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Trend of Organic Farming in India: A Spatio-Temporal Analysis

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Abstract
Background: Organic farming as a sustainable agricultural practice is gaining wide popularity in India. However, the overall coverage of organic farming in the country is only 2%. The indiscriminate use of chemical fertilizers and pesticides has resulted in severe decline in soil fertility, along with environmental pollution, death of beneficial insects, birds, soil microorganisms, etc., and has also posed serious threat to human health due to contamination of food by such chemicals. In order to understand the status of chemical and organic input use in Indian agriculture, this paper has attempted to calculate the growth rates in consumption of chemical and organic fertilizers and pesticides in the country in the last twenty years (2000-01 to 2020-21). A state/UT-wise analysis of the consumption trends have also been done. The states and UTs have been ordered as per their performance in terms of organic farming adoption. In the last section, important government organic policies have been reviewed using secondary data to find the relation between presence of government policy and area under organic farming in a state/UT.
Materials and Methods: The growth rate of chemical and organic fertilizers/pesticides has been calculated using Compound Annual Growth Rate (CAGR). States and UTs have been assigned ranks with respect to organic farming adoption by using the Kendall's Ranking Coefficient Index. Political maps of India have been created using ArcMap 10.3 software. Simple bar graphs and Line Graphs prepared in MS-Excel have been used to represent other data.
Results: Compound Annual Growth Rates (CAGR) for India has shown that growth of bio-fertilizers as well as bio-pesticides (19.06 and 13.56 percent respectively) has been much higher than chemical fertilizers and chemical pesticides (3.02 and 1.79 percent respectively). The application of total organic manure has declined slightly by 1.22 percent between 2007-08 and 2017-18. However, the use of vermin-compost has registered mani-fold rise of around 2400 percent in the same period. Kendall's composite index shows that the north-eastern states have performed the best with minimum use of chemical fertilizers/pesticides per unit of gross cropped area. It was found that states/UTs having a separate organic farming policy along In the last section, the area under organic farming in different states/UTs and important government organic policies were reviewed.have been able to perform better with respect to adoption of organic farming than other states with no policies of their own.
Key words: chemical farming, CAGR, composite index, organic farming, organic policies.

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I. INTRODUCTION

Chemical farming has taken the mainstream position in Indian agriculture since the Green Revolution. However, in recent years, organic farming is also gaining popularity due to increased awareness about the impacts of chemical farming on soil, water, animal and human health. The original purpose of the Green revolution of the 1960s was to intensify farming where returns would be high, with a focus on irrigated or high rainfall areas (Pingali 2012).The improved varieties needed a timely application of costly inputs like irrigation water, fertilizers and pesticides and, thus the diffusion of HYVs was mainly in the Satluj-Ganga Plains (Punjab, Haryana and Western Uttar Pradesh) and the Kaveri delta in Tamil Nadu (Husain 2019). The adoption of this technology gave remarkable increase in production, especially of wheat and rice. There also occurred rapid expansion in net sown area from 119 million ha in 1950-51 to 133 million ha by 1960-61, and further to 140 million ha by 1970-71 (Abrol undated). Afterwards, the net sown area increased at a negligible rate and reached 140.02 million ha. in 2010-11. The total consumption of chemical fertilizers thus also increased rapidly with increase in cultivation area, from 2.21 kg/ha. in 1960-61 to 16.12 kg/ha. in 1970-71, and to 142.26 kg/ha. in 2010-11 (Ministry of Agriculture).

Chemical Fertilizers

Chemical Fertilizers have played important role in addressing the macro-nutrient deficiency in soils and in improvement of crop yields. But several negative impacts are also caused by their use which include environment pollution (soil, water, air pollution), reduced input efficiency, decreased food quality, resistance development in different weeds, diseases, soil degradation, micronutrient deficiency in soil, toxicity to different beneficial living organisms present above and below the soil surface, less income from the production, etc. (Chandini et al 2015).

Chemical Pesticides

Pesticides were found to be the main cause of poisoning in adults in India in a recent study by Mittal et. al. (2021). Heavy doses of chemical pesticides in soil also kills beneficial insects and microbes, and prolonged use can develop resistance among pests with respect to certain pesticides, thus threatening crop health. Devi, Thomas and Raju (2017) have found a declining trend in pesticide consumption in India between 1990-91 and 2012-13, with an annual compound rate of -2.48 per cent, however, several states also registered positive growth and had higher intensity of pesticide use.

Need for Organic Farming

Declining soil productivity along with rising costs of cultivation (due to heavier investments in modern chemical inputs year after year) leads to agriculture becoming increasingly uneconomic, especially to small farmers. In such conditions, organic farming can be a solution to help small cultivators to come out of poverty. Studies have suggested that adoption of organic practices can lead to significant reduction in cultivation costs and higher profits, enhance soil fertility, reduce indebtedness and improve livelihoods (Eyhorn 2007, Antony 2019, Mariappan and Zhou 2019, Saxena et. al. 2020). More recently, organic practices like zero-budget natural farming (ZBNF), which has been adopted as a public policy in Andhra Pradesh and also initiated by states like Himachal Pradesh and Kerala, stresses on zero dependence on external inputs to reduce farmers' direct costs (hence 'zero budget'), while boosting yields and farm health through the use of non-synthetic inputs sourced locally ('natural farming') (Khadse and Rosset 2019; Bharucha, Mitjans and Pretty 2020).

