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Non-Pesticidal Management of Pests: An Empirical Analysis

B.Suresh Reddy

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B. Suresh Reddy

RULNR
RESEARCH UNIT FOR LIVELIHOODS AND NATURAL RESOURCES
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Foreword

The Centre for Economic and Social Studies (CESS) was established in 1980 to undertake research in the field of economic and social development in India. The Centre recognizes that a comprehensive study of economic and social development issues requires an interdisciplinary approach and tries to involve researchers from various disciplines. The centre's focus has been on policy relevant research through empirical investigation with sound methodology. In keeping with the interests of the faculty, CESS has made important contributions to social science research in several areas; viz., economic growth and equity, agriculture and livestock development, food security, poverty measurement, evaluation of poverty reduction programmes, environment, district planning, resettlement and rehabilitation, state finances, education, health and demography. It is important to recognize the need to reorient the priorities of research taking into account the contemporary and emerging problems. Social science research needs to respond to the challenges posed by the shifts in the development paradigms like economic reforms and globalization as well as emerging issues such as optimal use of environmental and natural resources, role of new technology and inclusive growth.

Dissemination of research findings to fellow researchers and policy thinkers is an important dimension of policy relevant research which directly or indirectly contributes to policy formulation and evaluation. CESS has published several books, journal articles, working papers and monographs over the years. The monographs are basically research studies and project reports done at the centre. They provide an opportunity for CESS faculty, visiting scholars and students to disseminate their research findings in an elaborate form.

The CESS has established the Research Unit for Livelihoods and Natural Resources (RULNR) in the year 2008 with financial support of Jamsetji Tata Trust. The core objectives of the RULNR are to conduct theoretical and applied research on policy relevant issues on human livelihoods and natural resource management, especially in areas related to river basins, forest and dryland ecosystems and to provide an effective platform for debates on policy relevant aspects for academicians, policy makers, civil society organizations and development practitioners. RULNR intends to adopt a multi-disciplinary approach drawing on various disciplines such as ecology, economics, social anthropology, political science.

This RULNR-CESS monograph titled "Non-Pesticidal Management of Pests : An Empirical Analysis" by B.Suresh Reddy is an attempt to look at the various issues related to non-pesticidal management of pests, especially its economics and farmers'

perspective regarding its livelihood and ecological significance. The field work of the study was facilitated by Centre for Sustainable Agriculture (CSA), Hyderabad in Maharashtra and Andhra pradesh states. Green revolution model of agriculture introduced in 1960s concentrated mostly on high yielding seed varieties and high external inputs which eventually resulted in the cultivation of monocrops and chemicalisation. Much of the native agricultural biodiversity in irrigated zones was destroyed. The modern agriculture farming practices and irrational use of chemical pesticides also simultaneously led to loss of genetic diversity of crops, loss of traditional knowledge and practices, loss of local biodiversity and decline in soil fertility. Given the perceived failure of chemical pesticides to control the crop pests "Non-Pesticidal Management of pests" has been recently introduced in agricultural policies.

The present study tries to add new knowledge to the field of non-pesticidal management of pests and brings out major issues relevant to non-pesticidal management of pests. Farmers perception regarding the livelihood significance of NPM practices are clearly brought out in this study. The study highlights the economic and ecological benefits of non-pesticidal management of pests. This study also underlines the importance of livestock in general and cows in particular for the stability of dryland agriculture and in particular for the successful adoption of NPM methods. The neglect of livestock has resulted in the decrease of cattle population in many dryland areas and a reorientation of policies in that respect appears highly desirable. The study brings out alternative technologies with low quantity of dung and large amounts of other locally available materials to adopt NPM practices. This technology also helps small and marginal farmers despite their inadequate livestock holding.

This monograph provides valuable suggestions to policy makers from the analysis of empirical data and review of policies. I hope it would be useful to the research community, policy makers, development practitioners and all those interested in the growth of non-pesticidal methods of pest management.

S. Galab
Director, CESS

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Author

Chapter 1
Introduction

1.1 Introduction

India accounts for about 2.4 % of the world's geographical area and 4 % of its water resources, supporting nearly 17 % of the world's human population and 15 % of the livestock. Agriculture is considered the predominant sector of the Indian economy, accounting for 14% of the nation's GDP and about 11% of its exports with more than half of the population still reliant on agriculture as its principal source of livelihood and income besides being a major source of raw material for a large number of industries. Therefore, accelerating the growth of agriculture production is necessary not only to achieve an overall GDP target of 8 per cent during the 12th Plan and to meet the rising demand for food, but also to increase incomes of those dependent on agriculture as part of ensuring inclusiveness. During 2011-12, there was a record production of foodgrains at 259.32 million tonnes, of which 131.27 million tones was during the Kharif season and 128.05 million tones during the Rabi season (GoI, 2013b). Of the total foodgrains production, cereals constituted was 242.23 million tonnes and pulses 17.09 million tonnes. This record level of agricultural production could be attributed to the adoption of green revolution technologies.

However, the green revolution model of agriculture introduced in the 1960s focused mostly on high yielding seed varieties (HYVs) and high external inputs, which eventually resulted in the cultivation of monocrops and chemicalisation. The Green revolution phenomenon drew a fair amount of praise by some because it could increase crop yields for a certain period, but simultaneously led to a slow poisoning of people and animals, loss of genetic diversity of crops, loss of traditional knowledge and practices, loss of local biodiversity, a decline in soil fertility, increased farmers' dependency on inputs with the resultant indebtedness, and an increase in the number of people living in poverty in some countries in the region (IAASTD, 2009). The 'high yielding' varieties, introduced during the green revolution period, had a disastrously eroding effect on agricultural biodiversity (Reddy, 2009). The United Nations' Economic and Social Commission for

Asia and the Pacific (ESCAP, 2002) had expected that by 2005, India would be producing 75 per cent of its rice from just 10 varieties as compared to the 30,000 varieties traditionally cultivated. Infact, the modern agricultural farming practices alongside an irrational use of chemical inputs over the last four decades have resulted in the natural habitat imbalance, decreased ground water levels, soil salinisation, pollution due to an excessive use of fertilisers and pesticides, genetic erosion, ill effects on environment, reduced food quality and increased cost of cultivation, making the farmer poorer from year to year (Balak Ram, 2003).

In farming, pest management is an important aspect that needs to be addressed always. Globally about 50 percent of all food and cash crops are lost to pre and post harvest pests (DFID, 2001). Even in India, with the existing protection levels, based on significant advances in crop protection research during the past 40 years, still about 30% of the pre-harvest crop yield worth Rs.45,000 crore is lost annually (Agriculture Today, 2012). The use of pesticides in modern farming practices for obtaining increased yields has been viewed as a sine qua now for the success of the agricultural sector. However, most of the pesticides may affect non-target organisms, contaminating soil and water (Chandrika, 2003). The pesticide consumption in India has increased from 434 metric tonnes in 1954 to over 52,979 metric tonnes in the year 2011-12(see table1.1) accounting for 30% of the cropped area. Today, pesticide consumption in India is less than 1Kg/ha as against 4.5Kg/ha in USA and 11 Kg/ha in Japan (GoI, 2013a). All the same, an indiscriminate use of pesticides has led to a number of environmental problems (Rajendran, 2003; GoI, 2008). According to Mancini *et al*, (2005), in India, 60 per cent of all the pesticides is applied to cotton crop, accounting for only 4 per cent of the total cropped area. It is alarming to note that about 17.53% of the total pesticides are used only in Andhra Pradesh (A.P.), thus remaining as the largest consumer of pesticides in the country (see table 1.2) followed by Uttar Pradesh and Maharashtra states as second and third largest consumers at 16.68 percent and 12.68 percent respectively. As a result of outbreak of *Helicoverpa armigera* in cotton crop in 1997, large amount of money has been spent on pesticides by farmers. However its failure to control pest not only pushed the farmers into debt traps, but also ultimately drove them into committing suicide. "On an average, one Indian farmer committed suicide every 32 minutes between 1997 and 2005. Since 2002, that has become one suicide every 30 minutes" (Sainath, 2007). After four years of work by more than 400 eminent scientists, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD, 2008) concluded that, if we are to feed the people of the world, we cannot continue to practise agriculture as it is being done now:

Table1.1: Consumption of Pesticides (Technical Grade) in India during 1991-1992 to 2012-2013

(In ' 000 Tonne)

Year	Consumption
1991-92	72.13
1992-93	70.79
1993-94	63.65
1994-95	61.36
1995-96	61.26
1996-97	56.11
1997-98	52.24
1998-99	49.16
1999-00	46.20
2000-01	43.58
2001-02	47.02
2002-03	48.30
2003-04	41.00
2004-05	40.67
2005-06	39.77
2006-07	41.51
2007-08	44.77
2008-09	43.86
2009-10	41.82
2010-11	55.54
2011-12	52979

Source: Ministry of Agriculture, GoI, 2013.

"Business as usual is no longer an option". It has been clearly established that the technological gains from the green revolution technologies have exhausted their potential (Kumar *et al.*, 2008).

Pesticides allow the use of chemical fertilizers that produce soft disease-prone plants, and contaminate water ways and ground water. The chemical fertilizers that come with the pesticide package allow the farmer to boost yield levels without using compost. But the resultant failure to return organic matter to the soil can eventually lead to a break down of the soil structure and health, build up of diseases and insects, and loss of productivity that enriches the soil, seeds that are naturally resistant, and a greater biodiversity that protects crops and facilitates a greater level of overall production (Reddy, 2010c). Similarly,

Table1.2: State-wise Consumption of Pesticides (Technical Grade) in India during 2011-2012.

State/UT	Metric tonnes	Percentage
Andaman and Nicobar Islands	15	0.02
Andhra Pradesh	9289	17.53
Assam	160	0.30
Arunachal Pradesh	17	0.03
Bihar	655	1.23
Chandigarh	-	-
Chhattisgarh	600	1.13
Dadra and Nagar Haveli	-	-
Daman and Diu	-	-
Delhi	-	-
Goa	8	0.01
Gujarat	2190	4.13
Haryana	4050	7.64
Himachal Pradesh	310	0.58
Jammu and Kashmir	1711	3.22
Jharkhand	151	0.28
Karnataka	1412	2.66
Kerala	807	1.52
Lakshadweep	-	-
Madhya Pradesh	850	1.60
Maharashtra	6723	12.68
Manipur	33	0.06
Meghalaya	9	0.01
Mizoram	4	0.007
Nagaland	15	0.02
Odisha	555	1.04
Puducherry	38	0.07
Punjab	5625	10.61
Rajasthan	2802	5.28
Sikkim	-	-
Tamil Nadu	1968	3.71
Tripura	266	0.50
Uttar Pradesh	8839	16.68
Uttarakhand	206	0.38
West Bengal	3670	6.92
India	**52979**	**100.00**

Source: Ministry of Agriculture, GoI, 2013.

an indiscriminate use of pesticides has led to the development of pesticide resistant strains in insects, resurgence of pest species, direct toxicity to the applicator, destruction of parasites, predators and other beneficial organisms, accumulation of pesticide residues in agricultural commodities, poisoned food, water, air and soil (Watts, 2010). Above all, the modernisation process in agriculture has made the farming community depend more on external input which inturn, have not only increased the overall costs of cultivation but also created ecological crises.

Although pesticides are not used in respect of all crops, their use does involve in respect of a substantial crops like Cotton, Redgram, Chillies, Paddy and Bengal gram etc. Fifty four percent of the total quantity of pesticides used in India is accounted for by cotton, 17% by rice and 13 % by vegetable and fruits (Devi, 2010). Rola and Pingali (1993) found that the costs related to pesticides use in crop production are higher than the gains from the reduction in crop yield losses. Hence the economic relevance of pesticide application to crop production is a widely debated topic in environmental economics. Interestingly, bio-pesticide use increased 66 times in India over a span 10 years -from 123 tonnes in 1994-95 to 8,110 tonnes in 2011-12 and as a result of this, the use of chemical pesticides declined by one third during this period (GoI, 2013a). A study by Alam (2000) in India finds that in the use of biopesticides, a key problem has been that departments promoting Integrated Pest Management (IPM) have very little knowledge and experience with respect to biopesticides, while most state agricultural universities, on whose recommendations pest control methods are promoted, do not tend to recommend the use of biopesticides. In the absence of an active promotion by the agriculture department, the demand for these products has not improved, while most private shops and dealers do not stock nor sell biopesticides. The same study recommended that the Agricultural Departments and universities pay a greater attention to the promotion of biopesticides, that IPM training is improved and that there is a greater focus on cropping techniques and varieties which do not the use of pesticides.

1.2 Pest management and Shifting Paradigms

1.2.1 Integrated pest management (IPM)

The dominant paradigm of pest management is largely counting on chemical pesticides. Pesticides sprays can only be applied when the pest is in the most damaging stage of its life cycle, mostly the larval stage. Farmers are suggested to spray pesticides when the pest population reaches the Economic Threshold Level (ETL). That means farmers try to control insects when they are in a damaging stage and damaging proportion. An indiscriminate use of pesticides can lead to genetic resistance in insects and thereby

making sprays ineffective. Besides, pesticide sprays can also tilt the ecological balance in favour of pests by killing the natural enemies (Reddy, 2010a). Therefore the farmer has to keep increasing the dosage which, inturn, can escalate the overall cost of cultivation.

In response to a growing concern regarding the sustainability of conventional agriculture, the concept of Integrated pest management (IPM) has been promoted by National Centre for Integrated Pest Management (NCIPM). It is an ecological approach to plant protection, which discourages the use of pesticides on a large scale. However, IPM has no standard definition, but comprises approaches that range from a carefully targeted use of chemical pesticides to biological techniques that use natural parasites and predators to control pests (Sorby *et al,* 2003). Considering that the use of chemical pesticides is expensive for poor farmers, approaches like Integrated Pest Management (IPM) can offer a better prospect of lower production costs and higher profitability (Susmita *et al,* 2004). On the other hand, a mere replacing of chemical products with biological products may not solve the problem without a fundamental change in the perspective or thinking towards pest management (Ramanjaneyulu *et al,* 2009). Although integrated pest management (IPM) initiatives have come up as an alternative paradigm of pest management, debates regarding the effects of pesticides on human health and environment continue to focus more on indispensability of the chemical pesticides at least as a last resort and on a small scale. IPM is being promoted by the government of India and state governments primarily through trainings and demonstrations in farmers field schools, capacity building programmes for extension personnel and support to state governments for the setting up of bio-control and bio-pesticides testing laboratory facilities (GoI, 2013b) It can be seen from table 1.3 that the consumption of pesticides has declined gradually in Andhra Pradesh from 2002-03 to 2008-09. This could be due to two reasons: the first reason being that farmers have started reducing the use of pesticides due to debt traps and suicide experiences of other farmers coupled with an active promotion of IPM approach by the state government. A relatively less use of pesticides, especially in the initial stages, in respect of Bt cotton could be the second reason.

It is interesting to note that despite the use of Bt cotton varieties, as data from table 1.3 shows for the years 2010-11 and 2011-12, claims of companies promoting Bt, that Bt cotton cultivation reduces the use of pesticides seem to be totally wrong. In fact the quantity of pesticides used has doubled between the period 2001-02 to 2011-12 from 3850 metric tonnes to 9289 metric tones in respect of A.P. Experiences from the field indicate that with the cultivation of Bt cotton, the pest menace has shifted to other food crops as well. Despite growing Bt cotton, farmers are still forced to spray pesticides to control sucking pests and diseases other than *Heliothis* worm.

Table 1.3: Consumption of Pesticides (Technical Grade) in Andhra Pradesh and Maharashtra during the period 2000 to 2012 (in Metric tones)

Year	Andhra Pradesh	Maharashtra
2000-01	4000	3239
2001-02	3850	3135
2002-03	3706	3725
2003-04	2034	3385
2004-05	2135	3030
2005-06	1997	3198
2006-07	1394	3193
2007-08	1541	3050
2008-09	1381	2400
2009-10	1015	4639
2010-11	8869	8317
2011-12	9289	6723

Source: Ministry of Statistics and programme, Government of India, 2013.

The field experiences also reveal that agriculturists follow several paradigms. The latest paradigm being the ecology based approach encouraged by Food and Agriculture Organisation (FAO) throughout the world i,e., Farmers Field Schools (FFS) approach. Vasquez-caicedo *et al*, (2000) observe that FFS approach encourage farmers to experiment and to independently solve their problems through interactive learning and field experimentation with an expectation that these farmers would require fewer extension services in future and that they would be able to adopt technologies suitable to their conditions. However, the effectiveness of the IPM-FFS approach could have been enhanced by broadening the focus from a single crop to a broader system approach, to address other issues, such as water management, crop rotation, crop diversification and marketing (Mancini *et al,* 2005). Unfortunately, a proper space was not provided for traditional knowledge and practices or grass root innovations by farmers. Mancini *et al* (2007), while evaluating the cotton IPM-FFS in Andhra Pradesh report that farmers' confidence in implementing the new management practices was not strong enough to translate into change in behaviour. This supports the argument that an effective, empowering learning process is based on experience, rather than a simple information and technology transfer (Lightfoot *et al,* 2001).

1.2.2 Non-Pesticidal management (NPM)

Although pesticide use is being encouraged by the industry, public research and extension bodies, there are several successful grass roots level experiences emerging from farmers'

innovations which call for a paradigm shift in pest management. One such ecological approach is Non-pesticidal management of insect pests. It is a 'system that maintains the insect populations at levels below those causing economic injury, by having healthy crop and managing the population dynamics in the crop eco-system'. It is simply not the superimposition of two or more control techniques, but an integration of all suitable management techniques in a harmonious manner with natural regulating and limiting elements of the environment. It is a paradigm shift in terms moving from a input centric model to a knowledge and skill based model. It involves making the best use of natural resources locally available besides the advantage associated with the natural process. There are many alternatives available for managing pests (Kashyap, 1998; Reddy, 1999; Ramanjaneyulu *et al,* 2009 and Reddy, 2010a). Even if a pest species becomes a hazard, there are far safer alternatives available than spraying poisonous pesticides. Although biopesticides represent a very small portion of plant protection at present, their role is considered significant (Rao *et al,* 2007). Traditionally, farmers have been following several practices to prevent the hazards of pests (Rao *et al*., 2010). For instance, in Andhra Pradesh, over 3,00,000 farmers have adopted Community Managed Sustainable Agriculture (CMSA) across 1.36 million acres of farmland and 5.1 percent of the net cropped area in the state since the last four years (Vijay Kumar *et al*, 2009). The CMSA approach while avoiding the use of chemical pesticides, focuses on a combination of physical and biological measures including eco-friendly bio-pesticides and the adoption of complementary biological and agronomic soil fertility improvement measures as a part of reducing the use of chemical fertilizers. This paradigm shift both at the farmer and extension system levels has helped tackle the pest menace effectively besides providing ample benefits to farmers in the form of reduced input costs and health costs. The NPM methods being adopted can provide employment to villagers, thus supporting their livelihoods whereas on the contrary, the amount spent on pesticides mostly goes to pesticides producing companies (Reddy, 2010b).

While the indispensability of pesticides in respect of pest control continues to be emphasized and promoted by the industry as well as public research and extension bodies, there are successful experiences emerging from farmers' innovations which call for a change in approach to pest management. Against this background, a Non-Pesticidal Management (NPM) of pests has assumed immense significance in the present context and a study on "Non-Pesticidal Management of pests: An Empirical Analysis", was taken up in collaboration with an NGO, Centre for Sustainable Agriculture (CSA), Hyderabad, to understand the various issues related to Non-pesticidal management of pests in Andhra pradesh and Maharashtra states of India with the following objectives.

1.2.3 Objectives of the study

1. To understand farmers' perceptions about the livelihood and ecological significance of NPM practices.
2. To identify and record the NPM practices across pesticide free farms.
3. To assess the economic returns from NPM adopted crops vis-à-vis chemically controlled crops.
4. To identify the constraints involved in the adoption of NPM option.
5. To contribute to policy discourse on non- pesticidal management of pests in India.

1.2.4 Methodology

The study employed both qualitative and quantitative methods for an assessment of economic and ecological returns on NPM adopted farms Vis-à-vis Conventional farms where pesticides are being used for managing pests. The study collected data from both primary and secondary sources. Quantitative information was collected using a semi-structured questionnaire during the year 2011-12. Data related to 2009-10 and 2010-11 was collected using recall method, whereas, qualitative information was collected through focused group discussions. This research aimed at uncovering a range of Non-pesticidal management strategies adopted by farmers on their land, with a view to assessing their livelihood, economic and ecological significance. The study used an *Ex-post facto* research design since the variables chosen have already occurred.

1.2.5 Locale of the study

The states with the highest pesticides consumption in India and where the approach of Non-pesticidal management of pests is widely followed due to the efforts of both the NGOs and state governments were selected for the study. The states of Andhra Pradesh and Maharashtra, which stand first and third (see table 1.2) respectively in terms of pesticide consumption in India and where NPM approach is being practiced, were chosen for the study.

The state of Andhra Pradesh (undivided state) chosen for the study is the fifth largest state in India in terms of both surface area and population. Based on physiographic, soil types, crops and cropping pattern, the state has been divided into nine agro climatic zones, namely, high altitude and tribal zone, North coastal zone, Godavari zone, Krishna zone, Southern zone, Northern Telangana zone, Central Telangana zone, Southern Telangana zone and Scarce rainfall zone.

Andhra pradesh state is richly endowed with natural resources and has a geographical area of 274.40 lakh hectares and an estimated population of 8.46 crore (Census of India, 2011). The population of SCs and STs constitute 16.41 and 7.0 percent respectively. The overall literacy rate in A.P, as per 2011 Census, is 67 percent as against the literacy rate of 74 percent at all India level. The average land holding size in the state during 2011-12 is 1.08 hectares. About 70 per cent of the state's population is engaged in agriculture. Over 80 percent of those involved in agriculture are small and marginal farmers and landless labourers who own a mere 35 per cent (3.5 million hectares) of the total 10 million hectares of cultivated land. About 24.49 million bovines (cattle and buffaloes), 35.16 million sheep and goats, 0.75 million pigs and 123 million poultry are distributed across some 10 million households engaged in agriculture. Andhra Pradesh has the distinction of being home to most of the diversified livestock resources across nine agroclimatic zones with different production systems. Livestock farming is one of the most sustainable and dependable livelihoods options as an alternate to their dependable resources in rural areas, especially for small and marginal farmers and agricultural labourers who hold 70 percent of the total livestock resources and 20 percent of the total land holdings. Small ruminants and backyard poultry are reared primarily by the landless adivasi, the traditional small-ruminant farming castes such as kurma, golla, and dalits. The size of bovine herd is closely linked to private land ownership, with the number of bovines increasing with land holding size. In all agricultural settings across AP, women play a greater role than men in agriculture-related activities work and food preparation besides looking after almost 80 per cent of the day-to-day livestock management. The net area sown for 2011-12 was 111.60 lakh hectares constituting about 40.57 percent of its total geographical area. Similarly the state has about 62 lakh hectares of forest area. Gross area irrigated in A.P during the year 2011-12 was 67.85 lakh hectares. Wells account for a major share of 25.44 lakh hectares (50.0 percent) followed by canals for 18.17 lakh hectares (35.71 percent) and 5.49 lakh hectares under tanks (10.79 percent). A highest ever priority has been accorded to the development of irrigation infrastructure in backward and drought prone regions of the state. The state government has initiated a historical mission named *'JALAYAGNAM'* with the aim of completing 86 projects (44 Major, 30 Medium, 4 Flood Banks and 8 Modernization) in a record time. These projects to be completed are expected to create a new irrigation potential of 97.07 lakh acres besides stabilizing 22.53 lakh acres. The state also has initiated a project for encouraging micro irrigation systems for achieving water use efficiency. The area under micro-irrigation systems for the year 2011-12 comes to 8.95 lakh hectares.

The average annual rainfall of the state amounts to 830 mm, the range being 690mm (Rayalseema region) to 950mm (coastal Andhra). While the average annual rainfall of

Telangana region in the state is 860mm. Cereals and millets account for a lion's share under food crops (38.94 percent of the total area) followed by commercial crops (20.19 percent), oil seeds crops (14.09 percent) and pulses (14.02 percent). Rice under cereals; groundnut, sunflower and castor under oil seeds, cotton, chillies and sugarcane under commercial crops; and Bengal gram, blackgram, redgram and green gram under pulses constiute the major crops grown in the state, whereas an area of 25.59 lakh hectares is under various horticultural crops. Mango and sweet orange occupy a predominant position in acreage under fruits besides vegetables and flowers.

1.2.6 Maharashtra

Maharashtra is the second largest state in India both in terms of population and geographical area (3.08 lakh sq. km). The State is home to a population of 11.24 crore (Census, 2011) which in other words, is 9.3 per cent of the total population of India. The overall literacy rate is much higher at 82.9 per cent than the national literacy rate of 74 per cent, as per Census 2011. Progress on Human Development Index is often depicted as a benchmark for a state's progress of key development indicators. As per India Human Development Report-2011, Human Development Index of India is 0.467 while the State ranks 5th in the country with a Human Development Index of 0.572 after Kerala, Delhi, Goa and Punjab. The State is also well known for its administrative acumen and innovative ideas besides being the first to have implemented a Women policy and engendering the budget by way of a establishing a separate Woman & Child Development Department. Besides, it was a pioneer in implementing its 'Employment Guarantee Scheme' which subsequently came to be replicated by the Government of India.

In Maharastra, the agriculture & allied activities sector contributes 12.9 per cent to the State's income. For the year 2011-12 the net area sown was 174.01 lakh hectares constituting about 56.59 percent of its total geographical area. Similarly the state has about 52.1 lakh hectares of forest area. Gross area irrigated in Maharashtra during the year 2011-12 was 40.50 lakh hectares out of which 55% is well irrigation and 45% by surface irrigation. Numbers of irrigation projects are being implemented to improve irrigation. A watershed mission has been launched to ensure that soil and water conservation measures are implemented speedily in the unirrigated areas. Presently, there are 44185 micro watersheds in Maharashtra, while the area under in-situ moisture conversation and micro-irrigation systems comes to 5.51 lakh hectares.

The production of food grains for 2011-12 amounts to 127.30 lakh MT. Maharashtra produces about 17.54 m. MT of horticultural produce under an area spread over 2.49 mha., accounting for 7.30% of the total horticultural production in the country with a

major share coming from fruits (54.24%), i.e., Sapota, Banana, Citrus, and Grapes. Other fruits grown are Mango, Pomegranate and Guava. The vegetable produce forms about 42.78 % of the total horticultural production in the state. Maharashtra is also a leading producer of Onion, Cut Flowers and Cashew. Animal husbandry is an important agriculture-related activity. The total livestock of Maharashtra state stands at 3.59 crore. The State's share in livestock and poultry population in India is about 7 per cent and 10 per cent respectively. It is important to note there that more than 6.5 lakh hectares of area is under organic cultivation in the state. Maharsahtra is also been the first state to have adopted dry land farming technology in addition to being a pioneer in the promotion of Horticultural crops through the Employment Guarantee scheme. In Maharastra, 159 lakh hectares come under drought prone areas, amounting to 52 percent of state's geographical area.

In Maharashtra, an agricultural productivity improvement campaign has been taken up through innovative initiatives such as Farmer field schools, soil health improvement projects, efficient use of water, crop planning according to agro climatic conditions, seed village programmes, increasing fertilizer use efficiency and plant protection through cost reduction methods. During the year 2008-09 a massive drive for testing 2,20,000 soil samples was taken up (5 from each village) besides a massive programme to distribute the soil analysis results including micronutrients in the form of soil health cards. The aim of this activity is to generate a fertility index for all villages which, inturn, is expected to help bring about a qualitative improvement in nutrient management. By the year 2008-10, more than 9.37 lakh farmers had been trained through the Farmer Field School programme with an emphasis on the adoption of eco-friendly measures to pest management for strengthening the natural eco-system.

In Andhra Pradesh and Maharashtra the agriculture sector has been undergoing many changes over the past two to three decades. The increasing interventions of the state in agriculture, and the Green and Yellow revolutions, have brought about several changes throughout the semi-arid regions, especially in respect of land ownership, cropping pattern, irrigation, credit and extension, agricultural productivity and prices, and marketing. In rainfed areas, a shift towards the cultivation of commercial crops like groundnut, cotton and chillies has resulted in the use of modern inputs like hybrid seeds, chemical fertilizers and pesticides, all of which are produced through industrial methods and marketed through networks of public and private dealers. Infact, the wide spread cultivation of commercial crops has led to a decline in the cultivation of food crops. The traditional crop rotation practices and the use of organic manures are increasingly replaced with monocropping and an intensive use of chemical fertilizers. These new cropping practices

while enhancing crop productivity, initially, have also led to increased production costs and severe environmental and health problems, including pollution of water bodies.

Agricultural development is overall, influenced, to a large extent, by institutions ranging from government bodies to local agents, who carry an inherent bias in favour of well-off and large farmers. Thus, the combination of technology and institutional bias towards 'progressive' farmers places non-literate and socially marginalized small cultivators at a great disadvantage. The current trend towards a reduction in the government extension services and the introduction of privately paid services may further increase small farmers' technological and financial dependence on profit-driven agencies.

Farmers' increased dependency on the state, on the one hand and the market, on the other, is a major cause for the 'agrarian crisis' as highlighted by a citizens report prepared by a group of social scientists in warangal district (citizens' report, 2004). Agriculture development in the semi-arid regions, has to be understood not only in the context of farmers' vulnerability and resource scarcity, but also resilience and adaptations. More importantly, it is the industrial and technological developments that are presently reshaping the agrarian relations and rural livelihoods.

A.P is one of the highest pesticide consuming states in India with an intake of 9289 Metric tonnes (Technical grade) as of 2011-12 (see table 1.3). Similar is the case with fertilizer consumption. The use of fertilizers too is high in A.P. For the year 2011-12, the consumption of Nitrogen (N), Phosphorus(P) and Potassium(K) amounts to 19.77, 10.43 and 3.22 lakh metric tonnes respectively (INM-Fertilser Statistics division, GOI,Ministry of agril, Depart of agril and cooperation). As of 2011-12 the total NPK consumption per hectare works out to 245.41Kgs as against 141.30 kgs/hectare for India as a whole (GoI, 2012). The state has 2.03 lakh farmer clubs called Rythu Mithra Groups (RMGs). There is also has a programme called POLAMBADI (Farmer Field School) that emphasizes the adoption of eco-friendly measures for pest management as part of strengthening the natural eco-system. Besides, there are several private companies promoting their technology and business regarding seeds, pesticides, fertilizers and farm machinery.

Similarly, Maharashtra is also one of the highest pesticide consuming states in India with an intake of 6723 Metric tonnes (Technical grade) as of 2011-12. For the year 2011-12, the consumption Nitrogen (N), Phosphorus (P) and Potassium(K) amounts to 19.77, 10.43 and 3.22 lakh metric tons respectively. While the total NPK consumption per hectare was 143.59 Kgs (INM-Fertiliser Statistics division, GOI,Ministry of Agriculture,

Department of agriculture and cooperation), which is slightly higher than India's average consumption of 141.30 kgs/ha (GoI, 2012).

All the above mentioned aspects in respect of A.P and Maharashtra have a huge bearing on the pest management. It was in this context that Andhra Pradesh and Maharashtra were selected for the study "Non-Pesticidal Management of pests: An Empirical Analysis" with a focus on the socio-economic, ecological and livelihood dimensions under NPM practices in dryland regions of these states.

1.2.7 A Profile of the selected districts

In each of these two states one drought prone semi-arid district with highest area under rainfed cultivation and where NPM approach is being followed was selected for the study. A Similar criterion was followed in the selection of blocks. One block each in Maharashtra and in Andhra Pradesh, three mandals (as they are quite smaller than blocks) were selected for the study. Out of 23 districts of Andhra Pradesh, Anantapur district having arid and semi-arid regions was selected for the study. Out of 35 districts in Maharashtra, the district of Wardha was selected for the study. These districts represent important socio-economic and ecological regions of these two states.

