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Performance of Irrigation in Tamil Nadu: A Macro Perspective

K Sivasubramaniyan*

Abstract

In India, the growth of agriculture in terms of area, production and yield of major crops such as rice and wheat from the beginning of the 20th century until Independence was stagnant. Subsequently, it gained momentum after the Indian government undertook planned economic development. The major factors contributing to an appreciable growth in agriculture in India during the post-Independence period, especially in states like Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Punjab, Haryana, West Bengal and Uttar Pradesh, include the expansion of irrigated area and increase in crop yields. In an attempt to understand the growth of agriculture, this paper makes an analysis of the growth trends of irrigated agriculture in Tamil Nadu and across India during the period 1950–51 to 2010–11. Also, a similar analysis has been done taking into account of variables such as area, production, yield and extent of irrigated area under paddy in Tamil Nadu and across India and wheat across India. Further, a comparative trend analysis of rice and wheat yields in India and a few leading producing countries is made to highlight the low level of productivity in India and to suggest policy measures for sustaining the growth of these crops.

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1. Introduction

Indian agriculture has come a long way since Independence — from suffering acute food shortage that led to food rationing and a dependence on imported food under the U.S. Public Law (PL480) program¹ to generating capacity after the Green Revolution. The foodgrain output stood at 265 million tonnes (mt) in 2013–14 (indiaagristat.com) for an Indian population of 1.28 billion during the same time. Yet, ensuring food security and sustainability remains a continuing challenge. Among the three sectors of the economy — agriculture, industry and services — the primary sector is the key to several states as well as India’s economy, because it provides employment for a large chunk of the population even now. In India, in 1970 agriculture provided employment to about 75 per cent of the workforce, which declined to 55 per cent in 2006 and further to 49 per cent in 2013. The contribution of agriculture to gross domestic product (GDP) stood at 48 per cent in 1970, reducing to 18 per cent in 2006 and further down to 14 per cent in 2013² (Sivasubramaniyan 2014: 117). Likewise in Tamil Nadu, three-fifths of employment (91 lakh out of 151 lakh workers) was generated by agriculture in 1970, which declined to 50.3 per cent (146 lakh out of 290 lakh workers) and further to 42 per cent in 2011 (139 lakh out of 328 lakh workers). The contribution of agriculture to gross state domestic product (GSDP) has steadily declined from 35 per cent in 1970 to 26 per cent in 1980, to 17 per cent in 2000 and further down to 6 per cent in 2013 (Tamil Nadu and Economic Appraisal, Various issues).

Although both employment and GDP from agriculture has been declining over time, its importance as a backbone of the country’s economy has not diminished. In 1951, when India’s first five-year plan was initiated, the country had a population of 361.1 million and foodgrain production was 50.8 mt. In 2011, the population had grown to 1,210.2 million and foodgrain production stood at 257.4 mt. A simple calculation shows that the population grew 3.4 times and foodgrain production approximately 5.1 times between 1951 and 2011. During the same period in Tamil Nadu, the population had grown from 30.1 million to 72.1 million, whereas the foodgrain

production increased from 4.6 mt to 10.2 mt, indicating a 2.4-fold increase in population and a 2.2-fold rise in foodgrain production. It is evident that the population growth and the rate of increase in foodgrain production in Tamil Nadu are much lower compared to the all-India levels.

Importantly, the growth of foodgrain production depends upon the extent of area brought under irrigation. Among others, the expansion and improvement of irrigation facilities occupies a prominent place in the programmes for agricultural development both at the state (Tamil Nadu) and national level (India). Between the reference period 1951 and 2012, the Central and state governments had invested nearly Rs. 4,94,300 crore on irrigation works, accounting for about one-sixth of the total public investment (Table 1). In normal terms, the financial outlay has risen from an average of Rs. 91 crore per annum during the First Plan (1951–56) to Rs. 44,145 crore per annum in the Eleventh Plan (2007–12). Steep rise in prices and construction costs have contributed considerably to the enhanced outlay.

The growth in the volume of investment has resulted in major changes in irrigation development programmes, especially in canal-based surface irrigation system. The marked shift of emphasis in the investment allocation favouring minor irrigation works during the Eleventh Plan led to trebling of their share (Rs. 44,671 crore) in the total irrigation outlay compared to the Tenth Plan. Within minor irrigation works, groundwater development received greater attention for faster expansion, aided by private financial assistance, mostly in the form of loans through financial institutions to farmers, compared to direct investment by state agencies. Another important focus area was more efficient use of water, which was reflected in the emphasis on farm strategies such as conjunctive use of surface and groundwater, command area development and modernisation of older irrigation systems. Given the important role of irrigation in agricultural development and a large amount of public and private spending, the focus of this study is on the performance of agriculture in Tamil Nadu as well as across the country, considering irrigation as a major influencing factor towards such performance status during the reference period.

Table 1: Magnitude and composition of investment through Plan periods in irrigation and flood control sectors in India, 1951-2012
(Rs. crore)

Plan period	Major and medium irrigation	Minor irrigation			Command area development	Flood control	Total (2+5+6+7)	Total public sector outlay	Total plan outlay for all sectors	per cent of irri. outlay to total plan
		Plan outlay	Institutional credit	Total (3+4)						
1	2	3	4	5	6	7	8	9=(8-4)	10	11=10/9
I 1951-1956	376	66	3	69	NA	13	455	455	1960	23.2
II 1956-1961	380	142	19	161	NA	48	589	570	4672	12.2
III 1961-1966	576	328	115	443	NA	82	1101	986	8577	11.5
Annual 1966-1969	430	326	235	561	NA	42	1033	798	6625	12.0
IV 1969-1974	1242	512	661	1173	NA	162	2577	1916	15779	12.1
V 1974-1978	2516	631	779	1410	NA	299	4225	3446	28653	12.0
Annual 1978-1980	2079	503	480	983	363	330	3755	3275	22950	14.3
VI 1980-1985	7369	1979	1438	3417	743	787	12315	10877	109292	10.0

VII	1985-1990	11107	3118	3061	6179	1448	942	19676	16615	218730	7.6
Annual	1990-1992	5459	1680	1350	3030	619	461	9569	8219	123120	6.7
VIII	1992-1997	21072	6408	5331	11739	2146	1692	36649	31318	483060	6.5
IX	1997-2002	49289	6819	5422	12241	1519	3038	63681	61022	941041	6.5
X	2002-2007	83647	7502	6835	14337	2122	4344	103315	96480	1618460	6.0
XI	2007-2012	165350	33598	11073	44671	1677	20100	231798	220725	3644718	6.1
Total	1951-2012	350892	63612	36802	100414	10637	32340	494283	457481	7227637	6.3
Per cent to total	1951-2012	71	12.9	7.4	20.3	2.2	6.5	100	92.6		

Note: NA = Not Available.

Source: GOI, Planning Commission, X, XI and XII Five Year Plans, 2002-07; 2007-12 and 2012-17, Sectoral Policies and Programme, Vol. II; Vol III and Vol I respectively, New Delhi, p. 894; 50, 52 and 181, 184 respectively.
RBI, Handbook of Statistics on the Indian Economy, 2012-13, Institutional Credit, pp. 121-2.

2. Focus of the Study

Although agricultural performance depends upon many factors, this paper mainly dwells on two prime aspects of agriculture development, namely (i) the output resulting from continuous flow of investment in terms of expansion in irrigation facilities, since the beginning of the Plan period; and (ii) the outcome of expanded irrigation in terms of productivity of major crops and its growth. Since these two factors directly affect the growth of output in agriculture in both Tamil Nadu and across India, it is appropriate to focus on these issues related to irrigation in this paper.

3. Expansion of Irrigation Facilities in Tamil Nadu and Across India

For the growth and development of any sector such as agriculture, industry and services, considerable investment is required, which may be made by the government or private institutions. Accordingly, as stated earlier, development of irrigation attracted a huge investment. Consequently, the expansion and growth of agriculture was made possible through the development of multiple sources of irrigation in various states in India.

In this context, the net irrigated area (NIA) that expanded as a result of development of different sources of irrigation in Tamil Nadu and across India are presented in Table 2. It is revealed that in absolute terms, canal irrigation in Tamil Nadu has been found to be stagnant over the past five decades, but in relative terms, it has been gradually and steadily declining. The decline is very steep, both in absolute and relative terms, in the last decade. In Tamil Nadu, since there is no clear data available on the registered command area served by canals, one can assume the canal command area at about a million hectares. So, the maximum area commanded by canals was highest only in the 1970s (8.9 lakh hectares) and the same level or higher coverage has never been achieved even once after the 1970s in Tamil Nadu. The prime reason for the decline in canal area has been the expansion of canal-irrigated area in the upper riparian states of Karnataka (Cauvery)

and Andhra Pradesh (Palar) after the 1970s and non-adherence of the 999-year Mullaperiyar river water sharing agreement between Kerala and Tamil Nadu by the Kerala government (Sivasubramaniyan 2010: 28). Unless these states adhere to the orders of tribunals on river water sharing, it is very difficult to sustain canal irrigation in Tamil Nadu. The all-India data on canal irrigation shows that while the absolute area has gradually increased from 92 lakh hectares to 173 lakh hectares up to the late 1990s, the percentage share of canal irrigation has been marginally decreasing and this decrease has been comparatively higher since the 1980s than in the previous decades.

As per the 1977 data available from the office of the Chief Engineer, PWD, the registered ayacut of tanks in Tamil Nadu was 10,11,892 hectares (Vaidyanathan and Sivasubramaniyan 2001). Both in absolute and relative terms, NIA by tanks in Tamil Nadu and across India had increased up to the 1960s; subsequently it has been declining steeply. However, in Tamil Nadu, the percentage share to all-India level had remained more or less constant compared to the 1950s and increased only in the last decade. This trend indicates that in other states also, the contribution of tanks has been much less compared to Tamil Nadu. One of the major causes for the declining trend of tank irrigation is the effect or initiation of the Green Revolution. Since the mid-1960s, more importance was given to quality irrigation (assured, adequate and timely supplies of water to crops) to increase the yield of high-yielding varieties. This has been possible mainly through well irrigation as a private source of irrigation (Vaidyanathan and Janakarajan 1989; Janakarajan 1993; Sivasubramaniyan 1995, 1997, 2000, 2006, 2011). Once the wells were developed, the importance given to tank irrigation, as a community management source, declined sharply and steadily, and governments did not take any steps to reverse the situation even then. To restore tank irrigation to its previous position, the only possibility is to bring all the 41,000 tanks in Tamil Nadu as well as those in all other states to their original storage capacity and to decentralise their management mainly through user participation by strengthening water users' associations (IAMWARM, Final Impact Evaluation Project Report – June 2014). This requires a huge investment but it is a worthy spend. In the World Bank-funded

Table 2: Trends in net irrigated area (NIA) by sources from 1950–51 to 2010–11

Source	1950–51 to 1959–60		1960–61 to 1969–70		1970–71 to 1979–80		1950–51 to 1979–80	
	Area	Per cent to NIA	Area	Per cent to NIA	Area	Per cent to NIA	Area	Per cent to NIA
Tamil Nadu								
Canals	8 (8.7)	37.6	8.8 (7.9)	35.6	8.9 (6.5)	33.2	8.6 (7.5)	35.3
Tanks	7.8 (18.7)	36.8	9.1 (20.5)	36.8	8.5 (22.3)	31.5	8.5 (20.5)	34.8
Wells+ tube wells	5 (7.5)	23.5	6.5 (7.4)	26	9.2 (6.4)	34.1	6.9 (6.9)	28.3
Other sources *	0.5 (2)	2.2	0.4 (1.6)	1.6	0.4 (1.5)	1.3	0.4 (1.7)	1.6
Total NIA	21.2 (9.5)	100	24.8 (9.3)	100	27 (7.8)	100	24.3 (8.7)	100
All India								
Canals	91.9	41.2	111.9	41.9	137.7	40.1	113.8	40.9
Tanks	41.5	18.6	44.5	16.6	38.1	11.1	41.4	14.9
Wells+ tube wells	66.3	29.8	87.1	32.6	144.1	41.9	99.2	35.7
Other sources *	23.2	10.4	23.9	8.9	23.8	6.9	23.6	8.5
Total NIA	222.9	100	267.3	100	343.6	100	277.9	100

Note: Figures in brackets indicate source-wise percentage compared to India. Date from 2000–01 to 2010–11 relate to 11-year average. * Indicates anaicuts, bhandaras, springs, kuttai, thangal, small diversion networks and so on.

