bangalore and in 1997 Bagalkot district split from Bijapur, Chamrajnagar district split from Mysore, Gadag district split from Dharwad, Haveri district split from Dharwad, Koppal district split from Raichur, Udupi district split from Dakshina Kannada, and Davanagere district was created from parts of Bellary, Chitradurga, Dharwad, and Shimoga. Karnataka's capital, Bengaluru, is the capital city of the State with a population of more than 6 million.

Most parts of Karnataka were a part of the Mauryan Empire, which was ruled by Emperor Ashoka, by the third century BC. Later, Karnataka was ruled by a series of Jain/Vaishnavite/Hindu Dynasties such as the Kadambas, the Ganga Dynasty and the Chalukyas and Rashtrakutas. With the rule of the state changing hands from the Wodeyars to Haidar Ali and Tippu Sultan, the state was later incorporated into the British Raj at the turn of the 19th century.

The earliest known references to *Karnataka* are found in the *Sabha Parva* and the *Bhishma Parva* of the Mahabharata. The term *Karnataka* is used by the astrologer Varaha Mihira in his work *Brihatkatha* and the Tamil classic *Sillapadikaram* of the same time period calls the people of present day Karnataka region as *Karunatakars*.

Karnataka lies in the Deccan Plateau and borders with Maharashtra, Goa, Andhra Pradesh, Tamil Nadu and Kerala. Karnataka is situated in the Deccan Plateau and is bordered by the Arabian Sea to the west, Goa to the northwest, Maharashtra to the north, Andhra Pradesh to the east, Tamil Nadu to the east and southeast, and Kerala to the southwest.

In Karnataka, soil and vegetation shows a varied feature with different kinds of soils spread in different regions. The soil in Karnataka is varied with red clay and laterite soil, red soil mixed with clay and sand, black soil or split; and it is owing to the availability of different kinds of soil in different region that influences the cropping pattern of Karnataka. The soil and vegetation in Karnataka are two complimentary terms that go hand in hand with each other. It is noteworthy that in Karnataka about 61.95 per cent of the land is cultivable; that is to say that the soil and vegetation produce a complete sync in Karnataka. In fact, the percentage of cultivable land in Karnataka is higher than any other state in India.

The weather in the state is dynamic; it changes from place to place owing to its altitude, topography and its distance from the sea. The hills and plateau in Karnataka show a different climatic trait compared to the plains, viz. the average rainfall in the Western Ghats is 254 centimeters, whereas in the parts of the Kanara coast, it is nearly 762 centimeters; moreover in the plains rainfall is considerably low. Geography of Karnataka states that Karnataka is the eighth largest state in India.

With a geographic area of 1,91,791 square kilometers, the State of Karnataka lies between 11.5° and 18.50° North latitude and 74° East and 78.30° East longitudes in the southern plateau. With a population of 4,49,77,201 the literacy rate of the state accounts to 55.98 per cent. The total number of farmers in the state is 62,20,798, out of which 26,09,513(41.9 per cent) are marginal having below 1 hectare land, 17,06,839 (27.44 per cent) are small having 1-2 hectare land, 12,04,185 (19.65 per cent) semi medium having 2-4 hectares, 5,94,232 (9.55 per cent) medium farmers having 4-10 hectares and finally 1,06,029 (1.70 per cent) large farmers having more than 10 hectares (Map 3.I).

Map 3.I: Karnataka state depicting the districts and state boundaries

Source: www.mapsofindia.com

The state receives an annual rainfall from both the South-West monsoon and North-East monsoon, which starts from June and extends up to November. Major rain is received from the South-West monsoon. The state on an average is categorized as drought prone; the severity of the drought varies from year to year.

3.2. Agricultural Economy

The agrarian economy of Karnataka comprises of many valuable enterprises. The normal net cultivated area in the state is about 106 lakh hectares, which accounts for 56 percent of the total geographical area (Table-3.1). The major crops grown are cereals, pulses, oilseeds and cash crops. Important food crops of the state are ragi, paddy, jowar, maize and bajra. Pulses like red gram, bengal gram, field been, cow pea and horse gram are also grown. The important oil seed crops in the state are ground nut, sunflower, safflower and sesamum. Cotton, sugarcane, coffee, tobacco and mulberry are the major commercial crops. The vegetable crops include potato, carrot, cabbage, beetroot, radish, cauliflower, brinjal, beans and leafy vegetables. The major fruit crops like mango, guava, sapota, grapes and the flower crops like rose, chrysanthemum, crossanrda, aster, jasmine, champaka and marigold are grown. The unique feature of the Karnataka state is the existence of sericulture from the time immemorial. It is said that the then ruler Tipu Sultan is responsible for the prominent growth of sericulture in the state. Now, Karnataka accounts for more than 55 per cent of the raw silk produced in the country.

The *kharif* crops (April to September) in Karnataka comprise millets, paddy (rice), maize, moong (pulses), groundnut, red chillies, cotton, soyabean, sugarcane, rice, and turmeric. It is also known as the autumn harvest as it is cropped with the beginning of the first rains in the month of July. The major rabi crops (October to December) of Karnataka are wheat, barley, mustard, sesame, and peas. Karnataka is one of the major producers of rice among all other states in India. Cash crops grown in the state comprise of sugarcane, cashews, cardamom, betel (areca) nut, and grapes. The cool slopes of Western Ghats are well-known for coffee and tea plantations whereas the eastern regions are widely known for producing a heavy amount of sugarcanes, a bit of rubber plants, and fruits such as oranges and bananas. The north-western region of Karnataka has black soil which supports oilseeds, cotton, and peanut (groundnut). Karnataka is also highly potential for its horticulture production

and it ranks second in this aspect in India. Karnataka's agricultural products also include raw silk which has the highest production range among all other states in India. Karnataka agriculture is experiencing major development plans and strategies to ensue more flexibility and advancement in harvesting crops which is adding value to Karnataka's economy to a great extent.

3.3. Land utilisation in Agriculture

A perusal of the data in Table – 3.1., reveals that, with an existing area of 190.49 lakh hectares, the net sown area was 100.31 lakh hectares during the year 2000-01. With an additional 16.38 lakh hectares of land coming under area sown more than once, the gross cropped area during the year 2000-01 was 116.70 lakh hectares. The cropping intensity which is calculated as the proportion of total cropped area to the net sown area was found to be 1.16. Among the districts the district Gulbarga is the biggest among all the districts with a total geographical area of 16.10 lakh hectares, followed by Belgaum (13.44 lakh hectares), Tumkur (10.65 lakh hectares), Bijapur (10.54 lakh hectares) and Uttara Kannada (10.25 lakh hectares). The cropping intensity was highest among the districts of Dharwad (1.45), Mysore (1.27), Udupi (1.27) and Haveri (1.26) during the year 2000-01.

Table 3.1.: District Wise Geographical Area, Net Area Sown and Total Cropped Area in Karnataka State (2000-01)

(Area in hectares)

Sl. No	District	Total geographical area	Net area sown	Total cropped area	Area sown more than once	Cropping intensity
1	Bagalkote	658877	436119	475080	38961	1.09
2	Bangalore (Urban)	217410	81833	88506	6673	1.08
3	Bangalore (Rural)	585431	295042	332189	37147	1.13
4	Belgaum	1344382	728473	870100	141627	1.19
5	Bellary	813196	457906	525409	67503	1.15
6	Bidar	541765	372202	450789	78587	1.21
7	Bijapur	1053471	676925	757937	81012	1.12
8	Chamarajanagar	569901	153264	203681	50417	1.33
9	Chickmagalur	722075	282464	304264	21800	1.08
10	Chitradurga	770702	422574	489849	67275	1.16
11	Dakshina Kannada	477149	133698	162238	28540	1.21
12	Davanagere	597597	365451	436052	70601	1.19
13	Dharwad	427329	331396	480267	148871	1.45
14	Gadag	465715	392790	442433	49643	1.13
15	Gulbarga	1610208	1168658	1340470	171812	1.15
16	Hassan	662602	370437	414017	43580	1.12
17	Haveri	485156	346425	435845	89420	1.26
18	Kodagu	410775	147111	148623	1512	1.01
19	Kolar	779467	350559	372031	21472	1.06
20	Koppal	552495	359970	436251	76281	1.21
21	Mandya	498244	247076	286357	39281	1.16
22	Mysore	676382	390943	494749	103806	1.27
23	Raichur	835843	522093	606364	84271	1.16
24	Shimoga	847784	213096	241230	28134	1.13
25	Tumkur	1064755	574739	627215	52476	1.09
26	Udupi	356446	101638	129285	27647	1.27
27	Uttara Kannada	1024679	108610	118519	9909	1.09
	Karnataka State	**19049836**	**10031492**	**11669750**	**1638258**	1.16

Note: Normal Net cultivated area is about 106 lakh hectares and the Gross cultivated area is about 123 lakh hectares under all crops

Source: Directorate of Economics & Statistics (2002) Annual Season and Crop Report, Government of Karnataka, Bangalore

3.4. Performance of Principal Crops

A comparison of productivity under the different agricultural crops suggest that, the state of Karnataka stood first in the productivity of maize, second in sugarcane, third in tobacco, cotton, soyabean and jowar (Table-3.2.). The state also ranked fifth in the productivity of rice. Thus, the state of Karnataka constitutes an important agrarian economy in India. Besides, Karnataka ranks first in the production of silk cocoon and raw silk in the country.