Organic Fertilizers/Manures and Bio-Fertilizers

Organic fertilizers are naturally available mineral sources which gradually release nutrients into the soil solution, maintain nutrient balance for healthy growth of crop plants and also act as an effective energy source of soil microbes which in turn improve soil structure and crop growth (Shaji, Chandran and Mathew 2020). Compost and vermicompost, green manures, animal manure, microbial fertilizers and mineral fertilizers are major types of organic fertilizers (FAO 2015).

Bio-fertilizer can be defined as a formulation containing live microbes which helps in enhancing the soil fertility by fixing atmospheric nitrogen, solubilization of phosphorus and other nutrients and augmenting plant growth by producing growth hormones (Barman et. al. 2017). Some common bio-fertilizers are Rhizobium, Azospirillum, Azolla, Phosphate-Solubilizing Bacteria(PSB), Azotobacter, Blue Green Algae, etc. Biofertilizers are favoured for sustainable agriculture due to their less harmful impacts on environment. However, these fertilizers are of recent origin and have negligible share in total fertilizer consumption as compared to chemical fertilizers and organic manures.

Bio-Pesticides

Bio-pesticides, which are derived from living natural enemy organisms including plants and microbes, are considered as target-specific, easily biodegradable and cheap and safer alternatives of chemical pesticides (Nayak and Solanki 2021). Bacillus thuringiensis (BT), Trichoderma and Neem-based insecticides are a few bio-pesticides used in India.

II. AIM & OBJECTIVES OF THE STUDY

The aim of the study is to examine the growth rates of chemical and organic agricultural inputs (fertilizers and pesticides) in India in the last twenty years (2000-01 to 2020-21) and its states/UTs, and to analyze the organic farming coverage in India.

The objectives of the study are:

- To find growth rates of chemical and organic inputs (fertilizers and pesticides) in India and its states.
- To calculate composite index for finding out the relative position of states/UTs with respect to organic practices.
- To analyze organic farming area in different States and government organic policies.

III. METHODOLOGY AND DATABASE

Secondary data has been used to perform the analysis of consumption pattern of chemical/bio-fertilizers and pesticides in India from 2000-01 to 2020-21. Government data has been collected from- i) various editions of Agricultural Statistics at a Glance, published by the Ministry of Agriculture and Farmers Welfare, Government of India (GoI) . ii) reports of Directorate of Plant Protection, Quarantine and Storage (DPPQS), GoI. iii) Department of Fertilizers, GoI. Besides, a number of published research articles, reports and websites have also been consulted for this study. The data recorded against 2020-21* is upto 31st March 2021. In some cases where data for required year are not available for a state/UT, the data for nearest year is considered for that state/UT. The thematic maps of India are prepared in ArcGIS 10.3 software.

- Compound Annual Growth Rate (CAGR)- CAGR for a given time represents the average rate at which the value of a variable changes per year to reach the value in final year.

The formula for CAGR is:

$CAGR = (V_{final} \div V_{begin})^{1/t} - 1$

where, CAGR= Compound Annual Growth Rate

V_{begin} = beginning value (initial year)

V_{final} = final value (last year)

t = time in years.

- Kendall's Ranking Coefficient Index with composite score- The ranking coefficient index is calculated from the sum of the ranks (composite score) by the following formula:

Composite Score = $R_1+R_2+R_3+\ldots\ldots..+R_N$

Ranking Coefficient Index= (Composite Score) ÷ N

where, R_1 , R_2 are the respective ranks for different variables and 'N' is the number of variables considered.

States with lowest consumption of chemical inputs per unit of gross cropped area (GCA) and highest use of organic inputs per unit of GCA are given a rank of 1 and vice versa.

IV. RESULTS

All-India Figures

Trend of use of Pesticides and Fertilizers (Chemical and Organic)

Annual growth rates have been found out for consumption of pesticides and fertilizers for India (Tables 1 and 2).

It is understood from Figure 1(a) that chemical pesticide consumption has shown an uneven growth in the last twenty years. The CAGR for 2000-01 to 2020-21 is 1.79 per cent.

Bio-pesticides have shown an impressive CAGR of 13.56 per cent with maximum increase seen in consumption after 2008-09. Unlike chemical pesticides, bio-pesticides have not experienced fluctuating trend but the growth has been positive overall.

The CAGR for chemical fertilizers is 3.015 per cent. The annual growth has been consistently positive, only for a few years when it declined, as between 2010-11 and 2013-14 (Figure 1b).

Bio-fertilizers have registered the maximum CAGR of 19.06% with a sharply rising slope from the year 2011-12 till 2017-18 as can be seen in Figure 1(c). However, bio-fertilizers represent negligible portion of the total fertilizer consumption (0.45% of the total in 2017-18).

The gross cropped area of the country has shown a very small positive growth of 0.48% between 2000-01 and 2020-21 (Table I). This means that per hectare investment of inputs has been increasing every successive year, indicating declining productivity of agricultural land.

The CAGR for organic manures between 2007-08 and 2017-18 is -1.22 percent, mainly owing to a decline in rural and urban compost production. Farm-yard manure (FYM) has shown a small positive growth of 1.28 per cent. However, the amount of vermin-compost has experienced tremendous rise of about 25 times in a span of ten years. This has occurred due to the growing popularity of vermin-compost among the organic farming community. Other manures rose by more than 150%.