Source: Indian Agricultural Statistics, 1985-86--1989-90, Vol. I, Ministry of Agriculture, Government of India, New Delhi. CMIE, Agriculture, Various Issues. Indian Agriculture

(Area in lakh hectares)

1980-81 to 1989-90		1990-91 to 1999-2000		2000-01 to 2010-11		1980-81 to 2010-11	
Area	Per cent to NIA	Area	Per cent to NIA	Area	Per cent to NIA	Area	Per cent to NIA
Tamil Nadu							
8.2 (5.0)	33	8.3 (4.8)	29.3	7.3 (4.7)	26.8	7.9 (4.9)	29.6
6.2 (20.6)	24.7	6.3 (20.4)	22.4	5.1 (25.6)	18.6	5.9 (21.8)	21.8
10.4 (5.0)	41.6	13.5 (4.6)	47.7	14.8 (4.2)	54.2	12.9 (4.5)	48
0.2 (0.7)	0.8	0.2 (0.5)	0.6	0.1 (0.2)	0.4	0.2 (0.4)	0.6
25.0 (5.9)	100	28.4 (5.4)	100	27.3 (4.7)	100	26.9 (5.2)	100
All India							
163.1	38.3	173.4	32.7	154.6	26.7	163.7	32
29.9	7	31.1	5.9	19.7	3.4	26.9	5.3
207.8	48.7	292.5	55.2	353.9	61	284.7	55.6
25.4	6	33.1	6.2	51.9	8.9	36.8	7.2
426.3	100	530.1	100	580.1	100	512.2	100

in Brief 27th Edn. January 2000. Government of Tamil Nadu, Tamil Nadu-An Economic Appraisal, Various Issues, Evaluation and Applied Research Department, Chennai. Government of Tamil Nadu, Season and Crop Reports, Various Issues. Chennai. www.indiaagristat.com

Irrigated Agriculture Modernisation and Water Bodies Restoration and Management (IAMWARM) project in Tamil Nadu, Rs. 2,500 crores was spent on restoring about 5,000 major irrigation tanks out of 11,000 during 2007 to 2015 and was the latest development in this regard (The World Bank Project Appraisal Document, 21 December 2006). The second phase of the World Bank-funded project is in the pipeline and it will be taken up soon to modernise the remaining major tanks in Tamil Nadu.

In the case of wells and tube wells, a very steep rise in NIA is observed in both Tamil Nadu and across India over the past 60 years. This increase has been considered remarkable at the all-India level in both absolute and relative terms while in Tamil Nadu, it has nearly trebled. The contribution of 'other sources' to NIA in Tamil Nadu was negligible even in the 1950s and has been showing a steady decline in both absolute and relative terms. But at the all-India level, this source has been contributing a considerable proportion compared to tanks. This has to be viewed in terms of an increase in absolute area from 23.2 lakh hectares to 51.9 lakh hectares over a period of 60 years. The reason behind the increase might be that, in some states, irrigation by other sources is dominant and in many others, the contribution of tanks to irrigation has been on the decline.

On the whole, in Tamil Nadu the contribution of different sources to NIA over a 60-year period has been found to be discouraging compared to the all-India level. More importantly, clear data as available for the all-India level is not provided even in the five-year plan documents for Tamil Nadu. However, the Eleventh Five-Year Plan (2007–12) and Twelfth Five-Year Plan (2012–17) reports provide some details (Table 3). During the eleventh and twelfth plans, the actual amount spent for irrigation projects was not available and it is difficult to assess the extent of funds utilised for the irrigation projects over a period of time.

As per Table 2, the NIA in Tamil Nadu has increased only by 29 per cent over the 60-year period. Ironically, even after making planned investment in this sector it is less than half a per cent increase per annum. Whereas at the all-India level, the increase was 160 per

Table 3: Investments in irrigation development during Tenth and Eleventh Five-Year Plans in Tamil Nadu (Rs. crore)

Plan period	Major and medium projects		Minor irrigation projects		Total	
	Outlay	Expenditure	Outlay	Expenditure	Outlay	Expenditure
Tenth FYP 2002–2007	1670	1230	500	447	2170	1677
% to total	77	73	23	27	100	77
Eleventh FYP 2007–2012	148	NA	824	NA	972	NA
% to total	15	NA	85	NA	100	NA
Twelfth FYP 2012–2017	7081*	NA	1622	NA	8703	NA
% to total	81	NA	19	NA	100	NA

Note: NA = data not available. * Includes an outlay of Rs. 148 crore under command area development programme.
 Source: Eleventh FYP 2007–2012, (2008) State Planning Commission, GoTN, p. 220, 222, 240 and 241.
 Twelfth FYP 2012–17, (2012) State Planning Commission, GoTN, p. 181.

cent compared to the 1950s, accounting for an average increase of 2.7 per cent per annum.

In Tamil Nadu, considering the decade of the 1970s as a mid-point, the trend from the 1950s to 1970s indicates that irrigation from all sources has marginally increased. Later on, except for the wells and tube wells categories, a steady decline in each source has been noticed in the state between 1970s and 2000s. Among all the sources of irrigation referred to earlier, this declining trend is more intensive for the most part for tank irrigation than canal irrigation. Although the contribution of area under 'other sources' of irrigation is negligible, that too also declined.

On the whole, Table 2 reveals that the contribution of minor irrigation (MI) sources in Tamil Nadu is steadily declining whereas at the all-India level, the contribution of MI has been found to be steadily increasing over time except in the case of tank sources. This uneven trend in NIA implies that 'other sources' also deserves equal focus in Tamil Nadu. The table shows that Tamil Nadu's position in relation to surface sources of irrigation, especially under tanks, is not encouraging. This calls for further research to gain more insights on this issue.

4. An Analysis of Rainfall and Net Irrigated Area by Tanks in Tamil Nadu

It is a well-known fact that rainwater is the primary source for tanks. Hence it is pertinent to analyse critically the causal relationship between rainfall and area under tank irrigation in Tamil Nadu over a period of 60 years. Table 4 provides the trend in rainfall status.

Over the six decades after Independence, the 1960s is considered as the 'golden period' of tank irrigation in terms of area irrigated by tanks. For seven years in this decade, there was an increase in area under tank irrigation of an overall extent of 9 lakh hectares.

During the 1960s, 1990s and 2000s, the decadal annual average rainfall was 940 mm, 942 mm and 971 mm respectively, which was slightly more than the amount reported for the decades of the

1950s and 1970s. However, the 1980s saw the lowest rainfall of 856 mm, which was 86 mm lower than the 1990s. Even though average rainfall during these two decades was highly varying, the NIA by tanks between these two decades was more or less the same (which is about 6.2 lakh hectares). Likewise, the rainfall comparison between the 1990s and 2000s indicates that although the latter decade recorded more rainfall (higher by 29 mm), the decadal average NIA by tanks was 1.15 lakh hectares less than the 1990s. Both the variance in the NIA and rainfall trends indicate that over the period of 20 years, available rainfall is not an important constraint for the area under tank irrigation. But the main concern is the efficiency in the optimum utilisation of harnessed water in the catchment area of waterbodies. Also, the operation and maintenance of these bodies remains challenging in sustaining the efficiency of the utilisation of water and retaining NIA in the command area as well.

Comparing the 1990s and 2000s, a higher average rainfall was recorded in the latter decade, which happened to be the highest among all decades since the 1950s. In the same manner, it is observed that the 1980s had the lowest average rainfall compared to any other decade since the 1950s.

Comparing the trends with the 1960s and 1970s, the NIA served by tanks in all the later decades declined considerably. It is clear that the decline of irrigated area in the 1980s was mainly due to poor rainfall over many years but the same cannot be said of the following two decades where the average rainfall was higher compared to any other decades.

Over the three decades since 1977, there was no evidence of an increase in the tank-irrigated area of over 9 lakh hectares in Tamil Nadu and nowhere had it reached its registered ayacut of a million hectares. This trend of stagnancy in NIA implies that the factors other than rainfall such as negligible investment in tank irrigation and lack of strengthening of institutions for tank management, which remain non-transparent, hamper the growth and sustainability of NIA in the ayacut of tank irrigation in Tamil Nadu. These hidden realities could be seen only during field visits to these water bodies.

Table 4: Size class and NIA by tanks and rainfall in Tamil Nadu: 1950-51 to 2010-11

S. No	Year	Number of tanks		Total	NIA by tanks '000 ha	Rainfall in mm --->					Average 10 Years	
		>40ha	<40ha			June to Sept.	Oct. to Dec.	Jan. to May	June to May	10		11
Normal rainfall --> As per 2010-11 SCR -->												
1	1950-51	7525	15459	22984	545.4	283	350	215	159	908	847.5	
2	1951-52	6435	17380	23815	635.7	335	325	158			817.5	
3	1952-53	6793	18378	25171	617.8	198	368	183			747.5	
4	1953-54	6652	18512	25164	795.5	390	405	263			1058.0	
5	1954-55	6628	18613	25241	861.9	335	415	300			1049.8	904
6	1955-56	7276	17798	25074	794.4	340	420	96			855.8	
7	1956-57	7327	20117	27444	884.3	395	450	153			997.8	
8	1957-58	6994	21366	28360	847.4	330	500	230			1060.0	
9	1958-59	7459	21013	28472	840.1	343	401	172			916.0	
10	1959-60	6986	22612	29598	832.8	342	459	168			969.0	960
11	1960-61	7150	22753	29903	936.4	349	580	195			1124.0	
12	1961-62	7030	27437	34467	939.5	371	309	187			867.0	
13	1962-63	7220	27703	34923	946.2	325	395	212			932.0	

(contd.)

14	1963-64	7562	29246	36808	914.9	315	506	87	908.0
15	1964-65	7842	28323	36165	892.2	347	406	106	859.0
16	1965-66	8611	26730	35341	902.5	315	441	115	871.0
17	1966-67	8183	28187	36370	965.8	416	606	139	1161.0
18	1967-68	8452	28180	36632	989.9	285	496	179	960.0
19	1968-69	8442	28193	36635	750.5	271	312	100	683.0
20	1969-70	8726	27019	35745	879.2	238	613	186	1037.0
21	1970-71	8544	27278	35822	897.9	318	420	180	918.0
22	1971-72	9358	28056	37414	923.5	323	489	147	959.0
23	1972-73	9286	27917	37203	949.5	304	608	79	991.0
24	1973-74	8093	29776	37869	928.5	333	407	102	842.0
25	1974-75	8427	29547	37974	593.9	326	178	143	647.0
26	1975-76	7386	30593	37979	749.8	420	340	97	857.0
27	1976-77	7412	30923	38335	800.0	314	440	187	941.0
28	1977-78	7480	31461	38941	909.9	333	682	109	1124.0
29	1978-79	7402	30795	38197	841.9	261	582	107	950.0
30	1979-80	7398	30896	38294	896.2	361	605	125	1091.0
31	1980-81	7399	30895	38294	590.2	196	337	136	669.0
32	1981-82	7408	30896	38304	738.4	406	453	97	956.0
33	1982-83	7116	30828	37944	516.6	217	352	94	663.0
34	1983-84	7125	30591	37716	807.1	399	484	340	1223.0

(contd.)

(contd. Table 4)

S. No	Year	Number of tanks		Total	NIA by tanks '000 ha	Rainfall in mm ---->					Average		
		>40ha	<40ha			June to Sept.	Oct. to Dec.	Jan. to May	June to May	10 Years	5 Years		
1	2	3	4	5	6	7	8	9	10	11	12		
Normal rainfall --> As per 2010-11 SCR -->													
						319	430	159	908				
35	1984-85	7191	30438	37629	715.0	331	300	160	791.0				860
36	1985-86	7224	30421	37645	671.7	382	377	192	951.0				
37	1986-87	7200	30749	37949	509.6	272	331	98	701.0				
38	1987-88	7280	30949	38229	609.9	271	525	187	983.0				
39	1988-89	7282	31067	38349	479.0	376	218	115	709.0				
40	1989-90	7281	31202	38483	522.7	349	341	227	917.0	856			852
41	1990-91	7281	31202	38483	530.9	239	373	103	715.0				
42	1991-92	7299	31453	38752	577.0	332	485	82	899.0				
43	1992-93	7176	31687	38863	628.8	316	477	69	862.0				
44	1993-94	7164	31678	38842	668.1	305	710	78	1093.0				
45	1994-95	7169	31694	38863	674.3	224	479	231	933.8				901

46	1995-96	7423	31283	38706	512.3	348	248	68	663.7
47	1996-97	7476	31527	39003	623.5	455	541	125	1121.2
48	1997-98	7483	31520	39003	675.5	286	782	84	1152.2
49	1998-99	7522	31776	39298	689.7	340	602	138	1080.0
50	1999-00	10070	31878	41948	633.1	200	500	197	896.8
51	2000-01	7529	31837	39366	588.6	315	336	135	785.3
52	2001-02	7529	31837	39366	536.7	260	379	155	794.0
53	2002-03	7529	31837	39366	422.3	185	407	138	730.0
54	2003-04	7529	31837	39366	385.0	337	403	295	1034.6
55	2004-05	7933	32386	40319	465.4	361	472	246	1078.8
56	2005-06	7933	32386	40319	575.4	309	829	167	1305.0
57	2006-07	7982	33278	41260	531.4	251	498	111	860.0
58	2007-08	7982	33278	41260	506.1	342	515	308	1165.0
59	2008-09	7984	33278	41262	540.2	334	553	137	1024.0
60	2009-10	7984	33278	41262	503.5	317	483	138	938.0
61	2010-11	7985	33142	41127	533.2	384	605	176	1165.0

Source: Government of Tamil Nadu, Season and Crop Reports, Various Issues, Dept. of Economics and Statistics.

