

**SOCIO-ECONOMIC IMPLICATIONS OF PESTICIDE USE IN
BATHINDA DISTRICT OF THE PUNJAB STATE**

Dissertation Submitted to the Central University of Punjab

For the award of

Master of Philosophy

In

Economic Studies

By

Harvinder Kaur

Supervisor

Dr. Sandeep Kaur Bhatia



Centre for Economic Studies
School of Social Sciences
Central University of Punjab, Bathinda

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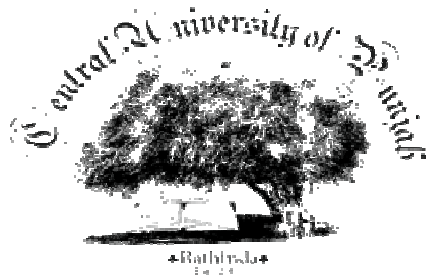
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CERTIFICATE

I declare that the dissertation entitled “SOCIO-ECONOMIC IMPLICATIONS OF PESTICIDE USE IN BATHINDA DISTRICT OF THE PUNJAB STATE” has been prepared by me under the guidance of Dr. Sandeep Kaur Bhatia, Assistant Professor, Centre for Economic Studies, School of Social Sciences, Central University of Punjab. No part of this dissertation has formed the basis for the award of any degree or fellowship previously.

Harvinder Kaur
Centre for Economic Studies,
School of Social Sciences,
Central University of Punjab,
Bathinda – 151001.

DATE:

CERTIFICATE

I certify that HARVINDER KAUR has prepared her dissertation entitled “SOCIO-ECONOMIC IMPLICATIONS OF PESTICIDE USE IN BATHINDA DISTRICT OF THE PUNJAB STATE”, for the award of M.Phil. degree of the Central University of Punjab, under my guidance. She has carried out this work at the Centre for Economic Studies, School of Social Sciences, Central University of Punjab.

Dr. Sandeep Kaur Bhatia
Centre for Economic Studies,
School of Social Sciences,
Central University of Punjab,
Bathinda - 151001.

DATE:

ABSTRACT

Socio-Economic Implications of Pesticide Use in Bathinda District of the Punjab State

Name of Student : Harvinder Kaur
Registration Number : CUP/MPhil-PhD/SSS/CES/2012-2013/08
Degree for which submitted : Master of Philosophy
Name of Supervisor : Dr. Sandeep Kaur Bhatia
Centre : Centre for Economic Studies
School of Studies : School of Social Sciences
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The excessive use of the pesticides in agriculture has not only increased production cost but also led to negative externalities. The present study is an attempt to analyse the socio-economic implications of pesticide use in Bathinda district known as cotton belt as it has maximum area under cotton cultivation. Among eight blocks, two blocks namely Talwandi Sabo having maximum area under cotton cultivation and Phul block having maximum area under paddy cultivation had been selected for the study. Therefore, in the present study entitled "Socio-Economic Implications of Pesticide use in Bathinda District of the Punjab State", an attempt has been made to assess efficiency of two farms growing cotton and paddy and also to find out the impact of pesticides on gross returns of the crops and also on health of farmers and agricultural labourers. The farmers and agricultural labourers engaged in growing cotton and paddy were randomly selected across two villages i.e. Laleana and Rayia respectively. The primary data was collected from 120 farmers and 80 agricultural labourers through structure schedules. The data was analysed using Data Envelopment Analysis programme, Simple regression analysis, Multiple (Step-up) regression analysis and Probit model. The rate of return from pesticides for cotton crop for large farmers (Rs. 13.40) was less than medium farmers (Rs. 14.31) and small farmers (Rs. 15.44). It was the highest for small farmers (Rs. 15.44) showing that it decreases with the increase in the expenditure on pesticides. Likewise for paddy, rate of return was less for large farmers (Rs. 18.56) as they incurred more on pesticides while the highest for small farmers (Rs. 22.67). Regarding the impact of different inputs

used for returns of cotton, pesticides were significant and positive input while for paddy; labour was significant and positive variable. The result of technical efficiency reveals that cotton farms were less efficient than paddy farms. Usage of pesticides had harmful effect upon the health of farmers and agricultural labourers indicating that those were using manual backup sprayer face many problems. The farmers should be educated to identify the threshold level of pest infestation and take measures only after that instead of blindly following the neighbouring farmers while applying pesticides.

Harvinder Kaur

Dr. Sandeep Kaur Bhatia

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Harvinder Kaur

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LIST OF ABBREVIATIONS

S. No.	Full form	Abbreviation
1.	Gross Domestic Product	GDP
2.	Hectare	ha
3.	Constant Returns to Scale	CRS
4.	Variable Returns to Scale	VRS
5.	Decision Making Unit	DMU
6.	Data Envelopment Analysis	DEA

Chapter I

Introduction

The agriculture sector plays a vital role in the development of India. India witnessed a major increase in agricultural productivity in 1966 with the advent of Green Revolution. There was an enormous increase in the productivity of wheat and rice during this period (Shiva, 1991). Among the various states of India, Punjab was the hub of the green revolution. With the effect of green revolution, usage of new irrigation techniques, chemical fertilizers, synthetic pesticides, herbicides, and high-yielding varieties have increased. In India, the consumption of fertilizers has increased from around 78,000 tonnes in 1965-66 to 26.5 million tonnes during 2012-13 and the pesticides consumption has also increased from 154 metric tonnes to 55,590 metric tonnes during the same period (Indiastat.com, 2013). Green revolution has attained a significant advancement in the agricultural production, aside from food crops; the production of cash crops has also increased to a significant extent however to achieve higher productivity, high yielding varieties of seeds used by farmers were found to be prone to epidemic diseases, to protect the crops from these diseases caused by pests, it is compelled to use large amount of pesticides that is why, this increased production leads to more usage of pesticides, so the “miracle” seeds of the green revolution have become mechanism for producing new pests and creating new diseases (Shiva, 1991). Pesticides are creating more problems due to the emergence of pesticide-resistant pests. The loss through to pests is a major constraint in agricultural production and productivity. In the absence of adequate pesticides, the positive contribution of improved seeds, fertilizers and irrigation to output could be completely nullified and farmers may incur heavy losses (Shetty, 2004).

Out of all inputs, pesticides play a vital role in modern agriculture by controlling pests and diseases. According to Rao (1980) “unless production inputs are fitted with protective measures, yield increases are not possible. Today, more than 50 per cent of yield increase in agriculturally advanced countries of the world is the result of agro-chemicals” (Srivastava, 1981), but on the other hand, it leads to many health and environmental problems.

There are many crops like cotton, paddy, sugarcane and vegetables which had showed greater reliance on pesticides. Among the various crops, pesticides are generally used on cotton fields as about 45 percent of the total pesticides consumption is on cotton alone, though its cultivated area is only 5 per cent. The trend has shifted from cotton Desi to cotton American resulting less usage of pesticides. On the other hand, paddy covers just 20 per cent of the total pesticides consumed. Nearly 20-25 per cent is used for the control of sucking pests and bollworm (Murugan et al., 2011). For instance, the yield of these two most pesticides using crops, cotton and rice increased by a factor of 1.9 times and 1.8 times respectively. According to one estimate, every rupee spent in chemical pest control helps saving crop output worth Rs. 3 (Bami, 1996).

Food plants of the world are damaged by more than 10000 species of insects, 30000 species of weeds, 100000 diseases and 1000 species of nematodes. However, less than 10 per cent of the total identified species are generally considered as major pests (Dhaliwal et al., 2010), but the problem of crop loss due to pests remains an important issue.

In India pesticides were introduced in 1948 but production was started in 1952. Now, India is the second largest manufacturer of pesticides after China in Asia and ranks 12th in the world. The global average of its consumption is 500 grams per hectare. In India, it is lower than developed countries as it is 381 grams per hectare, which is very low as compared to Taiwan that has 17 kg per hectare followed by Japan and USA (Murugan et al., 2011). Among the predominant classes of pesticides used, insecticides account for 61 per cent of total consumption, followed by fungicides 19 per cent and 17 per cent of herbicides. Globally, herbicides constitute the major share, but in India insecticides play an important role (Devi, 2010).

The usage of pesticides in Indian agriculture has increased rapidly during the last few decades. It has been contributing significantly to the reduction of post harvest losses, but there is a growing concern on the ill effects of pesticides on health and the environment. In India the value of crops loss due to pests was estimated at Rs. 6,000 crore in 1983, which reported to have further increased to Rs. 29000 crore in early 1990s (Dhaliwal and Arora, 1996). The agro- chemical policy group an

apex body of 200 crop protection companies has reported that agricultural productivity loss in 2007 due to pests was about at Rs. 1.40 lakh crore (Kumarswamy, 2008). According to CARE Rating report it is estimated that country losses approximately 18 per cent of its crop yield valued at Rs 90,000 crore due to pest attacks each year. Losses due to insect pests in Indian agriculture have been estimated from time to time (Pradhan, 1964; Atwal, 1986; Dhaliwal and Arora, 1996). Cotton suffered from large loss due to pests as there was 50 per cent loss in post-green revolution period as compared to pre-green revolution when it was just 18 per cent. 32 per cent was change in loss followed by oilseeds, 20 per cent and paddy 15 per cent (Dhaliwal et al., 2010). So, the consumption of pesticides has increased after green revolution.

Table 1.1 represents the consumption of pesticides in India during the year 1991-92 to 2012-13. The results revealed that the consumption of pesticides showed a decreasing trend from 1991-92 to 2000-01. The figures came out to be 72.13 thousand tonnes in 1991-92 and 43.58 thousand tonnes in 2000-01 due to the abolishment of subsidies in year 2000. Further, the consumption of pesticides has increased to 43.58 thousand tonnes to 47.02 thousand tonnes in year 2001-02. After that it showed a mixed trend. In 2003-04 it again decreased to 41 thousand tonnes due to the introduction of BT cotton seeds, which requires less usage of pesticides due to less pest attack, but if we compare the year 2010-11 to 1991-92, the results exhibits that consumption of pesticides has decreased from 72.13 thousand tonnes to 55.54 thousand tonnes due to increase in consumption of Bio-pesticides usage in 2011-12. This clearly indicates that consumption of pesticides had decreased over time, but showing a mixed trend.

**Table 1.1: Consumption of Pesticides (Technical Grade Material) in India
(1991-92 to 2012-13)**

(Thousand tonnes)

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
1999-2000	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	52.97
2012-13	45.38

Source: Indiatat.com, 2013

Its consumption has not been uniform in the country and it varies with the intensity of pests, diseases and cropping pattern regions. The usage of pesticides is the highest in regions with better irrigation facilities and where commercial crops are grown (Shetty, 2004). Table 1.2 depicts the consumption of pesticides in all states of India from 2000-01 to 2012-13. It shows that Andhra Pradesh, Haryana, Punjab, Maharashtra and Uttar Pradesh are amongst that states using pesticides at higher level because these states have more cropped area under cotton, paddy and

vegetables. Table revealed that in few states i.e. in Andhra Pradesh and Maharashtra, this trend has increased i.e. 4000 metric tonnes in 2000-01 to 6500 metric tonnes in 2012-13 and 3239 metric tonnes to 6617 metric tonnes respectively during the same time period respectively. Overall pattern of pesticides consumption for India shows fluctuations over the time period. The same trend is followed by Punjab and found as 5725 metric tonnes in 2012-13 which was still higher than other states in the country due to intensive agriculture that needs a high utilization of pesticides. As it comprises just 2.5 per cent of the total agricultural land but consumes more than 13 per cent of the total pesticides used in India.

Table 1.2: State-Wise Consumption of Pesticides in India, 2000-01 to 2012-13
(Metric tonnes)

States/UTs	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Andhra Pradesh	4000	3850	3706	2034	2135	1997	1394	1541	1381	1015	8869	9289	6500
Assam	245	237	181	175	170	165	165	158	150	19	150	160	183
Arunachal Pradesh	13	17	15	143	17	2	17	16	10	10	10	17	-
Bihar	853	890	1010	860	850	875	890	870	915	828	675	655	687
Chhattisgarh	NA	NA	NA	332	486	450	550	570	270	205	570	600	675
Delhi	55	58	60	56	53	39	NA	57	57	49	48	-	-
Goa	6	5	5	5	5	5	9	2.3	9	10	9	8	9
Gujarat	2822	4100	4500	4000	2900	2700	2670	2660	2650	2750	2600	2190	1210
Haryana	5025	5020	5012	4730	4520	4560	4600	4391	4288	4070	4060	4050	4050
Himachal Pradesh	302	311	380	360	310	300	292	296	322	328	328	310	320
Jammu and Kashmir	1	4	98	9	12	1433	829	1248	2679	1640	1818	1711	-
Jharkhand	150	36	40	56	69	70	82	81	85	89	84	151	151
Karnataka	2020	2500	2700	1692	2200	1638	1362	1588	1675	1647	1858	1412	1225
Kerala	754	1345	902	326	360	571	545	880	273	631	657	807	856
Madhya Pradesh	871	714	1026	62	749	787	957	696	663	645	633	850	659
Maharashtra	3239	3135	3725	3385	3030	3198	3193	3050	2400	4639	8317	6723	6617

Manipur	20	14	19	25	26	28	26	26	30	30	30	33	30
Meghalaya	6	6	6	6	8	6	9	6	-	6	10	9	-
Mizoram	8	26	15	15	25	25	40	44	44	39	4	4	4
Nagaland	8	7	7	7	5	5	5	5	18	14	-	15	16
Odisha	1006	1018	1134	682	692	963	778	NA	1156	1588	871	555	601
Pondicherry	65	58	57	46	42	41	40	41	39	39	39	38	40
Punjab	7005	7200	7200	6780	6900	5610	5975	6080	5760	5810	5730	5625	5725
Rajasthan	3040	4628	3200	2303	1628	1008	3567	3804	3333	3527	3623	2802	1250
Sikkim	4	2	3	3	-	-	2	6	3	4	-	-	-
Tamil Nadu	1668	1576	3346	1434	2466	2211	2048	3940	2317	2335	2361	1968	1919
Tripura	11	16	88	118	17	14	19	27	38	55	12	266	-
Uttar Pradesh	7023	6951	6775	6710	6855	6672	7414	7332	8968	9563	8460	8839	9035
Uttarakhand	99	105	129	147	132	141	207	270	221	222	199	206	220
West Bengal	3250	3180	3000	3900	4000	4250	3830	3945	4100	-	3515	3670	3390
India	43584	47020	48350	41020	40672	39773	41515	43630.3	43860	41822	55540	52979	45386

Source: Indiastat.com, 2013

Among the Northern zone states, Punjab occupies the second position in the consumption of pesticides. The pest problem has increased with the introduction of high yielding varieties of crops, intensive use of inputs and new cropping pattern. Problems of weeds have also increased with the increase in cropping intensity. This resulted in a tremendous increase in demand of pesticides and weedicides over the period of time (Singh et al., 2012).

