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Study on Yield Gap in Food Crops and Commodity Potential in Tamil Nadu

A. Malaisamy

Associate Professor, Agricultural Economics, Tamil Nadu Agricultural University, Tamil Nadu, India

Corresponding author: malaisamyecon@gmail.com (**ORCID ID:** 0000-0001-8822-6714)

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ABSTRACT

The food production must increase substantially in pace with the population growth. However, the food production is limited due to land availability, climatic conditions, water resources, and many other biophysical factors. Quantifying the food production in every hectare is necessary to take counter measures to improve the yield growth. The yield gap is the variation between the average actual yield and the average expected yield. This study quantifies the yield gap in significant regions of the Tirunelveli district concerning Food Crops production. The study involves the historical information of Tirunelveli for a range of 20 years. This gap is likely due to degraded, less fertile soils, pockets of endemic cropping systems, and a low adoption rate of high yielding technologies by farmers. . The yield gap in India reveals the bridgeable gap to be quite broad. The districts are clustered based on productivity and the yield gap. The inferences will help to take necessary precautions to reduce the yield gap and keep pace with the demand and the supply of essential food crops.

HIGHLIGHTS

- Yield gap analysis provides a measure of untapped food production capacity.
- Increase the yields on the existing croplands (i.e. closing the yield gaps) –Reallocate current agricultural production to more productive uses.
- A novel approach was developed to investigate causes of yield gap over large regions agricultural food crop demand is expected to increase by 50% by 2050.

Keywords: Yield gap, potential yield, average yield, cropping intensity, net area sown

Yield potential is the yield of a crop cultivar when grown in an environment to which it is adapted, with non-limiting water and nutrient supplies, and with pests, weeds, and diseases effectively controlled (Sadras *et al.* 2015). The difference between Yp in rainfed conditions) and average producer yield is termed the yield gap (Yg). (Van Ittersum *et al.* 2013). The most common approach for assessing the magnitude and causes of Yield gap in localized areas involves conducting controlled research trials in which researchers experimentally evaluate various input levels or management practices to identify whether a particular input or practice improve yield and if the degree of yield improvement justifies input costs (Yang *et al.* 2017). Consequently, most studies addressing the causes of the Yield gap through on-farm trials have been confined to small geographic

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areas where field-to-field variation in weather is small Villamil *et al.* 2012).

Tirunelveli district is located in the southern part of Tamil Nadu and surrounded by Virudhunagar District on the North, Western Ghats on the West, Kanyakumari District on the South and Tuticorin District on the East. This District has three Revenue Divisions comprising 11 Taluks, 19 Development Blocks, 628 Revenue Villages, and 425 Village Panchayats. Tirunelveli district is provided with varied agro-climatic conditions ranging from extreme tropical to subtropical. The District is blessed with the Western Ghats from which the perennial rivers flow and drain towards the east (Silva *et al.* (2016). The entire surface water of the District is drained into major river basins *viz.*, Thamiraparani, Vaippar, Nambiar, and Hanmanathi. Thamiraparani is the central river basin in the District. The other seasonal streams are Servallar, Manimuthar, Ramanathi, Pachayar, Chittar and Uppodai rivers, which drain into the Thamiraparani basin. The significant sources of irrigation are canals, Tank, and Well. The present study was to identify causes of the Yield gap across large Tirunelveli geographic areas, and results were presented.

MATERIALS AND METHODS

Tirunelveli District, Tamil Nadu, was purposively selected, as it formed one of the predominant food crops growing areas of the State. The sample size selected was 60, consisting of 20 farmers from marginal; small, and big farmer categories. A well-structured interview schedule was constructed, and data was collected from the respondents through the personal interview method.

Yield Gap = Potential Yield – Actual yield /Potential Yield X100

The yield gap was operationalized as the percent difference between potential yield (yield obtained at the Research Station) and the actual yield obtained in the farmers' field (Rowntree *et al.* 2013). The average yield gap was assessed for food crops for Paddy and Block Gram

RESULTS AND DISCUSSION

Trend in Area, Production, and Productivity of Major Crops in Tirunelveli District

The area and production and productivity (CGR) of major crops like paddy, Cholam, maize, sugarcane, and Bengal gram cotton of Tirunelveli district are given in Table 1.

