An Eminent Scientist and a Great Humanist

Print

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It is a great honour and privilege to be asked to write about Dr. M. S. Swaminathan, who was not only an outstanding scientist, but also one who did his best to provide a bridge between the laboratory and the field. In this process, he transformed Indian agriculture. Thanks to him India ceased to be a land of food scarcity.

Swaminathan's research and his subsequent efforts to change the status of Indian agriculture have to be seen in context. India's wheat production in 1950–51 was 6.46 million tonnes a year. On the eve of the Green Revolution in 1966–67, production touched 11.39 million tonnes a year. The yield per hectare in 1950–51 was 663 kg. By 1971–72, wheat production touched 26.41 million tonnes a year, that is, it more than doubled in five years. The yield per hectare in 1971–72 rose to 1380 kg. The rate of increase in production subsequently slowed. Nevertheless, there was a steady increase and India's wheat production in 2021 was 109.59 million tonnes.

Prior to 1966–67, the wheat we produced was not adequate to meet our demand. We depended heavily on wheat imports under the PL-480 scheme from the United States. The situation was described as a "ship to mouth" existence. The wheat revolution was followed by a rice revolution, although the latter was not as dramatic (see Table 1 and Figures 1 and 2). Today, India is self-sufficient in grain and is even a net exporter of grain, thanks to the transformation in agriculture heralded by the Green Revolution.

Table 1 *All-India production and yield of wheat, rice, and total food grain*

Year	Wheat		Rice		Total foodgrain	
	Production (Million Tonnes)	Yield (Kg/Hectare)	Production (Million Tonnes)	Yield (Kg/Hectare)	Production (Million Tonnes)	Yield (Kg/Hectare)
1950-51	6.46	663	20.58	668	50.82	522
1951-52	6.18	653	21.30	714	51.99	536
1952-53	7.50	763	22.90	764	59.20	580
1953-54	8.02	750	28.21	902	69.82	640
1954-55	9.04	803	25.22	820	68.03	631
1955-56	8.76	708	27.56	874	66.85	605
1956-57	9.40	695	29.04	900	69.86	629
1957-58	7.99	682	25.53	790	64.31	587
1958-59	9.96	789	30.85	930	77.14	672
1959-60	10.32	772	31.68	937	76.67	662
1960-61	11.00	851	34.58	1013	82.02	710
1961-62	12.07	890	35.66	1028	82.71	706
1962-63	10.78	793	33.21	931	80.15	680
1963-64	9.85	730	37.00	1033	80.64	687
1964-65	12.26	913	39.31	1078	89.36	757
1965-66	10.40	827	30.59	862	72.35	629
1966-67	11.39	887	30.44	864	74.23	644
1967-68	16.54	1103	37.61	1032	95.05	783
1968-69	18.65	1169	39.76	1075	94.01	781
1969-70	20.09	1208	40.43	1073	99.50	805
1970-71	23.83	1307	42.22	1123	108.42	872
1971-72	26.41	1380	43.07	1141	105.17	858
1972-73	24.74	1271	39.24	1070	97.03	813
1973-74	21.78	1172	44.05	1150	104.67	827
1974-75	24.10	1338	39.58	1045	99.83	824
1975-76	28.84	1410	48.74	1235	121.03	944
1976-77	29.01	1387	41.92	1089	111.17	894