In Punjab, total area under cultivation was 42.21 lakh hectares in 2010-11, out of which 35.45 lakh hectares was under the usage of chemical pesticides indicating much higher usage in Punjab. Among various crops, the usage of pesticides is the highest on cotton crop. The consumption of pesticides in technical grade during 2011-12 for Rabbi was 1950 metric tonnes and for Kharif was 4200 metric tonnes (Department of Agriculture, Govt. of Punjab). Pesticides are distributed to the farmers through Government /Semi Government Agencies, Co-operative Societies and registered dealers. In 2011, the total sale points were 10653, out of which 295 sale points were of State Department of Agriculture, 994 in Co-operative and 9364 were in private sector (Department of Agriculture, Govt. of Punjab).

Table 1.3 depicts the demand and consumption of pesticides in Punjab as well as in India during 2009-10 to 2012-13. Table revealed that in 2009-10, its demand was 6500 metric tonnes while its consumption was 5810 metric tonnes; gap was 690 metric tonnes in Punjab. The corresponding data at India level shows the gap was 442 metric tonnes. In 2012-13 the demand has decreased to 6300 metric tonnes and consumption was 5725 metric tonnes that has increased as compared to the previous year. Again demand was higher than consumption due to higher cost and less availability of pesticides.

**Table 1.3: Demand and Consumption of Pesticides in Punjab
(Metric Tonnes)**

Year	Punjab		India	
	Demand	Consumption	Demand	Consumption
2009-10	6500	5810	42264	41822
2010-11	6500	5730	54637	55540
2011-12	6500	5625	59046	52979
2012-13	6300	5725	55590	45386

Source: Department of Agriculture, Govt. of Punjab, 2013

The Malwa region is less than 15 per cent of the total area of Punjab but it consumes nearly 75 per cent of the total pesticides consumed in the state. 70 per cent of Punjab's population is directly or indirectly associated with agriculture and nearly the same trend is observed in the Malwa region (Mittal et al., 2013). Cotton is a major crop in the Malwa region, which relies more on pesticides to control the infestation of pests, as the pests have developed resistance to the pesticides (Shetty, 2004). Farmers use pesticides in much higher concentration than recommended, which is another reason for fast deposition of pesticides in this region. It includes Bathinda, Barnala, Faridkot, Ferozepur, Mansa, Moga and Sangrur districts. Among these districts Bathinda and Ferozepur are highly pesticides consumed districts due to cotton belt areas because pesticide usage is the highest in the cotton fields to protect the crop from the attacks of the *Helicoverpa armigera* (American bollworm) pest.

Consumption of pesticides in Bathinda is presented in Table 1.4 during the period 1991-92 to 2011-12. Consumption of pesticides was 694620 litre in 1991-92. It was highest in 2001-02 i.e. 776434 litre while in 2008-09, it was the lowest i.e. 210864 litre indicating that an erratic trend was recorded during the study period. Overall, the consumption of pesticides has decreased. The decline in consumption was due to large scale adoption of BT cotton and availability of new chemicals requiring application in relatively small doses.

Table 1.4: Consumption of Pesticides in Bathinda
(Litre/Kg)

Year	Total pesticides
1991-92	694620
1992-93	478679
1993-94	499357
1994-95	445330
1995-96	456465
1996-97	478025
1997-98	515421
1998-99	723350
1999-2000	718540
2000-01	714091
2001-02	776434
2002-03	654914
2003-04	682945
2004-05	475850
2005-06	310832
2006-07	277384
2007-08	287602
2008-09	210864
2009-10	281041
2010-11	283755
2011-12	292460

Source: Department of Statistic, Chief Agriculture Office Complex, 2012-13

Need of the Present Study

The intensive cultivation leads to reduction in fertility of the soil and it is compensated by some additional nutrients and agro-chemical products .So, plant protection chemicals i.e. pesticides are used against insect-pests, diseases, rodents and different types of weeds, being one of the major determinants in the production process. Usage of pesticides has serious implications to economic and social development as it increases the cost of crop and leads to health and environmental problems. On the other hand, though it increases productivity by

controlling pests, but framers get diminishing returns due to its high cost. However, these crucial aspects are required to be studied in Bathinda district of Punjab known as cotton belt area irrigated by canal water grows largely cotton and rice crop - the two crops known for excessive use of pesticides is selected for the study. The present study is useful to study the social and economic impact of pesticides.

Objectives of the study

Keeping in view of the significant of the present study, an attempt is made to analyze the socio-economic implications of pesticides in Bathinda district, which is one of the major cotton producing districts of Punjab. The main objectives of the study are:

- To estimate the costs and returns of cotton and paddy crops with special reference to pesticide use.
- To estimate the efficiency of cotton and paddy farms using different inputs including pesticides.
- To examine the impact of pesticides use on returns of crops.
- To access the probability of sickness among the farmers and agricultural labourers.

Plan of the study

In order to achieve the envisaged objectives of the study, it has been divided into six chapters including the present chapter. Second chapter reviews the studies related to the socio-economic impact of pesticides in different states of India as well as in different countries. Third chapter explains the study area and methodology adopted for analyzing the primary data. The fourth chapter describes the socio-economic behaviour of selected farmers and agricultural labourers. The fifth chapter examines the socio-economic impact of pesticides and efficiency of two different farms of selected villages of Bathinda district. Lastly, sixth chapter summarizes the study with suggestions.

Chapter II

Review of Literature

The present chapter is an attempt to discuss the literature review related to the theme of the study. It has focused socio-economic aspects of pesticides including environment and health in various countries in the world as well as in various states of the India. The review of literature has been discussed under two major sections i.e. impact of pesticides at world levels in section I and at India level in section II.

Section I

An attempt has been made to know the environmental and economic costs of pesticides use in U.S. by **(Pimentel et. al., 1992)**. Study revealed that pesticides were used to increase the production, as a dollar invested in it, returns \$4 i.e. it had increased income by reducing loss due to pests. If these were not used properly, then loss would increase 10 per cent. Not only improper use of pesticides leads to crop loss, results showed that in U.S changes in agricultural practices have leads to crop loss from 7 per cent to 13 per cent. The study had showed that users of pesticides and society had to pay more. It considered \$8 billion environmental and social costs of pesticides usage in each year. Out of which \$3 billion of this cost was paid by directly users of pesticides and society had to pay \$3 billion plus the remaining \$5 billion in environmental and public health costs. This analysis of pesticide use reduced the profitability of pesticides. It was recommended that nonchemical pest control should be used to benefit the society.

Antle and Pingali (1994) had discussed the impact of pesticides on farmer's health and impact of farmer's health on productivity of crops in Philippine. Study revealed that more usage of pesticides leads to many health problems like respiratory problems and neurologic problems affecting the production process as farmers suffering from diseases could not work properly. These relationships were used in a simulation analysis to investigate the health and productivity tradeoffs. It was directly used to control pests in the process and considered their benefits but production loss due to health problems was more. Results revealed that its use had a negative effect on farmer health and positive effect on productivity. The study describes that taxes had been imposed on pesticides to minimize its

consumption as it improved the farmer's health but also reduced productivity indicating that productivity loss from reduced pesticides would be offset by the productivity gain from improved farmer's health. So the most hazardous, least pesticides should be reduced so that it could not more effect on the production process.

An economic evaluation of pesticide use externalities in the cotton zones of Punjab, Pakistan had evaluated by **Khan et al. (2002)**. The study found that the additional cost of pesticide applications, due to pesticides resistance developed in the pests was about Rs 11000 per hectare. The actual gross benefit of pest control was calculated as 8069 million rupees by multiplying incremental yield with price of seed-cotton and the total cotton area of 9 districts. The study concluded that reduced reliance on crop protection products seems inevitable for sustainable and healthy crop production. It recommended that the government of Pakistan should review mechanism for the enforcement of existing legislation in pesticide for import, registration, formulation, distribution, advertising and disposal.

Technical efficiency of cotton growers by using stochastic and Non stochastic production function approaches in four west Texas countries has been measured by **Chakraborty et al. (2002)**. The objective of the study was to find out technical efficiency of irrigated and non-irrigated farms under the assumption of constant returns to scale indicating that mean efficiency was similar i.e. 80 per cent under Data Envelopment Analysis and Stochastic Frontier Analysis. On an average, irrigated farms were more efficient indicating 80 per cent efficiency than non-irrigated farms i.e. 70 per cent. Under variable returns to scale, it was similar for irrigated and non-irrigated farms as 88 per cent. To improve technical inefficiency, it is suggested that expenditure should be reduced on other inputs without decreasing their current level of output.

Nguyen and Tran (2003) analysed the economic and health consequences of pesticides usage in paddy production in the Mekong Delta, Vietnam. The study reported that among the pesticides, insecticides were used the most i.e. 394 grams per hectare followed by herbicides 323 grams per hectare and fungicides 300 grams per hectare in the study area. On an average, farmers applied 1,017 grams of pesticides per hectare per crop. The amount of pesticides used by the

sample farmers decreased by 43 per cent compared with the amount they used in the 1992 dry season. A general decrease in the quantity of pesticide use was observed, which was attributed to the adoption of the Integrated Pest Management (IPM). Farmers tended to use hazardous but highly effective pesticide types.

Budak and Budak (2006) conducted a study based on survey comprising of 100 farmers from twenty villages to compare the differences in pest management and farm profitability in the two provinces i.e. Adana and Kahramanmaras, in East Mediterranean region of Turkey. Farmers were selected on the basic characteristics of farms, input use per hectare, type of pesticides used, and share of inputs in variable costs, target insects and type of containers. Study showed that the usage of insecticides was not same in the two regions as varied according to conditions. The average level of herbicides and fungicides use was slightly higher in Kahramanmaras than in Adana. Share of pesticides was much higher in Adana than that in Kahramanmaras which shows that in Adana 12.8 per cent of farmers reported sickness, headaches and eye or skin irritation while mixing or applying pesticides which results, more variable cost of pesticides in Adana. Shifting to organic production was considered to increase the producer's income and reduce the possible environmental and health hazards. Input taxes, subsidies, credit instruments can be used to reduce pesticide usage. Public extension services can play a major role in the reduction of pesticide use.

Ngowi et al. (2007) studied type, pattern and frequency of pesticides application in Northern Tanzania with of 61 small sample farmers growing vegetables. The study found that 41 different types of pesticides were used by the farmers in the area were, insecticides (59%), fungicides (29%) and herbicides (10%) with the remaining two per cent being rodenticides. 8 out of 41 were unregistered for general use. More than 50 per cent of the respondents applied pesticides up to five times or more per cropping season depending upon the crop. Insecticides and fungicides were routinely applied by 77 and 7 per cent, respectively. The fact was that more than 15 per cent of farmers applying pesticides 16 times or more indicating increasing trend in pesticide use. 68 per cent of farmers reported having fell sick after routine application of pesticides out of which 61 per cent farmers spends no money on health costs while others spend between .018\$ to 116 US \$ indicating higher cost. The study showed that usage of pesticides was influenced

by manufacturers and pesticide vendors as they want to increase their sales. So there is need to introduce pest management strategies to the farmers which are inexpensive and environmental friendly.

Sanfilippo and Perschau (2008) studied the social and environmental effects of pesticide use in cotton production at the world level depicting that about 25 per cent of world's insecticides are used on cotton that lead to health problems to farmers. It revealed that between 26 million and 77 million of agricultural workers suffer from acute pesticide poisoning. So chemical pesticides not only have a negative health effect but are responsible for economic loss because farmers spent US \$43 a year on medical treatment. A hazardous pesticide leads to major threat to biodiversity. So it is recommended, organic cotton should be cultivated which will be best solution to achieve long term soil fertility.

Mariyono and Bhattarai (2009) analyzed the factors affecting chilli farmers' decision to use pesticides in Indonesia indicating that farmers' objectives for plant protection are not only to obtain high yield, but also to minimize risk of crop failure and to ensure economic efficiency of farm inputs used including pesticide chemicals. The study is based on a primary survey consisting of 160 farmers from three districts of Central, Java. On an average, farmers applied 12 kg of pesticide per hectare of chilli in a crop season of four months depicting that farmers have to depend upon pesticides to control pests as it compel the government to import pesticides. The study revealed that age has a positive and size of farm has a negative relationship with the usage of pesticides. 90 per cent of farmers surveyed in the study applied pesticides more than the recommended dose, which contribute to the development of resistance to insecticides. It is recommended that there should be focus on education level of farmers that there should be focus on education level of farmers.

Shrestha et al. (2010) studied the knowledge, practice and use of pesticides among commercial vegetable growers of Dhading district, Nepal. They collected data from 30 households growing of broccoli, brinjal, cauliflower and lady finger. The study revealed that large numbers of respondents were using pesticides for more than six years. It showed that nearly 46.6 per cent applied pesticide 5-6 times, whereas, nearly one-fourth i.e. 23.3 per cent used it 3-4 times depending on

severity of pest problem in vegetables which causes more health risk to growers and consumers. 16.7 per cent farmers use extremely hazardous pesticides which were banned in the country. Majority of the growers did not receive any training on usage of pesticides and even not use protective equipment. So it is recommended that there is need for awareness, education among the farmers and there should be Integrated Pest Management programme for reducing pesticide usage.

Shrawasti (2012) made an attempt to know the socio-economic impact of pesticides use in agriculture in Panchkhal the area in Nepal. Questionnaire survey has been conducted of a sample of 1320 persons to know the pattern, frequency and extent of pesticides. The study revealed that farmers use pesticides mostly on standing crops in the field. Pattern of pesticides is increasing due to change in climate and low rate of pesticides. Increasing trend of pesticides and more usage of chemical fertilizers has increased the crop production. Lack of knowledge about usage of pesticides leads to many health problems to respondents. So, there is urgent need of the awareness among the farmers and the community regarding the pesticide issues.

Mohd Fuad et al. (2012) undertook a study to know the impact of pesticides on paddy farmers and their ecosystem in Malaysia. The study consisted of 219 farmers, which were selected from district of Tanjung Karang, in the state of Selangor. It is also known as 'the rice bowl of Selangor'. It found that Paraquat, Rumpuq, Malathion, 2, 4-D and Actara 250 GM pesticides were used in the area. 93 per cent of the farmers use Paraquat which has been subsidized by District Agriculture Department, is highly toxic pesticide for the crop which have retarded the growth of paddy. Survey showed that 51.5 per cent of the farmers said that they had difficulty in breathing while spraying the pesticides. 26 per cent had itchiness and 13.7 per cent had rashes. The results showed that the use of pesticides harm the health, environment, plants, fishes, livestock and farmers. The study recommended that Integrate Pest Management technique should be used.

Section II

Kumar and Dandapani (2000) studied frequency, intensity and determinants of pesticide use in rain fed cotton, by using farm level cross sectional data from Nanded district of Maharashtra. Average pesticide use was 3.2 kg active ingredient per hectare of cotton area. Farmers also used a number of cultural and physical methods directly or indirectly to limit the crop loss due to pest and diseases. The attitude of farmers towards insect pest risk varied and accordingly the use of pesticides. Risk averse farmers used pesticides excessively and indiscriminately. The study suggested that improving existing stock of knowledge of pests and management practices can help reduce pesticide use.