Table 1: Growth Rates of Area, Production and Productivity of Major Crops in Tirunelveli

CGR for Principle Crops (percentage)				
Sl. No.	**Crop name**	**Area**	**Production**	**Productivity**
1	Paddy	0.705	0.749	0.044
2	Cholam	-0.359	2.915	3.285
3	Cumbu	-17.310	-13.428	4.694
4	Maize	10.470	28.734	16.534
5	Ragi	-16.596	-16.005	0.709
6	Bengal gram	6.759	16.578	9.198
7	Green gram	9.923	6.770	-2.868
8	Red gram	-0.064	0.796	0.861
9	Black gram	6.555	2.144	-4.139
10	Horse gram	-9.378	-15.111	-6.327
11	Chilles	-4.710	-1.075	3.814
12	Turmaric	-8.024	-7.867	0.171
13	Sugarcane	4.419	5.016	0.572
14	Onion	4.675	9.926	5.017
15	Gingelly	-2.995	1.943	5.090

Projected Area, Yield and Production based on Current Trend

The Area, Production, Productivity of the crops for the year of 2023 has been calculated and furnished in the Table 2.

Table 2: Projected Area, Production, Productivity for 2023

Sl. No.	Crop name	Area (ha)	Production (Tonnes)	Productivity (Production/ Area
1	Paddy	91681.366	376849.647	4.110
2	Cholam	1999.376	7038.282	3.520
3	Cumbu	23.165	93.620	4.041

4	Maize	39284.443	1036723.680	26.390
5	Ragi	8.878	25.987	2.927
6	Bengal gram	11.439	47.362	4.140
7	Green gram	32116.240	9120.879	0.284
8	Red gram	53.372	40.914	0.767
9	Black gram	38172.482	7216.634	0.189
10	Horse gram	30.123	4.035	0.134
11	Chilles	930.798	2059.196	2.212
12	Turmaric	1.155	5.961	5.163
13	Sugarcane	9557.126	911611.204	95.385
14	Onion	3774.095	100452.246	26.616
15	Gingelly	835.468	760.808	0.911

Paddy

Table 3: Yield Gap Analysis for Paddy in Tirunelveli District

	Yield in Kg/ha		Overall Yield Gap
Variety	**Yield GAP I**	**Yield GAP II**	
ADT 43	1895	1431	3326
ADT 45	3330	1679	5009
ASD 16	404	1046	1450
ADT 39	626	249	1450
CO 49	1459	1666	3125
BPT 5204	185	304	489

Ruling Varieties	**ADT 43**	**ADT 45**	**ASD 16**	**ADT 39**	**CO 49**	**BPT 5204**
Potential Yield	8381	9230	5600	7000	9750	7989
Progressive farmer yield	6486	5900	5196	6374	8291	7804
Average Yield	5055	4221	4150	6125	6625	7500
Overall Yield Gap	3326	5009	1450	875	3125	489
Required Growth Rates	65.80	118.67	34.94	14.29	47.17	6.52
Annual Growth Rate	5.48	9.89	2.91	1.19	3.93	0.54

Year	**ADT 43**	**ADT 45**	**ASD 16**	**ADT 39**	**CO 49**	**BPT 5204**
2010-11	5055	4221	4150	6125	6625	7500
2011-12	5332	4638	4271	6198	6885	7541
2012-13	5625	5097	4395	6272	7156	7582
2013-14	5933	5601	4523	6346	7437	7623
2014-15	6258	6155	4655	6422	7730	7664
2015-16	6601	6764	4790	6498	8034	7706
2016-17	6963	7433	4930	6576	8349	7748
2017-18	7345	8168	5073	6654	8678	7790
2018-19	7748	8975	5221	6733	9019	7832
2019-20	8173	9863	5373	6813	9373	7875
2020-21	8621	10838	5530	6894	9742	7918
2021-22	9093	11910	5691	6977	10125	7961
2022-23	9592	13088	5856	7060	10522	8004

		Units
Area under Paddy	79764	Ha
Production	351822	Tonnes
Yield	4.41	Tonnes
Doubling the production	703644	Tonnes
Yield	8.82	Tonnes

