

**Pesticide Scenario of India with particular reference to Madhya Pradesh: A review**

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**Abstract:** In the agricultural areas of the world, there is an increasing concern about the effects of widespread use of pesticides. Since there is no certain demarcation to show whether they ultimately are productive or harmful, the present review discusses the different aspects of chemical pesticides in Indian agriculture with particular reference to Madhya Pradesh. The review provides a brief history of pesticides, the benefits, hazards and the persistence potential of these chemicals. Present scenario of their use and importance in attaining self sufficiency in cereal grain yield is also discussed. In addition to all this, the regulatory framework that functions to keep a check on use of banned chemicals and to approve and regulate the supply of viable products has also been evaluated. The inclination of Indian agriculturalists towards the use of ecologically favorable techniques like the use of IPM is also documented. The review suggests conceptualization of ill effects of the overuse of pesticides within the farmer community as the main weapon to bring down the application of chemical pesticides. Economical availability of efficient sprayers, graduated containers, regular field checkups and promotion of IPM also among marginal farmers will help minimize the effects on non target organisms. Also we need to provide water proof clothing with resistant masks and gloves for applicators and in case of emergency antidotes. Focus should be on species specific non resistant pesticides with minimum half life so that soil integrity is also maintained.

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**Introduction**

India is the second most populous country in the world after china and has to feed about 16.8% population of the world with a meager share of 2.3% of the world area and 4.2% water resources. Agriculture supports 65% of the population of India. In order to gain self sufficiency in food grains and other agricultural commodities, Chemical fertilizers and Pesticides were introduced on a large scale in combination with genetically advanced High yielding crop varieties. Initially the produce was increasing towards the potential productivity of the plants but after a few decades of regular use of these chemicals, the produce came down or showed decreased response to the amendments. Also it was found that the chemicals persisted in soil and affected directly or indirectly the life of both the plants and animals including Humans. In the mean time the concept of organic agriculture gained momentum and has become a substitute to the farmer community for sustainable and productive agriculture without any harmful by products.

Although India is the largest producer of milk, cashew nut, areca nut, mango, banana, cheeku and acid lime in the world, second largest producer of paddy (after china) with a contribution of 21% in global production, ranks 2nd in wheat and sugarcane production, positioned among top three producers of pulses, roots & tuber crops, vegetables, eggs, inland

fish, dry fruits, coconut, textile raw materials etc and also average productivity of grapes is highest in India compared to other countries even then, nearly half of child population in India is underweight and 20% of World's hungry people (One billion) live in India. To overcome the problem of malnutrition and unavailability of food grains, agricultural output should increase and should be securely stored for regular supplies.

**Origin of pesticides**

In spite of the absence of written reports, growers, knowingly or unknowingly, have been using selected resistant plants for control of plant diseases. This is likely to have occurred not only because seeds from resistant plants looked bigger and healthier from infected susceptible plants, but also because in severe disease outbreaks, resistant plants were the only ones surviving and, therefore, their seeds were the only ones available for planting (Agrios, 2005). But since extensive artificial selections were performed for commercial benefits, man sometimes helped the pest by eliminating a natural pesticide through classical breeding procedures e.g. elimination of gossypol from present-day cotton made cotton much more pest-sensitive (Hedin et al., 1983).

People tried different methods to keep their produce safe for future use. But even after their best efforts, they lost part of the produce to the pest

population either in the fields or during its storage. In 1600 people somehow accidentally in England found that wheat seeds soaked in brine were resistant to bunt and later in 1700 Copper sulphate was substituted for sodium chloride. In 1885 with the discovery of Bordeaux mixture (combination of copper sulphate and hydrated lime), Millardet revolutionized the chemical control methodology for pests. Then in 1913, organic mercury compounds were introduced as seed treatments followed by Thiram (First dithiocarbamate pesticide) in 1934 and Carboxin (A systemic fungicide) in 1965. In the earlier period of organic synthesized pesticides, there were mainly three kinds of insecticides, carbamated insecticides, organophosphorus insecticides and organochlorinated insecticides but now new, more effective and less toxic formulations like pyrethroids have made a greater share in the world pesticide production. Chemical pesticides had been widely used for reducing the estimated 45% gross crop loss due to pests, amounting to around Rs. 290 billion per annum. Estimated global crop loss due to insects is 14%, due to plant pathogens 13% and about same percentage by weeds. About one-third of the agricultural products are produced by using pesticides (Liu et al., 2002). Without pesticide application the loss of fruits, vegetables and cereals from pest injury would reach 78%, 54% and 32% respectively (Cai, 2008). From past few years botanical pesticides have also become a sustainable and safe way of pest resistance and bears potential near or equal to that of conventional pesticides and when used synergistically could have even better outcome.