Anantapur district in Andhra Pradesh has high inter-annual variations in precipitation. Normal rainfall of the district averages 552 mm (see table 1.4) which is bound to influence crop yields of the region. Most of the rainfall is received during June to September, although recently rainfall has become unreliable with a distribution is highly erratic distribution. The soils are mainly shallow, barren, sandy and only marginally fertile. The district is primarily characterised by rainfed agriculture. Most farmers are 'small and marginal' and grow a wide variety of both food and commercial crops (Oil seeds, pulses, millets and fibre crops) under dryland farming practices. Agriculture in Anantapur district of Rayalseema is practised on degraded and infertile soils with a majority of them being sandy soils. A large percentage of area is under groundnut. An erratic and deficient rainfall, rising costs of cultivation coupled with low market prices have led to a severe problem of indebtedness among farmers.

Interestingly, Anantapur has the least area under irrigated rice and highest rural livestock population in Rayalseema region. Large flocks of goat and sheep are managed extensively in the district. Certain parts of the district have a significant population of Adivasis (known as Scheduled Tribes), who happen to be among the most marginalised sections of the Indian society.

Table 1.4: Basic features of the Selected states and districts for the year 2011-12

Particulars	Andhra Pradesh	Anantapur District	Maharashtra	Wardha District
Area in Sq Km	274.40 Lakh Sq.Km	19130 Sq.Km	308 Lakh Sq.Km	6309 Sq.Km
Normal Rainfall (mm)	720.4	552		1041.1
Population in Lakh Nos	846.66	40.83	1124.0	13.0
a)Male	425.10	20.64	583.0	6.68
b)Female	421.56	20.18	540.0	6.32
Literacy rate (per cent)	67.02	64.28	82.91	86.99
a)Male	74.88	74.09	89.82	91.92
b)Female	58.68	54.31	75.48	81.81
Average Operation land holding (in hectares)	1.08	1.76	1.44	1.46
Gross cropped area '000 ha	13,759	1114.0	23,175	458.9*
Gross irrigated area '000 ha	6785	171.9	4050	41.80*
Percentage of Net irrigated area	45.60	15.43	17.9	11.11*
Food grains production In '000 tonnes(2011-12)	18402	298.0	12,728	-
Food grain yield in Kgs per hectare(2011-12)	2588.7	1059.1	1172.12	-
Total Livestock Population (Numbers as per 2007 census)	**6,02,00,863**	**55,17,104**	**35,955,000**	**565,000**

Note: * data is for the year 2009-10

Source: Bureau of Economics and Statistics(BES),Hyderabad; Government of A.P, 2013 and BES, Government of Maharastra, Economic Survey of Maharsatra 2012-13.; District Soci economic Review 2009 of respective district pub by Govt. of M.S., Mumbai ; Director of Animal Husbandry, Andhra Pradesh,Hyderabad. Census of India, 2011. WWW.ap.gov.in and WWW,Mahaagri.gov.in

1.2.8 Wardha

Wardha District lies in the Vidarbha region of Maharashtra. It has been experiencing a distress situation in agriculture over the last decade besides being identified as one of the six districts with a special package to alleviate agricultural distress, launched by the government of Maharashtra in the year 2005[1]. Further, in the year 2006, Wardha, one of the thirty-

[1] The six districts of Vidarbha where the package is applicable are Yavatmal, Amravati,Akola, Buldana, Washim, and Wardha.

one districts identified by the Government of India as being prone to agriculture-related suicides, received a rehabilitation package involving short-term and long-term measures to be implemented during 2006-2009[2] .

The district is spread over 6,309 sqkm with a total population of 1.3 million of which 74 percent, or 9.1 lakh people live in rural areas, according to Census, 2011(see table 1.4). The percentage of population living in rural areas in Wardha District is far higher than the state as a whole. As per 2011 census, 67.46 % of the population of Wardha district lives in rural areas. The overall literacy rate of Wardha is higher than that of Anantapur district.

Table 1.5: Land Utilisation pattern in the Selected states and districts (Percentage)

Land use	Andhra Pradesh (2011-12)	Anantapur District (2011-12)	Maharashtra 2010-11*	Wardha 2009-10*
Forests	22.65	10.28	16.95	9.96
Barren and uncultivable land	7.35	8.75	5.62	1.66
Cultivable waste	2.23	2.52	2.98	2.38
Pastures and other grazing land	2.01	0.18	4.03	5.58
Tree crops	1.04	0.49	0.81	1.39
Current fallows	8.26	10.47	4.46	9.92
Other fallows	5.66	4.48	3.86	3.64
Net area Sown	40.57	3.44	56.57	57.89

Note : * Data for the year 2011-12 not available.

Note: The data regarding Andhra Pradesh pertains to the year 2011-12 and Maharashtra for the year 2009-10

Source: Bureau of Economics and Statistics, GoAP,Hyderabad;

Economic survey of Maharashtra 2012-13, Directorate of Economics and Statistics, Planning department, Government of Maharastra,Mumbai.

Agriculture Census 2010-11(Phase-I), Agriculture Census Division, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

[2] Of the thirty-one districts identified, six are in Maharashtra while the rest are from the states of Andhra Pradesh, Kerala,and Karnataka. These are: Akola, Washim, Wardha, Buldhana, Amravati, and Yavatamal in Maharashtra; Prakasam, Guntur, Nellore, Chitoor, Kadappa, Anantapur, Kurnool, Adilabad, Karim Nagar, Khammam, Mahbubnagar, Medak, Nalgonda, Nizamabad, Rangareddy, and Warangal in AndhraPradesh; Belgaum, Hassan, Chitradurga, Chikmagalur, Shimoga, and Kodagu in Karnataka; and Wayanad, Palakkad, and Kasaragod in Kerala.

The agro-climate of Wardha District is characterised by hot, dry, and sub humid bioclimate with dry summers and mild winters. While analysing the soil type in the district, it is found that black soil is the predominant one. This is further classified into *kanhar* (Heavy soils), *madhyam* (Medium soils), and *bardi* (Light soils).

The Percentage share of forest is more in Andhra pradesh is as compared to Maharashtra (see Table 1.5), whereas the area under pastures and grazing lands is high in Wardha relative to Anantapur with significant rearing implications for livestock. It is evident from table 1.5 that the area under current fallows is high in both Wardha and Anantapur districts. This is due to multiple hardships faced by the farming community in both the regions.

1.2.9 Study area and Methodology

The study was carried out in 11 villages coming under C.K.Palli, Ramagiri and Roddam mandals of Anantapur district with least net irrigated area and where NPM methods are being adopted were selected for the study (Table No 1.6). Similarly in Maharashtra, 6 villages in wardha block[3] coming under wardha district where NPM methods are followed by farmers were selected for the study. A sample of 480 farmers was selected for the study. A total of 120 NPM and 120 Non-NPM farmers were selected from each state of Andhra Pradesh and Maharashtra from 11 villages and 6 villages respectively using proportionate random technique.

Correspondingly, the required number of conventional farmers[4] were selected using proportionate random sampling method representing similar dryland conditions except that of their non-pesticidal management practices. Henceforth, these conventional farmers are referred as non-NPM farmers in the discussion. Along with personal interviews, focused group discussions were used for acquiring an indepth understanding of issues relevant to non-pesticidal management of pests. A thorough review of pest management policies was conducted based on secondary sources. The data gathered was analysed using both qualitative and quantitative methods

1.2.10 Methods of Data collection

Secondary data on rainfall, net irrigated area and demographic features of the villages were collected from mandal revenue office/block development office and village panchayat records. A thorough review of past and current trends in agricultural policies was conducted based on secondary sources. A structured questionnaire was used for collecting data

[3] In Wardha block NPM methods were adopted in six villages.

[4] Conventional farmers are those farmers who are using chemical fertilizers and pesticides along with other modern methods of farming.

from the selected sample households spread across the selected villages. The interview schedule, comprising variables to be measured was prepared in consultation with experts, keeping in view the objectives of the study. The interview schedule was pre-tested in one of the villages in an identical village outside the present study. In the light of the experience gained a pilot study, suitable modifications were made before finalizing the interview schedule. Enumerators were used for collecting the information with the help of an individual questionnaire. In the beginning, enumerators were given a one week training on how to canvas the questionnaire besides aiding them in understanding the general issues of non-pesticidal management.

Table 1.6 : Study area and sampled households in Anantapur district of Andhra Pradesh and Wardha district of Maharashtra

Andhra Pradesh -Anantapur district				
S.No	Mandal/Block	Village	No of Sample Households	
			NPM farmers	Non-NPM farmers
1	Roddam	Rachur	22	21
2	Roddam	Beedanpalli	9	9
3	Roddam	Shapuram	5	5
4	C.K.Palli	Venkatampalli	7	11
5	C.K.Palli	Boocharla	15	15
6	Ramagiri	Kondapuram	13	16
7	Ramagiri	Venkatapuram	5	7
8	Ramagiri	Gantimarri	20	11
9	Ramagiri	Kantiruddi	6	7
10	C.K.Palli	Narsingarayunipalli	9	8
11	Ramagiri	Kuntimaddi	9	10
		Total	120	120
Maharashtra-Wardha district				
1	Wardha	Dorli	30	28
2	Wardha	Shekapur	10	20
3	Wardha	Lonsawli	40	42
4	Wardha	Amla	20	10
5	Wardha	Dhamangoan	10	10
6	Wardha	Wathoda	10	10
		Total	**120**	**120**

The questionnaire was divided into 7 sections. The first section is related to general information about the household family particulars (family members, age, sex, social

category, education, role in household activity and occupation), membership with organizations, farming experience and sources of income. Second section is related to land holding details such as the total operational land holdings, grazing lands, fallows, land use pattern in Kharif 2011-12 and non-pesticidal management practices. The third section focused on crops grown, livestock details and inputs.

The fourth section covered details of pest management related control methods and inputs used. Section five covered agricultural expenses and livestock management along with income obtained under both conventional and non-pesticidal management farming practices for the years 2009-10, 2010-11 and 2011-12. Sixth section dealt with sources of information related to pest management and credit details of sample households. Section seven focused on general awareness level regarding pesticide use among non-NPM farmers along with constraints involved and suggestions for upscaling NPM approach. Village-related basic information was obtained through a questionnaire administered to the village panchayat secretary of the respective selected villages and the Mandal/Block revenue office concerned.

1.2.11 Focused Group Discussions (FGDs)

FGDs were held with both non-NPM and NPM farmers. The objective of these discussions was to have a general idea regarding NPM approach and related issues irrespective of the farm size. FGDs helped us understand livelihoods options of the villagers, ecological and economic dimensions of NPM methods and their associated advantages and disadvantages. This helped us bring to the fore perceptions of various categories of people with respect to reference to Non-pesticidal management approach to pests.

1.2.12 Methods used for data analysis

Both quantitative and qualitative information regarding NPM of pests and its determinants was gathered. The analysis was basically carried out by way of drawing a comparison between the NPM and non-NPM farmers as also between the Andhra Pradesh and Maharashtra states. The results of the study have been discussed at the household level and plot levels. The data gathered was analysed using different statistical tools, averages, frequency and percentages.

1.2.13 Design of the study

The report is organised into five chapters with the present chapter being an introduction to this work. In this chapter, the importance of organic farming is discussed, followed by objectives and methodology. The second chapter presents a detailed review of the existing literature on issues related to the integrated pest management/non-pesticidal management. The third chapter provides a profile of NPM and non-NPM farmers, regarding demographic features, landuse pattern, livelihoods and socio-economic aspects. The fourth chapter focuses on the economics of pest management followed by concluding observations in the fifth chapter.

Chapter 2
Non-Pesticidal Management of Pests - A Review

Keeping the research questions in mind, this review aims at spanning issues relating to the role of pest management in agricultural production with an emphasis on semi-arid conditions. Hitherto, most research looked into the integrated pest management of crop pests. In the India context, hardly any research has been carried out on the socio-economic, ecological, cultural and livelihood dimensions of non-pesticidal management of pests. Experiences are often drawn from other countries where, of late, a considerable research has been done related to biological control of crop pests. In this chapter, an attempt has been made to critically review different views, which have a direct and indirect bearing on the study. The broad issues covered in the review include; a) Socio-economic and technological aspects of pest management; b) Institutional aspects; c) Human and environmental health ; d) IPM/NPM vis-à-vis pesticides; e) Alternative pest management methods.

2.1 Socio- Economic and Technological aspects of Pest management

2.1.1 Inputs

Inputs play a key role in crop cultivation, yields levels and net financial returns. Along with seeds, fertilizers, irrigation and labour, pesticides are an important input. The quantum of pesticide applied influences the cost of cultivation and there by net returns. It has been found that cash return is the strongest motivating factor in cropping and livelihood strategies and hence, an 'effective' pest management must be a 'cost-effective' option (Sinzogan, 2004). A reduced pesticide application can result in lower production costs and increased returns to household labour for the producers. A study reports that pea yields are 23.4% higher in the IPM plots as compared to control plots (Sullivan et al, 1999). A similar finding by Chong (2005) indicates that perceived economic benefits comprise anticipated cost savings resulting from a reduced use of pesticides.

Rao and Mahendra Dev (2009) in a study carried out in 2004-05 on 'Socio-economic impact of Bt cotton in Warangal district of Andhra pradesh', adopting multi-stage stratified random sampling method (covering 623 farmers) and double difference method, revealed that the expenditure on insecticides decreased by 18.2 per cent in Bt cotton vis-a-vis

non Bt cotton. However, this decrease in cost of insecticides by Rs 594 was more than matched by the increased costs on seed, labour, fertilizers and irrigation. Contrary to this finding, a study conducted in 2006 by Narayanamoorthy and Kamalakar reveals that, despite the less need to spray pesticides on Bt crop, there was an increase of 34 percent in the cost of cultivation of Bt cotton over non-Bt cotton.

2.1.2 Yield

Yield is an important parameter in crop production and is, sometimes, seriously affected by pest incidence. A study done by Ahmed *et al*, (2004) in chittagong district of Bangladesh assessed farmers' pest control methods and direct yield loss of country bean, using qualitative and quantitative data related to parameters such as incidence of insect pests, pest control practices, insecticides used, frequency of insecticide application, waiting period for harvest after insecticide application and healthy yield, infested yield and total yield. The study found that, to manage pests, farmers used both chemical and non-chemical practices. The non-chemical methods comprised the use of ash and hand picking of insect pests. The study also found that pod infestation by pod borer and aphids in country bean caused a direct yield loss of 76.50 to 273.24kg per hectare.

In a participatory study involving more than thousand farmers in Zanzabir on experiences related to the adoption of IPM, it was found that there was a yield increase for all the crops in the adoption of IPM practices (Zainab *et al,* 2010). Snow pea yield on an average, was 23.4% higher in respect of IPM plots as compared to control plots (Sullivan, 1999). Production in seven of the nine IPM plots recorded higher yields. Moreover, the product quality was found to be higher in respect of IPM plots as measured by marketable yield at the shipping point grading facilities. Product rejections at the shipping point averaged 6 % less from IPM plots. Yet another study found that the farmers using chemical pesticides were willing to accept a reduced pesticide use, provided they were assured of equal or higher yields (Sinzogan, 2004).

A on-farm study on bio-pesticide front indicated 20-40% increased yields in respect of pigeon pea and chickpea (Rao *et al*, 2007). The same study also reveals that bio-intensive cotton IPM crops realized 1-30% and vegetable farmers obtained 72% of increased yields through a better management of pests and augmenting natural enemies. Contrary to this was the finding of a study conducted by Susmita *et al* (2004) in Bangladesh in 2003. A comparison of IPM and conventional techniques was done, using input-use accounting, conventional production functions and frontier production estimation along with farmers' assessment of their own health status and local ecological conditions. All of their results suggested that the productivity of IPM rice farming was not significantly different from the productivity of conventional farming.

Iyengar and Lalitha (2007) concluded that advances in biotechnology not only helped resist the dreaded bollworm, reduce the yield gap in respect of cotton by resisting the dreaded American bollworm. Rao and Dev (2009) argued that biotechnology helped improve the viability of small farmers and that technology was scale-neutral and profitable for all groups of farmers.

2.1.3 Size class

Kolawale and Laogun (2005) report that almost all the farmers belonged to one association or the other which invariably created a suitable environment for social interactions and information exchanges related to agriculture. As agriculture becomes more commercial, the vulnerability of small and marginal farmers increases with no safety nets either locally or from the government during the period of a crisis (Vasavi, 1999). A Gautemalan comparative study (Sullivan *et al.*, 1999) of IPM and control case study plots, found most of the farmers belonging to the category of small farmers with less than 0.5 hectares. The study points out that the technical recommendation related to pest management should fit into the real context or that socio-economic interventions need to complement technical research and development (Sinzogan, 2004).

Several constraints hinder the spread of non-pesticidal management approach. A study by Sinzogan *et al,* (2004) on cotton in Benin, point out technical, institutional and socio-economic production constraints involved low yields in respect of cotton. Technical problems relate to pest damage, low soil fertility and weeds, whereas institutional and socio-economic problems relate to delays in payments for seed cotton, low price of produce, expensive inputs, lack of technical assistance and labour.

2.1.4 Farmers' perceptions

Farmers' decision regarding crop protection may depend, among other factors on their knowledge of and experience with pests and diseases and the damage inflicted on cultivated plants. It is widely accepted that, pest management extension is more robust when farmers' perceptions and practices are taken into account (Heong *et al,* 2002). Pest resistance is an important varietal characteristic along with drought tolerance and suitability for making special products in determining technology choices (Joshi and Pandy, 2005). The study finds that traditional varieties were considered superior items of taste by farmers. A study by Segura et al in Chipas, Mexico, in 2004, regarding farmers' perceptions, knowledge and management of coffee pests, finds that farmers had low levels of awareness regarding the existence of natural enemies, despite the use of ectoparasitoid by a substantial number of organic farmers. A study by Sinzogan *et al,* (2004) on cotton in Benin came up with a similar finding, while observing that only a few sample farmers had any knowledge

about natural enemies mainly through extension courses. This calls for a need to increase awareness among farmers with respect to natural enemies of crop pests and their role in pest control.

2.1.5 Technology

Access to a better technology helps the farming community reap better harvests from their agricultural fields. Appropriate technology to manage pest is of paramount importance. Pesticides allow the use of modern 'high-yielding' disease-susceptible hybrid and high yielding seeds that are bred only to increase yield levels in a one-dimensional sense, e.g. to increase yield of grain at the expense of the overall biomass per hectare or total productivity (Watt, 2010). Vasavi (1999) observes that the promotion of commercial agriculture, based on hybrid seeds, chemical fertilizers and pesticides, in a pre-dominantly semi-arid region has had several repercussions in the form of loss of land race seeds, depletion of soil fertility and an increase in crop susceptibility to pests and diseases which, inturn, have finally led to the lack of fit between the ecological specificity of the region and commercial agricultural practices. Ramanjaneyulu and Kavita (2006) inform that the regulation as well as marketing of Bt cotton hybrids in India reflects a kind of "uniform application of decision" which is inexplicable. They argue that Genetic Engineering Approval Committee, sitting in Delhi, allows Bt cotton hybrids to be grown in different zones irrespective of the differential base line resistance levels of different bollworms to Bt toxin, the presence or absence of alternate host crops, relative area of Bt cotton in a given region, the toxicity exhibited by particular hybrids. They conclude that all possible safer and effective options have not been assessed before zeroing in on Bt cotton as the answer.

Access to good quality pesticides has always been an important aspect in pest management. The presence of spurious pesticides has become wide spread across many parts of the country. A study by Vasavi (2009) points out that, in Bidar district, farmers complained of the sale of spurious pesticides along with a large scale dilution of the same. More than 40 percent of the study farmers opined that the efficiency of the endosulfan had got reduced as compared to its initial introduction. Farmers cited the inefficiency of pesticides as a cause behind pest problems (Sinzogan, 2004). The pesticide dealers and agents are required to have licenses in addition to registration. Many distributors in the village operate without licence. For the past two decades, we have also witnessed an indiscriminate use of pesticides by farmers. Sinzogan (2004) reports that nearly 70% of the conventional cotton farmers and organic cotton farmers do not respect the number of pesticide applications (including botanical pesticides).

2.2 Institutions

2.2.1 Traditional Knowledge

Historically pests have been managed by farmers using local-orogin technologies that are based on their indigenous knowledge and experience. Traditional pest management practices consist mainly of cultural control methods such as crop associations, planting and harvesting time, crop rotation, closed season, mechanical control, use of biopesticides, and, sometimes, dealing with pests in a supernatural way. Several researchers have reported that traditional control practices are still the major means of pest management to small-scale farmers in India. (Reddy, 1999; Kumar, 2010; purushottam *et al,* 2009 and Rao *et al,* 2010). These control practices are based on built-in features in cropping systems, such as soil type, farm plot location, crop rotation, mixed and intercropping, or on specific responsive actions to reduce pest attack, such as timing of weeding, use of plants with repellent or insecticide action, traps and bird perches. However, a detailed information on traditional pest management practices widely followed by Indian farmers is often found lacking. In general traditional agricultural systems are poorly understood (Reddy, 2010c), and often it is not sufficiently recognized that crop protection is a thoroughly tested and built-in process within the overall production system. In principle, farmers have a good ecological understanding of pests that can easily be observed (Reddy, 2010a). For example, farmers in India have been able to develop a control method against the pests which pupate in soil by way of adopting a deep summer ploughing practice which exposes these pupae to sunlight and kills them (Butterworth *et al,* 2003).

Sinha *et al.,* (2008) documented the traditional pest management practices of the communities in the six districts of North east India, covering 120 villages under North East Region Community Resource Management project. The study meticulously documented the traditional practices and indigenous knowledge systems. Traditional pest management practices included the use of crabs as Gundhi bug attractant; citrus grandis as pesticide or repellent; Bridelia retusa as predator (bird) attractant and JAM-an indigenous granary. The study points out that communities can solve their problems in the absence of sufficient external inputs. Out of a total of 46 traditional management practices identified, 33 are plant based. Communities are not only very much aware of the resources available around them but also know how to utilize the resources in a sustainable manner. They possess an excellent knowledge about different kinds of pests (bugs, beetles, soil borne pests and rats) and the different concepts (attractants, repellents, insecticidal) employed in the conventional pest control. This study highlights how the documentation of traditional practices can be a sound basis for bio-prospecting of sustainable and environment-friendly pest management methods.

Traditional agricultural systems are finely tuned and adapted, both biologically and socially, to countering the pressures of what are often harsh and inimical environments. Often such systems represent hundreds of years of an adaptive evolution (Abatel *et al*, 2000; NBSAP, 2001; Reddy, 2009). A long standing practice followed in traditional Indian agriculture is growing two or more crops in a given field at a given time (Satheesh, 2002; Poinetti, 2006 ; Reddy, 2011). Farmers use well-adapted crop species in mixtures that are generally more stable than those in pure stands. This practice, although discouraged in favor of mono cropping practices of late, better meets the agronomic, socio-economic, pest and disease management and nutritional needs of the small and marginal farmers. This includes better food security, optimal use of soil and space, maintenance of soil fertility, especially where intercropping involves leguminous species, better erosion control, and reduction of the need for weeding (Reddy, 2010c). There are also several advantages from the view of pest control (Reddy, 2010b). Pest and disease incidence is reduced and natural enemy abundance favored (Poinetti and Reddy, 2002; Reddy, 2010c ; 2010d),

Farmers in India also follow the practice of diversionary hosts by sowing trap crops such as marigold in redgram and cotton so as to reduce economic damage to main crops (Reddy, 1999; 2010a). In African countries, adjusting planting or harvesting time to escape pest damage is the most important means of keeping pest damage below economic threshold levels. For example, early planting is perhaps the most effective means of control against stem borers on sorghum and maize in many parts of Africa and is widely practised by farmers (Gebre *et al*., 1989; Abate, 1998). Pigeon pea farmers in Medak district of Andhra Pradesh hand pick important pest like *Heliothis* (Reddy, 2010a) larvae, while ground nut farmers in Anantpur set bonafires to lure and burn red hairy caterpillar moths (Reddy, 2010b).

In a Bangladesh study done in 2004 with 139 IPM farmers and 689 chemical pest control farmers, Susmita *et al.,* have reported IPM techniques such as manual removal of pests (70 % of the sample), use of natural parasites and predators (58%), light traps (14%), crop rotation (10%) and smoke (5%). All of the surveyed IPM farmers have received formal training from Agriculture Ministry officials. The farmers have attributed their adoption of IPM to Ministry officials' 'recommendations (41%); cost-saving from a reduced pesticide use (33%); environmental benefits (12%); and improved health (6%). About 52% of the respondents have reported increased output and 67% reduction in pesticide use. In a study done by Ahemed *et al*, (2004) in Pakistan reported that farmers use fanfan, Nogos, Ripcord, Malathion, Roxion and Sumithion as chemical methods and applying ash and hand picking of insect pests as non-chemical methods to control insect pests.

Farmers of certain ethnic groups have a thorough knowledge of the history, biology and biomics of a variety of insect pests (Altieri, 1990). In West khasi Hills and West Garo Hills of Meghalaya in North east, Sinha *et al* (2004) documented several pest management practices to control pests and diseases. These include mixture of cow dung, cow urine, chilli and garlic; twigs and leaves of Pinus kesiya; use of local crabs to control insect pests of paddy and vegetables; silk worm excreta to control insect pests; raw blood of cow to control bird pests; use of "Re'not-bol' and citrus grandis as pesticide; use of fruits belonging to plants such as *Sapium baccatum roxb., Dendropthoe falcate(*L) Elting, *Morus macroura* Mig and *Bridelia retusa* to attract insect predators; use of mixture of Garlic and Ginger to control pests of paddy; use of neem and *Cannabis sativus* leaves to protect crops from pests; use of 'lime' to control worms damaging pests; use of chilli to repel paddy pests; use of *Dendrocnide sinuate* leaves to control rats; use of *Entada purseatha* seeds to control rats; using Indigenous store house for grains; use of household ash to protect crops; indigenous traps for rats; Scare crows sound creating devices to protect crops and traditional storing of maize, beans and local onion. It becomes apparent from the wide spread practices that the communities are very much aware of the plant resources available around them and that they are wise enough in utilizing the resources in a sustainable manner. This is evident from the fact, that out of 23 practices documented, more than 50 per cent are plant based. Similarly, the methods to attract natural pest predators highlight their understanding of the principles of food-web linkages in their indigenous ways. Therefore, there is an urgency for proper documentation of such practices prevalent among different communities in India.

Presently, the interest in indigenous knowledge research is increasing globally even as and the contribution of every community to this global knowledge is being acknowledged. All the nations are increasingly recognizing this resource generated by their own citizens. "Regardless of the degree to which they have embraced modernity, local people continue to prefer concrete knowledge, which belongs to them in time and space, and which they deem suitable for particular purposes" (Kolawole, 2005).

2.2.2 Information/Training

The dissemination of right kind of information on various aspects of farming is critical to farmers. Little and *et al* (2000), find that access to information is a key factor in the farmer decision making process of farmers. The availability and variety of sources of information, their reliability and farmers' confidence in them are issues which research and intervention projects need to take into account. A study also points out that a given context can affect farmers' priorities and decision making criteria, their access to sources of information and advice, and the availability of inputs. In Mekong Delta, the introduction

of insecticide reduction interventions such as media campaign to motivate farmers and implementation of Farmers Field School have resulted in reduced spray frequencies of 3.4 to 1.0 spray per season (Huan *et al*, 1999). A study carried out in Kenya (little *et al,* 2000) points out that those farmers who have not been trained in FFS believe that pesticides are necessary to produce profitable crops as against those FFS trained farmers who are confident of their pest management capability and as such rely more on their own knowledge or their group to solve pest related problems.

2.2.3 Grass roots Institutions

Little and *et al* (2000) took up a study in India (on cotton) and Kenya (vegetables) with an objective of synthesizing current knowledge with regard to farmer decision-making processes and also to develop and test methodologies for exploring pest management decision-making. This study used a combination of participatory tools: causal diagrams, participatory budgeting and semi-structured interviews. The focus of the exploratory field work was on the dynamic decision- making 'processes' rather than the decision 'event'. The study finds that the absence of strong representative institutions at the village level inhibits local initiatives that could anticipate and contain the problems such as farmers' suicide (Vaidynathan, 2006 ; Sarma, 2004).

2.3 Health

2.3.1 Human Health

There are two types of health effects resulting from exposure to pesticides: acute and chronic. Acute poisoning has generally been the most recognized form of effects. These days chronic poisoning too is gaining attention. Added to this, pesticides also aggravate existing health conditions-both acute and chronic-such as asthama and allergies, heart and immune system disorders. For 25 years, endosulfan, an insecticide was aerially sprayed over cashew nut plantations in Kasargod district of Kerala. As a result people residing in and around the plantations suffered from large number of serious neurological, developmental, reproductive and other disorders, including cancer. Watts (2010) found high incidence of cancer, cerebral pasly, mental retardation, epilepsy, congenital anomalies and psychiatric disorders in 197 cases documented out of only 123 households in Kasargod.

The cancer cases reported included abdominal, uterine, liver, and neuro blastoma apart from serious growth retardation and delayed psychomotor development. Endosulfan is a known neurotoxicant that blocks inhibitory receptors of the central nervous system and destroying the integrity of nerve cells. It is also a known endocrine disruptor besides being mutagenic and causes chromosomal aberrations. Based on self-reported health effects, a Bangladesh study reveals that among conventional farmers, 37% reported frequent

Table 2.1 : Pesticide poisoning cases in India during the years 2000-2009.

State/UTs	Number of poisoning cases
Andaman & Nicobar Islands	69
Andhra Pradesh	564
Arunachal Pradesh	-
Assam	2
Bihar	nil
Chandigarh	nil
Chhatisgarh	4
Dadra & Nagar Haveli	9
Dadra & Nagar Haveli	nil
Daman & Diu	nil
Delhi	17
Goa	nil
Gujarat	7
Haryana	2453
Himachal Pradesh	465
Jammu & Kashmir	303
Jharkhand	992
Karnataka	nil
Kerala	12256
Lakshadweep	nil
Madhya Pradesh	nil
Maharashtra	37943
Manipur	nil
Meghalaya	nil
Mizoram	nil
Nagaland	nil
Orissa	28
Pondicherry	7193
Punjab	3058
Rajasthan	2215
Sikkim	nil
Tamil Nadu	212
Tripura	nil
Uttaranchal	470
Uttar Pradesh	3325
West Bengal	324
India	**71909**

Source: Ministry of Agriculture, GoI, 2010.

health problems such as eye irritation, headaches, dizziness, vomiting, and shortness of breath, skin effects, and convulsions. While among IPM farmers, 29% reported similar health problems. Of these, 54% reported that the health of laborers working in their field's improved only after they switched over to IPM.

Chitra *et al.* (2006) in their study in Tanzavur district of Tamil nadu found that 88 percent sprayers did not take necessary personal protective measures while handling pesticides. In Andhra Pradesh state of India, 71 per cent of the respondents indicated that, while spraying pesticides they wore long-sleeved shirts, but some also informed that they wore the same clothes for 2-3 days. Similarly in Andhra Pradesh 42 percent of the farmers found that the pesticide protection equipment (PPE) was expensive, while as per 31% of the farmers, PPE was not available, whereas in Orissa state, 80 percent of non-wearers indicated that PPE was not available (Pesticide Action Network, 2010). A study done by Mekonnen and Agonafir (2002) in Ethiopia clearly brought out the need for safety education, provision of better facilities, appropriate pesticide protection device and improved hygiene and sanitation for pesticide sprayers. The survey done in 2001-2002 with respect to the traditional pest management practices of the Khasis and the Garos, the two dominant tribal communities of Meghalaya, inhabiting West Khasi Hills and West Garo Hills districts found that 75 per cent of farmers used "moderately Hazardous" to "Highly Hazardous pesticide" (Sinha *et al.*, 2004). But WHO recommends that hazardous pesticides should not be used and moderately hazardous pesticides should avoided. North east study also found that most of the farmers were unaware of the health hazards caused by inappropriate handling of pesticides. A study in India found that 97 percent of farmers in Odisha and 71 per cent in Andhra Pradesh stored their pesticides at home (Pesticide Action Network, 2010). The same study also found that in Andhra Pradesh over a quarter of respondents did not observe any particular safeguards in storage rooms, but others indicated that they were locked up out of reach of children, and separated from other items.

