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ENVIRONMENT AND HEALTH ASPECTS OF PESTICIDES USE IN INDIAN AGRICULTURE

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Abstract

In the recent past, pesticide related issues have been extensively highlighted in the media including research journals and attracted wider debate and sharp focus among the interested groups in India. Indiscriminate and excessive application of synthetic pesticides damaged not only the environment and agriculture but also have entered into the food chain thereby affecting health and development. The main intention of the introduction of pesticides was to prevent and control insect pests and diseases in the field crops and of course, initially the use of pesticides reduced pest attack and paved the way for increasing the crop yield as expected. Simultaneously, increased use of chemical pesticides has resulted in contaminating the environment and the long-term implications on the society are found multidimensional. In India pests cause crop loss of more than RS 6000 crores annually, of which 33 per cent are by weeds, 26 per cent by diseases, 20 per cent by insects, 10 per cent by birds and rodents and the remaining (11 per cent) is due to other reasons. The magnitude of the problem would grow further as more and more (newer) pests and diseases likely to attack crops and the need to use pesticides in different forms will be necessitated in the years to come.

The common formulation types of pesticide are liquids, wettable powder, emulsifiable concentrates and dusts, and when they are sprayed, move through the air and eventually end up in other parts of the environment like soil and water. Also pesticides break into ground water, soil and surface water depending upon soil type, temperature, vapor pressure, the amount of sunlight and rain, the water solubility of the pesticides and magnitude of application. The pesticides have toxic effects like reproductive, teratogenic, mutagenic and carcinogenic as well as on ecology including non-target host plants and animals. Theoretically agro-chemicals are used on large scale for all crops under a market oriented farming system but under subsistence farming scenario farmers tend to use less quantum of pesticides as they consider that production is sufficient to meet the domestic requirements. While the intensity of production increases towards market orientation from subsistence level, invariably farmers use a high dosage of agro-chemicals for generating more income via production. Another aspect is that when the land becomes scarce and the agriculture production moves towards market orientation (with scarce land), more chemicals including pesticides are required. Now as the cultivable land becomes a scarce and inelastic commodity, due to population growth, the situation will be aggravated in the years to come especially in highly populated countries like India and China. It is to be noted that

in India the annual pesticide business is estimated at around RS 5000 crores and in coming years, this would grow faster and soon becomes a major player in the world.

Detailed literature on the environment and health dimensions of pesticide use in Indian agriculture is found to be scarce. In addition to this there exists poor appropriate and alternative framework to the use of pesticides. Under this scenario, it is important to understand the crucial issues like what are the environment and health costs of pesticide use? What alternative frameworks would help solve the problem? To address a few issues this study is taken up and it relies on available literature on the subject particularly in India and is divided into five sections. After introduction, the next section provides the factors contributing to the growth of pesticides use and the third section illustrates the laboratory findings and impact of pesticides use and fourth part examines the possible remedial mechanisms and the final section deals with the conclusion and suggestions. This study found that application of pesticides increased as much as 30 times over fifty years in India (from merely 2.35 thousand tonnes to around 60 thousand tones between 1959 and 2000). Liberal subsidies, extensive and intensive pest attack, shortsighted public policies, lack of legal framework, nepotism, strong campaigns favoring pesticides, poor alternative systems and farmers' attitude have contributed to increasing pesticide application. It is obvious that continuos and indiscriminate pesticide use contributes to many environment pollution and health problems.

Laboratory findings indicate that the environment is highly polluted as there are many toxic metals and residues found in the soil, water, humans, animal and plants. The pesticide particles also enter into agricultural products (some times more than 500 times of maximum permissible limit). Another observation is that pesticide residues at alarming rates are observed in bottled water and soft drinks. The source for packaged water and soft drinks companies is largely from agriculture fields and industrial suburbs. Maximum permissible limit for pesticide residues in packaged water and soft drinks exceeds many times the international norms like European Economic Union. Laboratory results also reveal that pesticide residues present in leafy vegetables create health disorders like neural tube defect (NTD) among newborn children. These findings enable us to corroborate the fact that pesticide residues are responsible for causing environmental problems and health disorders. Continous, indiscriminate and non-judicial application of pesticides contribute to unviable agricultural production. It was also brought out that farming with external factory made inputs including pesticides becomes less profitable in the long run. Research findings indicate that pesticide residues contribute to polluting the soil, ground water and surface water besides affecting animals, plants and human beings. Water became unfit for consumption and living beings became victims of the pesticides. In the pretext of agricultural development health disorders like cancer and mental retardation are observed via pesticide use. Human (breast) milk and cow milk are found with pesticide (endosulphan) residues and many habitants suffer from diseases like cancer, epilepsy, skin diseases and unbearable suffering due to pesticide use, some of the villagers committed suicides. Thus pesticide use takes a heavy toll on environment and health and hence there is a need for alternative models for synthetic inputs.

Possible alternativse could be application of non-toxic environment friendly formulations and solutions to combat pest for maintaining environment security and creating a healthy society for attaining overall development and well being. In fact there is a paradigm shift in agriculture towards low external input sustainable farming and subsequently (ecological) farming with only local inputs. Ecological or organic farming is considered as environmentally sustainable, economically viable and socially adaptable through which sustainable agriculture development

(SAD) is attained. Organic farming rely on local resources including plants that have pest repellent properties to control the pests. In India it is estimated that around 3000 plants do possess pest repellent features, which need to be scientifically studied and utilized for promoting sustainable agriculture development. In fact, some of the research centers have already started working on this direction but in a compartmentalized form. Comprehensive research by different institutions and individuals in coordination with stakeholders – farmers – on alternatives to pesticides would solve the problem. This needs careful examination and understanding of the whole issue of pesticide use in the larger context of environment and health for attaining social equity with economic development.

It is clear from this study that pesticide use has increased manifold obviously due to many complex factors. Research findings reveal that pesticide residues have been found in the environment many times higher than the maximum permissible limit. Pesticide residues present in the environment affect the soil, water, agricultural products, animals and plants. Continuos application of pesticides have caused diseases like cancer and epilepsy and the people have been made to suffer for years. Alternative techniques to pesticides are to be found viable in the long run and hence a concerted effort needs to be put by all concerned for promoting SAD in the broader framework of environment and health.