Table 1: Annual Growth Rate (in %) of Chemical and Organic Inputs- All India.					
YEAR	CHEMICAL PESTICIDES	BIO-PESTICIDES	CHEMICAL FERTILIZERS	BIO-FERTILIZERS	GROSS CROPPED AREA
2000-01					
2001-02	7.89	32.35	3.94	44.55	1.44
2002-03	2.72	-13.33	-7.29	-20.40	-7.51
2003-04	-15.11	46.15	4.38	21.17	9.07
2004-05	-0.80	13.16	9.52	20.46	0.76
2005-06	-2.21	-14.73	10.56	12.12	0.86
2006-07	4.38	24.55	6.44	35.06	-0.19
2007-08	5.11	36.50	4.25	26.72	1.48
2008-09	0.53	-21.93	10.36	24.66	0.06
2009-10	-4.65	130.82	6.33	-20.06	-3.14
2010-11	32.81	52.82	6.18	89.62	4.49
2011-12	-8.93	26.41	-1.18	6.11	-0.95
2012-13	4.74	2.61	-8.11	16.17	-0.81
2013-14	-13.89	-15.72	-4.13	39.90	3.47
2014-15	23.35	-8.53	4.47	23.15	-1.28
2015-16	0.80	19.42	4.60	9.08	-0.67
2016-17	3.37	16.91	-3.00	23.84	1.60
2017-18	8.15	-0.28	2.47	11.05	N.A.
2018-19	-5.90	0.42	2.95	N.A.	N.A.
2019-2020	3.40	22.92	7.28	N.A.	N.A.
2020-21	0.79	-2.26	N.A.	N.A.	N.A.
CAGR %	1.79	13.56	3.02	19.06	0.48
N.A.= Not Available					

Table 2: Organic Manure Produced/Available- All India.
(in hundred thousand tonnes)

TYPE OF MANURE	2007-08	2017-18	% CHANGE
Rural Compost	1693.24	377.4	-77.71
Urban Compost	152.65	110.5	-27.61
Farm Yard Manure	1862.00	1885.9	1.28

Vermi-compost	30.96	775.0	2403.23
Other manures	92.08	232.6	152.61
TOTAL	3830.93	3387.2	-11.58
CAGR (%)			-1.22

Source:- (i) Charyulu&Biswas (2010) (ii) Khurana&Kumar (2020)

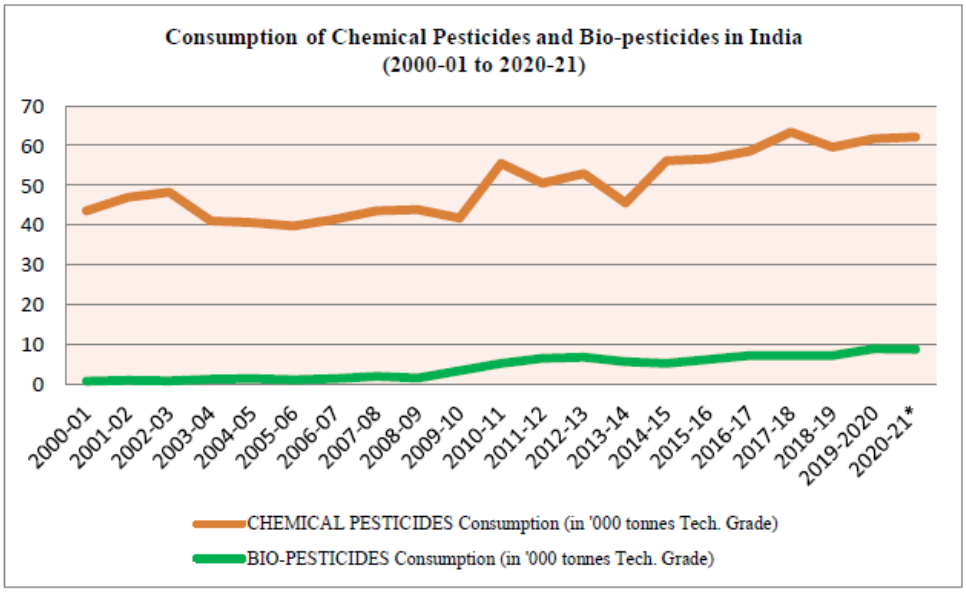

Figure 1(a)

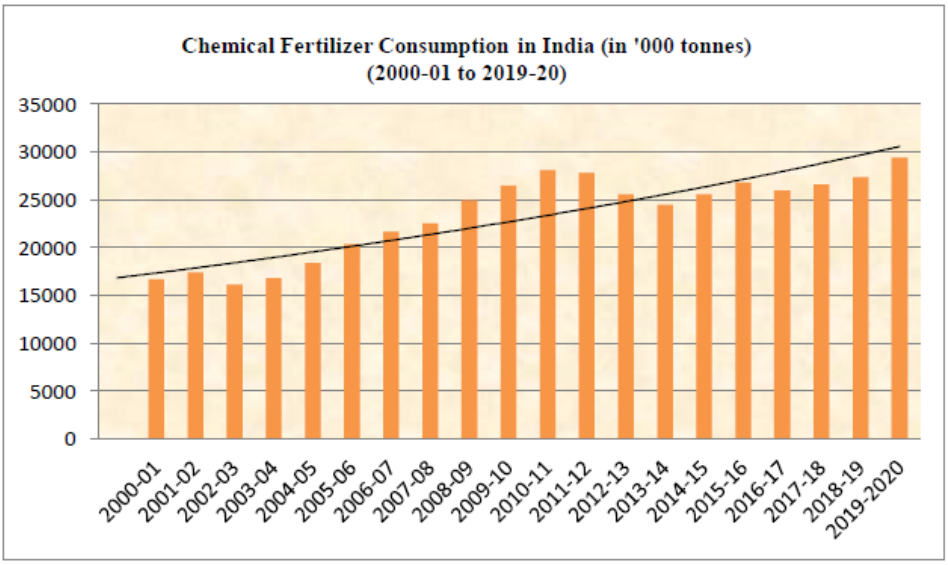

Figure 1(b)