Pesticide poisoning is a major problem in India. The use of pesticides and its improper handling tend to impact the health of farmers. Pesticide poisoning among human beings through an exposure to the toxic fumes while spraying is a lesser known and acknowledged aspect of pesticide abuse in places like Warangal district of Andhra Pradesh (Kavitha, 2005). A study by Rao *et al,* (2005) in Warangal district of Andhra Pradesh reveals that during the period 1997 to 2002, 8040 patients were admitted to the hospital with pesticide poisoning out of which 22.6 percent died. Two thirds of the patients admitted to the hospital were less than 30 years old. Two compounds monocrotophos and endosulfan-accounted for a majority of deaths in 2002. Low-income marginal farmers were more

often subjected to a severe poisoning than landlords (Mancini *et al.*, 2005). It can be seen from table 2.1 that between the years 2000-2009 in India, the state of Maharashtra had registered the highest number (37943) of poisoning cases followed by Kerala (12256). Despite standing first in terms of pesticide use in the country, the state of Andhra Pradesh had registered only 564 cases during the same period.

2.3.2 Environmental Health

Pesticide contamination can pose significant risks to the environment and non- target organisms ranging from beneficial soil microorganisms, to insects, plants, fish and birds. The best way to reduce pesticide contamination (and the harm it cause) is to do use safer, non-chemical pest control (including weed control) methods (Akhtar, 2008). Harmful environmental effects reported from Kasargod district in India, where many villagers are ill from aerially applied endosulfan, included deformed calves and disappearing honeybees. Chickens, jackals, frogs, birds and cows have all died. Calves have stunted growth. Miscarriages, bleeding, infertility and deformities in domestic animals have been reported. A study by Quean (2002) found high levels of endosulfan in soil, water and plant tissues.

Kavita (2006) brings out the dual standards followed regulators of genetic engineering in the country. She points out that when it comes to Bt plant impacts on soil health, the regulators believe the company's argument which says that there has been no persistence of the toxin or presence of toxin found in their studies, which is quite contrary to the findings of other studies conducted elsewhere, which show that toxin leaves its impact on the soil. Similarly, there are no studies mandated which, for instance, look at the effects of Bt crop on the subsequent crop, say, over a three to five year period. She also highlights in her paper that there is no coherent policy in India to debate and take technology-related decisions, especially with regard to genetically modified crops.

Biodiversity performs a variety of renewal processes and plants provide services as part of the agro-ecosystems. The diversity of crops and wild plants provides a rich vegetative cover which prevents soil erosion, regulates water flows and nutrient cycle and aids in the control of the abundance of undesirable organisms (Poinetti and Reddy, 2002; Alteiri and Letourneau, 1982). Certain existing crop mixtures contain built-in elements of pest control and such elements should be identified and retained in the course of modernization (Altieri, 1993; Poinetti, 2006). Researchers claim that when the natural services are lost, due to biological simplification through adoption of monoculture or use of high-input technologies, social, economic and environmental costs can be quite significant. Similarly, Soil fertility management can have several effects on plant quality, which, in turn, can affect insect abundance and subsequent levels of herbivore damage (Altieri and Nicholos,

2003). Awareness of health and food safety issues among developing country consumer is also increasing, resulting in a higher demand for organic and pesticide-free produce (World Bank, 2005).

2.4 IPM /NPM Vis-a-Vis Pesticides

Inorganic fertilizers that come a pesticide package allow the farmer to increase yield levels without using natural compost. But the resultant failure to return organic matter to the soil eventually leads to a break down in soil structure and health, a buildup of diseases and insects, and the loss of productivity (Watt, 2010). A study conducted in Uganda by Mark *et al* (2003), points out that gender based knowledge and perceptional differences need to be assessed and incorporated into agricultural research and extension program delivery, if these programs are to have meaningful and sustainable impacts.

A baseline survey carried out by Sharifi *et al* (2008) while assessing the integrated pest management rice farming practices in Marvdasht county of Iran as part of studying the respondents socio-economic characteristics, identified and prioritized the existing IPM practices among farmers besides exploring the rice growers' perceptions and attitudes towards IPM. The farmers were asked to rank the 23 IPM mechanisms being followed in rice farming on a continuum of 0 to 10 point scale. A notable aspect was that the respondents were encouraged to add to the list of IPM practices mentioned in the questionnaire. This study reveals that the farmers found the use of pesticide on a large scale was very effective controlling and eliminating pests. However, a correlation analysis for IPM components reveals that tendency to consume of pesticides was negatively and significantly correlated with optimal cultural practices, biological and mechanical practices. Contrary to this, in a study conducted in Gautemala highlands (Sullivan *et al,* 1999), the insect and disease incidence was similar in both the IPM and control case study test plots of snow pea (*Pisum sativum*). However, Pesticide applications in the IPM plots were significantly few, averaging about one-third of the number of applications in the control plots. The study reports that the IPM plots required an average of only 3.7 pesticide applications to fully achieve pest management objectives, while the traditional chemical control plots required an average of 10.4 pesticide applications to achieve the same objectives. A reduction in the number of applications reduction resulted in lower production costs and increased returns to household labour for the producers. In addition to this, the quality of pea produced was found to be higher in respect of IPM plots as measured by the marketable yields at the shipping point grading facilities. The product rejections at the shipping point averaged 6% less from IPM plots (Sullivan *et al,* 1999). Yet another study found conventional farmers using an average of 2.33 kg of pesticides per acre, while IPM farmers use 0.77 kg/acre (Susmita et al, 2004). Interestingly, farmers

using chemical pesticides affirmed that they would accept to reduction in pesticide use, provided they are assured of equal or higher yields (Sinzogan *et al.,* 2004).

The type of cropping systems also influences the pest incidence and management. Monocropping systems that are convenient for pesticide sprays are attractive to pests and encourage erosion through use of herbicides to remove so called weeds which, otherwise, hold soil in place, provide a habitat for beneficial insects, and feed people (Watts, 2010). "However, the underlying principle of land utilization is to mimic the community ecosystem and therefore capitalize on nature's own superior design for light and nutrient capture, pest control and soil and water conservation" (Osunade, 1996).

An all-India survey confirmed that 34% of the respondents as having no idea about IPM and only less than 5% of them as following complete IPM technology (Shetty *et al*, 2008). For the last one decade, the use of biopesticides has increased in pest management. As per Rao *et al* (2007) there are several reasons for low uptake of biopesticide science. These include: it is knowledge intensive, needs more time to understand the effectiveness; requires specialized job of intensive pest monitoring, which is a pre-requisite for decision making at farm level and hence farmers considered it as impractical; some farmers felt that they did not have time to keep a close watch on their fields to monitor pests and their natural enemies to calculate economies to calculate economic thresholds. Going further, the study observes that farmers have several misconceptions about bio-pesticides such as they are less effective, costly, difficult to produce, not compatible with other option; most importantly, in general, the extension programs have very little Knowledge and experience of biopesticides. However, Reddy (2010b) draws our attention to the use of several kinds of bio-pesticides by organic farmers in Anantapur district of Andhra Pradesh. The new research shows that the ability of a crop plant to tolerate insect pest and disease is tied to the optimal physical, chemical and mainly biological properties of soils. Soils with high organic matter and active soil biology generally exhibit a fair degree of soil fertility as well as complex food webs and beneficial organisms that prevent infection. On the other hand, farming practices that cause imbalances in nutritional levels can lower pest resistance (Magdoff and Van Es, 2009).

2.5 Alternative Pest Management Methods

2.5.1 Need for alternatives

The failure of pesticides to control pests effectively, has forced many people to scout for alternatives. At a national food security summit, organized by M.S.Swaminathan Foundation in collaboration with the UN world food programme in New Delhi in the year 2004, made the ecological security and the need to sensitize communities on biodiversity as

important recommendations out of the ten recommendations they made (Krishnaraj, 2006). An increased difficulty in controlling *H.armigera* in respect of cotton in the recent years has heightened the need for developing and adopting alternative, non-chemical pest management techniques. Obopile and Mosinkie (2007) concluded that the research on *H.armigera* should centre around developing an intergrated pest management programme with an emphasis on pest population monitoring, enhancing natural enemies, use of pathogens of *H.armigera*, host plant resistance, cultural methods, and a minimal use of insecticides. The study also observes that ploughing in of late maturing crops in winter increases mortality of any pupae formed in croplands by exposing them to heat and predation. The other cultural control method is early planting which avoids the seasonal peaks of population that occur late February to March, thereby avoiding very heavy larval infestations besides reducing the over-wintering population. During this period the infestation is mainly in the forms of eggs and young larvae which are easier to control.

Infact in 2004, a village called Punukula in Palvancha mandal became the first in the state of Andhra Pradesh to have completely implemented non-pesticidal practices. In this village, a large section of farmers has given up the use of pesticides entirely, letting natural enemies of pests save their crops (Down to Earth, 2006). However, the state agricultural university and the agricultural department of A.P did not get influenced much by this dramatic story. It seems NPM has hit the right chord with all- except the state agriculture university and the agriculture department that runs on its advice. How long will they stay away from such a dramatic success story?. Despite bio-pesticides providing an environmentally friendly alternative to chemical insecticides, they still face a number of constraints in respect of their development, manufacture and utilization; lack of effective multidisciplinary research, poor public sector industry linkage and little understanding of the quality of products; lack of education and awareness of bio-pesticide among farmers, extension and policy makers and lack of effective regulations to promote quality biopesticides.

2.5.2 Innovative approaches to alternative pest management

Since 2007, in the state of Andhra Pradesh in India, an alternative approach to green revolution based agriculture, called Community managed sustainable agriculture (CMSA) is being tested and practised. This approach replaces the use of chemical pesticides with a combination of physical and biological measures including eco-friendly bio-pesticides and complements it by adopting biological and agronomic soil fertility improvement measures which, inturn, lead to a reduced use of chemical fertilizers (Vijay Kumar *et al*, 2009). Over 3 lakh small and marginal farmers have adopted CMSA spread over 0.54 million hectares and 5.1 percent of the net cropped area in Andhra Pradesh. Initial

results from CMSA in Andhra Pradesh show a significant net increase in farmers' incomes in addition to significant health and ecological benefits. The guiding principles underlying CMSA include observation and documentation of pest and predator behavior, pest incidence on farms; replacing of chemical pesticides with physical methods of pest management complemented by botanical formulations and bio-pesticides; managing pest populations rather than eliminating pests; focus on balancing the predator and pest populations; enhancing and maintaining soil health; a reduced use of synthetic fertilizers; increased crop diversity; preserving and maintaining local varieties and crop genetic diversity. CMSA uses an institutional platform for community organizations and their federations to plan, implement, manage and monitor the program and to provide a single window approach for the delivery of livelihood improvement services and enterprises, exclusively for small-farm holders. The environmental benefits from Sustainable agriculture include better soil health, conservation of agro-biodiversity, fewer pesticide-related health problems and small carbon foot prints. CMSA approach challenges the dominant high input subsidized model for agricultural development and relies more on the efforts of communities. This calls for a debate on the new paradigm for rainfed agriculture practiced by mostly small holders.

2.6 Conclusions

Based on the above literature we can conclude that there is a need for a community-led, biodiversity based non-pesticidal management approach. Several studies have revealed that the adoption of non-chemical methods for pest control or an integrated management of pests has clearly resulted in economic, health and environmental benefits for rural communities. A holistic, systems-oriented approach is needed, with farmers empowered to innovatively manage soils, water, biological resources, pests, disease vectors, genetic diversity and to conserve natural resources as part of a culturally rich tradition. The review calls for a strong policy support for the development and promotion of environmentally friendly alternatives to pesticides. Similarly, a long term research must be conducted on the multiple utilities of a non-pesticidal management approach. Presently, there is a very less government support (mostly in the form of subsidies) to encourage a non-pesticidal management approach. The questions regarding the yield and financial viability of a non-pesticidal management of pests are crucial, however, there are no empirical studies available in the Indian context comparing the economic and ecological returns from non-pesticidal management farms vis-à-vis conventional farms using pesticides. Keeping the research gaps identified by the literature review in view, this study on "Non-pesticidal Management of pest-An Empirical Analysis" was taken up in Anantapur district of Andhra Pradesh and Wardha district of Maharashtra.

Chapter 3
A Socio-Economic Profile of the Sample Farmers

In this chapter an attempt has been made to present the socio-economic profile of the sample villages and sample farmers in the context of non-pesticidal management and conventional pest management/agricultural practises. The demographic features of the sample villages and livelihood patterns seen in the selected villages are discussed in section-I. The socio-economic features, age group, literacy rates, livestock population, market distance, farming experience, social participation, caste composition, land holding size, net income and borrowings are discussed in the latter part of this chapter. This profile is intended insights into the non-pesticidal management practices of the sample farmers as against the conventional pest management practices. The results of a soil sample analysis are also presented in detail in this chapter.

3.1 Profile of the sample villages

The present study is related to eleven villages belonging to Anantapur district of Andhra Pradesh and six villages of Wardha district in Maharashtra. Venkatampally is a village with the maximum number of households (450) with a population of 2100; Ragimekalapally is a village with the minimum number of households (90) with a population of 500 in the state of Andhra Pradesh. Scheduled caste familes are seen in all the villages. In Maharashtra, Lonsawli is a village with the maximum number of households (255) with a population of 1242. Only four villages have S.C population. There are no S.C households in Shekapur and Amla villages. The study reveals that, in Andhra Pradesh, most of the NPM sample farmers are in the age group of 31-40 (31.67%) years followed by 41-50years (30.00%). Whereas a majority of the conventional farmers are in the age group of 41-50years (35.83%) followed by 31-40 years (32.50%). In Maharashtra, most of the NPM sample farmers are in the age group of 31-40 (32.50%) years followed by above 60 years (25.00%). While a majority of the conventional farmers are in the age group of 51-60years (31.67%) followed by above 60 years (25.00%).

The basic features of the villages such as land use pattern, social composition of sample villages are presented in tables 3.1 and 3.2. Agriculture, agricultural labour and animal husbandry are the main livelihood sources of the sample villages.

Table 3.1 : Key Features of sample villages in Wardha district of Maharasthra (2012-13)

Features	Shekapur	Dorli	Lonsawali	Watodha	Amla	Dhamangoan
No of Households(Households)	42	66	255	60	205	250
Total Population	232	321	1242	350	774	772
Scheduled Caste Population(per cent)	-	79.75	22.14	17.14	-	19.04
Land value/acre in Rs 000's						
Irrigated	2,50,000	3,00,000	3,00,000	2,50,000	2,50,000	3,00,000
Dryland	1,50,000	2,50,000	2,50,000	2,00,000	2,00,000	2,50,000
Livestock						
a) Large ruminants(LR) (Buffaloes + Bullocks+Cows)	290	75	1110	182	-	434
b) Small ruminants(SR) (Sheep + Goats)	150	120	520	100	-	250
Crops grown under Rainfed conditions	Redgram, cotton, soya bean, Jowar	Redgram, cotton, soyabean, Jowar.	Redgram, Cotton, Soyabean, Jowar.	Redgram, cotton, soyabean, Jowar.	Redgram, cotton, soyabean, jowar	Redgram,cotton, soyabean,Jowar
Crops grown under Irrigated conditions	Wheat, Bengal Gram, Vegetables.	Wheat, Bengal Gram, Vegetables.	Wheat, Bengal Gram, Vegetables.	Wheat, Bengal Gram, Vegetables.	Wheat, Bengal Gram, Vegetables.	Wheat, Bengal Gram,Vegetables.
No of Tractors	2	1	4	3	2	7
Features	Shekapur	Dorli	Lonsawali	Watodha	Amla	Dhamangoan
No of Tanks(kuntas/checkdams)	9	8	14	2	1	4
No of Borewells	10	46	102	25	81	65
No of Self Help Groups(SHGs)	2	4	10	5	3	10
No of KisanMithra Groups	-	2	-	-	-	2
Distance to nearest market in Kms	25	20	23	18	15	17
Number of Households migrating in 2012-13	-	2	-	-	-	1

Source: Village records and Field survey

Table 3.2 : Key Features of sample villages in Anantapur district of Andhra pradesh (2012-13)

Features	Ragimekalapally	Boocherla	C.K.Palli	P.Kondapuram	Rachur	Shyapuram	Venkatampalli	Venkatapuram	Ganthimarri
No of Households (Households)	90	145	110	166	179	154	450	170	240
Total Population	500	1200	660	850	856	616	2100	629	1552
Scheduled Caste Population(per cent)			2.34	39.75	4.67	3.40	6.19	33.38	9.66
Social composition	mixed	mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed
Land value/acre in Rs 000's									
Irrigated	1.5lakhs	2-2.5lakh	65,000	2,50,000	50000	50,000	80000	35,000	30000
Dryland	1 lakh	1 lakh	70,000	1,00,000	35000	30,000	70000	65000	25000
Livestock									
a)Large ruminants(LR)	30000	280	78	230	130	95	650	330	158
b)Small ruminants(SR)	470	5000	1230	1650	6500	1300	10500	170	3650
Crops Grown under Rainfed condition	G.Nut, kandi, pesarlu, alsandalu +nuvvulu, safflower, korra, aargulu, jonnalu.		Groundnut, Redgram Cowpea, Jowar, Bajra, korra.	Groundnut, redgram, korra,jonna	Groundnut, Redgram, Cowpea, Greengram, Horsegram, Korra, Sama, Bajra, Jowar, Gingelly	Redgram, Groundnut, Cowpea, Jowar, Bajra, korra	Groundnut, redgram, alasanda, greengram, maize,sajja	Groundnut, redgram, rice , sunflower, jonna,	Groundnut, Redgram, Greengram, Cowpea, Field bean, Bajra Maize, Korra, samalu, horsegram, ragi.
Crops grown under Irrigated conditions	Ground nut, Paddy, sunflower, chillies, redgram, tomoato and brinjal	Paddy, kusuma, maize, wheat	Paddy, kusuma, maize, wheat	Groundnut, paddy, sunflower, maize, cucumber.	Raga, Maize, sunflower, chili, mulberry, wate rmelon, groundnut, paddy.	Paddy, kusuma, chillies, wheat, maize, tamato, brinjal	Irrigated: paddy, kusuma, chillies, wheat, maize, tamato,brinjal	Groundnut, redgram, korra, jonna	Paddy, maize, kusuma, chillies
Net Area Sown (percent)	45.25 (1235 acres)	56.50 (1500 acres)	69.25 (856acres)	47.46 (2900acres)	84.21 (2000acres)	60.71 (425acres)	90.90 (5000acres)	71.42 (500 acres)	16.19 (860acres)

Contd... Table 3.2

Features	Ragimekalapally	Boocherla	C.K.Palli	P.Kondapuram	Rachur	Shyapuram	Venkatampalli	Venkatapuram	Ganthimarri
No of Tractors	4	2	1	5	4	5	8	20	3
No of Tanks (kuntas/checkdams)	2	1	1	10	2	4	1	2	1
No of Borewells	45	75	52	50	20	8	130	10	130
No of Self Help Groups(SHGs)	9	18	15	14	14	10	8	5	16
No of Rythu Mithra Groups(RMGs)	1	2	-	2	3	-	1	1	1
No of organic groups(Each group consists of 15 people)	4	4	3	2	4	3	2	1	6
Distance to nearest market	20	15	0	10	50	30	0	2	0
Number of Households migrating in 2013	10	100	1	0-80	7	2	30	5	5
Government Schemes implemented	MNREGA NPM, IKP	Indiramma housing	Watersheds, EGS	NREGA, Sreenidhi, RDT, SSA(ssa), Check dam, sericulture.	IKP, RYS, IRDP	NREGS, Watershed, CLDP	EGS, NPM, CLDP, Watershed, PLANTATION	NPM, Watershed, EGS, RDT.	Indiramma Housing, MNREGA, Bank loans to SHGs and NPM

Source: Village records and Field survey

Both in Maharashtra and Andhra Pradesh, the dryland villages hosted higher crop diversity including traditional millet crops like Jowar (*Sorghum bicolor*), Pearl millet (*Pennisettum americanum*), Korra (*Setaria italica), Sama (Panicum milliaceum*) and Kodomillet (*Paspalum scrobiculatum*). Crop genetic diversity is an essential dimension of agricultural production in low-input farming systems and a reduction in diversity often leaves small cultivators more vulnerable (Cleveland *et al*, 1994; Poinetti and Reddy 2002; Reddy, 2009). The soils of sample villages in Andhra Pradesh have been predominantly red sandy and sandy loams (see table 3.13), whereas in Maharashtra they are predominantly black soils (see table 3.14). The predominant source of irrigation in the sample villages of Maharashtra and Andhra Pradesh has been only tube well irrigation.

The population of cows and bullocks is seen in good numbers in all the sample villages. The role of bullocks has been taken over by tractors to a certain extent in Venkatampuram, venkatam palli, P.Kondapur, Shyapuram villages of Andhra Pradesh and Dhamangoan, Lonsawli and Wathoda of Maharashtra. This has significant implications for the fertility of soils as they do not provide any manure to farms.

With uncertainty of rainfall and non-availability of irrigation facilities, majority of households in Boocherla, P.kondapuram and Venkatampalli villages coming under Anantapur district migrate seasonally to distant places in search of employment. Interestingly, migration is not a significant feature in the study villages of Maharashtra.

3.2 A Socio-Economic Profile of the Sample Farmers

An account of the socio-economic background of the sample farmers helps us assess the tendency of the sample farmers with respect to the adoption of non-pesticidal management practices.

3.2.1 Social Composition

In order to understand the social and economic dynamics of the sample villages, one has to look into the social system, which largely determines people's perceptions, values and knowledge. The size-class wise caste composition of sample households is presented in table 3.3 It is evident from the table that, the sample farmers in both the states belong to all social groups. A post stratification of the sample households adopting NPM practices reveals that, in A.P, a majority (38.33 percent) belong to backward classes followed by scheduled castes (31.67 per cent). Even in Maharashtra, the situation is similar with backward classes constituting a majority (33.33 percent) followed by S.Cs and other castes (26.67 percent each). The study data reveals that the population of Scheduled tribes among NPM sample households constitutes 17.5 percent in Andhra Pradesh and 13.33 percent in Maharashtra. Even among the sample households practising conventional agriculture, a majority belong to backward class communities (28.22%) in A.P and to Scheduled castes (29.17%) in Maharashtra.

Table 3.3 : Distribution of Sample Households according to their social category during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Social category	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
Scheduled Caste	31.67	37.5	26.67	29.17
	(38)	(45)	(32)	(35)
Scheduled Tribe	17.5	23.33	13.33	20.0
	(21)	(28)	(16)	(24)
Backward Communities	38.33	28.33	33.33	25.83
	(46)	(34)	(40)	(31)
Other Caste	12.5	10.84	26.67	25.0
	(15)	(13)	(32)	(30)
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**
	(120)	**(120)**	**(120)**	**(120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

3.2.2 Size-class

A size-class-wise distribution reveals that a majority are small farmers in A.P both in case of NPM farmers (55 percent) and non-NPM farmers (73.33 percent). Same is the case in Maharashtra with 51.67 percent small farmers among NPM farmers and 56.67 percent conventional farmers (see table 3.4). Large farmers among NPM households account for only 13.33 per cent and 9.17 percent in the states of Andhra Pradesh and Maharashtra respectively. Most of the NPM farmers belonging to scheduled caste and backward communities have organized themselves into groups for taking up non-pesticidal management methods. Obviously, the percentage of small farmers is high in this category.

3.2.3 Family Size

This refers to the total number of people in the sample farmers' families, usually consisting of husband, wife, children and other members. It can be observed from table 3.5 that in Andhra Pradesh, a majority (40.0%) of the NPM sample households have a family size of four followed by five (22.50%) and three members (16.67%). The same is the case with conventional farmers using pesticides in their farming. The probable reason being small holdings and nuclear families. In Maharashtra too, the family size of a majority of the sampled households among NPM as well as conventional farmers consists of five members followed by six members. In A.P, a family size of seven and above is seen among NPM and Non-NPM sample households.

Table 3.4: Distribution of Sampled Households according to their size class during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Famer category	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
Small Farmer (0.1-5 acres)	55.0 (66)	73.33 (88)	51.67 (62)	56.67 (68)
Medium Farmer (5.1-10 Acers)	31.67 (38)	17.5 {21)	39.16 (47)	24.16 (29)
Large Farmer (Above 10 Acers)	13.33 (16)	9.17 (11)	9.17 (11)	19.17 (23)
Grand Total	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of farmers.

Table 3.5: Distribution of Sampled Households according to their family size during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Family size	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
Less than 3 members	5.83 (7)	5.0 (6)	10.0 (12)	11.67 (14)
Three members	16.67 (20)	19.17 (23)	11.67 (14)	15.83 (19)
Four members	40.0 (48)	37.50 (45)	38.33 (46)	29.17 (35)
Five members	22.50 (27)	21.66 (26)	25.83 (31)	25.0 (30)
Six members	5.83 (7)	10.83 (13)	14.17 (17)	15.0 (18)
Seven members and above	9.17 (11)	5.83 (7)	0.0 (0)	3.33 (4)
Grand Total	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

3.2.4 Literacy

Education attainment, as used here, refers to the number of years of formal schooling attended by the sample farmers. For the purpose of distribution of farmers, six categories have been evolved i.e illiterate, classes I-V,VI-VII, VIII-X, Intermediate, Graduation and above. It is presumed that if a farmer is educated he can be sensitized to non-pesticidal management methods and marketing issues involved so that he can take advantage of the situation. More importantly, it might be relatively easier to communicate the message through extension agencies on recent advances in biological control and bio-pesticides to a literate farmer. Here, an attempt has been made to look into the educational background of the respondents. An analysis was carried out by calculating the percentage of farmers across various educational under the respective size class and also across the total sample households.

Table 3.6 : Distribution of Sampled farmers according to their educational level during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Education level	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
Illiterate	60.00	70.00	16.67	15.0
	(72)	(84)	(20)	(18)
Informal education	5.83	3.33	4.16	10.83
	(7)	(4)	(5)	(13)
I-V class	11.67	8.33		25.0
	(14)	(10)	(17)	(30)
VI-VII	10.0	5.0	15.0	9.17
	(12)	(6)	(18)	(11)
VIII-X	8.34	7.5	32.50	27.50
	(10)	(9)	(39)	(33)
Intermediate	4.16	1.67	15.0	10.0
	(5)	(2)	(18)	(12)
Degree and above	0.00	4.17	2.5	2.5
	(0)	(5)	(3)	(3)
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**
	(120)	**(120)**	**(120)**	**(120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of respondents.

Tale 3.6 indicates that among the total sample of NPM farmers in A.P., 60.00 per cent are non-literate followed by I-V (11.67 percent) and VI-VII (10.00 percent). Among the conventional farmers too, a majority are non-literate (70.0%), followed by VI-VII (8.33 percent) and VIII-X (7.5 percent). This could be attributed to the lack of a proper educational infrastructure base in these villages. Other reasons could be financial constraints and the need to work for the sustenance of their families. Hence, there is a need for strengthening the educational institutions at the village level so that farmers have a better access and capacity to make a full use of the developments taking place in organic agricultural management. Similarly, in Maharashtra, among NPM farmers, a majority have attained VIII-X (32.50 per cent) level education followed by illiterate (16.67 per cent) and 15 per cent each VI-VII and intermediate education levels.

Whereas, in the case of conventional farmers, a majority come under VIII-X (27.50 per cent) followed by class I-V education level and illiterate (15.0 per cent). The sample households with above intermediate level of education among NPM farmers are more in Maharashtra state. As a majority of the respondents are not literates in A.P, they are dependent on their neighbours and peers for useful knowledge and updated information related to the non-pesticidal management of pests.

3.2.5 Social Participation

Social participation, as used here , refers to the degree of participation of the respondents in formal organizations either as member, office bearer or public leader. The sample farmers have been categorised into those with no social participation, those with membership in one organization, those with membership in two organizations and, those with membership in three or more organisations. Table 3.7 shows the distribution of respondents based on their social participation.

It can be observed from table 3.7 that a majority of the NPM sample households (49.17%) in A.P have membership with two organisations, followed by membership with three organizations (25.0%). This could be due to the state governments' efforts to promote the participation of social groups such as self help groups (SHGs), Development of Women and Children in Rural Areas (DWCRA) groups and *Rythu Mithra* Groups (RMGs) as also occupation related institutions. The lack of social participation is more visible among non-NPM farmers (18.34) as compared to NPM farmers (9.17%) in A.P. A majority of the sample households both in the case of NPM (76.66) and non-NPM (82.50) households have membership with one organization followed by no membership with any group. On the whole a high level of social participation is seen in Andhra Pradesh.

Table 3.7: Distribution of Sampled Households according to their social participation during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Social participation	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
No membership with any group	9.17 (11)	18.34 (22)	14.17 (17)	13.33 (16)
Membership with one group	13.33 (16)	13.33 (16)	76.66 (92)	82.50 (99)
Membership with two groups	49.17 (59)	47.50 (57)	6.67 (8)	4.17 (5)
Membership with three groups	25.0 (30)	17.50 (21)	0.0 (0)	0.0 (0)
Membership with four groups	3.33 (4)	3.33 (4)	2.50 (3)	0.0 (0)
Grand Total	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**	**100.00 (120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

Table 3.8 : Distribution of Sampled Households' land in the study area during 2011-12 in Andhra Pradesh and Maharashtra (percent)

(N=480)

Particulars	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
Rain fed	65.45 (538)	69.65 (732)	56.11 (418)	60.24 (556)
Irrigated	11.19 (92)	9.80 (103)	40.0 (298)	39.44 (364)
Grazing land	6.08 (50)	1.62 (17)	2.82 (21)	0.10 (1)
Current fallows	9.73 (80)	13.89 (146)	0.80 (6)	0.22 (2)
Permanent Fallows	7.54 (62)	5.04 (53)	0.27 (2)	0.0 (0)
Total land owned	**100.00 (822)**	**100.00 (1051)**	**100.00 (745)**	**100.00 (923)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of acres.

3.2.6 Land

Table 3.8 shows that in Andhra pradesh and Maharashtra, both NPM and non-NPM sample households have most of the area under drylands, followed by area under irrigated lands, except in the case of non-NPM farmers in A.P who have 13.89 per cent of the cultivable area under current fallows the second highest. A considerable proportion of the area is under current and permanent fallows in Andhra Pradesh. This could be due to the lack of sufficient rains and moisture combined with excess rains at times. Extreme weather conditions not only force the farmers to keep their lands fallow, but also to look for alternate employment by way of migrating to distant places.

3.2.7 Livestock

This is the most crucial aspect influencing the soil fertility management practices of both NPM and non-NPM households. Both quantity and quality of livestock influences the soil fertility management directly and indirectly. Higher the livestock population, greater is the access to organic manure which, inturn, enriches the soils giving resistance to plants for withstanding pests and diseases. The livestock component of the farming system is crucial to maintaining soil fertility, supply of draft power and food for the family (Reddy, 2001; 2011).

