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Pesticide Consumption in India: A Spatiotemporal Analysis§

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Abstract

The paper has described the consumption trends of pesticides over two decade period, 1991-2012 across the states in India. The pesticide economy of India is more export-oriented in nature. The growth rate of domestic consumption of pesticides, however, over different decades has shown wide fluctuations, though the overall trend is negative (-2.48%).While analysing the trend of pesticide consumption in 29 states and Union Territories (UTs) of India for the period 2000 to 2013, a positive growth trend has been observed in 17 states/UTs. The positive growth has been observed highest in Jammu & Kashmir, Andaman & Nicobar Islands and Tripura. Uttar Pradesh, Maharashtra, Andhra Pradesh, Punjab and Haryana are the states that accounted for 70 per cent of total pesticide consumption. The use-intensity has been found highest in Jammu and Kashmir, followed by Punjab and Haryana. However, Punjab and Haryana have exhibited a declining trend in pesticide consumption. On the contrary, Meghalaya where the intensity of application is comparatively low, has registered an increasing trend in pesticide consumption. The majority areas in NE region in general apply low levels of pesticides and are in a declining mode of consumption, except the states like Sikkim, Meghalaya, Tripura, Manipur and Nagaland (positive growth rate). The paper has also discussed the retail sale pattern of pesticides. The paper has highlighted the need for critical review of mismatch in policy and governance in the pesticide sector.

Key words: Pesticide consumption, pesticide marketing, use intensity, retail sale

JEL Classification: Q12, Q18

Introduction

The UN Food and Agriculture Organization estimates that in developing countries, pests, weeds and disease destroy about 40 per cent of crops while they are still in the fields and 6 to 7 per cent of them after the harvest. In Africa and Asia, the pre-harvest losses are estimated at 50 per cent. Many researchers (Cramer,1967; FAO, 1975; Pimentel, 1992; Oerke *et al.,*1995) have put global crop losses due to pests between one-third and one-half of the attainable crop production, with crop losses in developing countries at the higher side. The crop damage is caused highest by insects, followed by pathogens and weeds. Consequently, the use of chemical pesticides in agriculture has been an integral part of crop production in many regions, often at very high levels and unscientific pattern of application (Atreya, 2007; Devi, 2010; Shetty *et al.,* 2010). The role of pesticides in augmenting agricultural output has been well perceived and these have been considered as essential inputs in agricultural production.

There is overwhelming evidence that some of these chemicals do pose potential risks to the ecosystem in general and human beings in particular (Jeyaratnam, 1990; Forget, 1993; Devi, 2010). It is estimated that around 800,000 people in developing countries have died due to pesticides since the onset of the Green

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Revolution. Nearly 20,000 people in developing countries die each year because of pesticide consumption through their food (Bhardwaj and Sharma, 2013). Though all sections of the population are exposed to the risks of pesticides at different levels, the direct exposure risk is more among workers in production centres, supply chain and end-users (farmers and farm workers). Reports addressing the health concerns of pesticide exposure are more concentrated in the case of farm workers and farmers (Nyakundi *et al.,* 2010; Devi, 2012) and are rather limited for the workers in production and handling sectors.

Despite these evidences, the pesticide market in many developing economies are on a high growth trajectory, with little concern on negative externalities. With the increasing focus on ecosystem health and human welfare, many states in India are in the process of transforming agriculture to organic modes of production. For instance, the state of Kerala has adopted organic farming policy which aims to transform agriculture fully to organic mode of production. The Government of India is also giving considerable emphasis on organic farming.

Despite several policy decisions, the pesticide consumption pattern and the regulatory mechanism across the states continue to be conventional—the one that was designed to achieve the objectives of green revolution. This mismatch in policy, governance and practices needs to be reviewed critically, in the background of organic farming policy. This paper analyses the pesticide consumption pattern in India and its different states to understand the pattern and trends of their consumption.