Table 3.2.: Comparison of Yields of Major Agricultural Crops for the Year 2000-2001

Unit: Kg/Hectare (Sugarcane Yield in MT/Ha)

Sl. No.	Crop	India	Karnataka	Tamil Nadu	Andhra Pradesh	Maharashtra	State's Rank
1	Rice	1913	2520	3415	2842	1285	5th
2	Jowar	772	917	1010	808	783	3rd
3	Wheat	2743	917	-	-	1256	14th
4	Bajra	719	729	1518	1004	604	7th
5	Maize	1841	3157	1619	2727	850	1st
6	Tur	616	441	710	426	602	8th
7	Bengalgram	720	648	-	650	519	7th
8	Groundnut	924	799	1765	1091	1000	7th
9	Soyabean	822	894	-	1009	1109	3rd
10	Sunflower	549	370	1083	853	524	7th
11	Cotton	191	298	285	277	100	3rd
12	Sugarcane	69.6	102.7	107.3	81.5	84.4	2nd
13	Tobacco	1704	653	-	1847	-	3rd

Source: Ministry of Agriculture (2002) Agricultural Statistics at a Glance, Government of India, New Delhi, India

The year wise area, production and yield of some important crops grown in Karnataka were studied. It was found that among cereals, the major crops like paddy (HYV), jowar, maize and ragi had an area up to the extent of 13.11 lakh hectares, 15.20 lakh hectares, 9.35 lakh hectares and 10.22 lakh hectares respectively during 2006-07 (Table 3.3.). The corresponding area change from 1990-91 to 2005-06 was up to an extent of 57.67 per cent, -29.45 per cent, 234.72 per cent and -3.09 per cent

respectively under high yielding varieties of paddy, jowar, maize and ragi. The area under maize improved significantly over the years. Though jowar and ragi lost considerable area share, their production contribution remained to be higher. The productivity levels of all the cereals during the period from 1990-91 to 2005-06, enhanced significantly, thereby leading to improvement in productivity per unit area.

There was a considerable increase in the area under pulses and oil seeds during the period from 1990-91 to 2005-06. It was noted that, the area share of pulses in Karnataka agriculture was to the extent of 19.80 lakh hectares and that of oilseeds was 28.63 lakh hectares during 2005-06 (Table – 3.4.). However, there was a negative rate of increase in the area under ground nut. The ground nut crop area which was around 12.12 lakh hectares in Karnataka during 1990-91, declined to 10.40 lakh hectares during 2005-06. However the area under sunflower increased from 8.95 lakh hectares during 1990-91 to 14.27 lakh hectares during 2005-06.

Considering the above factors it is clear that, while some agricultural crops are attaining higher growth rate in area, production and productivity some are loosing their share in the area. However it was noted that productivity level of all the cereals and pulses was increasing, while among oil seeds, the same trend was noticed in sunflower. The fact that the oil seed crops in Karnataka are mainly covered under rain fed conditions, which in turn has to depend on the arrival of monsoon, climatic changes and drought. Hence the productivity level under groundnut crop was erratic.

Table 3.3.: Year-Wise Area, Production and Yield of Important Cereal Crops in Karnataka State

Year	Paddy HYV			Jowar			Maize			Ragi		
	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)
1990-91	831591	3002782	3800	2154570	1282114	626	NA	NA	NA	1055330	976078	973
1991- 92	268524	1096291	4297	2086107	1629150	822	279591	844628	3179	1066187	1403605	1386
1992 - 93	775588	3232403	4387	2306087	1925870	879	315243	977103	3263	1038411	1536132	1557
1993 - 94	912146	3647311	4209	2085508	1895141	957	317530	947410	3141	1028508	1566564	1603
1994 - 95	795005	3443665	4560	2165401	1637885	796	343670	987502	3025	944155	1352668	1508
1995 - 96	776303	3372262	4573	1976349	1717497	915	365083	1142392	3294	1019932	1618138	1670
1996 - 97	1085903	4280214	4149	1998542	1897726	1000	445650	1385196	3272	1035204	1495149	1520
1997 - 98	869112	3653656	4425	1896999	1254001	696	561371	1510957	2833	938546	1273013	1428
1998 - 99	1155569	4908752	4471	1849867	1643239	935	512368	1671292	3434	1030679	1734076	1771
1999 - 00	1193544	5026358	4433	2023717	1790741	931	606387	1603392	2783	916328	1402162	1611
2000 - 01	1007603	4468024	4668	1782262	1546921	714	668855	2135644	3361	1022701	1835332	1889
2001 - 02	1187427	4505873	3994	1790815	1372066	806	580035	1451587	2634	953430	1539308	1699
2002 - 03	922244	3282759	3747	1786237	1224893	722	649544	1342942	2176	767148	714489	980
2003 - 04	866954	3500031	4250	1698177	781003	484	618173	1209900	2060	998266	1125093	1186
2004 - 05	1125994	5169901	4833	1662793	1358582	860	850369	2509349	3106	892841	1613873	1903
2005 - 06	1311183	5540551	4448	1520137	1478776	914	935854	2806523	3361	1022701	1835332	1889
% Change	57.67	84.51	17.05	-29.45	15.34	46.01	234.72	232.28	5.73	-3.09	88.03	94.14

Source: Directorate of Economics and Statistics, Government of Karnataka, Bangalore, Compiled from Various Issues of "Fully Revised Estimates of Principal Crops in Karnataka" for different years

Table 3.4.: Year-Wise Area, Production and Yield of Pulses and Important Oilseed Crops in Karnataka State

Year	All pulses			Groundnut			Sunflower			All oil seeds		
	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)
1990-91	1620602	539274	350	1212171	816127	708	895914	382158	449	2551177	1339094	552
1991- 92	1787482	673920	396	1359056	1103017	854	1201772	513327	449	2981286	1779869	628
1992 – 93	1659553	562459	357	1275657	1135892	937	1068506	424591	418	2771726	1754847	666
1993 – 94	1523085	630397	436	1243307	1198957	1015	1469302	474844	340	3126794	1888849	636
1994 – 95	1648213	620564	396	1200135	945501	829	839542	355049	445	2564926	1542249	633
1995 – 96	1519507	687961	477	1191879	1138749	1006	1012129	395337	411	2617491	1743480	701
1996 – 97	1776407	722242	428	1285485	1147479	940	881124	361536	432	2606382	1755492	709
1997 – 98	1681587	496469	311	1040382	706633	715	928522	258054	293	2371986	1139137	506
1998 – 99	1819963	746889	432	1230022	1192134	1020	833346	264037	333	2436992	1671445	722
1999 – 00	1920328	848436	465	1120423	768623	722	494099	200697	428	1982440	1192559	633
2000 – 01	2046670	956200	492	1063415	1081106	1070	477791	231037	509	1894104	1545196	859
2001 – 02	1893101	751714	418	854741	585707	721	584318	262406	473	1737268	1019867	618
2002 – 03	2060601	693525	354	843917	538987	672	876592	373937	449	2005364	1073724	564
2003 – 04	1874328	569255	320	817243	433478	558	1135465	364687	338	2267382	934052	434
2004 – 05	2108028	799863	399	968577	684086	743	1271128	528118	437	2672875	1446306	570
2005 – 06	1980606	950597	505	1040072	595867	603	1427435	667511	492	2862817	1527323	562
% Change	22.21	76.27	44.29	-14.20	-26.99	-14.83	59.33	74.67	9.58	12.22	14.06	1.81

Source: Directorate of Economics and Statistics, Government of Karnataka, Bangalore, Compiled from Various Issues of "Fully Revised Estimates of Principal Crops in Karnataka" for different years

Karnataka is known for the production of few important commercial crops. Out of these, sugarcane, tobacco and cotton were found to have major share in the area. A perusal of the data in the Table 3.5., which reveals that, the commercial crops such as sugarcane, tobacco and cotton had an extent of area of 2.21 lakh hectares, 1.01 lakh hectares and 4.13 lakh hectares respectively in Karnataka during the year, 2005-06. The area and production level of sugar cane and cotton was reduced to a considerable extent. There was a reduction in the area of sugarcane up to -18.67 per cent and cotton up to -30.65 per cent from 1990-91 to 2005-06 respectively. However the area under tobacco crop gained considerably during the period due to prevailing market prices.