It could be seen from table 3.9 that as compared to cows and buffaloes, the population of bullocks is declining in study villages of Andhra Pradesh, excepting venkatampalli and Gantimarri villages, while most other villages have bullock pairs ranging between 10-20. The population of buffaloes and cows is relatively more satisfactory. Among cows, we can see that the percentage of jersey cows is increasing in some villages. Sheep is the dominant small ruminant seen among the hillocks of the study villages which are unique to anantapur district. However, the livestock population declined due to fodder and drinking water shortages in the context of recurring drought (Ranjitha, 2004). Especially, bullock population has been steadily coming down among farming households. The probable reasons being reduction in the farm size, increased mechanization, declining area under common lands and changing patterns in labour availability (Conroy *et al*, 2001). Another reason perhaps is that children from scheduled castes(S.Cs) and backward communities(B.Cs) who used to work for the land lords earlier, are now going to school due to a fare level of awareness created by voluntary organizations in addition to a greater emphasis given by the government to promoting primary education.

Table 3.9: Livestock population in the Study Villages (2012-13)

Andhra Pradesh

Livestock category	P.Kondapuram	Gantimarri	Beedanpalli	Ragimekalapalli	Boocherla	Venkatampalli	C.K.Palli	Rachur	Shyapuram	Venkatapuram
Bullocks	30	100	40	20	40	200	30	34	22	50
Buffaloes	110	2	40	125	100	250	35	40	30	100
Cows	90	100	10	30 (dual purpose)	140 (100 jersey and 40 ND)	300 (75% jersey)	35	60	45	180
Sheep	1500	5000	100	400	3000	4000	400	5000	1000	70
Goat	150	150	1500	70	2000	600	500	1500	300	100

Maharashtra

	Shekapur	Dorli	Lonsawali	Watodha	Amla	Dhamangoan
Bullocks	40	40	150	50	44	120
Buffaloes	50	05	360	12	25	34
Cows	200	30	600	120	150	280
Sheep	-	-	-	-	-	-
Goat	150	120	520	100	110	250

Source: Field survey and Village records

Table 3.10 indicates that cows were more in A.P with both NPM and non-NPM sampled households in comparison with buffaloes. However, NPM households have a greater number of cows than non-NPM households. The requirement of cow urine in the preparation of bio-pesticdes and some of the NPM options is one of the reasons for the presence of number of cows among NPM households. Whereas in Maharashtra, the population of bullocks in the study villages is relatively larger as compared to A.P. Interestingly, in the study villages of Maharashtra, the population of cows is quite higher than that of buffaloes. In contrast to A.P there is no presence of sheep in the study villages of Maharashtra, but goats are seen. Traditionally, sheep are not predominant in the study area. When it comes to sample households, the population of bullocks is very high among NPM and non-NPM households in Maharashtra, which is quite contrary to the A.P situation. The reason being that despite a ready access to tractor in the villages (see table 3.1), a majority of the small farmers and medium farmers in the study villages of Maharashtra prefer to plough their lands with bullocks and with a relatively less buffaloe population they are the main source of organic manure to soils. Like in A.P, even in Maharashtra, the number of cows is slightly higher among NPM households which has helped adopt NPM options involving the use of cow urine.

Table 3.10: Distribution of livestock by type among the sampled households in A.P and Maharashtra during 2012-13.

Type of animal	Andhra pradesh		Maharashtra	
	NPM	Non- NPM	NPM	Non- NPM
Bullocks	40	38	184	141
Buffalos	228	199	51	13
Cows	308	237	152	132
Sheep	75	152	0	0
Goat	59	33	110	140

Source: Field Survey

3.2.8 Farming Experience

Farming experience operationalised as the number of years the sample farmer completed in farming at the time of investigation. The sample farmers have been categorized into five groups; those having experience of 0-10 years, 11-20 years, 21-30 years, 31-40 years and 41 years and above. Table 3.11 reveals that a majority of the sample farmers are in the age group of 31 and 50 years with obviously their farming experience ranging between 11-30 years. Among the total sample farmers in Maharashtra and Andhra pradesh, a majority have farming experience ranging from 11 to 20 years. Around fifty percent of

the NPM farmers have farming experience of more than 20 years. Experienced farmers have rich knowledge of practices which are suitable to local- specific conditions and can do well under constraints (Adolph and Butterworth, 2002). They are actively managing pest through a wide range of practices with significant inputs of time, knowledge and capital. However, dynamic pest management practices which are based on farmers long experience continue to remain largely unknown and undocumented by the official research and extension systems. Several such indigenous practices still exist among the farming community (Acharya *et al,* 2001; Reddy, 2013a).

Table 3.11: Distribution of Sample Households according to their farming experience during 2011-12 in Andhra Pradesh and Maharashtra (percent).

(N=480)

Farming experience in years	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
< 10 years	3.33	3.33	6.67	1.67
	(4)	(4)	(8)	(2)
11 to 20	47.5	50.0	43.33	38.33
	(57)	(60)	(52)	(46)
21-30	30.84	28.34	26.67	30.00
	(37)	(34)	(32)	(36)
31-40	11.67	15.0	14.17	17.50
	(14)	(18)	(17)	(21)
Above 40	6.66	3.33	9.16	12.50
	(8)	(4)	(11)	(15)
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**
	(120)	**(120)**	**(120)**	**(120)**

*Source: F*ield Survey

Note: Figures in parentheses indicate the actual number of respondents.

3.2.9 Agro-Biodiversity

Farmers in dryland regions have developed diversified cropping systems to ensure that the most essential natural resources such as sunlight, wind, rainfall and soil are optimally utilized through out the year. Crops developed over centuries have been specifically bred to suit local soils, nutritional needs of people, livestock needs and climatic conditions. Large number of farmers, especially women, have been nurturing the agro-biodiversity and soil fertility without any sort of support from the government (Satheesh, 2000; Pionetti and Reddy 2002; Reddy, 2009a). The lands of sample farmers of the study villages host a wide range of crops (table 3.12).

Table 3.12 shows that crop diversity is more in the fields of NPM farmers as compared to non-NPM farmers. In Andhra Pradesh, a majority (42.50 per cent) of the sample households with non-pesticidal management practices grow atleast two crops on lands owned by them followed by four crops (12.50 %) and three/five crops (10.0%). Above 17 percent of NPM farmers grow six and above crops in their fields, where as it is 3.33 percent in the case of Non--NPM farmers. Higher the diversity, better is the population of natural enemies of crop pests and there helps reduce crop losses due to pest attack. Add to this, diversity provides some protection from adverse price changes in respect of a single commodity and also a better seasonal distribution of inputs (Cacek and Langer, 2009). In the case of non-NPM households, a majority (42.50 per cent) grow two crops followed by three crops (25.0%) and four crops (21.70%).

Table 3.12: Average number of crops grown by sample Households in the study area during 2011-12(percent).

No of Crops	Andhra pradesh (N=240)		Maharashtra (N=240)	
	NPM	Non- NPM	NPM	Non- NPM
One crop	7.50	40.83	5.8	0.83
	(9)	(49)	(70)	(1)
Two crops	42.50	40.0	42.5	3.3
	(51)	(48)	(51)	(4)
Three crops	10.0	5.0	25.0	35.8
	(12)	(6)	(30)	(43)
Four crops	12.50	5.84	21.7	22.5
	(15)	(7)	(26)	(27)
Five crops	10.0	5.0	5.0	25.0
	(12)	(6)	(6)	(30)
Six crops	8.33	3.33	0.0	9.2
	(10)	(4)	(0)	(11)
Seven crops	5.84	0.0	0.0	2.5
	(7)	(0)	(0)	(3)
Eight crops and above	3.33	0.0	0.0	0.83
	(4)	(0)	(0)	(1)
Total	**100.0**	**100.0**	**100.0**	**100.0**
	(120)	**(120)**	**(120)**	**(120)**

Source: Field survey

Note: Figures in the parantheses indicate percentage.

In Maharashtra, a majority (42.50%) of NPM farmers grow two crops followed by three crops (25.0%) and four crops (21.70%). Interestingly, In Maharashtra nearly 12.53 per cent of Non-NPM farmers cultivate six and more crops as against nil (0.0%) by NPM farmers. One of the reasons could be the presence of more number of large farmers (see table 3.4) in the case of non-NPM farmers who possess sufficient land to take up diverse crops on different plots.

3.2.10 Soil type

The soils of the study area vary from deep black cotton soils to light sandy soils. The kind and depth of soils also influence soil fertility. Generally, it is observed that soils with a greater depth are more fertile than shallow soils. It is evident from table 3.13 that, in Andhra Pradesh, a majority (78.33 percent) of the soils owned by NPM and non-NPM farmers are red soils followed by sandy soils. Black soils are owned by (5.84%) only non-NPM farmers.

Table 3.13: Distribution of Sample households according to their soil types in 2011-12 in A.P
(Percent)

(N=240)

Soil type	**NPM**	**Non-NPM**
Red soil	78.33	77.50
	(94)	(93)
Black soil	0.0	5.84
	(0)	(7)
Sandy soil	17.50	14.17
	(21)	(17)
Saline soil	3.34	0.83
	(4)	(1)
Javuku soil	0.0	0.83
	(0)	(1)
Others	0.83	0.83
	(1)	(1)
Total	**100.0**	**100.0**
	(120)	**(120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

In the context of Maharashtra state, a majority of the soils belonging to NPM and non-NPM farmers are black soils followed by sandy soils and red soils (see table 3.14). There

are small proportions of saline soils present among NPM and non-NPM farmers in both Maharashtra and Andhra Pradesh.

Table 3.14: Distribution of Sample households according to their soil types in 2011-12 in Maharashtra (Percent)

(N=240)

Soil type	NPM	Non-NPM
Red soil	3.3	6.67
	(4)	(8)
Black soil	66.7	57.5
	(80)	(69)
Red + Black soil	4.2	5.0
	(5)	(6)
Black +Others	5.0	5.0
	(6)	(6)
Sandy soil	10.8	8.33
	(13)	(10)
Red +Sandy soil	0.0	5.0
	(0)	(6)
Black +Sandy soil	2.5	5.8
	(3)	(7)
Saline soil	0.8	0.0
	(1)	(0)
Saline + Black soil	5.0	4.2
	(6)	(5)
Saline +Sandy soil	0.0	1.7
	(0)	(2)
Others	1.7	0.8
	(2)	(1)
Total	**100.00**	**100.00**
	(120)	**(120)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

3.2.11 Cropping System

Dryland farmers have developed diversified cropping systems to ensure that the most essential natural elements such as sunlight, wind, rainfall and soil are optimally utilized through out the year. Crops developed over centuries have been specifically bred to suit changes in the rainfall pattern from year to year. The short and long-duration varieties, water-tolerant and drought-resistant varieties, developed are the result of a careful planning over centuries by farming communities. Inter cropping, mixed cropping, relay cropping

and multi-tiered cropping are the strategies adopted by the sample farmers and are highly relevant. By doing so, the farmers balance food and cash crops, along with the fodder needs of their animals and simultaneously manage the fertility of their marginal soils (Poinetti and Reddy, 2002).

Table 3.15: Cropping pattern adopted by the sampled households in Andhra pradesh state in 2011-12 (percent)

Cropping pattern	NPM	Non-NPM
Groundnut + Redgram +Cow pea	6.70	1.45
Castor	0.0	1.45
Groundnut	7.50	33.33
Groundnut + Redgram	42.00	37.36
Groundnut + Redgram + Fox tail millet (strip cropping on border)	11.00	0.83
Groundnut + Redgram + Cow pea + Jowar	15.86	7.0
Groundnut + Redgram + Cow pea + Green gram	11.05	6.0
Groundnut + Redgram + Castor	2.35	1.45
Groundnut + Redgram + Green gram	1.18	2.45
Jowar	0.0	1.45
Safflower	1.18	1.45
Redgram	1.18	2.89
Redgram + Castor	0.0	2.89
Grand Total	**100.00**	**100.00**

Source: Field survey

Table 3.15 shows different cropping patterns being adopted by the sample households in Andhra pradesh as of 2011-12. Ground nut + Redgram dominates the cropping pattern among NPM and non-NPM sample house holds. This was followed by ground nut + redgram + cow pea + jowar among NPM households and mono crop of ground nut among non-NPM households. Strip cropping with fox tail millet is predominant only among NPM households. Similarly, in Maharashtra, (table 3.16) inter cropping of Soya bean + Redgram is predominant among NPM households while mixed cropping of Soya bean + Cotton + Redgram predominant among non-NPM households. Cotton + Redgram is another major cropping pattern among NPM households.

Despite the constant encouragement for the adoption of monocropping by the agricultural extension agencies, private seed, pesticide and fertilizer companies from past three decades, farmers still follow inter cropping and mixed cropping realizing its merit (table 3.17).

The adoption of this practice needs seeds of required quantities of diverse crops that are grown in the fields. Just like crop rotation, this too has been a significant practice from the farmers' perspective in terms of maintaining soil fertility and managing crop pest.

Table 3.16: Cropping pattern adopted by the sampled households in Maharashtra state in 2011-12 (percent)

Cropping system adopted	NPM	Non-NPM
Cotton + Redgram	32.83	40.0
Cotton + Redgram + Soyabean +Jowar	0.0	0.83
Jowar	0.83	2.0
Soyabean	4.18	13.0
Soyabean + Redgram	41.34	11.67
Soyabean + Cotton + Redgram	18.33	32.50
Soyabean + Redgram + Jowar + Bajra + Black gram.	0.83	0.0
Soyabean + Redgram + Jowar	0.83	0.0
Soyabean + Redgram + Black gram	0.83	0.0
Grand Total	**100.00**	**100.00**

Source: Field survey

It is evident from table 3.17 that among the NPM sample households in Andhra Pradesh, mixed cropping amounts to 39.17%, 33.33% and 44.17% for the years 2011-12, 2010-11 and 2009-10 respectively. Whereas in conventional farming, among all size classes 18.34%, 15.83% and 16.67 percent was mixed cropping during the years 2011-12, 2010-11 and 2009-10 respectively. Monocropping is highly predominant in A.P with 40.83% and 26.67% during the years 2011-12, 2010-11 and 2009-10 respectively. Strip cropping with foxtail millet is gradually increasing among NPM households from 0.83% during the year 2009-10 to 10.84% in 2011-12. As far as Maharashtra is concerned intercropping was predominant in all the three years. Monocropping was more with non-NPM households during these years. Interestingly mixed cropping was predominant with non-NPM households in Maharashtra for the years 2011-12, 2010-11 and 2009-10. Farmers value such diversity since it provides greater protection against the risk of crop failure (Scoones, 2001). The reasons given by farmers for crop diversity include a better access to diverse and nutritive food for the family members, availability of different kinds of fodder and feed for the livestock, improved soil fertility, effective utilization of farmlands as part of ensuring that under no conditions of unfavorable environment and climate, the whole crop is lost.

Table 3.17: Distribution of sample households according to their cropping system in Kharif 2011-12, 2010-11, 2009-10 in Andhra Pradesh and Maharashtra (percent)

Cropping method	2011-12		2010-11		2009-10	
	NPM	Non- NPM	NPM	Non- NPM I	NPM	Non- NPM
Andhra Pradesh						
Mono crop	7.5 (9)	40.83 (49)	5.0 (6)	40.83 (49)	10.0 (12)	26.67 (32)
Inter crop	42.5 (51)	40.0 (48)	54.17 (65)	42.50 (51)	45.0 (54)	56.67 (68)
Mixed crop	39.17 (47)	18.34 (22)	33.33 (40)	15.83 (19)	44.17 (53)	16.67 (20)
Strip crop**	10.84 (13)	0.83 (1)	7.5 (9)	0.83 (1)	0.83 (1)	0.0 (0)
Total	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**
Maharashtra						
Mono crop	5.0 (6)	15.0 (18)	3.33 (4)	16.67 (20)	4.17 (5)	21.67 (26)
Inter crop	74.17 (89)	51.67 (62)	75.83 (91)	61.66 (74)	73.33 (88)	52.50 (63)
Mixed crop	20.83 (25)	33.33 (40)	15.0 (18)	21.67 (26)	22.50 (27)	25.83 (31)
Total	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**

Source: Field survey

Note: Figures in the brackets indicate the actual number of households.

* *Strip cropping with Korra is seen only in Anantapur district.

By practising inter/mixed cropping, farmers combine crops with varying lengths of root depth, thereby avoiding competition for space, moisture and nutrients. In mixed cropping systems, root diversity at different levels below the ground physically stabilises the soil structure against erosion and soil movement on steep slopes, and in tropical systems, the contribution of roots to soil organic matter is proportionately larger than from above ground inputs. The effects of roots on the soil biophysical properties are particularly critical to farming systems where crop residues are at a premium for fuel and fodder. Earthworms, other soil fauna and microorganisms, together with roots of plants and trees, ensure a proper nutrient cycling; pests and diseases are kept in check by predators and disease control organisms, as well as by genetic resistance in crop plants themselves; and insect pollinators contribute to the cross-fertilisation of out-crossing crop plants.

The natural process of biological nitrogen fixation by roots constitutes an important source of nitrogen for crop growth. It therefore provides a major alternative to the use of commercial nitrogen fertiliser in agriculture. Intercropping/mixed cropping will safeguard against total failure of the crops during unfavorable climatic conditions and can increase production and income on drylands (Poinetti and Reddy, 2002).

In monocropping system the incidence of pest or spread of disease is easy as there is single crop. Whereas the inter/mixed cropping system itself acts like a barrier to the establishment of pests and there by reducing the damage. More over it becomes difficult for the pest to locate its food in the mixed cropping system. Interestingly some of the crops in the mixed cropping system, simultaneously will be source of food for natural enemies of crop pest. So the more the variety of crops in a field, high is the population of beneficial organisms which takes care of pest. This helps in avoiding use of any pesticide. Table 3.18 provides an idea of varietal diversity adopted in various crops by farmers in Wardha district of Maharashtra.

Table 3.18: Details of Varieties used in different crops by farmers in the Study area of Maharashtra

Crops	Variety Used by farmers
Cotton	Mahabeej Bt, Ankur-Bt, Maruti-Bt, Yashoda-Bt,Bt-651, Jyoti-Bt,Eagle-Bt and Kaveri Bt.
Soyabean	JS-335.
Redgram	Maruti, Ganesh,Sweta, Asha,White redgram and Gowrani (Traditional).
Greengram	Kopargoan and Gowrani.

Source: Field survey

3.2.12 Indebtedness

This variable was operationalised as the amount of outstanding loan of a farmer from the loan taken from various sources. It is categorized into 5 groups as indebtedness ranging from Rs.1-20000, Rs.20001-40000, Rs.40001 to 60000, Rs.60001 to 80000 and indebtedness above Rs.80001.

Table 3.19 reveals that a majority (33.05 percent) of the NPM sample households in Andhra pradesh depend on loans from commercial banks, followed by Self Help Groups (21.19%) and rural banks (16.10%). It is a heartening sign to note that public sector banks are trying to cater to the credit needs of the farmers. Same was the case with non-NPM farmers, but instead of rural banks their third dependence was on land lords. Contrary to A.P, in Maharashtra, a majority of the NPM and non-NPM sampled households access credit from co-operative banks followed by rural banks. However, the credit facilities

extended by cooperative agencies, in view of rising costs of cultivation are inadequate and hardly benefit small farmers (Mohanty, 1999). The formal credit agencies provide low cost credit with facilities of repayment in installments and the possibility of postponement of repayment in case of crop failure (Mohanty and Shroff, 2004). Hence, the credit disbursement of these banks has to be increased further for reducing dependency on private money lenders who charge exorbitant interest rates. Rural credit plays an important role in meeting the financial requirements of the resource poor farmers (Adolph and Butterworth, 2002). Interestingly, the dependence on fertiliser and pesticide dealers is totally absent in Maharashtra, while negligible in A.P.

Table 3.19: Distribution of the sample households according to their source of loan during 2010-11 and 2011-12 years in Andhra Pradesh and Maharashtra (Percent)

Particulars	Andhra pradesh		Maharashtra	
	NPM (N=118)	Non-NPM (N=114)	NPM (N=111)	Non-NPM N=95)
Commercial Banks	33.05	37.28	1.80	2.10
Rural Banks	16.10	8.77	3.60	22.10
Co-operative Bank	5.08	5.70	92.79	73.68
Self Help Groups	21.19	32.46	1.80	1.06
NGOs	1.70	0.0	0.0	0.0
Traders	3.39	3.51	0.0	0.0
Land lords	4.24	10.53	0.0	0.0
Relatives/Friends	11.86	1.75	0.0	1.06
Others	3.39	0.0	0.0	0.0
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field survey

From table 3.20, it is evident, that among the total NPM sample farmers in A.P, indebtedness of a majority (37.61%) ranges between Rs.20001-40000 followed by 23.93 percent of them between Rs.40001 to 60000. The same is the case with non-NPM farmers but with 54.38 percent of farmers in the range of Rs20001-40000. A similar situation exists in Maharashtra. This is due to the purchase of agricultural inputs, increased input costs and decreased in profits from farming, pushing farmers into a debt trap. In Andhra Pradesh, nearly 19 percent of the NPM farmers account for indebtedness greater than 80001. The main reason revealed by these farmers for huge amount debt is the construction of houses (see table 3.21).

Table 3.20: Distribution of sampled households according to their loan amount in rupees, mortage items for credit and rate of interest for credit in Andhra Pradesh and Maharashtra during 2010-11 and 2011-12 (percent)

	Andhra pradesh		Maharashtra	
Loan amount Rs	**NPM (N=117)**	**Non-NPM (N=114)**	**NPM (N=111)**	**Non-NPM N=95)**
Less than 20000	5.98 (7)	2.63 (3)	17.12 (19)	10.53 (10)
20001-40000	37.61 (44)	54.38 (62)	59.46 (66)	54.74 (52)
40001-60000	23.93 (28)	23.08 (27)	12.61 (14)	18.95 (18)
60001-80000	13.68 (16)	14.03 (16)	6.31 (7)	5.26 (5)
80001-100000	7.69 (9)	3.59 (4)	2.70 (3)	1.05 (1)
Above I lakh	11.11 (13)	1.75 (2)	1.80 (2)	9.47 (9)
Grand Total	100.0 (117)	100.0 (114)	100.0 (111)	100.0 (95)
Collateral used for obtaining credit				
Patta Pass book	42.74 (50)	46.15 (54)	57.66 (64)	28.42 (27)
Gold	30.77 (36)	35.96 (41)	0.90 (1)	12.63 (12)
Trust	17.95 (21)	4.38 (5)	2.70 (3)	2.10 (2)
Promissory Note	8.55 (10)	12.28 (14)	9.0 (10)	34.74 (33)
Others	0.0 (0)	0.0 (0)	29.73 (33)	22.10 (21)
Grand Total	100.0 (117)	100.0 (114)	100.0 (111)	100,0 (95)
Monthly Interest rates on credit				
Less than 1	62.50 (75)	83.33 (95)	7.21 (8)	12.63 (12)
1 to 2	31.67 (38)	16.67 (19)	48.65 (54)	48.42 (46)
3 to 4	2.56 (3)	0.0 (0)	35.14 (39)	36.84 (35)
Above 5	0.85 (1)	0.0 (0)	5.40 (6)	2.10 (2)
Others	0.0 (0)	0.0 (0)	3.60 (4)	0.0 (0)
Grand Total	**100.0 (117)**	**100.0 (114)**	**100.0 (N=111)**	**100.0 (N=95)**

Source: Field survey

Note: Figures in parentheses indicate the actual number of households.

Table 3.21: Distribution of households according to their interest rates for credit in Andhra Pradesh and Maharashtra (percent)

Purpose of loan	Andhra pradesh		Maharashtra	
	NPM (N=117)	Non-NPM (N=114)	NPM (N=111)	Non-NPM N=95)
Crop production	53.0 (62)	68.42 (78)	74.77 (83)	48.42 (46)
Business	0.85 (1)	1.75 (2)	0.0 (0)	0.0 (0)
Cattle purchase	1.71 (2)	0.0 (0)	0.0 (0)	0.0 (0)
Dairy farm	2.56 (3)	0.88 (1)	0.0 (0)	0.0 (0)
Education	2.56 (3)	5.26 (6)	0.0 (0)	0.0 (0)
Consumption	5.13 (6)	0.0 (0)	0.0 (0)	13.68 (13)
Gold	0.0 (0)	0.88 (1)	0.0 (0)	0.0 (0)
Health care	2.56 (3)	2.63 (3)	0.0 (0)	0.0 (0)
House Construction	20.51 (24)	3.51 (4)	0.0 (0)	0.0 (0)
Land purchase	1.71 (2)	1.75 (2)	0.0 (0)	0.0 (0)
Performing Marriage	8.55 (10)	12.28 (14)	0.0 (0)	0.0 (0)
Purchase of Sheep	0.0 (0)	2.63 (3)	0.0 (0)	0.0 (0)
Purchase of Tractor	0.85 (1)	0.0 (0)	0.0 (0)	0.0 (0)
Agrilcultural implements	0.0 (0)	0.0 (0)	25.23 (28)	37.89 (36)
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field survey

Note: Figures in the parenthesis indicate the actual number of households

In A.P, the items pledged as mortgage by NPM and non-NPM sampled households for obtaining the loans include predominantly *patta* pass books and gold ornaments. This might be due to the fact that a majority of them had accessed loans from commercial banks which require land documents (patta pass books) for obtaining loans. Whereas in Maharashtra majority of NPM farmers mortgaged Patta pass books and non-NPM farmers gave promissory notes as surety. Similarly, in Maharashtra loan from other sources was also high. These sources predominantly include money lenders who provide loans to sample farmers against the surety of gold ornaments. Nearly 17.95 per cent of NPM households in A.P had obtained loans only on the basis by using good will and trustworthiness. A majority of both NPM and non-NPM farmers in A.P are found to have taken loans at an interest rate less than one percent per month. But in Maharashtra a majority of the sample farmers had taken loans at an interest rate ranging between 1-2 percent per month. Unfortunately, still more than 35 percent of both the NPM and non-NPM farmers are found to have obtained loans at an interest rate of 3-4 percent/month. Under these circumstances, institutions such as SHGs and non-banking financial companies have to play a major role in meeting the credit needs of farmers (Vyas, 2000). Credit will have to be provided by financing institutions in a big way to dryland agriculture (Rao, 1991).

Table 3.21 informs that the basic purpose behind loan taking by NPM and non-NPM households in both states is for crop production inputs. The loans were taken mainly for buying agricultural inputs, including those related to soil fertility management like FYM, chemical fertilisers and neem cakes, followed by for purposes such as house construction (NPM households) and performing marriages (non-NPM) in A.P and for repair/purchase of agricultural implements in Maharashtra (both NPM and non-NPM households). As farmers in Maharashtra generally take two crops in a year and that too commercial crops such as cotton, soyabean etc., they use different kinds of implements for regular land preparation. It is interesting to note that farmers in A.P have taken loans for diverse purposes as compared to the sample farmers in Maharashtra.

3.2.13 General Family Expenses

The study assessed the general family expenses so as to get an idea of other expenses linked to the sample households which have a bearing on the net family incomes of the sample households. At times, a higher expenditure on health and education can push the farm families into a debt trap. Table 3.22 indicates that, among the general family expenses, food occupies a major portion across both NPM and non-NPM households in Andhra pradesh followed by education. Anantapur being a dryland region is completely dependent upon rainfed agriculture. The farmers in the study villages follow only a

ground nut based cropping system during kharif. Any reduction in crop yield due to pests, unfavourable climatic conditions could result in increased expenses on food. Moreover, other sources of food which cannot be grown in the region have to be procured from the market regularly. In the conext of Maharashtra, a major expenditure incurred by both NPM and non-NPM households relates to education, followed by food which is just a reverse of the scenario prevailing in A.P. With the growing importance of education, sample households tend to admit their children to private schools which charge exhorbitant fees in comparison with government schools. The reason for expenses on food standing second is that some of farmers with black soils could take up both kharif and Rabi crops even under rainfed conditions. Similarly, farmers in Maharashtra have a better access to irrigation as compared to A.P (see table 3.8) which helps them cultivate food and other vegetable crops.

Table 3.22: Distribution of households according to their average expenditure in Rs.per annum in Andhra Pradesh and Maharashtra during 2011-12 (percent)

(N=240)

Particulars	**Andhra pradesh**		**Maharashtra**	
	NPM	**Non-NPM**	**NPM**	**Non-NPM**
Food	32.69	42.47	19.0	21.35
	(18013)	(18856)	(14903)	(20442)
Education	17.67	19.28	23.60	22.72
	(9735)	(8562)	(18500)	(21757)
Health	16.62	9.38	13.81	12.67
	(9157)	(4163)	(10825)	(12133)
Recreation	5.83	7.53	14.47	14.35
	(3214)	(3343)	(11345)	(13738)
Clothing	15.19	10.36	12.07	12.94
	(8374)	(4599)	(9467)	(12395)
Others	12.0	10.98	17.04	15.97
	(6610)	(4876)	(13361)	(15288)
Total expenses	**100,0**	**100,0**	**100,0**	**100,0**
	(55103)	**(44399)**	**(78401)**	**(95753)**

Source: Field Survey.

Note: Figures in parentheses indicate the average amount spent by the sample households.

The sample households in Maharashtra account for more than 14 percent of spending on recreation, as against those in Andhra pradesh (lesser than 8 percent). This is due to the cultural history of the study villages, or celebration of local fairs in nearby villages.

Table 3.23: Average agricultural expenses incurred by the sampled households in A,P for the years 2009-10, 2010-2011 and 2011-12 year in A.P

Particulars	NPM			Non-NPM		
	Total input cost	Own input cost	External nput cost	Total input cost	Own input cost	External input cost
Year 2009-10						
Bullock power	1733	1258	475	1753	1481	272
Seed	1935	1745	190	2018	1628	390
Organic manure	932	787	145	525	349	176
Chemical fertilizer	0.0	0.0	0.0	709	0.0	709
Pest management expenses	277	63	214	427	64	363
Tractor power	850	288	562	1375	450	925
Irrigation expenses	825	658	167	1050	767	283
Human labour	3859	809	3050	5897	851	5046
Agricultural implements	1870	925	945	1457	500	957
Other expenses	1321	791	530	1161	968	193
Average Total	13602	7324	6278	16372	7058	9314
Year 2010-11						
Bullock power	1321	1288	33	1354	1068	286
Seed	2085	1864	221	1938	1720	218
Organic manure	1150	1060	90	2420	1538	882
Chemical fertilizer	0.0	0.0	0.0	1024	0.0	1024
Pest management expenses	240	57	183	385	46	339
Tractor power	508	208	300	691	315	376
Irrigation expenses	720	525	195	950	678	272
Human labour	3500	700	2800	3110	890	2220
Agricultural implements	1588	1536	52	1150	500	650
Other expenses	200	0.0	200	200	0.0	200
Average Total	11312	7238	4074	13222	6755	6467
Year 2011-12						
Bullock power	2166	2079	87	2254	1926	328
Seed	2470	2185	285	2584	2166	418
Organic manure	1691	1504	637	2090	1300	790
Chemical fertilizer	567	200	367	1442	0.0	1442
Pest management expenses	263	71	192	527	62	465
Tractor power	1900	450	1450	1620	938	682
Irrigation expenses	1400	1067	333	1550	1250	300
Human labour	3600	800	2800	3710	890	2820
Agricultural implements	1909	1531	370	4167	1500	2667
Other expenses	1230	1012	218	1797	1325	472
Average Total	17196	10899	6739	21741	11357	10384

Source: Field Survey.

3.2.14 Per acre expenditure and income

An attempt has been made to arrive at the per acre average income of the total sample households for the years 2009-10, 2010-11 and 2011-12 in the states of Andhra Pradesh and Maharashtra. This is done by subtracting the cost of crop production from the gross income of agricultural produce. It could be seen from table 3.23 that the cost of cultivation expenses incurred by NPM households was lesser than non-NPM households for all three years i.e 2009-10, 2010-11 and 2011-12. The percentage of internal inputs used is more among NPM households than non-NPM households. Own inputs are those internal inputs which farmers have a ready access to without spending money on them. Similarly, NPM households are found spending more money on organic manures as compared to non-NPM households. This is due to the fact that, they do not use any chemical fertilizers and hence, are able to supplement the nutrients through organic materials and also cultural practices like deep summer ploughing and mixed cropping as revealed by farmers in the focused group discussions. More importantly NPM households are found to have spent less on pest management as compared to non-NPM households for all the three years. The percentage of amount spent on external inputs is lesser in the case of NPM households as compared to non-NPM households. The amount spent on irrigation, tractor power and human labour amounts to more in the case of non-NPM households as against to NPM households. The expenses incurred on seed are nearly the same in respect of both the categories of sample households.