#### Importance in Indian agriculture

Pesticides are the agrochemicals either natural or synthetic used to kill unwanted plant or animal pests. The pest can be an insect, a bird, mammal, nematode, fish, plant pathogen, weed or microbe that compete with humans for food, devastate property, spread diseases or act as a type of irritant. Pesticides are classified according to the pests they are applied to like Bactericides to control bacteria, Fungicides for fungi, Herbicides for weeds, Miticides for mites, Molluscicides for Slugs and snails, Nematicides for

nematodes, Rodenticides for rodents and Virucides for viruses. Natural substances have been used as pesticides for centuries (Orlob, 1964) but with the introduction of chemical pesticides and chemical fertilizers during the green revolution of 1940's, improvements in agricultural output boosted their production because of heavy demand from the farm sector. The importance of using herbicides in agriculture has been greatly realized in the world as means of obtaining an increase in grain yield and improve its quality, particularly in view of labour shortage and technology development (Saad El-Din et al., 1996).

#### Present scenario in India

Consumption of pesticides in India is a little bit skewed as against the world consumption. In India 62.23% of the pesticide used is insecticide as against 44% globally. The consumption of fungicides is 19.16%, 14.39% herbicide and 4.20% other pesticides as is evident from the data of pesticide use from the year 1995 to 2005 (Table.1). Paddy and cotton are the major consumers of crop protection chemicals accounting for 28% and 20% respectively & top three states Andhra Pradesh, Maharashtra and Punjab account for about 50% of the total pesticide consumption in India (FICCI, 2013). In terms of global pesticide consumption, Indian input of pesticide per hectare is low (around 0.6kg) against that in USA (7 kg) and China (13 Kg.)

The production capacity of pesticides in the country is more than 1, 39,000 Metric Tonnes annually with more than 219 manufacturing Units and over 4000 formulation Units. In the recent years, the consumption of pesticides has shown a downward trend from 75,000 Metric Tonnes in 1991-1992 to around 41,822 Metric Tonnes in 2009-2010 even then, The crop protection chemicals accounts for about 2% of the total chemicals market in India. India is currently the second largest manufacturer of pesticides in Asia, second only to Japan. The Indian pesticides industry has been growing at 8-9% p.a. over the past five years (2007-2011). Industry size is estimated to be USD 3.8 billion.

**Table 1. Consumption of pesticides in MT during 1995-96 to 2004-05**

Pesticide Group	1995-96	1999-2000	2004-05
Insecticide	38,788	28,926	25929
Fungicide	10,563	8,435	6397.4
Herbicide	6,040	7,369	7364
Others	5,869	1,465	1660
<b>Total</b>	<b>61,260</b>	<b>46,195</b>	<b>41350.4</b>

(Source: <http://www.ncipm.org.in/asps/pesticides>)

Madhya Pradesh is the 14th largest consumer of pesticides among the states and Union Territories in India. From the above graph, it is observable that the

consumption of pesticides was highest in 2006-07 but from then a gradual decrease in consumption of pesticides is seen, the reasons for this steady decline

may be the Popularization of Integrated Pest Management approach which includes physical, mechanical, biological and need based use of safest chemical pesticides including Neem based bio-pesticides in coordinated manner. Ban on Heptachlor,

Chlordane, BHC and other chlorinated pesticides and the cultivation of transgenic crops added to the soil and environment health and relieved the soil from continuous chemical over load.

**Table 2. Production of pesticides during the last five years 2005-06 to 2009-10**

S.N.	PESTICIDE	GROUP	2005-06	2006-07	2007-08	2008-09	2009-10
1	Mancozeb	f	18857	22875	22863	35338	NA
2	Acephate	i	8475	8333	10,059	9652	10833
3	Cypermethrin	i	6484	5100	4659	4034	6225
4	Phorate	i	6220	4713	3404	2029	2003
5	Chlorpyrifos	i	4942	4654	4539	3887	2897
6	Monocrotophos	i	4899	5913	5118	4570	5738
7	DDT	i	4329	4495	3441	3305	3609
8	Isoproturon	h	4295	3150	2962	2979	2910
9	DDVP	i	3840	3890	3292	2734	3121
10	Endosulfan	i	2939	3898	3960	4263	2797
11	Trizophos	i	2853	1835	1841	2062	1000
12	Malathion	i	2740	4040	3968	2000	619
13	Aluminium phosphide	r	1518	1526	1615	1722	2162
14	Gly-phosate	h	1517	2100	1517	2331	1697
15	Ethion	i	1508	1804	771	157	425

Source: Ministry of Chemicals & Fertilizers.