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1977-78	31.75	1480	52.67	1308	126.41	991
1978-79	35.51	1568	53.77	1328	131.90	1022
1979-80	31.83	1436	42.33	1074	109.70	876
1980-81	36.31	1630	53.63	1336	129.59	1023
1981-82	37.45	1691	53.25	1308	133.30	1032
1982-83	42.79	1816	47.12	1232	129.52	1035
1983-84	45.48	1843	60.10	1457	152.37	1162
1984-85	44.07	1870	58.34	1417	145.54	1149
1985-86	47.05	2046	63.83	1552	150.44	1175
1986-87	44.32	1916	60.56	1471	143.42	1128
1987-88	46.17	2002	56.86	1465	140.35	1173
1988-89	54.11	2244	70.49	1689	169.92	1331
1989-90	49.85	2121	73.57	1745	171.04	1349
1990-91	55.14	2281	74.29	1740	176.39	1380
1991-92	55.69	2394	74.68	1751	168.38	1382
1992-93	57.21	2327	72.86	1744	179.48	1457
1993-94	59.84	2380	80.30	1888	184.26	1501
1994-95	65.77	2559	81.81	1911	191.50	1546
1995-96	62.10	2483	76.98	1797	180.42	1491
1996-97	69.35	2679	81.73	1882	199.34	1614
1997-98	66.35	2485	82.54	1900	192.26	1552
1998-99	71.29	2590	86.08	1921	203.61	1627
1999-00	76.37	2778	89.68	1986	209.80	1704
2000-01	69.68	2708	84.98	1901	196.81	1626
2001-02	72.77	2762	93.34	2079	212.85	1734
2002-03	65.76	2610	71.82	1744	174.77	1535
2003-04	72.16	2713	88.53	2079	213.19	1727
2004-05	68.64	2602	83.13	1984	198.36	1652
2005-06	69.35	2619	91.79	2102	208.60	1715
2006-07	75.81	2708	93.36	2131	217.28	1756
2007-08	78.57	2802	96.69	2202	230.78	1860
2008-09	80.68	2907	99.18	2178	234.47	1909
2009-10	80.80	2839	89.09	2125	218.11	1798
2010-11	86.87	2988	95.98	2239	244.49	1930
2011-12	94.88	3177	105.30	2393	259.29	2078
2012-13	93.51	3117	105.23	2461	257.13	2129
2013-14	95.85	3146	106.65	2416	265.05	2120
2014-15	86.53	2750	105.48	2391	252.03	2028
2015-16	92.29	3034	104.41	2400	251.54	2041
2016-17	98.51	3200	109.70	2494	275.11	2129
2017-18	99.87	3368	112.76	2576	285.01	2235
2018-19	103.60	3533	116.48	2638	285.21	2286
2019-20	107.86	3440	118.87	2722	297.50	2343

Year	Wheat		Rice		Total foodgrain	
	Production (Million Tonnes)	Yield (Kg/Hectare)	Production (Million Tonnes)	Yield (Kg/Hectare)	Production (Million Tonnes)	Yield (Kg/Hectare)
2020-21	109.59	3521	124.37	2717	310.74	2394
2021-22*	106.84	3507	130.29	2809	315.72	2419

Source: Economics and Statistics Division, Department of Agriculture and Farmers Welfare, GoI.

*4th Advance Estimates.