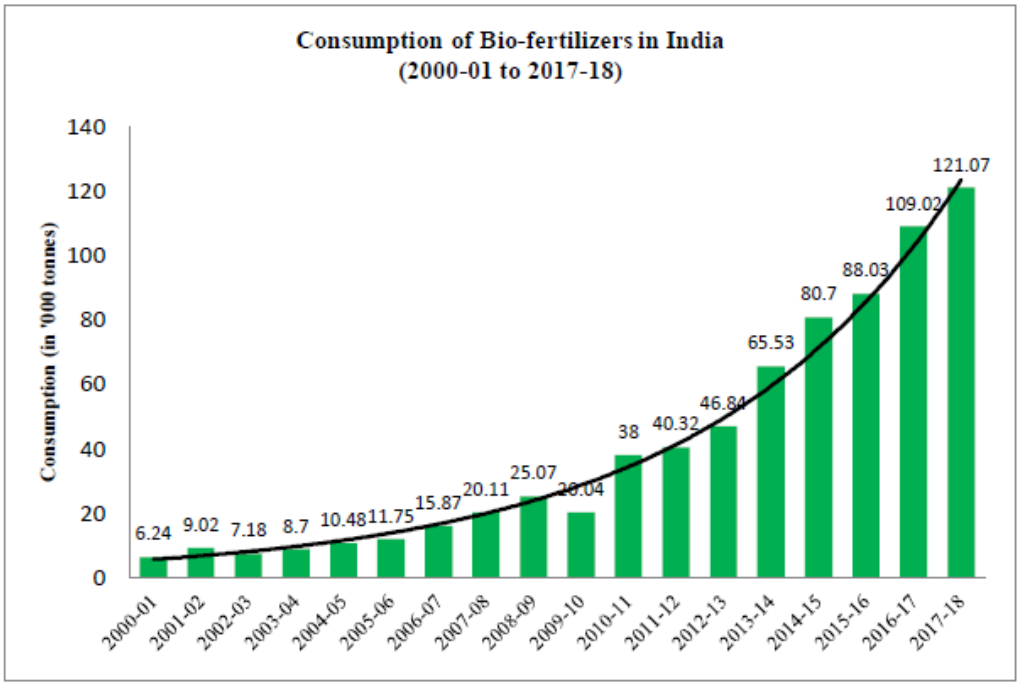

Figure 1(c)

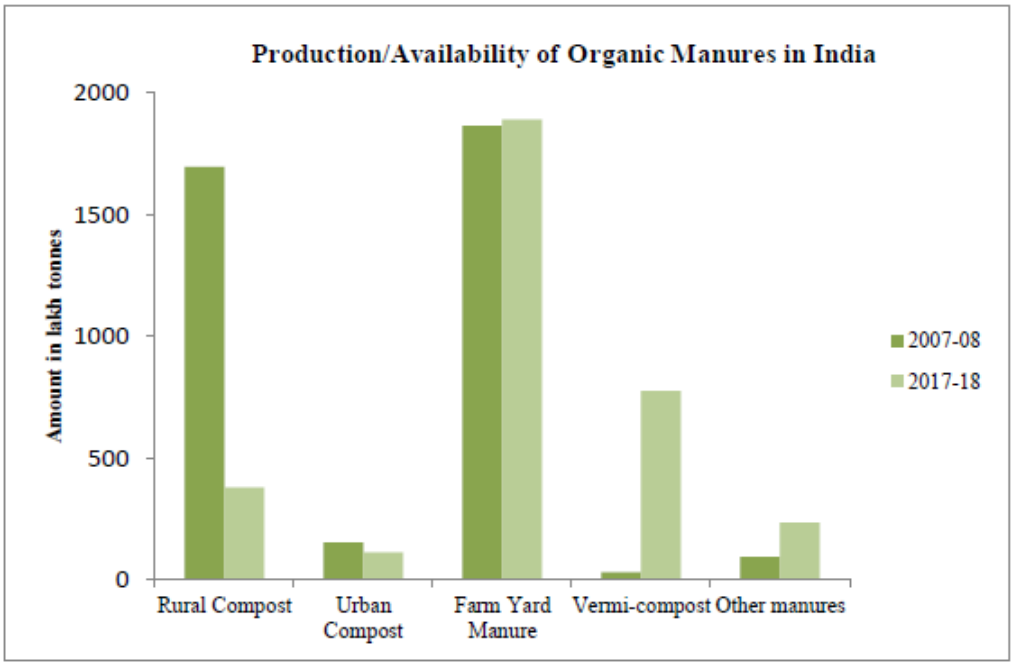

Figure 1(d)

State-wise Figures

Spatial trend of chemical and organic fertilizers and pesticides are represented in Figure 2(a) and that of bio-fertilizers is shown in Figure 2(b).

Chemical Pesticides (2010-11 to 2020-21)

Between 2010-11 and 2020-21, CAGR values for chemical pesticides indicate highest increase in Tripura (46.10 per cent), followed by Jharkhand and Mizoram. Goa, Chhattisgarh, Nagaland, Assam, Manipur, Delhi, Jammu & Kashmir also recorded greater use than before. Andaman & Nicobar Islands experienced maximum decline in chemical pesticide use (-23.06 per cent). Among the states, Himachal Pradesh(-16.14 per cent) reduced chemical usage the most, followed by Andhra Pradesh and Arunachal Pradesh. Gujarat, Rajasthan, Uttarakhand , Tamil Nadu and Kerala have also shown negative CAGR. A very small decline (<1 per cent) has been observed in Punjab, Karnataka and West Bengal.