Whenever the quantum of rainfall recorded is more than 600 mm during the North-East monsoon (October to December), the ayacut area served by the tanks in that particular year was more than 9 lakh hectares. This point holds good for five years during the 1960s and 1970s. But, the level of rainfall in the 1950s and 1980s did not reach this figure. However, in the 1990s and 2000s, this point seems misleading. During the 1990s, in three years — 1993–94, 1997–98 and 1998–99 — the season's rainfall was recorded at 710 mm, 782 mm and 602 mm respectively. Likewise, during the 2000s, in the year 2005–06, the rainfall was 829 mm. But, during these years, the extent of area served by tanks was found to be marginally less than 7 lakh hectares, which is surprisingly more or less the same as that of the other normal rainfall years in that decade. This point indicates that the area served by tanks had been encroached upon considerably for non-agricultural usage. Since there are no systematic studies available on this declining trend of tank irrigation, except the annual data as available (Table 4) from the statistical department of the state government, this aspect needs to be studied in depth through micro-level studies.

The North-East monsoon rainfall is a decisive factor for agricultural prosperity in a year in Tamil Nadu. During that season, if the quantum of rainfall is >400 mm, then the particular year is considered as agriculturally favourable year. If the South-West (June–September) monsoon rainfall is >300 mm coupled with the succeeding season's rainfall of >400 mm, then the year will be considered definitely as a favourable year. One more aspect is that if the rainfall is too high during one monsoon season and lower during other monsoon, which also reflects the norm prescribed above in the prediction of the favourable rainfall pattern in Tamil Nadu. In other words, we can take the average of 700 mm rainfall as the basic criteria collectively for both the seasons to arrive at the prediction of favourable agricultural years.

Compared to 1967–68 — where the area irrigated by tanks was 9.9 lakh hectares — over a period of 43 years up to 2010–11, as many as 467 tanks under the >40 hectare category had reportedly disappeared. However, the number of smaller-size tanks had increased

to about 4,960 during the same period. But discouragingly, the extent of area irrigated by them decreased considerably. This kind of negative outcome causes a grave concern and in the absence of data, it leads to the question whether larger tanks were converted unethically into smaller tanks due to encroachments and whether cultivation was reduced or abandoned in many smaller tanks.

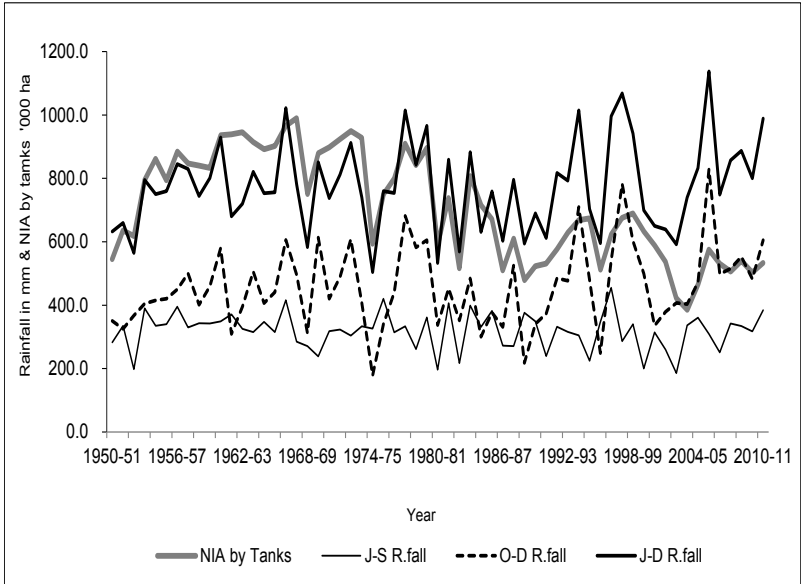
Between the 1960s and 2000s, the irrigated area under tanks was found to have decreased by 3.5 lakh hectares. This declining trend was noted only from 1984–85. Since then, the maximum area served by the tanks was only 6.9 lakh hectares, and the situation did not improve even in 1998–99, a good rainfall year. Also, during the 2000s, in three consecutive years from 2003–04 to 2005–06, the recorded rainfall was above normal but the maximum extent of NIA served by tanks was only 5.75 lakh hectares in 2005–06.² An important unpleasant point to be noted from the above phenomenon is the disappearance of more than 40 per cent of the registered ayacut (one million hectares) of total tanks, which ironically could not be brought under cultivation since 2000–01 in Tamil Nadu, where the majority eke out of their living by farming.

Table 4 amply demonstrates that although rainfall is an important external factor that decides the extent of area brought under tank irrigation, there are several other factors (which may be termed as physical, technical and institutional) that stand in the way of progress of tank irrigation in the state. Hence, this is an important issue that needs to be probed in detail through field study.

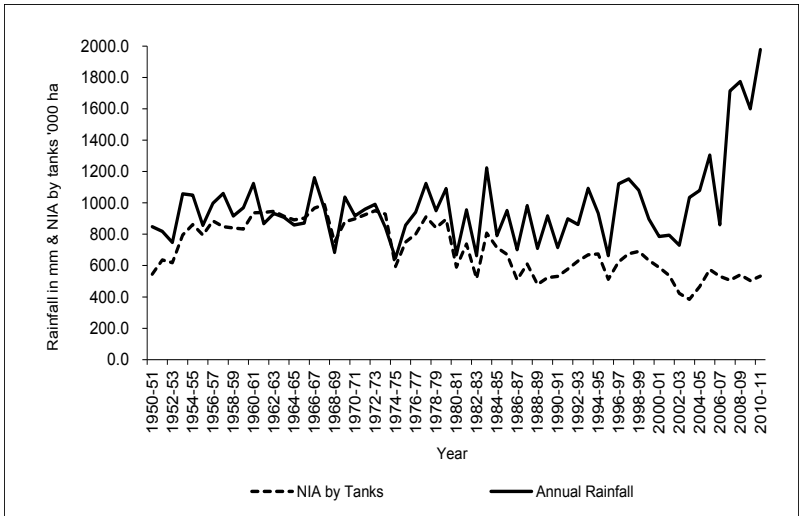
Some more details could also be drawn while analysing Table 4. This is represented through Graphs 1 and 2, and the following observations are made:

1. Over the years, there is no persistent decrease in rainfall; rather it merely fluctuates. Above normal rainfall (>950 mm) has occurred in 28 out of 61 years between 1950–51 and 2010–11.
2. Average/marginal deficit rainfall (850–950 mm) years are recorded in 17 out of 61 years. Deficit rainfall (650–850 mm) was recorded in 16 out of 61 years.

Graph 1 Seasonal rainfall and NIA by tanks in TN, 1950-1 to 2010-11



Graph 2 Annual rainfall and NIA by tanks in TN, 1950-1 to 2010-11



Note: NIA = Net Irrigated Area. J-S = June–September. O-D = October–December. J-D = June–December. R = Rainfall.

Source: Table 4.

3. Minimum rainfall is 647 mm (1974–75) and the maximum rainfall is 1305 mm (2005–06) over the 61-year period.
4. The correlation between rainfall and NIA by tanks is very positive. That is, whenever the quantum of rainfall increases, the extent of NIA by tanks also increases and vice versa. Only during the 1960s, even though the rainfall was relatively moderate, the NIA by tanks was found to be relatively higher consecutively for five years.³

On the whole, it is inferred from the above trend analysis that in Tamil Nadu, the area irrigated by groundwater source has been increasing steadily — as it has been happening across India also. Groundwater assumes significance in the context of declining contribution of surface water sources, especially when the area irrigated by tanks has been steadily declining from 1960s onwards. Considering the surface sources contribution, in terms of area under irrigation, it seems that this contribution is not sustainable and will have severe repercussions in the area served by groundwater source since the groundwater sources get their maximum recharge only from the surface sources, especially tanks and canals.

The above discussion necessitates a further study of the contribution of irrigated agriculture in terms of area under cultivation, production of crops and yields in terms of productivity of the irrigated land. These aspects are elaborated in Section 5.

5. Effect of Irrigation on Production and Productivity of Paddy Crop and its Growth in Tamil Nadu and Across India

There has been ample evidence, both at the macro and micro level, to show that irrigated crop yield performance is much better than unirrigated crop yield performance in Indian conditions (Moorthi 1976; Nadkarni et al. 1979; Adhvarayu and Patel 1984; Dhawan 1985; Vaidyanathan 2011; Sivasubramaniyan 2006, 2011). Moreover, studies have also shown that in the case of cultivation of high-value crops, yields are reported to be much better under irrigated conditions coupled with the use of modern technology, which cannot be replicated

under unirrigated conditions. Further, some of these studies have also proved that differences in output per gross irrigated hectare as well as cropping intensity across space are significantly and positively associated with the irrigation ratio (the ratio of irrigated area to cultivated area). A small sample of a few studies indicates the gross value of output per unit of gross sown area in the command area to be between 7 per cent and 300 per cent higher than the control area; the difference in productivity per unit of net sown area is invariably larger and ranges from 35 per cent to 400 per cent (Vaidyanathan 1987).

Many studies clearly indicate that irrigated crop yields pushed up the productivity of all crops, which led to overall increase in foodgrain production. However, the increase in output may go up to a certain level after which it stagnates or even declines. Precisely this aspect is analysed in this paper, taking the main food crop of rice using the data from 1950–51 to 2010–11 for both Tamil Nadu and across India.

The analysis has been done under four contexts in Tamil Nadu and across India: (1) decadal trends in net sown area (NSA), gross cropped area (GCA) under food crops and GCA under all crops; (2) decadal trends in cropping intensity (CI) and irrigation intensity (II); (3) trends in cultivated and irrigated area; and (4) area, production and yield of rice and wheat along with percentage coverage under irrigation.

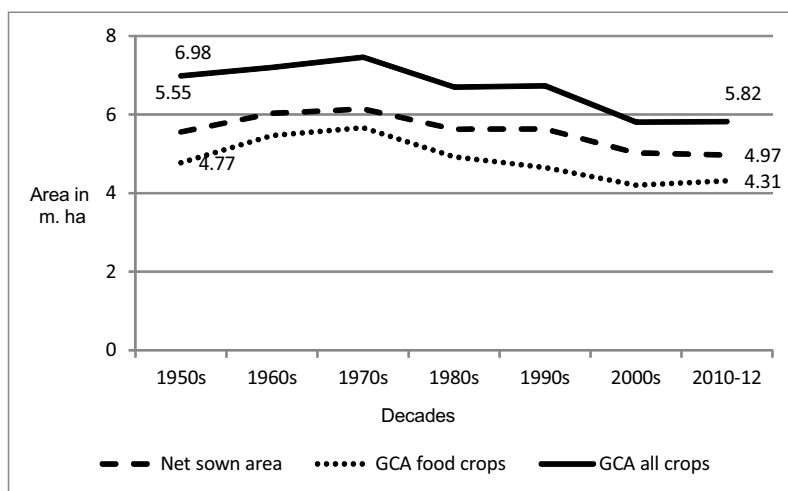
5.1. Decadal trends in NSA, GCA under food crops and GCA under all crops

Figure 1 shows that in Tamil Nadu, NSA reached its peak in the 1970s, after which it declined gradually from 5.62 million hectares in the 1980s to 5.02 million hectares in the 2000s. Apparently, the same trend has been noticed in GCA of food crops and also GCA of all the crops. The pattern depicts that Tamil Nadu has already maximised its net and gross sown area and further improvement in the area under cultivation is very difficult to attain.