Pesticide Economy in India

The increasing demand for agricultural products and the resultant commercialization of agriculture have induced a rising use of agricultural chemicals in India. The shift of agriculture management strategies to the mode of agribusiness laid emphasis on risk management as one of the major challenges in agriculture. Some estimates project that 35-45 per cent crop production is lost due to insects, weeds and diseases, while 35 per cent crop produces are lost during storage. This naturally has facilitated the growth of the crop protection market to the size of which, as per reports, was worth $3.8 billion (2011-12). India is at the fourth position in the global suppliers of agrochemicals, after USA, Japan and China. The Indian pesticide industry is the biggest in Asia and 12th in the world.

According to the Indian Insecticides Act 1968, all pesticide products are to be registered before they are manufactured, sold, exported or imported. The Pesticides Unit, under the Ministry of Agriculture, Government of India, monitors the demand and availability of pesticides in the states. The Unit coordinates with states/ UTs, Ministry of Chemicals & Fertilizers, Department of Chemicals & Petrochemicals and the pesticide industry for assessing the demand for pesticides to ensure their timely availability. It also collects/compiles data on pesticide consumption, production, import/export and sale points for the distribution of pesticides in the country.

As per the Standing Committee on Chemicals and Fertilizers (2013) of India, pesticide production in India during 2011-2012 stood at 68490 tonnes. The total value of annual production of pesticides in the country is about ₹8000 crore, out of which pesticides worth ₹6000 crore are consumed in the country and the rest are exported. The technical pesticides are produced in the country by about 60 companies and their formulations are produced by about 500 units. There are 256 registered pesticide products in India. These include two categories—technical grade and formulated. Formulations are developed from technical grade material by addition of emulsifiers or other agents.

The pesticide market in India is expected to grow at 12-13 per cent per annum to reach $6.8 billion (2017) of which the domestic demand growth may be at the rate of 8-9 per cent and export demand at 15-16 per cent. According to The India Pesticides Industry Analysis, the CAGR (compound annual growth rate) is 14.7 per cent making the predicted size of market at ₹2,29,800 million by 2018. According to the estimates of *Research on India* (a leading provider of market intelligence reports of industries), the pesticide market in India is expected to grow at a rate of 2.38 per cent (CAGR) per annum.

The Indian pesticide scenario seems to be more export-oriented, as their exports have been increasing over the years. The major export destinations for India are: USA, UK, France, Netherlands, South Africa, Bangladesh, Malaysia and Singapore. The recent

Table 1. Production, import, export and consumption of pesticides in India: 2005-06 to 2011-12

(in tonnes)

Year	Production	Import	Total	Consumption	Export
2005-06	82240	18619	100839	39773	90788
2006-07	84701	28223	112924	41515	108092
2007-08	79756	29297	109053	43630	96268
2008-09	85338	18476	103814	43860	184537
2009-10	82185	22250	104435	41882	125818
2010-11	NA	53996	NA	55540	177789
2011-12	NA	58647	NA	52980	207256

Source: Indiastat.com
NA: Not Available

export data (2015) show that the herbicide, 'Dicamba', is the maximum exported pesticide from India to the tune of about 30,000 kg with the value of US$6,51,578, followed by 'Cypermethrin' formulations with 19,000 litres. (*Source*:http://www.infodriveindia.com/india-export-data/pesticide-export-data.aspx).

The production capacity of pesticides in the country is more than 1,39,000 tonnes per annum. The production of pesticides in India remained at almost static level during the 2005-2010 period, while their imports show a varying trend (Table 1). The drought year of 2007-08 witnessed a reduction in pesticide production with the highest quantity of import that year than in any other period. The consumption, however, shows an increase in recent years. The imports, currently are higher than the domestic consumption.

Among the pest control chemicals, insecticides dominate the industry with 65 per cent of consumption, followed by herbicides (16%), fungicides (15%) and others (4%). This pattern is different from global pattern where herbicides form the major share (44%), followed by fungicides (27%), insecticides (22%) and others (7%). The herbicide sector in India is the one that has shown the fastest growth, mainly due to the rising farm wages, thus making manual weed control costly (Devi, 2011).