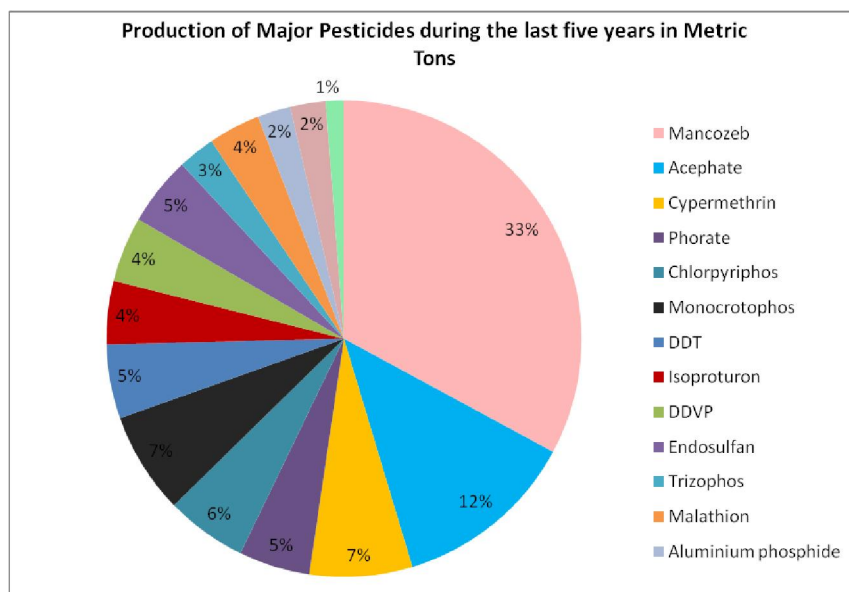
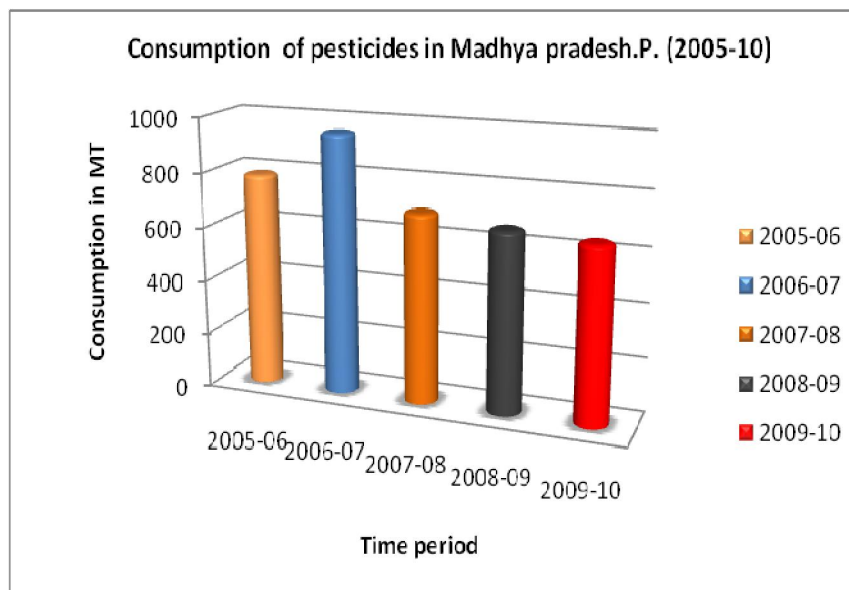
M.T. (Tech. Grade)

i- Insecticide, f- Fungicide, h - , Weedicide, r -Rodenticide, fm –Fumigants, NA-Not available