It could be seen from table 3.24 that in Maharashtra too the agricultural expenses incurred by non-NPM households is substantial for 2009-10, 2010-11 and 2011-12 as compared to NPM households. This is mainly due to increased expenses with respect to chemical fertilizers, pest management and irrigation. Similarly, the expenditure on cultivation is slightly lesser for the year 2010-11. This is due to lesser expenses on irrigation, human labour and agricultural implements. Contrary to A.P., the percentage of amount spent on external inputs is quite high as compared to internal inputs in the case of both NPM and non-NPM households.

Table 3.25 clearly indicates that, in Andhra Pradesh, for all the three years, a couple of thousands income earned by NPM households per acre amounts to a couple of thousand rupees as against a couple of thousand rupees less by the non-NPM households. This means that the adoption of NPM methods is economically viable as compared to conventional agriculture followed by non-NPM households. Although grain yield is almost similar for NPM and non-NPM households, the income from fodder, crop by-products and uncultivated foods[5] is higher for NPM households than for non-NPM

[5] Those food plants that grow on their own naturally in the agricultural fields without sowing is called uncultivated food or plants. These plants are consumed by villagers due to their rich nutrient content and medicinal properties.

Table 3.24: Average agricultural expenses incurred by the sampled households for 2009-10, 2010-2011 and 2011-12 in Maharashtra

Particulars	NPM			Non-NPM		
	Total input cost	Own input cost	External input cost	Total input cost	Own input cost	External input cost
Year 2009-10						
Bullock power	1285.83	453.62	832.21	1277.5	495.56	781.94
Seed	1763.67	495.97	1267.70	1900.42	292.05	1608.37
Organic manure	2539.08	1146.15	1392.93	2050.94	1566.67	484.27
Chemical fertilizer	0.0	0.0	0.0	2249.17	0.0	2249.17
Pest management expenses	325.0	200.0	125.0	875.0	125.0	750.0
Tractor power	1269.23	179.07	1090.16	1297.03	1098.33	828.70
Irrigation expenses	1031.73	242.31	789.42	4334.54	795.37	3539.17
Human labour	3562.08	1281.94	2280.14	3944.80	1158.97	2785.83
Agricultural implements	1217.27	229.31	988.0	1142.99	462.50	680.49
Other expenses	0.0	0.0	0.0	0.0	0.0	0.0
Average total	12993.89	4228.37	8765.56	19072.39	5994.45	13707.94
Year 2010-11						
Bullock power	1107.69	352.86	870.19	1141.11	473.44	804.44
Seed	1313.46	433.33	1380.49	1535.56	300.00	1522.22
Organic manure	1341.18	739.9	601.28	1140.00	720.00	525.00
Chemical fertilizer	0.00	0.00	0.00	1241.11	1241.11	0.00
Pest management expenses	290.0	185.0	105.0	790.0	130.00	660.00
Tractor power	915.38	211.11	842.31	938.89	0.00	938.89
Irrigation expenses	1213.46	568.29	780.39	781.11	0.00	781.11
Human labour	1863.00	514.52	1513.73	1891.11	794.74	1555.56
Agricultural implements	221.43	161.54	71.43	387.88	100.00	384.85
Other expenses	0.0	0.0	0.0	0.0	0.0	0.0
Average total	8265.60	3166.55	6164.82	9846.77	3759.29	7172.07
Year 2011-12						
Bullock power	1079.17	396.92	864.17	1262.50	485.14	963.33
Seed	1891.00	437.35	1717.30	1932.08	300.00	1827.08
Organic manure	2243.10	1251.28	991.28	1358.00	936.84	421.16
Chemical fertilizer	0.0	0.0	0.0	2354.85	229.41	2322.35
Pest management expenses	350.0	226.0	124.0	865.00	50.00	815.0
Tractor power	1032.20	223.81	960.68	1112.08	316.67	1104.17
Irrigation expenses	1055.32	308.82	831.91	800.98	200.00	789.22
Human labour	3058.40	969.90	2270.59	3693.33	1296.92	2990.83
Agricultural implements	967.07	163.00	819.74	751.79	317.86	698.81
Other expenses	0.0	0.0	0.0	0.0	0.0	0.0
Average total	11676.26	3977.08	8579.67	14130.61	4132.84	11931.95

Source: Field Survey.

Table 3.25: Per acre Average income (in rupees) from agriculture during 2009 to 2012 in A.P. and Maharashtra

Particulars	Andhra pradesh		Maharashtra	
	NPM	Non-NPM	NPM	Non-NPM
2009-10				
Grain yield value in Rupees	9091	8009	14423	14738
Fodder yield/stacks/bundles	1676	1559	1043	984
Crop byproducts	150	150	500	0.00
Uncultivated foods	145	200	141	187
Total agricultural income	11062	9918	16107	15909
2010-11				
Grain yield value in Rupees	14964	11305	7886	9087
Fodder yield/stacks/bundles	2189	2041	774	1351
Crop byproducts	100	1050	0.0	0.0
Uncultivated foods	125	96	149	160
Total agricultural income	17378	14492	8809	10598
2011-12				
Grain yield value in Rupees	12635	11231	22125	39347
Fodder yield/stacks/bundles	2964	3270	1954	2336
Crop byproducts	50	300	300	0.0
Uncultivated foods	380	10	272	170
Total agricultural income	16029	14811	24651	41853

Source: Field Survey.

households. This could be due to a wider adoption of inter/mixed cropping system by the organic farmers resulting in higher availability of fodder, crop by-products and uncultivated foods. Fodder is a precious resource in arid areas of anantapur, especially during summer. Similarly, NPM households spend a lesser amount on pest management and soil fertility enhancement as compared to non-NPM households. If we exclude the expenses of internal inputs the income is higher for both NPM and non-NPM households. In respect of Maharashtra state, for the year 2009-10, the expenditure incurred by NPM and non-NPM households is slightly higher than the income earned from agriculture. This is mainly due to poor yield levels. Whereas, for 2010-11 and 2011-12, as compared to A.P, in Maharashtra, the income earned from agriculture is significantly higher than the expenditure incurred by both NPM and non-NPM households. One of the reasons could be the cultivation of cash crops such as cotton and soya bean (see tables 3.15 and 3.16) which fetch higher incomes despite higher cultivation expenses. FGDs during the

field study reveal that, despite some losses in respect of cotton and wheat, other crops fetched farmers in Maharashtra higher incomes than their counter parts in Andhra pradesh (see table 3.26).

Table3.26: Crop wise Per acre average cost of cultivation and income in rupees for major crops in study villages of Maharashtra (includes both NPM or Non-NPM households).

Particulars	Cotton	Wheat	Soya Bean	Bengal gram	Redgram
Land Preparation (by Tractor)	1500	1500	1500	1500	1500
FYM	8000	4000	4000	This crop is sown in soya field and hence no application again.	-
Seed	2000	2200	1600-1700	1800	120
Chemical fertilizers	3215	1680	1315	950	-
Pesticides	2000-2500	No pesticide is sprayed.	-	-	-
Weeding/Weedicide	3000	600	-	1500	2000
Irrigation	5000	-	-	1500	-
Labour wages (Includes family labour)	2500	1500	1700	1100	1000
Total expenditure	27215	10880	10115	8350	4620
Yield in Quintal	4	7-8	6-7	5	3
Rate/Quintal (Rs.)	4000	1200	3000	3000	3500
Income obtained (Rs.)	16000	9600	21000	15000	10500
Net Income (Rs.) (**Total Income- Total expenditure**)	**-11215**	**-1280**	**10885**	**6650**	5880

Source: Focused group discussions

3.2.15 Access to Information

The various pest management practices require different types of knowledge, a wide range of skills, and access to a variety of technologies. Innovations in pest management come from multiple sources. Some come directly from extension advice, while others from contacts elsewhere i.e from other farmers, relatives or from their personal experiences.

Farmers in certain cases, adopt such innovations to their own settings, resulting a wide range of pest management practices and the adoption of technologies that are seen on the ground. The study tried to explore the major sources of information for the last three years. The analysis is presented based on the households responses to questions related to different aspects of pest management. Different sources of information regarding the key aspects which have a bearing on pest management in the study villages are given in tables 3.27 and 3.28.

It is clear from table 3.27 that in Andhra Pradesh state, farmers obtain information related to key aspects of pest management such as weather, diagnosis of pest/diseases, knowledge of natural enemies, knowledge of bio-pesticdes/pesticides and sprayers, from diverse sources such as radio, TV, Newspapers, elders/neighbours, NGOs, women groups, private companies and local fertiliser and pesticide dealers.. Table 3.27 also reveals that for weather related information, T.V is a major source of information for a majority of the NPM and non-NPM households followed by radio. Whereas, a majority of both NPM and non-NPM households depended on fellow farmers for the information related to pests and disease diagnosis followed by extension officers. Similarly, with respect to knowledge related to natural enemies, extension officers of the agricultural department happens to be a major source of information for a majority of NPM and non-NPM households followed by magazines covering agriculture related issues. Interestingly, for information regarding bio-pesticides, NGOs are a major source of information for NPM households followed by extension officers. But when it comes to non-NPM households, for pesticide related information, extension officers are a major source of information for a majority of the households followed by fertilizer/pesticide dealers.

In general, in the state of Andhra pradesh, for soil fertility, the most important source of information for farmers are their own elders in their community who possess an abundant knowledge related to soil fertility management (Reddy, 2011). Even the present study reveals that with respect to diagnosis of pest/diseases both NPM and non-NPM households tend to depend more on fellow farmers. However, regarding knowledge about natural enemies, they depend on agricultural officers and Agricultural Extension Officers of the State Department of Agriculture. It is seen that private fertiliser dealers play an important role in farmers' choice of pesticide. These dealers provide pesticides on credit basis thereby influencing farmers' practices (see box.1). Once the crop is harvested, farmers sell their produce to the same dealer at a lesser price, as dictated by him. In this way, the dealers stand to benefit both ways.

Box 1: Pesticide Dealers Influence Farmers' Input Management

In spite of many efforts on the part of government as well as other organizations, even today, a large number of farmers continue to depend upon private fertiliser and pesticide dealers for information related to their day-to-day farm activities, particularly, their input management. A large number of dealers are unaware of the basics of agriculture and are mostly driven by commercial interests. Laws enacted to supervise the manufacturing of agricultural inputs such as nutrients and pesticides are weak. Hence, many people who want to make money by hook or crook enter into this business. Their only motto is profit making and hence, least bothered about the basic principles of agriculture and ecology. Such companies tend to push their products through different ways and means, particularly by floating attractive schemes at dealers' level. The dealers want to sell or promote only those products which allow them huge profit margins, irrespective of the real need of the farmers. Often, in spite of being very much aware of the right product for their crops, farmers are not in a position to invest money and exercise their choice of input, and hence are dependent on the manipulative dealers for accessing inputs on credit basis.

The dealers give farmers a combination of products to make higher profits, thereby increasing unnecessary chemical loads on plants which, inturn, lead to environmental pollution, ecological imbalance, pest resistance, health (carcinogenic) problems and finally, push farmers into a debt trap. Since farmers procure these fertiliser and pesticide products from private dealers, by the end of the season, there would be a large amount of money due to the dealer. Hence, quite often, they are forced to sell off their produce to the very same dealers at a much cheaper rate than the existing market price. It can be said that thousands of crores of rupees are being pumped into the agri-business, which is not properly regulated or protected by strong laws. Consequently, it is the farming community that finds itself in a precarious condition both economically and health wise. Similarly, the natural resources in the villages are exposed to ecological degradation, leading to several environmental problems like climate change.

Source: Focused group discussions in A.P and Maharashtra.

Table 3.27: Distribution of the sample households according to their sources of key pest management information in Andhra Pradesh during 2009-2012 (percent)

Sources of information	Weather		Diagnosis of pest/disease		Knowledge of natural Enemies		Knowledge of Bio-pesticides/ pesticides		Knowledge of Sprayer usage	
	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
Radio	14.56	9.90	0.92	0.0	0.0	0.0	0.0	4.62	0.0	0.0
TV	55.33	89.10	2.75	1.98	7.55	0.0	0.0	0.0	12.76	0.0
News papers	3.88	0.0	1.83	0.0	1.89	0.0	0.0	0.93	0.0	0.0
Magazines	0.0	0.0	4.58	0.0	22.64	35.05	1.09	0.0	19.14	38.68
Fellow farmers	0.0	0.0	47.71	48.51	0.94	0.0	8.79	0.0	8.51	4.35
Relatives	0.0	0.0	2.75	0.0	8.49	1.03	6.59	12.96	0.0	18.84
Extension Officers	0.0	1,0	21.10	49.50	39.62	60.82	43.13	37.96	10.63	4.35
NGOs	0.0	0.0	0.0	0.0	2.83	3.09	56.04	8.33	2.12	0.0
Fertilizer /pesticide Dealers	0.0	0.0	0.0	0.0	0.0	0.0	1.09	32.40	10.63	5.80
Water shed committees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.94
SHGs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.91	0.0
Private institutions	0.0	0.0	0.92	0.0	0.0	0.0	2.20	0.0	4.25	0.0
Others	26.21	0.0	17.43	0.0	16.03	0.0	0.0	2.78	0.0	13.04
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Field Survey.

Table3.28: Distribution of the Sampled households according to their sources of pest management information in Maharashtra during 2009-12

(Percent)

Sources of information	Weather		Diagnosis of pest/disease		Knowledge of natural Enemies		Knowledge of Bio-pesticides/ pesticides		Knowledge of Sprayer usage	
	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
Radio	43.70	47.17	0.0	0.0	1.70	9.80	2.68	0.88	0.98	1.80
TV	41.18	33.96	3.68	0.0	4.27	7.84	4.46	2.63	1.96	3.00
News papers	7.56	11.32	1.47	0.0	0.85	2.94	0.89	0.88	0.0	0.0
Magazines	0.0	-	4.41	0.0	12.82	16.67	8.92	6.14	3.92	4.79
Neighbours	1.68	4.71	23.53	32.08	9.40	35.29	10.71	21.93	34.31	20.95
Extension agents	1.68	2.83	8.82	16.03	19.65	13.72	7.14	13.15	44.11	28.74
NGOs	0.0	0.0	35.29	3.77	45.30	12.74	44.64	4.38	0.0	0.0
Local fertilizer & pesticide dealers	0.0	0.0	5.15	31.13	1.70	0.0	5.35	32.45	9.80	36.52
Water shed Committees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Women's groups	0.0	0.0	11.03	1.89	2.56	0.98	11.60	0.0	1.96	0.0
Other local institutes	0.0	0.0	0.0	0.0	0.85	0.0	1.79	0.88	0.0	0.0
Private companies	0.0	0.0	2.20	11.32	0.0	0.0	1.79	16.67	1.96	3.00
Others	4.20	0.0	4.41	3.77	0.85	0.0	0.0	0.0	0.98	1.20
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey.

It is clear from table 3.28 that in Maharashtra state, contrary to A.P., radio is the key source of weather information followed by television for a majority of the NPM as well as non-NPM households. When it comes to information regarding diagnosis of pests and diseases, unlike Andhra Pradesh, a majority of NPM households are dependent on the field staff of non-governmental organizations (NGOs) followed by neighbouring farmers. Whereas, a majority of non-NPM households are dependent on neighbours followed by local fertilizer and pesticide dealers. The, main source of knowledge about natural enemies for majority NPM households is NGOs. Noticeably, for non-NPM households, the major source is neighbouring farmers. FGDs with non-NPM households, during the field study that they try to learn more from NPM households as they receive knowledge through NGOs. Similarly, NGOs have been the predominant source of information for a majority of the NPM households, while for the non-NPM households, the major source is the local fertilizer and pesticide dealers.

In general, a majority of the sample farmers in Maharashtra are not so much dependent on the Agriculture Department for information related to pest management, except for knowledge on sprayers. Similarly, in A.P., farmers are mostly dependent on extension officers for the information related to natural enemies of pests. However, there is a lot of scope for the Agriculture Department to provide innovative technologies related to pest management such as pheromone traps, egg parasites, bio-pesticides and other non-pesticidal management methods. Hence, efforts must be made in this direction through the vast machinery of the agriculture extension system present in the States of Andhra Pradesh and Maharashtra.

3.2.16 Pesticide spraying and associated Health problems

The data provided by only those households regarding the impacts of pesticides usage on human health was considered for our analysis with respect to disease symptoms, affected persons in the family, duration of suffering and source of treatment. This data was collected based on the households experience for the period between 2002 - 2012. Hence, the experiences of those NPM households following conventional methods of pest management before shifting to NPM methods were taken into consideration. In Andhra Pradesh state, the major health symptoms as reported by NPM households due to pesticide use/spray include excessive sweating, fatigue and itching in eyes(see table 3.29), Whereas in the case of non-NPM households, fatigue(30.95%) was the major symptom followed by excessive sweating. Affected persons happened to be mostly men under both the categories of households. Thirty six percent of the NPM households have reported on week as the duration of suffering, whereas for 45.24% of the non-NPM households have reported 15 days. A majority of both the NPM and non-NPM households are dependent on registered medical practitioners (RMP) at the nearest town followed by private hospitals at the nearest town.

Table 3.29: Details of health problems experienced by sampled households during the years 2002 to 2012 in Andhra Pradesh due to pesticide sprays and pest/disease management

(percent)

Particulars	NPM (N=25)	Non-NPM (N=42)
Type of disease symptom		
Excessive sweating	20.0(5)	19.05(8)
Blurred Vision	0.0(0)	7.14(3)
Shortness of breath/cough	8.0(2)	11.90(5)
Nausea	8.0(2)	0.0(0)
Headache	8.0(2)	11.90(5)
Stomach pain cramps/diarrhea	4.0(1)	4.76(2)
Insomnia	0.0(0)	2.38(1)
Burning/stinging/itching eyes	20.0(5)	0.0(0)
Fatigue	20.0(5)	30.95(13)
Dizziness	12.0(3)	11.90(5)
Total	100.0(25)	100.0(42)
Affected persons in family		
Men	96.0(24)	85.71(36)
Woman	4.0(1)	11.90(5)
Hired Workers	0.0 (0)	2.38(1)
Total	100.0(25)	100.0(42)
Duration of suffering		
Less than 3 Days	28.0(7)	7.14(3)
One week	36.0(9)	7.14(3)
15 Days	12.0(3)	45.24(19)
One Month	16.0(4)	16.67(7)
6 Months	4.0(1)	11.90(5)
Above 1 Year	4.0(1)	11.90(5)
Total	100.0(25)	100.0(42)
Source of treatment		
Within Village	20.0 (5)	7.14 (3)
RMP at Nearest town	44.0 (11)	59.52 (25)
Private hospital at nearest town	28.0 (7)	21.42 (9)
Govt. hospital at Nearest town	8.0 (2)	7.14 (3)
District Govt Hospital	0.0 (0)	2.38 (1)
Others	0.0 (0)	2.38 (1)
Total	**100.0(25)**	**100.0(42)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

Table 3.30: Details of Health problems experienced by the sampled households during the years 2002-2012 in Maharashtra due to pesticide sprays and pest/disease management

Particulars	NPM (N=31)	Non-NPM(N=49)
Type of disease symptom		
Excessive sweating	0.0(0)	6.12(3)
Burning/stinging/itching eyes	6.45(2)	18.37(9)
Dizziness	0.0(0)	4.08(2)
Skin redness	3.23(1)	0.0(0)
Skin scaling	0.0(0)	2.04(1)
Weakness/Muscle cramps	64.52(20)	51.02(25)
Blurred vision	0.0(0)	2.04(1)
Shortness of breath	3.23(1)	0.0(0)
Excessive salivation	0.0(0)	4.08(2)
Head ache	9.68(3)	4.08(2)
Hand tremor	0.0(0)	6.12(3)
Insomnia	3.23(1)	0.0(0)
Narrowed pupils	3.23(1)	2.04(1)
Others	6.45(2)	0.0(0)
Total	100.0(31)	100.0(49)
Affected persons in family		
Men	54.84(17)	48.98(24)
Women	29.03(9)	36.73(18)
Hired workers	16.13(5)	14.28(7)
Total	100.0(31)	100.0(49)
Duration of suffering		
Less than3 Days	0.0(0)	16.33(8)
One Week	58.06(18)	22.45(11)
15 Days	3.23(1)	8.16(4)
One Month	19.35(6)	14.28(7)
Six Months	12.90(4)	2.04(1)
Up to one Year	3.22(1)	18.37(9)
More than Year	3.22(1)	18.37(9)
Total	100.0(31)	100.0(49)
Source of treatment		
With in Village	3.22(1)	0.0(0)
RMP at Nearest town	3.22(1)	4.08(2)
Private hospital at nearest town	25.80 (8)	51.02(25)
Govt. hospital at Nearest town	58.06(18)	30.61(15)
District Govt Hospital	9.68(3)	14.28(7)
Others	0.0(0)	0.0(0)
Total	**100.0(31)**	**100.0(49)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

Similarly, table 3.30 reveals that in Maharashtra, the weakness/muscle cramps have been reported as the major symptoms by both NPM and non-NPM households due to pesticide spraying with a majority of the persons affected in the sample households being men. However, unlike Andhra Pradesh state, cotton being one of the predominant crops in Maharashtra involving numerous number of pesticidal sprays a large percentage of women and small percentage of hired workers are also reported to have suffered from the above mentioned symptoms among both NPM and non-NPM households with the duration of suffering lasting for a week for a majority of NPM (58.06%) and non-NPM households (22.45%). It is interesting to note that 19.34 percent of the affected NPM households and 38.78 percent of non-NPM households are reported to have suffered for six months. It is good to note from table 3.30 that in Maharashtra, a majority of NPM households (58.06%) are reported to have taken treatment from government hospitals in the nearest town, while 51.02% of the non-NPM households from private hospitals in the nearest town. It is important to note that a considerable number of NPM and non-NPM households trust government hospitals for treatment in Maharashtra. This could be due to a better attention and quality service provided in these hospitals.

The study tried to understand the awareness levels of non-NPM households regarding pesticide use and handling. Table 3.31 reveals that in Maharashtra 32.50 percent of the respondents do not read the labels on pesticide bottles, while 33.33 percent do not follow any instructions given on the labels. The situation is much poorer regarding this aspect in Andhra pradesh. However, it is heartening to note that 98.33 percent of the households in Maharashtra are aware of the toxic nature of pesticides being used, but only 70.83 percent have an idea of toxicity levels of pesticides being used. Whereas in A.P., only 62.50 percent the HHs are aware that pesticides are toxic in nature and 59.17 percent are aware of toxicity levels of pesticides they use in farming. A majority households in Maharashtra change clothes after spraying (78.33%), and do not keep pesticide bottles along with food (90.83%) and also do not store food items in pesticide bottles after use(83.33%). The situation is much better regarding these aspects in A.P, as especially 65 percent of the households change clothes after spraying pesticide. A fair percentage of people in Maharashtra (29.17%) and A.P (25.83%) eat inbetween, while spraying of pesticides is on. This poses a great risk to their health while warranting the attention of extension workers for creating more awareness regarding this. It has been reported that, in Maharashtra (25.0 percent) and A.P (23.33%), a significant number of households wash pesticide bottles in a canal or near by water body after spraying. This has negative implications not only for the aquatic life, but also the livestock which are likely to quench their thurst using such water bodies. Wind speed and direction plays a crucial role in pesticide spraying. In Maharashtra, 33.33 percent of households do assess the wind

Table 3.31: Awareness level regarding pesticide use and handling on the part of Non-NPM households in Maharashtra and Andhra Pradesh during the year 2012 (Percent)

(N=120)

Particulars	Maharashtra			Andhra pradesh		
	Yes	No	Total	Yes	No	Total
Do you read the labels on package ?	32.50	67.50	100.00	20.83	79.17	100.00
If you cannot read, do you seek help from others ?	49.17	50.83	100.00	31.67	68.33	100.00
Do you follow the instructions given on labels?	33.33	66.67	100.00	23.33	76.67	100.00
Are you aware of toxicity ?	98.33	1.67	100.00	62.50	37.50	100.00
Are you able to understand the toxicity level ?	70.83	29.17	100.00	59.17	40.83	100.00
Do you eat while spraying ?	29.17	70.83	100.00	25.83	74.17	100.00
Do you take bath immediately after spraying ?	79.17	20.83	100.00	71.67	28.33	100.00
Do you change clothes after spraying?	21.67	78.33	100.00	65.0	35.0	100.00
Do you keep pesticide bottle along with food?	9.17	90.83	100.00	20.0	80.0	100.00
Do you store food items in pesticide bottle after use?	16.67	83.33	100.00	10.0	90.0	100.00
Do you wash the bottle in canal etc.?	25.0	75.0	100.00	23.33	76.67	100.00
Do you observe the wind direction before spraying ?	33.33	66.67	100.00	78.33	21.67	100.00
Do you spray when it is windy?	84.17	15.83	100.00	20.83	79.17	100.00

Source: Field Survey.

direction before spraying. Unfortunately, 84.17 percent of the households do take up pesticide spraying in their fields despite windy conditions. This not only results in the wastage of pesticide being used, but also affects the person spraying. In contrast to this, the situation is much better in A.P with 78.33 per cent of the households determining the wind direction before spraying while 79.17 per cent of the households do not take up pesticide spraying during windy conditions. The department of agriculture and extension workers need to guide farmers in this aspect.

3.3 Conclusion

The predominant crops grown in Andhra pradesh are groundnut and redgram, whereas it is cotton, soyabean and redgram that are grown in Maharashtra. Intercropping and mixed cropping are seen among a majority of the sample plots. The population of cows and bullocks is going down. Livestock rearing is becoming slightly difficult due to problems involved in accessing fodder, drinking water and easy labour. Farmers' management of soil nutrients depends on a range of socio-economic factors. Access to bio-pesticides and livestock in gerenal and cows, labour and credit in particular, is of importance in explaining how farmers manage their crop pests effectively.

NPM farmers are keen on using a range of non-pesticidal management practices based on locally available resources. There is a need for providing credit to farmers for adopting their choice of pest management method. Otherwise, a greater dependence on local moneylenders, pesticide dealers and traders increases their exploitation in the form of higher interest rates, the use of only the available pesticides and credit-tied sale.

Integrated pest Management (IPM) practices, being advocated in semi-arid areas are often not based on the indigenous technological knowledge of farmers and do not take into account the basic needs of farm size, farm family, social groups and their perceptions. In this respect, technical interventions in pest management should be carefully targeted to suit the different requirements of small, medium and large farmers. Activities should aim at increasing the use of locally available resources that are environment-friendly and also improving population of natural enemies of crop pests.

Chapter 4
Economics of Pest Management : NPM vis-à-vis Non-NPM methods

4.1 Introduction

The pest management constitutes an important component of crop cultivation. To reduce the potential damage due to the presence of insect pests farmers have been employing cultural, mechanical, chemical and biological control methods. The quantum of pesticide applied influences the over all cost of cultivation and there by net returns. NPM farmers have been using all the above mentioned methods excepting chemical pesticides. Instead, they tend to use biopesticides to control the pest menace. Practices adopted by NPM farmers help increase the population of natural enemies of crop pests that play a prominent role in pest management. It has been observed that cash return being the strongest motivating factor in the adoption of a given cropping pattern and livelihood strategies, 'effective' pest management must be a 'cost-effective' option (Sinzogan, 2004). A reduced pesticide application results in lower production costs and increased returns to household labour for the producers. Similar, has been the finding of Chong (2005) who observes that perceived economic benefits are subject anticipated cost savings resulting from a reduced use of pesticides. This chapter presents the major pests seen among crops grown by farmers in A.P. and Maharashtra along with their detailed control measures adopted by NPM and non-NPM farmers in that it highlights the pest-wise inputs used by farmers. It also clearly brings out the economics of pest management among NPM and non-NPM households for the years 2009-10, 2010-11 and 2011-12.

4.2 Pest incidence in Andhra pradesh

Groundnut is the only major crop grown in Anantapur district of Andhra Pradesh and is predominantly intercropped with Redgram (see table 3.15). It could be seen from table 4.1 that, NPM sample households have witnessed a low less pest incidence for the years 2011-12 and 2010-11 as compared to non-NPM sample households. The incidence of aphid infestation is either constant or has increased since 2009-10. However, its incidence is less among the fields of NPM households. Helicoverpa larva is the most important pest affecting groundnut by way of causing leaf folding symptoms (see box.2). NPM households have reported a lesser incidence of this pest for the years 2010-11 and 2011-12. Bud necrosis disease which was a major threat to crop yields a few years back, seems to have decreased both among NPM and non-NPM farms. The adoption of interropping/

Table 4.1: Number of Sample households reporting the incidence of various pests and diseases during 2011-12, 2010-11 and 2009-10 in ground nut crop of A.P

(N=240)

Pest/Disease	2011-12		2010-11		2009-10	
	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
No pest /disease incidence	42.50 (51)	29.17 (35)	35.84 (43)	25.00 (30)	30.83 (37)	29.16 (35)
Aphids (Penubanka)	8.33 (10)	21.67 (26)	10.84 (13)	12.50 (15)	8.33 (10)	9.17 (11)
Gaju purugu	0.83 (1)	0.0 (0)	0.83 (1)	0.0 (0)	0.83 (1)	0.0 (0)
Red Hairy Caterpillar (Erra Gongadipurugu)	0.83 (1)	0.0 (0)	5.0 (6)	0.83 (1)	5.83 (7)	0.83 (1)
Black Hairy Caterpillar (Nall gongadi purugu)	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)	0.83 (1)	0.0 (0)
Nallacheedu	1.66 (2)	1.67 (2)	5,84 (7)	5.0 (6)	0.0 (0)	0.83 (1)
Heliothis (Paccha purugu)	37.50 (45)	41.66 (50)	38.33 (46)	40.83 (49)	45.83 (55)	38.33 (46)
Root grub (Veru purugu)	0.0 (0)	2.50 (3)	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)
Aggicheedu	7.5 (9)	1.67 (2)	0.83 (1)	8.33 (10)	1.67 (2)	6.67 (8)
Bud necrosis (Muvvakullu)	0.83 (1)	1.66 (2)	0.0 (0)	2.50 (3)	4.17 (5)	12.50 (15)
Rekkala purugu	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)	0.0 (0)	0.0 (0)
Booragalu	0.0 (0)	0.0 (0)	0.0 (0)	1.67 (2)	0.0 (0)	0.0 (0)
Kukkajaragi	0.0 (0)	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)	0.0 (0)
Leaf reddening	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)	0.0 (0)	0.0 (0)
Kemiti purugu	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	1.67 (2)
Spodoptera (Laddepurugu)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (())
Stem rot (Kandam kullu)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.83 (1)
Grand Total	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

mixed cropping by farmers in view of aggressive campaigns on the part of NGOs, agricultural department and agricultural scientists could be the reason for its lesser incidence. Similarly, we can notice that Red Hairy caterpillar which used to be a big menace earlier for farmers has declined drastically for all three years. Large scale bonafires resorted to by all the farmers of the region in their fields during summer are mainly responsible for a reduction in the population of this pest which earlier used to cause sever economic losses to farmers.

It can be seen from table 4.2 that farmers use diverse NPM methods for controlling different pests. For managing helicoverpa, the most important affecting ground nut, farmers use multiple methods.

Table 4.2: Non-pesticidal management (NPM) of pests in ground nut crop by farmers of study villages in Anantapur district of Andhra Pradesh.