Cotton and paddy are the major crops where pesticides consumption is 50 per cent and 18 per cent, respectively. Cotton covers only 5 per cent of the cropped area, but accounts for 50 per cent of pesticide-use. Rice, which is grown over 24 per cent of the cropped area, consumes 18 per cent of the pesticides. Fruits and vegetables account for a significant share of agrochemicals, while they account for 18 per cent of cropped area. Sugarcane uses 2 per cent of the pesticides and other crops grown over 6 per cent of the cropped area account for 1 per cent pesticides only (*Source:* agropages.com).

Trends in Pesticide use in India

The demand and availability position of different pesticides is reviewed regularly during the Zonal Conferences on inputs for *kharif* and *rabi* with the state representatives of the Departments of Agriculture. The data from Government of India show that the consumption of chemical pesticides (in terms of technical grade) has declined from 72,130 tonnes in 1991-92 to 56,090 tonnes in 2012-13. The consumption of pesticides shows wide fluctuations over the years, which may be due to its relation with weather parameters and availability in the market. During extreme years of drought, like in early-2000s, the consumption tends to move downwards. The intensity of use (consumption per hectare of gross cropped area) has also exhibited a similar trend. Figure 1 depicts a general downward trend in pesticide consumption, except in the past few years, which exhibit a rising trend. This trend, however, does not match with the organic farming policy, in general. But, the inferences can be drawn if we attempt item-wise break up analysis to find whether it is the ecofriendly chemical use that is increasing .

To get a more realistic and detailed picture on the consumption behaviour of pesticides in India over the decades (1991-2011), the CAGR was computed and the results are presented in Table 2. The growth rate

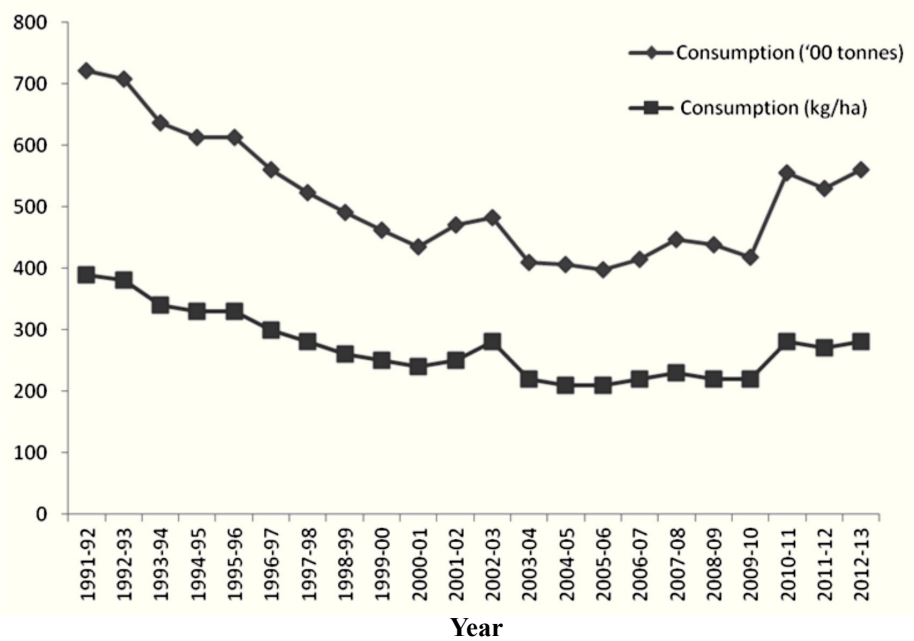

Figure 1. Trend in consumption of pesticides in India: 1991-92 to 2012-13

over different decades shows wide fluctuations, though the overall trend is negative (-2.48%). The decade of 1991-2001 has shown a very high rate of decline (-5.53%), though the succeeding decade has shown stagnation (0.70%). The overall trend in pesticide consumption has shown a declining pattern which is relieving. However, this needs further analysis to understand the real impact as to whether it is due to the use of new generation products which need to be applied in smaller quantities. The paper by Devi (2010), analysing the pattern of chemical pesticide-use in Kerala, reports about the situation in Kerala where the growth rate of toxic chemicals is higher vis-a-vis of safer ones.