Table 3.5.: Year-Wise Area, Production and Yield of Important Commercial Crops in Karnataka State

Year	Sugarcane			Tobacco			Cotton		
	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)
1990 - 91	272292	20750209	80	46450	32680	740	595947	640046	192
1991 - 92	285316	24062532	88	52860	43569	867	586101	954231	291
1992 – 93	261456	22479577	91	58363	52891	954	629845	865395	246
1993 – 94	300551	26602904	93	61195	45984	791	570915	773279	242
1994 – 95	344928	33092660	101	59488	44705	791	635810	815274	229
1995 – 96	323362	27558276	90	59550	48820	863	678356	962631	254
1996 – 97	282100	23374357	87	70305	57020	854	NA	NA	NA
1997 – 98	308857	28999269	99	70815	62220	925	501505	633530	226
1998 – 99	338761	34770919	108	83722	58988	742	636495	976876	275
1999 – 00	372995	37566920	106	75372	44519	622	545675	664547	218
2000 – 01	417141	42923496	108	70504	52131	778	551763	855236	277
2001 – 02	406950	33016618	85	72446	58595	851	608479	612415	180
2002 – 03	382719	32485308	89	82350	59227	757	392671	330913	151
2003 – 04	243341	16015440	69	98050	55107	592	316674	264624	149
2004 – 05	178881	13993198	82	91403	67502	777	521860	624566	214
2005 – 06	221462	19647650	93	100798	63879	667	413310	585498	253
% Change	-18.67	-5.31	16.25	117.00	95.47	-9.86	-30.65	-8.52	31.77

Source: Directorate of Economics and Statistics, Government of Karnataka, Bangalore, Compiled from Various Issues of "Fully Revised Estimates of Principal Crops in Karnataka" for different years

Among the selected few commercially viable horticulture crops, banana, potato and mango are the major crops grown in the state of Karnataka. The corresponding area under these crops was to the extent of 0.44 lakh hectares, 0.73 lakh hectares and 1.18 lakh hectares respectively (Table – 3.6.). A large extent of potato which is cultivated is mainly grown under rain fed conditions. Hence the productivity levels are fluctuating. Karnataka is one of the leading producers of mango fruits in India. The area and production of mango increased up to 130 per cent from 1990-91 to 2005-06.

Table 3.6.: Year-Wise Area, Production and Yield of Important Horticultural Crops in Karnataka State

Year	Banana			Potato			Mango		
	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)	Area (Ha)	Production (MT)	Yield (Kg/Ha)
1990 - 91	20055	421697	21027	18518	313138	16909	NA	NA	NA
1991 - 92	19902	502744	25260	23616	358421	15177	NA	NA	NA
1992 - 93	21432	617418	28808	25697	32819	12757	51303	258141	5032
1993 - 94	22838	635334	27819	26208	320372	12224	54512	244847	4492
1994 - 95	22945	631957	27542	31792	335569	10555	53845	239235	4443
1995 - 96	23436	641234	27361	28544	340157	11917	54116	203084	3753
1996 - 97	23496	606660	25820	30936	452852	14638	54977	207716	3778
1997 - 98	24285	645743	26590	31462	447307	14217	62929	186393	2962
1998 - 99	26046	503515	19332	34333	422473	12305	64004	165765	2590
1999 - 00	30329	711634	23464	32257	459979	14260	71715	286501	3995
2000 - 01	35335	649567	18383	38298	452462	12436	81190	334756	4123
2001 - 02	40251	815571	20262	39156	473407	12727	96297	255029	2648
2002 - 03	39813	681663	17122	50645	149282	3103	97992	415248	4238
2003 - 04	33220	431463	12988	53076	342752	6798	101533	299487	2950
2004 - 05	41977	526898	12552	51937	360759	7311	98347	317823	3232
2005 - 06	43562	517257	11874	73356	329401	4727	118158	450688	3814
% Change	117.21	22.66	-43.53	296.13	5.19	-72.04	130.31	74.59	-24.21

Source: Directorate of Economics and Statistics, Government of Karnataka, Bangalore, Compiled from Various Issues of "Fully Revised Estimates of Principal Crops in Karnataka" for different years

3.5. Performance of Sericulture

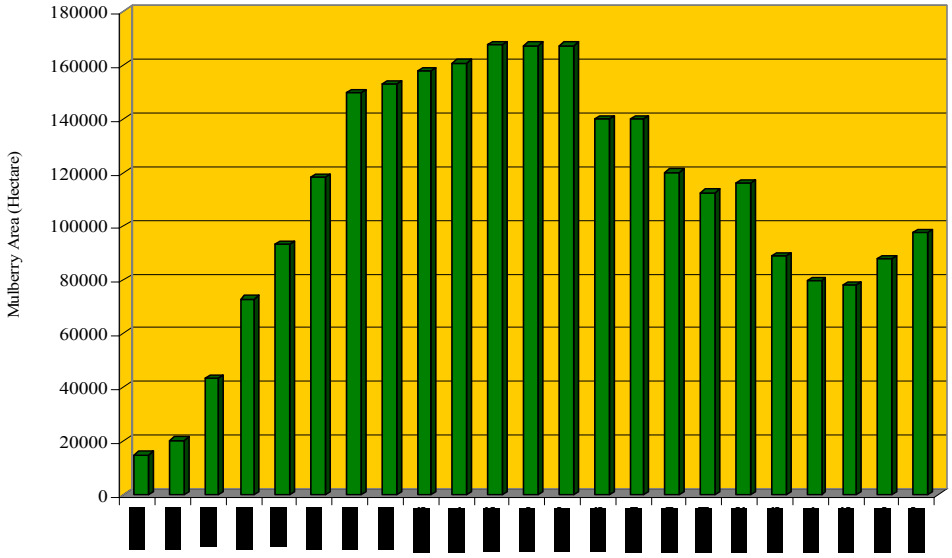
The state of Karnataka, the major silk producer of the country had an area of 0.97 lakh hectares under mulberry crop during 2006-07 (Table 3.7). The mulberry silk cocoon production of the state was to the extent of 0.59 lakh Metric Tons and had a Compound Growth Rate of (CGR) of 2.77 per cent. Similarly the raw silk produced during the year was to the extent of 7993 Metric Tons and with a Compound Growth Rate of 4.93 per cent. However the rate of increase in area and production in Karnataka was little lower when compared to the national figures, where the raw silk production grew at the rate of 6.20 per cent. The production figures indicate that, the prosperity in sericulture was brought about during 80s and 90s, while the same level of production trend was not continued from 2000 onwards. Many reasons can be cited to support this. While the area and production level dipped to certain level considerably, the productivity level of sericulture gained enormously during the recent period due to the wide spread technological innovations in sericulture. The efforts of National Sericulture Project (NSP) during late nineties had an impact on area expansion in sericulture. The drastic reduction in area has now been gradually compensated as is evident from the data presented in the Table- 3.7. The graphical representation of the changes in the area under mulberry in Karnataka also indicates that, with a greater extent of loss in the area under the mulberry, the recent years have claimed to be favorable for the expansion of mulberry area in Karnataka (Graph – 3.A). Similar is the case with production of silk cocoon and the raw silk in Karnataka (Graph – 3.B. & 3.C). The Graph- 3.D indicates the status of Karnataka in the production of mulberry raw silk as compared the national production over the years, needless to say that, major proportion of silk comes from Karnataka.