In the case of the trend across India, it may be observed from Figure 2 that the NSA has reached the maximum of 142.3 million hectares in the 1990s. However, the GCA under food crops and GCA

Figure 1: Tamil Nadu: Decadal trends in NSA, GCA foodgrains and all crops
(Area in million ha)

Year	Net sown area	GCA food-crops	GCA all crops
1950s	5.55	4.77	6.98
1960s	6.03	5.46	7.20
1970s	6.14	5.66	7.46
1980s	5.62	4.92	6.70
1990s	5.63	4.65	6.73
2000s	5.02	4.20	5.80
2010-12	4.97	4.31	5.82



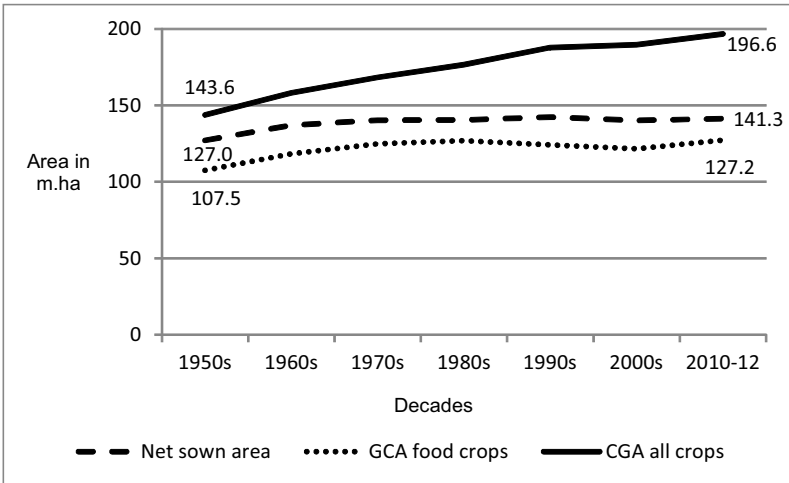
Source: Appendix 1

under all crops have been showing an increasing trend till 2010–12. The all-India trend shows that further growth of GCA under food crops and all crops is still feasible.

Overall, the 60-year data shows that the position of Tamil Nadu in terms of NSA, GCA under food crops as well as all crops is not sustainable and has already started declining. While at the all-India level, the same being true only for NSA; GCA has been moving up gradually.

Figure 2: All India: Decadal trends in NSA, GCA foodgrains and all crops
(Area in million ha)

Year	Net sown area	GCA food- crops	GCA all crops
1950s	127.0	107.5	143.6
1960s	136.9	118.2	158.0
1970s	140.2	124.8	168.2
1980s	140.4	126.8	176.6
1990s	142.3	124.1	187.7
2000s	140.1	121.5	189.7
2010-12	141.3	127.2	196.6



Source: Appendix 2

5.2. Decadal trends in cropping intensity and irrigation intensity

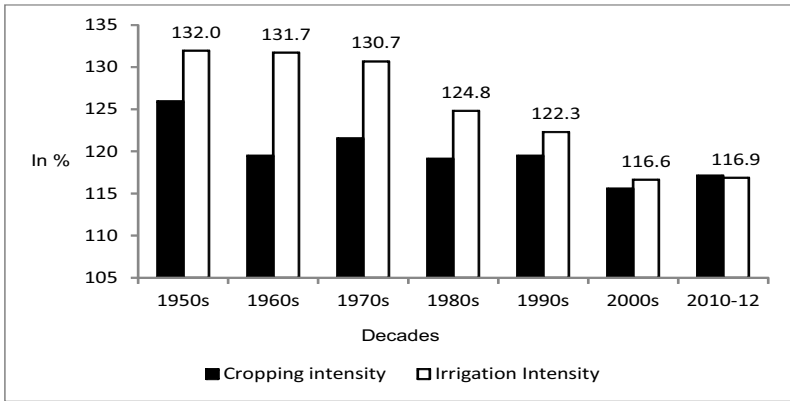
Cropping intensity (CI) refers to the gross cropped area to net sown area ($GCA/NSA \times 100$) in a given year counting three seasons of four months each. CI is calculated in percentage.

Irrigation intensity (II) refers to the gross irrigated area to net irrigated area ($GIA/NIA \times 100$) in a given year counting three seasons of four months each. II is calculated in percentage.

In Tamil Nadu, over a period of 60 years since the 1950s, there

Figure 3: Tamil Nadu: Decadal trends in cropping intensity and irrigation intensity (in per cent)

Year	Cropping intensity	Irrigation intensity
1950s	126.0	132.0
1960s	119.5	131.7
1970s	121.5	130.7
1980s	119.1	124.8
1990s	119.5	122.3
2000s	115.6	116.6
2010-12	117.1	116.9



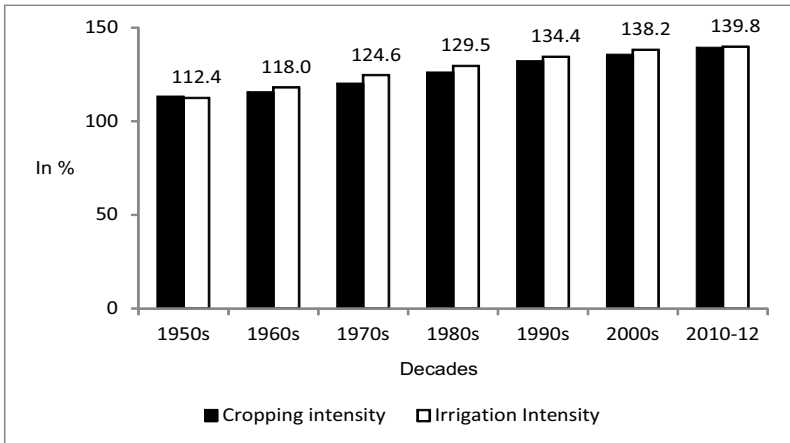
Source: Appendix 1

has been no upward movement of both CI and II (see Figure 3). The CI has declined from 126 per cent in the 1950s to 115.6 per cent in the 2000s. Similarly, II also declined from 132 per cent to 116.6 per cent during the same period. This data predicts neither the monsoon condition nor the irrigation facilities is favourable to sustain CI as well as II over the 60-year period.

The all-India data (Figure 4) shows that both CI and II have been on an increasing trend since the 1950s. Interestingly, it may be seen that CI and II have never declined over the 60-year period. This means that it is still possible to sustain and grow both CI and II in the future also at the all-India level. One may also observe from

Figure 4: All India: decadal trends in cropping intensity and irrigation intensity (in per cent)

Year	Cropping Intensity	Irrigation Intensity
1950s	113.1	112.4
1960s	115.4	118.0
1970s	120.0	124.6
1980s	125.9	129.5
1990s	131.9	134.4
2000s	135.4	138.2
2010-12	139.1	139.8



Source: Appendix 2

Figure 4 that both CI and II had the same level of about 113 per cent during the 1950s. The same has been growing steadily and finally reached a figure of about 139 per cent in the years 2010–12. Overall, the data reveals that there is still possibility of moving upward in both CI and II at the all-India level.

The time-series data clearly shows that in Tamil Nadu, sustaining both CI and II has been very difficult and it requires meticulous planning, especially increasing investment in irrigation development and introducing modern technology to increase II wherever feasible. At the all-India level, the present upward movement of CI and II

are favourable for which the required steps have to be taken for its sustenance and future growth.

5.3. Trends in cultivated and irrigated area in Tamil Nadu and India

Tamil Nadu: As against the NSA and GCA, which have been declining gradually since the 1950s, the net irrigated area (NIA) and gross irrigated area (GIA) have shown some positive trend under irrigated agriculture in Tamil Nadu. Actually, only the growth of irrigated agriculture can safeguard the agricultural production in an economy. Figure 5 depicts that the extent of irrigated area in the 1970s has been more or less maintained till the 2000s in Tamil Nadu. However, sustainability of the irrigated area needs to be assured, because irrigation supplies come from different sources, which need to be safeguarded. As seen in Sections 3 and 4, the area under tank irrigation in Tamil Nadu has declined and the contribution of canal irrigation also has decreased steeply. Both the surface irrigation systems require adequate attention to stabilise irrigated agriculture in Tamil Nadu.

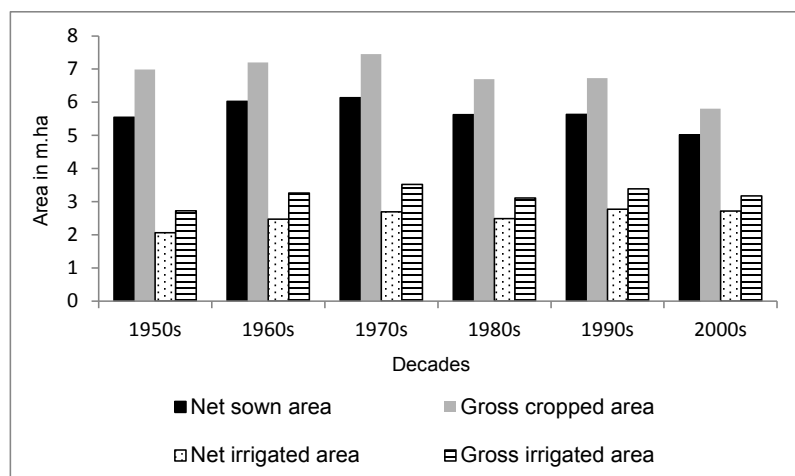
All India: As already observed, except NSA, which has reached its peak in the 1990s, GCA and NIA as well as GIA have been steadily increasing at the all-India level (Figure 6). Apparently, the growth of irrigated area propelled agricultural production in all possible ways. As in the case of Tamil Nadu, different sources of irrigation are responsible for the growth of irrigated agriculture in the country. As analysed in Section 3, the 60-year data on different sources of irrigation showed that irrigated area has been steadily expanding from the 1950s to 2000s in all sources, except under tank irrigation, especially in the 2000s. Since the tank-irrigated area at all-India level contributed only to a small extent, its decline has not much affected the overall irrigated area at the all-India level.

5.4. Area, production and yield of rice and wheat along with percentage coverage under irrigation

The performance of agriculture can be inferred from the production of gross output realised by different crops cultivated in a year. The extent of crop yield determines the total agricultural production in

Figure 5: Cultivated and irrigated area in Tamil Nadu, 1950s to 2000s
(Area in million ha)

Decades	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1950s	5.5	7.0	2.1	2.7
1960s	6.0	7.2	2.5	3.3
1970s	6.1	7.5	2.7	3.5
1980s	5.6	6.7	2.5	3.1
1990s	5.6	6.7	2.8	3.4
2000s	5.0	5.8	2.7	3.2



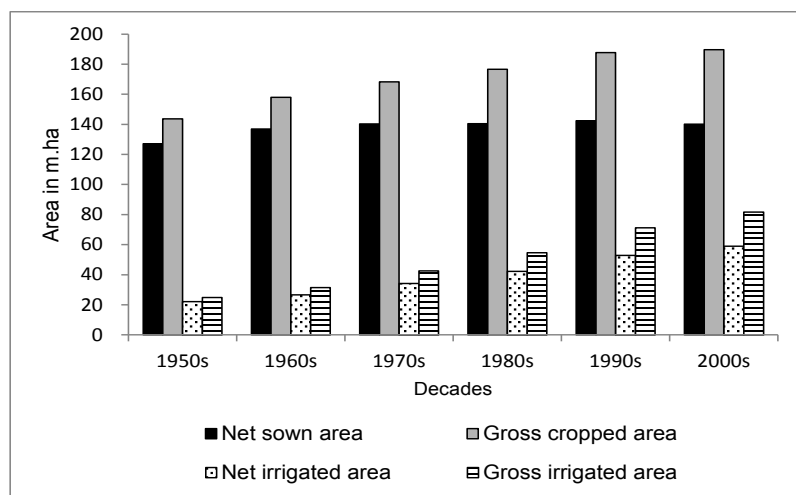
Source: Appendix 3

an economy. Crop yields are basically dependent upon the extent of availability of irrigation. Consequently, there are interconnections among the irrigated area, yields and production.

In Tamil Nadu and across India, foodgrain production dominates the total production of all crops, which includes non-foodgrains as well. Rice dominates foodgrain production in Tamil Nadu, whereas rice and wheat are major crops across India. Hence, the focus is on rice production in Tamil Nadu and wheat production at the all-India level.