A study in the four states i.e. Karnataka, Andhra Pradesh, Maharashtra and Punjab was conducted by **Shetty (2004)** to determine the impact of pesticide usage on the agricultural production, health of farmers and pest resistance. Consumption of pesticides is 38.14 per cent of the total amount of pesticides in the four states. In 48 villages, small, medium and large farmers were selected randomly. Study revealed that excessive use of nitrogenous fertilizers and continuous mono cropping of paddy led to pest problems which compel the farmers to usage of pesticides. Pesticides account for about 42-50 per cent cost for cotton and 25 per cent for paddy crop indicating higher cost effecting upon their socio-economic status. Due to heavy cost of pesticides, about 74 per cent and 47 per cent of the respondents in Karnataka and Andhra Pradesh respectively buy pesticides on loan. Farmers do not follow any rules which impacted upon the health system of the farmers. Hence, over application and indiscriminate use of pesticides had several adverse impacts. It is recommended that government should provide educational qualification to distributor and Integrated Pest Management practices should be encouraged to reduce the pesticide usage.

Jeyanthi and Kombairaju (2005) studied the usage of pesticides in four important vegetable crops i.e. chillies, cauliflower, brinjal and bhindi and its frequency, intensity and determinant factors among these vegetables. Cross-sectional data is used in the study. Vegetables were beset with a number of insect pests if, they were not controlled, may cause heavy damage. The study had revealed that chemical control was the important pest control method followed by the farmers.

Bio pesticides and botanical pesticides were applied by a limited number of growers while the usage of weedicide was absent. On an average, cauliflower and brinjal crops were each given 15 sprayings. Chilli was given 13 and bhindi was given 12 applications of pesticides. The average pesticide-use intensity had been found high in chilli (5.13 kg of a.i/ha), followed by brinjal (4.64 kg of a.i/ha), bhindi (3.71 kg of a.i/ha) and cauliflower (2.77 kg of a.i/ha). Farmer's nature about risk aversion was the main reason for the indiscriminate use of pesticides. The study has recommended that farmer's should be educated about the usage of pesticides. They will be encouraged to adopt Integrated Pest Management (IPM) practices.

Pouchepparadjou et al. (2005) conducted a study in rise irrigated area in Pondicherry with primary survey. It is based on a comparison of adopters of Integrated Pest Management (IPM) technology and non-adopters of Integrated Pest Management (IPM) technology. Three farmer field schools, villages were selected randomly. From these villages, 30 farmers were selected who were trained through FFS and 30 farmers who did not take training were selected. Logistic regression analysis was used to find out results. The study revealed that total cost of pesticides spent in non-adopter farms was higher than adopter farms at Rs. 360 and Rs. 402.2 /acre respectively due to higher usage of pesticides. Returns were more in among adopter farmers than non-adopters. There is need for reorientation of agricultural and environmental policies to introduce appropriate economic incentives.

Devi (2007) in her working paper 'Pesticide Use in the Rice Bowl of Kerala: Health Costs and Policy Options' assessed short-term health costs associated with pesticide exposure. The study found that the toxicity level and dose of pesticides had a significant effect on the health of pesticide applicators. Rs. 38 per day per individual was spent on health damages. The study suggested to providing training in self-handling of pesticides to improve the health of pesticide applicators. Insurance protection measures for pesticide applicators could be introduced.

Prabuddha (2007) studied the pattern of pest infestation on vegetables and the extent of the use of pesticides by vegetable growers in 18 villages in Katwa block, Bardhaman district, West Bengal, India. The study found that the intensity of insect

pest infestation on aubergine, pointed gourd, cabbage and cauliflower was greatest during the Rabi season, followed by the kharif and pre-kharif seasons over the last five years. Most of the farmers applied pesticides on aubergine and cabbage, but the application rates, number of chemical groups of pesticides and application frequency adopted by the farmers were more than the recommended. This practice was most pronounced for aubergine, followed by cauliflower, cabbage and pointed gourd.

The adoption of Integrated Pest Management technology (IPM) on cotton in Punjab and on paddy in Haryana was assessed by **Singh et al. (2008)**. The study is based on the primary data collected during the year 2003-04 from a sample of 95 cotton farmers from the Bathinda and Ferozpur districts of Punjab and 83 farmers cultivating paddy in the Karnal and Kaithal districts of Haryana. Poisson count regression models have been used to analyze technology adoption. The study hypothesized that the level of education will have a positive effect and age a negative effect on adoption behaviour towards the IPM technology. It was estimated that the adoption level of farmers who received formal IPM training was higher than those who did not undergo training by 12 per cent in paddy and 76 per cent in cotton farmers. Hence investment in IPM education will have long term beneficial impact. The study has found mixed evidence about the relationship between farm age and adoption of IPM technology. It shows that small farmers are poor adopters of this technology. It is therefore recommended that there should be some training about the use of IPM technology. These will help farmers' capacity on decision making.

Aktar and Paramasivam (2009) have reviewed the article, "Impact of pesticides use in agriculture: their benefits and hazards". It describes primary as well as secondary benefits of pesticides. Primary benefit of pesticides is to protect the crop from loss which brings higher yield. This primary benefit led to secondary benefits. Higher yields bring additional revenue that could be put towards children's education and medical care leading to healthier and better educated population. The study has shown that pesticides are considered a boon in income generation, employment creation and in many social works. The study also explained harmful effects of pesticides. It has resulted many serious health implications to man and his environment. During manufacturing, workers handle

various chemicals including pesticides; raw materials etc. which makes many problems. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects and non-target plants. The study shows that overuse of pesticides leads to many problems so education and training of workers as a major vehicle to ensure a safe use of pesticides is being increasingly recognized. It is recommended that message should be convey that prevention of adverse health effects and promotion of health are profitable investments for employers and employees as a support to a sustainable development of economics.

Dhaliwal et al. (2010) analysed the changing trend between pre-green revolution and in post green revolution era. Study showed that globally, crop loss has increased due to insects in post green revolution era to 13.6 percent which was 10.8 percent in pre-green revolution i.e. in 1965. Loss in cotton has decreased from 16 per cent to 15.4 percent. Data revealed that losses in post green revolution era have shown an increasing trend than in the pre-green revolution era. Overall loss had increased from 7.2percent in early 1960's to 23.3 per cent in early 2000's. The maximum increase in loss occurred in cotton (18.0 to 50.0 per cent) followed by other crops like sorghum and millets (3.5 to 30 per cent) maize (5.0 to 25.0 per cent) and oil seeds (5.0 to 25.0 per cent). So, in monetary value, the Indian agriculture currently suffers an annual loss of about Rs. 8, 63, 884 million due to insect pests. Efforts are made to implement Integrated Pest Management programmes in principal food and cash crops.

Patil and Katti (2012) analyzed a relationship between the extent of the usage of pesticides and signs and symptoms of illness among agricultural labourers in Western Maharashtra. The study is based on primary survey consisting of 100 agricultural labourers indicating that usage of pesticides has been directly proportional to farm productivity and indirectly to health and environment. About around 97 per cent of labourers was suffering from skin problems. Lack of awareness, illiteracy, and poverty among labourers indicating heavy doses of pesticides in agriculture that affecting upon their economic structure. It revealed that usages of pesticides have harmful impact on agricultural labourers. The study recommended that the quantity of pesticides should be used according to rules.

Singh and Singh (2013) evaluated the technical efficiency of Indian agriculture for the period of 1971 to 2004 using the technique of Data Envelopment Analysis (DEA) under constant returns to scale. It had been observed that average efficiency level in Indian agriculture was 0.81 which shows 19 per cent of technical inefficiency. Thus, 19 per cent wastage of inputs could be utilized to produce more of agricultural output. Technical efficiency varies from 96.6 per cent in case of Tamil Nadu to 69.6 per cent for the state of Gujarat due to small size of holding technical inefficiency increases.

Umanath and Rajasekar (2013) analyzed the efficiency level of paddy farms in Madurai district of Tamil Nadu state in India. In order to obtain the objective, a sample size of 90 farmers was selected for the study in 2010-11. Input-oriented method was used under CRS while all the firms were operating under the optimum scale and VRS when there was difference between technical efficiency i.e. is called pure technical efficiency. Overall and pure technical efficiency was 80 and 85 per cent respectively indicating that there exist still a potential of 20 per cent and 15 per cent for increasing the output. More than 60 per cent of the farmers had scale efficiency which indicated that majority of farmers were not operating at the optimal scale. It is recommended that government should provide necessary education, training to bring in social change among farmers.

Most of the studies have emphasized upon the health impact on farmers and labourers but neglected the economic impact of pesticides especially in Punjab. This impact has not been found by any study for farmers of Bathinda district known as cotton belt of Punjab. Therefore, the present study is an attempt to examine socio and economic impact of pesticides in Bathinda district.

Chapter III

Study Area and Methodology

This chapter deals with the selection of the area, sample, methods of data collection and analytical techniques used for analyzing the data, in order to find out the socio-economic implications of pesticide use.

The study was carried out in the Bathinda District. However, the study area was confined to Laleana village of Talwandi Sabo block and Rayia village of Phul block. Laleana village selected from Talwandi Sabo block is located 29 kilometer towards South from District head quarters Bathinda, 6 kilometer from Talwandi Sabo and 218 KM from state capital Chandigarh. Bhagiwander, Mahinangal, Kamaloo are the adjoining villages of Laleana. Rayia is a village in Phul Tehsil in Bathinda District, selected for the study. It is located 36 kilometer towards East from Bathinda and 179 kilometer from State capital Chandigarh. It is surrounded by Rampura Tehsil towards South, Nathana Tehsil towards west, Sehna Tehsil towards East and Bhagta Bhaika Tehsil towards North. This place is in the border of the Bathinda District and Barnala District.

METHODOLOGY

Multistage sampling technique was used to select the sample for the present study.

1. Selection of the district

Out of the total number of 22 districts in Punjab, seven districts namely Ferozpur, Faridkot, Muktsar, Moga, Bathinda, Mansa and Sangrur are located in the Malwa region of Punjab. These seven districts are major cotton producing districts of Punjab and comprise the cotton Belt of Punjab. Among these districts, Bathinda district has maximum area under cultivation of cotton (153 thousand hectare) and paddy (101 thousand hectare) crop also grown there. Accordingly, Bathinda district has been selected for the study (Statistical Abstract of Punjab, 2012-13).

2. Selection of Blocks

Among the eight blocks, Talwandi Sabo and Phul blocks were selected for the field survey as these blocks had maximum area under cotton and paddy production respectively. Area under major crops in the year 2012-13 in different blocks of

Bathinda district has been presented in Table 3.1. It shows that area under cotton crop was the maximum in Talwandi Sabo block i.e. 42392 hectare. Area under paddy was the highest in Phul block (35950 hectare). Hence, both blocks were selected to know the impact of pesticides on both crops.

Table 3.1: Area under major crops in Bathinda (2012-13)

Block	Cotton		Paddy	Total cropped area
	Cotton-A	Cotton-D		
Bathinda	30724	517	20359	56406
Nathana	11433	378	16653	30274
Sangat	32385	132	3849	37221
Talwandi Sabo	42392	144	1653	48112
Maur	20107	47	6606	28897
Rampura	11322	326	16198	29615
Phul	6831	815	35950	46696
Bhagta	5081	425	13858	20245

Source: Department of Statistic, Chief Agriculture Office Complex, 2012-13

3. Selection of Villages

Laleana village from Talwandi Sabo block and Rayia village from Phul block were purposely selected for primary survey.

4. Selection of Farmers

A sample of 120 farmers and 80 agricultural labourers from both selected villages in equal numbers were randomly chosen. The selected farmers were categorized into three categories (Small, Medium and large) on the basis of size of land holdings.

Small Farmer: A small farmer is a cultivator who owns land more than 2.5 acres and up to 5 acres and his major source of income is farm business income.

Medium Farmer: A medium farmer is a cultivator who owns land 5-10 acres and his major share of income is farm business income.

Large Farmers: Large farmers are those who own land more than 10 acres and his major source of income is farm business income.

Data collection

In order to examine the cost and returns of cotton and paddy, efficiency of farms, impact of pesticides on gross returns and to know the health impact of pesticides on farmers and labourers; two different structured schedules have been prepared (given in appendix B). The primary data was collected from the sample respondents through personal interview method pertaining to demographic information regarding the farmers, particulars of landholdings, crop-wise inputs used with main emphasis on pesticides, health problems and environmental related issues were asked from farmers. Agricultural labourers were asked questions related to their age, education, methods of applying pesticides, protective measures used, information sources etc.

The secondary data related to consumption of pesticides in India was collected from indiastat.com, punjabstat.com, Statistical abstract of Punjab (Various issues), Department of Statistics, Chief Agriculture Officer Complex, Bathinda and Official website of Bathinda district for the different time periods.

Data Analysis

Statistical Tools: The following statistical tools are used in the study mentioned below:

Technical Efficiency

The most common concept of efficiency is “Technical Efficiency” that means transferring physical inputs into outputs at the best level of performance i.e. TE requires there is no waste in using inputs to produce specific quantity of output.

The data envelopment analysis (computer) program version 2.1 is used for the analysis of technical efficiency of farm.

Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a nonparametric method. It is used to empirically measure productive efficiency of decision making units. DEA develops a function whose form is determined by the most efficient producers. This method differs from the ordinary least squares (OLS) statistical technique that bases comparisons relative to an average producer (Singh and Singh, 2013).

Technical efficiency analysis was applied to input oriented variable return to scale. Input oriented measure is that method in which output can be increased by reducing the input quantities used (Coelli, 1996).

Under the constant returns to scale, following input-oriented linear programming model is used.

$$\begin{aligned} \min_{\theta, \lambda} \quad & \theta, \\ \text{st} \quad & -y_i + Y\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & \lambda \geq 0, \end{aligned} \quad (1)$$

Where,

y_i is a $m \times 1$ vector matrix of output for i th farm,

x_i is a $k \times 1$ vector matrix of inputs for i th farm,

Y is a $n \times m$ output matrix for 'n' number of farms,

X is a $n \times k$ input matrix for 'n' number of farms,

where θ is an efficiency score, it is a scalar whose value would be the efficiency measure for each 'i' farm and it ranges from 0 to 1. If $\theta = 1$, then the farm would be efficient; otherwise, the farm would be below the efficient level and λ is a $n \times 1$ vector of matrix which provides the optimum solution.

The CRS is only applicable only when all firms are operating under optimal scale. But all firms cannot operate under optimal condition. So, CRS can be changed into VRS by adding $N1'\lambda = 1$

$$\begin{aligned} \min_{\theta, \lambda} \quad & \theta, \\ \text{st} \quad & -y_i + Y\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & N1'\lambda = 1 \\ & \lambda \geq 0, \end{aligned}$$

where $N1$ is an $N \times 1$ vector of ones. This specification is often used for agricultural production because in general farmers may not operate at the optimal scale (Umanath & Rajasekar, 2013).

Correlation Analysis

In order to study inter-correlations between dependent and independent variables, correlation matrix was constructed.