Table 3.7.: Year-Wise Area under Mulberry, Silk Cocoon and Raw Silk Production in Karnataka *Vis-à-vis* India

Year	Karnataka State			India	
	Area under Mulberry (Ha)	Silk Cocoon Production (MT)	Mulberry Raw Silk Production (MT)	Mulberry Raw Silk Production (MT)	Total Raw Silk Production (MT)
1931-32	14775.00	4364.00	336.00	NA	NA
1941-42	20234.00	6350.00	454.00	NA	NA
1951-52	43200.00	11818.00	419.00	625.00	NA
1961-62	72843.00	15100.00	947.00	1308.00	NA
1971-72	93200.00	27096.00	1775.00	2046.00	2600.00
1981-82	118400.00	33516.00	3127.00	4801.00	5249.00
1990-91	149785.00	59033.00	6224.00	11486.00	12560.00
1991-92	153085.00	51966.00	5482.00	10658.00	11763.00
1992-93	157935.00	65565.00	7147.00	13000.00	14168.00
1993-94	160835.00	70208.00	8250.00	12550.00	13691.00
1994-95	167778.00	77557.00	8865.00	13450.00	14579.00
1995-96	167422.00	70708.00	8264.00	12884.00	13909.00
1996-97	167422.00	70678.00	8328.00	12954.00	14126.00
1997-98	140026.00	80656.00	9236.00	14048.00	15236.00
1998-99	140034.00	76198.00	8944.00	14260.00	15544.00
1999-00	120119.00	68920.00	8121.00	13944.00	15214.00
2000-01	112557.00	66518.00	8200.00	14432.00	15857.00
2001-02	116158.00	73860.00	8727.00	15842.00	17351.00
2002-03	88903.00	55851.00	6760.00	14617.00	16319.00
2003-04	79778.00	44652.00	5949.00	13970.00	15742.00
2004-05	77998.00	54210.00	7302.00	14620.00	16813.00
2005-06	87734.00	55493.00	7471.00	15445.00	17602.00
2006-07	97647.00	58697.00	7993.00	16525.00	18475.00
CGR %	0.16	2.77	4.93	6.48	6.20

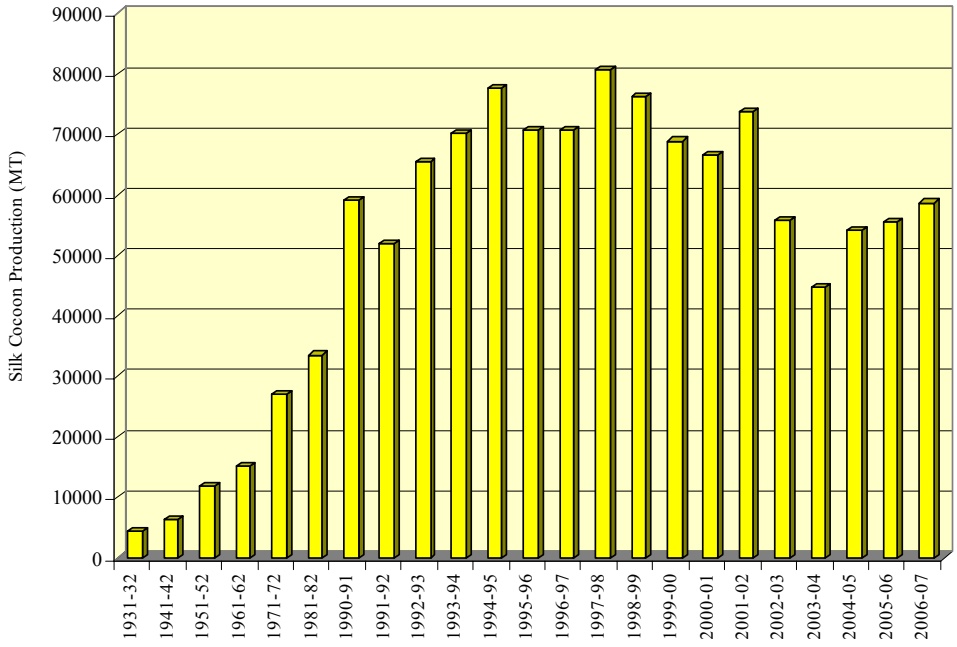
Source: Department of Sericulture (2007) *Suvarna Reshme, Smarana Sanchike* (Kannada)-1956-57 to 2006-07, Government of Karnataka, Bangalore, India

Graph 3.A : Year-Wise Area Under Mulberry in Karnataka State



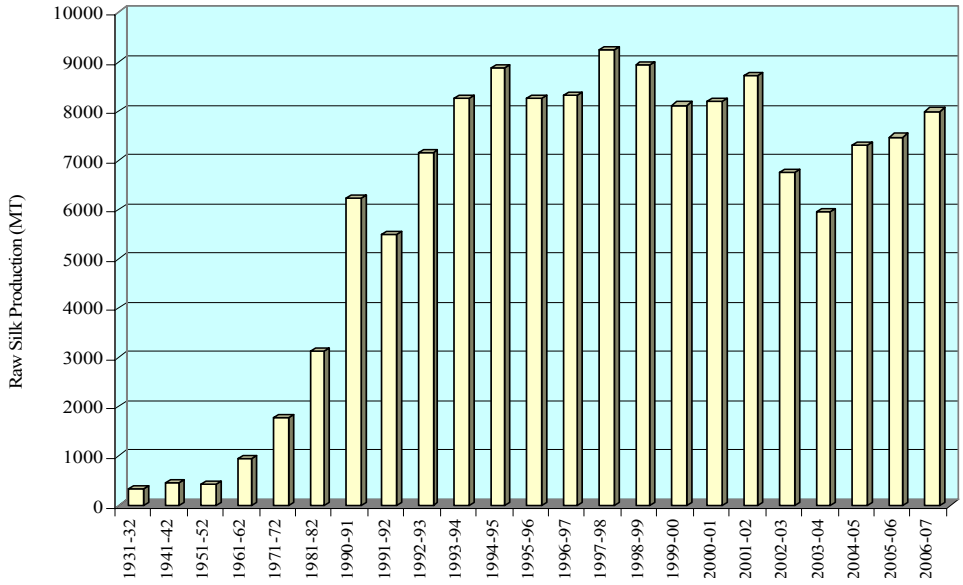
Data source: Table - 3.7.

Graph 3.B : Year-Wise Silk Cocoon Production in Karnataka State



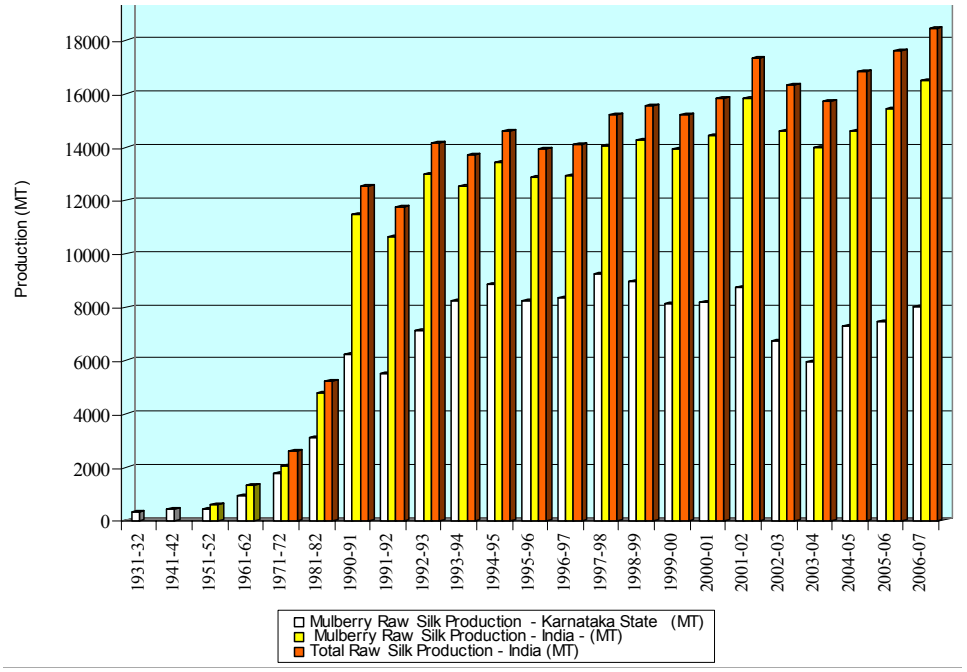
Data source: Table - 3.7.

Graph 3.C : Year-Wise Mulberry Raw Silk Production in Karnataka State



Data source: Table – 3.7.

Graph 3.D : Raw Silk Production Status of Karnataka State vis-à-vis India



Data source: Table – 3.7.

The district wise analysis of performance of sericulture in Karnataka was studied. It was noted that during 2005-06, out of the area under mulberry crop of 87,734 hectares, the major share of area among the districts was from Kolar (34.92 per cent) followed by Bangalore (Rural) district (20.40 per cent), Mandya (12.66 per cent), Chamarajanagara (9.80 per cent), Mysore (5.27 per cent) and Tumkur (3.78 per cent) districts. The district Chamarajanagara constituted the major area under rain fed mulberry.

During the following year 2006 – 07, there was a moderate increase in the area under mulberry. It was found that out of an area under mulberry crop of 97647 hectares, the major share of area among the districts was from Kolar (36.23 per cent) followed by Bangalore (Rural) (20.79 per cent), Mandya (13.22 per cent), Chamarajanagara (8.93 per cent), Mysore (4.45 per cent) and Tumkur (3.67 per cent) districts.