Major pests in Ground nut	NPM method of Control
Aphids (*Penubanka*)	1. Five litres of cow urine + 2 kgs of cow dung in required quantities of water for spray. Because of this combination the population of lady bird beetles, the natural enemies of aphids, has increased.
Red Hairy caterpillar (*Erra gongadi purugu*)	1. Bonafires in fields during ploughing time 2. Chilli + Garlic extract (2-3 sprays).
Aaaku paccha purugu (*Aakumudutha*)	1. Pulling of Ber bush in crop rows so as to unfold the pest attacked leaves (Kampa eedchadam). 2. Chilli + Garlic extract spray - Two times 3. Vitex nigunda extract. 4. Dravajeevamrutham + neem + cow urine (ganju). 5. Panchapatra kashayam 6. Dashapatra Kashayam
Muthyalamma purugu (during 2008-09). But now this pest is not seen much.	Pheromone traps and Bird perches. Intercrops such as jowar and Bajra act as natural bird perches.
Root grub (*Veru purugu*) and Stem rot (*Kandam tholochu purugu*)	Castor paste is placed in pots in four corners of the field into which pests fall and die.
Aggi seela	Panchapolapatra kashayam spray for 2-3 times.

Source: Field survey and Focused group discussions.

Table 4.3: Non-Pesticidal Management options used by NPM households for controlling various pests and diseases in respect of major crops in the study villages of A.P for the years 2009-10, 2010-11 and 2011-12

Pest/Diseases	Option followed in 2011-12	Option followed in 2010-11	Option followed in 2009-10
Aphids (*Penubanka*)	Neem oil	Neem leaf extract	Neem oil and Neem seed Kernel extract
Helicoverpa (*Paccha purugu*)	Cow urine, *Panchapatra kashayam*.	Cow urine and Chiili garlic extract	*Jeevamrutham*, Cow urine, Neem Seed Kernel extract (NSKE), *Panchapatra Kashayam* and Chiiligarlic extract
Red Hairy caterpillar (*Gongadi Purugu*)	Cow urine and leaf extract	*Bramhastram*	Chiili-garlic extract
Nallacheedu	NeemNeem leaf extract	Neem oil	-
Black Hairy caterpillar (*Nalla gongadi purugu*)	-	Neem leaf extract, *Pancha gavya* and Cow urine	Neem leaf extract
Aggicheedu	*Panchagavya* and Cow urine	Neem leaf extract	Neem leaf extract
Bud necrosis (*Muvvakullu*)	*Dasha patra Kashayam* and *Kampa* (pulling of thorny bush between rows)	-	Chiili-garlic extract
Root grub (*Verupurugu*)	Placing pots of castor paste in four corners of the field.	Placing pots of castor paste four corners of field.	Surf powder and Cow urine
Tikka leaf spot (*Aakumaccha*)	-	-	*Panchapatra Kashayam*
Spodoptera (*Laddepurugu*)	-		*Panchapatra Kashayam*

Source: Field survey and Focused group discussions

Table 4.3 gives us an idea of NPM options used by a majority of the farmers for the years 2009-10 to 2011-12. It is clear from table 4.3 that different options are used by farmers in different years. The incidence of tikka leaf spot (*aakumaccha*) and spodoptera (*ladde purugu*) has not been reported for 2010-11 and 2011-12.

In addition to the above NPM options, farmers also use trap crops with Groundnut. Traps crop used by Anantapur farmers in Andhra pradesh include 1) Growing of cow pea as a trap crop to attract aphids (*penubanka*) for protecting ground nut from it; 2) castor is a grown as trap crop to attract pest spodoptera (*ladde purugu*); 3) Marigold is also sown as a trap crop with Groundnut to trap Heliothis larva. It also helps know the intensity of pest menace so that spraying measures are taken up accordingly. Farmers in India also tend to use diversionary hosts i.e sowing trap crops such as marigold with redgram and cotton so as to reduce the potential economic damage to main crops (Reddy, 1999 and 2010a).

Table 4.4 reveals that higher quantities of bio-pesticides mixed with cow urine, dung, kerosene etc.are used under NPM plots for controlling pest. Excepting neem oil, most of the bio-pesticides have to be used in higher quantities unlike pesticides, whereas, 1-2 litres of neem oil is enough. As can be seen from the same table, for the year 2009-10, a very high quantity of bio-pesticide has been used for controlling aphids. This is mainly due to the use of extracts made of neem leaves which are used in large quantities and for efficient results higher quantities of extract are used. On the other hand for the years 2010-11 and 2011-12 much lesser quantities i.e just over 14 litres of bio-pesticide has been used for controlling the same pest. From 2010 onwards farmers started using neem seed kernel extract as it is needed in lesser quantities, while non-NPM farmers use pesticides. Although the incidence of red hairy caterpillar pest has been on the decline, farmers continue to use some quantities of bio-pesticides so as to prevent it from spreading further.

For 2011-12, major pests reported by the sampled households in respect of ground nut include aphids and helicoverpa with the amount spent to control them amounting to more for non-NPM households as compared to NPM households. Infact, the amount spent to control aphids by non-NPM households is almost three times the amount spent by NPM households. Similarly, the amount spent on controlling helicoverpa is high for both NPM and non-NPM households (see table 4.4). Whereas, in the case of aphids, the amount spent is more in the case of non-NPM households as compared to NPM households for 2010-11 and 2011-12. However initially, for the year 2009-10, the amount spent on controlling aphids works out more for NPM households as compared to non-NPM households.

Table 4.4: Average quantity of pesticide/bio-pesticide used (along with cost) in respect of Groundnut for the years 2011-12, 2010-11 and 2009-10 in A.P

Pest/disease	Bio-pesticide (in litres)	Pesticide (in litres)	Cost (in rupees) per acre	
	NPM	Non-NPM	NPM	Non-NPM
Year 2011-12				
Aphids (*Penubanka*)	14.11	3.40	112.50	326.67
Gaju purugu	4.00	0.00	100.00	0.00
Red hairy caterpillar	8.00	0.00	80.00	0.00
Nalla cheedu	10.00	0.25	100.00	80.00
Helicoverpa (*Paccha purugu*)	5.84	3.18	283.64	301.58
Root grub (*Veeru purugu*)	0.00	3.67	0.00	683.33
Aggicheedu	3.63	2.50	156.25	200.00
Leaf miner (*Aakumudatha*)	4.50	1.63	149.80	218.13
Bud necrosis (*Muvva kullu*)	1.00	1.50	200.00	300.00
		Total	**1182.19**	**2109.71**
Year 2010-11				
Aphids (*Penubanka*)	14.27	1.46	272.31	282.50
Red hairy caterpillar	9.0	0.00	171.67	0.00
Nallacheedu	3.00	2.10	140.00	116.00
Nallagongali	5.00	0.00	0.00	0.00
Helicoverpa (*Paccha purugu*)	8.67	3.26	219.35	309.41
Rekkala purugu	24.00	0.00	200.00	0.00
Aggicheedu	50.00	1.52	150.00	204.29
Leaf miner (*Aakumudatha*)	18.86	2.28	224.09	193.82
Boorigalu	0.00	0.50	0.00	450.00
Kukkajarangi	0.00	5.00	0.00	220.00
Leaf reddening	1.00	0.00	130.00	0.00
Bud necrosis (*Muvva kullu*)	0.00	0.50	0.00	480.00
		Total	**1507.42**	**1776.02**
Year 2009-10				
Aphids (*Penubanka*)	47.75	3.47	462.22	256.36
Gajupurugu	4.00	0.00	100.00	0.00
Gongadipurugu	9.0	0.20	106.67	250.00
Kemiti purugu	0.00	2.13	0.00	400.00
Spodoptera (*Laddepurugu*)	1.00	0.00	100.00	0.00
Black Hairy caterpillar	5.00	0.00	0.00	0.00
Helicoverpa (*Pacchapurugu*)	6.89	2.46	150.67	378.42
Root grub (*Veeru purugu*)	12.00	0.00	30.00	0.00
Aggicheedu	7.50	1.79	125.00	207.86
Tikka leaf spot (*Aakumaccha*)	4.00	0.00	150.00	0.00
Stem rot (*Kandamkullu*)	0.00	3.00	0.00	600.00
Bud necrosis (*Muvvakullu*)	2.70	1.0	214.00	236.00
		Total	**1438.56**	**2328.64**

Source : Field Survey.

Box. 2: Leaf miner (*Aakumudutha*) and its management

In respect of Groundnut crop, leaf rolling is the major problem and is caused by Helicoverpa pest (paccha purugu). Farmers adopt the following sequence of NPM method in controlling the pest.

Stage 1: The bush of ber *(Zizyphus zuzuba)* plant is pulled manually over the field once to either side of the field so that the leaves open up and the pest is exposed and dies.

Stage 2: For a field of one acre, 1Kg of Green chillies is pound and soaked in cow urine. In another bowl, half a kg of garlic is pound and soaked separately in kerosene. Both are then added together with rita powder added as an emulsifying agent before spraying.

Stage 3: After pulling the ber bush when the pest is still in a small stage, panchapatra kashayam is sprayed. Details of panchapatra kashayam are as follows.

Ingredients needed: Cow urine; Neem leaves; Calotropis; Vitex nigunda; Pongamia and, Parthenium grass (*Congress grass*). As the extract is made of the above mentioned five different leaves, it gets its name Panchpatra kashayam.

Method of Preparation: Add 10 litres of water to a drum and place all the leaves in it and keep it for 10 days. After ten days, filter the extract. This is called "*Panchapatra Kashayam".*

Utility: In addition to paccahpurugu, this bio-pesticide is effective against pests like aphids (*Penubanka*) and pod borer (*kayatholuchu purugu*) in Ground nut.

Stage 4 : After panchapatra kashayam , Dashaptra Kashayam is sprayed which is made of 10 different leaves. These include Teel teega, Pongamia (*Kanuga*), Calotrpois (*Jilledu*), Neem (*Vepa*), Vitex nigunda (*Vavili*), Custard apple (Seethaphalam), Gangireni aaku, Palvaraku, Aloevera (*kalabanda*), Lantana Camara (*Pathi vrathashiromani*), Theetagarjalaku. For one acre, 1Kg each of different leaves mentioned above are pounded and soaked in cow urine for a week but has to be sprayed within two weeks.

***Vavilaku* (Vitex nigunda) Kashayam :**

In respect of Groundnut crop, the incidence of helicoverpa (pacchapurugu) results in stickiness because of which there will be no flowering. To avoid this Scenario, the extract of Vitex nigunda leaves is sprayed on the crop. The leaves of vitex are boiled in water till it bubbles with foam(at least thrice). It is then filtered before being applied to the crop. Earlier, farmers used to use a ash and cow urine combination to control the pest.

Source : Focused group discussions.

It can be seen from table 4.5 that different pests attack different economic parts of plants at various stages of their growth. It could be seen that in respect of groundnut crop, all parts of the plant like leaf stem, flower, primordial leaves and roots are affected by different pests.

Table 4.5: Average age of major pest/disease incidence and the affected plant part among the sample plots for the year in 2011-12 in Andhra pradesh

Pest/disease	Affected plant part	Average days of incidence
	NPM and Non- NPM	NPM and Non- NPM
Aphids (*Penubanka*)	Stem, Flower	31
Gajupurugu	Leaf	4
Red Hairy caterpillar(*Erra Gongadipurugu*)	Leaf, whole plant	38
Nallacheedu	Leaf,flower	30
Black Hairy caterpillar (*Nalla gongadi*)	Leaf	40
Helicoverpa (*Pacchapurugu*)	Stem and Flower	35
Root grub (*Verupurugu*)	Roots	25
Aggicheedu	Leaf	41
Leaf miner (*Aakumudatha*)	Stem	36
Bud necrosis (*Muvvakullu*)	Primordial leaves	35
Leaf reddening	Leaf	15
Boorigalu	Flower	40

Source: Field survey.

Average per acre costs were calculated for the years 2009-10, 20010-11 and 2011-12. For this purpose, the average expenses of all the farmers were taken into account excepting those who have reported no pest and disease incidence for different years (see table 4.1). Table 4.6 clearly indicates that per acre pest management costs are higher for non-NPM households as compared to NPM households. Infact, for the year 2011-12, the total cost incurred by NPM farmers (Rs.263) is fifty percent lesser than non-NPM farmers (Rs.527). The monetary value of own inputs used for pest management is slightly higher for NPM farmers. However, for all the three years, around twenty five percent of the inputs used are own, indicating that the NPM options used by them are based on local resources. The own inputs used by farmers include family labour, neem leaves, neem seeds, cow urine, lime, chillies, pongamia and other leaves for bio-pesticide preparations, whereas, the percentage of own input cost borne by non-NPM farmers ranges between 11 to 15%. The average cost incurred by farmers for one acre is almost the same for all the three years. However, due to a lesser pest incidence reported for 2010-11, the amount spent by both NPM and non-NPM farmers is lesser than for 2009-10 and 2011-12.

Table 4.6 indicates that the cost of pest management in respect of NPM fields has come down by Rs.14 from Rs/277/acre for 2009-10 to Rs.263 for 2011-12, whereas, in the case of non-NPM fields, it has increased by Rs.100 from Rs 427 to Rs.527 for the same years. However, there is a slight reduction inbetween for 2010-11 with respect to both NPM and non-NPM sample households.

Table 4.6: Average cost of plant protection (in Rs.per acre) incurred by the sample households in respect of ground nut crop in Andhra pradesh for the years 2009-10, 2010-11 and 2011-12

Andhra Pradesh (Ground Nut)						
Year	NPM			Non-NPM		
	Own input cost	External input cost	Total cost/ acre	Own input cost	External input cost	Total cost/ acre
2011-12	71	192	263	62	465	527
	(27.0)	(73.0)	(100.0)	(11.76)	(88.24)	(100.0)
2010-11	57	183	240	46	339	385
	(23.75)	(76.25)	(100.0)	(11.95)	(88.05)	(100.0)
2009-10	63	214	277	64	363	427
	(22.74)	(77.26)	(100.0)	(14.99)	(85.01)	(100.0)

Source: Field Survey.

Note : Figures in parentheses indicate the percentages.

4.3 Soil fertility and Pest management

Soil fertility and pest incidence are closely linked. Healthy soil is the first anecdote for pest management. Being aware of this, farmers have been following several soil fertility management practices which not only enhances fertility of soils, but also strengthens plants interms of withstanding of pests and diseases. In this respect, National project on Management of Soil health and Fertility (NPMSF) promotes the use of organic manuring, soil amendments (lime / basic slag) in acidic soils and the distribution of micro nutrients (GOI, 2008; Reddy, 2013b). The Prime Minister's Economic Advisory Council (PMEAC), in its latest Economic Outlook 2012/13, argues for dismantling of fertilizer subsidy because, agricultural input subsidies are progressively losing their relevance besides becoming an unbearable fiscal burden on the government, even as their role in terms of contributing to productivity enhancement is fast disappearing (PMEAC, 2012; Reddy, 2013b). Of late, the farming community has come to realize that fertilizers provide only a short-lived boost to plant growth and that FYM is widely superior and long lasting with a positive impact on soil properties. Hence, FYM is ranked highest and chemical fertilisers lowest in most matrix ranking exercises (Adolph and Butterworth, 2002; Reddy, 2013b).

The farmers in the study villages have adopted diverse SFM practises to address the issue of pest management through an improvement in the over all soil health.

Table 4.7: No of households using different Soil fertility Management methods in 2011-12, 2010-11 and 2009-10 in A.P (Percent).

(N=240)

Soil Fertility	2011-12		2010-11		2009-10	
Management method	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
Farm yard manure	20.0	11.67	32.50	20.0	37.50	23.34
	(24)	(14)	(39)	(24)	(45)	(28)
Chemical fertilizers	0.0	45.83	0.0	26.67	0.0	25.0
	(0)	(55)	(0)	(32)	(0)	(30)
Tank silt	24.17	9.17	10.0	4.17	12.50	8.33
	(29)	(11)	(12)	(5)	(15)	(10)
Sheep penning	0.83	5.0	1.67	1.67	6.67	6.67
	(1)	(6)	(2)	(2)	(8)	(8)
Neem cake	6.66	1.66	3.34	0.0	1.66	0.83
	(8)	(2)	(4)	(0)	(2)	(1)
Jeevamrutham	8.33	5.0	12.50	0.83	6.66	0.83
	(10)	(6)	(15)	(1)	(8)	(1)
Ganajeevamrutham	8.33	2.50	2.50	0.83	5.0	4.17
	(10)	(3)	(3)	(1)	(6)	(5)
Chemical fertilizer and	0.0	9.17	0.0	10.83	0.0	0.0
Farm yard manure	(0)	(11)	(0)	(13)	(0)	(0)
Tank silt and Farm Yard Manure	29.17	5.83	35.83	33.34	29.17	27.50
	(35)	(7)	(43)	(40)	(35)	(33)
Green leaf manuring	0.0	0.0	0.83	0.83	0.83	0.83
	(0)	(0)	(1)	(1)	(1)	(1)
Vermicompost	0.0	0.0	0.83	0.0	0.0	0.0
	(0)	(0)	(1)	(0)	(0)	(0)
Others	2.5	4.16	0.0	0.83	0.0	2.5
	(3)	(5)	(0)	(1)	(0)	(3)
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
	(120)	**(120)**	**(120)**	**(120)**	**(120)**	**(120)**

Source: Primary survey

Note : Figures in the parenthesis indicate the actual no of households using the SFM method

In A.P, the sample farmers in general and NPM farmers in particular follow different SFM practices in their fields. The practices followed for the period 2009-10 to 2011-12 include Farm yard manure, Jeevamrutham, Ganajeevamrutham, tank silt, Sheep penning, Neem cake, Poultry manure, green leaf manuring and vermicomposting (see table 4.7). Some times, farmers use more than one method in a given field for a given year. Table 4.7 indicates the range of SFM practices and also the combinations used by the sample households. Some practices are followed only during certain years. Chemical fertilizers are being used by only non-NPM farmers. It could be seen that for all the three years, more than 50 percent of both NPM and non-NPM households have used farm yard manure perse or in combination with tank silt or chemical fertilizers. This is crucial from the pest management angle. The higher the organic matter added, the better will be the resistance to pests and diseases. The results from table 4.7 show that, a large number of NPM households use farm yard manure as compared to non-NPM households. Anantapur district is predominantly characterized by sandy soils. The practice of tank silt application for improving the structure of soils is also a major SFM practice followed by farmers. Using of tank silt not only improves crop yields but also the water holding capacity of light sandy soils. This practice is followed perse or in combination with chemical fertilizers and FYM.

Practices such as *Jeevamrutham, Ganajeevamrutham* and neem cake, which have become of late popular, are being used more by NPM households than non-NPM households. An active support of the local NGOs engaged in promoting non-pesticidal management methods is the main reason for this higher adoption. Some of the major SFM practices followed by NPM sample households are discussed below in detail. The practices like Panchagavya and biofertilisers which were prevalent prior to 2009-10 are also discussed as they are potential SFM practices.

4.3.1 Manuring

To achieve optimal production, fertility of the soil has to be maintained and gradually improved. Improvement and maintenance of the organic matter of the soil is important, as this would increase the physical parameters of soil besides, improving soil structure and nutrient supply. Vasavi (1999) observes that the promotion of commercial agriculture, based on hybrid seeds, chemical fertilizers and pesticides, in a pre-dominantly semi-arid region has led to the loss of land race seeds, depletion of soil fertility and an increase in crop susceptibility to pests and diseases which, in turns, has finally led to the lack of fit between the ecological specificity of the region and commercial agricultural practices. Since huge amounts of farm yard manure to meet the nutrient requirement of the crops are not available, a combination of sources with different biological properties is being

used. This includes Jeevamrutham, Podijeevamrtutham, Tank silt, Sheep manure, Sheep penning, Neem cake, Biofertilisers, Green leaf manuring, Green manuring, Panchagavya and Vermicompost. Details of ingredients used, preparation method and the associated advantages of some of these practices are presented in the following sections.

4.3.1.1 Farm Yard Manure

A wide range of organic inputs are being utilised by farmers with farm yard manure being the major fertility enhancing input among them. It has been the principal means of replenishing soil losses since ages (Butterworth *et al*, 2003). Typically, organic inputs require transport as well as labour-intensive processing to provide nutrients in the right quantities and form. Importantly, these materials are valued by farmers for other properties than for just providing nutrients. This includes the ability of soils to hold and provide water and nutrients for crops.

Farm yard Manure is usually a combination of various wastes and crop residues. It is derived from cattle, goats, sheep, and (to a lesser extent) poultry. Besides adding nutrients, FYM adds organic matter to the soil that improves the soil structure (aeration and water holding capacity) and other soil properties. Farmers are aware of these benefits and have listed them side by side with soil nutrient aspects. This shows clearly farmers' holistic understanding of soils, whereby yield is seen as a function not only of nutrient availability in the soil, but also other physical and biological properties.

4.3.1.2 Panchagavya (preparation for two acres)

Ingredients needed: 5lits of milk from local cow(desi cow) + 5lits of curd from desi cow + half Kg ghee from desi cow + 5 Kg of cow dung + 5 lits of cow urine + 5lits of pure Palm toddy + 2 lits of coconut water + one dozen banana + 2Kgs of Jaggery.

Preparation : Cow ghee is mixed well in cow dung and stored in a pot for a day. Next day morning, everything is mixed with cow urine in a plastic container. Every day, the ingredients are *mixed twice in a clock wise direction*. This goes on for a week. After one week a good fragrance can be felt. The ingredients are then filtered. For 20 litres of water, 250 ml of the extract filtered is added before spray on any crop at the flowering stage. The advantage of this is that flowering does not drop, yield increases as also the weight of produce.

4.3.1.3 Jeevamrutham

This is made of a mixture of sieved FYM powder(200Kgs), Cowpea(2Kgs), Jaggery(2Kgs), Redgram or Horsegram flour(1Kg), cow dung(10Kgs), Cow urine(20 litres). All the materials are soaked in a tin for a week and the contents stirred once in the morning and once in the evening. This liquid is then added to FYM powder and stored under dry

shade. Jeevamrutham is made in such a way that it is ready for application in a given season or can be made in advance and stored in a place. Speaking of its effect, farmer Kondappa of Kondapur village says, *"DAP kkanna yekkuva power choopisthadhi, Inka DAP vesthe varsham rakunte vadi pothadhi. Adhe jeevamrutham ayithe vadipodhu"* (This is more powerful than DAP).

4.3.1.4 Podi Jeevamrutham :

Initially, a mixture is made by combining together 50Kgs of neem cake powder and 150Kgs of powdered Farm yard manure. Another mixture is made by combining 10 litres of cow urine + 10Kgs of cow dung + 2Kgs of redgram dal or any dal+2 Kgs of Jaggery + 20 litres of water. This solution is sprinkled on the mixture of Farm yard manure and neem cake powder prepared earlier and the resultant product is finally called as Jeevamrutham. *This jeevamrutham preparation should be done under shade and the resultant mixture should also be stored under shade. If the jeevamrutham preparation is done in sunlight, the micro organisms are likely to die and thereby become less efficient.* The product produced using above mentioned quantities of ingredients is enough for 5 acres of land, provided the manure is placed near the base of the plant, whereas, if the broadcasting method is adopted, it would be sufficient for only one acre.

Method of use: At the time of sowing, in the seed drill the seed, is placed in one hole and the *podi jeevamrutham* in the other hole. It can be applied after taking up intercultivation. For crops such as chillies and brinjal, *podi jeevamrutham* is placed near the base of the plant

4.3.1.5 Vermicompost

Vermicompost is a newly introduced method that is spreading rapidly. While there are different methods of making the compost bed and different types of worms used in the process, the overall principle is the same. By decomposing the organic matter, nutrients are more easily available to micro-organisms in the soil and thereby ultimately to plants. Depending on temperature, humidity, and nature of the organic material, the process last for several weeks. The nutrient composition of the vermicompost varies with substrate that is vermicomposted, but generally contains several diverse microflora that aid a good plant growth. The resultant fine-grained compost can be applied before sowing, or as top-dressing after germination.

4.3.2 Biofertilisers

Seed inoculation of Azatobactor, Rhizhobium and Azospirillum biofertilisers is done to help nitrogen fixation. FGDs held with farmers reveal that this low cost practice helps them achieve atleast 10 to 20 percent higher yield in respect of pulse crops. However,

timely accessibility to bio-fertilisers is a major obstacle observed in adopting this practice.

4.3.3 Green Manuring

Green manure plants are cultivated primarily to enhance soil fertility by way of ploughing the plant (generally before flowering) back into the land. Crops such as sunhemp, diancha and green gram are used as green manuring crops. These crops are sowed and ploughed back when they reach a height of 1.5 to 2 feet. This is a rich fertility enhancing practice. As a lot of organic matter is added into soil, the overall soil structure and texture also improves (Butterworth *et al,* 2003).

4.3.4 Intercropping/Mixed Cropping

It is the same principle as crop rotation, but this is done at the same time and space so that an adjoining crop replaces the nutrient extracted from the soil by one crop. It helps maintain nutrient balance. The adoption of this practice needs seeds of required quantities of diverse crops that are grown in the field. Just like crop rotation, this too has been a significant practice from the farmers' perspective in maintaining soil fertility and managing crop pest. Crop rotation, agro forestry and intercropping are the most widely practised of the low external input practices in the rural Kenyan districts of Nyandarua and Mumias (Yengoh and Svensson, 2008).

4.3.5 Selection of crop rotations

Crop rotations play a very important role in restoring soil fertility and minimizing damage due to insect pests and weeds. Legumes that help fix nitrogen are typically intercropped or included in rotations. Crops grown in the study villages include groundnut, red gram, cow pea, horse gram and green gram. Crop rotation ensures that the same soil nutrients are not used up by the same crop every season. Crops, which use different nutrients, are grown alternatively to keep the nutrient balance of the plots. Farmers attach a high value to this practice indicating the significant contribution of this practice to soil fertility maintenance since ages (Reddy 2011; 2013b). Crop rotation by itself does not involve any cost, but the decision to change the crop every season in a particular plot.

4.4 Pest incidence scenario in Maharashtra

Cotton, Redgram and Soyabean are the major crops grown in the study villages of Wardha district in Maharashtra. The predominant cropping pattern adopted by both NPM and non-NPM sample households includes Cotton + Redgram, Soyabean + Redgram and Soyabean + Cotton and Redgram (see table 3.16). An analysis of pest incidence carried out for all the three major crops. The farmers' concern mainly centres around only those pests which tend to cause a considerable economic damage and hence, only such pests were included for our analysis. The occurrence of pests varies from year to year. A pest

might have caused a severe economic damage for 2011-12, but the damage caused by the same pest might not be quite significant for 2010-11. Table 4.8 indicates a very high percentage of no pest and disease incidence with regard to cotton crop for NPM sample households for the years 2009-10, 2010-11 and 2011-12 as compared to non-NPM households. The incidence of major pests such as heliothis, pink boll worm and jassids is high in respect of non-NPM households as compared to NPM households. This is due to multiple NPM options being adopted by the farmers for this crop. However, the same methods have not succeeded in keeping the population of aphids and white fly among the fields of NPM sample households. The incidence of mealy bugs and thrips is found negligible in respect of both NPM and non-NPM fields.

Table 4.8 : Number of Sample households reporting incidence of various pests and diseases in respect of Cotton crop for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

(N=240)

	2011-12		2010-11		2009-10	
Pest/Disease	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**
No pest/disease	51.7	5.0	41.67	1.67	50.0	2.5
	(62)	(6)	(50)	(2)	(60)	(3)
American Boll worm	10.8	31.67	17.50	49.17	24.17	47.50
	(13)	(38)	(21)	(59)	(29)	(57)
Aphids	2.5	1.7	0.0	0.0	0.0	8.3
	(3)	(2)	(0)	(0)	(0)	(10)
Jassids	1.7	25.8	0.0	18.33	0.83	14.2
	(2)	(31)	(0)	(22)	(1)	(17)
Heliothis Bollworm	6.67	17.5	10.83	9.17	4.2	9.2
	(8)	(21)	(13)	(11)	(5)	(11)
Mealy Bugs	0.0	0.8	0.0	0.0	0.0	0.8
	(0)	(1)	(0)	(0)	(0)	(1)
white fly	26.7	17.5	30	21.66	20.8	11.7
	(32)	(21)	(36)	(26)	(25)	(14)
Thrips	0.0	0.0	0.0	0.0	0.0	5.8
	(0)	(0)	(0)	(0)	(0)	(7)
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
	(120)	**(120)**	**(120)**	**(120)**	**(120)**	**(120)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

4.5 NPM options followed in Cotton crop in Maharashtra

Farmers' pest management is based on built-in features in cropping systems, such as soil type, farm plot location, crop rotation, mixed and intercropping, or specific responsive actions to reduce pest attacks, such as the timing of weeding, use of plants with repellent or insecticide properties, traps and bird perches. However, a detailed information on traditional pest management practices widely used by Indian farmers is often found lacking. In general, traditional agricultural systems are poorly understood (Reddy, 2010c), and it is often not sufficiently recognized that crop protection as such is a thoroughly tested and built-in process with in the overall production system. The details of practices adopted by the sample households in Maharashtra with regard to cotton crop are thoroughly discussed in the following section.

1 **Summer ploughing :** Ploughing once in a month in summer is one of the NPM options adopted by farmers. Deep ploughing of soil exposes the pupae present in the soil to sunlight. They are either eaten by birds or get sterilized/killed due to scorching temperatures in summer. Similarly, soil-borne pathogens also get killed due to high temperatures in summer. In addition to reducing the pest population. The adoption of this practice also enhances soil fertility in that the soil structure gets improved, rain water infilitration increases and the water holding capacity of soil enhances considerably thereby influencing the yield levels positively.

2 **Seed treatment:** For 1kg of seed, 250gms of Cow dung + One glass of cow urine + 50gms of lime + 100gms of soil from field (*Keth ki mitti*) are mixed and seed is rubbed with the above mixture gently. The advantages of this seed treatment are 1) Seed's germination capacity increases; 2) Burshi and *Maiorog* (weevils) won't show up ; 3) Yeild increases by 10 %; and 4) The plant will be healthy and robust.

3 **Inter cropping / Mixed cropping :** It is another NPM option followed by farmers interms of intercropping with redgram, beans, *motitura* and hibiscus and other crops in small proportions.

4 **Trap crop:** Planting of Marigold (*Jhendu*) as a trap crop in the cotton fields is prevalent among the sample households. The adavantage is that, pests like heliothis get attracted to marigold, there by causing less damage to economic parts of cotton.

5 **Pheramone trap:** For each acre 5-6 pheramone traps are installed. The cost of each trap amounts to Rs.32. These are freely distributed to farmers by the local NGOs and also at subsidized rates by the department of agriculture. These traps consist of a lure in the middle. Lure consists of hormone of female species of heliothis moth.

Due to this, male moths get attracted to this and get trapped. As a result, the mating of male moths with female moths gets reduced. This, inturn results in a reduction in the number of eggs layed. Another adavantage of pheromone trap is that the pest population can be monitored which , inturn, helps take pest control measures.

6 **Yellow tins or white tins-** Castor oil and grease are applied to attack and kill white flies (*pandrimashi*). 4-5 tins/acre are placed. It costs Rs.50 per acre. Those who don't find tins, use polythene covers. The white flies get stuck to this sticky substance.

7 **Bird Trap (*Pakshi Thamba*):** 4-5 (per acre) T shaped sticks are placed on land. Chimney bird feeds on aliya pest . Bird traps are more useful in respect of cotton and Bengal gram.

8 **Neemastra :** 5Kgs of green leaves of Neem + 5lit of cow urine are fermented in a pot for 15 days. (If needed urgently it can be boiled with 50gms of soda and Nirma powder). This is then filtered to obtain three litres of extract and 50gms of soda is added to it. When cotton is in the initial stage, 3 litres of extract is enough to cover 2 to 2.5 acres with 13 litres of water mixed. As the growth stage of the crop increases, a lesser area is covered with 3 litres of extract. With the crop growth, water quantity also increases.