**Table 3. Highest 14 pesticide consuming states during the last five years 2005-06 to 2009-10**

S.No.	States/UTs	2005-06	2006-07	2007-08	2008-09	2009-10
1	Uttar Pradesh	6671	7414	7332	8968	9563
2	Punjab	5610	5975	6080	5760	5810
3	Haryana	4560	4600	4390	4288	4070
4	West Bengal	4250	3830	3945	4100	NA
5	Maharashtra	3198	3193	3050	2400	4639
6	Rajasthan	1008	3567	3804	3333	3527
7	Gujarat	2700	2670	2660	2650	2750
8	Tamil Nadu	2211	3940	2048	2317	2335
9	Karnataka	1638	1362	1588	1675	1647
10	Jammu & Kashmir	1433	829	1248	2679.27	1640
11	Andhra Pradesh	1997	1394	1541	1381	1015
12	Orissa	963	778	N/A	1155.75	1588
13	Bihar	875	890	870	915	828
14	Madhya Pradesh	787	957	696	663	645
	<b>Other states</b>	<b>1872</b>	<b>116</b>	<b>4378</b>	<b>1574.98</b>	<b>1765</b>
	<b>Total (round fig.)</b>	<b>39773</b>	<b>41515</b>	<b>43630</b>	<b>43860</b>	<b>41822</b>

Source: [http://ppqs.gov.in/Ipmpesticides\\_Cont.htm](http://ppqs.gov.in/Ipmpesticides_Cont.htm) (Directorate of Plant protection, quarantine and storage, GOI)



### Persistence of pesticides in the soil

It is almost impossible to limit the area of effect of pesticides. Even when it is applied in a very small area, it spreads in the air, is absorbed in the soil or dissolves in the water and eventually reaches a much bigger area. Pesticides also often seep into ground water. Approximately 4.6 million tons of chemical pesticides are annually sprayed into the environment and only 1% of the sprayed pesticide is effective, while the other 99% is released to non-target bodies such as soils, water, and atmosphere, which increases the risk of human pesticide poisoning and death (Zhang et al, 2011).

The persistence of the pesticide depends on its physical and chemical properties (partition coefficients, degradation rates, deposition rates) and the characteristics of the environment. Climate characteristics of soil also play a role in persistence. Studies in the Arctic have shown that insecticides and herbicides persist 3 to 8 times longer in cold climates than in temperate ones. Variability in herbicidal effects have also been attributed to soil type, soil moisture, temperature, pH, Nutrient availability and many other factors (Smith, 1982). The most persistent pesticides are termed “persistent organic pollutants” (POPs).

S.No	Particulars	Total No. of Samples assayed	Pesticide detected	Pesticide Above MRL	Non-Recommended
1	Vegetables	4239	417 (9.8%)	84 (2.0%)	137 (3.3%)
2	Fruits	2114	187 (8.8%)	18 (0.8%)	44 (2.0%)
3	Spices	336	63 (18.8%)	3 (0.9%)	91 (27%)
4	Cereals	1412	86 (6.0%)	44 (3.0%)	38 (2.7%)
5	Fish	689	12 (1.7%)	0	6 (0.9%)
6	Pulses	669	32 (4.7%)	0	33 (4.8%)
7	Packaged milk	630	10 (1.6%)	6 (0.9%)	1 (0.1%)
8	Animal feed	414	2 (0.5%)	0	2 (0.4%)
9	Tea	187	23 (12.3%)	0	3 (1.6%)
10	Meat + Eggs + Honey + Dry fruits	251,222,36,86	0	0	0
	Total	14225	832	155	355

Source: All India Network Project on Pesticide Residues

### Benefits of pesticides

Better crop management systems based on genetically improved (high-yielding) varieties, enhanced soil fertility via chemical fertilization, pest control via synthetic pesticides, and irrigation were the backbone of Green Revolution. The pooled effect of these factors almost doubled the world food production in the past 3 to 4 decades. Fertilizers and pesticides are extremely important inputs in the agricultural sector to bridge the yield gap that exists between potential yield and the realized yield. Pesticide application is still the most effective and accepted means for the protection of plants from pests, and has contributed significantly to enhanced agricultural productivity and high crop yields (Bolognesi, 2003). India has low crop productivity as compared to other countries. Average productivity in India stands at 2 MT/ha as compared to 6 MT/ha in USA and world average of 3 MT/ha. At the same time, India's pesticide consumption is also low at 0.60kg/ha as compared to the world average of 3 kg/ha. Hence, increased usage of pesticides could help the farmers to improve crop productivity (FICCI, 2013).