I. Introduction:

The pesticide related issues have been increasingly and extensively highlighted in the media including research journals and have attracted sharp focus among the policy makers in India and elsewhere too. Indiscriminate and excessive use of toxic synthetic pesticides damaged not only environment and agriculture but have also entered into the food chain thereby affecting all living beings. The recent research findings on the presence of pesticide particles in the packaged water are classic cases pointing out the nature and magnitude of the problem. Pesticides, herbicides and fungicides have been introduced during the mid-sixties on a large scale along with other inputs for propagating green revolution package in Indian agriculture. The main intention of the introduction of pesticides was to prevent and control insect pests and diseases in the field crops and of course, initially the use of pesticides reduced pest attack and paved way for increasing the crop yield as expected. Simultaneously, increased use of chemical pesticides has resulted in contaminating the environment and the long-term implications on the society are found to be many. Knowingly or unknowingly, now the farmers are addicted to using agro-chemcials indiscriminately and excessively to make the situation from bad to worse not only in India but also in other parts of world as well (Conway, 1984).

A rough estimate shows that about one third of the world's agricultural production is lost every year due to pests despite the pesticide consumption which totalled more than 2 million tons. In India pests cause crop loss of more than Rs 6000 crores annually, of which 33 per cent is due to weeds, 26 per cent by diseases, 20 per cent by insects, 10 per cent by birds and rodents and the remaining (11 per cent) is due to other factors. The magnitude of the problem would accelerate further as more and more (newer) pests and diseases are likely to attack crops and the need to use pesticides in different forms will be necessary in the years to come.

The common formulation types of pesticide are liquids, wettable powder, emulsifiable concentrates and dusts, and the utilization of pesticides enters into the environment and has many different fates. When they are sprayed, pesticides move through the air and eventually end up in other parts of the environment like soil and water. Also pesticides break into ground water, soil

and surface water depending upon soil type, temperature, vapor pressure, the amount of sunlight and rain, the water solubility of the pesticides and magnitude of application. The pesticides have toxic effects like reproductive, teratogenic, mutagenic and carcinogenic as well as on ecology, including non-target plants and animals like bees. Unless utmost care is taken to use the pesticides rationally, the above toxicological and ecological effects are bound to occur and if such pesticides were applied continously for years, the particle concentration in the soil and water would create adverse complex problems.

The FAO estimated that between 1960 and 1995 the annual growth of the global pesticide market was 11 per cent (FAO, 1997) and it is expected to grow faster in coming years. Initially chemical pesticides were applied for cereal crops and now they are increasingly used due to increase in pest and disease attack on other crops as well. The International Food Policy Research Institute (IFRRI) estimated that pesticides have been largely used now on fruits and vegetable crops (26 per cent) followed by rice and maize (23 per cent) and the remaining on all other crops (IFRRI, 1996). Across the globe pesticides have been applied at different levels depending upon the cropping systems and farming systems (Table 1). When the subsistence farming system moves towards commercialization, farmers have to use more input including agro-chemicals for generating additional income as well as for export to earn foreign exchange. Besides, to get more color and aesthetic appearances farmers use chemical pesticides to attract the customers to motivate them to pay a higher price.

Table – 1: Agro-chemicals use by stage of agriculture and cropping system

Farm Characteristics	Cropping System		
	Cereals (e.g., rice)	Other filed crops (e.g., cotton, tobacco)	Horticulture (e.g., fruits and vegetables)
Land abundant	All chemicals	All chemicals	All chemicals
Subsistence	None	None to low	None to low
Land Scarce	Insecticides	Insecticides, fungicides	Fungicides
Subsistence	Low to moderate	Low to moderate	Low to moderate
Land abundant	Herbicides	Herbicides, fungicides	Fungicides, herbicides
Market oriented	Moderate to high	Moderate to high	Moderate to high
Land scarce	Insecticides, herbicides	All chemicals	All chemicals
Market oriented	High	High	High

Source: Rola and Pingali (1993)

The above table illustrates that agro-chemicals are used on a large scale for all crops under a market oriented farming system. Under subsistence farming scenarios farmers tend to use less quantum of pesticides as they consider production to be sufficient to meet the domestic requirements. While as the intensity of production increases towards market orientation from subsistence level, invariably farmers use high doses of agro-chemicals for generating more income via production. Another aspect is that when the land becomes scarce and the agriculture production moves towards market orientation (with scarce land), more chemicals, including pesticides are required. Now, as the cultivable land becomes a scarce and inelastic commodity due to population growth, the situation will aggravate in the years to come especially in highly populated countries like India and China. It is to be noted that in India the annual pesticide

business is estimated at around RS 5000 crores and in coming years, this will grow faster and soon becomes a major player in the world. In this context it is important to examine different aspects of environment and health implications due to pesticide use in India and this paper relies on available literature on the subject particularly in India. This study has been divided into five sections. The next section provides the factors contributing for the growth of pesticides use and the third section illustrates the impact of pesticides use with case studies. Fourth section deals with the possible remedial mechanisms and the final section deals with the conclusions and suggestions.

II. Factors Contributing to Growth of Pesticides:

In India, during the mid-sixties, when the new and high yielding (HYV) crop varieties, mainly cereals, were introduced among farmers, the synthetic inputs covering fertilizers (as nutrient) and pesticides (as insecticides) were recommended to increase production and productivity[1]. The agricultural scientists, policy makers and extension officials had to work hard to educate and convince the farming community to use chemicals without carefully looking into their adverse effects[2]. Realizing the quick effect of these chemicals on crops in terms of yield response, farmers reacted favorably albeit slowly and the use of these has increased manifold over the years. Similarly, after the farmers were convinced that chemical pesticides were effective in preventing and controlling pests and diseases (Table 2), their use increased considerably (Table 3).

Table - 2: Distribution of pesticides and their target pests

Pesticides	Target groups	Formulations
Insecticides	Insects	Organochlorine compounds like Endosulphan, Aldrin, DDT and Chlordane
		Organophosphorous compounds like Malathion, Parathion, Monocrotophos and Phorate
		Carbamate compounds like Aldicarb, Carbaryl, Carbofurna and Methomyl
Herbicides	Weeds	Paraquat, Atrazine, Nitrofen and 2,4-D
Fungicides	Fungus	Captan, Captafol, Bavistin and Vitavax
Rodenticides	Rodents	Zinc phosphide, Coumachlor and Warfarin

[1] While commenting on increased output, Petit, in his forward to Farah (1994) made the following observation for developing countries. When chemical pesticides started to be used on a large scale, they significantly contributed to the enhancement of productivity and the suppression of insect transmitted human diseases. Indeed, as the food and fiber requirements of growing population increased, coupled with the need to generate foreign exchange, increasing productivity became a vital national concern. Thus an important component of government strategies to increase agricultural production has been the encouragement of pesticide use since pests and diseases were one of the major causes of yield losses. This was coupled with the adoption of economic policies that facilitated the access to, and the domestic industry of, pesticides.