Table 3.8.: District-wise Mulberry Area and Production during 2005-06 in Karnataka State

Sl. No.	Districts	Area under Mulberry				Production	
		Irrigated (Ha)	Rainfed (Ha)	Total (Ha)	% Share in total area	Reeling cocoons (MT)	Raw Silk (MT)
1	Bangalore(U)	1790	-	1790	2.04	1188.24	162.66
2	Bangalore(R)	17900	-	17900	20.40	15197.25	2048.66
3	Bagalakote	467	-	467	0.53	101.99	13.87
4	Belgaum	591	-	591	0.67	291.73	40.90
5	Bellary	861	-	861	0.98	543.21	73.11
6	Bidar	254	-	254	0.29	97.12	13.37
7	Bijapur	151	-	151	0.17	50.18	6.75
8	Chamarajanagar	1642	6960	8602	9.80	1372.37	171.82
9	Chikmagalur	148	-	148	0.17	16.78	2.49
10	Chitradurga	1906	-	1906	2.17	918.91	124.54
11	Dakshina Kannada	67	25	92	0.10	3.56	0.54
12	Davanagere	320	-	320	0.36	129.19	17.51
13	Dharwad	142	-	142	0.16	32.92	4.57
14	Gadag	170	-	170	0.19	46.57	6.35
15	Gulbarga	407	-	407	0.46	92.00	12.40
16	Hassan	597	442	1039	1.18	263.57	39.64
17	Haveri	517	-	517	0.59	283.89	38.19
18	Kodagu	25	74	99	0.11	5.16	0.78
19	Kolar	30635	-	30635	34.92	21240.02	2867.15
20	Koppal	156	-	156	0.18	39.73	5.43
21	Mandya	10731	376	11107	12.66	9293.34	1260.53
22	Mysore	1741	2884	4625	5.27	1542.10	198.43
23	Raichur	395	-	395	0.45	42.14	5.99
24	Shimoga	210	-	210	0.24	74.07	10.35
25	Tumkur	3304	12	3316	3.78	2101.12	284.85
26	Udupi	36	12	48	0.05	2.15	0.32
27	Uttara Kannada	240	-	240	0.27	37.09	5.49
28	Mysore Seed area	1410	136	1546	1.76	485.89	53.98
	Total	**76,813**	**10,921**	**87,734**	**100.00**	**55492.26**	**7470.71**

Source: Department of Sericulture (2007) Annual Report-2006-07, Government of Karnataka, Bangalore, India

Table 3.9.: District-wise Mulberry Area and Production during 2006-07 in Karnataka State

Sl. No.	Districts	Area under Mulberry				Production	
		Irrigated (Ha)	Rainfed (Ha)	Total (Ha)	% Share in total area	Reeling cocoons (MT)	Raw Silk (MT)
1	Bangalore(U)	1,699	-	1,699	1.74	997.00	139.78
2	Bangalore(R)	20,298	-	20,298	20.79	17,775.00	2,382.44
3	Bagalakote	640	-	640	0.66	166.00	22.66
4	Belgaum	627	-	627	0.64	333.00	46.64
5	Bellary	1,061	-	1,061	1.09	662.00	89.46
6	Bidar	297	-	297	0.30	121.00	16.76
7	Bijapur	223	-	223	0.23	80.00	10.87
8	Chamarajanagar	1,713	7,003	8,716	8.93	944.00	127.05
9	Chikmagalur	177	6	183	0.19	34.00	5.14
10	Chitradurga	1,702	-	1,702	1.74	776.00	104.92
11	Dakshina Kannada	77	31	108	0.11	7.00	1.14
12	Davanagere	393	-	393	0.40	190.00	25.80
13	Dharwad	101	2	103	0.11	32.00	4.42
14	Gadag	189	-	189	0.19	83.00	11.33
15	Gulbarga	367	-	367	0.38	125.00	16.99
16	Hassan	910	467	1,377	1.41	276.00	41.23
17	Haveri	745	-	745	0.76	311.00	41.87
18	Kodagu	29	78	107	0.11	6.00	0.85
19	Kolar	35,373	-	35,373	36.23	22,210.00	2,975.33
20	Koppal	200	-	200	0.20	46.00	6.35
21	Mandya	12,545	368	12,913	13.22	9,738.00	1,308.31
22	Mysore	2,066	2,276	4,342	4.45	961.00	131.50
23	Raichur	461	-	461	0.47	49.00	6.93
24	Shimoga	246	42	288	0.29	81.00	11.31
25	Tumkur	3,579	-	3,579	3.67	2,297.00	311.57
26	Udupi	32	20	52	0.05	4.00	0.69
27	Uttara Kannada	155	48	203	0.21	50.00	7.35
28	Mysore Seed area	1,352	49	1,401	1.43	340.00	33.98
	Total	**87,257**	**10,390**	**97,647**	**100.00**	**58,697.00**	**7,883.00**

Source: Department of Sericulture (2008) Annual Report 2007-08, Government of Karnataka, Bangalore, India

3.5.1. Pattern of Growth and Instability in Sericulture

In Karnataka stagnation in agriculture production was noticed during mid eighties which led to the adoption of new agricultural policies during 2006. The priority was set to change from food Self Sufficiency to raising income of farming community. The objective was to transform agriculture into a system to meet the non food demands of the domestic market instead of viewing it as a mere food production system. Diversification from traditional agriculture was encouraged. In this respect the contributions from sericulture to the economy of Karnataka is highly significant. Hence the introduction over the years, of a package of technological innovations has brought about significant increase in farm output and changes in cropping patterns in many parts of the world.

The advances made through the technological innovations gave way to spread the area under agricultural crops, with higher growth rates. Stability in area and production with respect to certain crops was not possible, due to variation in prices, climate and all other vagaries of monsoon in India. In spite of this sericulture sector could achieve formidable progress in the expansion of area and production in India, particularly in Karnataka. Sericulture as a domestic sector providing income and employment in Karnataka had the similar experience. However the conservativeness remained intact with sericulture, as the activities in sericulture still remain labour intensive, which mainly employs family labour

Instability is one of the important decision parameters in development dynamics and more so in the context of agricultural production. An analysis of fluctuations in crop output, apart from growth, is of importance for understanding the nature of food security and income stability. Wide fluctuations in crop output not only affect prices and bring about sharp fluctuation in them but also results in wide variations in disposable income of the farmers. The magnitude of fluctuations depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs and many other factors.[1]

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[1] Wasim, M. P., Qazi Mohammad, Tausif Akhtar, Amjad Ali, Shaukat Ali,(2005) "Growth and Instability in the Major Crops Sector of East Asian Countries", *Journal of Contemporary Asia*., Vol. 35, pp. 35-40

High growth in production accompanied by low level of instability for any crop is desired for sustainable development of agriculture.[2] There is a growing concern that rapid technological change in agriculture has increased variability in crop production and thereby created a serious threat to food security of the developing world. Several studies conducted in different countries analyzed the instability in cereal production responding this concern.[3]

Until now, no empirical studies have been able to settle the debate. Some studies show that production instability has increased due to the expansion of modern technology while some other studies showed that production instability has decreased with the expansion of modern technology. Some important studies conducted on instability during 1980s[4&5] concluded that agriculture production had become more unstable after the introduction of new agricultural technology. This was attributed to diverse factors like nature of new technology, increase in variability of rainfall and prices, higher sensitivity of production to variation in rainfall and prices. Hazel[6] observed that production variability in world cereal and Indian food grain production increased due to the adoption of modern technology. Mehra[7] also argues that instability in India's total food grain production has increased due to the widespread adoption of the improved seed-fertilizer intensive technologies since the mid-1960s.

3.5.1.1. Estimation of Compound Growth Rates (CGR)

Growth rates are commonly used as summaries of trends in the time series data. They are the measures of past performance of economic variables. They are not developed to predict; but describe the trends in a variable over time. Price indices, productivity indices and output series are usually discussed in terms of the changing growth rates over a period of time. Policy decisions are often based on such growth

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[2] Rama Rao, I.V.Y. and V.T. Raju (2004) "Instability Analysis of Foodgrain Production Growth in Andhra Pradesh", *Productivity*, Vol. 45, No.1, pp.102 -109

[3] Wasim, M. P., Qazi Mohammad, Tausif Akhtar, Amjad Ali, Shaukat Ali,(2005). *Op. Cit.* pp.35-40.

[4] Dev, Mahendra S. (1987) "Growth and Instability in Foodgrains Production : An Interstate Analysis", *Economic and Political Weekly*, Vol. 22(39), pp. A82-A92

[5] Ray, S.K. (1983) "An Empirical Investigation of the Nature and Causes for Growth and Instability in Indian agriculture: 1950-80" *Indian Journal of Agricultural Economics*, 38(4), pp.459-474.