Bio-Pesticides (2010-11 to 2020-21)

In the case of bio-pesticides, Jammu & Kashmir has the highest CAGR (104.60 per cent) followed by Jharkhand (42.86 per cent). Punjab, Telangana, Meghalaya, Rajasthan, Tripura, Chhattisgarh, Haryana and Assam have CAGR above 25 per cent.

States/UTs with decline in bio-pesticide consumption are Andaman & Nicobar Islands(-78.41 per cent), Puducherry, Goa, Uttar Pradesh, Andhra Pradesh, Nagaland, Odisha. Other states have shown very small differences over the years.

Chemical Fertilizers (2010-11 to 2017-18)

Most of the states and UTs have shown decline in the use of chemical fertilizers between 2010 and 2018. Arunachal Pradesh and Meghalaya each have experienced CAGR of

-100.0 per cent. Andhra Pradesh and Goa also have significant decline in chemical fertilizer use (-10.86 and -8.64 per cent , respectively) . Among UTs, Daman&Diu and Dadra&Nagar Haveli, and Puducherry have negative CAGR values. Delhi, however, experienced more than 50 per cent rise in fertilizer use.

Organic Fertilizers (2007-08 to 2015-16)

- Composts and Manures- Majority of the states/UTs have experienced a decline in organic fertilizer production/availability. The greatest decline has been in the state of Punjab (-52 per cent) between 2007-08 and 2015-16 followed by Uttarakhand (-33 per cent). Goa has registered maximum increase in compost and manure production (120 per cent) followed by Mizoram (104 per cent), Jammu&Kashmir (92 per cent) and Jharkhand (70 per cent).
- Bio-fertilizers- Most of the states have a positive CAGR value between 2010 and 2016. The highest growth has been found in the Green Revolution states of Punjab (261.01 per cent) and Haryana (166.90 per cent) followed by Uttarakhand, Assam and West Bengal. A decline in bio-fertilizer consumption has been observed in case of Delhi, Puducherry and Himachal Pradesh.

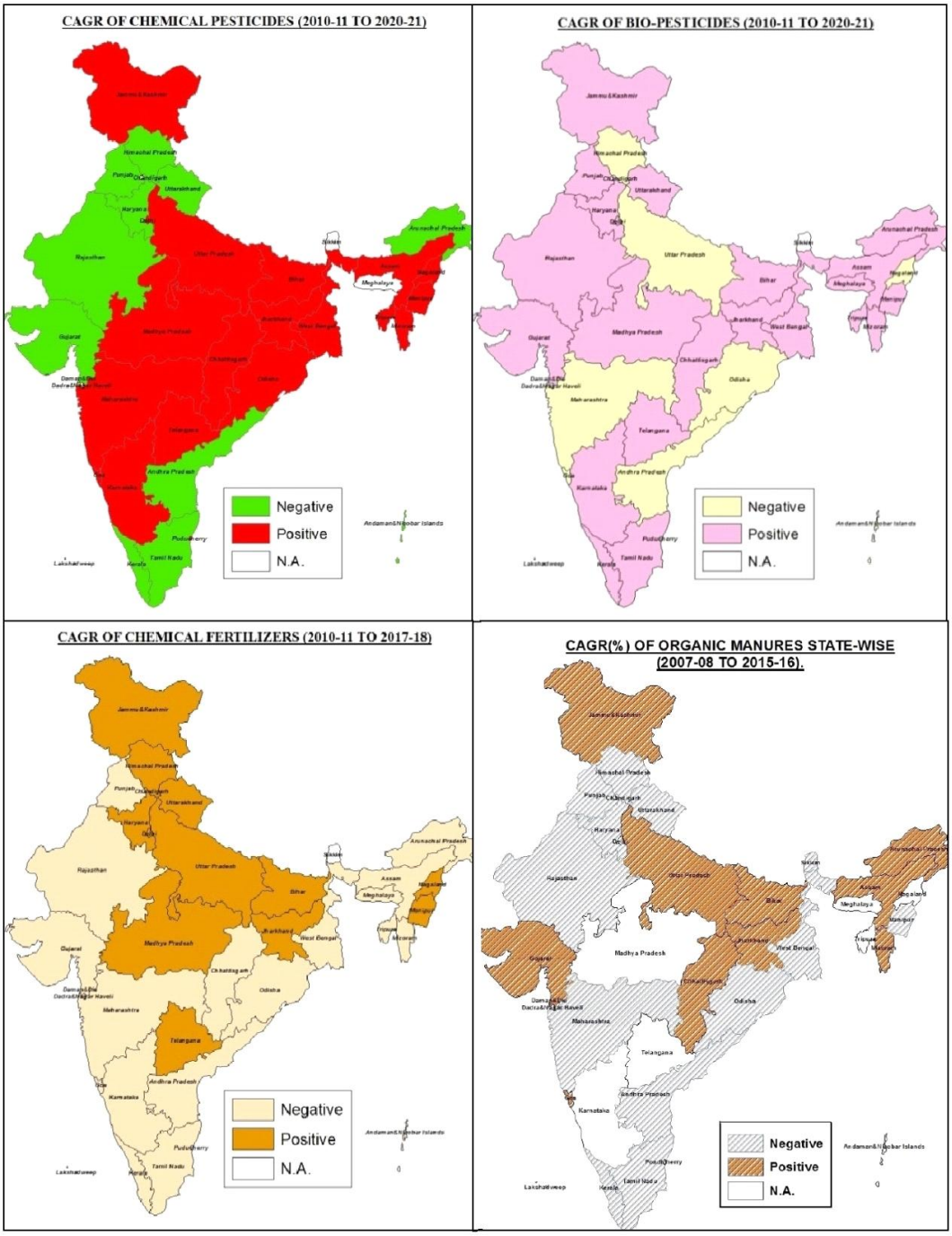
CAGR OF CHEMICAL PESTICIDES (2010-11 TO 2020-21)
Negative
Positive
N.A.
CAGR OF BIO-PESTICIDES (2010-11 TO 2020-21)
Negative
Positive
N.A.
CAGR OF CHEMICAL FERTILIZERS (2010-11 TO 2017-18)
Negative
Positive
N.A.
CAGR(%) OF ORGANIC MANURES STATE-WISE (2007-08 TO 2015-16).
Negative
Positive
N.A.