Regression Analysis

Regression analysis has been applied to know the impact of inputs on output of the both crops i.e. gross return. To run regression, gross return was taken as dependent variable and other inputs expenditure incurred on seeds, manure and fertilizers, labour, pesticides were taken as independent variable. The dependent and independent variables in production function were defined on per acre basis.

$$\log(Y) = \log A + a_i \log(X)_i + \log u$$

Here Y is dependent variable i.e. gross return and while X_i is independent variable which varies from X_1 to X_4

Y= Gross returns from cotton/paddy (Rs/ha)

X_1 = Expenditure incurred on seeds (Rs/ha)

X_2 = Expenditure incurred on fertilizers and manure (Rs/ha)

X_3 = Expenditure incurred on labour used (Rs/ha)

X_4 = Expenditure incurred on pesticides (Rs/ha)

A= Constant

U= Error

Multiple (Step-up) Regression Analysis

The major problem likely to be faced in the multiple linear regression analysis is that of multi collinearity. In order to overcome the problem of multi collinearity, step-wise forward regression analysis can be used.

$$\log Y = \log A + a_1 \log X_1 + a_2 \log X_2 + a_3 \log X_3 + a_4 \log X_4 + \log u$$

It is hypothesized that a_i 's > 0

To compare the explanatory power of different sets of multiple regression equation adjusted coefficients of determination (R^2) has also been calculated for each regression equation.

$$R^2 = 1 - [(n-1) / (n-k) \{1 - R^2\}]$$

Explanatory variables were entered in the stepwise forward regression model in accordance with the correlation of dependent variable and also taking into account the collinearity as well as explanatory power in view. The results obtained through the regression analysis were interpreted accordingly regression.

Dependent variable

Gross returns: The gross returns were computed by multiplying the quantity of output (main and by product) obtained with respective prices received.

Independent variables

Seeds cost: The cost of seeds has been calculated at local market price for the cotton and paddy seeds.

Manure and fertilizers: The quantity of manure used in the cultivation of both crops has been measured in terms of tonnes and the cost has been imputed at the market price prevailing in the village. Cost of fertilizers has been computed considering the actual price paid by the farmers.

Labour cost: The human labour is measured in terms of man days for different farm operations in cotton and paddy cultivation.

Pesticides cost: The cost of different insecticides, weedicides and fungicides used in controlling pests and diseases were charged on the basis of actual price paid by the farmers towards the purchase of these chemicals.

Probit Model

Probit model is used to study the determinants of the probability of getting sickness due to exposure of pesticides among farmers and agricultural labourers. The general model is a binary choice model involving estimation of the probability of falling sick (y) as a function of a vector of explanatory variables (x).

$$Y_i^* = \beta' x_i + u_i$$

Y_i^* is unobservable and, what is observed is a dummy variable y defined by

$Y = 1$ if $y_i^* > 0$ (major problems)

$= 0$ otherwise (minor problems)

From the above relations,

$$\text{Prob}(y_i = \text{major problem}) = \text{Prob}(u_i > -\beta' x_i) = 1 - F(-\beta' x_i)$$

Where, F is the cumulative distribution function. Following likelihood function can be obtained:

$$L = \prod_{y=0} F(-\beta' \dots \dots \dots)$$

Taking the logarithm of L and maximizing with respect to β , which gives us the maximum likelihood estimator of the slope coefficient from which impact of different variables on the probability of having health problems can be estimate (Devi, 2010).

The independent variables used in the study are given following:

Personal habit: The primary data showed smoking and drinking as the key personal habits that pose a health danger to farm workers. These two variables were included as two separate dummy variables. We expected a positive health risk associated with smoking and alcohol consumption.

Education: Education was expected to have a negative impact. The more educated people were expected to be at a lower risk owing to better awareness. The respondents were grouped into two groups on based their educational level. From 1 year of schooling up to 4 years and above 4 years. Two dummy variables were used to estimate the effect of education on the probability of sickness.

Age: Age was expected to have a positive effect included in number of years.

Method of application: Method of application includes spraying by manually backup sprayer and by tractor sprayer. These two variables were included as two dummy variables. We expected a positive health risk as applying by manually.

Limitations of the Study:

The study is based on information obtained from 120 selected farmers and 80 agricultural labourers. Information from the sample farmers and labourers is based upon the memory and the experience. Hence, various conclusions drawn and the explanation of various problems have been based on their behaviour. In general the farmer does not keep records concerning their farming activities. Though, every effort was made to obtain accurate information.

Chapter IV

Socio Economic Behaviour of Pesticides Users

Socio-economic features of the respondents are important to find out the socio-economic analysis of any study. These features give a picture about their basic characteristics. Therefore, this chapter is an attempt to overview the socio-economic background of the sample farmers and agricultural labourers as both are engaged in pesticide-spraying operations directly and indirectly.

Distribution of Farmers

The farmers were randomly selected from two villages i.e. Laleana and Rayia from Talwandi Sabo and Phul blocks respectively. The farmers in Laleana village cultivates mostly cotton while in Rayia grows paddy. Farmers were distributed across different farm size groups and had been given along with their average land holdings in Table 4.1 and Table 4.2 respectively. The farmers having land holdings up to 5 acres had been considered as small farmers, while farmers having 5-10 acres were called medium farmers and farmers having land more than 10 acres were grouped as large farmers¹. The perusal of Table 4.1 revealed the distribution of sample farmers in both the villages. Out of 120 farmers, 60 farmers from each village were surveyed include 20 farmers from each category.

Table 4.1: Distribution of Farmers

Size of Farms	Laleana	Rayia
Small Farmers (up to 5 acres)	20 (33.33)	20 (33.33)
Medium Farmers (5-10 acres)	20 (33.33)	20 (33.33)
Large Farmers (more than 10 acres)	20 (33.33)	20 (33.33)
Total	60 (100)	60 (100)

Source: Survey Data

Note: Figures in parentheses indicates percentage of each farm size group

¹Jeevandas et al. have followed the same method for distribution of farmers in their study in Amritsar and Faridkot districts.

Table 4.2 depicts that average landholdings were more in cotton cultivated grown area (11.82 acres) than paddy cultivated area (8.41 acres) in selected villages. The average landholdings ranged from 3.10 acres for small farmers to 8.30 acres for medium and 24.07 acres for large farmers in the cotton (Laleana) area. In paddy grown village, average landholdings for small farmers was 2.9 acres while for medium and large farmers was 8.15 acres and 14.2 acres respectively.

Table 4.2: Landholdings of Farmers

Size of farms	Area of Laleana (Acre)	Area of Rayia (Acre)
Small farms	62 (3.10)	58 (2.9)
Medium farms	166 (8.30)	163 (8.15)
Large farms	481.5 (24.07)	284 (14.2)
Total	709.5 (11.82)	505 (8.41)

Source: Survey Data

Note: Figures within the parentheses indicate average land ownership (in acres) among the related farm size group

General characteristics of Farmers

Analyzing the demographic characteristics of the farmers is an important part of socio-economic profile. Table 4.3 indicates that 15 per cent of the all sample farmers in Laleana village lie in the age group of 20-30 years. Small, medium and large farmers i.e. nearly 20 per cent, 15 per cent and 10 per cent lie in the age group of 20-30 years. It was found that 18.33 per cent of all sample farmers lie in the age group of 30-40 years. Further, about 20 per cent and 10 per cent of the small and medium farmers lie in the age group of 30-40 years respectively. The figure for the large farmers comes out to be 15 per cent. The results revealed that about 37 per cent of all sample fall in the age group of 40-50 years. This indicates that majority of the sample respondents in each of the three sized farmer's categories were in an active group and have learning farm experience. The figure for paddy area (Rayia) village shows that more number of respondents lie in the age group of 40-50 years. The average age for the all farmers of cotton and paddy grown in selected villages was 45.48 and 43.25 years respectively. The corresponding data, for small, medium and large farmers was 44.95, 46.35 and

45.15 years in cotton area and indicating that most of the farmers were of the middle age group. On the other hand, average age of small, medium and large farmers in paddy grown village was about 46, 43 and 41 years respectively. The average age was slightly higher of the Laleana farmers' as compared to Rayia farmers. The results depict that in both villages large number of farmers was in middle age group indicating more farming experience.

Table 4.3: Age of Farmers

Age Group	Laleana Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
20-30	4 (20)	3 (15)	2 (10)	9 (15)
30-40	4 (20)	2 (10)	5 (15)	11 (18.33)
40-50	5 (25)	9 (45)	8 (40)	22 (36.67)
50-60	5 (25)	5 (25)	4 (20)	14 (23.33)
60-70	2 (10)	1 (5)	1 (5)	4 (6.67)
Total	20 (100)	20 (100)	20 (100)	60 (100)
Average age (years)	44.95	46.35	45.15	45.48
Age group	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
20-30	3 (15)	4 (20)	4 (20)	11 (18.33)
30-40	3 (15)	5 (25)	7 (35)	15 (25)
40-50	7 (35)	8 (40)	6 (30)	21 (35)
50-60	5 (25)	2 (10)	2 (10)	9 (15)
60-70	2 (10)	1 (5)	1 (5)	4 (6.67)
Total	20 (100)	20 (100)	20 (100)	60 (100)
Average age (years)	46.05	42.6	41.1	43.25

Source: Survey Data

Note: Figures within parentheses are percentages

Family composition of farmers has been presented in Table 4.4. Results revealed that the average family size of the sample farmers of Laleana was around 6 members in their family, consisting of 2 males, 2 females and 2 children. The comparable figure for Rayia farmers was 5 members in their family, consisting of 2 males, 2 females and 1 child.

Table 4.4: Family Composition of Farmers

Particulars	Laleana Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Male	1.81 (39.18)	1.95 (39.80)	2.18 (36.89)	2 (38.58)
Female	1.56 (33.76)	1.77 (36.11)	2.09 (35.36)	1.83 (35.19)
Children	1.25 (27.06)	1.18 (24.10)	1.63 (27.68)	1.36 (26.25)
Average family size	4.62 (100)	4.9 (100)	5.91 (100)	5.2 (100)
	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Male	1.85 (44.57)	1.6 (38.55)	1.7 (35.05)	1.72 (38.22)
Female	1.65 (39.75)	1.85 (44.57)	1.7 (35.05)	1.73 (38.44)
Children	0.8 (19.27)	0.8 (19.27)	1.35 (27.83)	1.03 (22.88)
Average family size	4.15 (100)	4.15 (100)	4.85 (100)	4.5 (100)

Source: Survey Data

Note: Figures within parentheses are percentages

Educational Status

Regarding the educational level of the farmers of Laleana village and Rayia village, results have been depicted in Table 4.5. In Laleana village, about 28 per cent of the farmers had education up to primary level, 15 per cent of them studied up to matric and almost 18 per cent of the respondents having secondary level education. The farmers who had college education worked out to be 15 per cent. The remaining about 23 per cent of the farmers was illiterate. The study revealed that small farmers were more illiterate as compared to medium and large farmers for cotton producing village. On an average, about 77 per cent of the farmers were literate. On the other hand, in Rayia, 13 per cent of the farmers had education up

to primary level, 45 per cent of them studied matric and just 6 per cent of farmers had higher education. On an average, 72 per cent of the farmers were literate. Thus farmers were more literate in Laleana village than Rayia.

Table 4.5: Educational Status of Farmers

Education	Laleana Farmers			
	Small n=20	Medium n=20	Large n=20	All n=60
Illiterate	7 (35)	4 (20)	3 (15)	14 (23.33)
Primary	5 (25)	7 (35)	5 (25)	17 (28.34)
Matric	4 (20)	3 (15)	2 (10)	9 (15)
Secondary	4 (20)	2 (10)	5 (25)	11 (18.33)
College & above	0 (0)	4 (20)	5 (25)	9 (15)
Total	20 (100)	20 (100)	20 (100)	60 (100)
	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Illiterate	5 (25)	6 (30)	6 (30)	17 (28.33)
Primary	4 (20)	3 (15)	1 (5)	8 (13.33)
Matric	7 (35)	9 (45)	11 (55)	27 (45)
Secondary	2 (10)	1 (5)	1 (5)	4 (6.67)
College & above	2 (10)	1 (5)	1 (5)	4 (6.67)
Total	20 (100)	20 (100)	20 (100)	60 (100)

Source: Survey Data

Note: Figures within parentheses are percentages

Cropping Pattern of Farmers

The crops grown by farmers during rabbi and kharif season in both villages are discussed in Table 4.6. Cotton, paddy, guara and wheat were the important crops grown by Laleana farmers. Results described that about 33 per cent of the gross cropped area was under cotton crop in kharif season due to sandy soil in the area. Contrary to it, farmers of the Rayia village from Phul block more prefer to grow

paddy crop as about 40 per cent of the gross cropped area under paddy production. So, farmers follow mainly paddy-wheat pattern. Due to shortage of water resources small farmers grew a less proportion of area to paddy cultivation as compared to medium and large farmers. Area under fodder and vegetables decreases with the increase in the size of landholdings in both the villages.

Table 4.6: Cropping Pattern among Farmers

(Per cent of Gross Cropped Area)

Crop	Laleana Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Cotton	37.58	36.91	30.01	33.03
Paddy	4.62	4.57	7.99	6.54
Guara	0.57	4.70	9.55	7.72
Wheat	42.77	45.74	47.30	46.28
Fodder & Vegetables	14.45	8.08	5.15	6.43
Gross Cropped Area	100 (10.81)	100 (21.36)	100 (39.23)	100 (25.1)
Crop	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (60)
Cotton	7.40	6.62	6.98	6.92
Paddy	38.92	41.41	41.16	40.9
Wheat	46.97	47.74	48.05	47.79
Fodder & Vegetables	6.71	4.21	3.72	4.39
Gross Cropped Area	100 (7.45)	100 (27.57)	100 (35.47)	100 (17.02)

Source: Survey Data

Note: Figures in parentheses indicate average gross cropped area in acres

Table 4.7 discuss about the methods of spraying pesticides used by farmers. Results depicts that in both villages, a large number of small farmers were applying pesticides by knapsack sprayer as they could not afford machinery.

About 45 per cent of the cotton farmers and 33 per cent of the paddy farmers were spraying pesticides through knapsack sprayer. About 55 per cent and 67 per cent of the farmers in cotton cultivated area and paddy cultivated area applied pesticides through tractor sprayer.

Table 4.7: Method of Spraying Pesticides followed by Farmers

Particulars	Laleana Farmers				Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Knapsack sprayer	13 (65)	8 (40)	6 (30)	27 (45)	11 (55)	5 (25)	4 (20)	23 (33.33)
Tractor sprayer	7 (35)	12 (60)	14 (70)	33 (55)	9 (45)	15 (75)	16 (80)	40 (66.66)
All	20 (100)	20 (100)	20 (100)	60 (100)	20 (100)	20 (100)	20 (100)	60 (100)

Source: Survey Data

Note: Figures within parentheses are percentages

Health hazardous

Usage of pesticides has adverse impact on the health of farmers and labourers. Health hazardous perceived by the selected farmers from both villages to exposure of pesticides are presented in Table 4.8. On perceptions basis, few symptoms of health problems were found among farmers and labourers. Skin allergy was the major problem among all the categories of farmers to an account of about 47 per cent and 37 per cent respectively in cotton and paddy cultivated villages followed by eye irritation i.e. about 32 per cent and 30 per cent respectively. Breathing, headache and vomiting were the minor health problems. 12 per cent of the farmers were suffering from breathing problem and about 13 per cent of farmers had reported headache problem in cotton area. Further, 15 per cent and about 12 per cent had breathing and headache problems in paddy grown area respectively. It was found that 20 per cent and 15 per cent of farmers had vomiting problem in Laleana and Rayia villages respectively. It was described that small farmers were facing more health problems during knapsack sprayer application of pesticides.