[6] Hazell, Peter B.R. (1982) Instability in Indian Foodgrains Production, Research Report No. 30, International Food Policy Research Institute, Washington D.C., U.S.A.

[7] Mehra, Shakuntala (1981) Instability in Indian Agriculture in the Context of the NewTechnology, Research Report No. 25, International Food Policy Research Institute, Washington D.C., U.S.A.

rates, which depend on nature and structure of data. Different forms of growth models have been used in Bandyopadhyay[8] Dass[9] Chand and Tiwari[10] Gemtessa[11] Singh *et al*.[12] Jalajakshi[13] Kumar[14] and Rajesh[15] to estimate the growth rates.

In the present study, district wise growth in area under mulberry and production of silk cocoon are analyzed using the exponential growth function. The Compound Growth Rates (CGR) for area, production and yield of different crops grown in each selected districts were estimated for the period from 1990-91 to 2006 - 07. These growth rates were estimated by fitting an exponential function of the following form;

$$Y = Ab^t$$

Where;

Y = Area under mulberry / Production of silk cocoon

t = Time variable in years (1,2,3, - - - - n)

A= Constant

Logarithmic transformation of the above function is;

$$\text{Log } Y = \log A + t \log b$$

Where,

Log b = log (1 + r)

r = [antilog (log b) – 1]

Compound Growth Rate (CGR %) = [antilog (log b) – 1] x 100

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8 Bandyopadhyay, S. (1982) "Economic Analysis of Some Critical Problems of Tea Exports of India", *Indian Journal of Agricultural Economics,* Vol.37(3), pp.306-312.

9 Dass, S.R. (1985) "Growth Rates in Coffee Exports", *Agricultural Situation in India,* Vol.38(2), pp.115-118.

10 Chand, R. and S.C. Tiwari (1991) "Growth and Instability of Indian Exports and Imports of Agricultural Commodities", *Indian Journal of Agricultural Economics,* Vol.46(2), pp.159-165.

11 Gemtessa, K. (1991) An Analysis of the Structure of Ethiopian Coffee Exports, An Unpublished M.Sc (Agri) Thesis submitted at the University of Agricultural Sciences, Bangalore, India, pp.48-52.

12 Singh, R.P., Lal Roshan and D.R.Singh (1993) "Cotton Development and Exports Potential in India: An Analysis", *Agricultural Situation in India,* Vol.63(4), pp.251-256.

13 Jalajakshi, C.K. (1994) Exports of Shrimps from India: An Economic Analysis, An Unpublished M.Sc (Agri) Thesis submitted at the University of Agricultural Sciences, Bangalore, India, pp.44-47.

14 Kumar, Ranjit, (2000) "Export Performance of Agricultural Commodities in India", *Yojana,* Vol. 44(7), pp.41-43.

15 Rajesh, S.R. (2002) Export Performance of Major Spices in India, An Unpublished Ph.D. Thesis submitted at Tamil Nadu Agricultural University, Coimbatore, India, pp.54-55.

The Standard Error of growth rate was calculated by:

$$SE(\log b) = \sqrt{\Sigma(Y - \bar{Y})^2 - [(\log b)^2 - \Sigma(t - \bar{t})^2 / (N-2)\Sigma(t - \bar{t})^2]}$$

Student 't' test was used to test the significance of growth rates.

$$t = \frac{Logb}{SE(\log b)}$$

The district wise performance of sericulture in Karnataka with respect to area under mulberry and production of silk cocoon is evaluated by analyzing the growth during the period from 1991-92 to 2006-07. The exponential form of the function is employed to estimate the growth rates for area and production. The adequacy of the model for the respective type is indicated by the coefficients of multiple determination. The results are furnished in Table-3.10.

Table 3.10: Annual Compound Growth Rates (ACGR) of Area under Mulberry in different Districts of Karnataka State (Period 1991 - 92 to 2006 -07)

. District	Compound Growth Rate (%)	
	Mulberry Area	Silk Cocoon Production
Bangalore (Urban)	-2.24**	-2.01**
Bangalore (Rural)	-1.29^{NS}	-0.93^{NS}
Chitradurga	-2.31*	-0.67^{NS}
Kolar	0.31^{NS}	-0.64^{NS}
Shimoga	-11.95**	-4.73**
Tumkur	-10.34**	-5.93**
Chikmagalur	-16.39**	-15.57**
Dakshina Kannada	-16.13**	-20.60**
Hassan	-13.55**	-12.13**
Kodagu	-15.13**	-19.17**
Mandya	-2.99*	-1.34^{NS}
Mysore	-12.15**	-12.49**
Belgaum	-7.08**	-2.88^{NS}
Bijapur	-0.33^{NS}	-4.94**
Dharwad	-5.64**	5.22**
Uttara Kannada	-7.69**	-6.76**
Bellary	-0.10^{NS}	6.43**
Bidar	-1.37^{NS}	5.49*
Gulbarga	-10.41**	-6.19**
Raichur	-2.09^{NS}	-4.06**
Karnataka state	-5.13**	-2.62**

* - Significant at 5 % level; ** - Significant at 1 % level; NS – Non Significant

Data source: Department of Sericulture, Government of Karnataka, Bangalore, India, Compiled from Annual Reports for different years, ,

A perusal of the Table - 3.10 on the growth rates of area under mulberry and production of silk cocoon between the period 1991-92 to 2006-07 revealed that the trend in area and production were negative and significant. The Compound Growth Rate (CGR) for area and cocoon production was found to be -5.13 per cent and -2.62 per cent, respectively for the state of Karnataka. Besides the fact that the sericulture is at its prime during the National Sericulture Project Period and later, there was a significant fall in the area and production. The same trend was noticed in the case of individual districts of Karnataka. The districts in the traditional sericultural belt like, Bangalore (Rural), Bangalore (Urban), Kolar, Tumkur, Mandya and Mysore registered a negative growth during the same period. The fall in the area under mulberry and production of silk cocoon, was however compensated by the increase in the productivity level, which was mainly contributed through the R & D efforts of Central Silk Board. In this respect, sericulture attained stability in area and production, due to the improvement in the productivity levels. The assessment of stability in sericulture was attempted through working out the Instability Indices.

3.5.1.2. Estimation of Instability Index

The property of not being stable; thus, moving around over time, and/or uncertain in its movement over time, which is termed as instability, in production has been considered to be an important criterion in deciding the crop performance. While high growth coupled with low instability is most preferred, low growth rate and high instability with respect to crop performance appears not too sound for a growing economy. In the present study an attempt was made to study the instability in sericulture in Karnataka in terms of the change in area and production by employing the Instability Index.

The instability index as worked out by Ramesh Chand and Raju[16] for variability estimation of crops is used in the current study and is as given below:

Instability index = Standard deviation of natural logarithm (Y_{t+1}/ Y_t)

where, Y_t is the area / production in the current year and,

Y_{t+1} is for the next year.

[16] Ramesh Chand and S.S. Raju (2008) "Instability in Indian Agriculture During Different Phases of Technology and Policy", *Discussion Paper*: NPP 01/2008 , National Centre for Agricultural Economics and Policy Research (Indian Council of Agricultural Research) Library Avenue, Pusa, New Delhi 110012, India and also http://www.ncap.res.in/upload_files/others/oth_12.pdf.

This index is unit free and very robust and it measures deviations from the underlying trend (log linear in this case). When there are no deviations from trend, the ratio of Y_{t+1}/Y_t is constant and thus standard deviation is zero. As the series fluctuates more, the ratio of Y_{t+1} and Y_t also fluctuates more, and standard deviation increases. Slightly different variant of this index has been used in the literature before to examine instability and impact of drought on it.[17&18] The above instability measure also indicates risk involved in agricultural production.

3.5.1.2.1. **Assessment of Instability in Sericulture in Karnataka**

Estimates of instability in area under mulberry and production of silk cocoon during the period between, 1991-92 to 2005-06 was estimated and are presented in Table-3.11 and Table- 3.12 respectively. The Table contains two sets of results, one covering the period of National Sericulture Project (NSP) between1991-92 to 1996-97 and the second covering the period after the National Sericulture Project from 1997-98 to 2005-06. It was noticed that the instability in area under mulberry was quite low and nearer to zero both during and after the NSP periods. . The instability index for the period 1991-92 to 1996 -97 was found to be 0.16 while for the period 1997-98 to 2005-06, the same was 0.13. Among the districts also same trend was noticed, wherein the instability during both the periods remained at very lower rate of standard deviation, nearing zero. This in turn suggests that, adoption of new technologies in sericulture marked the decline in instability. The success of National Sericulture Project brought down the rate of instability in mulberry area. When improved technology spread to larger areas the variability in productivity declined further. These results are in complete disagreement with the findings of earlier studies by Mehra, et al.,[19] Hazell[20] and Dev.[21] The reason is that all these studies based their inference on 10 to 15 years of adoption of green revolution technology. With the passage of time adoption of technology spread to much larger area and a large number of improvements in various aspects of technology took place.