[2] According to the chairman of the Commission on Agriculture Costs and Prices, government of India, "At the time green revolution was adopted, sustainability issue was not the criteria. The only way out was to pump in the inputs so that production rises" (DTE, 2000, pp31).

Nematicide	Nematodes	Ethylene, Dibromide (EDB) and DBCP
Acaricide	Mites, ticks and spiders	Azobenzene, Chlorobenzilate, Tedion and Kalthane

Source: Down To Earth, 2000, p 42.

Table – 3: Pesticide application in Indian agriculture from 1950-51 to 1998-99

Reference year	Pesticide use (technical grade material) in '000' tons
1959-51	2.35
1960-61	8.62
1970-71	24.32
1980-81	45.00
1990-91	75.00
1995-96	61.26
1998-99	57.00*

Note:* Estimated demand
Source: GOI (1999)

The government was proactive in providing liberal policy packages to agro-chemical industries[3] and expectedly, the production increased and in special circumstances the government provided subsidies to farmers. For instance, during 2000-01 the Union government released a sum of RS 96.2 millions of which a major share of RS 74 millions was contributed by the Union government alone to combat Eriophyide mite on coconut palms in Karnataka (GOK, 2002).

Table 3 shows that application of synthetic pesticides has increased significantly from 1950-51 to the late nineties. Though there is a sharp decline during the later parts of the reference periods, especially in the nineties, pesticides use is still found to be high in India. Notably, total pesticides use was highest during the eighties as the period was undergoing the spiral effects of the green revolution. The continous decrease after the eighties in the use of pesticides may be related to the fact that the farmers are increasingly aware of the adverse effects of such inputs. Also the focus on public policies towards pesticides have been changing more favorably for using biodegradable and environmentally sound pesticides like Neemazol, Repellin, Wellgro, Econeem and GB biopesticides. The liberalization policy initiated during the early nineties towards reducing the subsidies (for pesticides along with fertilizers) would have discouraged the farmers in applying pesticides. According to an estimate made by Thippaiah and Deshpande (1999) during 1980-81, the proportion of budgetary subsidies in terms of percentage was 1.4, which increased to 2.1 during 1990-91 and declined to 1.2 during 1998-99. And at the same time, no one knew the scientific application of pesticides and therefore, there is every possibility that chemical pesticides may have been indiscriminately used in India.

In the context of globalization and trade policies, production and application of chemical pesticides have increased in different parts of the world as observed by Dasgupta and others (2001) for Brazil. Unfortunately, empirical studies on the impact of trade liberalization and pesticide use are found scarce as the effect of pesticides is local in nature and more complex in practice. In India, both the Union and state governments (obviously for political reasons and

[3] According to Gulati (1990) subsidy on agrochemical (fertilizer and pesticide) is largely shared by the industry and the farmers are not net subsidized but actually taxed.

gains), subsidize the pesticide price especially to the resource poor farmers[4] to the tune of 75 per cent (GOK, 2002). While application of chemical fertilizers is largely restricted to irrigated areas, chemical pesticides are used under both wet and dry land agricultural systems. The ignorance and strong faith on hearsay, resulted in wooing the farmers to apply dreaded chemicals for which the price is being paid now. Without carefully understanding the directions for application and prescriptions, farmers started applying chemical pesticides indiscriminately and in some cases the government encouraged it by providing liberal subsidies to use for specific crops[5]. In other words, when farmers seek to expand their production frontiers, they do so by increasing the inputs used which in turn is determined by their prices. This has contributed to an increase in the production and use of agro-chemicals.

III. Impact of Pesticide Use:

Green vegetables have been detected with pesticide residues and their health impacts were exposed in the state of Rajasthan. More importantly, the consignments of agricultural commodities like tea[6], egg powder and cashew kernels have been rejected on the contention of chemical contamination and presence of pesticide residues by European countries. A recent report from largely chili producing state of Andhra Pradesh indicates that dry chilies too have pesticide particles and the importers refused to accept the consignment. Normally since dry chilies are not washed while cooking, no wonder that the consumers have to pay heavily in terms of ill health and health care in the long run. In India, the Central Food Technological Research Institute's study shows that of 204 samples of cereals, pulses, milk, eggs, meat and vegetables, 108 were found to contain pesticide residues (quoted in Vahab and others, 1991).

The problem of chemical pesticides is not restricted to India alone; even developed countries face this problem. According to Metha, (1991) in the USA, only one in hundred citizens does not carry DDT in his/her body. Nearly 500,000 illnesses and 20,000 deaths can be attributed annually to chemical pesticides worldwide. According to an estimate made by the WHO, each year 3,000,000 cases of pesticide poisoning including 220,000 deaths are reported across the globe (DTE, 2001). Similarly, as contended by Dasgupta and others (2001), the application of pesticides has caused environmental and social cost in Brazil, where trade liberalization encouraged the farmers to use them on exportable crops for economic gains. These findings give enough evidence and credentials to argue that under the market economy regime and consumerism, agricultural goods that carry pesticide residues would have lower demand across the globe. Hence, this issue needs serious attention and quick action for social, environment and economic considerations in the context of sustainable development.

Despite these, advocates of agro chemicals are complacent and argue that to control pests and diseases in the interest of increasing food production, chemical inputs cannot be minimized let alone stopped. According to them, without chemicals, it is very impractical to increase food production in the short run and they argue that because of this India attained self-sufficiency in food grains production. On the other hand, environmentalists contend that there are alternative

[4] A GOI subsidy scheme is in operation beginning rabi 1979-80 for the purchase of fertilisers and pesticides ranging from 26 per cent in the case of small farmers, $33_{1/3}$ per cent in the case of marginal farmers and 50 per cent in the case of scheduled tribes.

[5] Farmers after availing pesticides with subsidy, they misuse and there is no private cost involved (Rajendran, 2002).

[6] In January 1994, Germany rejected a consignment (after arrived that country) of Darjeeling tea on the ground that it contained 0.24 mg of tetradifrn – pesticide – per kg of tea which is 24 times more than the permissible limit set by Germany (Jain, 1994).

methods and mechanisms, by which crop diseases and pests can be effectively checked. They lament that nature has given enough checks and balances to minimize the pests and diseases if not eradicate them in total. In fact, some of the pesticides (like endosulphan) that have been banned or restricted in their use (Table 4) in many countries have been liberally used in India due to lack of strict regulations and political will. In fact the US Environmental Protection Agency classifies endosulphan as a category lb (highly hazardous) chemical as it is easily absorbed by the human systems like stomach, lungs and skin[7]. This explains the fact that gross violation[8] of environment protection prevails in India as compared to its neighbors like Bangladesh and Sri Lanka.