### Hazards of pesticides

Pesticides generally tend to appear have no adverse effects when used under their prescribed limits but more often the farmer community in order to gain more control of field pests apply higher quantities of these chemicals and this overwhelming and injudicious use of pesticides has resulted in lowering of yields due to mineralization of soil. Although the Green revolution of 1940's was very much dependent on pesticides but then, the optimism was such that the large-scale consequences of the application of thousands of tonnes of poisonous substance were not perceived or at least were overlooked. The studies of some previous workers (Fletcher & Nath 1984; Gao et al., 1988; Reicher & Throsel, 1997; Siddiqui et al.,

1997) have shown that beyond a certain threshold concentration, the pesticide begin to act as growth inhibitor instead of growth promoter or regulator. Pesticides trigger the formation of phenolic compounds like iso-flavones, phenolic acid and hydroxycinnamic acid derivatives. These compounds are potential inhibitors of germination and plant growth (Einhellig et al., 1985; Macias et al., 1992; Gerald et al., 1992; Mersie & Singh 1993). The presence of pesticide residues in soil tends to decrease the uptake of water along with nutrients (Taiz & Zeiger 2003) as pesticides residue gets attached with the soil particles affecting the nutrient uptake from the soil to root (Rengel & Wheal 1997).

In addition to plants, pesticides have profound effects on animals and humans too. Pesticide sprayers represent the most exposed group of agricultural workers. Pesticides are the most important method in self-poisoning in the developing world. Three million cases of pesticide poisoning, nearly 220,000 fatal, occur world-wide every year (Eddleston et al., 2002). Pesticides can not only cause death but also induce various diseases. It is estimated that cancer patients resulted from pesticide poisoning account for nearly 10% of the total cancer patients (Gu and Tian, 2005). Associations with cancer have been reported in human studies for chemicals such as phenoxy acid herbicides, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), lindane, methoxychlor, toxaphene and several organophosphates (IARI,2002). Exposure to pesticides has also been the subject of great concern in view of its possible role in the induction of congenital malformations (Rojas et al., 2000).

### Integrated Pest Management in India

Integrated pest management includes various techniques suitable to maintain pest infestations below economically acceptable levels. It is a management



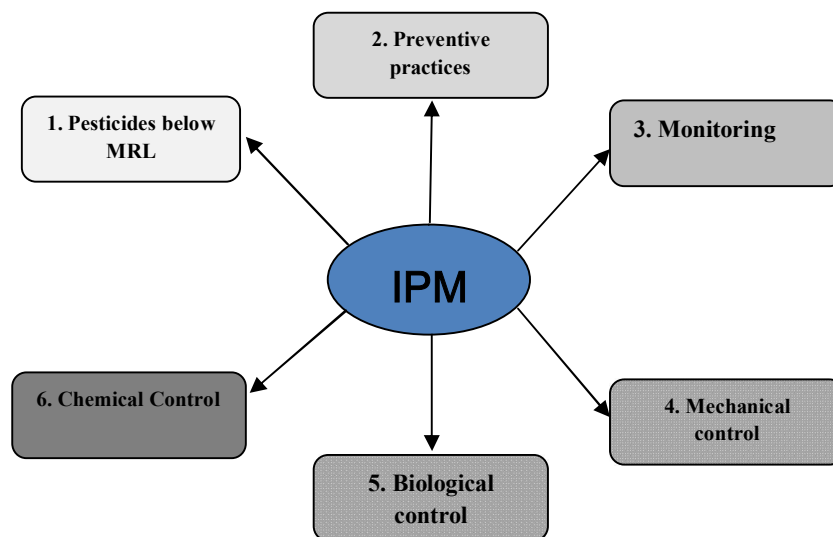
approach that encourages natural control of pests using resistant crops, cultural management practices, and natural enemies of the pest and also judicious use of pesticides. The initial research efforts registered towards the development of IPM was the Operational Research Project (ORP) in cotton and rice crops of the Indian Council of Agricultural Research (ICAR) (Swaminathan, 1975). Since then many initiatives at the national and state levels have been implemented. The Directorate of Plant Protection, Quarantine and Storage, Government of India, has established 31 Central Integrated Pest Management Centers (CIPMCs) in 1992 to promote the concept of IPM across the country. Since then the centers are inclined to the objectives of

- Maximize crop production with minimum input costs.