Pesticide Consumption and Distribution Pattern

There is a wide regional variation in the use of pesticides across the states in India. Table 3 details the state-wise consumption of chemical pesticides in India in 2012-13. Uttar Pradesh, Maharashtra, Andhra Pradesh, Punjab and Haryana are the states that account for 70 per cent of total pesticide consumption in India. Twelve states consume more than 1000 tonnes each, annually. Utter Pradesh is the leading consumer with 9035 tonnes. Sikkim, Mizoram, Goa, Meghalaya, Nagaland, Manipur and Arunachal Pradesh are relatively the poor consumers of pesticides (less than100 tonnes each). Rest of the states (Madhya Pradesh, Chattisgarh, Jharkhand, Bihar, Uttarakhand, Himachal Pradesh, Assam, Odisha and Kerala) can be included in the medium users group where the pesticide consumption is between 100 and 1000 tonnes.

Table 2. Compound annual growth rate (CAGR) of pesticide consumption in India

Period	CAGR (per cent/year)
1991-01	-5.53
2001-11	0.70
1991-11	-2.48

However, this comparison is meaningful only when it is made at unit area consumption level. This was estimated by dividing the pesticide consumption by gross cropped area in the respective states for a selected year (intensity of use).

Though crop losses due to pest attack in India are reported to be very high, the intensity of pesticide consumption in the country is one of the lowest in the world (291.2 grams/ha), compared to US (4.5kg/ha), Japan (11kg/ha) and China (14kg/ha) and the world average of 3 kg per ha. The worldwide consumption of pesticides is about 2 million tonnes per year, out of which India's share is only 3.75 per cent. The area under

Table 3. State-wise consumption and CAGR of chemical pesticides in India: 2012-13

Sl. No.	State	Consumption (in tonnes)	Per ha consumption (kg/ha of gross cropped area)	CAGR (per cent) 2000-01 to 2012-13
1	Andhra Pradesh	6500	0.581	4.26
2	Arunachal Pradesh	17*	0.080	-5.44
3	Assam	183	0.065	-6.08
4	Bihar	687	0.131	-2.4
5	Chhattisgarh	675	0.144	3.29
6	Goa	9	0.069	5.42
7	Gujarat	1210	0.117	-6.24
8	Haryana	4050	1.151	-2.07
9	Himachal Pradesh	320	0.594	-0.26
10	Jammu & Kashmir	1711*	2.337	100.22
11	Jharkhand	151	0.139	6.89
12	Karnataka	1225	0.116	-4.3
13	Kerala	856	0.413	-0.66
14	Madhya Pradesh	659	0.044	2.18
15	Maharashtra	6617	0.380	6.67
16	Manipur	30	0.086	5.25
17	Meghalaya	9*	0.032	3.05
18	Mizoram	4	0.031	-7.53
19	Nagaland	16	0.044	8.82
20	Odisha	601	0.128	-2.08
21	Punjab	5725	1.377	-2.23
22	Rajasthan	1250	0.068	-1.78
23	Sikkim	3	0.039	1.13
24	Tamil Nadu	1919	0.387	1.37
25	Tripura	266*	1.039	9.21
26	Uttar Pradesh	9035	0.545	2.95
27	Uttarakhand	220	0.304	7.29
28	West Bengal	3390	0.679	0.91
29	Andaman & Nicobar Islands	7	0.467	17.85
	India	45619	0.2912	

Note: *Data for 2011-12

pesticide-use in India is only 9 per cent of the total cultivated land (16.7 million hectares).