Table – 4: Regulatory status of endosulphan in other parts of the world

Status	Country
Banned its use	Denmark, Germany, The Netherlands, Sweden, Belize and Singapore
Preparing for its ban	Columbia, Indonesia and the Brazilian state of Rondonia
Disallowed its use in rice fields	Bangladesh, Indonesia, Korea and Thailand
Restricted its use	Canada, Finland, Great Britain, Kuwait, The Philippines, Russia, Sri Lanka, Thailand and Madagascar

Source: Pesticide Action Net Work (2000) Endosulphan, Fact Sheet in Pesticide News, No. 47. March pp 20-21, UK.

The research studies (CSE, 2003, Rajendran, 2002, Kabra, 2000 and VHAI, 1991) on the ill effects of agro-chemicals by and large report that continuous application of chemical inputs have caused innumerable damage to the environment and living beings. While some empirical studies like Pagiola (1995) found that pesticide use actually lowered the yields, others observed that there was an adverse impact on health (Mencher, 1991, and Antle and Pingali, 1994). Dismally the value of crop loss due to pests is invariably lower than the cost of pesticide related illness (Rola and Pingali, 1993) and the associated loss in farmer productivity (Antle and Pingali, 1994) for many Asian countries including India. Very importantly some of the state run agencies have been sponsoring environmental terrorism, despite grass roots agitation and research exposure on the adverse effects of pesticides. The classic example is that of the Kerala state's Plantation Corporation's role in aerial spraying of endosulphan on the cashew gardens in Kasargod district. Another important revelation is the recent findings of the pesticides' residues in bottled water, which is supposed to be free from even minor particles of chemicals. Thus the environmental terrorism continues to haunt millions of poor and innocents in the country on the pretext of food security. Undeniably food security has to be maintained to save people from starvation in the country. Does it mean that there is no alternative mechanism? In other words, there is an urgent need for searching for alternative strategies in the larger context of maintaining food security and economic viability along with environmental balance (for sustainable development of the society) instead of indiscriminate application of synthetic pesticides. Against this backdrop, this paper examines the environmental terrorism of pesticides on the agriculture (soil, environment, ground water, health, flora and fauna) and a host of other issues. Further, it

[7] DDT is another noted pesticide that is being used in India, with an average consumption of 0.27 mg per capita and India has the highest number of lipids.

[8] There is an obligation on the part of the government to provide clean environment to people and Article 21 of the Indian Constitution ensures the right to a clean environment and health as a fundamental right.

highlights the present legal loopholes and also provides some mechanisms to overcome the situation in the larger framework of sustainable agricultural development (SAD) and food security.

A number of research studies in India have focused their attention on the impact of agro-chemicals in a more general perspective (for a brief review on Asian countries, see Pingali, 2001). Notably, most of these studies have been conducted by the voluntary sector and of course later (after a series of deliberations and sometimes strong criticisms) by the state sponsored research agencies. Perhaps this is mainly due to the fact that the state sponsored agencies do have their own objectives and agenda for soft peddling the issue and perhaps the industry lobby is so strong that nothing could be done against this malady at least in the short run[9]. Here, a couple of case studies on the adverse implications of pesticide spraying have been taken up for a closer examination. A physician at the Indian Institute of Health Management Research in Jaipur, Rajasthan, reported that newborn children have neural tube defect (NTD), a deformity that results from the incomplete closure of the neural tube during early pregnancy[10]. Alarmingly NTD takes a heavy toll of the order of half a million babies every year in the world and in Rajasthan alone about 8,000 babies are reportedly affected. According to the above study, the primary cause of NTD is the excessive use of pesticides on crop fields. Further, the study also notes that pesticides are mainly responsible for these as they are antagonistic to folic acid, a vitamin that is essential for the development of the brain. In this country, while folic acid is given after pregnancy is detected – normally after four to eight weeks – the brain develops from the neural tube in the first four weeks of pregnancy. The pregnant women have to eat leafy vegetables and grains because they contain folic acid, (which is a vitamin B) that is essential for the development of the brain. Immediately after the harvest of rabi crop, farmers grow vegetables and greens and apply heavy dose of chemical pesticides, which are reservoirs of toxic heavy metals. Obviously the pregnant women, who eat such contaminated and toxic vegetables and green leafs succumb to complications. The physician contends that pesticide residue in food can prevent the availability of folic acid leading to the birth of children with NTD. Despite the fact that this study needs wider analysis and deeper examination across a cross section of pregnant women in diverse conditions[11], the findings do show that congenital malformations are due to pesticide use and abuse.

Field based and laboratory research findings reported[12] on the impact of endosulphan on field crops including vegetables and green leafs indicate that pesticide residue have been found more than 75 times the maximum permissible limit (Table 5). Realizing the research potential on this crucial issue, the Texas A&M University, New Mexico in the USA has taken up a research project to examine the possible link between pesticide residues and NTDs.

Table – 5: Results on endosulphan residues in Kasargod district

Sample items	Detected value Of Endosulphan	Maximum Residue Limit (MRL)	Number of Times Value Exceeds MRL	Site/source of sample
Water	9.19	0.18	51	The Kodenkiri stream near

[9] For a detailed arguments and counter arguments on the effect of endosulphan by independent research findings and comments from scientists and industrialists see DTE (2002, July 15,PP25-34).

[10] The brain of the baby develops from the neural tube in the initial four to six weeks of pregnancy and failure of the tube to close completely results in deformities. Deficiency of folic acid at the time of conception and during the weeks immediately succeeding it results in the malformation.

[11] The evaporation, solubility, dose response, absorption and toxicity levels of pesticides vary across diverse weather conditions and hence it warrants a comprehensive examination and cross checking.

[12] The India's leading Science and Environment magazine, Down To Earth has published many such critical reports between 2000 and 2003 and made policy makers to act.

				Vaninagar
Butter	14.00	NA	NA	From the milk of a cow of Saletadka
Cows skin/fat tissue	49.99	0.1	500	From the abdominal region of cow from Padre
Vegetables	31.24	0.4-2.0	78-16	'Basale' leafy, spinach like vegetables from Kajampady
Human milk	22.40	NA	NA	Lalitha, 35, resident of Kumbdaje village
Human blood				Muthakka Shetty, 50
Live frog	196.47	NA	NA	From a stream in Kumbdaje
Cashew	10.35	NA	NA	From a plantation near Kajampady
Spices	3.74	NA	NA	Pepper bunch from Kajampady
Fish	212.28	NA	NA	From a tank in Kajampady
Soil	22.24	NA	NA	From Lalitha's house in Kumbdaje
Cashew leaves	35.16	0.09	391	From the heart of plantation at Periyal
	6.52	NA	NA	

Notes: 1. All figures in parts per million (ppm).
2. NA – MRL not available
Source: Down To Earth (2001).