Figure 6: Cultivated and irrigated area in India, 1950s to 2000s
(Area in million ha)

Decades	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1950s	127	144	22	25
1960s	137	158	27	32
1970s	140	168	34	43
1980s	140	177	42	55
1990s	142	188	53	71
2000s	140	190	59	82



Source: Appendix 4

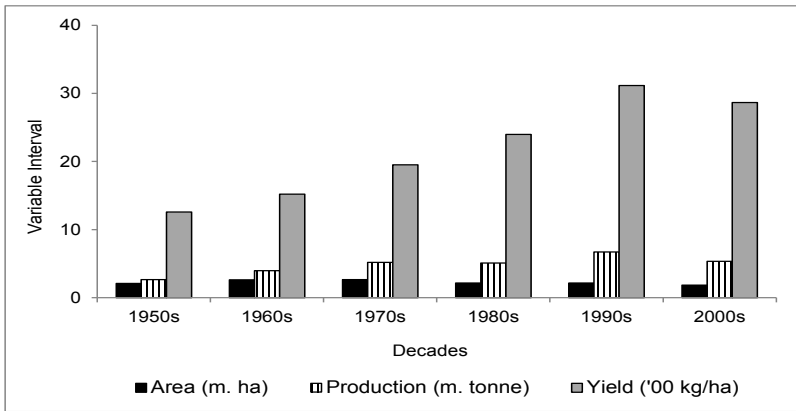
5.4.1. Area, production and yield of rice in Tamil Nadu and India

Rice is a water-intensive crop and is grown predominantly during the kharif and rabi seasons coinciding with the two rainfall seasons referred to earlier and also where assured groundwater source of irrigation is possible.

Tamil Nadu: A glance at Figure 7 shows that irrigated area under rice has been stagnant in the 1980s and 1990s and declined in the 2000s, whereas production of rice has increased up to the 1990s

Figure 7: Area, production and yield of rice in Tamil Nadu, 1950–2010

Decades	Area (m. ha)	Production (m. tonne)	Yield ('00 kg/ha)
1950s	2.085	2.663	12.59
1960s	2.603	3.959	15.20
1970s	2.646	5.182	19.50
1980s	2.153	5.106	23.97
1990s	2.152	6.716	31.16
2000s	1.847	5.353	28.65



Source: Appendix 5

and declined only in the 2000s. This decline in production is caused by two factors: (a) decline in the area and (b) decline in rice yield from 3,116 kg/ha in the 1990s to 2,865 kg/ha in the 2000s. Although the yield has been raising progressively, in the 2000s it showed a declining trend. This point assumes greater importance, because this yield level is primarily dependent upon the extent of availability of irrigation for the production of rice. A rough estimate in Tamil Nadu shows that the coverage area under irrigated rice is between 70 and 80 per cent. It is inferred from the data that irrigation sources did not keep pace to sustain rice production in Tami Nadu, especially in the 2000s. Consequently, the earlier level of productivity (3,116 kg/ha) could not be sustained.

All-India — Rice and Wheat: Figures 8 and 9 depict the production of rice and wheat across India. In the case of rice and wheat across India, area, production, yield and percentage coverage under irrigation have been gradually and steadily increasing from the 1950s to 2000s. However, two points on the level of production between rice and wheat merit attention: (1) Over the 60-year period, rice yield has improved roughly 2.5 times that of the 1950s, whereas in the case of wheat, this level has increased about four-fold; and (2) the percentage coverage under rice irrigation increased only 20 percentage points (from 34 to 55 per cent) over the 60 years.

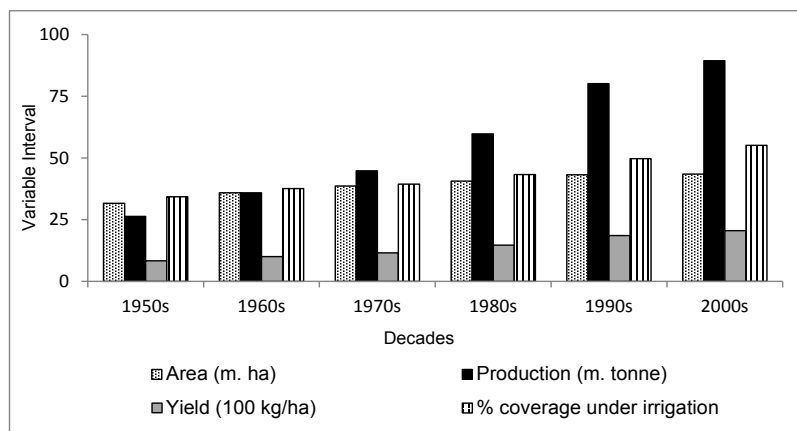
But in the case of wheat, there has been nearly a three-fold increase in area covered under irrigation. Hence, it is clear that production and productivity of rice and wheat crops are mainly dependent upon the extent of irrigation facilities available for these crops. Accordingly, steps have to be taken to increase the cropped area under irrigation by stepping up water-saving modern technology for increasing the production of these crops.

In this context, it is worthwhile to mention the productivity levels achieved by top producing countries. Especially in the case of rice and wheat, India's productivity level is much lower than its potential. This could be seen in two contexts: (1) Yields of rice and wheat in India have been steadily improving in the last 60 years and there is a possibility to improve further; and (2) as one would see from Tables 5 and 6, possibilities exist to improve yields up to three times that of the present yields of rice and wheat in India. This can be achieved through the use of modern scientific technologies, especially drip irrigation for paddy, which reduces 50 to 60 per cent of water requirements and increases the yield two- to threefold compared to the present yield level (IAMWARM Final Project Report: June 2014).

To take this discussion further, a mention should be made of the efficiency of water use in Indian agriculture. A basin-wise efficiency of water use study in two periods, viz., the mid-1960s (1966–68) and the early 1990s (1991–93) in India reveals, 'between the mid-1960s and the 1990s, total consumptive use of irrigation water nearly doubled, while gross utilisation rose by barely 20 per cent. This

Figure 8: Area, production, yield of rice and % coverage of irrigation in India, 1950–2010

Decades	Area (m.ha)	Production (m.tonne)	Yield ('00 kg/ha)	Per cent coverage under irrigation
1950s	31.6	26.3	8.30	34.3
1960s	35.9	35.9	9.99	37.6
1970s	38.6	44.8	11.56	39.4
1980s	40.7	59.8	14.67	43.3
1990s	43.2	80.1	18.52	49.7
2000s	43.4	89.4	20.52	55.1

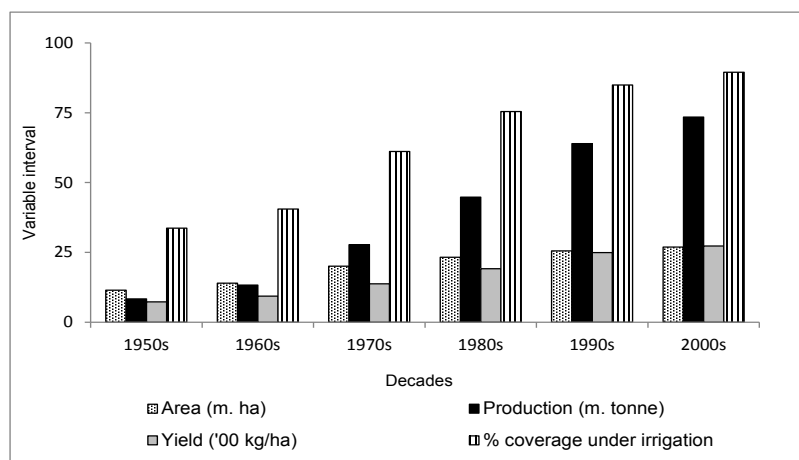


Source: Appendix 5

implies a large increase in the technical efficiency⁴ of irrigation water use in the country taken as a whole, from around 23 per cent in the 1960s to nearly 38 per cent in the early 1990s' (Vaidyanathan and Sivasubramaniyan 2016: 383). Also, from this study it was found that the productivity under irrigated area is comparatively lower than rain-fed crops: 'That productivity per unit of consumptive use on irrigated area is lower than in rain-fed crops is a surprising finding; so is the

Figure 9: Area, production, yield of wheat and % coverage of irrigation in India, 1950–2010

Decades	Area (m.ha)	Production (m.tonne)	Yield ('00 kg/ha)	Per cent coverage under irrigation
1950s	11.5	8.4	7.28	33.7
1960s	14.0	13.3	9.37	40.6
1970s	20.1	27.8	13.75	61.2
1980s	23.3	44.8	19.18	75.4
1990s	25.5	63.9	24.96	85.0
2000s	26.9	73.4	27.27	89.5



Source: Appendix 6

fact that even in states where the former is higher, the differential is not as striking as one would expect' (ibid: 388). So, it would be safely concluded that our potential yield levels in rice and wheat can be achieved as expected, if the efficiency of water use is intensified and better use of technological advancements in irrigation supplies, especially by conveyance of water under canal systems and application techniques through drip and sprinkler, is made in due course of time.

Table 5 Area, production and yield of rice (paddy) in selected countries

		2012					2013					2014				
		Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area
Harvested area of rice (paddy) in selected countries																
																(million ha)
1	India	42.41	1	India	43.94	1	India	43.40								
2	China	30.56	2	China	30.58	2	China	30.87								
3	Indonesia	13.45	3	Indonesia	13.84	3	Indonesia	13.80								
4	Thailand	12.28	4	Thailand	12.37	4	Bangladesh	11.82								
5	Bangladesh	11.42	5	Bangladesh	11.77	5	Thailand	10.83								
6	Myanmar	8.15	6	Africa	10.89	6	Vietnam	7.82								
7	Vietnam	7.75	7	Vietnam	7.90	7	Myanmar	6.79								
8	Philippines	4.69	8	Myanmar	7.50	8	Philippines	4.74								
9	Cambodia	3.01	9	Americas	6.56	9	Cambodia	3.10								
10	Nigeria	2.86	10	Philippines	4.75	10	Nigeria	3.10								
	World	162.94		World	165.16		World	NA								
Production of rice (paddy) in the selected countries																
		2012					2013					2014				
																(million tonnes)
Rank	Top 10 Countries	Production	Rank	Top 10 Countries	Production	Rank	Top 10 Countries	Production	Rank	Top 10 Countries	Production					
1	China	205.99	1	China	205.21	1	China	208.24								
2	India	157.80	2	India	159.20	2	India	157.20								
3	Indonesia	69.06	3	Indonesia	71.28	3	Indonesia	70.85								
4	Bangladesh	50.50	4	Bangladesh	51.50	4	Bangladesh	52.23								
5	Vietnam	43.66	5	Vietnam	44.04	5	Vietnam	44.97								

		Yield of rice (paddy) in selected countries (kg / ha)														
		2012					2013					2014				
Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield		
6	Thailand	37.47	6	Thailand	36.06	6	Thailand	36.06	6	Thailand	32.62					
7	Myanmar	28.08	7	Myanmar	28.77	7	Myanmar	28.77	7	Myanmar	26.42					
8	Philippines	18.03	8	Philippines	18.44	8	Philippines	18.44	8	Philippines	18.97					
9	Brazil	11.55	9	Brazil	11.78	9	Brazil	11.78	9	Brazil	12.18					
10	Japan	10.65	10	Japan	10.76	10	Japan	10.76	10	Japan	10.55					
	World	734.91		World	740.90		World	740.90		World	NA					
Yield of rice (paddy) in selected countries (kg / ha)																
1	Egypt	9529.6	1	Australia	10217.7	1	Australia	10217.7	1	Australia	10920.0					
2	Australia	8909.8	2	Egypt	9529.8	2	Egypt	9529.8	2	Egypt	9529.9					
3	USA	8348.7	3	USA	8623.7	3	Greece	8623.7	3	Greece	8891.1					
4	Uruguay	7851.3	4	Turkey	8138.2	4	USA	8138.2	4	USA	8487.3					
5	Spain	7756.2	5	Uruguay	7855.5	5	Uruguay	7855.5	5	Uruguay	8054.4					
6	Peru	7726.3	6	Greece	7774.0	6	Spain	7774.0	6	Spain	7850.9					
7	Morocco	7601.5	7	Peru	7711.2	7	Uzbekistan	7711.2	7	Uzbekistan	7619.6					
8	Turkey	7350.5	8	Uzbekistan	7650.5	8	Peru	7650.5	8	Peru	7550.8					
9	Greece	7135.8	9	Morocco	7543.2	9	Turkey	7543.2	9	Turkey	7485.6					
10	Korea	6988.0	10	Tajikistan	7538.5	10	Tajikistan	7538.5	10	Tajikistan	7180.8					
61	India	3720.8	63	India	3623.1	60	India	3623.1	60	India	3622.1					
	World	4510.4		World	4485.9		World	4485.9		World	NA					

Note: NA = Data not available. Source: Food and Agriculture Organization (FAO). (ON1001)
Data accessed from www.indiaagricstat.com on 23 June 2016.