- Minimize environmental pollution in soil, water and air due to pesticides.
- Minimize occupational health hazards due to chemical pesticides.
- To improve farming system with no or less use of chemicals

Farmer Field Schools (FFS) have been used to train the illiterate farmers of the latest technologies. Season Long Training (SLT) programmes on major agricultural crops are arranged. Up to 2010, 17 microbial and 2 botanical biopesticides with many formulations were registered for use. During the late 20th century, pesticide consumption in the United States declined by 35% without reducing crop production (SDNX, 2005), all because of the Integrated pest management practices.

### Components of Integrated Pest Management



*Source: Industry reports Tata strategic analysis*

### Regulations on pesticides

The government of India has been very serious in order to make judicious and justifiable use of agrochemicals. Initially the use of insecticides in the public health programmes was being controlled under the Drugs and Cosmetics Act, 1940. Then the Government of India introduced The Insecticides Act, promulgated in 1968 and enforced on 1st August, 1971 to regulate the import, manufacture, sale, transport, distribution, and use of insecticides and ensure safe use of pesticides. Pesticides in India are registered by the Central Insecticide Board and Registration Committee (CIBRC) and suggest them for various crops while Food Safety and Standards Authority of India (FSSAI) is accountable for setting Maximum residue limits (MRLs) for the registered pesticides. The concepts of

Maximum Residue Limits (MRLs), Acceptable Daily Intake (ADI) and Theoretical Maximum Daily Intake (TMDI) for pesticides have been devised to keep a check on the pesticides' residues in food chain and keep them within safe limits.

Maximum Residue Limits (MRLs) are the maximum residues of pesticides, which may be expected in a product treated with them, considering that Good Agricultural Practices have been followed. ADI is the maximum intake of pesticide that can be tolerated from all dietary sources in a day without posing any chronic health risk. TMDI is an estimate of the maximum intake of the pesticide with the existing MRLs for a person following a particular dietary practice. About 183 pesticides and formulations were registered for use in India under the Insecticides Act,

1968. Currently, there are about 217 pesticides registered for use in India (Feb.-2009). 41 pesticides have been either banned or withdrawn and about 18 pesticides were restricted for registration. Only 20-25 biopesticides have been registered as per the Insecticide Act 1968 (as on 2008). Neem based pesticides, *Bacillus thuringiensis*, *Nuclear Polyhedrosis Virus* and *Trichoderma* are some of the major biopesticides produced and used in India.

### Recommendations

- The first and foremost requirement in order to restrict the pesticide pollution in the environment is to conceptualize the effects of overuse of pesticides to the farmers, pesticide applicators and their families which usually are illiterate and are the most effected community.

- Rather than repeated application of the same pesticide which could prove fatal for beneficial organisms also, IPM is suggested and focus should be to develop new safer technologies like biopesticides to control the main pests.

- A large proportion of pesticides applied to crops hit the non-target areas because of the untrained manpower and faulty spray equipment. Improvement in the spray equipments is also needed so that major portion of the pesticide hits the target and pests are controlled without much effect to the non-target organisms. The equipment should be graduated so that the farmer uses fixed volumes of the pesticides and residual effects are minimized.

- Users should always follow the safety measures specified by the manufacturer and observe all safety recommendations including use of gloves, masks, protective clothing etc.

- Regular checkups of the crop field should be done so that pesticidal application is timely. Majority of the farmers do not monitor their fields regularly. Thus they apply pesticides when the damage has already been done.

- Pesticides are supposed to be stored in their original tagged containers so that at the time of adverse condition, easy identification of antidotes is possible.

### Conclusion

The "Rain of Chemicals" to drive increased crop production has led to depletion of soil fertility and degraded 21.97million hectares of land in terms of acidity and alkalinity (Bhattacharyya et al., 2005). Agriculture sector is base to the economy of our country and also the major sector of nutritional security for a developing country ranking highest in the number of malnourished children and 15th leading country with hunger situation (Global Hunger Index, 2011).Among the options available (Chemical Crop

Protection (CCP), Threshold IPM (TIPM), Ecotechnology (ET) and Organic Farming (OF), IPM remains the best option as it has the potential to feed the growing population and ensure the security of our environment. The need of the hour is to diverse resources in the upliftment of IPM. Researches in this sector could prove a major breakthrough to overcome the present difficulties to the sector and would definitely resolve the issues discussed in the paper in a manner feasible and globally accepted.

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