Once the pesticides are sprayed, (most of the time in excessive[13] quantity on the plants), the residues and particles directly enter into the humans through the food chain. The table also shows that endosulphan residues on the soil are 400 times more than the MRL, which is going to create an environmental hazard for a long time to come. Another notable observation is that around 500 times of MRL of endosulphan is noticed in animals' skin/tissue and these explain the maladies of chemical pesticides on the environment and living organisms, being a consequence of the governments sponsored environmental terrorism. In fact the state government's extension officials and scientists recommend and prescribe the required quantity and type of pesticides, which are unheard and unheeded by the farmers more often obviously for quick returns. Moreover, there is complete lack of effective supervisory mechanism to regulate the use of pesticides at the farm level.

Another case of indiscriminate pesticide dumping by a state owned department resulted in serious environment and economic revelations in the highly literate state of Kerala (Rajendran, 2002). Way back in the 1970s, the Plantation Corporation of Kerala (PCK) began aerial spraying of pesticides on its 2,200 ha cashew gardens in Padre village in Kasargod district mainly to check pests during fleshing, flowering and fruit setting seasons. Continuous and indiscriminate application of synthetic pesticides affected the flora and fauna, and local people became victims of severe health problems like cancer (Table 6). Records of disorders in Padre village indicate that in each household at least one person has been found to toil and from 1990 to 2001, 156 cases of disorders from 123 households were noted. In the beginning PCK sprayed endrin and later changed to endosulphan, an organochlorine, effective in a number of field crops. As was discussed earlier, this pesticide has been either banned or its use restricted in many parts of the

[13] Many farmers in India have an impression and belief that if the pesticides are used in excesses, the pests can be controlled quickly to get more yields.

world and for little economic gains for cashew production, the state itself contributes to damaging the environment.

Table – 6: Health disorders in Padre village of Kerala

Disorders	No. of cases
Cancer	49
Mental retardation	23
Congenital anomalies	09
Psychiatric cases	43
Epilepsy	23
Suicides	09
Total	156

Source: Down To Earth (2001)

The table 6 also indicates that apart from 9 suicides, a greater incidence of cancer (49), psychiatric problems (43), epilepsy (23) and the like have been reported in the village. The entire happenings occurred albeit the warnings given by the local villagers and the permission not being given by the Central Insecticide Board for aerial spraying of toxic chemicals including endosulphan. Besides, the preventive and cautious steps that should have been followed during aerial spraying to check the pesticide contamination on the water bodies and animals was surprisingly not adopted. The affected families are worried about the future of their offspring as the health effect will spill over to next generation. Aerial spraying of endosulphan is expectedly polluting the air and water bodies including the drinking water sources. This reveals how the environment and human beings suffer due to state owned agency's unilateral aerial spraying of pesticide.

The next case study pertains to detection of pesticide residues in the bottled drinking water. During the last week of February 2003 as the research findings reported that 'clean bottled water' is pesticide contaminated the bottled water manufacturers had to face rough weather. The environmental NGO, CSE, came out with startling findings that the 'elite clean water is unsafe' (Table 7).

Table – 7: Pesticide residues (mg/l) in different brands of bottled water

			Organochlorine					Organophosphorus			
Name	Batch No	State	γHCH*	βendo**	DDT	DDD	DDE	Dimethoate	Phosphamidon	Chlorpyrifos	Malathion
Bisleri1	719	Delhi	0.003	ND	0.0008	ND	0.0005	ND	ND	0.0109	0.04
Bisleri2	29	UP	0.0014	ND	0.0003	ND	ND	ND	ND	0.0024	0.0196
Aquafina1	B38	UP	0.001	ND	ND	ND	ND	0.0013	ND	0.0023	0.0008
Aquafina2	B39	UP	0.0007	ND	ND	ND	ND	ND	ND	0.0006	0.0004
Kinley1	92	UP	0.0021	ND	ND	ND	ND	ND	ND	0.0109	0.001
Kinley2	99	UP	0.0001	ND	0.0002	ND	ND	ND	ND	0.0003	ND
Mcdowel1	A	UP	0.0043	ND	0.0011	ND	ND	ND	ND	0.037	0.0126
Mcdowel2	B	UP	0.0032	ND	0.0007	ND	ND	ND	ND	0.018	0.0075
Paras1	787	Delhi	0.0031	ND	0.001	ND	0.00052	ND	ND	0.0022	0.0128
Paras2	1608	Delhi	0.004	ND	ND	ND	ND	ND	ND	0.004	0.0099
Bailley1	2202	UP	0.0023	ND	0.0011	ND	0.0077	ND	ND	0.0025	0.0073
Bailley2	2102	UP	0.0034	ND	0.0016	ND	0.0006	ND	ND	0.0049	0.0109
Pure life1	INUOEPNS	HR	0.004	ND	ND	ND	ND	ND	ND	0.0028	0.0008
Pure life2	INUOEPNS	HR	0.0032	ND	ND	ND	ND	ND	ND	0.0018	0.0018
Volga1	A365	UP	0.0029	0.00039	0.0016	0.00032	0.00068	ND	ND	0.0059	0.0147
Volga2	A365	UP	0.0029	ND	0.0037	ND	ND	ND	ND	0.0064	0.0238
Kingfisher1	IB003	HR	0.0033	ND	0.0006	ND	ND	ND	0.0001	0.006	0.0189

Kingfisher2	IB006	HR	0.003	ND	0.001	ND	0.00051	ND	0.0012	0.002	0.0132
Prime1	4	UP	0.002	ND	0.0012	ND	ND	ND	ND	0.0032	0.0007
Prime2	5	UP	0.0016	ND	0.0008	ND	ND	ND	ND	0.0018	0.0018
Aquaplus1	B93	Delhi	0.004	ND	0.0008	ND	0.00036	ND	ND	0.01	0.0368
Aquaplus2	B122	Delhi	0.0026	ND	0.0009	ND	0.00052	ND	ND	0.0092	0.0392
Hello1	377	UP	0.0045	0.00055	0.0016	ND	0.00118	ND	ND	0.004	0.011
Hello2	378	UP	0.0042	0.0004	0.0022	ND	0.00092	ND	ND	0.0046	0.008
KwencheR1	B128	HR	0.0029	ND	0.0005	ND	ND	ND	ND	0.006	0.0147
KwencheR2	A:KK0102	HR	0.0029	ND	0.0003	ND	ND	ND	ND	0.0045	0.0178
Minscot1	8/185	HR	0.0015	ND	0.0002	ND	ND	ND	ND	0.0018	0.0012
Minscot2	5/182	HR	0.0013	ND	0.0001	ND	ND	ND	ND	0.002	0.0015
Himalaya1	157Q	HP	0.002	ND	ND	ND	ND	ND	ND	ND	ND
Himalaya2	187S	HP	0.0009	ND	ND	ND	ND	ND	ND	ND	ND
Catch1	IOW058	HP	0.0015	ND	0.0008	ND	ND	ND	ND	ND	0.0012
Catch2	IOW053	HP	0.001	ND	0.0005	ND	ND	ND	ND	ND	0.0005
Evian1	--	France	ND	ND	ND	ND	ND	ND	ND	ND	ND
Evian2	--	France	ND	ND	ND	ND	ND	ND	ND	ND	ND