Table 6: Area, production and yield of wheat in selected countries

		2012					2013					2014				
		Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area	Rank	Top 10 Countries	Area
Harvested area of wheat in selected countries																
																(million ha)
1	India	29.86	1	India	29.65	1	India	31.19								
2	China	24.14	2	China	24.12	2	China	25.00								
3	Russia	21.28	3	Russia	23.37	3	Russia	23.91								
4	USA	19.80	4	USA	18.27	4	USA	18.82								
5	Kazakhstan	14.41	5	Australia	12.98	5	Australia	12.61								
6	Australia	13.90	6	Kazakhstan	12.95	6	Kazakhstan	11.92								
7	Canada	9.50	7	Canada	10.44	7	Canada	9.46								
8	Pakistan	8.65	8	Pakistan	8.69	8	Pakistan	9.20								
9	Turkey	7.53	9	Turkey	7.77	9	Turkey	7.82								
10	Iran	7.00	10	Iran	7.05	10	Ukraine	6.01								
	World	217.63		World	219.05		World	NA								
Production of wheat in the world																
																(million tonnes)
1	China	120.59	1	China	121.93	1	China	126.21								
2	India	94.88	2	India	93.51	2	India	94.48								
3	USA	61.68	3	USA	57.97	3	Russia	59.71								
4	France	40.30	4	Russia	52.09	4	USA	55.40								
5	Russia	37.72	5	France	38.61	5	France	38.97								

Yield of wheat in the selected countries										(yield in kg / ha)	
2012										2014	
Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield
6	Australia	29.91	6	Canada	37.53	6	Canada	29.28			
7	Canada	27.21	7	Germany	25.02	7	Germany	27.78			
8	Pakistan	23.47	8	Pakistan	24.21	8	Pakistan	25.98			
9	Germany	22.41	9	Australia	22.86	9	Australia	25.30			
10	Turkey	20.10	10	Ukraine	22.79	10	Ukraine	24.11			
	World	671.48		World	715.91		World	NA			

2012										2013		2014		
Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield	Rank	Top 10 Countries	Yield
1	New Zealand	8924.5	1	New Zealand	9105.3	1	Ireland	10014.0						
2	Netherlands	8587.0	2	Ireland	8993.4	2	Belgium	9412.9						
3	Belgium	8452.2	3	Belgium	8934.9	3	Netherlands	9169.8						
4	France	7599.2	4	Netherlands	8719.1	4	Germany	8629.6						
5	Denmark	7368.7	5	Germany	7997.9	5	New Zealand	8626.9						
6	Germany	7331.2	6	UAE	7600.0	6	UK	8585.2						
7	Namibia	7250.0	7	Namibia	7500.0	7	UAE	7500.0						
8	Ireland	7224.5	8	UK	7381.4	8	Denmark	7461.1						
9	UAE	7000.0	9	Denmark	7284.4	9	France	7356.7						
10	Zambia	6813.5	10	France	7254.2	10	Zambia	7155.9						
46	India	3177.5	54	India	3153.8	56	India	3029.5						
	World	3085.4		World	3268.3		World	NA						

Note: NA = Data not available. Source: Food and Agriculture Organization (FAO). (ON701) and (ON1001).
Data accessed from www.indiaaigristat.com on 23 June 2016.

5.4.2. Rice and wheat – potential yield and realised yield: A comparison

Rice: Since rice (41 per cent) and wheat (37 per cent) occupy 78 per cent of total foodgrain production (259.3 million tonnes in 2011–12) in India, the above analysis has focussed only on these two crops. Regarding rice yield, although it has been gradually improving from 994 kg/ha in 1950–51 to 3,918 kg/ha in 2011–12 in Tamil Nadu, this yield level is 2.3 times lower than the world's highest yield (8,925 kg/ha) achieved in New Zealand (Table 5).

However, the world average yield (3,085 kg/ha) is less than Tamil Nadu's average yield of rice. The yield level across India is 1,546 kg/ha, which is far less compared to Tamil Nadu. This clearly shows that there are wide variations in yields across states and districts within the country. As a result, among the rice-producing countries, India was ranked 46th in 2012 in terms of rice yield and it further declined to 56th position in 2014. This again indicates that still India, including Tamil Nadu, has not reached its full potential of rice yield and further growing of rice with increased yield level is possible in the coming years. This can be achieved through drip irrigation in paddy, which is presently practiced in Amaravati sub-basin in Karur district, where the drip-irrigated paddy yield is reported to be about twice (8,000 kg/ha) the present highest yield (3,900 kg/ha) achieved in Tamil Nadu (IAMWARM Final Project Report: June 2014).

Wheat: Similarly in the case of wheat yield, India is lagging behind leading producer countries. In 2012, the yield in Egypt was 9,530 kg/ha and India's yield was only 3,140 kg/ha. Also, India's average wheat yield (3,140 kg/ha) was still less than that of the world average yield of 4,510 kg/ha in 2012 (Table 6). Among others, advanced technology in wheat crop production should be introduced by the Central and state governments to achieve a higher potential yield in India. It should be noted that the average wheat yield in India from 1950–51 to 1966–67 was 763 kg/ha. This had increased to 1,612 kg/ha during 1968–69 to 1990–91 and further to 2,727 kg/ha during 1991–92 to 2012–13 (RBI, Handbook of Statistics on the Indian Economy, 2013). All these improvements are possible in two ways: (1) bringing more wheat area under irrigation and (2) adoption

of improved technologies. For comparison of technology development and increase of yield between India and Israel, see Sivasubramanian (2010: 97).

6. Conclusion and Suggestions

- In India, although huge investments have been made for irrigation development, a major share has been earmarked so far only for major and medium irrigation systems (71 per cent of total investments from 1951 to 2021). The important minor irrigation sources (tanks and wells) attracted only 13 per cent of the Plan outlays and 7 per cent of investments from institutional sources. So, at least 25 per cent of Plan outlays should be earmarked for minor irrigation systems and their development because this source has been the backbone of water for many village economies, especially in south India. Tank irrigation accounts for the major part of minor irrigation sources, which needs to be given primary attention at least from the Twelfth Plan onwards.
- Although four sources of irrigation are considered prime at all-India level, Tamil Nadu has been benefitting only from three sources, which excludes 'other sources', since its contribution is negligible. Compared to canals and tanks, the latter source has been declining considerably over the last 50 years in both Tamil Nadu and across India. This source strengthens groundwater recharge considerably in most villages. Hence preference should be given to restore and develop tank irrigation in totality.
- Unless due attention is paid to develop tanks and canal sources for irrigation, growth of well irrigation will become unsustainable. Especially in Tamil Nadu, the future of irrigated agriculture is mostly dependent upon the development of tanks.
- In both Tamil Nadu and across India, NSA reached its peak in the 1970s and 1990s respectively. After that, a declining trend is observed. So, there is no further scope to increase NSA under cultivation. As a result, steps have to be taken to sustain at least the present level of NSA without causing a further decline.

- Foodgrain production reached its peak in the 1970s in Tamil Nadu and in the 1980s across India. Hence due attention has to be paid to sustain and increase foodgrain production.
- In Tamil Nadu, due to a gradual decline in NSA and NIA, and very little increase in GCA / GIA, the cropping and irrigation intensities have shown a declining trend. But across India, NSA has stabilised and NIA has been improving marginally, which has resulted in cropping and irrigation intensities being more or less equal to each other.
- In Tamil Nadu, the 2000s saw a declining trend in the area under foodgrain production, especially rice. This has happened due to a decrease in area and also average yield, which has come down in the last decade from 3,116 kg/ha to 2,865 kg/ha. At the all-India level, interestingly, area, production and yield of rice has been improving without any decline. The same is true for wheat crops also at the all-India level. However, the all-India average yield of paddy (2,052 kg/ha) is relatively lower than that of yield in Tamil Nadu.
- While comparing productivity levels in the leading rice-producing countries of the world, India's position is still weak. India ranks 63rd in rice yield and for wheat, it occupied the 54th place. So, a huge potential remains untapped to raise the rice and wheat productivity levels to at least two times the present level.
- Overall, the paper clearly indicates that NSA and NIA in Tamil Nadu have been gradually decreasing in the past three decades and the same is also true across India in the recent decade. Hence, due attention has to be paid to develop the irrigation sector in all possible ways. In states like Tamil Nadu, a separate minister for irrigation and water management should be appointed to develop this vulnerable sector. Both the Central and state governments should take steps to prevent land-grabbing for non-agricultural purposes, especially of agricultural lands. Agriculture should be considered a special sector and treated on par with the business sector instead of treating it as a way of life.

Notes

- ¹ Public Law 480 (PL 480), also known as 'Food for Peace', is a funding avenue of the United States which allows food to be used for overseas aid. PL 480 is the Agricultural Trade Development Assistance Act, signed on 10 July 1954 by President Dwight D. Eisenhower. During the 1960s, India benefitted from this program.
- ² In Tamil Nadu, except well irrigation no other sources of irrigation have shown an increasing trend for several decades. Hence, one can conclude that part of the ayacut land served by tanks has been irrigated by wells located close to the tank ayacut. This is possible because once insufficient rainfall occurs, the tanks get very little storage to be used for irrigation. The rainwater seeps out or percolates. If this process continues twice or thrice, there will be no water from tanks for irrigation. However, the water that seeps or percolates enriches / recharges the well water supply that helps to irrigate land. In this case, although tanks supply water, the irrigation is performed by wells. So, it is accounted only under well irrigation category and not under tanks per se.
- ³ The secret behind the maximum area served by tanks in the 1960s was as follows: (1) Till the 1960s, the area under well irrigation had not been developed and no attention was paid to develop well irrigation. (2) Tank irrigation was the prime source of irrigation, which was considered equal to that of canal irrigation in Tamil Nadu and also in most other states in India. (3) The Green Revolution was initiated in the mid-1960s, which facilitated full exploitation of irrigated lands to be put under cultivation through various schemes of the Central and state governments. (4) After the Green Revolution, well irrigation (private irrigation source) took off and tank irrigation (community-managed irrigation source) started declining heavily and consistently, and this pattern has not been reversed by either the states or the Centre.
- ⁴ Technical (irrigation) efficiency, as conventionally defined by engineers, relates to the ratio of the consumptive use of irrigation to gross irrigation supplies.

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http://www.spc.tn.gov.in/fiveyearplans/12plan_e.htm XII FYP (2012-2017) GOTN, Chennai.

Appendix 1: Tamil Nadu - Area sown and area irrigated, 1950-51 to 2011-12
(’000 ha)

Sl. No	Year	Area sown			Area under food crops (%)	Cropping intensity	Irrigated area		Irrigation intensity
		Net	Gross				Net	Gross	
			Food crops	All crops	4/5*100	5/3*100			
		1	2	3	4	5	6	7	8
1	1950-51	5073	4217	6914	61	136	1788	2190	123
2	1951-52	5348	4419	7414	60	139	1934	2366	122
3	1952-53	5263	4465	7212	62	137	1775	2249	127
4	1953-54	5657	5225	6839	76	121	2091	2707	129
5	1954-55	5746	4977	6942	72	121	2105	2959	141
6	1955-56	5668	4893	6869	71	121	2101	2959	141
7	1956-57	5683	4969	6938	72	122	2210	2925	132
8	1957-58	5560	4781	6756	71	122	2197	2992	136
9	1958-59	5681	4846	6919	70	122	2225	2959	133
10	1959-60	5775	4944	7043	70	122	2248	2979	132
	1950s	5545	4774	6985	68	126	2068	2729	132
11	1960-61	5997	5523	7321	75	122	2462	3236	131
12	1961-62	6017	5502	7270	76	121	2503	3207	128
13	1962-63	6096	5511	7290	76	120	2507	3295	131
14	1963-64	6055	5454	7192	76	119	2434	3268	134
15	1964-65	6030	5528	7176	77	119	2425	3263	135
16	1965-66	5936	5316	7066	75	119	2399	3178	132
17	1966-67	6085	5528	7305	76	120	2511	3372	134
18	1967-68	6083	5493	7309	75	120	2629	3476	132
19	1968-69	5891	5257	6914	76	117	2417	3092	128
20	1969-70	6069	5522	7162	77	118	2508	3272	130
	1960s	6026	5463	7200	76	119	2480	3266	132
21	1970-71	6169	5619	7384	76	120	2592	3410	132
22	1971-72	6348	5693	7641	75	120	2710	3530	130
23	1972-73	6332	5844	7699	76	122	2815	3673	130
24	1973-74	6175	5681	7649	74	124	2814	3674	131
25	1974-75	5553	4951	6640	75	120	2438	3033	124
26	1975-76	5989	5622	7235	78	121	2565	3376	132
27	1976-77	6007	5495	7147	77	119	2329	3001	129
28	1977-78	6295	5953	7768	77	123	2836	3723	131
29	1978-79	6251	5832	7684	76	123	2873	3819	133
30	1979-80	6232	5920	7717	77	124	2984	3983	133
	1970s	6135	5661	7457	76	122	2696	3522	131

Contd.