The state of Jammu & Kashmir tops in the intensity of pesticides application with an average level of 2.337 kg/ha, followed by Punjab (1.377kg/ha) and Haryana (1.151 kg/ha). Apart from these states, the use-intensity is high (more than 600 grams/ha) in Tripura and West Bengal. The lowest use- level on a per hectare basis is in Mizoram (0.031 kg/ha) and Meghalaya (0.032 kg/ha). Most of the NE states (Sikkim, Assam, Nagaland, Arunachal Pradesh, Manipur), Rajastan and Madhya Pradesh apply pesticides at less than 100 grams/ha of cropped area. The rest of the states are medium users of pesticides (100-600 grams/ha) (Figure 2).

While analyzing the trend of pesticide consumption in 29 states and Union Territories (UTs) of India for the period 2000 to 2013, a positive growth trend was observed in 17 states/UTs. The positive growth was observed highest in Jammu & Kashmir (100.22%), followed by Andaman & Nicobar Islands (17.85%) and

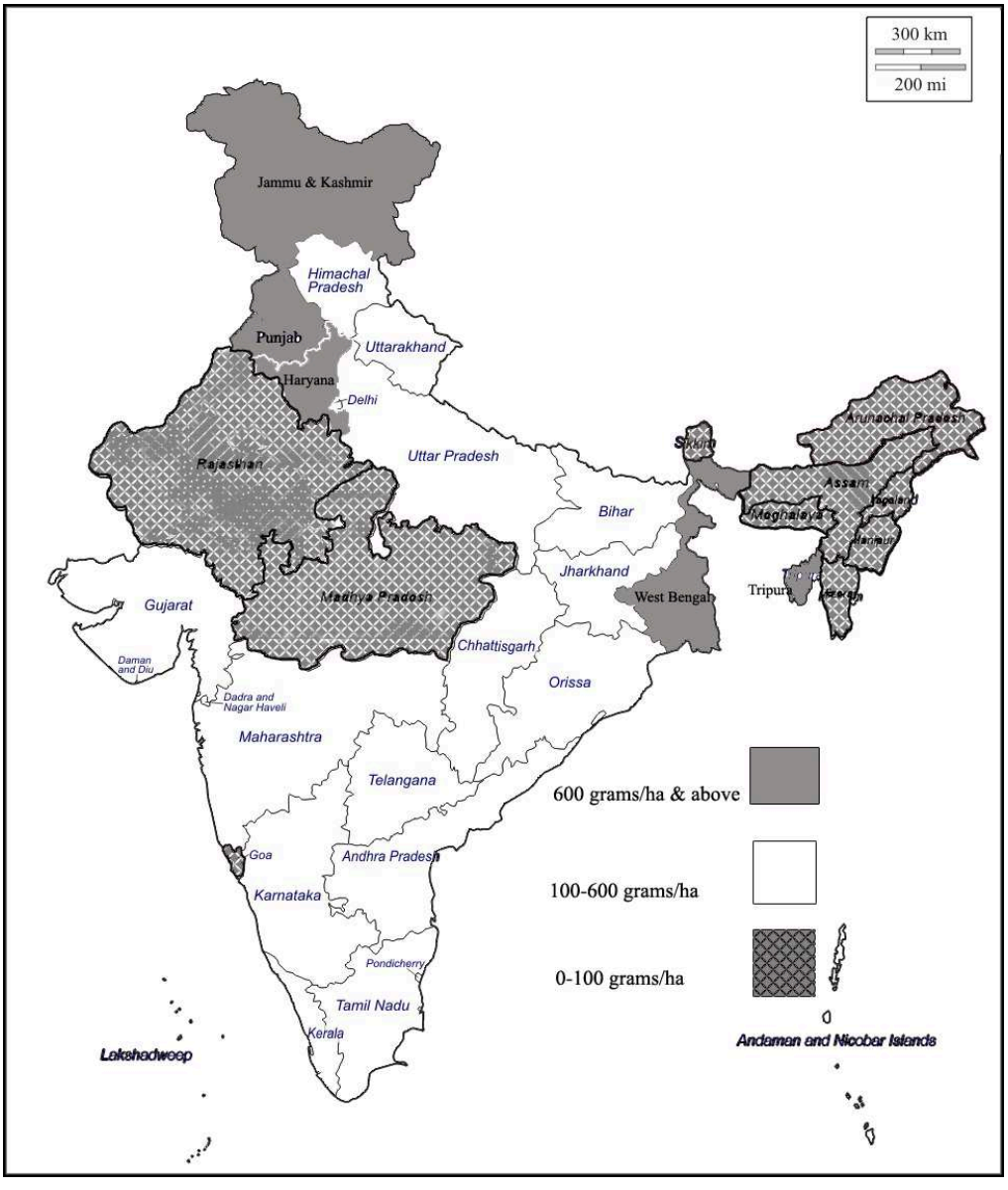

Figure 2. Intensity of pesticide-use in different states of India: 2000 to 2013

Tripura (9.21%). The states of Andhra Pradesh, Goa, Jammu & Kashmir, Jharkand, Maharashtra, Manipur, Nagaland, Uttarakhand and Andaman & Nicobar Islands have registered a growth rate of above 5 per cent. However, agriculturally-prominent state of Punjab has registered a negative growth pattern in pesticide-use. Uttar Pradesh, Maharashtra and Andhra Pradesh, the three major consumers of pesticides in the country, have exhibited a positive growth trend. The state of Jammu & Kashmir, with the highest intensity of pesticide-use, has also registered a positive growth trend. However, Punjab and Haryana (with second and third position in intensity of use) have exhibited a declining trend in pesticide consumption, though the intensity of pesticide-use is high. On the contrary, Meghalaya state where the intensity of pesticide application is comparatively low, has registered an increasing trend in total consumption. The majority areas in NE region in general apply low levels of pesticides and are in a declining mode of consumption, except the states like Sikkim, Meghalaya, Tripura, Manipur and Nagaland (positive growth rate) (Figure 3).