Source: Down To Earth, 2003 p29

Note : αHCH βHCH, δHCH, α-endosulphan, Heptaschlor and Aldrin among organochlorines and Methyl Parathion, Diazinon, Profenofos and Parathion among organophosphorous pesticides were not detected in any sample. * An average of three replicates have been taken. **β endosulphan, ND : Not detected. UP: Uttar Pradesh, HR : Haryana, HP: Himachal Pradesh.

It is evident from the table that many of the popular brands of bottled water in this country have pesticide residues, much above the permissible limits. Only one brand (Evian 1 and 2) from France does not contain any pesticide residue in its packaged water and another brand, Himalaya 1 and 2 contain only one pesticide particle in its bottles. It is believed that residues from the use of agro-chemicals in the long run percolated into soil and contaminated the ground water, which is the main source for bottled water companies.

The chemical tests clearly indicate that all other brands of bottled water contain hazardous pesticide particles well above the permissible limits and such pesticide residues cause health disorders for the human body over the years. Of course, the report indicates that the source of water and type and method of treatment are all responsible for the presence of varying levels of pesticide residues across different brands. Nonetheless, the striking observation is that despite the rapid growth of market for bottled water due to consumerism, globalization and market economy, the producers (incidentally many of the brands belong to MNCs) have failed to provide crystal water to the consumers. Another notable feature of the finding is that water drawn from industrially polluted fields and heavily pesticide sprayed agricultural farm plots are responsible for the presence of the high dosage of chemical pesticides in the bottled water[14].

As is well known the green revolution motivated the farmers to use pesticides to combat pests and states like Haryana and parts of Uttar Pradesh benefited to a great extent from the revolution and although no clear relationship is established agricultural fields have been contaminated. Another important feature is that in order to reduce transport costs and access to resource centers, the bottled water companies draw water from around industrial estates, where the ground water is contaminated by the industrial wastes and agro-chemicals. The CSE study

[14] Another dimension of the issue is that the giant MNCs like CoCo Cola do have tie up with local business organizations to dig larger tube wells to draw water for marketing bottled water. Fearing the fall of water table the farmers in the vicinity of such factories started objecting to this (Junior Vikatan, 16.3.2003) in Sivaganga district of Tamil Nadu

reveals that some of the bottled water companies are located mainly on the periphery of industrial estates and are drawing water from the same locality. A comparative picture reveals that raw water samples drawn from New Delhi (highly industrially polluted) contains less chemical residues as compared to water tested from moderately polluted (Mumbai) locations. Naturally such water contains heavy dosage of pollutants and in spite of treatment, pesticides presence is observed. Lack of standardization and certification procedures are also responsible for the present state of tangle and environmental crisis. After much cue and cry the ISI label has been withdrawn from as many as 20 major bottled companies for violating the international standards for packaged water.

One may postulate that despite a series of chemical treatment for purification of water, it contains pesticide residues if water around agricultural fields is used. The crops too would pose threat to human health if they are grown using such water. As has already been found, not only pests[15] but also weeds have become resistant to many pesticides and herbicides (Down To Earth, June 15th 2000 pp60). During 30 years of reference period (1970-2000) as many as 250 weeds have become resistant as a result of continous application of herbicides. At the same time an equal number of pests became resistant to pesticides. Thus, while the cost of inputs, including pesticides increases, the farmers get lower yields and income thereby making agriculture less profitable, besides posing an environmental hazard.

The CSE again exploded another pesticides' related issue and accordingly, the soft drinks contained pesticide residues many times permitted above the European standards. As per this, the products of MNCs like Coca-Cola and Pepsi sold their soft drinks with pesticide residues and some of the state governments forced the ban of the sale of such soft drinks. The supreme body of governance – Parliament – banned the sale of soft drinks in its canteen and a Joint Parliamentary Committee has been set up to examine the whole issue of the presence of pesticide particles in the soft drinks. It clearly explains the fact that the pesticides are present everywhere due to non-judicial and reckless use across the fields. More importantly the vulnerable groups – agricultural laborers, marginal and small farmers and women laborers succumb to pesticide related health disorders in the long run[16] . For brief symptoms of pesticide poison see table 8.

Table – 8: General pesticide toxicity categories

Category	System affected	Common symptoms
Respiratory	Nose, trachea, lungs	Irritation, tight chest, coughing, choking,
Gastrointestinal	Stomach, intestines	Nausea, vomiting, diarrhea
Renal	Kidney	Back pain, urinating more or less than usual
Neurological	Brain, spinal cord	Headache, dizziness, confusion, behavior, depression, coma, convulsions
Hematological	Blood	Anemia (tiredness, weakness)
Dermatological	Skin, eyes	Rashes, itching, redness, swelling
Reproductive	Ovaries, testes, fetus	Infertility, miscarriage

Source: Kamrin, (1997).

The above table explains that by and large all parts of human body are vulnerable to pesticide toxicity. Even if precautionary measures are taken, pesticide particles, which enter into

[15] American Bollworm *(Heliothis armigera)* has become resistant to pesticides and it is a serious pest in cotton crop in India.

[16] Even if some one come across mild health problems like headache during the application of poisonous pesticides, due to various reasons, he will not take any first aid.

the human body are likely to cause health problem only in the long run. Alarmingly, as noted already, pesticides that have been banned or restricted to their use in many countries have been liberally used in India mainly due to lacuna in the existing legal framework. Perhaps the users cost is less and social cost is more as the farmers incur only buying the pesticides whereas the government has to spend huge resources on pesticide related public health programs. All these point to the fact that developing countries like India become dumping grounds for chemical pesticides, while many developed countries try hard to minimize the use of synthetic pesticides. Since empirical literature on this aspect is scarce it is difficult to draw a drastic conclusion albeit the problem continues to persist in Indian fields.