9 **Neem seed powder :** 1Kg of neem seed powder is tied in a cloth and soaked in a bucket of water overnight to obtain 5-6 litres of extract. This can be sprayed with 100 litres of water. This is a bit expensive as compared to Neemastra and hence its usage is relatively less. This is used in respect of crops such as cotton, Soya bean, Redgram and vegetables.

10 **Bramhastra :** This is made by mixing 2 kgs of Papaya leaf + 2 kgs of neem leaf + 2 kgs of Pongamia +2 kgs of *Ganneru* + 2 kgs of calotropis (*Besharam*) + 2 kgs of Datura + 2 kgs of castor seed (*Erandi*) + 2 kgs *Uttaravan* + 2 kgs *Rooy* + *Jaswanth* leaves (*Hibiscus*). All these are ground gently and soaked in 5 litres of cow urine and 5 litres of water before boiling for 30 minutes. If there is sufficient time for applying it, there is need for it to be boiled and it should be left for 40days to be more powerful. Aprroximately 8 to 9 litres of extract is obtained after being soaked for 40 days. 250ml of bramhastra extract is sufficient for a 16 litre capacity sprayer. This extract is used in respect of the following crops for specific pests.

Cotton - American boll worm; Redgram (*Tur*) - Heliothis (*Ali*); Soya bean -Semi looper

Bengal gram (*Chana*) - if needed, it is used in respect of this crop too. However it is generally not used in respect of vegetables, excepting Brinjal, that too rarely. When Bramhastra, is used, the pest dies quickly.

11 **Agni Aastra:** 1Kg of green chillies (worth Rs.40) + 1 Kg of tobacco (worth 60Rs) + 500gms of garlic (10Rs.) -A paste is made and soaked in 5 litres of cow urine before boiling for 30 minutes and after it gets cool, it is filtered with 50gms of Nirma added. From this, an extract of 4 litres is obtained. Agni astra has to be prepared in open air as inhalation of tobacco fumes could be dangerous for human health. It is used as the last weapon during the last stage of the crop. Generally 6-10 pumps are needed to spray and for each pump, 250ml of agni astra/pump is needed. This is mostly used in respect of cotton and red gram. This is the last kind of spray used as part of NPM methods.

Table 4.9: Number of Sample households reporting the incidence of various pests and diseases in respect of Redgram for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

(N=240)

	2011-12		2010-11		2009-10	
Pest/Disease	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**
No pest/disease	11.67 (14)	0.83 (1)	7.5 (9)	0.83 (1)	10.0 (12)	0.83 (1)
American Bollworm	13.33 (16)	0.0 (0)	5.8 (7)	3 0.0 (0)	5.83 (7)	0.83 (1)
Heliothis bollworm	45.83 (55)	50.0 (60)	40.83 (49)	46.67 (56)	49.17 (59)	48.33 (58)
Semi Lopper	29.17 (35)	35.83 (43)	42.5 (51)	42.5 (51)	30.83 (37)	35.84 (43)
Spotted bollworm	0.0 (0)	11.67 (14)	0.0 (0)	7.5 (9)	0.0 (0)	12.5 (15)
Tobacco boll worm	0.0 (0)	1.67 (2)	0.0 (0)	0.83 (1)	0.0 (0)	1.67 (2)
Thrips	0.0 (0)	0.0 (0)	0.0 (0)	0.83 (1)	0.0 (0)	0.0 (0)
Army worm	0.0 (0)	0.0 (0)	3.3 (4)	0.83 (1)	4.17 (5)	0.0 (0)
Total	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

In the case of redgram crop (see table 4.9), heliothis is the major pest followed by semilooper and American boll worm observed among NPM and non-NPM farmers' fields. Heliothis and semilooper are observed on a large scale in respect of both the NPM and non-NPM fields, whereas, American boll worm is observed on a largescale among NPM fields. Spotted boll worm is seen only among non-NPM fields. Thrips and army worm incidence is found negligible. In respect of soyabean, heliothis is the only major pest reported followed by army worm (see table 4.10). Interestingly, contrary to cotton and redgram crops, a large number of the non-NPM sample households have reported a relatively low pest incidence as compared to NPM households.

Table 4.10: Number of Sample households reporting the incidence of various pests and diseases in respect of Soyabean crop for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

(N=240)

	2011-12		2010-11		2009-10	
Pest/Disease	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**	**NPM**	**Non-NPM**
No pest/disease	30.0	36.67	40.0	48.34	38.33	50.83
	(36)	(44)	(48)	(58)	(46)	(61)
Heliothis bollworm	60.83	42.50	36.67	28.33	48.34	28.33
	(73)	(51)	(44)	(34)	(58)	(34)
Castor Semi-looper	0.83	0.0	0.83	0.83	0.0	1.67
	(1)	(0)	(1)	(1)	(0)	(2)
Army worm	8.34	20.83	22.5	22.5	13.33	19.17
	(10)	(25)	(27)	(27)	(16)	(23)
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
	(120)	**(120)**	**(120)**	**(120)**	**(120)**	**(120)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

In addition to general NPM methods, in Maharashtra, farmers have been following crop-specific NPM methods

Soyabean: Calotropis (*Besharam*) and *Ruyi* branches are cut and placed for pest Kesalayi in the fields of soyabean crop. These insects relish the leaves and start feeding on them. They are collected and burnt later. These Branches are placed in the morning and are collected in the evening and burnt. This has proved to be a very effective method, reducing 50% of the pest population.

Wheat: For Tambela disease, one litre of butter with mixed in 15 litres of cold water before spraying on the crop.

In addition to the crop specific NPM practices, farmers have been using indigenous technologies that are based on the knowledge and experience of local farmers through generations. Cultural and mechanical practices are being used by farmers to manipulate the pest population and there by reducing economic damage to crops. Although it has been briefly discussed earlier, this study tried to understand these cultural and mechanical practices being used by farmers in the study villages of Maharashtra. Table 4.11 indicates that these practices involve mainly of manipulation of sowing time, crop rotation, over planting, selective weeding, crop diversity, use of resistant varieties,

Table 4.11: Adoption of indigenous pest control methods by the sample households in Maharashtra (2011-12)

Type of Practice	NPM			Non-NPM		
	Yes	No	Total	Yes	No	Total
Manipulation of sowing time	76.67 (92)	23.33 (28)	100.0 (120)	77.5 (93)	22.5 (27)	100.0 (120)
Crop rotation	89.17 (107)	10.83 (13)	100.0 (120)	85,0 (102)	15.0 (18)	100.0 (120)
Over planting	94.17 (113)	5.83 (7)	100.0 (120)	86.67 (104)	13.33 (16)	100.0 (120)
Selective weeding	86,67 (104)	13.33 (16)	100.0 (120)	84.17 (101)	15.83 (19)	100.0 (120)
Crop diversity	81.67 (98)	18.33 (22)	100.0 (120)	60.0 (72)	40.00 (48)	100.0 (120)
Use of resistant varieties	85.83 (103)	14.17 (17)	100.0 (120)	79.17 (95)	20.83 (25)	100.0 (120)
Ploughing and cultivation techniques	92.50 (111)	7.5 (9)	100.0 (120)	84.17 (101)	15.83 (19)	100.0 (120)
Use of repellents or attractants	91.67 (110)	8.33 (10)	100.0 (120)	54.17 (65)	45.83 (55)	100.0 (120)
Bird Perches	44.17 (53)	55.83 (67)	100.0 (120)	42.50 (51)	57.50 (69)	100.0 (120)

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households.

ploughing and cultivation techniques, use of repellents or attractants and bird perches. Several researchers have highlighted that the traditional control practices continue to be the major means of pest management, especially among small-scale farmers in India (Reddy, 1999; purushottam *et al*, 2009; Kumar, 2010 ; Rao *et al*, 2010 and Reddy,

2013a). In principle, farmers have a fair ecological understanding of those pests that can easily be observed (Reddy, 2010a).

It can be observed from table 4.11 that a large number of farmers belonging to both NPM and non-NPM categories continue to use several cultural and mechanical practices to deal with crop pests. However, the percentage of farmers following these practices is slightly higher in the case of NPM farmers while crop rotation, over planting, ploughing and cultivation techniques and the use of repellents or attractants are mostly practised by NPM sample households. On the other hand, ploughing and cultivation techniques, over-planting, selective weeding and crop rotation are largely practiced by non-NPM sample households.

4.6 A Pest-wise Analysis of Bio-pesticides/pesticides usage

Tables 4.12 indicates that the quantity of bio-pesticides used is higher in respect of NPM fields as compared to non-NPM fields. However, when compared to A.P., the quantity of per acre bio-pesticides used is less in the case of Maharsahtra. In A.P., neem leaf extract is used (see table 4.3) for controlling some pests. Generally higher quantities of extract are made from these leaves as they are not as effective as concentrated neem oil or other bio-pesticdes. It is evident from table 4.12 that in Maharashtra, for controlling major pests of cotton such as heliothis, American boll worm, jassids and white fly, the per acre cost of pest management two and half times higher in respect of non-NPM sample households than NPM households. Almost a similar scenario exists regarding pest management costs in the case of redgram and soyabean. Despite growing Bt cotton which is supposed to be resistant to heliothis, yet on an average, a sum of more than Rs1000 has been reported spent/acre in managing this pest by non-NPM farmers. A similar amount of money is incurred in managing pests such as American boll worm, jassids and white fly by non-NPM farmers.

Interestingly, the incidence of spotted bollworm and tobacco bollworm is not seen among NPM fields for all the three years (see table 4.12) in respect of cotton. For most of the pests, the amount spent per acre is either double or more in the case of non-NPM households vis-a-vis NPM households. It can be seen from tables 4.12 and 4.13 that, all the pests are not seen for all the three years. For certain years, certain pests have not caused damage to the extent of an economic threshold level and hence, not reported by farmers. With regard to redgram crop, the pests such as spotted boll worm, thrips and tobacco boll worm have not caused any economic damage and hence no expenditure incurred on them. Similarly, semilooper is found more prevalent in the case of soyabean and redgram crops, while Army worm incidence is specific to only soyabean.

Table 4.12: Average quantity of bio-pesticide /pesticide used for controlling different pests in the case of cotton crop for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

Pest/disease	Bio-pesticide in Litres	Pesticide in litres	Cost per acre (in Rs.)	
	NPM	Non-NPM	NPM	Non-NPM
Year 2011-12				
American Bollworm	2.62	1.00	373.33	1167.57
Aphids	2.00	1.00	333.33	450.00
Jassids	2.00	0.83	350.00	1155.45
Heliothis Bollworm	2.33	1.14	338.33	1238.10
Mealy Bugs	0.00	0.25	0.00	750.00
white fly	4.63	0.86	336.25	1102.38
Year 2010-11				
American Bollworm	2.71	0.97	380.00	1074.56
Jassids	0.00	0.89	0.00	1127.27
Heliothis Bollworm	1.80	1.00	430.00	829.09
White fly	4.92	0.91	323.33	1112.69
Year 2009-10				
American Bollworm	2.54	0.91	347.14	1134.91
Aphids	0.00	1.05	0.00	805.00
Jassids	0.00	0.86	0.00	1134.71
Heliothis Bollworm	4.60	1.09	330.00	1181.82
Mealy Bugs	0.00	0.30	0.00	1500.00
Thrips	0.00	0.85	0.00	1100.00
White fly	8.00	0.76	339.20	936.43

Source: Field Survey.

In Maharashtra, the average timing (crop age days) pest incidence was assessed with respect to three major crops-cotton, redgram and soyabean. It could be seen from table 4.14 that the attack by jassids occurs at the earliest i.e at the crop age of 30 days, while the attack by mealy bugs and pink boll worm extend even upto 110 crop age days.

An effort was made to gain an understanding of pests that caused damage beyond an economic threshold level over the past few decades and the control measures adopted by farmers in handling these pests. Table 4.15 gives us a clear picture of the changing pest scenario over the years. It was infact interesting to know from farmers that, thirty years ago there was not a single pest that caused economic damage. This could be mainly because of the mixed cropping system adopted by farmers, using high yielding traditional varieties and the administering of organic manure to soils. Over the last 30 years, the

Table 4.13: Average quantity of bio-pesticide /pesticide used for managing different pests and diseases in respect of Redgram and Soyabean crops for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

Red gram				
Year 2011-12				
Pest/disease	**Bio-pesticide/Pesticide in litres**		**Cost per acre**	
	NPM	**Non-NPM**	**NPM**	**Non-NPM**
Heliothis bollworm	1.87	1.04	332.55	984.67
Semi Lopper	2.09	0.79	309.71	926.28
Spotted bollworm	0.00	1.09	0.00	1296.43
Tobacco bollworm	0.00	0.25	0.00	770.00
Year 2010-11				
Heliothis bollworm	2.06	0.95	311.43	918.57
Semi lopper	2.07	0.89	310.78	902.75
Spotted bollworm	0.00	0.88	0.00	867.78
Thrips	0.00	0.50	0.00	1000.00
Tobacco bollworm	0.00	1.00	0.00	1800.00
Year 2009-10				
Armyworm	1.60	0.00	418.00	0.00
Heliothis Bollworm	1.86	1.01	287.14	871.55
Pink bollworm	0.00	1.00	0.00	700.00
Semi -lopper	2.32	0.94	312.43	882.56
Spotted bollworm	0.00	0.93	0.00	898.67
Tobacco bollworm	0.00	0.50	0.00	900.00
Soya bean				
		2011-12		
Army worm	2.10	0.96	320.00	804.40
Heliothis bollworm	1.86	1.08	310.00	796.05
Semi lopper	4.00	0.00	200.00	0.00
2010-11				
Army worm	2.20	1.00	301.11	883.70
Heliothis bollworm	2.01	1.04	284.21	751.30
Semi lopper	5.00	1.00	300.00	950.00
2009-10				
Army worm	2.40	0.96	286.88	797.83
Heliothis bollworm	8.95	1.05	282.18	723.79
Semi lopper	0.00	1.00	0.00	725.00

Source: Field Survey.

scenario has changed in terms of gradually replacing the mixed cropping system with monocropping wherein, the usage of high yeilding varieties, chemical fertilizers and poisonous pesticides is predominant. It can be seen from table 4.15 that despite the control of so many deadly pesticides, as farmers have reported there is no remedy for *lale* disease (reddening of leaves) problem in the case Bt.cotton (see box.3).

Table 4.14: Average timing of major pest incidences in respect of Cotton, Redgram and Soyabean in the sampled plots for the year in 2011-12 in Maharashtra

Pest/disease	Average timing of incidence among NPM and Non- NPM farms
Jassids	30.00
Aphids	45.00
Bollworm	47.50
white fly	74.11
American Boll worm	96.78
Heliothis bollworm	110.00
Mealy Bugs	110.00

Source: Field Survey

Table 4.15: Pests of Economic Significance and their control measures in Maharashtra over the last 30 years

	30 years back
Crop Name	
All crops	Not much loss was seen due to pests. There used to be good rains and farmers never noticed serious pests and diseases.
	20 years back
Jowar	Wilting was seen but no sprayings were done
	10 years back
Cotton	*Ali* and *Bondali* pests. To control them Endosulpahn and Monocroptophos used to sprayed.
Soya bean	Laskari pest was seen
	Now in 2013
Bt.Cotton	a) *lale* (reddening of green leafs) disease and at present, there is no solution to it.
	b) Pandre mashe (is it heliothis effect)- Polo and Acephate.
Soya bean	*Laskari* pest is seen and Quinolphos is sprayed.
Redgram	*Ali* is seen and Quinolphos is sprayed.
Bengal gram	*Ali* is seen and Quinolphos is sprayed.
Wheat	*Geirva* disease is seen and the whole grain dries up. However, no spraying is done.

Source: Focused group discussions

Box 3: Story of Bt-Cotton in Maharashtra

All the study villages in the wardha block grow Bt-Cotton. Initially, when the farmers shifted to NPM methods of pest management, there was a yield reduction to the extent of 40 per cent in the case of Cotton crop. However, a reduction was not seen in respect of Soyabean and redgram. Farmers of the study villages observe that the present Bt cotton yield is 2-3 quintals less per acre as compared with to hitherto non-Bt varieties such as 1007, 468,H-4, LRA,Nanded-44.

During initial years of introduction the Bt yield was 15 quintals/acre. At that time Non-Bt gave 10 quintals/ acre. After 5 years, the Bt yield has come down to 6-8quintals/ acre. Now desi varieties do not exist. As of 2012, the performance of Bt is very bad due to virus and reddening of leaves. Farmers feel that if non-Bt varieties were available, they could have grown them.

Initially, Bt Cotton farmers used to spray a quantity of 250ml. One to two sprays would have been sufficient to control the pest. Now after 5years of Bt cultivation, farmers have to use 5-6 sprays with a quantity of one litre/acre. Initially, when 250ml quantity was being sprayed, pesticides used were like Endosulphon, Metacin, monocroptophos, Agrasen and Acetaph. Now, for each acre, one litre quanity is being used. Roger and other pesticides are being used. The cost of these pesticides ranges from Rs1800-3000/litre.

Farmers point out that during the first two years, not much of pest and diseases was seen in respect of Bt. But it is not the case now. There is also a change in the composition of pests seen now in the case of Bt cotton as compared to non-Bt cotton earlier. Earlier, non-Bt cotton Pests seen were *chude, turtude, safed masi*, whereas now, in Bt-Cotton we find virus, l*ele, churdai, safed masi*. As of 2012 on an average, a sum of Rs4000-5000/acre has been spent on pesticides. Earlier, i.e., 5 years back, for non-Bt varieties, they used to spend Rs1500/acre for only two sprays. This clearly indicates that the claims of companies promoting Bt-cotton are hollow and that the farmers spend huge amounts on pesticides. In addition to this, Bt cotton is found to be performing very poorly during unfavorable climatic conditions. Hitherto, cotton varieties used to give good yields withstanding unfovrable climatic conditions with multiple pickings from these varieites.

Source: Focused group discussions

Table 4.16 : Type of bio-pesticides and their average quantity used(in litres) by NPM sample Households for cotton crop for the year 2011-12 in Maharashtra.

Type of Bio-pesticide	Average quantity used in Litres/acre
Agni astra	2.00
Bramhastra	2.36
Chilli garlic extract	1.75
Dhashparni (extract made from ten kinds of leaves)	2.67
Neemastra	4.00
Nimboli Powder	2.53
Tambakhu (Tobacco leaves)	1.00

Source: Field Survey.

As discussed earlier, and also from table 4.16, it can be seen that NPM farmers use a range of bio-pesticides made of low-cost locally available resources. It could been seen that powerful biopesticides such as thambaku are used in lesser quantities (one litre/ acre), whereas, neemastra, which is made of neem leaves, is used in higher quantities (4 litres/acre) in Maharashtra. Witnessing the efficacy of these bio-pesticdes in the neighbouring NPM farms, some of these bio-pesticides are being tried out by non-NPM farmers at times. Similarly, table 4.17 shows a range of pesticides used by non-NPM farmers for the year 2011-12. The quantities of pesticides used per acre range from 0.25 litres(omite) to 1.31 litres (monocrotophos). The table also shows thirteen kinds of pesticides used by the non-NPM farmers in the study villages of Maharashtra.

Table 4.17: Type of pesticides and their average quantity used (in litres) by non-NPM sample households for cotton crop as of 2011-12 in Maharashtra state

Type of Pesticide used	Average quantity used in Litres/acre
Acephate	0.96
Avaunt	0.94
chloropyriphos	0.96
Confidor	0.89
Cypermethrin	1.00
Endosulphon	1.09
Fem	0.64
Larvin	0.38
Metacin	0.66
Monocrotophos	1.31
Omite	0.25
Pride	0.68
Rogor	0.84

Source: Field Survey.

A lot of care needs to be excercised while handling such a diverse number of pesticides, carefully. The present study tried to understand how the non-NPM sample farmers were handling the storaging of these deadly pesticides. It can be seen from table 4.18 that nearly 50 percent of the farmers store pesticides at home, which is a major concern from the point of children's safety in these households and about twenty three percent of the non-NPM farmers store pesticides in sheds, while 11.67 per cent of the farmers do not have proper storage facilities to keep these harmful pesticides.

Table 4.18: Distribution of Non-NPM respondents based on type of pesticide storage facility in Maharashtra (2011-12)

Storage facility	Non-NPM
Shed	23.33 (28)
Shed & Home	15.83 (19)
Home	49.17 (59)
No storage facility	11.67 (14)
Total	**100.0 (120)**

Source: Field Survey.

Note: Figures in parentheses indicate the actual number of households

The average per acre cost for major crops grown in the study villages was calculated for the years 2009-10, 20010-11 and 2011-12. Similar to A.P, the average cost incurred by all the farmers was taken into consideration excepting those reporting no pest and disease incidence for different years (see tables 4.8, 4.9 and 4.10). Table 4.19 clearly shows that per acre pest management cost is higher for non-NPM households as compared to NPM households for all the three crops. Infact, for the years 2011-12, 2010-11 and 2009-10, the cost incurred by NPM farmers for pest management in majority cases shows a reduction by fifty percent relative to non-NPM farmers. For all the three years, around forty five percent of the inputs used by NPM sample households is their own, indicating that the NPM options adopted by them are based on locally available resources. The own inputs used by farmers include family labour, trap crops, bird perches, cow urine and bio-pesticides (see table 4.16), whereas, the percentage of own input cost incurred by non-NPM farmers ranges between 26% to 33%. The average cost incurred by NPM farmers for one acre is almost the same for cotton, redgram and soyabean for all the three years with no huge variations, excepting soyabean for 2009-10. This is true for non-NPM farmers too, excepting redgram. It is interesting to note from table 4.19 that there has been a maximum increase of Rs.62 in the pest management cost in the case of the three crops for NPM households for the period 2009-10 to 2011-12, but it is not the case

with non-NPM sample households. However there has been a negligible increase in the cost of pest management for the period 2009-10 to 2011-12 for both NPM and non-NPM sample households in the case of cotton and Redgram, whereas, in the case of non-NPM households, the cost has increased for the period 2009-10 to 2011-12, especially in respect of the case of cotton (by Rs.56) and redgram(Rs113).

Table 4.19: Average cost of plant protection (in Rs.per acre) incurred by the sampled households in Maharashtra for the years 2009-10, 2010-11 and 2011-12 for major crops

Year	NPM			Non-NPM		
	Own input cost	External input cost	Total cost/ acre	Own input cost	External input cost	Total cost/ acre
Cotton						
2011-12	155 (45.19)	188 (54.81)	343 (100.0)	231 (26.86)	629 (73.14)	860 (100.0)
2010-11	154 (44.64)	191 (55.36)	345 (100.0)	226 (28.64)	563 (71.36)	789 (100.0)
2009-10	143 (41.09)	205 (58.91)	348 (100.0)	234 (29.10)	570 (70.90)	804 (100.0)
Redgram						
2011-12	146 (46.35)	169 (53.65)	315 (100.0)	223 (29.04)	545 (70.96)	768 (100.0)
2010-11	134 (43.51)	174 (56.49)	308 (100.0)	202 (29.93)	473 (70.07)	675 (100.0)
2009-10	136 (43.87)	174 (56.13)	310 (100.0)	211 (32.21)	444 (67.79)	655 (100.0)
Soya bean						
2011-12	139 (45.87)	164 (54.13)	303 (100.0)	205 (32.39)	428 (67.61)	633 (100.0)
2010-11	155 (45.06)	189 (54.94)	344 (100.0)	195 (30.95)	435 (69.05)	630 (100.0)
2009-10	126 (44.06)	160 (55.94)	286 (100.0)	195 (30.95)	435 (69.05)	630 (100.0)

Source: Field Survey.

Note : Figures in parentheses indicate the percentage.

Table 4.20: Households reporting reduction in pest incidence in AP and Maharashtra in the context of NPM of crops

Percentage of Reduction	Andhra Pradesh (Ground Nut)	Maharashtra	
		Cotton	Soyabean
Not Applicable	14.17 (17)	19.17 (23)	14.17 (17)
Up to 25	10.0 (12)	42.50 (51)	20.83 (25)
25-50	10.0 (12)	37.50 (45)	37.50 (45)
50-75	25.0 (30)	0.83 (1)	11.67 (14)
Above 75	40.83 (49)	0.0 (0)	15.83 (19)
Total	**100.0 (120)**	**100.0 (120)**	**100.0 (120)**

Source: Field Survey.

Given a fifty percent reduction in the cost of plant protection in respect of NPM households, the study tried to understand to what extent the pest incidence had been reduced in the context various NPM practices being followed, ranging from summer ploughing to spraying of diverse bio-pesticides. In A.P, more than 40 percent of the farmers growing groundnut have reported that the adoption of NPM methods has helped reduce the pest incidence by more than 75 percent, while 25 percent of them have reported a pest reduction to the extent of 50-75 percent. On the other hand, in Maharashtra, according to more than 25 percent of the farmers there has been a reduction in the pest incidence inrespect of soyabean crop, ranging from 50-75 percent. However, in the case of cotton, a majority of the farmers have reported that pest reduction is less than 50 percent and hence, a higher cost of plant protection per acre(see table 4.19).

4.7 Soil Fertility and Pest management in Maharashtra

Similar to Andhra Pradesh, farmers in the wardha district of Maharashtra have been using inputs as part of enhancing soil fertility so as to keep soil healthy and thereby help them with stand the occurrence of pest incidence in their fields. On the other hand, an excessive application of chemical fertilizers makes plant susceptible to pests and diseases. The sample farmers have adopted different SFM practices in their fields. When compared to Andhra Pradesh, in Maharashtra a large number of farmers follow multiple practices. The practices adopted by NPM and non-NPM households for the period 2009-10 to 2011-12 include Farm yard manure, chemical fertilizers, tank silt, sheep penning, neem cake, Jeevamrutham, Ganajeevamrutham, Poultry manure, green leaf manure and vermicompost (see table 4.21).

It could be seen from table 4.21 that, like Andhra Pradesh, farmers in Maharashtra too consider FYM as the best input for improving soil health and accordingly, more than 84

Table 4.21: No of households using different Soil fertility Management methods for the years 2011-12, 2010-11 and 2009-10 in Maharashtra (Percent).

(N=240)

Soil Fertility	2011-12		2010-11		2009-10	
Management method	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
Farm yard manure	95.0	88.33	90.83	84.17	89.17	92.50
	(114)	(106)	(109)	(101)	(107)	(111)
Chemical fertilizers	0.0	100.00	0.0	97.50	0.0	99.17
	(0)	(120)	(0)	(117)	(0)	(119)
Tank silt	4.17	1.67	1.67	0.83	2.50	3.33
	(5)	(2)	(2)	(1)	(3)	(4)
Sheep penning	2.50	2.50	4.17	0.83	1.67	4.17
	(3)	(3)	(5)	(1)	(2)	(5)
Neem cake	1.67	0.83	1.67	0.0	0.83	0.83
	(2)	(1)	(2)	(0)	(1)	(1)
Jeevamrutham	81.67	0.0	75.83	0.0	75.0	0.0
	(98)	(0)	(91)	(0	(90)	(0
Ganajeevamrutham	69.17	6.67	64.17	6.67	66.67	0.0
	(83)	(8)	(77)	(8)	(90)	(0)
Poultry Manure	0.0	0.0	1.67	0.83	0.0	1.67
	(0)	(0)	(2)	(1)	(0	(2)
Green leaf manuring	8.33	8.33	6.67	4.17	5.0	0.83
	(10)	(10)	(8)	(5)	(6)	(1)
Vermicompost	0.83	0.83	1.67	0.83	0.83	3.33
	(1)	(1)	(2)	(1)	(1)	(4)
Others	72.50	0.0	69.17	0.0	66.67	0.0
	(87)	(0)	(83)	(0)	(80)	(0)

Source: Primary survey

Note : Figures in parentheses show the percentage of households adopting that particular SFM practice to the total no. of sample Households under that category. A sample HH may adopt more than one SFM practice at a given point of time and hence, the total percentage exceeds 100 due to multiple responses.

percent of both NPM and non-NPM households have used it for the years 2009-10, 2010-11 and 2011-12 in some proportion or the other, while chemical fertlisers are found used only by non-NPM sample households. Unlike Andhra Pradesh, tank silt application is not at all a major practice observed in Maharashtra. The reason being that

soils in the study villages are diverse and are predominantly black soils (see table 3.14) and as such tank silt application does not go well with black soils. Ganajeevamrutham (solid organic fertilizers) and Jeevamrutham (liquid organic fertilizer) are found applied predominantly by NPM households, while a few non-NPM households have used Ganajeevamrutham for the years 2010-11 and 2011-12. The adoption of green leaf manuring in Maharashtra is slightly better than Andhra Pradesh. A large number of NPM households use other practices such as Castor cake, Panchagavya and green manuring.

A further analysis was carried out in respect of Maharashtra regarding the quantities of different soil fertility management practices adopted per acre by farmers for various years. Table 4.22 indicates that NPM and non-NPM households use different quantities for different years. A three years average, reveal that, non-NPM households use higher quantities of FYM. This is due to their capacity to buy farm yard manure from the neighbouring villages. Similarly, the quantity of chemical fertilizers used by non-NPM households is also high because of the cultivation of cash crops like Cotton and soyabean across large areas. A three year average reveals that excepting FYM and vermicompost, in respect of for all other practices, NPM households use higher quantities vis-à-vis non-NPM households.

4.7.1 Fertility enhancing inputs

Some of the major SFM practices being followed by NPM sample households in Maharashtra are presented below in detail.

4.7.1.1 Farm Yard Manure (Shane khad): 2-4 tractor loads are used per acre. Each tractor load contains 2.5 tons of FYM. The cost of FYM amounts to Rs 2000/ tractor load i.e., Rs 1600 for FYM and Rs.400 towards travel charges.

4.7.1.2 Pit compost : The dimension of pits varies i.e., it can be 5 ft.long x 6 feet deep, 10 ft.long x 6 feet deep and 10 x 10 feet. All the agricultural waste and animal dung are placed systematically in layers. The compost prepared in these pits will be in a completely decomposed form with increased micro-organisms being present.

4.7.1.3 Heap compost: More heat is generated in a pit method composting. Hence, this is an improvement over pit method of composting. In this method there is scope for a lot of aeration. Pit and heap compost manures are finely decomposed. Hence, they are used while sowing, so that nutrients are available to the germinating seed.

4.7.1.4 Jeevamruth: This is prepared by mixing 200 lits of water + 10 kgs of desi cow dung + 5 lits of cow urine. The desi cow-dung is more powerful and useful. Neither

Table 4.22: Per acre average quantity of different SFM methods used (in Kgs) by sample households for the years 2011-12, 2010-11 and 2009-10 in Maharashtra

N=240)

Soil Fertility	2011-12		2010-11		2009-10		Average of three years	
Management method	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM	NPM	Non-NPM
Farm Yard manure	2829.82	3355.66	3550	1249	3110.28	6847.75	3163.36	3817.47
Chemical fertilizers	0.0	523.04	0.0	430.94	0.0	348.57	0.0	434.18
Tank silt	2000	2800	3500	600	2333.33	1850	2611.11	1750
Sheep penning	1500	2333.33	1620	600	1400	600	1506.67	1177.77
Neem cake	1400	800	350	0.0	500	900	750	566.67
Jeevamrutham*	546	0.0	443	0.0	427.78	0.0	472.26	0.0
Ganajeevamrutham	870.48	0.0	604.0	1243.75	611.25	600	695.16	614.58
Poultry Manure	0.0	0.0	3500	450	0.0	300	1166.67	250
Green leaf manuring	905	610	1825	560	383	300	1037.67	490.00
Vermicompost	500	900	200	500	40	625	246.67	675.0
Others	419.59	0.0	24.70	0.0	26.01	0.0	156.76	0.0

Note: *The quantity of jeevamrutham is given in litres

jersey dung nor buffaloe dung should be used. To this liquid, one kg each of redgram and Bengal gram flour along with 1-2 kgs of jaggery is added. The quality of jaggery can be of ordinary type. In case jaggery is not available, even papaya or banana fruit can be used. Finally 2kgs of soil (mixed with bird droppings) collected from beneath a large peepal tree or any big tree added to the mixture. This kind of soil contains diverse soil microorganisms which multiply fast in the mixture. All these ingredients are mixed for 4 days under shade and is mixed in a clock-wise direction 3 times a day. It should not be stirred in an anti clock-wise direction as it is believed to have a negative impact on micro-organisms being present. The resultant product is called jeevamruth. For effective results, in the first year, a quantity of 1000litres (5drums) of jeevamruth per acre is applied. In the subsequent 2nd and 3rd years a quantity of 800 litres and 600 litres of jeevamruth is applied respectively. After that, every year application of 600-800 litres of jeevamruth, is good for soil health. Initially, in view of the soil being already is affected due to continous applications of chemical fertilizers, higher doses of jeevamruth are used to bring it back to a healthy condition. The dosage of jeevamruth is the same for all crops. No preparation expenses are involved as farmers can make it by themselves with the locally available resources.