Table 4.8: Farmers' Perceptions of Pesticide Exposure on Health

Particulars	Laleana Farmers				Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Skin allergy	11 (55)	9 (45)	8 (40)	28 (46.67)	8 (40)	7 (35)	7 (35)	22 (36.66)
Eye irritation	9 (45)	6 (30)	4 (20)	19 (31.67)	6 (30)	6 (30)	5 (25)	17 (28.33)
Breathing problems	3 (15)	2 (10)	2 (10)	7 (11.66)	4 (20)	3 (15)	3 (10)	10 (16.67)
Headache	3 (15)	3 (15)	2 (10)	8 (13.33)	2 (10)	3 (15)	2 (10)	7 (11.66)
Vomiting	4 (20)	5 (25)	3 (15)	12 (20)	4 (20)	3 (15)	2 (10)	9 (15)

Source: Survey Data

Note: Figures within parentheses are percentages

Characteristics of Agricultural Labourers

To know the impact of pesticides on labourer's health, 40 agricultural labourers from each village were surveyed. It has been observed that in both villages they spray pesticides directly. Table 4.9 shows age group and the average age of labourers. Table 4.9 highlights that 11 labourer's lie in the age group of 20-30 years. It was found that 22 lies in the age group of 30-40 years and 28 labourers were in the category of 40-50 years. While, 19 were found to be in 50-60 years age group. Average age of labourers was 43 years indicating that majority of them were in active and middle age group.

Table 4.9: Age of Agricultural Labourers

Age Group	Labourers
20-30	11
30-40	22
40-50	28
50-60	19
Average age (Yrs.)	42.93

Source: Survey Data

Protective measures during the application of pesticides followed by agricultural labourers have been presented in Table 4.10. The results revealed that 20 labourers were found to use mask to cover their faces while 60 labourers did not cover their faces. It indicates that 75 per cent of sample labourers did not protect their faces. Likewise, there were only 15 per cent labourers using gloves while 85 per cent were using bare hands to mix the pesticides. It is clear that labourers are not aware about precautions while spraying pesticides. Direction of spraying pesticides also matters as incorrect direction effects upon their health. Therefore, they have been asked for the same. Many labourers (76 out of 80) applied pesticides along the wind while only 4 labourers did not consider the direction of wind.

**Table 4.10: Protective measures followed by Agricultural Labourers
N=80**

Sr. No.	Particulars	Yes	No
1	<i>Protective measures</i>		
a.	Use of mask/scarf	20 (25)	60 (75)
b.	Use of hand gloves	12 (15)	68 (85)
2	<i>Direction of applying pesticides</i>		
a.	Along the wind	76 (95)	4 (5)
b.	Across the wind	4 (5)	76 (95)

Source: Survey Data

Note: Figures within parentheses are percentages

Information about Proper Pesticides Usage

Table 4.11 depicts that land owners were the key source of information for labourers regarding the usage of pesticides (45per cent). However, 30 per cent of labourers consulted with fellow labourers and only 10 per cent of labourers considered government officials as their source of information. This highlights that there is need for the training and extension programmes for proper pesticides usage for the agricultural labourers.

Table 4.11: Information about proper Pesticides usage**N=80**

Sr. No.	Source of information	Yes	No
1	Govt. officials	8 (10)	72 (90)
2	Land owners	36 (45)	44 (55)
3	Fellow labourers	24 (30)	56 (70)
4	Retail shop owners	12 (15)	68 (85)

Source: Survey Data

Note: Figures within parentheses are percentages

Sprayer Use and Maintenance by Labourers

Table 4.12 revealed that two types of sprayers were used by labourers. 45 per cent of labourers used power sprayer through tractor while the knapsack sprayer was used by 55 per cent of the labourers. About 38 per cent of the labourers were found to sell the bottles to junk dealers, 25 per cent left in the field after use while 20 per cent use it for other purposes and just 18 per cent of the labourers were burning the bottles in the fields.

Table 4.12: Sprayer Use and Maintenance by Agricultural Labourers**N=80**

Sr. No.	Particulars	Yes	No
1	<i>Type of sprayer used</i>		
a.	Tractor sprayer	36 (45)	44 (55)
b.	Knapsack sprayer	44 (55)	36 (45)
2	<i>Disposal of pesticide bottle</i>		
a.	Left in the field	20 (25)	60 (75)
b.	Sell it to junk dealers	30 (37.5)	50 (62.5)
c.	Use it for other purpose	16 (20)	64 (80)
d.	Burn the bottle	14 (17.5)	66 (82.5)

Source: Survey Data

Note: Figures within parentheses are percentages

Behaviour of Agricultural Labourers

Table 4.13 depicts the behaviour of pesticide applicants. It shows that majority of the farmers did not work after spraying the pesticides. They rested, at least for one day. Just 20 per cent of the agricultural labourers worked after applying the pesticides. In the sample around 80 per cent labourers took bath and changed their clothes after applying the pesticides. Approximately 55 per cent of the sample labourers ate immediately after applying the pesticides but by washing their hands with soap.

Table 4.13: Behaviour of Agricultural Labourers

N=80

Sr. No.	Particulars	Yes	No
1	Work in the field after spraying	16 (20)	64 (80)
2	Take bath after spraying	64 (80)	16 (20)
3	Change clothes right after spraying	64 (80)	16 (20)
4	Eat, drink or smoke during applying pesticides	44 (55)	36 (45)

Source: Survey Data

Note: Figures within parentheses are percentages

Health hazards perceived by the agricultural labourers are discussed in the Table 4.14. Skin irritation was the major problem reported by the labourers to an account of 85 per cent followed by eye irritation reported to an account of 80 per cent. Minor problems reported by labourers were vomiting, dizziness, shortness breaths to an account of 17.5 per cent, 12.5 per cent and 7.5 per cent respectively due to pesticides usage. Mostly the labourers had atleast two problems. As discussed already that they do not take precautions while spraying pesticides, leading to more health problems for them.

Table 4.14: Agricultural Labourer's perception of Pesticide Exposure on Health

N=80

Sr. No.	Symptom	Yes	No
1	Eye irritation	64 (80)	16 (20)
2	Head ache	28 (35)	52 (65)
3	Dizziness	10 (12.5)	70 (87.5)
4	Vomiting	14 (17.5)	66 (82.5)
5	Shortness breaths	6 (7.5)	74 (92.5)
6	Skin irritation	68 (85)	12 (15)

Source: Survey Data

Note: Figures within parentheses are percentages

Awareness about Environment Issues

Pesticides lead to air and water pollution. Number of studies also supported that pesticides have an adverse effect on the environment. Besides health, it is important to find out that whether farmers are aware of environment issues. So, on the basis of perception of farmers it can be stated that pesticides have negatively affected on the environment. It is just based on their perceptions as they had not much scientific knowledge.

Their awareness has been represented in Table 4.15 indicating that pesticides lead to many problems like air pollution, water pollution and damage the living organisms. 28 per cent of the farmers in Rayia were illiterate depicting the less knowledge about the negative impact of pesticides on environment as compare to Laleana village which had about 23 per cent illiterate farmers. In Laleana, 65 per cent, 80 per cent and 90 per cent of small, medium and large farmers respectively were aware about the negative effects of pesticides that lead to air pollution by applying pesticides. So, around 78 per cent farmers revealed the negative effects of pesticides on air. About 22 per cent of farmers had no knowledge about it. The corresponding data for Rayia village indicating 75 per cent of the total farmers were aware about the effect of pesticides in the air. In Laleana, around 76 per cent and 52 per cent of farmers revealed that pesticides lead to water pollution and damage the living organisms respectively. Similarly in Rayia, 65 per cent and

about 47 per cent of farmers knew about the impact of pesticides on water and living organisms. So, on the perceptions of farmer's knowledge, it can be said that pesticides has negatively affected on the environment. 90 per cent of the sample farmers opined that the fertility of the soil decreases with the usage of pesticides.

Table4.15: Awareness about Environment Issues

Particulars	Laleana Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Impact on air pollution	13 (65)	16 (80)	18 (90)	47 (78.33)
Impact on water pollution	10 (50)	17 (85)	17 (85)	44 (76.33)
Damage of toxic pesticides on living organisms	7 (35)	11 (55)	13 (65)	31 (51.66)
	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
Impact on air pollution	13 (65)	15 (75)	17 (85)	45 (75)
Impact on water pollution	12 (60)	14 (70)	13 (65)	39 (65)
Damage of toxic pesticides on living organisms	8 (40)	9 (45)	11 (55)	28 (46.67)

Source: Survey Data,

Note: Figures within parentheses are percentages

Thus, this chapter has examined the socio-economic profile of the sample farmers and agricultural labourers of cotton and paddy cultivators. Laleana farmers are more literate than Rayia farmers and have large size of holdings. Laleana is prominent area for cotton, indicating that their farmers having more health problems. On the basis of their perceptions, it can be said that they have little bit awareness regarding the environmental issues. Agricultural labourers are not using precautions while spraying pesticides, which lead to many health problems. So, they should be educated through training programmes.

Chapter V

Use of Pesticides: Its Diverse Impacts

Cotton American and paddy are important kharif crops, playing a key role in the economic development of the Bathinda district. The main pest i.e. American bollworm has been the major cause for the decline in cotton production and pesticides have played a major role to increase their output by controlling this pest. This chapter has been divided into two sections. In the first section, costs and returns of these two distant crops using pesticides and efficiency of farms cultivating these crops has been analyzed. The impact of pesticides on gross returns of these two crops and on human health is discussed under second section.

Section I

Costs and Returns from Cotton and Paddy Cultivation

The cost incurred and returns earned from cotton cultivation for Laleana village farmers is calculated and presented in Table 5.1. Among the three categories of farmers, the total cost incurred by the large farmers was the highest (Rs. 14538.91/acre) as compared to small farmers (Rs. 13664.66/acre) and medium farmers (Rs.14437.85/acre). The average cost of cultivation worked out to be Rs. 13966.67/acre. Total returns obtained per acre from large farmers were the highest (Rs. 39904.52 /acre) as compared to small farmers (Rs. 36332.73/acre) and medium farmers (Rs.39389.76 /acre). Similarly, net returns were also the highest for large farmers (Rs. 25365.61 /acre) as compared to small and medium farmers (Rs. 24668.07 /acre and Rs. 24951.91 /acre respectively). Table also shows that the cost of fertilizers and manure forms the largest component of total cost of cotton cultivation. Cost of pesticides was another second component of cost of cultivation. Among all the categories of the farmers, cost incurred on pesticides by large farmers was the highest (Rs. 2045.23 /acre) as compared to small and medium farmers, which was Rs. 1708.12 /acre and Rs. 1873.41 /acre respectively. Thus, pesticides expenditure increases with the increase in the farm size. On the other hand, the rate of return of large farmers (Rs. 13.40) was less than medium and small farmers because of more cost incurred on pesticides. It was the highest for small farmers (Rs. 15.44) due to less cost of pesticides, showing that it decreases with the increase in the size of holdings.

Table 5.1: Costs and Returns in Cotton Cultivation with special reference to Pesticides used

(Rs. /acre)

Items of cost	Small Farmers (n=20)	Medium Farmers (n=20)	Large Farmers (n=20)	All Farmers (60)
Seeds cost	1635.93	1841.59	1797.72	1758.41
Fertilizers and manure cost	2422.81	2337.45	2450.45	2403.57
Labour cost	1421.87	1706.82	1784.09	1637.59
Picking	3877.81	4049.07	3847.05	3924.64
Pesticides cost	1708.12	1873.41	2045.22	1875.58
Tractor expenditure	1478.12	1509.51	1494.38	1493.99
Interest on working capital	1120.00	1120.00	1120.00	1120.00
Total cost	13664.66	14437.85	14538.91	14213.81
Value of main product	35846.82	37645.42	38145.46	37212.57
Value of by product	1585.91	1744.34	1759.06	1696.43
Total returns	38332.73	39389.76	39904.52	39209
Net returns	24668.07	24951.91	25365.61	24995.19
Rate of return ¹ from pesticides	15.44	14.31	13.40	14.32

Source: Survey Data

Note: *expenditure incurred on irrigation by farmers was nil due to free electricity and surface water charges

¹Rate of return to pesticides= Total returns- total cost other than pesticides/pesticides cost (Nguyen and Tran Thi, 2003)

Table 5.2: Costs and Returns in Paddy Cultivation with special reference to Pesticides used

Items of cost	(Rs. /acre)			
	Small Farmers (n=20)	Medium Farmers (n=20)	Large Farmers (n=20)	All Farmers (60)
Nursery preparation	375.00	415.00	445.00	411.66
Fertilizers and manure cost	2499.75	2670.05	2548.65	2572.82
Labour cost	3112.50	3192.50	3275.00	3193.33
Harvesting	800.00	800.00	800.00	800.00
Pesticides cost	1241.50	1522.25	1535.50	1433.08
Tractor expenditure	1922.50	1980.00	2050.00	1984.16
Irrigation	875.00	Nil	Nil	291.67
Interest on working capital	1435.00	1435.00	1435.00	1435.00
Total cost	12261.25	12014.80	12089.15	12121.73
Total returns	39170.34	38900.69	39054.01	39041.68
Net returns	26909.09	26858.89	26964.86	26919.95
Rate of return from pesticides	22.67	18.66	18.56	19.78

Source: Survey Data

*labour cost includes both wages cost and transplanting cost

*expenditure incurred on irrigation by medium and large farmers was nil due to free electricity and surface water charges.

Per acre costs and returns in paddy cultivation in all categories of farmers are presented in Table 5.2. The total cost incurred by small farmers was the highest (Rs. 12261.25 /acre) as compared to medium farmers (Rs. 12014.8 /acre) and large farmers (Rs. 12089.15 /acre) due to irrigation charges as paid by small farmers to other farmers due to no connection of tube wells. Average cost of cultivation was Rs. 12121.73 /acre for all farmers. Total returns earned by small farmers (Rs.39170.34 /acre) were the highest as compared to medium farmers (Rs. 38900.69/acre) and large farmers (Rs. 39054.01 /acre). Again, Net returns were the highest for small farmers (Rs. 26909.09 /acre) while these were the

lowest for medium farmers (Rs. 26858.89 /acre). For this crop, labour cost remains the main component of cost followed by manure and fertilizers cost. Average cost of pesticides was the third component of cost and it increases with the increase in size of land holdings of paddy. It was the highest for large farmers (Rs. 1535.5 /acre) as compared to small and medium farmers. It can be said from table that cost incurred by large farmers was maximum (Rs. 1535 /acre) as compared to small farmers (Rs. 1241.5 /acre) and medium farmers (Rs.1522.25 /acre). Similarly like cotton crop, rate of return was less for large farmers (Rs. 18.56) as they incurred more on pesticides while highest for small farmers (Rs. 22.67).

Results revealed that rate of return from pesticides decreases with the increase in the expenditure on pesticides for both crops indicating that it was high for small farmers due to less cost of pesticides incurred by them.