	ADT 43	**ADT 45**	**ASD 16**	**ADT 39**	**CO 49**	**BPT 5204**	
Proportion of varieties	0.036	0.131	0.47	0.063	0.23	0.07	1
Area	2872	10449	37489	5025	18346	5583	79764
2011-12	15311	13319	12264	17797	19772	21653	100116
2012-13	16151	53260	164771	31516	131283	42332	439314
2013-14	17036	58527	169569	31891	136444	42562	456030
2014-15	17971	64315	174506	32271	141807	42794	473663
2015-16	18956	70675	179587	32655	147381	43026	492280
2016-17	19995	77664	184816	33044	153175	43260	511953
2017-18	21092	85344	190197	33437	159196	43495	532761
2018-19	22248	93784	195735	33835	165453	43731	554787
2019-20	23468	103058	201434	34238	171957	43969	578124
2020-21	24755	113250	207299	34646	178716	44208	602873
2021-22	26112	124449	213335	35058	185741	44448	629143
2022-23	27544	136756	219547	35476	193042	44690	**657054**

In Tirunelveli district, the major paddy varieties are ASD 16 (47%), CO 49 (23%), ADT 45 (13%), BPT (7%), ADT 39 (6%) and ADT 43 (3%), The yield gap for this varieties are 1450kg/ha, 3125kg/ha, 5009kg/ha, 489kg/ha, 875kg/ha and 3326 respectively. The required annual growth was worked out as 2.91 %, 3.93 %, 9.89 %, 0.54%, 1.19 % and 5.48 % respectively to reduce yield gap in this varieties. With this calculated annual growth rate, Tirunelveli district will reach the projected production near to double (657054 tonnes) in 2023 from the present level of 351822 tonnes.

Blackgram

In Tirunelveli district, the major Blackgram varieties are VBN 3 (60%), VBN 4 (20%), ADT 3 (10%), ADT 4 (2%), CO 5 (3%) and T 9 (5%). The yield gap for this varieties are 490kg/ha, 560kg/ha, 400kg/ha, 172kg/ha, 850kg/ha and 858kg/ha respectively. To reduce yield gap in this

varieties, the required annual growth was worked out as 12.19 %, 13.73%, 10.42 %, 3.35%, 16.87 %, and 50.35%, respectively. With this calculated annual growth rate, as per our Tamil Nadu Government, concentration on pulses on Tirunelveli district will reach the projected production of more than triple (23684 tonnes) in 2023 from the present level 3281 tonnes.

Table 4: Yield Gap Analysis for Black gram Yield in Kg/ha

Variety	Yield GAP I	Yield GAP II	Overall YG
VBN3	436	54	490
VBN4	294	266	560
ADT3	63	337	400
ADT4	100	72	172
CO5	830	20	850
T9	844	14	858

Ruling Varieties	VBN3	VBN4	ADT3	ADT4	CO5	T9
Potential Yield	825	900	720	600	1270	1000
Progresive farmer yield	389	606	657	500	440	156
Average Yield	335	340	320	428	420	142
Overall Yield Gap	490	560	400	172	850	858
Required Growth Rates	146.27	164.71	125.00	40.19	202.38	604.23
Annual Growth Rate	12.19	13.73	10.42	3.35	16.87	50.35

Year	VBN3	VBN4	ADT3	ADT4	CO5	T9
2010-11	335	340	320	428	420	142
2019-20	943	1082	781	576	1708	5575
2020-21	1058	1230	862	595	1996	8383
2021-22	1187	1399	952	615	2332	12604
2022-23	1332	1591	1051	635	2726	18950

		Units
Area under Black gram	10459	Ha
Production	3281	Tonnes
Yield	0.31	Tonnes
Doubling the production	6562	Tonnes
Yield	0.63	Tonnes

	VBN3	VBN4	ADT3	ADT4	CO5	T9	
Proportion of varieties	0.6	0.2	0.1	0.02	0.03	0.05	1
Area	6275	2092	1046	209	314	523	10459
2011-12	2359	2426	2217	2776	3080	1340	14198
2019-20	5919	2263	816	120	536	2916	12570
2020-21	6640	2574	902	124	626	4384	15250
2021-22	7450	2927	995	129	732	6591	18824
2022-23	8358	3329	1099	133	855	9910	23684

Conclusion

Prioritize research and inform agricultural policies to ensure global food security through a focus on regions with the most significant unexploited yield gaps and most significant potential to close them through new high-yielding varieties. The spatial patterns of agricultural management practices and yield limitation, and the management changes that may be necessary to achieve increased yields.

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