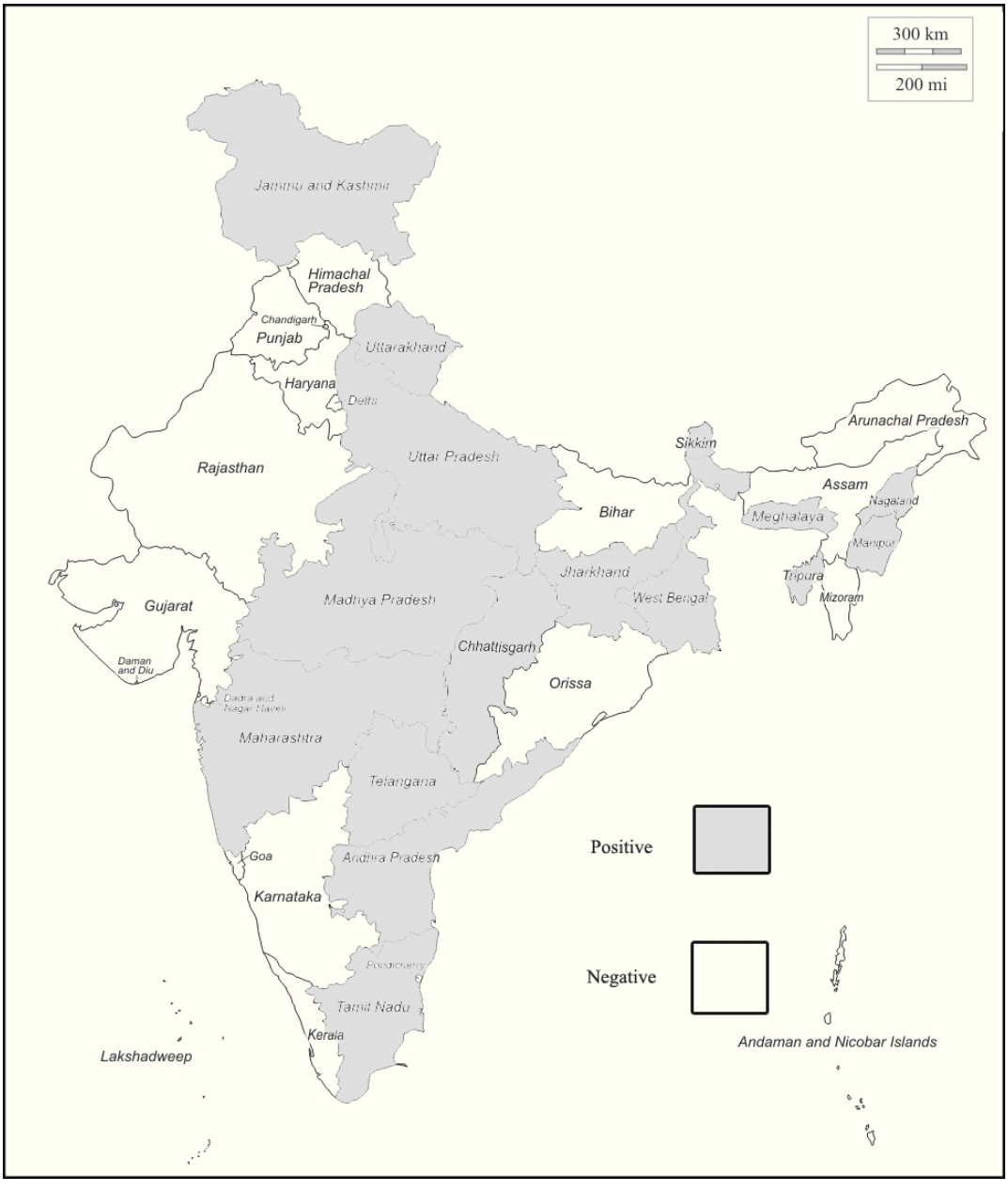

Figure 3. Map depicting compound annual growth rate of pesticide consumption in different states of India: 2012-13

It can be seen that Union territories like Daman & Diu (-14.65%), Chandigarh (-12.58%) and Lakshadweep (-9.43%) had highest negative growth rate of pesticide consumption in the country while it was Mizoram, Gujarat and Assam in the case of states. The general policy towards organic production can be facilitated only if the pesticide sales are regulated and organic alternatives are popularized. However, these trends do not reflect the type of pesticide material that is consumed and hence, we cannot conclude that these trends are against the objectives of green growth strategies. This, analysis, however underlines the need for more detailed analysis with focus on pesticide formulations that are used (i.e. ecofriendly or not/ new generation chemicals which are more toxic and persistent but more effective and need to be applied in lesser quantities).The analysis also indicates the need for focused policy interventions in states where the use pattern exhibits positive trends,if the chemicals are of negative ecosystem impacts.

The Marketing Scene

The manufacturing, imports, distribution and use of pesticides in India is regulated by the Central Insecticides Board and Registration Committee (CIBRC), which was established under the Department of Agriculture and Cooperation, Government of India. The CIBRC is responsible for registering the insecticides which are manufactured in or imported to the country and registration is a fundamental requirement for its sale and distribution. The claims of the manufacturer/importer regarding the efficiency and efficacy of the chemical