Continuous application of synthetic pesticides has also contributed to the extinction of useful organisms present in the soil. Besides contaminating the environment, including the soil, pesticide residues also affect useful organisms like earth worms, bees, spiders, plants and the like to natural decay, which otherwise would have contributed towards preventing harmful pests. Realizing this, the extension personnel have now been recommending the reduction of chemical inputs and utilization of local decomposable resources including plant based items at maximum level, which enhances the proliferation level of useful microorganisms in the soil and environment. But this needs strong commitment from all quarters for complete understanding and effective implementation.

Associated with the ill effects of pesticides, disposal of empty containers is another serious problem across the country. Normally, after the application of pesticides (liquid and dust) farmers are advised to bury the containers for avoiding possible spread of pesticides to human habitation and cattle shed. Nonetheless, such containers have been conveniently used for preparing lamps. Sometimes they are used for packing and storing food products like edible oil, rice, pulses and flours and as the toxic pesticide particles, present in the containers have slow but long effect, this must be carefully dealt with. In India studies on environmental impact of the disposal of empty containers are scanty and this calls for immediate attention of researchers.

The legal aspects for pesticide licencing and marketing are very vague in India and also interdepartmental cooperation and coordination are very poor. For instance, if a particular pesticide substance is found problematic at later stages, it will take a long time to suspend the same as a complex procedure is involved. Similarly, due to various administrative and other reasons, public interest litigation on pesticide abuse takes a prolonged course in the courts for a verdict. Insecticide Act 1958 cannot cancel the registration (already given by the Pesticide Registration Committee) to a substance specified in the Act, even if the same is found later to be hazardous to environment by a scientific body. Also pesticides are regulated under the Insecticide Act of 1968, Insecticide Rule of 1971 and the Insecticide (Amendment) Bill 2000. But the question is how different ministries like environment, agriculture and health coordinate with long bureaucratic procedures in the entire pesticide issue of use and abuse? Moreover, there is dearth of scientific data on the effects (beneficial and adverse) of pesticides application in India under wider agriculture systems. Understandably, bribing is common in the entire process of getting permission and approval for pesticides. Surprisingly, reports and former officials in the pesticide quarentine division confess that touts are arranging favorable laboratory results and permission for marketing and use by taking bribes. A glaring point is that the pesticide entrepreneurs normally approach private approved laboratories through touts for availing favorable tests and data. The entire process takes just one to one and half years in India and in some cases such data are lifted from other parts of the world. In other words laboratory results are fabricated and provided without rigorous analysis and examination on long term implications

of pesticide. In the United States as many as 75 specific tests are required by the Environmental Protection Agency for pesticide registration. Under this scenario, it is essential to find out alternative sustainable and environmentally suitable techniques and technologies for combating pests without compromising food security. The next sections deals with some of the aspects by keeping environment and health issues in the broader context of sustainable agriculture development (SAD).

IV. Alternative Mechanism:

The above discussion of pesticide application and environmental terrorism in India shows that it needs thorough examination and a search for alternative solutions. There has been a paradigm shift though slow from modern – chemical – farming towards sustainable farming, which depends on local farm resources across the globe. The concept of SAD seeks the use of low external inputs and sometimes without chemical inputs in agriculture and it has been extensively discussed and used in literature (Reijnties and others, 1991). There are sufficient cases to strengthen the larger issue both for developing and developed countries (Jager and Werf, 1992, Rajendran, 1998 and ARNOA, 2002). As the value of loss to pests is invariably lower than the cost of treating pesticide related illness (Rola and Pingali, 1993) the social cost of pesticide use is higher. Some studies demonstrate that farmers using chemical inputs including synthetic pesticides obtained less income as compared to ecological farmers, who used natural methods for combating pests. Based on the intensity and types of input use, economic viability and environmental sustainability farming can broadly be classified into three (Table 9) as; conventional, traditional and ecological (for a conceptual framework, see Jager and Werf, 1992).

From table 9 it is evident that conventional agriculture makes intensive use of external inputs ranging from pesticides to information for market oriented commercial production. Traditional agriculture is subsistence oriented farming practice using low levels of locally available inputs and on the other, ecological or sustainable agriculture seeks to optimize the use of local resources through creating complex and diverse farms, aiming at a stable, growing and long lasting production level.

Table - 9: Features of different farming systems

Farming Systems			
Issues	Conventional	Traditional	Ecological
Productivity	High	Low	High
Sustainability	Low	Moderate	High
Farm Complexity	**Simple**	Complex	Complex
Environment Diversity	Uniform	Diverse	Diverse
Production Orientation	Market	Subsistence	Subsistence/market
Inputs – Seeds	HYVs	Local	Improved/local
Synthetic Inputs - including pesticides	High	Low	Nil

Source: Werf and Narayan, 1989.

Moreover, arguably no chemical inputs including pesticides are applied in ecological farming system and production is found sustainable and viable, (environmental balance is maintained), technologically feasible and socially adaptable. Unfortunately, across the world many individuals, NGOs and some state supported agencies have ventured into this eco-friendly farming system (SAD) more on compartment basis rather than comprehensive. According to a

few experiments, dreaded pests like caterpillars were effectively controlled, when they posed a serious threat to groundnut crop in Pudukottai district of Tamil Nadu in the early nineties. With the technical help of a local NGO, farmers prepared decoctions with leaves of neem (*Azadirachta indica)*, cactus and *errukkan* (*Calotropas gigantica*) and sprayed this on the groundnut fields to control caterpillars. As commonly admitted by the agricultural scientists, following cultural practices like intercropping and mixed cropping keep the pests at bay. For this, the organic farmers grow castor plants on the borders and sometimes as rows on the groundnut fields to control caterpillars. Such intercrops act as soldiers and shields and pests attack the castor plants thereby the groundnut crop is saved. Cultivation of sweet corn as an intercropping on the turmeric fields keep at bay the pests like grass and leaf hoppers and enhances yields. Adoption of crop rotation, trap cropping, pruning infested plant parts and adjusting sowing/transplanting also reduce the severity of insect pests and diseases in sustainable organic farms.