Appendix 1 contd.

Sl. No	Year	Area sown			Area under food	Cropping intensity	Irrigated area		Irrigation intensity
		Net	Gross				Net	Gross	
			Food crops	All crops	4/5*100	5/3*100			9/8*100
		1	2	3	4	5	6	7	8
31	1980-81	5360	4908	6470	76	121	2571	3294	128
32	1981-82	5740	5333	6909	77	120	2709	3425	126
33	1982-83	5259	4586	6031	76	115	2255	2732	121
34	1983-84	5846	5313	6945	77	119	2618	3249	124
35	1984-85	5788	5304	7088	75	122	2640	3506	133
36	1985-86	5691	5054	6819	74	120	2501	3240	130
37	1986-87	5544	4810	6508	74	117	2356	2844	121
38	1987-88	5778	4689	6729	70	116	2438	2945	121
39	1988-89	5547	4476	6651	67	120	2375	2873	121
40	1989-90	5661	4776	6822	70	121	2497	3045	122
	1980s	5621	4925	6697	74	119	2496	3115	125
41	1990-91	5579	4633	6632	70	119	2373	2894	122
42	1991-92	5726	4766	6977	68	122	2605	3257	125
43	1992-93	5814	4749	7067	67	122	2698	3385	125
44	1993-94	5901	4901	7158	68	121	2800	3544	127
45	1994-95	5790	4802	7026	68	121	2903	3588	124
46	1995-96	5342	4258	6267	68	117	2625	3183	121
47	1996-97	5486	4443	6457	69	118	2812	3347	119
48	1997-98	5581	4587	6558	70	118	2945	3519	120
49	1998-99	5635	4663	6627	70	118	3019	3635	120
50	1999-00	5464	4658	6519	71	119	2972	3585	121
	1990s	5632	4646	6729	69	119	2775	3394	122
51	2000-01	5303	4535	6338	72	120	2888	3490	121
52	2001-02	5172	4493	6226	72	120	2801	3412	122
53	2002-03	4590	3700	5191	71	113	2309	2622	114
54	2003-04	4689	3718	5316	70	113	2148	2479	115
55	2004-05	5097	4226	5889	72	116	2637	3087	117
56	2005-06	5244	4398	6033	73	115	2920	3397	116
57	2006-07	5126	4334	5843	74	114	2889	3416	118
58	2007-08	5062	4234	5815	73	115	2864	3251	114
59	2008-09	5043	4269	5824	73	115	2931	3393	116
60	2009-10	4892	4098	5572	74	114	2864	3238	113
	2000s	5022	4201	5805	72	116	2725	3179	117
61	2010-11	4954	4270	5753	74	116	2912	3348	115
62	2011-12	4986	4347	5890	74	118	2964	3519	119
	2010-12	4970	4309	5822	74	117	2938	3434	117

Source: GOTN, Season and Crop Reports, Various Issues.
GOTN, Tamil Nadu Economic Appraisal, Various Issues

Appendix 2: All India - Area sown and area irrigated from 1950-51 to 2011-12
(m.ha)

Sl. No	Year	Area sown			Area under food crops (%)	Cropping intensity	Irrigated area		Irrigation intensity
		Net	Gross				Net	Gross	
			Food crops	All crops	4/5*100	5/3*100			9/8*100
		1	2	3	4	5	6	7	8
1	1950-51	119	97	132	74	111	21	23	108
2	1951-52	119	97	133	73	112	21	23	110
3	1952-53	123	102	137	74	111	21	23	110
4	1953-54	127	109	143	77	112	22	24	111
5	1954-55	128	108	144	75	113	22	25	113
6	1955-56	129	111	147	75	114	23	26	112
7	1956-57	131	111	150	74	114	23	26	114
8	1957-58	129	110	146	75	113	23	27	115
9	1958-59	132	115	152	76	115	23	27	115
10	1959-60	133	116	153	76	115	24	27	114
	1950s	127	108	144	75	113	22	25	112
11	1960-61	133	116	153	76	115	25	28	113
12	1961-62	135	117	156	75	115	25	29	114
13	1962-63	136	118	157	75	115	26	29	114
14	1963-64	137	117	157	75	115	26	30	115
15	1964-65	138	118	159	74	115	27	31	115
16	1965-66	136	115	155	74	114	26	31	117
17	1966-67	137	115	157	73	115	27	33	122
18	1967-68	140	121	164	74	117	27	33	122
19	1968-69	137	120	160	75	116	29	36	122
20	1969-70	139	124	162	76	117	30	37	123
	1960s	137	118	158	75	115	27	32	118
21	1970-71	140	124	166	75	118	31	38	123
22	1971-72	140	123	165	74	118	32	38	122
23	1972-73	137	119	162	74	118	32	39	123
24	1973-74	142	127	170	74	119	33	40	124
25	1974-75	138	121	164	74	119	34	42	124
26	1975-76	142	128	171	75	121	35	43	125
27	1976-77	140	124	167	74	120	35	44	124
28	1977-78	142	128	172	74	121	37	46	126
29	1978-79	143	129	175	74	122	38	48	127
30	1979-80	139	125	170	74	122	39	49	128
	1970s	140	125	168	74	120	34	43	125

Contd.

Appendix 2 contd.

Sl. No	Year	Area sown			Area under food	Cropping intensity	Irrigated area		Irrigation intensity
		Net	Gross				Net	Gross	
			Food crops	All crops	4/5*100	5/3*100			9/8*100
1	2	3	4	5	6	7	8	9	10
31	1980-81	140	127	173	73	123	39	50	129
32	1981-82	142	129	177	73	125	41	51	127
33	1982-83	140	125	173	72	123	41	52	127
34	1983-84	143	131	180	73	126	42	54	128
35	1984-85	141	127	176	72	125	42	55	129
36	1985-86	141	128	179	72	127	42	54	130
37	1986-87	140	127	176	72	126	43	56	131
38	1987-88	134	120	170	70	127	43	56	131
39	1988-89	142	128	181	71	128	46	61	132
40	1989-90	142	127	182	70	129	46	61	131
	1980s	140	127	177	72	126	42	55	130
41	1990-91	142	128	186	69	131	48	63	131
42	1991-92	142	123	182	67	129	50	65	130
43	1992-93	143	125	186	67	130	50	67	133
44	1993-94	142	125	186	67	131	52	68	133
45	1994-95	143	124	188	66	132	53	71	133
46	1995-96	142	121	187	65	131	53	71	134
47	1996-97	143	124	190	65	133	55	76	138
48	1997-98	142	124	191	65	134	55	75	137
49	1998-99	143	125	193	65	135	57	78	137
50	1999-00	141	123	190	65	134	57	79	138
	1990s	142	124	188	66	132	53	71	134
51	2000-01	141	121	185	65	131	55	77	139
52	2001-02	141	123	188	65	134	57	79	138
53	2002-03	133	114	176	65	133	54	74	136
54	2003-04	141	123	190	65	135	57	78	137
55	2004-05	141	120	192	63	136	59	80	135
56	2005-06	142	122	193	63	136	60	83	137
57	2006-07	140	124	193	64	138	62	86	140
58	2007-08	141	124	196	63	139	62	87	140
59	2008-09	142	123	195	63	138	64	89	140
60	2009-10	140	121	189	64	135	62	86	139
	2000s	140	121	190	64	135	59	82	138
61	2010-11	142	128	198	65	140	64	89	140
62	2011-12	141	127	196	65	139	65	92	140
	2010-12	141	127	197	65	139	64	90	140

Source: Ministry of Agriculture, Directorate of Economics & Statistics.
Ministry of Agriculture, Government of India, RBI. 2012-13.

Appendix 3: Tamil Nadu area sown and area irrigated from 1950-51 to 2011-12
(*000 ha)

Sl No	Year	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1	2	3	4	5	6
1	1950-51	5073	6914	1788	2190
2	1951-52	5348	7414	1934	2366
3	1952-53	5263	7212	1775	2249
4	1953-54	5657	6839	2091	2707
5	1954-55	5746	6942	2105	2959
6	1955-56	5668	6869	2101	2959
7	1956-57	5683	6938	2210	2925
8	1957-58	5560	6756	2197	2992
9	1958-59	5681	6919	2225	2959
10	1959-60	5775	7043	2248	2979
	1950s	5545	6985	2068	2729
11	1960-61	5997	7321	2462	3236
12	1961-62	6017	7270	2503	3207
13	1962-63	6096	7290	2507	3295
14	1963-64	6055	7192	2434	3268
15	1964-65	6030	7176	2425	3263
16	1965-66	5936	7066	2399	3178
17	1966-67	6085	7305	2511	3372
18	1967-68	6083	7309	2629	3476
19	1968-69	5891	6914	2417	3092
20	1969-70	6069	7162	2508	3272
	1960s	6026	7200	2480	3266
21	1970-71	6169	7384	2592	3410
22	1971-72	6348	7641	2710	3530
23	1972-73	6332	7699	2815	3673
24	1973-74	6175	7649	2814	3674
25	1974-75	5553	6640	2438	3033
26	1975-76	5989	7235	2565	3376
27	1976-77	6007	7147	2329	3001
28	1977-78	6295	7768	2836	3723
29	1978-79	6251	7684	2873	3819
30	1979-80	6232	7717	2984	3983
	1970s	6135	7457	2696	3522

Contd.

Appendix 3 contd.

Sl. No	Year	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1	2	3	4	5	6
31	1980-81	5360	6470	2571	3294
32	1981-82	5740	6909	2709	3425
33	1982-83	5259	6031	2255	2732
34	1983-84	5846	6945	2618	3249
35	1984-85	5788	7088	2640	3506
36	1985-86	5691	6819	2501	3240
37	1986-87	5544	6508	2356	2844
38	1987-88	5778	6729	2438	2945
39	1988-89	5547	6651	2375	2873
40	1989-90	5661	6822	2497	3045
	1980s	5621	6697	2496	3115
41	1990-91	5579	6632	2373	2894
42	1991-92	5726	6977	2605	3257
43	1992-93	5814	7067	2698	3385
44	1993-94	5901	7158	2800	3544
45	1994-95	5790	7026	2903	3588
46	1995-96	5342	6267	2625	3183
47	1996-97	5486	6457	2812	3347
48	1997-98	5581	6558	2945	3519
49	1998-99	5635	6627	3019	3635
50	1999-00	5464	6519	2972	3585
	1990s	5632	6729	2775	3394
51	2000-01	5303	6338	2888	3490
52	2001-02	5172	6226	2801	3412
53	2002-03	4590	5191	2309	2622
54	2003-04	4689	5316	2148	2479
55	2004-05	5097	5889	2637	3087
56	2005-06	5244	6033	2920	3397
57	2006-07	5126	5843	2889	3416
58	2007-08	5062	5815	2864	3251
59	2008-09	5043	5824	2931	3393
60	2009-10	4892	5572	2864	3238
	2000s	5022	5805	2725	3179
61	2010-11	4954	5753	2912	3348
62	2011-12	4986	5890	2964	3519
	2010-12	4970	5822	2938	3434

Source: GOTN, Season and Crop Reports, Various Issues.
GOTN, Tamil Nadu Economic Appraisal, Various Issues

Appendix 4: All India Area sown and area irrigated from 1950-51 to 2011-12
(million ha)

Sl. No	Year	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1	2	3	4	5	6
1	1950-51	118.8	131.9	20.9	22.6
2	1951-52	119.4	133.2	21.0	23.2
3	1952-53	123.4	137.2	21.1	23.3
4	1953-54	126.8	142.5	21.9	24.4
5	1954-55	127.8	144.1	22.1	24.9
6	1955-56	129.2	147.3	22.8	25.6
7	1956-57	130.8	149.5	22.5	25.7
8	1957-58	129.1	145.8	23.2	26.6
9	1958-59	131.8	151.6	23.4	26.9
10	1959-60	132.9	152.8	24.0	27.4
	1950s	127.0	143.6	22.3	25.1
11	1960-61	133.2	152.8	24.7	28.0
12	1961-62	135.4	156.2	24.9	28.5
13	1962-63	136.3	156.8	25.7	29.4
14	1963-64	136.5	157.0	25.9	29.7
15	1964-65	138.1	159.2	26.6	30.7
16	1965-66	136.2	155.3	26.3	30.9
17	1966-67	137.2	157.3	26.9	32.7
18	1967-68	139.9	163.7	27.2	33.2
19	1968-69	137.3	159.5	29.0	35.5
20	1969-70	138.8	162.3	30.2	37.0
	1960s	136.9	158.0	26.7	31.6
21	1970-71	140.3	165.8	31.1	38.2
22	1971-72	139.7	165.2	31.5	38.4
23	1972-73	137.1	162.1	31.8	39.0
24	1973-74	142.4	169.9	32.6	40.3
25	1974-75	137.8	164.2	33.7	41.7
26	1975-76	141.6	171.3	34.6	43.4
27	1976-77	139.5	167.3	35.1	43.5
28	1977-78	141.9	172.2	36.6	46.1
29	1978-79	143.0	174.8	38.1	48.3
30	1979-80	138.9	169.6	38.5	49.2
	1970s	140.2	168.2	34.4	42.8

Contd.