Figure 2(a)

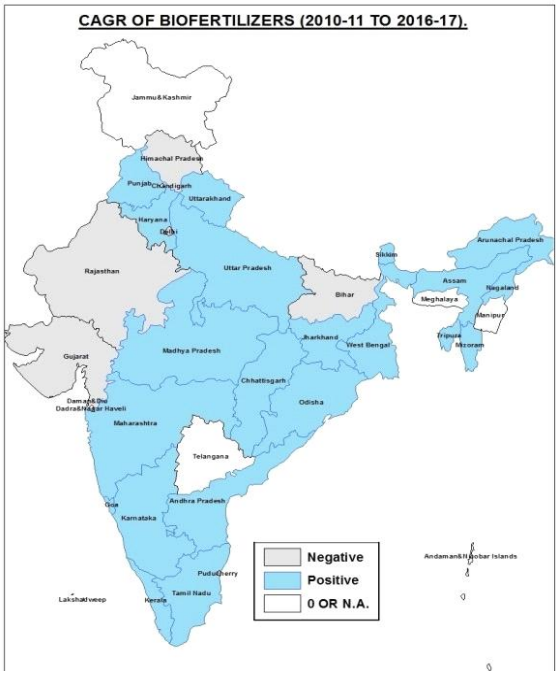

Figure 2(b)

Ranking Coefficient Index for States/UTs

Kendall's ranking coefficient index has been calculated for all the states and UTs of India and results presented in Table 3. States with the highest rank (in an ascending order, thus here rank 1.5) signify lowest usage of chemical inputs and highest usage of organic inputs per unit of gross cropped area. Thus, it can be inferred that such states lead other states in terms of organic practices (use of organic manures, bio-pesticides and bio-fertilizers). The ranking

coefficient map (Figure.3) shows that the northeastern states of Sikkim, Meghalaya, Arunachal Pradesh, Nagaland and Assam, and the UTs of Andaman & Nicobar Islands, Dadra & Nagar Haveli and Lakshadweep have the highest ranks (1.5 to 9.0). The index values for Rajasthan, Himachal Pradesh, Jharkhand, Chhattisgarh, Kerala, Goa, Manipur, Mizoram and Tripura come next, ranging from 9.01 to 19.0. Jammu & Kashmir, Uttarakhand, Bihar, West Bengal, Madhya Pradesh, Karnataka and Tamil Nadu fall in the moderate category. The states with lowest intensity of organic inputs use and/or high use of chemical inputs are Punjab, Uttar Pradesh, Haryana, Gujarat, Maharashtra, Telangana and Andhra Pradesh.

Table 3: Average Rank of States as per usage of Chemical and Organic Inputs

STATE/UT	CHEMICAL PESTICIDE (I)	CHEMICAL FERTILIZER (II)	BIO-PESTICIDE (III)	BIOFERTILIZER AND TOTAL MANURES (IV)	COMPOSITE SCORE (I+II+III+IV)	RANKING COEFFICIENT INDEX(Composite Score/N)	RANK
Andaman&Nicobar Islands	5	7	NR	NR	12	6	3
Andhra Pradesh	17	31	28	11	87	21.75	31
Arunachal Pradesh	3	3	11	15	32	8	5.5
Assam	10	16	10	3	39	9.75	8
Bihar	12	34	13	17	76	19	25
Chandigarh	NR	3	NR	NR	3	3	1.5

Chhattisgarh	20	20	5	7	52	13	12.5
Dadra&Nagar Haveli	NR	8	NR	NR	8	8	5.5
Daman&Diu	NR	14	NR	NR	14	14	15
Delhi	31	24	NR	8	63	21	30
Goa	16	10	17	1	44	11	10.5
Gujarat	13	26	21	28	88	22	32
Haryana	26	32	9	16	83	20.75	29
Himachal Pradesh	6	15	22	20	63	15.75	18
Jammu&Kashmir	32	22	25	2	81	20.25	28
Jharkhand	25	18	14	9	66	16.5	19
Karnataka	15	25	12	26	78	19.5	26
Kerala	18	19	3	13	53	13.25	14
Lakshadweep	NR	3	NR	NR	3	3	1.5
Madhya Pradesh	4	17	23	25	69	17.25	20.5
Maharashtra	24	23	16	30	93	23.25	33
Manipur	9	12	26	5	52	13	12.5
Meghalaya	1	3	19	12	35	8.75	7
Mizoram	14	9	NR	10	33	11	10.5
Nagaland	7	6	24	6	43	10.75	9
Odisha	19	21	18	22	80	20	27
Puducherry	30	36	1	4	71	17.75	22
Punjab	27	33	20	29	109	27.25	36
Rajasthan	8	13	15	23	59	14.75	16
Sikkim	1	3	NR	19	23	7.67	4
Tamil Nadu	21	30	4	18	73	18.25	23.5
Telangana	29	35	8	NR	72	24	34
Tripura	28	11	2	21	62	15.5	17
Uttar Pradesh	23	29	27	24	103	25.75	35
Uttarakhand	11	28	7	27	73	18.25	23.5
West Bengal	22	27	6	14	69	17.25	20.5

Source:- (i) Agricultural Statistics at a Glance 2020; (ii) DPPQS, Govt. of India. (iii) "Fertilizers Scenario", 2018- Dept. of Fertilizers, Govt. of India, (iv) Mishra. J. et.al. (2020), (v) Devi, P.I., et.al. (2017) (vii) Lok Sabha Answer for Starred Qs.No. 215, 03.12.2019, Ministry of Agriculture and Farmers Welfare.