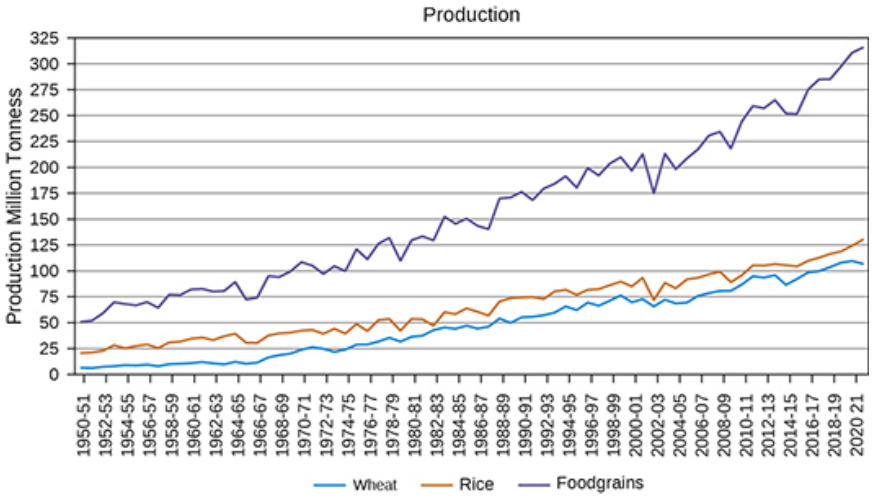

Figure 1 *Production of wheat, rice and foodgrain, India, 1950-51 to 2020-21*

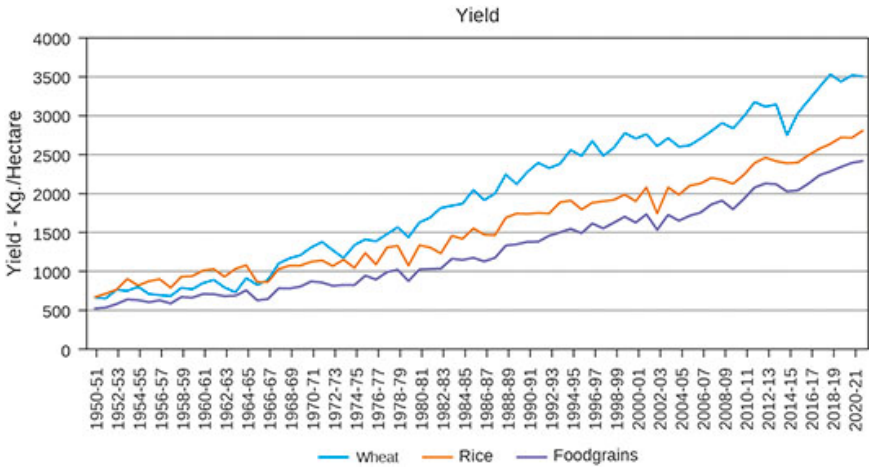

Figure 2 *Yield of wheat, rice and foodgrain, India, 1950-51 to 2020-21*

Genesis of the Green Revolution

What were the key elements of the "Green Revolution"? What propelled India's agricultural growth? What was the combination of factors needed to push the agrarian economy forward? What was the role of public policy in this whole effort?

The beginnings of the Green Revolution lay in the technological developments in agriculture that were being studied and researched, particularly in the area of plant genetics. The main leader in this area was Norman Borlaug. Dwarf varieties of wheat had been developed as high-yielding varieties. Swaminathan's efforts led to Borlaug visiting India. Swaminathan wrote:

> In March 1963, some of my colleagues and I took Dr. Borlaug to the major wheat-growing regions of the country. It was a wonderful experience travelling with him, since I found him to be not only a brilliant scientist, but humanitarian to the core. In an article in *Yojana* (published by the Planning Commission in 1965), I referred to Dr. Borlaug as the Albert Schweitzer of agriculture, and I was happy that, like Schweitzer, he received the Nobel Peace Prize. (Swaminathan, 2010)

Swaminathan's efforts to adapt the seeds to suit Indian conditions were equally important in ushering in the Green Revolution. It is interesting to note that the visit of Borlaug to India was financed by the Rockefeller Foundation. The import of 18,000 tonnes of wheat seeds was also funded by the Rockefeller Foundation. Thus, from scientific research to actual operation, there was a high degree of international cooperation.

Swaminathan's efforts to usher in the new revolution in agriculture went beyond his scientific research. The new varieties of seeds needed a large quantum of fertilizers. Seed farms had to be established to produce the new varieties in adequate quantities. Last but not least, farmers had to be convinced of the "miracle" nature of the new technology. Swaminathan's actions in coordinating and creating a programme to follow deserves recognition as much as his scientific work.

C. Subramaniam was Minister for Food and Agriculture at that time and also played an important role in getting the programme going. Volume 2 of his memoir, *Hand of Destiny*, is titled "The Green Revolution." He describes the great efforts he had to make to get the Cabinet and Parliament to approve the new agricultural policy. The new policy was even criticised by some as a "sellout" to foreigners. The Left was highly sceptical. While some of the misgivings might have been genuine, some were invented.

It is interesting to note some of the issues on which decisions had to be taken. One was whether the launch should be confined to "progressive farmers" (which may have meant large farmers) or spread over a wide cross-section of farmers. The second was whether the launch should be a phased one or should be a big leap. Should the government be prepared to compensate farmers in case of failure? Subramaniam's and Swaminathan's writings refer to these issues and how they were resolved.

There were also other questions. Should the new strategy follow land reforms or precede them? Other economists, notably B. S. Minhas and T. N. Srinivasan, questioned the allocation of fertilizers between new varieties and existing varieties. They were also critical of the recommended dose of fertilizer application. They wrote:

> It is our contention that these conclusions are based on insufficient evidence on the responses of new crop varieties to fertilizers. The enthusiasm for extremely high dosages of chemical fertilizers is born out of lack of appreciation of the problem of optimal allocation of fertilizers from the point of view of maximal production in the nation. The recommended dosages seem to disregard the criterion of private profitability of fertilizer use to millions of farmers who are going to put this programme through. (Minhas and Srinivasan, 1966)

There was a reply to this article by an official of the Agriculture Ministry. This did not address the issues brought up by Minhas and Srinivasan, who were raising a point with respect to the optimal allocation of fertilizers between the new and old varieties. They did not disagree with the high productivity of the new varieties. Also, at the time of launching the Green Revolution there was limited knowledge on the response to the new varieties. Much of the available data came from experimental farms. However, the leaders of the Green Revolution were very confident of the success of the programme, and ultimately were proven right. Success often comes to those who dare and act. Seldom does it go to the timid.