4.7.1.5 Gana Jeevamruth: This is a solid form jeevamruth. 100 litres of jeevamruth is poured on 100 Kgs of cow dung heap and gunny bag is covered on this heap and water is sprinkled on this heap. After 10-15 days, ganajeevamruth gets ready. It can be broadcast on soil. As a Maharashtrian farmer says, *"Ganajeevamruth urea ka kaam kartha, jeev badaneka kam jeevamruth kartha"* (Ganajeevamruth does the function of urea, while as jeevamruth enhances the population of microorganisms. In general, farmers tend to use more of jeevamruth. For example, while irrigating, it is used in the case of wheat and Bengal gram. In respect of Bengal gram, some times, a broom stick is dipped in jeevamruth before thumping on plants. In the case cotton crop 15 days after germination for the first time, it is applied using a small tin and bucket. They pour jeevamruth near each plant, while in the case of cotton Jeevamruth is applied 4-5 times. Jeevamruth does not get spoiled even upto 1-2 months and hence, family members can apply in cotton according to their convenience. In Maharashtra, Jeevamruth is used mostly in respect of wheat and Bengal gram (chana) with a yield increase of 2-3 quintals.

In addition to above inputs, similar to like in Andhra Pradesh, farmers in Maharashtra also have been using soil fertility enhancing practises such as deep summer ploughing, inter/mixed cropping and crop rotation.

4.8.1 Constraints involved in NPM adoption

We could see from this study that farmers in Maharashtra and Andhra pradesh have adopted different kinds of NPM methods successfully. However, they have expressed certain difficulties in following these methods. Some of the major constraints reported by farmers are listed below.

- Farmers expect ready made NPM products to use. They do not have time and interest to prepare those bio-pesticides, as a bit of hard work is involved in making bio-pesticides. All these days, they have been used to ready made products.
- Lack of cement tank/drum for preparation of Jeevamruth, a crucial soil fertility enhancing input with implications for resistance to pest incidence through healthy crops.
- Labour shortage for manual application of jeevamruth near each plant. Lack of timely availability of labour during critical periods also discourages farmers from opting for Jeevamruth.
- Everybody says it is effective, but does not come forward to adopt it. More awareness and support are needed.

4.8.2 Suggestions for the spread of NPM

Farmers in both the states have suggested the following measures for the spread of Non-pesticidal management methods .

- Provision of cements tank for preparation of Jeevamruth. Cement tanks of 1000 litres capacity should be supported by Government. This costs around Rs.4,000.
- NPM approach needs to be continuous so that soil quality improves over a period of time with stabilized yield levels.
- A premium price should be provided to organically grown products through NPM method, which is not happening now.
- Market prices should be stabilized for agricultural produces like cotton in that in that prices should not fluctuate.
- Soil and moisture conservation measures which play a key role in crop yields should be taken up across dryalnds.
- Loans for purchasing of livestock should be provided to small and marginal farmers.

- Model farms need to be established for promoting NPM approach.
- While discouraging the use of chemical pesticides, the government should promote the use of organic and bio-pesticides.
- Government should extend all kinds of subsidies for the spread of NPM approach.

4.8 Conclusion

The empirical evidences emerging from the present study in respect of Maharashtra and Andhra pradesh very clearly indicates that, farmers are inclined towards non-pesticidal management options for different crop pests. The use of local resources for pest management has drastically reduced the input costs incurred on pest and disease management. The study results show that pest management expenses of NPM households are relatively less than non-NPM households who used chemical pesticides for pest and disease control. The study also shows that there is a need for encouraging and supporting the activities which promote the adoption of these practices among farmers in respect of diverse agricultural and horticultural crops. The evidence from this chapter clearly brings out the farmers' understanding of the relationship between soil fertility and pest/disease incidence. Given the range of bio-pesticides being used by farmers, there is a need for further research in the arena of bio-pesticides and their application besides promoting the preparation of these bio-pesticides at the village level, using the community based organizations such as self help groups and rythu mithra groups, that are stronger in both these states.

Chapter 5
Conclusions

Pest management is a crucial component of crop husbandry. Hitherto, traditional cropping systems with local pest and disease resistant varieties could take care of pest menace to a great extent without causing much economic damage. However, the introduction of green revolution technologies not only increased crop yields, but also enhanced the incidence of pests and diseases. Several secondary pests have become primary pests as their natural enemies got wiped out due to an indiscriminate use of pesticides. Out break of dreaded pests such as heliothis in respect of cotton crop have caused severe economic losses to farmers besides pushing them tinto a debt trap. In several cases, farmers in cotton growing states have committed suicides as they were unable to overcome financial crisis due to heavy investments on pesticides. The present study looked at the non-pesticidal management methods of pest control which the farmers of Maharashtra and Andhra pradesh have been using in the cultivation of crops for a fairly long time. Based on the empirical findings of this study, the following conclusions are drawn.

5.1 Non-Pesticidal Management Practices

NPM farmers in Maharashtra and Andhra pradesh have been using diverse non-pesticdal management practices. These include cultural, mechanical, biological and botanical pesticide usage practices. Most of these practices are based on the resources available at village level and are easy to adopt. Certain crop-specific/pest-specific NPM methods are also seen.

5.2 Strengthening of village economy through livelihood enhancement

Adoption of several NPM practices involves labour component. Preparation of botanical pesticides also involves certain amount of manual work. The use of non-pesticidal management methods on a large scale is providing employment to villagers, there by increasing their basket of livelihood options. As a result of this, the village economy has become increasingly stronger with money not going to pesticide companies.

5.3 Revival of Intercropping/mixed cropping systems

Inter and Mixed cropping system is the fundamental principle to be adopted for a successful pest management. Empirical evidence from the study reveals that, a large number of

sample farmers in both the states have adopted either intercropping or mixed cropping system. This, inturn, has enhanced the population of natural enemies, thereby controlling crop pests naturally, to a certain extent. The adoption of the mixed cropping system with traditional pest and disease resistant varieties has enhanced the agro-biodiversity of the study region.

5.4 Abundance of Traditional Knowledge

The empirical evidence based on the present study points to a treasure of vast traditional knowledge possessed by farmers in Maharashtra and Anantapur with regard to pest management. This knowledge is based on farmers' experience accumulated through generations regarding pests and their behavoiur. Livestock play a key role in pest management through the usage of cowdung and cow urine. It could be seen that the non-pesticidal pest management is based on the locally available resources. Hence, farmers had greater control over managing their crop pests without depending on external resources (Sinha *et al*,2008).

5.5 Diverse Soil fertility Management practices

Fertile soil is the first anecdote to pest management. The evidence from the study reveals that farmers practise a range of soil fertility management methods which keep soil healthy. Interestingly, a majority of these practices are organic in nature, adding large amounts of organic matter to soil. An, improvement in the over all soil health helps crops become more resistant to pests and diseases (Reddy, 2011).

5.6 Economically viable

The empirical evidence from the period between 2009-12 reveals that farmers adopting non-pesticidal management methods have incurred less expenses in respect of pest management as compared to those farmers who use chemical pesticides for pest control. The study indicates that for all the three years, NPM households have earned a couple of thousand more net income from farming as compared to non-NPM households. This strongly suggests that crop cultivation is economically viable for farmers adopting non-pesticidal management methods.

5.7 Environmental benefit

Farmers have been using bio-pesticides as an alternative to chemical pesticides and hence, pollution levels have come down. As a result of this a threat to soil, underground water, water bodies in the villages and all life forms on earth got reduced substantially. Similarly, some of the famers have been using organic soil fertility enhancement methods. This too adds to an improvement in the environmental conditions. The long term negative impacts

of Bt cotton cultivation is a matter for serious concern for farmers as they could see the failure of Bt cotton on many fronts in Maharashtra.

5.8 Need for policy support

The empirical evidence based on the study in respect of Maharashtra and Andhra pradesh clearly indicates that farmers use non-pesticidal management methods so as to reduce their costs on pest management. Farming is economically viable in the context of NPM methods. However, farmers have reported that they face difficulty in timely accessing of NPM technologies such as bio-pesticides. There is an emerging need for providing a strong policy support for promoting non-pesticidal management methods at the grass roots level in general and the establishment of small-scale enterprises for manufacturing bio-pesticides, in particular. More importantly, NPM methods should be provided a level playing field with chemical pesticides. More awareness regarding the handling and use of poisonous pesticides should be created among farmers who are still dependent on pesticides for pest management. Efforts must be directed towards increasing the population of natural enemies of crop pests. To protect people and the environment from pesticides, there is a need for shifting from a chemicals centric agricultural system to one that embraces ecological practices, traditional knowledge and farmers' rights, especially those of women (Watts, 2010). A gradual reduction in the pesticide usage in crop production can result in an improvement in access to safe and healthy food for human beings, animals and birds.

References

Abate, T. (1998) "Carbosulfan Seed Dressing, Sowing Date and Varietal Effects on Maize Stalk Borer". P*est Management Journal, Ethipia* 2:85-89.

Abatel, T., Van Huis, A. and Ampofo, J.K.O. (2000) "Pest Management Strategies in Traditional Agriculture: An African perspective", *Annul.Rev.Entomology*, 45:631-659. Agriculture Today. (2012) National Agriculture Magazine, New Delhi.

Ahemed, K.U., Raheman, M.M., Alam, M.Z. and Ahemed, S.U. (2004) "Method of Pest Control and Direct Yield Loss Assessment of Country bean at Farmers field Conditions: A Survey Finding", Pakistan *Journal of Biological Sciences*, 7(2):287-291.

Akhtar, Wasim (2008) "*Harmful Effects of Pesticides on Non- targeted Organisims*". Ezine9.com, Hyderabad.

Alam, Ghayur (2000) "A study of Bio-pesticides and Bio-fertilisers in Haryana, India", *Gate Keeper Series* no.93, International Institute for Environment Development, London,U.K.

Altieri, M.A. and Letourneau, D. K. (1982) Vegetation Management and Biological Control in Agro Ecosystems. *Crop Protection,* 1:405-430.

Altieri, M.A. (1990) The Ecology and Management of Insect Pests in Traditional Agro-ecosystems, In: D.A.Posey and W.L Overal (Editors), *Proceeding of First International congress of Ethnobiology*, 19-22 July 1988, Belem, Brasil, pp.131-143.

Altieri, A.M. (1993) "Ethno Science and Biodiversity: Key Elements in The Design of Sustainable Pest Management Systems for Small Farmers in Developing Countries", *Agriculture, ecosystems and environment*, 46 , 257-272.

Altieri, A. M. and Nicholls, I.C. (2003) "Soil Fertility Management and Insect Pests: Harmonizing Soil and Plant Health in Agro Ecosystems", *Soil & Tillage Research*, 72(2003) 203-211, ELSEVIER.

Balak Ram. (2003) Impact of Human Activities on Land Use Changes in Arid Rajasthan: Retrospect and Prospects. In *Human Impact on Desert Environments*, eds,P.Narain, S.Kathaju, A.Kar, M.P.Singh and Praveen Kumar, 44-59, Jodhpur, India: Scientific Publishers.

Butterworth, J., Adolph, B. and Suresh Reddy, B. (2003) *"How Farmers Manage Soil Fertility. A Guide to Support Innovation and Livelihoods"*, Hyderabad: Andhra Pradesh Rural Livelihoods Programme/Chattam: Natural Resources Institute.

Cacek, Terry and Langer,L., Linda (2009), "The Economic Implications of Organic Farming", *American Journal of Alternative Agriculture*, June2009,pp. 1-9.

Chandrika, M. (2003) "Pesticides Hardly Hit Pests, They Hit Us", Times of India.15th April,

Chitra Grace. A., Muraleedharan, V.R., Swaminathan. T. and Veeraraghavan, D. (2006) "Use of Pesticides and Its Impact on Health of Farmers in South India". *International Journal of Occupational and Environmental Health* 12: 228-233.

Chong Mark. (2005) "Perception of The Risk and Benefits of Bt Egg Plant by Indian Farmers", *Journal of Risk Research*, pp 617-634.

Cleveland, D.A., Soleri, D. and Smith, S.E. (1994) "Do Folk Varieties have a Role in Sustainable Agriculture?", *BioScience*, Vol. 44, pp. 740-51.

Department for International Development (2001) "*Perspectives on pests*", Achievements of research under the UK DFID's Crop Protection Programme, 1996-2000.

Devi, P.I. (2010) "Pesticides in Agriculture- A Boon or a Curse? A Case study of Kerala", *Economic and Political Weekly*, Vol. XLV Nos. 26 &27.

Down to Earth (2006) "*Out of the Trap - No Pesticides*", May 31st, Centre for Science and Environment, New Delhi.

ESCAP. (2002) *Organic Agriculture and Rural Poverty Alleviation: Potential and Best Practices in Asia*. Economic and Social Commission for Asian and the Pacific, United Nations, New York.

GoI. (2008) APEDA, Ministry of Commerce and Industry, New Delhi, India

GoI. (2012) "Indian Fertiliser Scenario". Department of Fertilisers, Ministry of Chemicals and fertilisers, Government of India, New Delhi.

GoI. (2013a) Report on "*Production and Availability of Pesticides*" submitted by standing committee on chemicals and Fertilisers (2012-13) to parliament, August 2013, Ministry of Chemicals and Fertilisers, New Delhi.

GoI. (2013b) "*State of Indian Agriculture 2012-13*", Ministry of Agriculture, Department of Agriculture and Co-operation, New Delhi.

Gebre-Amlak, A., Sigvald, R. and Pettersson, J. (1989) "The Relationship Between Sowing Date, Infestation and Damage by The Maize Stalk Borer, *Busseola fusca* on Maize in Awassa, Ethiopia", *Tropical Pest Management* 35: 143-45.

Heong, K.L., Escalad, M. M., Sengsovlivong,V. and Schiller, J. (2002) "Insect Management Beliefs and Practices of Rice Farmers in Laos, Agri. Ecos. Environ.92:137-145.

Huan, N.H., Mai. V., Escalada,M.M and Heong, K.L. (1999) "Changes in Rice Farmers' Pest Management in The Mekong Delta, Vietnam", Elsevier.

IAASTD (2008) The International Assesment of Agricultural Knowledge, Science and Technology for Development (IAASTD. http://www.agassessment,org

IAASTD (2009) "Agriculture at Cross Roads: Synthesis report", International Assessment of Agricultural Knowledge. Science and technology for Development ,Washington.

Iyengar, Sudharshan and Lalitha, N. (2007) "GM Cotton in Gujarat: General Madness or Genuine Miracle", Asian Biotechnology and Development Review, 9(2): 45-82

Joshi. G. and Pandy, S. (2005) "Effects of Farmers Perception on The Adoption of Modern Rice Varieties in Nepal" paper presented at the conference on International Agricultural Research for Development, Oct 11-13.

Kashyap (1998), "Farmers Innovatory Approach Towards Managing Gram-pod Borer on Redgram", Honey Bee Newsletter, Shristi, Ahmedabad,Vol.3.

Kavitha, K. (2005) "Effects of Pesticide Exposure on Developmental Task Preferences in Indian Children", Children,Youth and Environments, 15(1):83-114.

Kavita, K (2006) "Biosafety and Beyond", Economic and Political Weekly, Oct 7, pp4245-4247

Kolawole, O.D. and Laogun, E. A. (2005) "Between Man and His Environment: Indigenous Knowledge Approaches to Soil Fertility Conservation Amongest Farmers in Ekiti State, Nigeria", J.Home. Ecol., 17(2): 109-115.

Krishna raj, M. (2006) "Food Security, Agrarian Crisis and Rural Livelihoods Implications for Women", Economic and Political Weekly, December 30, pp 5376-5388.

Kumar, Anil, K. (2010) "Local Knowledge and Agricultural Sustainability: A Case study of Pradhan Tribe in Adilabad District", Working paper No.81, Centre for Economic and Social Studies, Hyderabad.

Kumar, Praduman., Mittal, S. and Hussian, M. (2008) "Agricultural Growth Accounting and Total Factor Productivity in South Asia: A Review and Policy Implications", .Agricultural Economics Research Review, 21(2):145-172.

Lightfoot, C., Ramirez, R., Groot, A., Noble, R., Alder, C., Shao, F., Kisauzi, D. and Bekalo, I (2001) "Learning Our Way Ahead: Navigating Institutional Change and Agricultural Decentralisation". Gatekeeper Series no.98. London: IIED.

Little, A., Robinson, E., Williamson, R., Lamboll, R., Meir, C., Acola, G., Ali, A., Bagirwa, G., Bockett, G., Kimani, M., Miro, R., Otieno Oruko, L., Sekamatte, B., Serubombwe, W and Ssemwanga, J.(2000) "Analysis of Farmers Decision-Making in Pest Management".pp 81-90 In: Sustaining change; Proceedings of workshop on the factors affecting uptake and adoption of Department for International Development (DFID) Crop Protection Programme research out puts. Hainsworth, S.D and Eden-Green, S.I (Eds). Imperial college at Wye.Wye College, Kent,U.K.21-23 june 2000, Natural Resources International Limited, Chatam Maritime, Kent, U.K.

Magdoff, F. and Vanes, H. (2009) "Building Soils for Better Crops-Sustainable Soil Management", Hand book series book 10, Sustainable Agriculture Research and Education(SARE), Mational Institute of Food and Agriculture, University of Maryland and University of Vermont.

Mancini, F., Van Brugen, A., Jiggins, H.C., Jiggins, J.L.S., Ambatipudi, A.C., Murphy, H and Helen. (2005) "Acute Pesticide Poisoning among Female and Male Cotton Growers in India". Int J Occup Environ Health; 11:221-232.

Mancini, F., Van Bruggen, A., Jiggins, H.C and Jiggins J.L.S. (2007) "Evaluating Cotton Integrated Pest Management (IPM) Farmers Field School Outcomes Using The Sustainable Livelihoods Approach in India". Experimental Agriculture, 43:97-112 C_2006 Cambridge University Press.

Mansur,C.P., Kubsadand, V.S. and Monjonath, L. (2007) "A Study on Farmers' Perception About Contour Bunding" Karnataka Journal of Agricultural Science, 20 (2), pp.228-229.

Mark, E.J., Joseph, D., Magdalene, A. and Samuel.K. (2003) "The Role of Women in Pest Management Decision Making in Eastern Uganda" Journal of International Agricultural and Extension Education, Vol 10, No.3.

Mekonnen,Y. and Agonafir, T. (2002) "Personal Protective Equipment Use by Farm Workers in Ethiopia", Pesticide News, 2002:55

Mohanty, B.B. (1999), "Agricultural Modernisation and Social inequality: Case Study of Satara District", Economic and Political Weekly, Vol. 34, No. 26 pp. A50-61.

Mohanty, B.B. and Sangeetha Shroff (2004), "Farmers' Suicides in Maharashtra", Economic and Political Weekly, December 25th, pp. 5599 to 5606.

Narayanamoorthy, A. and Kalamkar, S. S. (2006) "Is Bt Cotton Cultivation Economically Viable for Indian Farmers? An Emplical Analysis", Economic & Political Weekly, 41 (26): 2716-24,

National Biodiversity Strategy and Action plan. (2001) Strategy and Action Plan for Agro-biodiversity for Sub-state site of Zaheerabad region in the Deccan, Andhra Pradesh, India, Published by Deccan Development Society, Pastapur, Medak District, AP.

Obopile, M., and Mosinkie, K.T. (2007) "Integrated Pest Management for African Bolloworm (Helicoverpa armigera) in Botswana: Review of Past Research and Future Perspectives", Journal of Agricultural, Food and Environmental Sciences, Vol.1, Issue 2.

Osunde, M.A.A (1996) "Research in Indigenous Knowledge Systems for Sustainable Agricultural Development", A Paper delivered at a workshop on indigenous knowledge and Biotechnology, Polyconsult seminar room, The polytechnic, Ibadan.pp1-8.

Pesticide Action Network (2010) "Communities in Peril: Global report on health impacts of Pesticide use in Agriculture".

Poinetti, C. and Reddy Suresh. B. (2002) "Farmers' Perceptions of Crop diversity in the Deccan Plateau", SEEDLING, Quarterly news letter of Genetic Resources Action International (GRAIN), Spain.

Pioneeti, C. (2006) "Seed Diversity in The Drylands: Women and Farming in South India", Gate Keeper Series, No 126, International Institute for Environment and Development.

PMEAC. (2012) "Economic Outlook 2012/13" Economic Advisory Council to the Prime Minister, New Delhi. August 2012.

Pretty, J. and Hine. R. (2001) "Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence", Centre for Environment and Society, University of Essex.

Purushottam, M., Ponnurasan, N. and Narayansamy, P. (2009) "Tribal Pest Control Practices of Tamil nadu for Sustainable Agriculture", Indian Journal of Traditional Knowledge, Vol.8 (2),pp.218-224.

Quijano, R.F. (2002) Endosulfan Poisoning in Kasargad, Kerala, India: Report on a Fact-Finding Mission. Pesticide Action Network Asia and the Pacific, Penang.

Rajendran. S, (2003) "Environment and Health Aspects of Pesticides Use in Indian Agriculture" in Martin J.Bunch, V.Madha Suresh and T.Vasantha Kumaran, eds. Proceedings of the third International conference on Environment and Health, Chennai, India, 15-17 December, 2003. Department of Geography, University of Madras and Faculty of Environmental studies, York University, pages 353-373.

Ramanjaneyulu, G.V. and Kavitha, K. (2006) "Bt Cotton in India: Sustainable Pest Management", Economic and Political Weekly.

Ramanjaneyulu, G.V., Chari, M.S., Raghunath,T.A.V.S,, Zakir, H. and Kavita, K (2009), "Non-Pesticidal Management-Learning from Experiences", Leisa India, Volume 11,No4.pp 6-9.

Rao Krishna G.V. (1991), "Impact of Dryland Farming Technology Production, Income and Employment in Ranga Reddy District of Andhra Pradesh", PhD Thesis, Agriculture College, Acharya N.G. Ranga Agricultural University, Rajendra Nagar.

Rao, Srinivas., Venkateswarlu, V., Surender, T., Eddleston, M. and Buckley, N.A.(2005) "Pesticide Poisoning in South India: Opportunities for Prevention and Improved Medical Management". Tropical Medicine and International Health. 10(6): 581-588.

Rao, Chandrashekar. N. and Mahendra Dev. (2009) "Socio-economic Impact of Transgenic Cotton", Agricultural Economic and Research Review, Vol 22 (conference number), 2009 pp 461- 470

Rao Ranga G.V., Rupela, O.P., Rao Rameshwar,V. and Reddy, Y.V.R. (2007) " Role of Biopesticides in Crop Protection: Present Status and Future Prospects", Indian Journal of Plant Protection Vol. 35. No.1, 2007(1-9)

Rao Sreenivas,I., Naidu, D.C., Swamy,V. and Naidu, M.V. (2010) "Biodiversity and Traditional Knowledge Systems of Rice in The High-altitude and Tribal zone of Andhra Pradesh, India", Paper presented at the 28th International Rice Research Conference on "The Social and Cultural Dimensions in Rice Farming and Communities", 8-12 November, Hanoi, Vietnam.

Reddy Suresh. B. (1999) "NPM-Way of Achieving Food Security", LEISA India, AME, Banglore,

Reddy Suresh, B. (2009) "Sustenance and Enhancement of Agro-biodiversity: Voice of Stake Holders from Deccan Area of Southern India". Journal of Social Action, Vol 59, No1, pp19-30.

Reddy Suresh, B. (2010a) "Paradigm Shift in Non-Pesticidal Management: A Case Study of Pod Borer Management in Deccan Plateau", Madhya Pradesh Journal of Social Sciences,Vol.15, No.1,June 2010, pp77-86.

Reddy Suresh, B. (2010b) "Assesment of Economic and Ecological Returns from Millet based Bio-diverse Organic Farms vis-à-vis Conventional Farms", CESS Monograph Series No.8, Centre for Economic and Social Studies, Hyderabad.

Reddy Suresh, B. (2010c) "Soil Fertility Management in Semi-Arid Regions: The Socio-Cultural, Economic and Livelihood Dimensions of Farmers' Practices - A case of Andhra Pradesh, unpublished PhD Thesis, Centre for Economic and Social Studies, Dr.B.R.Ambedkar University, Hyderabad.

Reddy Suresh, B. (2010d) "Organic Farming: Status, Issues and Prospects -A Review", Agricultural Economics and Research Review", Vol.23, July-Dec, New Delhi.

Reddy Suresh, B. (2011) "Dynamics of Soil Fertility Management Practices in Semi-Arid Regions : A Case Study of AP". Economic and Political Weekly, Mumbai, Vol XLVI No 3, pp 56-63.

Reddy Suresh, B. (2013a) "Non-Pesticdal Management of Pests: Status, Issues and Prospects - A Review", working paper no.130, Centre for Economic and Social Studies, Hyderabad.

Reddy Suresh, B. (2013b) "Soil Health: Issues and concern - A Review", working paper no.131, Centre for Economic and Social Studies, Hyderabad.

Rola, A.C. and Pingali, P.L. (1993) "Pesticides, Rice Productivity and Farmers' Health: An Economic Assessment", The Phillipines; International Rice Research Institute and Washington, DC: World Resources Institute.

Sainath, P. (2007) One Farmers' Suicide every 30 minutes. The Hindu. Thursday Nov 15.http;/www.hindu.com/2007/11/15/stories/2007111554771300.htm.

Sarma, E.A.S. (2004) "Is Rural Economy Breaking Down? Farmers' Suicides in Andhra Pradesh", Economic and Political Weekly, July 10, pp 3087-3089.

Satheesh, P.V.(2002) "Crops of Truth: Farmers' Perception of Agro-biodiversity in The Deccan Region of South India", Booksline publishing, Hyderabad.

Scoones Ian, (2001) "Dynamics and Diversity: Soil Fertility Management and Farming Livelihoods in Africa: Case Studies From Ethiopia, Mali and Zimbabwe", DFID, London.

Segura.H.R., Barrera,J.F., Morales,H., and Nazar,A (2004) "Farmers' Perceptions, Knowledge, and Management of Coffee Pests And Diseases and Their Natural Enemies in Chiapas, Mexico", Entomological Society of America.97 (5): 1491-1499.

Sharifi, M., Sharifzadeh, A., Akbari, M. and Hashemi, S.M. (2008) "Studying Integrated Pest Management Rice Farming Practices in Marvdasht County, Iran: A Baseline Survey", American-Eurasian Journal of Sustainable Agriculture, 2(2): 158-164.

Shetty, P.K., Murugan, M and Sreeja, K.G (2008) "Crop Protection Stewardship and in India: Wanted or Unwanted" , Current Science, 95(4):457.

Sinha, B., Choudhary,D. and Roy, S. (2004) "Traditional Practices in Pest Management:Some Examples from North-East India", Paper presented at the regional seminar on the role of biodiversity and environmental strategies in North East India.

Sinha. B., Dey,S. and Kalita, J. (2008) "How The Hill Farmers Control Pests Using Locally Available Resources: Lessons From The Upland Areas of North East India", Available at SSRN: http://ssrn.com/abstract=1303990 or http://dx.doi.org/10.2139/ssrn.1303990..

Singh, Ranjay K. and Singh, Pavan K. (2005) "Fertility Management Dynamics of Soil: Exploration of Farmers Hidden Wisdom" Journal of Asian Agri-History vol 9, No.4, pp 291-303.

Sinzogan, A.A.C., Van Huis, A., Kossou, D.K., Jiggins, J. and Vodouhe, S. (2004) " Farmers' Knowledge and Perception of Cotton Pests and Pest Control Practices in Benin: Results of a Diagnostic Study", NJAS , 52-3/4.

Sorby, K., Feischer, G and Pehu, E (2003) "Integrated Pest Management in Development: Review of Trends and Implementation strategies". Agriculture and Rural Development working paper 5, World Bank Washington D.C.

Sullivan, G.H., Sanchez, G.E., Stephen, Weller, S.C and Edwards, R.C. (1999) "Sustainable Development in Central America's Non-Traditional Export Crops Sector Through Adoption of Integrated Pest Management Practices: Guatemalan Case Study", Sustainable Development International, pp-123-126.

Susmita Dasgupta., Craig.M and David,W. (2004), "Is Environmentally-Friendly Agriculture Less Profitable for Farmers? Evidence on Integrated Pest Management in Bangladesh", World Bank Policy Research Working Paper 3417.

Vaidyanathan, A. (2006) "Farmers' Suicide and The Agrarian Crisis", Economic and Political Weekly, Sept 23, pp 4009-4013.

Vasavi, A,R. (1999), Agrarian Distress in Bidar: Market, State and Suicides, Economic and Political Weekly, August 7, pp 2263-2268.

Vasavi, A,R. (2009), "Suicides and The Making of India's Agrarian Distress", South African Review of Sociology, 40(1).

Vasquez-Caicedo, G., Portocarrero, J., Ortiz,O. and Fonseca,C. (2000) "Case Studies on Farmers' Perceptions About Farmers Field School (FFS) Implementation in San Miguel Peru: Contributing to Establish the Baseline for Impact Evaluation of FFS". Report to the DECRG from the World Bank, May. As quoted in by Godtland Erin, Elisabeth Saoulet, Alain de Janvry, Rinku Murgai and Oscar Ortiz (2003). The Impact of Farmer-Field-Schools on Knowledge and Productivity: A study of Potato Farmers in the Peruvian Andes, Department of Agricultural and Resource Economics, UCB CUDARE Working Papers (University of California, Berkeley).

Vijay Kumar, T., Raidu,D.V., Jayaram, K., Madhavi, P., Parmesh,S., Vijayasekar, K. and Smriti, L. (2009) "Ecologically Sound, Economically Viable - Community Managed Sustainable Agriculture in Andhra Pradesh, India", Society for Elimination of Rural Poverty, Hyderabad, Andhra Pradesh and the World Bank, Washington, DC.

Vyas, V.S. (2000), "Agrarian Structure, Environment Concerns and Rural Poverty", Elmhirst Memorial Lecture, XXI International Conference of Agricultural Economists, Tokyo,Japan, August 22.

Watts, M.A. (2010) "Pesticides: Sowing Poison, Growing Hunger, Reaping Sorrow", Pesticide Action Net work Asia and the Pacific, Penang.

World Bank Agriculture and Development Department (2005) "Sustainable Pest Management : Achievements and Challenges, Report No.32714-GLB.

Yengoh, G.T. and Svensson, M.G.E. (2008) "Low External Input Strategies for Sustainable Small-Scale Farming in Kenya: A Systems Dynamic Approach", Paper presented at the 26th International Conference of the System Dynamics Society, July 20-24, Athens, Greece.

Zainab S.Abdullah., Lada,Y.V. and Khamis,M. (2010), "Experiences in Adoption of Integrated Pest Management Strategies in Zanzabir", OIDA International Journal of Sustainable Development, 02:03, pp49-55.

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