Application of spraying pesticides

Table 5.3 shows the number of applications of pesticides in two different crops among different categories of sample farmers. For cotton, medium and large farmers spray more than 3 times. The majority of the medium and large farmers applied six times during the cropping season. 60 per cent of the large farmers applied 6 times. Out of 60 per cent, 57 per cent of the farmers applied pesticides through tractor sprayer. Similarly, small farmers applied four or five times pesticides on cotton crop through knapsack sprayer. On the contrary, on paddy crop 5 sprays were the maximum. Majority of the farmers applied four times of pesticides by tractor sprayer. Overall data shows that on cotton crop, just 5 per cent farmer's spray 3 times while for paddy the share was 32 per cent.

Table 5.3: Distribution of Sample Farmers, according to the Application of Pesticides

No. of Applications	Laleana Farmers			
	Small (n=20)	Medium (n= 20)	Large (n= 20)	All (n= 60)
3	3 (15)	0 (0)	0 (0)	3 (5)
4	7 (35)	3 (15)	2 (10)	12 (20)
5	7 (35)	6 (30)	2 (10)	15 (25)
6	1 (5)	10 (50)	12 (60)	23 (38.33)
7	2 (10)	1 (5)	4 (20)	7 (11.67)
Total	20 (100)	20 (100)	20 (100)	60 (100)
	Rayia Farmers			
	Small (n=20)	Medium (n=20)	Large (n=20)	All (n=60)
3	10 (50)	6 (30)	3 (15)	19 (31.66)
4	8 (40)	10 (50)	9 (45)	27 (45)
5	2 (10)	4 (20)	8 (40)	14 (23.33)
Total	20 (100)	20 (100)	20 (100)	60 (100)

Source: Survey Data

Note: Figures within parentheses are percentages

Technical Efficiency of Farms

Technical efficiency of two distinct crops i.e. cotton and paddy producing in two different farms has been estimated by using the program of Data Envelopment Analysis (DEA) under Constant Returns to Scale and Variable Returns to Scale. One output (per acre yield of crop in quintal) and four inputs are size of farm (acre), expenses incurred on seeds (Rs. /acre), expenses incurred on fertilizers (Rs. /acre) and expenses incurred on pesticides (Rs. /acre) have been taken for the study.

The perusal of Table 5.4 shows the descriptive statistics of different variables for cotton farming. Results revealed that average yield per acre was 8.84 quintal and the standard deviation was 0.89 showing less variation in yield for all farmers.

Mean size of the farm was 8.56 acre and its standard deviation was 5.43 indicating moderate variations in the size of farms. Similarly, average expenses on seeds, manure and fertilizers and pesticides were Rs.1770, Rs. 2473 and Rs.1892 respectively and their standard deviation was 474.72, 291.39 and 507.96 respectively depicting significant differences in the expenses of pesticides.

Table 5.4: Descriptive Statistics of the Variables used in DEA for Cotton Farmers

Variable	Mean	Standard Deviation
Yield (qt/acre)	8.84	0.89
Size of farm (acre)	8.56	5.43
Expenses on seeds (Rs./acre)	1770	474.72
Expenses on manure fertilizers (Rs./acre)	2473	291.39
Expenses on pesticides (Rs./acre)	1892	507.96
N (Sample size)	60	

Source: Survey Data

The results from DEA showed the frequency of technical efficiency estimates of cotton farming in Laleana village of Bathinda district under Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) in Table 5.5. Under the CRS specification the estimated input-oriented technical efficiency ranged from 59 per cent to 100 per cent with mean efficiency level of 78 per cent in cotton cultivated areas. On the other hand, in the case of VRS technical efficiency measures were ranging from 68 per cent to 100 per cent. Although, an average efficiency scores of cotton was 81 indicating that on an average farm operated 19 below the frontier output levels. This means that a 19 per cent reduction in all inputs was possible with unchanged outputs to remove completely technical efficiency. Results revealed that under constant returns to scale (CRS), the efficiency level of farms was less as compared to under variable returns to scale (VRS). Consequently, more farms were efficient under VRS.

Table 5.5: Frequency of Efficiency Estimates of Farms in Cotton Production

Efficiency level	CRS	VRS
	Number of farms	Number of farms
Up to 0.60	1	0
0.61-0.70	14	8
0.71-0.80	25	24
0.81-0.90	11	17
0.91-1.00	9	11
N	60	
Average efficiency	0.78	0.81
Minimum efficiency	0.59	0.68
Maximum efficiency	1.00	1.00

Source: Survey Data

For paddy crop, descriptive statistics of variables which had been taken for program DEA was analyzed in Table 5.6. Average yield per acre was about 31 quintal and its standard deviation was 1.25 indicating existence of low variation in it. There were more variations among farmers for the use of fertilizers and pesticides as their standard deviations were found 280.95 and 183.66 respectively.

Table 5.6: Descriptive Statistics of the Variables used in DEA for Paddy Farmers

Variable	Mean	Standard Deviation
Yield (qt/acre)	30.75	1.25
Size of farm (acre)	7.04	3.93
Expenses on seeds (Rs./acre)	411.16	135.94
Expenses on manure and fertilizers (Rs./acre)	2572	280.95
Expenses on pesticides (Rs./acre)	1448	183.66
N (Sample size)	60	

Source: Survey Data

Technical efficiency was presented for paddy production in Table 5.7. Under CRS average technical efficiency was 84 per cent ranging from 61 per cent to 100 per

cent showing 16 per cent technical inefficiency. Under VRS, 87 per cent mean efficiency level ranging from 69 per cent to 100 per cent. This means that a 13 per cent decrease in all inputs was possible with the present state of technology and unchanged outputs by removing technical inefficiency completely.

Thus the results of technical efficiency for both cropping farms revealed that majority of the cotton farms fell under 71-80 per cent of efficiency category, while in paddy, above 90 per cent. So, paddy farms were more efficient and using their inputs efficiently. Almost similar results had been found by Umanath and Rajasekar indicating that 85 per cent of average technical efficiency under paddy farming in Madurai district of Tamil Nadu. Different results had been described by Singh and Singh indicates that average technical efficiency of agriculture in Punjab was 96 per cent in post reforms as compared to all India was 84 per cent. It was due to the usage of high quality of seeds, pesticides etc

Table 5.7: Frequency of Efficiency Estimates of Farms in Paddy Production

Efficiency level	CRS Number of farms	VRS Number of farms
Up to 0.60	0	0
0.61-0.70	5	2
0.71-0.80	21	16
0.81-0.90	17	19
0.91-1.00	17	23
N	60	
Average efficiency	0.84	0.87
Minimum efficiency	0.61	0.69
Maximum efficiency	1.00	1.00

Source: Survey Data

Section II

Impact of Pesticides on Gross Returns of Crops

To know the impact of various inputs i.e. expenditure incurred on seeds, manure & fertilizers, labour and pesticides on output i.e. gross returns, simple regression analysis and multiple (Step-up) regression analysis has been used.

For cotton crop, Inter correlation of gross returns and different inputs used i.e. seeds, manure and fertilizers, labour and pesticides has been depicted in Table 5.8. The gross returns were significantly and positively related with all the variables. Seeds were significantly and positively associated with gross returns, labour and pesticides and only with fertilizers it was non-significantly and positively related. Fertilizers were significantly and positively related with gross returns, labour and pesticides but non-significantly with seeds but positively. Further, Labour and pesticides were significantly and positively related with all the variables.

Table 5.8: Correlation Matrix for Cotton Farmers (Laleana Village)

Variable	Gross Returns	Seeds	Manure and Fertilizers	Labour	Pesticides
Gross Returns	1	0.29*	0.33**	0.34**	0.47**
Seeds	0.29*	1	0.17	0.32*	0.35**
Manure and Fertilizers	0.33**	0.17	1	0.31*	0.29*
Labour	0.34**	0.32*	0.31*	1	0.28*
Pesticides	0.47**	0.35**	0.29*	0.28*	1

Source: Survey Data

*denotes significant at five per cent level

**denotes significant at one per cent level

To find out the impact of various inputs used for cotton crop specifically pesticides on its gross returns, simple regression analysis has been used, depicted in Table 5.9. Results revealed that all the four variables significantly and positively affected the gross returns of cotton. Pesticides were highly significantly and positively related with gross returns.

Table 5.9: Results of Regression Analysis for Cotton Farmers (Laleana Village)

Dependent variable: Gross Returns (Rs. /acre)

Constant	Seeds	Manure and Fertilizers	Labour	Pesticides	R ²	R ² (F)
2.84* (3.86)	0.53* (2.34)	-	-	-	0.08	0.07 (5.49)
1.24 (1.00)	-	0.98* (2.68)	-	-	0.11	0.09 (7.20)
2.88* (4.66)	-	-	0.52* (2.74)	-	0.11	0.10 (7.52)
2.54* (5.03)	-	-	-	0.61* (4.02)	0.21	0.20 (16.17)

Source: Survey Data

* denotes significant at five percent level

Note: Figures in parentheses indicates t values

To find out the most important input among all the inputs, Multiple (Step-up) regression analysis has been used, represents the results in Table 5.10. Results revealed that in the first step of a regression equation, pesticides significantly and positively affected the gross returns of cotton. It explained 21 per cent variations in gross returns. The addition of labour increased the value of R² (26 per cent). This had non-significantly and positively affected gross returns. In the third step, addition of manure and fertilizers further increased the value of R² (29 per cent). Lastly, addition of seeds, made the value of R² low. So, third combination was found to be most important combination. The estimated parameters of pesticides were positively significant at five per cent for cotton. It explained that all the variables had positively affected the gross returns but pesticides showed a significant and positive impact on the gross returns of cotton. Although, the trend has changed after the introduction of BT cotton, now the usage of pesticides has decreased from about 12 numbers of sprays to five-six sprays. But still usage of pesticides shows a significant effect on gross returns of cotton.

Table 5.10: Results of Multiple (Step-up) Regression Analysis for Cotton Farmers (Laleana Village)

Dependent variable: Gross Returns (Rs. /acre)

Constant	Pesticides	Labour	Manure and Fertilizers	Seeds	R ²	R̄ ² (F)
2.54* (5.03)	0.61* (4.02)	-	-	-	0.21	0.20 (16.17)
1.68* (2.53)	0.54* (3.42)	0.35 (1.91)	-	-	0.26	0.24 (10.28)
0.38 (0.32)	0.48* (3.04)	0.29 (1.52)	0.49 (1.37)	-	0.29	0.25 (7.59)
0.06 (0.05)	0.45* (2.69)	0.25 (1.29)	0.49 (1.36)	0.17 (0.75)	0.28	0.24 (5.79)

Source: Survey Data

*denotes significant at five percent level

Note: Figures in parentheses indicates t values

Correlation matrix of gross returns and different inputs i.e. seeds, manure and fertilizers, labour and pesticides has been represented in Table 5.11. It describes that gross return was non-significantly and positively related with labour and pesticides while non-significantly and positively with seeds and fertilizers. Seeds were non-significantly and positively associated with fertilizers, labour and pesticides but non-significantly and negatively with gross returns. Again, manure and fertilizers were showing the same results as seeds. Further labour was non-significantly and positively related with all the variables. Lastly, pesticides were significantly and positively associated with seeds but non-significantly and positively with the remaining three variables.

Table 5.11: Correlation Matrix for Paddy Farmers (Rayia Village)

Variable	Gross Returns	Seeds	Manure and Fertilizers	Labour	Pesticides
Gross Returns	1	-0.01	-0.18	0.19	0.06
Seeds	-0.01	1	0.10	0.17	0.30*
Manure and Fertilizer	-0.18	0.10	1	0.03	0.11
Labour	0.19	0.17	0.03	1	0.34
Pesticides	0.06	0.30	0.11	0.34	1

Source: Survey Data

*. Denotes significant at five per cent level

**Denotes significant at one per cent level

Similarly like cotton, simple regression analysis has been depicted in Table 5.12 to find out the impact of various inputs used for paddy crop specifically pesticides on its return. Results revealed that labour had significant and positive affect on gross returns of paddy. Seeds and fertilizers had non-significant but negative affected on the gross returns. Further pesticides were showing non-significantly and positively impact on gross returns.

Table 5.12: Results of Regression Analysis for Paddy Farmers (Rayia Village)

Dependent variable: Gross Returns (Rs. /acre)

Constant	Seeds	Manure and Fertilizers	Labour	Pesticides	R ²	R ² (F)
4.60* (49.65)	-0.002 (-0.07)	-	-	-	0.001	-0.02 (0.006)
4.82* (29.41)	-	-0.06 (-1.37)	-	-	0.03	0.02 (1.90)
2.88* (4.66)	-	-	0.52* (2.74)	-	0.03	0.02 (2.32)
4.54* (46.55)	-	-	-	0.01 (0.48)	0.004	-0.01 (0.23)

Source: Survey Data

* Denotes significant at five percent level,

Figures in parentheses indicates t values

Multiple (Step-up) regression analysis has been used to find out the most significant input among all the variables in Table 5.13. The results revealed that in the first step of regression, expenditure incurred on labour significantly and positively affected the gross returns of paddy. It explained 3 per cent variations in gross returns. The addition of fertilizers had increased the value of R^2 (7 per cent). It had non-significantly and negatively affected on the output. In the third step, addition of pesticides, increase the value of R^2 i.e. 8 per cent. Finally, the addition of seeds resulted in a decrease in the value of R^2 (7 per cent). Thus, third combination was found to be most important combination when adjusted R^2 was maximized. Lastly, addition of seeds made the value of R^2 low. The estimated parameter of labour had significantly and positively affected the gross returns of paddy.

Table 5.13: Results of Multiple (Step-up) Regression Analysis for Paddy Farmers (Rayia Village)

Dependent variable: Gross Returns (Rs. /acre)

Constant	Labour	Manure and fertilizers	Pesticides	Seeds	R^2	\bar{R}^2 (F)
2.88* (4.66)	0.52* (2.74)	-	-	-	0.03	0.02 (2.32)
4.65* (24.29)	0.64* (2.89)	-0.07 (-1.45)	-	-	0.07	0.04 (2.24)
4.65* (23.42)	0.70* (3.02)	-0.07 (-1.44)	0.003 (0.11)	-	0.08	0.05 (1.47)
4.66* (22.62)	0.76* (3.10)	-0.068 (-1.41)	0.005 (0.17)	-0.009 (-0.244)	0.07	0.006 (1.10)

Source: Survey Data

* Denotes significant at five percent level

Note: Figures in parentheses indicates t values

Correlation matrix of gross returns and inputs used for cotton and paddy crops has been depicted in Table 5.14. Gross returns were positively and significantly related with manure and fertilizers but non-significantly and positively with labour and pesticides while negatively with seeds. Seeds were significantly and positively

associated with labour and pesticides while non-significantly and negatively with gross returns and fertilizers. Further, manure and fertilizers were significantly and positively related with gross returns. Lastly, pesticides were significantly and positively associated with gross returns, seeds and labour but non-significantly with manure and fertilizers.