Role of Public Policy

The new strategy called for many new initiatives in public policy. Take the example of fertilizer. The need for fertilizer increased phenomenally after the new varieties became widespread. India did not have enough foreign exchange to import the quantity of fertilizer it needed. A new policy for the fertilizer industry had to be put in place. The entry of the public sector into fertilizer production was one consequence. Questions also arose on the appropriate policy with respect to agricultural prices. Should policy aim at providing a remunerative price for farmers, and if so, what form should such policy take? A huge procurement policy would require adequate organisational and financial support.

Ultimately, the Green Revolution was the result of a successful combination of technology and public policy intervention. As Swaminathan himself put it:

> Scientific and public policy initiatives led to the green revolution of the 1960s. Amongst them, sharply focused inter-disciplinary research and international collaboration are important. Eternal vigilance is the price of stable agriculture and this will call for concerted and continuous attention to soil and plant health and to the scientific checkmating of the adverse impact of climate change. At the public policy level, assured and remunerative marketing opportunities hold the key to stimulating and sustaining farmers' interest in achieving higher productivity and production. This is the pathway to shaping our agricultural future. (Swaminathan, 2013)

Post-Green Revolution Issues

Swaminathan's concerns about agriculture continued even beyond the Green Revolution. High-yielding varieties of seeds introduced during the Green Revolution need more fertilizers and more water. Punjab, which was a pioneer in the Green Revolution, faces a serious situation in terms of its cropping pattern. Analysts are raising questions about the continued cultivation of paddy. The damage caused by ecologically unsustainable growth is talked about widely now. Swaminathan warned early of the need to "prevent the Green Revolution from becoming a 'greed revolution'." He coined the term "evergreen revolution" to emphasise the need for improving productivity in perpetuity without any associated ecological harm. Parenthetically, Swaminathan was adept at coining catchy phrases. In fact, he was a brilliant speaker, a very rare capacity among scientists.

One of the reasons for agrarian distress is the declining average size of farm holdings and the difficulty of raising farm incomes on plots of small size. The average size of holding declined from 2.3 ha in 1970–71 to 1.08 ha in 2015–16. The share of small and marginal farmers increased from 70 per cent of cultivators in 1980–81 to 86 per cent in 2015–16. At the State level, the average size of farm holdings in 2015–16 was 3.62 ha in Punjab, 2.73 ha in Rajasthan, 2.22 ha in Haryana, 0.75 ha in Tamil Nadu, 0.73 ha in Uttar Pradesh, 0.39 ha in Bihar, and 0.18 ha in Kerala. This raises the question of ensuring adequate incomes to farmers, even if we increase productivity. The ingredients of transformation have thus far been scale-neutral. Will farmer-producer organisations be an answer to the declining size of land holdings? The price policy for agricultural products has been a controversial issue. Has not the time come to distinguish between minimum support

price and remunerative price? The area available for agriculture will diminish in the future. At the same time, because of income growth, the demand for agro-products -- as industrial inputs and for direct consumption -- will increase. The number of people dependent on agriculture will decline. This is related to how fast the growth of the industrial and service sectors is likely to be. I analysed the interdependence between agriculture and industry in an article in 1982 (Rangarajan, 1982). There is a mutually interacting favourable impact that we need to exploit. In consolidating the income of the marginal farmers, the link with small and tiny industries must be explored. Quite clearly, with a significant proportion of the population living in rural areas, growth in agricultural income is key to reducing, and ultimately eliminating, poverty.

A host of other issues now beset Indian agriculture and food consumption. Today, although we have, in a sense, achieved food security, for a healthy society, we need to move from *food* security to *nutrition* security. Malnutrition, especially among children, is high in India. This is only partly an agricultural problem. Here again, public policy intervention becomes important.

Swaminathan was an outstanding scientific innovator, an able organisation man and a humanist with a deep empathy for the farmers of India. His efforts to revolutionise Indian agriculture transformed India. The country is truly poorer with his demise. As we grapple with newer issues related to agricultural productivity and production, ecological impact, farmers' incomes, and nutrition levels, we should seek to find solutions to these issues in the spirit in which M. S. Swaminathan launched the original Green Revolution.

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