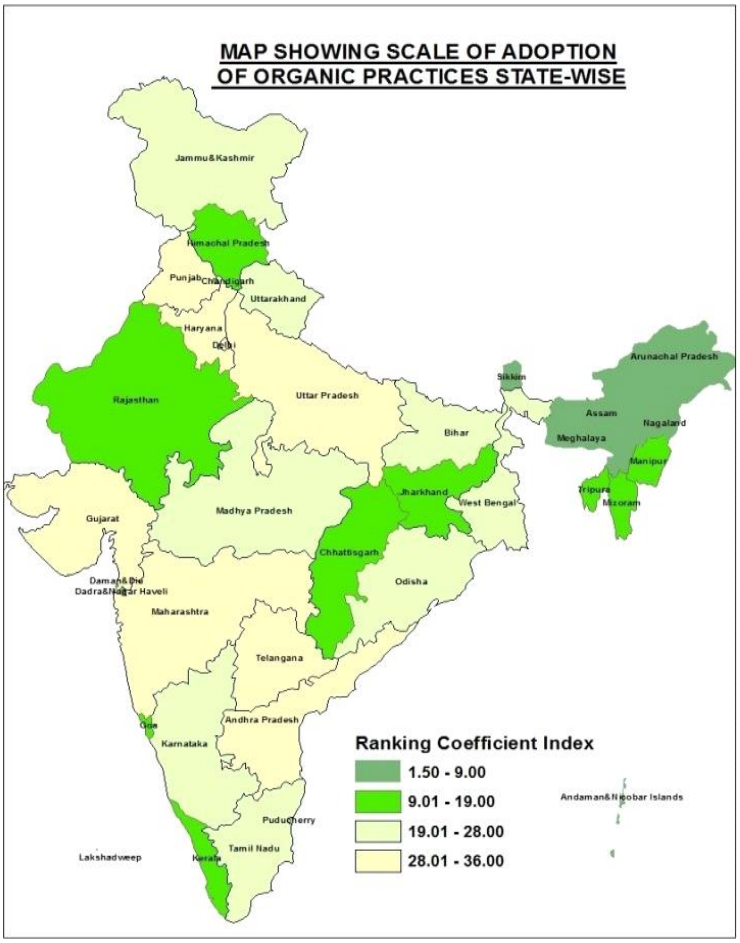

Figure 3

National/State Policies on Organic Farming in India

Of the net area sown in India in March 2020, only around 2 per cent was under organic farming (Khurana and Kumar 2020). The National Programme for Organic Production (NPOP), was launched in 2001 under Agricultural and Processed Food Products Export Authority (APEDA), Ministry of Commerce. The Paramparagat Krishi Vikas Yojna (PKVY), launched in 2015-16, is one of the flagship programmes under National Mission on Sustainable Agriculture (NMSA). Some state schemes like Climate-Resilient Zero Budget Natural Farming (CRZBNF) programme of Andhra Pradesh are running successfully and seen as models for organic development. Odisha is encouraging organic millet production, whereby millets are procured by the state government and linked with the PDS, which in turn aims to link it with state nutrition programmers like ICDS, mid-day meal, etc. (Kumar 2020). At present, 19 States have their own policy/scheme/mission for organic farming promotion. Such states which have not introduced any organic policy or scheme are having negligible areas under organic farming, like Uttar Pradesh, West Bengal, Punjab and Haryana.

Figure 4. shows the percentage of agricultural land under organic cultivation in India in 2019.

It is understood from Figure 4. that Sikkim, Chandigarh and Lakshadweep have become 100 per cent organic. Except Puducherry, all other UTs have large area under organic farming. The hilly states of Uttarakhand and Meghalaya have more than 15 percent land as organic. 18 per cent cultivation area in Goa is organic. Among major states, Madhya Pradesh Jammu & Kashmir, Odisha, Kerala, Andhra Pradesh, Rajasthan have considerable area under organic farming, followed by Chhattisgarh, Maharashtra, Assam and Karnataka.

The states lagging behind in this respect are Haryana, Punjab, West Bengal and Bihar, having very small coverage (<0.5 per cent) of organic agriculture. Also, bigger states like Uttar Pradesh, Telangana and Tamil Nadu have not been able to increase land under organic farming in recent years.