Table 5.14: Correlation Matrix for All Farmers (Laleana and Rayia Villages)

Variable	Gross Returns	Seeds	Manures and Fertilizers	Labour	Pesticides
Gross Returns	1	-0.04	0.24**	0.15	0.28**
Seeds	-0.04	1	-0.13	0.70**	0.58**
Manures and Fertilizers	0.24**	-0.13	1	0.04	0.09
Labours	0.15	0.70**	0.04	1	0.54**
Pesticides	0.28	0.58**	0.09	0.54**	1

Source: Survey Data

*Denotes significant at five per cent level,

**Denotes significant at one per cent level

To find out the impact of various inputs used for cotton and paddy crop specifically pesticides on its gross returns, simple regression analysis has been used in Table 5.15. Results revealed that expenditure incurred on fertilizers and pesticides had significant and positive affected the gross returns of both crops. But non-significantly and positively associated with labour. It was non-significantly and positively related with seeds.

Table 5.15: Results of Regression Analysis (Laleana and Rayia Villages)

Dependent variable: Gross returns (Rs. /acre)

Constant	Seeds	Manures and Fertilizers	Labours	Pesticides	R ²	R̄ ² (F)
4.67* (51.05)	-0.01 (-0.5)	-	-	-	0.001	-0.006 (0.22)
2.81* (4.25)	-	0.52* (2.69)	-	-	0.06	0.05 (7.26)
4.11* (14.68)	-	-	0.15 (1.66)	-	0.23	0.01 (2.78)
3.73* (13.80)	-	-	-	0.26* (3.13)	0.08	0.07 (9.85)

Source: Survey Data

* Denotes significant at five percent level

Note: Figures in parentheses indicates t values

Results of Multiple (Step-up) regression analysis have been described in Table 5.16 to find out the most important input among all the variables. The results revealed that in the first step of a regression equation, expenditure incurred on pesticides had significantly and positively affected the gross returns of cotton and paddy. It explained 8 per cent variations in gross returns. The addition of manure and fertilizers in the second step resulted in improvement in the value of R² i.e. 12 per cent. It was significantly and positively affected on the gross returns. In the third step, addition of labour slightly increases the value of R² i.e. 12 per cent to 13 per cent. It was non-significant but positive. Finally, expenses on seeds were added in the equation. The addition of this variable explained 18 per cent of variation in cotton and paddy output as revealed by R². Thus, all variables positively affected the gross returns in combination, but the seeds had negatively affected the gross returns. Results describe that pesticides and seeds showed a significant effect on the gross returns of cotton and paddy. The impact of various inputs like seeds, fertilizers, labour and pesticides on productivity of paddy in Karnataka was also discussed by Uday, K. (2009) indicating that seeds, pesticides and labour were significant variable.

Table 5.16: Results of Multiple (Step-up) Regression Analysis (Laleana and Rayia Villages)

Dependent variable: Gross Returns (Rs. /acre)

Constant	Pesticides	Manure and Fertilizers	Labours	Seeds	R ²	R̄ ² (F)
3.73* (13.80)	0.26* (3.13)	-	-	-	0.08	0.07 (9.85)
2.20* (3.29)	0.24* (2.95)	0.47* (2.48)	-	-	0.12	0.11 (8.22)
2.20* (3.18)	0.24* (2.44)	0.46* (2.47)	0.004 (0.04)	-	0.13	0.10 (5.44)
2.08* (3.11)	0.35* (3.48)	0.31 (1.65)	0.21 (1.77)	-0.13* (-3.07)	0.18	0.16 (6.73)

Source: Survey Data

* Denotes significant at five percent level

Note: Figures in parentheses indicates t values

Health Impact on Farmers and Labourers

Probability of sickness depends upon many factors like age, method of spraying pesticides, education, consumption of alcohol and smoking. The impact of pesticides on health effect through Probit model has been presented in Table 5.17. Age of farmers showed expected positive sign indicating that chances of getting ill are more in aged people as compared to younger. Again, method of spraying pesticides shows significant and positive relation with health effect, describing that large number of farmers were using knapsack sprayer. Education was found significant and negative sign as more educated people know the dangerous effects of pesticides and use precautions. Consumption of alcohol and smoking, which was expected to have a positive effect on health damage, shows a negative sign as there were few farmers having alcohol and smoking. The corresponding data was found to be positive sign on health for both medium and large farmers as they were having more consumption. The method of spraying pesticides was significantly but positively affected the health of farmers. For large farmers, none of the variable showed significant impact. Health hazardous has been found more for small farmers as they were directly engaged in spraying pesticides. It revealed

that in cotton cultivated village, method of spraying pesticides, education level of farmers, consumption of alcohol and smoking recorded a significant influence on the dependent variable for small farmers.

Table 5.17: Probit Estimates of Determinants of Health Damage (Laleana Village)

Dependent variable: Health effect

Particulars	Small Farmers (n=20)	Medium Farmers (n=20)	Large Farmers (n=20)
Constant	12.1156* (8.30)	0.6223 (0.54)	-.9367 (-0.60)
Age	0.1641 (0.14)	0.1839 (0.19)	0.5332 (0.51)
Method of spraying pesticides	6.6868* (5.83)	1.7624* (2.13)	0.3505 (0.55)
Education	-5.9757* (-4.87)	0.8907 (1.07)	-0.3193 (-0.44)
Alcohol	-5.5929* (-4.62)	1.032 (0.25)	0.2668 (0.44)
Smoking/Drugs	-6.3040* (-3.67)	-1.3323 (-0.85)	-
Pseudo R ²	0.30	0.25	0.02

Source: Survey Data

Note: Figures within parentheses are z values, * significance at five per cent level

The impact of pesticides on health effect of Rayia farmers through Probit model has been presented in Table 5.18. Results for small, medium and large farmers revealed that age showed expected positive but non-significant sign on health damage. Method of spraying pesticides showed a negative sign for small farmers but positive for medium and large farmers. Education was expected a negative effect on health risk for medium and large farmers but showed a positive sign for small farmers indicating that they were not more educated as compared to medium and large farmers. Consumption of alcohol was found significant and positive effect on health damage for large farmers. Smoking was expected as a positive effect on health sickness but negative and non significant for all the

categories of farmers as there were only few farmers smoking. It was concluded that probability of health risk was very less in paddy farming as compared to cotton farming as paddy does not heavily depend on pesticides.

Table 5.18: Probit Estimates of Determinants of Health Damage (Rayia Village)

Dependent variable: Health effect

Particulars	Small Farmers (n=20)	Medium Farmers (n=20)	Large Farmers (n=20)
Constant	0.2141 (0.15)	0.7942 (0.65)	-1.6167 (-1.34)
Age	0.2145 (0.19)	0.0991 (0.09)	6.067 (1.51)
Method of spraying pesticides	-0.6363 (0.92)	0.6723 (0.72)	1.6753 (1.51)
Education	0.7913 (0.92)	-0.4501 (-0.50)	-.0585 (-0.05)
Alcohol	0.8361 (0.87)	0.2445 (0.31)	5.0999* (4.42)
Smoking/Drugs	-0.9474 (-0.83)	-0.9436 (-0.92)	-0.9966 (-0.83)
Pseudo R ²	0.20	0.18	0.29

Source: Survey Data

Note: Figures within parentheses are z values, * significance at 5 % level

Probability of the sickness of agricultural labourers depends upon many factors which have been demonstrated in Table 5.19. Results revealed that the method of spraying pesticides found expected positive and significant effect upon the health of the labourers because they use knapsack sprayer. Age was expected a positive effect on health risk but showed negative sign. However, this coefficient was not significant. Education was expected a negative effect on health sickness but showed a positive sign as, large number of labourers were illiterate. Consumption of alcohol and smoking found expected a positive effect on health damage as labourers were used of these things. It was concluded that method of spraying pesticides was affecting more on the health damage of labourers.

Table 5.19: Probit Estimates of Determinants of Labourers Health Damage

Dependent variable: Health effect

Variable	Coefficient	z-value
Constant	0.6119	1.35
Age	-.2450	-0.56
Method	1.0964*	2.01
Education	0.2900	0.87
Alcohol	0.0203	0.06
Smoking/Drugs	0.0242	0.06
N	80	
Pseudo R ²	0.05	

Source: Survey Data

*significance at five per cent level

Thus, this chapter has summarized the technical efficiency of different farms and socio-economic impact of pesticides. It concludes that cost of pesticides was the highest for cotton crop as more number of applications applied on cotton. As compared to cotton, inputs were efficiently used in paddy production indicating more technical efficiency for paddy farms. Pesticides were positive and significant variable affecting on the gross returns of cotton. Although, the number of spraying pesticides has decreased from 12 to 6 but still usage of pesticides has not eliminated as BT cotton is also affected by pests. In paddy crop, labour was the positive and significant variable affecting on the gross returns. Probability of sickness shows significant results for small farmers of cotton cultivated area depicting that more affect on their health, On the other hand probability of health risk was very less in paddy farming due to less toxic and less number of applications of pesticides are applied on it. It was concluded that method of spraying pesticides showed a significant effect on the health damage of farmers and labourers.

Chapter VI

Summary and Conclusion

Pesticides have emerged as an important agricultural input to ensure sustainable agricultural production. India is considered as one of the largest consumers as well as a manufacturer of pesticides in South Asia. The usage of pesticides has serious implications as it increases cost of crops and also leads to health and environmental problems. In India, about 45 percent of the total pesticides consumption is on cotton alone, though its cultivated area is only 5 per cent. On the other hand, paddy covers just 20 per cent of the total pesticides consumed. Among the Northern zone states of India, on an average, Punjab has been the prominent state in the consumption of pesticides. Out of 42.21 lakh hectares cultivated area about, 35.45 lakh hectares was under the usage of pesticides.

Punjab's Bathinda district is famous for cotton production due to sandy soil which is suitable for it has been selected. Among the eight blocks, Talwandi Sabo block has maximum area under cotton cultivation while Phul block has maximum area under paddy cultivation has been selected. Therefore present study is an attempt to analyze the socio-economic implications of pesticide use in Bathinda district for two distinct crops i.e. cotton and paddy. For this an attempt is made to analyze the cost and returns and the farm efficiency for both crops and also to examine the impact of pesticides on gross returns and also on health of farmers and labourers. In order to achieve the envisaged objectives of the study, the data was collected from primary as well as secondary sources. Two villages namely Laleana from Talwandi Sabo block and Rayia from Phul block were purposely selected for primary survey. Primary data was collected from 120 farmers and 80 labourers with the help of two structured schedules. Secondary data was collected from various government, semi government and private sources. Collected data was processed through tabular analysis, Data Envelopment Analysis program, Simple regression analysis, Multiple (Step-up) regression analysis and Probit model.

Main Findings

Sample of 60 farmers was randomly selected from each village including small, medium and large farmers. The average landholdings was more in cotton cultivated grown area (11.82 acres) than paddy cultivated area (8.41 acres). The

respondents from the present study belonged to an average age of 45.48 years and 43.25 years in Laleana and Rayia village respectively indicating that majority of the farmers were in middle age group and had farm experience. On an average, about 77 per cent of the farmers were literate in Laleana village while 72 per cent of the farmers were literate in Rayia village, out of which 45 per cent had matric education. On an average, Laleana farmers were more literate than Rayia. As out of the total gross cropped area, 33.03 per cent area was under cotton in Laleana village. In Rayia village, 40.90 per cent area was under paddy. About 45 per cent of the farmers were using knapsack sprayers while 55 per cent were applying pesticides through tractor sprayers in Laleana village but 65 per cent of the small farmers were using knapsack sprayers. On the other hand, in Rayia, 55 per cent of the small farmers were using knapsack sprayers. Due to using knapsack sprayers, few symptoms of health problems have been found among them. Skin allergy was the major problem among the farmers to an account of around 47 per cent and 37 per cent respectively in cotton and paddy cultivated villages followed by an eye irritation i.e. about 32 per cent and 30 per cent respectively. Method of spraying pesticides also affects labourers as most of them spray manually indicating that they were having more problems as nearly 80 per cent of the labourers were suffering from eye and skin allergy problems.

Labourers were not aware about protective measures as just 25 per cent of labourers put mask to cover their faces and only 15 per cent wear hand gloves for mixing pesticides. About 55 per cent of the labourers used knapsack sprayer. Awareness about environmental issues related with pesticides depicted that farmers had not inadequate knowledge about the negative impacts of pesticides on environment in both villages.

The average cost of cotton cultivation worked out to be Rs. 14213.81/acre. Among the three categories of farmers, the total cost incurred by the large farmers was the highest (Rs. 14538.91 /acre) as compared to small farmers (Rs. 13664.66 /acre) and medium farmers (Rs.14437.85 /acre). Also, the cost incurred on pesticides by large farmers was the highest (Rs. 2045.23 /acre) as compared to small and medium farmers, which was Rs. 1708.12 /acre and Rs. 1873.41 /acre respectively. On the other hand, the rate of return from pesticides among large

farmers (Rs. 13.40) was less than medium farmers (Rs. 14.31) and small farmers (Rs. 15.44). It was the highest for small farmers (Rs. 15.44) showing that it decreases with the increase in the size of landholdings. On the other hand, average cost of paddy cultivation was Rs. 12121.73 /acre for all farmers. Cost incurred on pesticides by large farmers was maximum (Rs. 1535 /acre) as compared to small farmers (Rs. 1241.5 /acre) and medium farmers (Rs.1522.25 /acre). Similarly for paddy, rate of return was less for large farmers (Rs. 18.56) as they incurred more on pesticides while highest for small farmers (Rs. 22.67). It is clear that increase in the expenditure on pesticides leads to decrease in the rate of returns obtained from it.

Technical efficiency of farms producing cotton and paddy was found out by Data Envelopment Analysis under Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). Under CRS, in the case of cotton cultivated farm, minimum technical efficiency in farm was 59 per cent and mean technical efficiency was 78 per cent indicating that on an average, the farms operated 22 per cent below the frontier output levels implying that there was injudicious use of inputs. The efficiency was higher in the case of the paddy farms with the mean technical efficiency of 84 per cent. Output in the paddy could be increased by 16 per cent in the area. Under the VRS specification the estimated input-oriented mean technical efficiency was 81 per cent in cotton cultivated farms. This means that the same level of output can be reached by only using 81 per cent of the used inputs, if technical inefficiency is completely removed. On the other hand, in paddy farming the mean technical efficiency was 87 per cent indicating that inputs are more efficiently used in paddy farming.

The impact of various inputs specifically pesticides on gross returns was estimated through simple regression analysis and multiple (step-up) regression analysis for both crops separately as well as together. The results of simple regression revealed that all the four variables i.e. expenditure incurred on seeds, manure and fertilizers, labour and pesticides significantly and positively affected the gross returns of cotton. According to multiple (Step-up) regression analysis expenditure incurred on pesticides had significant and positive effect on gross returns of cotton. On the other hand, results of simple regression analysis for paddy crop

revealed that labour was significantly and positively associated with its gross returns. Seeds and fertilizers were non-significantly and negatively affected on the gross returns. Further pesticides had non-significant but positive impact on gross returns. Results for multiple (step-up) regression revealed that expenditure incurred on labour had significant and positive effect on gross returns of paddy. It can be concluded that pesticides is an important for cotton while labour for paddy. In combined analysis of both crops, the results of simple regression analysis revealed that fertilizers and pesticides had significantly and positively affected the gross returns of both crops but non-significantly and positively associated with labour. It was non-significantly and negatively related with seeds. Results of multiple (step-up) regression revealed that pesticides and seeds showed a significant effect on their gross returns.