Moreover, in the organic farms, beneficial organisms like spiders and bees, breed and multiply and they protect the field crops. Many of these farming techniques have been carried out based on the indigenous knowledge system (IKS), learned from experience over years. This IKS has to be documented at the local level and if need arises, patenting may be done and in this direction a magazine – Honey Bee – from the Indian Institute of Management in Ahamadabad has done considerable exercise and the same may be carried out in all parts of the country. The experience so far reveals that many agricultural scientists hesitate to admit this and according to them to maintain food security, chemical inputs are a must. However, some of the leading farm scientists, have realized and suggested that chemicals must be judiciously used for attaining SAD (Swaminathan, 1968). Experiments of the ecological farming system have been on a piece meal basis which needs to be on a comprehensive manner covering wider agro-ecological conditions including cropping systems. Plant based decoctions with cattle urine sprayed on the garden crops like guava proved effective in controlling Grey blight and fruit spot *(Pesralotia psilii)* during harvest seasons but such technique resulted in black spots on the fruits. For this, the local agricultural researchers in partnership with interested organic growers and committed NGOs have to undertake research for environmentally viable indigenous solutions, in general, and for SAD in particular, for pest control.

More than 2400 plant species are reported to possess pest control properties, while some plants kill through poisonous exudates, others control through non killing activities like repellency, feeding deterrence and growth inhibition without adverse effects on environment and human health. Since India has rich bio-diversity, plant based bio-pesticide solutions may be encouraged to prepare and use at local level on commercial lines (for a brief reference on botanical pesticides see, Chari and others, 1991). In remote and tribal areas, plant based solutions (decoctions) with extracts from cow dung cakes and cattle urine are stored for a couple of days for strong odour to spray on the crops to effectively control pests. Such practices ought to be recorded and suitable patenting arrangements made for the local innovative farmers. Mulching of plants especially horticulture with crop residues and other degradable materials proved effective in controlling weed growth and enhancing yield levels. Continous mulching resulted in making the soil around the plants more porous and useful organisms like earth worms proliferated faster. In addition to these, mulching technique has reduced the water evaporation thereby a quantum of water requirement is reduced.

Case studies on organic agriculture systems indicate that pests in plantation crops like tea and coffee can be controlled with plant based formulations. These high value crops do have

export potential and, realizing this, some of the large companies started converting the chemical contaminated plantations into organic gardens and one company got a certificate as its product is organically grown. The neem based solutions like oil[17] have been sprayed on the crops (tea plantations) to control diseases like red rust and blister blight.

There is an increasing demand (Table 10) for organically grown food products across the globe mainly on health grounds. This is more so in developed countries and urbanites in developing countries as their income allows the buying of pesticide free agricultural products, that attracts more premium. In general, organically grown products are expensive as the cost of cultivation and opportunity costs are more in the beginning of transformation towards sustainable agriculture system and hence farmers have to sell their products at higher rates. Despite high prices, the consumers are keen to buy as they are worried about the health implications of chemical farming.

Table – 10: Organic food market in 2000

Market destination	Retail sales (in billion USD)	Total food sales (in per cent)	Expected growth (in per cent)
Germany	2.2-2.4	1.24-1.5	10-15
United Kingdom	1.0-1.05	1.0	25-30
Italy	1.0-1.05	1.0	15-20
France	0.75-0.80	1.0	15-20
Switzerland	0.42-0.45	2.0-2.5	15-20
Denmark	0.35-0.37	2.5-3.0	10.15
Austria	0.25-0.30	2.0	10-15
Netherlands	0.22-0.27	0.75-0.10	10-20
Sweden	0.12-0.15	1.0	20-25
Other European countries	0.30-0.40	NA	NA
Europe total	7.0	-	-
United States	8.0	1.5	15-20
Japan	2.50	NA	NA
Total	17.50	-	-

Note: Official trade data are not available. Compilations are based on rough estimates. The figures for Japan include 'green products'
Source: DTE, 2002, p35.

Developing and utilizing alternatives like plant based solutions (to chemical pesticides) also create employment opportunities to local laborers. Collections of plant based materials (like seeds and leaves), preparation of solutions and application of the same on crops are labor intensive in nature. Instead of spending on chemical pesticides and inviting environmental hazard, it is appropriate to spend on laborers for developing alternatives, which will increase employment and protect the environment for SAD. Application of environment friendly plant based solutions has been found to control the pest slowly but the impact is reported to sustain for a number of crop seasons among field crops. After realizing the growing demand for environment friendly inputs like earthworms and plant based decoctions, some of the private agencies started preparing and sometimes adulterating them to hoodwink the farmers and hence standard mechanisms and licencing have to be developed in the larger interest for promoting SAD. In the long run, this would help to do away with synthetic agro-chemicals.

[17] Realizing the growing market potential, some of the leading agro chemical companies stared marketing neem based pesticides.

The concept of integrated pest management (IPM) has been advocated across the fields especially where the new farm techniques and technologies have been targeted. As per this concept, application of synthetic inputs covering pesticides must be a last option after every attempt with biological, manual and cultural practices of controlling pests and diseases have been carried out. This needs strong political will, committed contingent of extension personnel, enough resources and above all the stakeholders' – farmers' – full participation and cooperation. Going by the experience of spending money on treating pesticide related health hazards, taking up IPM will have a sustainable effect on the farm and environmental fronts[18].

V. Conclusion and Suggestions:

The purpose of this paper was to critically look at the adverse impact of synthetic pesticides and it attempted to identify appropriate alternative mechanisms in the broader context of SAD. The above discussion reveals that increased use of pesticides has caused economic, environmental, health and social problems in India and unfolded many issues that are confronting the society at large. Lack of awareness among the farmers, deliberate suppression of facts, resource constraints, unlawful approaches, public policies and poor alternative mechanisms are found responsible for the present state of affairs. This calls for immediate policy attention and action. Cases of environment friendly pest control and mechanisms, have to be researched, developed and propagated on a large scale for attaining SAD. Nevertheless, any policy decision towards promoting SAD via organic/ecological agriculture needs careful examination in the context of ecological balance, economic viability, food security and technical feasibility. Because farming is a complex matrix covering a number of issues like weather conditions, farmers' decisions, market behavior, supply of crucial inputs and demand for output, strides in science and technology, resource base, public policies and a host of aspects. In addition to these, the state intervention in the form of liberal subsidies to pesticides must be economically rationalized for discouraging excessive pesticide use and this issue has been seriously debated in India in the context of liberalization era beginning in the early nineties. As propounded by Pingali (2001) the gradual dismantling of input subsidies can provide direct benefits to the sustainable management of the agriculture resource base. Concerns across the policy circles have been expressed about the declining trend of public investment in Indian agriculture. Encouraging private investment through cost effective mechanism is essential to promote SAD. The legal and administrative framework on pesticide trail, approval, monitoring and revision has to be hardened to save not only the environment and farmers but also for promoting SAD. An army of agricultural graduates may be well trained for disseminating the SAD packages (under training and visit programs at the village level all over India). A strong commitment both ideologically and at policy levels on this whole issue alone will help solve the maladies of indiscriminate use of dreaded agro-chemicals on the mother earth in the name of killing pests and controlling diseases.

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