Table 4: Organic Farming Schemes and Policies in India			
CENTRAL GOVERNMENT SCHEMES		SOME STATE GOVERNMENT SCHEMES	
Year	Organic Policy/Scheme	State	Scheme and Year
2001	National Programme for Organic Production	Uttarakhand	Organic Farming Policy 2000, Organic

	(NPOP) under APEDA, Ministry of Commerce.		Agriculture Act 2019.
2005	Organic Farming Policy , 2005	Sikkim	State Organic Farming Policy 2004, Sikkim Organic Mission 2010.
2014-15	National Mission on Sustainable Agriculture (NMSA) (i) Paramparagat Krishi Vikas Yojna (PKVY) (ii) Mission Organic Value Chain Development in North-Eastern regions (MOVCDNER) (iii) National Centre of Organic Farming	Chhattisgarh	Mission 2013, Godhan Nyay Scheme 2020
		Odisha	Odisha Organic Mission 2018
		Andhra Pradesh	Climate Resilient-Zero Budget Natural Farming (CR-ZBNF), 2015
		Karnataka	Organic Policy 2017
2015-16	Participatory Guarantee System of certification for India (PGS-India), Ministry of Agriculture and Farmers Welfare.		
Related Schemes			
2007-08	(i) Rashtriya Krishi Vikas Yojna (RKVY) (ii) Mission for Integrated Development of Horticulture (MIDH)		
Source:- Khurana&Kumar(2020) ; Annual Report 2020-21, Ministry of Agriculture&Farmers Welfare, GoI.			

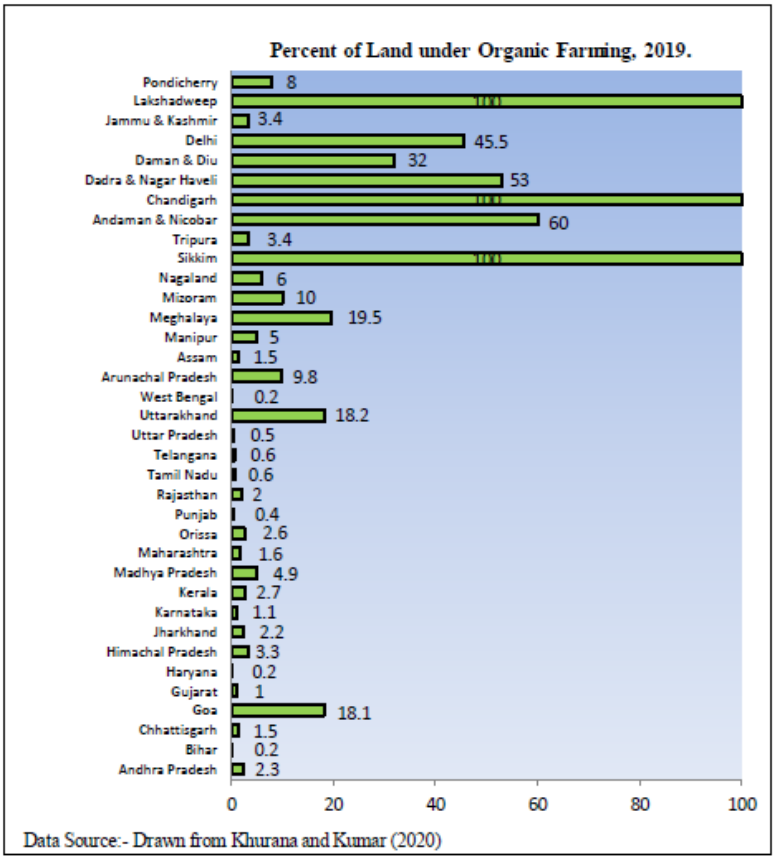

Figure 4.

V. FINDINGS

The study analysed the change in consumption of chemical and organic agricultural inputs in India. The main observations are listed below:

- It is found that the CAGR for all-India is positive for both chemical fertilizers/pesticides and bio-fertilizers/pesticides. However, the rate of increase has been much higher in case of the latter. Chemical fertilizers and pesticides grew with an annual compound rate of 3.015 and 1.79 per cent respectively, whereas the corresponding values for bio-fertilizers and bio-pesticides were 19.06 and 13.56 per cent respectively.
- Organic manures production has indicated slight decline of -1.22 per cent in the period 2007-08 to 2017-18. This has been due to significant reduction in rural compost availability However, vermin-compost production showed a remarkable growth from 3096 thousand tonnes to 77500 thousand tonnes in the same period.
- In the states, highest growth of chemical pesticide consumption was seen in Tripura, Jharkhand and Mizoram between 2010-11 and 2020-21. Jammu& Kashmir saw the most increase in bio-pesticide use.
- Chemical fertilizer use declined in most of the states and UTs, except in Delhi between 2010-11 and 2017-18. Majority of the states have shown decline in organic manures production The biggest decline is seen in Punjab. States like Goa and Mizoram, though, have recorded higher production of compost and manures.
- In the case of bio-fertilizers, the Green Revolution states of Punjab (261 per cent) and Haryana (167 per cent) showed highest positive growth, while almost all other states and UTs also experienced a positive CAGR.
- Kendall's ranking coefficient index values have shown that the northeastern states of Sikkim, Meghalaya, Nagaland and Assam use minimum chemical inputs per unit of gross cropped area and thus, are the front-runners in organic farming. Apart from the northeast, Goa, Kerala, Himachal Pradesh, Jharkhand, Rajasthan and Chhattisgarh have also performed better with respect to use of organic materials in farming.
- Among some larger states like Uttar Pradesh, Bihar, West Bengal, Telangana, Tamil Nadu, etc., organic coverage is very limited.
- There is absence of state-sponsored organic schemes or policies in the states having negligible area under organic farming. Uttar Pradesh, Bihar, West Bengal, Punjab, Haryana are examples.

VI. CONCLUSION

Organic farming in India is in its infant stage. But, this study has shown that there has been decline in use of chemical fertilizers and pesticides in most of the states in recent time. Farmers should be taught proper techniques of preparing composts, natural insecticides, etc. from own farm materials that would save on external costs. Training must be given to use the organic compost and manures carefully so that no losses of nutrients take place. Lastly, government support at the Central and state levels is essential for the success of the organic movement.

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