Appendix 4 contd.

S/No	Year	Net sown area	Gross cropped area	Net irrigated area	Gross irrigated area
1	2	3	4	5	6
31	1980-81	140.0	172.6	38.7	49.8
32	1981-82	141.9	176.8	40.5	51.4
33	1982-83	140.2	172.8	40.7	51.8
34	1983-84	142.8	179.6	42.0	53.8
35	1984-85	140.9	176.3	42.2	54.5
36	1985-86	140.9	178.5	41.9	54.3
37	1986-87	139.6	176.4	42.6	55.8
38	1987-88	134.0	170.1	42.9	56.1
39	1988-89	141.7	181.1	45.8	60.5
40	1989-90	141.5	182.2	46.2	60.5
	1980s	140.4	176.6	42.4	54.9
41	1990-91	142.2	185.9	47.8	62.5
42	1991-92	141.5	182.2	49.9	65.1
43	1992-93	142.6	185.6	50.3	66.8
44	1993-94	142.4	186.4	51.5	68.4
45	1994-95	143.0	188.1	53.0	70.6
46	1995-96	142.2	186.6	53.4	71.3
47	1996-97	143.0	189.5	55.1	76.0
48	1997-98	142.0	190.6	55.2	75.4
49	1998-99	142.8	192.6	57.4	78.4
50	1999-00	141.1	189.7	57.1	78.8
	1990s	142.3	187.7	53.1	71.3
51	2000-01	141.4	185.3	55.1	76.6
52	2001-02	140.7	188.3	56.9	78.7
53	2002-03	132.5	175.6	53.9	73.5
54	2003-04	140.8	190.1	57.0	78.0
55	2004-05	141.2	191.5	59.2	80.0
56	2005-06	141.5	193.0	60.4	82.6
57	2006-07	140.0	193.2	61.7	86.4
58	2007-08	140.9	195.8	62.3	87.4
59	2008-09	142.0	195.3	63.6	88.9
60	2009-10	140.0	189.0	61.9	85.9
	2000s	140.1	189.7	59.2	81.8
61	2010-11	141.6	197.6	63.5	88.6
62	2011-12	141.0	195.6	65.3	91.5
	2010-12	141.3	196.6	64.4	90.1

Source: Ministry of Agriculture, Directorate of Economics & Statistics.
Ministry of Agriculture, Government of India, RBI.

Appendix 5: Area, production and yield of rice along with % coverage under irrigation in India and Tamil Nadu 1950-1951 to 2009-2010

Year	Area (million ha)	Production (million tonne)	Yield ('00 kg/ ha)	% Coverage under irrigation	Area (million ha)	Production (million tonne)	Yield ('00 kg/ ha)
	INDIA				TAMIL NADU		
1950-51	30.8	20.6	6.68	31.7	1.723	1.712	9.94
1951-52	29.8	21.3	7.14	31.7	1.800	1.815	10.08
1952-53	30.0	22.9	7.64	32.3	1.716	1.713	9.99
1953-54	31.3	28.2	9.02	33.6	2.063	2.595	12.76
1954-55	30.8	25.2	8.20	34.4	2.159	2.780	12.88
1955-56	31.5	27.6	8.74	34.9	2.222	3.011	13.55
1956-57	32.3	29.0	9.00	35.4	2.316	3.247	14.02
1957-58	32.3	25.5	7.90	36.4	2.266	3.288	14.51
1958-59	33.2	30.9	9.30	36.3	2.273	3.134	13.79
1959-60	33.8	31.7	9.37	35.8	2.315	3.333	14.40
1960-61	34.1	34.6	10.13	36.8	2.518	3.559	14.13
1961-62	34.7	35.7	10.28	37.5	2.538	3.907	15.40
1962-63	35.7	33.2	9.31	37.4	2.666	4.024	15.10
1963-64	35.8	37.0	10.33	37.1	2.619	3.876	14.80
1964-65	36.5	39.3	10.78	37.3	2.626	4.036	15.37
1965-66	35.5	30.6	8.62	36.5	2.502	3.524	14.09
1966-67	35.3	30.4	8.63	37.9	2.628	4.076	15.51
1967-68	36.4	37.6	10.32	38.6	2.669	4.116	15.42
1968-69	37.0	39.8	10.76	38.4	2.572	3.94	15.32
1969-70	37.7	40.4	10.73	38.2	2.695	4.532	16.82
1970-71	37.6	42.2	11.23	38.4	2.686	5.303	19.74
1971-72	37.8	43.1	11.41	37.2	2.691	5.302	19.70
1972-73	36.7	39.2	10.70	39.1	2.851	5.569	19.54
1973-74	38.3	44.1	11.51	38.4	2.704	5.59	20.67
1974-75	37.9	39.6	10.45	38.8	2.238	3.575	15.97
1975-76	39.5	48.7	12.35	38.7	2.564	5.203	20.29
1976-77	38.5	41.9	10.89	38.4	2.284	4.215	18.46
1977-78	40.3	52.7	13.08	40.2	2.782	5.705	20.50
1978-79	40.5	53.8	13.28	41.6	2.756	5.559	20.17
1979-80	39.4	42.3	10.74	42.8	2.906	5.800	19.96

Contd.

Appendix 5 contd.

Year	Area (million ha)	Production (million tonne)	Yield ('00 Kg/ ha)	% Coverage under irrigation	Area (million ha)	Production (million tonne)	Yield ('00 kg/ ha)
	INDIA				TAMIL NADU		
1980-81	40.2	53.6	13.36	40.7	2.230	4.159	18.65
1981-82	40.7	53.3	13.08	41.5	2.467	5.607	22.73
1982-83	38.3	47.1	12.31	42.0	1.889	3.504	18.55
1983-84	41.2	60.1	14.57	42.7	2.353	4.466	18.98
1984-85	41.2	58.3	14.17	43.7	2.508	5.362	21.38
1985-86	41.1	63.8	15.52	42.9	2.264	5.371	23.72
1986-87	41.2	60.6	14.71	44.1	1.955	5.333	27.27
1987-88	38.8	56.9	14.65	43.6	2.012	5.604	27.86
1988-89	41.7	70.5	16.89	45.8	1.887	5.590	29.62
1989-90	42.2	73.6	17.45	46.1	1.963	6.063	30.89
1990-91	42.7	74.3	17.40	45.5	1.856	5.782	31.16
1991-92	42.7	74.7	17.51	47.3	2.118	6.596	31.15
1992-93	41.8	72.9	17.44	48.0	2.184	6.806	31.16
1993-94	42.5	80.3	18.88	48.6	2.306	6.750	29.27
1994-95	42.8	81.8	19.11	49.8	2.229	7.563	33.94
1995-96	42.8	77.0	17.97	49.9	1.951	5.290	27.12
1996-97	43.4	81.7	18.82	51.0	2.174	5.805	26.71
1997-98	43.5	82.5	19.00	50.8	2.261	6.894	30.50
1998-99	44.8	86.1	19.21	52.3	2.275	8.141	35.79
1999-00	45.2	89.7	19.86	53.9	2.164	7.532	34.81
2000-01	44.7	85.0	19.01	53.6	2.080	7.366	35.41
2001-02	44.9	93.3	20.79	53.2	2.060	6.584	31.96
2002-03	41.2	71.8	17.44	50.2	1.517	3.577	23.59
2003-04	42.6	88.5	20.77	52.6	1.397	3.223	23.08
2004-05	41.9	85.1	19.84	54.7	1.873	5.062	27.03
2005-06	43.7	91.8	21.02	56.0	2.051	5.220	25.46
2006-07	43.8	93.4	21.31	56.7	1.931	6.611	34.23
2007-08	43.9	96.7	22.02	56.9	1.789	5.040	28.17
2008-09	45.5	99.2	21.78	58.7	1.932	5.183	26.83
2009-10	41.9	89.1	21.25	58.0	1.846	5.665	30.70
2010-11	42.6	96.0	22.40	59.2	1.906	5.792	30.40
2011-12	44.0	105.3	23.72	59.6	1.904	7.459	39.18

Source : Indian Council of Agricultural Research. (13682),
Ministry of Agriculture, Govt. of India. (14105) & (14268)

Appendix 6: Area, production and yield of wheat along with % coverage under irrigation in India, 1950-1951 to 2009-2010

Year	Area (million ha)	Production (million tonne)	Yield ('00 kg/ ha)	% Coverage under irrigation
1950-51	9.8	6.5	6.63	34.0
1951-52	9.5	6.2	6.53	35.8
1952-53	9.8	7.5	7.63	37.2
1953-54	10.7	8.0	7.50	36.2
1954-55	11.3	9.0	8.03	35.0
1955-56	12.4	8.8	7.08	32.7
1956-57	13.5	9.4	6.95	29.4
1957-58	11.7	8.0	6.82	33.3
1958-59	12.6	10.0	7.89	31.8
1959-60	13.4	10.3	7.72	31.8
1960-61	12.9	11.0	8.51	32.7
1961-62	13.6	12.1	8.90	31.9
1962-63	13.6	10.8	7.93	33.8
1963-64	13.5	9.9	7.30	34.9
1964-65	13.4	12.3	9.13	36.8
1965-66	12.6	10.4	8.27	43.1
1966-67	12.8	11.4	8.87	48.0
1967-68	15.0	16.5	11.03	43.4
1968-69	16.0	18.7	11.69	49.8
1969-70	16.6	20.1	12.08	51.1
1970-71	18.2	23.8	13.07	54.3
1971-72	19.1	26.4	13.80	54.5
1972-73	19.5	24.7	12.71	57.6
1973-74	18.6	21.8	11.72	57.7
1974-75	18.0	24.1	13.38	61.8
1975-76	20.5	28.8	14.10	61.8
1976-77	20.9	29.0	13.87	65.1
1977-78	21.5	31.8	14.80	64.6
1978-79	22.6	35.5	15.68	66.0
1979-80	22.2	31.8	14.36	68.3
1980-81	22.3	36.3	16.30	76.5

Contd.

Appendix 6 contd.

Year	Area (million ha)	Production (million tonne)	Yield ('00 kg/ ha)	% Coverage under irrigation
1981-82	22.1	37.5	16.91	70.7
1982-83	23.6	42.8	18.16	72.5
1983-84	24.7	45.5	18.43	73.0
1984-85	23.6	44.1	18.70	74.5
1985-86	23.0	47.1	20.46	74.6
1986-87	23.1	44.3	19.16	76.3
1987-88	23.1	46.2	20.02	76.8
1988-89	24.1	54.1	22.44	79.2
1989-90	23.5	49.9	21.21	80.3
1990-91	24.2	55.1	22.81	81.1
1991-92	23.3	55.7	23.94	83.7
1992-93	24.6	57.2	23.27	84.2
1993-94	25.2	59.8	23.80	84.8
1994-95	25.7	65.8	25.59	85.2
1995-96	25.0	62.1	24.83	85.8
1996-97	25.9	69.4	26.79	86.2
1997-98	26.7	66.4	24.85	85.8
1998-99	27.5	71.3	25.90	85.8
1999-00	27.5	76.4	27.78	87.2
2000-01	25.7	69.7	27.08	88.1
2001-02	26.3	72.8	27.62	87.4
2002-03	25.2	65.8	26.10	88.0
2003-04	26.6	72.2	27.13	88.4
2004-05	26.4	68.6	26.02	89.4
2005-06	26.5	69.4	26.19	89.6
2006-07	28.0	75.8	27.08	90.2
2007-08	28.0	78.6	28.02	90.9
2008-09	27.8	80.7	29.07	91.3
2009-10	28.5	80.8	28.39	91.7
2010-11	29.3	86.9	29.38	92.1
2011-12	29.9	94.9	31.40	92.8

Source : Ministry of Agriculture, Govt. of India. (14105) & (14268)

Source : Ministry of Agriculture, Government of India, RBI, 2012-13.

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