are verified by the agency before issuing the registration certificate. The Board is the technical body to advise the government regarding the pesticides. It also prescribes the methods for safe use and handling of pesticides. A total of 256 pesticides are registered in India. The Food Safety and Standards Authority of India (FSSAI) which was established under the Food Safety and Standards Act 2006, is the agency to fix and monitor the pesticide residue standards (tolerance limits) in food commodities.

At the state level, the prescriptions for use of pesticides in agriculture are provided by the State Agricultural Universities (SAUs) and Commodity Boards. The SAUs undertake research focusing on local crops and conditions and suitability of the chemical for specific pests and its safety aspects. The information is disseminated though the extension mechanism and package of practices.

The marketing channel for pesticides in India starts with domestic production and imports. There are pesticide formulators who convert the original technical grade material into an applicable form by using suitable solvents or carriers. There are associated formulators who have direct association with the manufacturers and others (non-associated) who do not have such direct association. Many of the manufacturers also formulate the product. The manufacturers/ formulators do not directly sell the product to end-users (farmers). They usually operate through the wholesale agents/ distributors and retailers. But, there are cases of farm demonstrations and direct sales by manufacturing companies to farmers during the peak seasons. The cases of sales of pesticide mixtures or non-descript/ non-registered chemicals are also observed (Devi, 2015).