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17 Ray, S.K. (1983) *Op. Cit.* pp.459-474.

18 Rao, C.H.H., S.K. Ray and K. Subbarao (1988) Unstable Agriculture and Droughts- Implications for Policy, New Delhi: Vikas Publishing House Pvt. Ltd.

19 Mehra, Shakuntala (1981) *Op. Cit.*

20 Hazell, Peter B.R. (1982). *Op. Cit.*

21 Dev, Mahendra S. (1987) *Op. Cit.* pp. A82-A92

Table 3.11.: Instability Indices of Mulberry Acreage in Karnataka State during and after the National Sericulture Project Period

District	Period		
	1991-92 to 1996-97	1997-98 to 2005-06	Pooled
Bangalore (U)	0.10	0.10	0.10
Bangalore (R)	0.08	0.21	0.18
Chitradurga	0.20	0.14	0.19
Kolar	0.06	0.17	0.14
Shimoga	0.52	0.33	0.40
Tumkur	0.14	0.29	0.24
Chikmagalur	0.94	0.32	0.61
Dakshina Kannada	0.50	0.33	0.39
Hassan	0.29	0.32	0.31
Kodagu	0.85	0.31	0.56
Mandya	0.38	0.08	0.23
Mysore	0.31	0.18	0.23
Belgaum	0.29	0.23	0.26
Bijapur	0.32	2.43	1.85
Dharwad	0.22	0.37	0.31
Uttara Kannada	0.32	0.19	0.24
Bellary	0.42	0.17	0.30
Bidar	0.45	0.47	0.45
Gulbarga	0.50	0.38	0.42
Raichur	0.17	0.20	0.21
Total	0.16	0.13	0.14

Data source: Department of Sericulture, Government of Karnataka, Bangalore, India, Compiled from Annual Reports for different years,

The variability in production was too low during the two different periods considered in the study (Table 3.12). This was noticed through the estimates of instability in the production of silk cocoon during the period from 1991-92 to 1996-97 (during NSP) and 1997-98 to 2005-06 (after NSP). It was noticed that the instability in the production of silk cocoon too was quite low and nearer to zero during and after the NSP periods. Among the districts also same trend was noticed, wherein the instability during both the periods remained at very lower rate of standard deviation, nearing zero. The instability index for the period 1991-92 to 1996 -97 was found to be

0.14 while for the period 1997-98 to 2005-06, the same was 0.18. This in turn suggests that, adoption of new technologies in sericulture marked the decline in instability.

Table 3.12.: Instability Indices of Silk Cocoon Production in Karnataka State during and after the National Sericulture Project Period

District	Period		
	1991-92 to 1996-97	1997-98 to 2005-06	Pooled
Bangalore (U)	0.06	0.11	0.10
Bangalore (R)	0.20	0.18	0.19
Chitradurga	0.12	0.17	0.16
Kolar	0.15	0.15	0.15
Shimoga	0.22	0.14	0.22
Tumkur	0.18	0.31	0.28
Chikmagalur	0.34	0.42	0.39
Dakshina Kannada	0.16	0.54	0.42
Hassan	0.14	0.36	0.32
Kodagu	0.24	0.30	0.30
Mandya	0.12	0.18	0.16
Mysore	0.17	0.39	0.35
Belgaum	0.32	0.38	0.35
Bijapur	0.02	0.35	0.27
Dharwad	0.31	0.24	0.30
Uttara Kannada	0.50	0.16	0.32
Bellary	0.12	0.19	0.18
Bidar	0.18	0.22	0.28
Gulbarga	0.18	0.21	0.19
Raichur	0.18	0.32	0.27
Total	0.14	0.18	0.17

Data source: Department of Sericulture, Government of Karnataka, Bangalore, India, Compiled from Annual Reports for different years,

Hence, the instability analysis of area and production revealed an insignificant rate of instability in sericulture, which indicates that the sector remained stabilized over the years due to the absorption of technologies in the field. Technological innovations in the field of sericulture have extensively guided the sector far well.

3.5.2. Markovian Analysis for the Estimation of Probability of Change in acreage under Different Crops

The Markovian analysis is generally employed to find out the structural changes in any system whose progress through time can be measured in terms of single outcome variable. There is a growing awareness of the usefulness of this technique for analysis and forecasting in many areas including exports, particularly when the process is constant but has a gradual change. The approach was tested by a number of empirical studies such as Brasili *et al.,*[22] Redding,[23] Hinloopen and Marrewijk[24] and Fertö and Hubbard.[25] The methodology was adopted to predict the changes in mulberry area, by comparing with other competing crops over the years. According to the model, the estimated transitional probability matrix could explain the nature of change by indicating the relative competitive strength of different crops.

3.5.2.1. Changes in Acreage under Different Crops

The change in the acreage of major crops was examined by estimating the transitional probability using Markov-chain model. This econometric analysis not only helps to know the trend in sustaining existing area, but also the shift in shares from one crop to another over a period of time. The model is a stochastic process which describes the finite number of possible outcomes S_i (i=1,2,----,r) which is a discrete random variable X_t (t=1,2,---,T) and which assumes that (a) the probability of an outcome on the t-th trial depends only on outcome of the preceding trial, and (b) this probability is constant for all time periods.[26] (Lee *et al.,*1970)27 Central to Markov chain analysis is the estimation of the transitional probability matrix P. The element P_{ij} of this matrix indicates the probability that crop area will switch from crop 'i' to crop 'j' with the passage of time. The diagonal element P_{ij} measures the probability that the area share of the crop will be retained.[27]

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22 Brasili, A., P. Epifani and R. Helg (2000) "On the Dynamics of Trade Patterns", *De Economist*, Vol.148(2), pp.233-257.

23 Redding, S. (2002) "Specialization Dynamics", *Journal of International Economics*, Vol.58(2), pp.299–334.

24 Hinloopen, J. and Charles van Marrewijk (2004) "Dynamics of Chinese Comparative Advantage", *Discussion Paper* TI 2004–034/2, Tinbergen Institute, Rotterdam, pp.10-14.

25 Fertő, I. and L.J. Hubbard (2003) "Revealed Comparative Advantage and Competitiveness in Hungarian Agri-Food Sectors" *World Economy*, Vol.26(2), pp. 247-259.

26 Lee, T.C., G.G. Judge and A. Zellener (1970) Estimating the Parameters of the Probability Model from Aggregate Time Series Data, North Holland Publishing Company, Amsterdam.

27 Atkin, M. and D. Blandford (1982) "Structural Changes in Imports Shares for Apple in the UK", *European Journal of Agricultural Economics*, Vol. 9(1), pp.313-326.

In the context of the current application, the average area under a particular crop was considered to be a random variable which depends only on its past area under the same crop and which can be denoted algebraically as,

$$A_{jt} = \sum_{i=1}^{r} A_{it-1} P_{ij} + e_{jt} \quad \text{..... (3.1)}$$

where, A_{jt} = Acreage under j^{th} crop during the year 't'

A_{it-1} = Acreage under i^{th} crop during the year t-1

P_{ij} = The probability that acreage will shift from i^{th} crop to j^{th} crop

e_{jt} = The error term which is statistically independent of A_{it-1}, and

r = Number of crops

The transitional probabilities P_{ij}, which can be arranged in a (c x r) matrix, have the following properties

$$O \leq P_{ij} \leq 1 \quad \text{..... (3.2)}$$

$$\sum_{i=1}^{r} P_{ij} = 1 \text{ for all I} \quad \text{..... (3.3)}$$

Thus, the expected area shares of each crop during period 't' were obtained by multiplying the acreage in the previous period (t-1) with the transition probability matrix.

The transition probability matrix is estimated in the linear programming (LP) framework by a method referred to as Minimisation of Mean Absolute Deviation (MAD)[28] the LP formulation is stated as

$$\text{Min } OP^* + Ie \quad \text{..... (3.4)}$$

$$\text{Subject to, } XP^* + V = Y$$

$$GP^* = 1$$

$$P^* \geq 0$$

Where, P* is a vector of the probabilities P_{ij} are arranged

O is a vector of zeros

I is an appropriately dimensional vector of crops

e is the vector of absolute errors (|U|)

Y is the vector of acreage under each crop

X is a block diagonal matrix of lagged values of Y, and

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P*, to unity.

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[28] Fisher, W.D. (1961) "A Note on Curve Fitting with Minimum Deviations by Linear Programming", *Journal of American Statistical Association*, Vol.50, p.361.