The pesticide distribution in India is managed by 1,78,979 sale points, across the country. Of these, the number is highest in Maharashtra (19%), followed by Andhra Pradesh (11%) and Uttar Pradesh (10.86%). The bulk (90%) of retail trade is managed by the private sector and the cooperatives handle roughly 7 per cent of the retail outlets. The Department of Agriculture (public sector) has registered its presence only in 11 states (Himachal Pradesh, Meghalaya, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and Union Territory of Delhi). In North Eastern states (Mizoram, Meghalaya and Nagaland), the public sector has a major share in pesticide retailing. Due to the absence of public sector outlets in most of the states, the pesticide markets have almost monopoly of the private sector (Table 4). This situation can lead to unregulated sale guided by the profit motive alone. The level of awareness and the dispensing pattern of retailers indirectly influence the pesticide use pattern of end-users and farmers, as they most often depend on the retailers for advice on choice of chemical and use pattern. In a nationwide study in India on pesticide-use pattern by farmers (Shetty *et al.*, 2010) it was seen that only 20 per cent of the respondents obtained their information on plant protection aspect from the agricultural extension officer and the rest 80 per cent of the farmers used unreliable information. Nearly 40 per cent farmers get totally unreliable information from untrained persons.

In another study, 47 per cent farmers said they obtained information from pesticide sellers in the market and 33 per cent from neighbours or relatives (Sadavy *et al.*, 2000). The influence of pesticide dealers on farmers' decisions is well documented worldwide in studies conducted in United States (Wolf, 1995), China (Puyun *et al.*, 2007), South Africa (Rother *et al.*, 2008), Vietnam (Van Hoi *et al.*, 2009) and Tanzania (Leiki *et al.*, 2014). In Kerala too, where the pesticide retailing is mainly with the private sector, the dependence on these traders is reported to be quite high (Devi, 2010). Thus, the dominance of private sector in pesticide retailing can hinder the implementation of organic farming policy.

Conclusions

The policy towards use of chemical pesticides during green revolution era has been promotive in nature. The policy support in favour of HYVs naturally

Table 4. Retail sale points of pesticides in India: 2001 and 2012

Particulars	Sale points (No.)	
	2010	2012
Department of Agriculture	3817 (2.71)	4274(2)
Cooperatives	9680(6.86)	13800(7.7)
Private Sector	126967 (90)	160447(90)
Others	576 (0.41)	458(0.3)
Total	141040(100)	178979(100)

Note: Figures within the parentheses show per cent to total

necessitated the application of chemical pesticides. Later on, these chemicals were used in a highly unscientific way, starting from the choice of chemical to the application practices, timing and even necessity (Devi, 2009). The pesticide application has often been adopted as a risk avoidance strategy, where the chances of pest incidence/critical pest population are often wrongly perceived to be on the higher side. The professionalism in the choice of chemical and its application has slowly been replaced by the private operators who handle the retail sales, mostly without any formal training or information on these aspects. Consequently, the concerns on the negative externalities of chemical pesticides across the world have resulted in increasing awareness on the pesticide-use, especially in the socioeconomically advanced societies (Kerala, for example). Despite this, the supply side of pesticide management is largely a neglected area, where the operators lack proper awareness, training, and education (Devi, 2015).The situation is further polluted by the poor monitoring and regulatory mechanism (Devi, 2010). The WHO reports that the negative externalities due to pesticide exposure as more prominent in the developing economies despite their lower consumption. It indicates adoption of unscientific use practices that exist in these regions.

The analysis has pointed out to the need for a detailed look on the pesticide-use pattern, distribution systems and regulatory mechanism at a micro level. The attainment of green growth strategies and sustainable development goals necessitates the adoption of safe production practices in agriculture.This can be ensured through scientific management of supply chain systems.

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