3.5.2.2. Empirical Results

3.5.2.2.1. Analysis of Structural Changes in Area under Different Crops

The dynamics in the direction of changing pattern in the area under different crops in Karnataka over a period of 1991-92 to 2006-07 are analyzed by employing the Markov Chain model. The trend in sustaining the existing area and the gains and losses to different competing crops were obtained from the transition probability matrices. Similar analysis is carried out separately for different selected districts to understand the structural changes in the area under different crops.

The transitional probability matrix presented in Table-3.13, gives a broad indication of the changes in the direction of area under different crops during the period of National Sericulture Project and later (1990-91 to 2005-06). The diagonal elements in the transitional probabilities matrix indicate the probability of the retention in the acreage under the crop. The other elements in the rows provide the information on loss in share of the particular crop on account of diversion of acreage to other competing crops. Similarly, the column elements depict the probability of retention of acreage and the gains in the acreage from other competing crops.

3.5.2.2.2. Area Share Pattern of Different Crops during 1990-91 to 2005 - 06

It is evident from the transition probability matrix depicted in Table-3.13, that the crops such as maize, oil seeds, mulberry and other crops were having stable acreage during the period. The probability that the crops such as maize, oil seeds retained their share from one year to another year was 55.27 per cent and 60.23 per cent respectively during the period from 1990 - 91 and 2005-06. Accordingly, the probability that the crop mulberry retained its share from one year to another year was 81.42 per cent during the same period. Hence it can be inferred that, the area under mulberry remained stable without much variation during the period. The thrust on technological change during the implementation of National Sericulture Project (NSP) yielded much to the benefits of improvement of sericulture in the state of Karnataka.

Table 3.13: Transitional Probability Matrix of Area under Different Crops in Karnataka State (1990-91 to 2005 -06)

	Paddy (HYV)	Jowar	Maize	Pulses	Oil seeds	Mulberry	Others
Paddy (HYV)	**0.0000**	0.0000	0.1514	0.3166	0.0000	0.0000	0.5321
Jowar	0.0000	**0.1399**	0.0000	0.0000	0.2677	0.0000	0.5925
Maize	0.3663	0.0000	**0.5527**	0.0810	0.0000	0.0000	0.0000
Pulses	0.3214	0.0000	0.0739	**0.3619**	0.0022	0.0000	0.2407
Oil seeds	0.0649	0.3098	0.0000	0.0135	**0.6023**	0.0096	0.0000
Mulberry	0.0000	0.1858	0.0000	0.0000	0.0000	**0.8142**	0.0000
Others	0.0034	0.1979	0.0000	0.1850	0.0928	0.0000	**0.5209**

Data source: Department of Sericulture, Government of Karnataka, Bangalore, India, Estimated from the data compiled from Annual Reports for different years

The crop maize gained 15.14 per cent share from the area under High Yielding Varieties of paddy and 7.39 per cent from pulses, while it also lost up to 36.63 per cent to High Yielding Varieties of paddy and 8.10 per cent to pulses (Table - 3.13). Similarly the area share of oil seeds gained through the crops such as jowar (26.77 per cent) and other crops (9.28 per cent), while the loss in area share was to the extent of 30.98 per cent through jowar and 6.49 per cent through High Yielding Varieties (HYV)) of paddy. The other crops together gained from 59.25 per cent from jowar, 53.21 per cent from High Yielding Varieties of Paddy and 24.07 per cent from all pulses, while they together lost the area share to crops such as jowar, pulses and oil seeds up to 19.79 per cent, 18.50 per cent and 9.28 per cent respectively.

3.5.2.2.3. Projections of Crop Acreage in Karnataka

The projections of crop acreage in the state of Karnataka are computed up to 2011-12 using the transitional probability matrix. The actual and projected area under different crops is presented in Table-3.14. The predicted values in the table indicate that there would be an increase in the area of paddy (HYV), maize, pulses and mulberry, while there would be a declining trend in the area of jowar, oil seeds and other crops. The detailed representation of projected and actual area under mulberry through the graph (Graph -3.E) reveal that, by the year 2011-12, the area could touch an extent of 1.16 lakh hectares against the existing 0.98 lakh hectares in Karnataka.

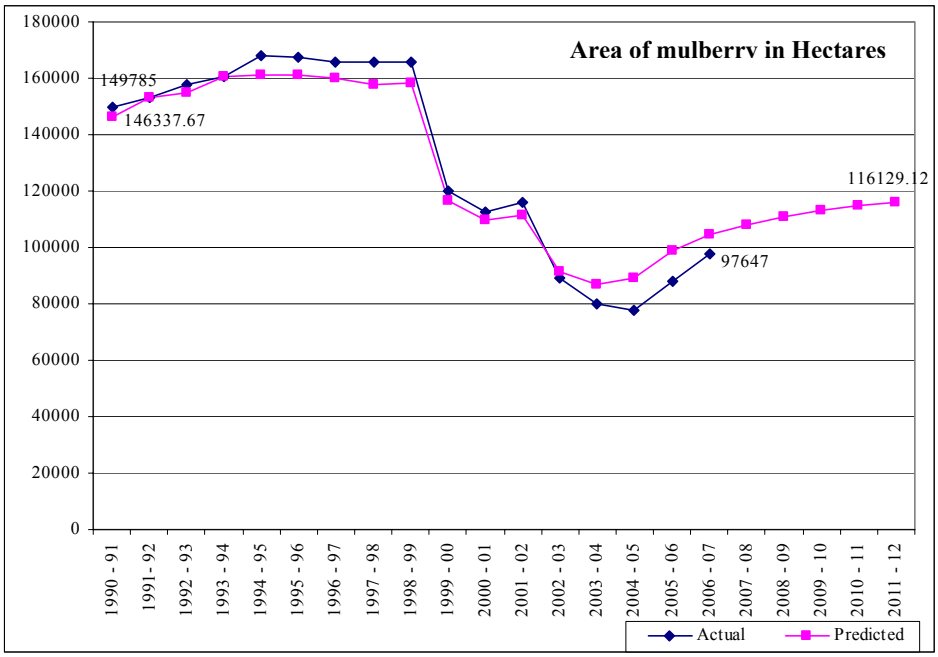
Table 3.14.: Predicted Acreage under Different Agricultural Crops

(Value in lakh hectares)

Year	Agricultural Crops						
	Paddy HYV	Jowar	Maize	Pulses	Oil seeds	Mulberry	Others
1990 - 91	7.26	20.81	2.80	17.88	25.67	1.46	46.40
1991- 92	8.86	21.69	3.27	16.59	27.91	1.53	42.43
1992 - 93	8.43	20.50	4.14	16.94	26.84	1.55	43.88
1993 - 94	8.23	21.43	4.26	17.04	28.44	1.61	43.31
1994 - 95	8.37	19.85	4.32	17.11	25.30	1.61	43.57
1995 - 96	8.07	20.27	4.32	17.10	25.35	1.61	43.41
1996 - 97	9.18	19.64	5.42	18.49	25.05	1.60	44.16
1997 - 98	9.14	18.52	5.66	17.29	23.25	1.58	41.52
1998 - 99	9.46	19.10	5.93	19.07	23.72	1.58	44.26
1999 - 00	9.82	17.61	6.58	19.35	21.34	1.17	45.10
2000 - 01	10.41	17.65	6.73	19.88	20.48	1.10	44.73
2001 - 02	9.50	17.59	6.40	20.18	19.74	1.11	46.45
2002 - 03	10.46	18.32	6.51	20.00	21.33	0.92	45.30
2003 - 04	9.90	17.68	6.11	17.93	22.05	0.87	40.58
2004 - 05	11.72	16.60	7.96	17.70	23.33	0.89	36.29
2005 - 06	11.79	19.29	8.62	20.06	25.17	0.99	42.15
2006 - 07	11.38	19.02	8.03	19.83	24.28	1.04	44.49
2007 - 08	11.04	19.18	7.63	19.99	23.88	1.08	45.27
2008 - 09	10.92	19.25	7.36	20.04	23.76	1.11	45.63
2009 - 10	10.83	19.29	7.20	20.07	23.74	1.13	45.81
2010 - 11	10.78	19.33	7.10	20.07	23.75	1.15	45.88
2011 - 12	10.75	19.36	7.04	20.06	23.78	1.16	45.92

Data source: Department of Sericulture, Government of Karnataka, Bangalore, India, estimated from the data compiled from Annual Reports for different years and Tables - 3.3, 3.4., 3.5., & 3.6.

Graph 3.E.: Actual and Predicted Area under Mulberry in Karnataka State from 1990-91 to 2005–06 and Projection up to 2011 – 12.



Source of data: Calculated based on the Transitional probability matrix in Table 3.13.