Probit model has been used to find out the probability of sickness due to exposure of pesticides among farmers and agricultural labourers. Probability of sickness depends upon many factors like age, method of spraying pesticides, education, consumption of alcohol and smoking. In cotton cultivated area, age of farmers confirmed a positive sign indicating that chances of getting ill are more in aged people as compared to younger. Again, method of spraying pesticides showed significant and positive relation with health effect depicting that large number of farmers using knapsack sprayers are getting ill. Education was found significant but negative sign as more educated people know the dangerous effects of pesticides and use precautions. Consumption of alcohol and smoking, expected to have a positive effect on health damage, shows a negative sign as there were few farmers having alcohol and smoking. The corresponding data was found to be positive effect on health for both medium and large farmers. The method of spraying pesticides significantly and positively affected the health of medium farmers. For large farmers, none of the variable showed significant impact. Health hazardous have been found more for small farmers as they were directly engaged in spraying pesticides, It revealed that in cotton cultivated village, method of spraying pesticides, education level of farmers, consumption of alcohol and smoking recorded a significant influence on the dependent variable for small farmers.

In paddy grown area, results for small, medium and large farmers revealed that age showed expected positive but non-significant sign on health damage. Method of spraying pesticides showed a negative sign for small farmers but positive for medium and large farmers. Education was expected a negative effect on health risk for medium and large farmers but shows a positive sign for small farmers indicating that they were not more educated as compared to medium and large farmers. Consumption of alcohol was found positive and significant effect on health damage for large farmers. Smoking was expected as a positive effect on health sickness but non significant and negative for all the categories of farmers as there were only few farmers smoking. It has been concluded that probability of health risk was very less in paddy farming as compared to cotton farming as paddy does not heavily depend on pesticides.

Results of Probit model revealed that for agricultural labourers, the method of spraying pesticides found significant and positive effect upon the health because they use knapsack sprayers. Age was expected a positive effect on health risk, but showed a negative sign. However, this coefficient was not significant. Education was expected a negative effect on health sickness but showed a positive sign as, large number of labourers were illiterate. Consumption of alcohol and smoking found expected a positive effect on health damage as they were used of these things. It was concluded that method of spraying pesticides was affecting more on the health damage of labourers.

The present study concludes that cost of pesticides is more on cotton crop as it is more affected by pests. So, it can be stated that it becomes necessary for farmers to depend upon pesticides. In spite of the decreasing trend of pesticides consumption, its usage had not been totally eliminated. Even one newspaper has reported that in Mansa district about Rs. 160 crore on pesticides has been spent on an area of one lakh 5000 hectare of cotton¹. Farmers and labourers spraying pesticides directly or indirectly are facing a number of health problems.

¹ Press reporter. (2012, September 6). BT cotton' yield is now depended on pesticides. *Punjabi Tribune, Malwa*.

Suggestions

The following suggestions would be useful to minimize the problems related to the theme of the study:

The study found that cotton farmers were making indiscriminate use of pesticides. Therefore, there is need for proper education to the farmers about the judicious use of pesticides. They should follow the recommendations of Punjab Agriculture University about application of pesticides instead of blindly following the neighbouring farmers while applying pesticides.

Pesticides are an essential input in production process for many crops especially for cotton but its usage leads to many health problems. The present study found that maximum farmers and labourers are not using the protective measures during its application. Government should conduct workshops to provide basic knowledge about the safe guards to them.

Pesticides increases the yield, it is a short-term gains as it lead to health problems. Farmers need to be encouraged to reduce the use of pesticides, with the introduction of incentives to the farmers to help them shift from synthetic pesticides to bio pesticides.

They need to be advised about the method of applying pesticides.

The introduction of BT cotton has reduced the problem of American bollworm pest. So, there is need of more research and development on adequate seeds of resistant other varieties.

Pesticides lead to environmental pollution but study found that many farmers and labourers are not aware of this fact. Therefore, there is an urgent need to educate them about negative effects. People need to be educated about new technology like trap crop and bio pesticides which will help in reducing incidence of insects.

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Appendix A

Table A.1: Summary of Literature Review (World)

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
1	Pimental et al.	1992	To know the environmental and economic costs of pesticides use in U.S.	\$8 billion is considered as environmental cost. Out of which \$3 billion paid by directly users of pesticides and \$5 billion in environmental.
2	Antle and Pingali	1994	To know the impact of pesticides on farmer's health and impact of farmer's health on productivity in Philippine.	Pesticides use has a negative effect on farmer's health and positive on productivity. Tax imposition on pesticides is emphasized in the study to reduce the use of pesticides.
3	Khan et al.	2002	An economic evaluation of pesticide use externalities in cotton zones of Punjab, Pakistan.	Reduced reliance on crop protection products seems inevitable for sustainable and healthy crop production and recommended for the enforcement of existing legislation in pesticide for import, registration and advertising.
4	Chakarborty et al.	2002	Analyzed technical efficiency of irrigated and non-irrigated cotton farms in four west Texas	Under CRS irrigated farms were more efficient than non-irrigated farms, while in

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
			countries	VRS are similar.
5.	Nguyen and Tran Thi	2003	Discuss the economic And health consequences Of pesticides use in paddy production in the Mekong Delta, Vietnam.	The amount of Pesticides has Decreased by 43 per cent compare with the year 1992 due to adoption of IPM
6	Budak and Budak	2006	To compare the differences in pest management and farm profitability in two provinces, in East Mediterranean.	Usage of pesticides was much higher in Adana than Kahramanmaras which reported more health problems. Shifting to organic production reduce environmental and health problems.
7	Ngowi et al.	2007	To find out type, pattern and frequency of pesticides application in Northern Tanzania for vegetable growers.	Users of pesticides were influenced by manufactures and vendors which were the main reason for increase in no. of applications. Emphasis on IPM was suggested.
8	Sanfilippo and Perschau	2008	To study the social and environmental impact of pesticide use in cotton production at world level.	Pesticides had negative impact on health and responsible for health loss. Organic cotton should be cultivated to achieve long term soil fertility.

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
9	Mariyono and Bhattarai	2009	Analyzed the factors affecting chilli farmers' decision to use pesticides And to minimize risk of crop failure in Indonesia.	Age has a positive and size of farm has a negative relationship With usages of pesticides. Educational level of farmers should be increased to reduce its use.
10	Shrestha et al.	2010	To study the knowledge, practice and use of pesticides among vegetable growers of Dhading district, Nepal.	Majority of growers not use protective equipment. There is need for awareness for reducing usage.
11	Mohd Fuad et al.	2012	To know the impact of pesticides on paddy farmers and their ecosystem in Malaysia.	Usages of pesticides harm the health, environment, plants, fishes and livestock. Farmers should be educated to reduce the use of pesticides.
12	Shrawasti	2012	An attempt to know the socio-economic impact of pesticides used in the area of Nepal.	Due to lack of knowledge and low rate of pesticides led to health problems. Awareness should be needed.

Table A.2: Summary of Literature Review (India)

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
1	Kumar and Dandapani	2000	Discuss the frequency, intensity and determinants of pesticide use on cotton in Nanded the area of Maharashtra	Risk averse farmers used pesticides excessively and indiscriminately. Improving knowledge of pests and management practices could help to reduce its use.
2	Shetty	2004	To determine the impact of pesticides usage on agricultural production and health of farmers in four states.	Excessive use of nitrogenous fertilizers and continuous mono cropping of paddy led to pest problems.
3	Jeyanthi and Kombairaju	2005	An attempt to study the usage of pesticides on four important vegetables, its frequency, intensity and determinant factors.	Risk aversion of farmers was the main reason for more number of applications found on cauliflower and brinjal as compare to chilli and bhindi as intensity is Found high for chilli.
4	Pouchepparadjou	2005	To compare the farmers of adopters of IPM and Non-IPM	Cost of pesticides spent in non-adopters farms was high than adopters.
5	Devi	2007	Analyzed the health Impact of pesticides in the rice bowl of Kerala	Toxicity level and dose of pesticides has positive impact on health which can be improved by training in self-handling.

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
6	Prabuddha	2007	To study the pattern of pest infestation and extent of pesticide use on vegetables in Katwa block, the area of West Bengal.	Intensity of pest infestation on vegetables found greatest during Rabi season.
7	Singh et al.	2008	To analyze the adoption of IPM technology on cotton in Punjab and on paddy in Haryana.	Investment in IPM education will have long term beneficial impact.
8	Aktar and Paramasivam	2009	To discuss the benefits and hazards of pesticides use.	Pesticides increase production which brings additional revenue. On the other hand, it led to health and environmental problems.
9	Dhaliwal et al.	2010	To analyzed the changing trend between pre-green revolution and in post-green revolution.	Change in loss was maximum for cotton followed by millets, maize and oil seeds. Efforts were made to implement Integrated Pest Management.
10	Pati and Katti	2012	To examine the relationship between the extent of the usage of pesticides and signs and symptoms of illness among labourers in Maharashtra.	Pesticides are directly related to farm productivity and indirectly to health which lead to about 97 per cent labourers suffering from skin

Sr. No.	Author	Year	Objectives	Conclusion and Suggestions
				problems.
11	Singh and Singh	2013	To evaluate the technical efficiency of Indian agriculture over the period of 1971 to 2004.	Technical efficiency varies from 96 per cent in Tamil Nadu to 69 per cent for the state of Gujarat. Due to small size of holding, technical inefficiency increases.
12	Umanath and Rajasekar	2013	To analyze the efficiency level of paddy farms in Madurai district of Tamil Nadu.	Majority of farmers were not operating at the optimal scale. Government should provide necessary education to bring in social change.

**Unmarried-1, Married-2, Widow/Widower-3, Divorced/ Separated-4, Others-5.

Nuclear family-1, Joint family-2, Extended family-3

\$ Self Cultivation-1, Causal Labourer in Agriculture-2, Casual Labourer in non Agriculture-3, Long term attached labour-4, Salaried/govt.job-5, Individual Service (Caste Occupation)-6, Self business based on agriculture and allied activities-7 (Animal Husbandry, Poultry etc.), Small Business/trade/construction-8, Big Business/trade/construction-9, Unemployed-10, Student-11, Only domestic work-12, Retired/ Very old-13, Disable/Handicapped/ sick-14, Others (Specify)-15

B. Farm Particular

1.1

Land	Acres
Un-irrigated land	
Irrigated land	

1.2

Land	Acres
Through tube-well	
Through canal	

2. Area under different crops

Crops	Acre	Prod. (Qts.)	Yield (qt/acre)	Price/qts.	Gross returns
Cotton					
Paddy					
Wheat					
Fodder					
Other					
Grand Total					

C. Source of Income

Sr. No.	Source	Annual Income
1	Agriculture and Allied Activity	
2	Business	
3	Salary	
4	Wages	
5	Others	

D. Economic issues:

Cost and Returns of Cotton/Paddy

I. Costs:

Items of Cost		Cotton		
		Quantity/acre	Price	Total cost
Seeds				
Fertilizer	Urea			
	DAP			
	Potash			
Farm yard Manure				
Hired labour				
• Hoeing and weeding				
• Pickings				
Tractor Expenditure				
Pesticides/ insecticides/ weedicides				
No of sprays				
Irrigation charges				
Interest on working capital				
Others (specify)				

Items of cost		Paddy		
		Quantity/acre	Price	Total cost
Nursery preparation				
Preparatory tillage				
Sowing/transplanting				
Fertilizer	Urea			
	DAP			
	Potash			
Farm yard Manure				
Hired labour				
• Hand weeding				
• Harvesting				

Tractor Expenditure			
Pesticides/ insecticides/ weedicides			
No of sprays			
Irrigation charges			
Interest on working capital			
Others (specify)			

II. Input costs:

Type of pesticide used	No. of times	Quantity/ each time	Method of application	Total quantity	Price	Labour wage
Name of insecticides						
Name of weedicides						

III. Return:

Indicators For returns	Cotton (2012-13)			Paddy (2012-13)		
	Quantity (Qtl.)	Price/Unit	Total	Quantity (Qtl.)	Price/Unit	Total
Main product (per acre)						
By product (per acre)						

E. Socio- issues

1	What are the factors to use pesticides?	More attack of pests	1
		Easy marketing facility	2
		To achieve more production	3
2	What is the dose you are using? RD/>RD/<RD (RD=Recommended dose)		
	If >RD	Due to higher incident of pests	1
		Anticipate higher returns	2
		Other farmers apply pesticides; it is necessary for me to use pesticides, so that pest would not develop	3
		More availability of pesticides	4
		To increase more effectiveness of pesticides	5
		Any other	6
	If <RD	Due to lack of funds	1
		Lack of availability of pesticides	2
		Less pest attack	3
		Any other specify	4
3	What are trends of pesticide usage in your area?	Increasing trends	1
		Constant trends	2
		Decreasing trends	3
3.1	If it is increasing trends, it is due to	Ineffective pesticides	1
		Pest resistance	2

		Increase in pest problems	3	
		Increase in area under crop	4	
		More advertisement by manufactures	5	
3.2	If it is constant trends	Pesticides are effective	1	
		Same acreage, farm size	2	
		Fewer insect pests	3	
3.3	If it is decreasing trends	Unavailability of pesticides	1	
		Reduced farm acre	2	
		Price of pesticides increases	3	
		Due to introduction of bt cotton	4	
4	Do you use pesticides for other crops	Yes	1	
		No	2	
4.1	If yes which are the crops and name of the pesticides you use?			
Sr. No.	Crop	Name of the pesticide	Quantity (ltr/kg)	Value (Rs.)
4.2	If no why you do not use pesticides?			
5	Have you ever purchased banned pesticides?	Yes	1	
		No	2	
5.1	If yes, why?			

6	Do you use bio-pesticides?	Yes	1
		No	2
7	Do you see labels on packs?	Yes	1
		No	2
7.1	If yes, are you able to read toxicity, reading the sign on the label?	Yes	1
		No	2
8	What are the methods to apply pesticides?	Knapsack sprayer	1
		Tractor sprayer	2
9	Where do you store the pesticides?		
10	Have you ever sprayed?	Yes	1
		No	2
10.1	If yes, is there any negative impact of pesticides on health like?	Skin allergy	1
		Harm to eyes	2
		Breathing problems	3
		Others specify	4
10.2	If no, do you see these symptoms in labourers who sprayed?	Yes	1
		No	2
11	Do you drink or smoke?	Yes	1
		No	2
12	Acc. to you, with the usage of pesticides, fertility of soil	Increases	1
		Decreases	2
		Constant	3
13	What are the impacts of pesticide use on environment?		
14	Have you attend any training/workshop/discussions on pesticide use and care?	Yes	1
		No	2
14.1	Is yes, what are the benefits of these workshops?		

15	What would you like to suggest for the usage of pesticides whether these are harmful or not?

CENTRAL UNIVERSITY OF PUNJAB (BATHINDA)

Socio-Economic Implications of Pesticide use in Bathinda District of the Punjab State

Interview Schedule for Agricultural Labourers

Date.....

A. General information

1. Agricultural Labourers profile:

Name of the respondent	
Age	
Village	
Post Office	
Block	
Tehsil	
Contact no.	

2. Education:

Primary	High School	Illiterate
1	2	3

B. Pesticide application procedure

1	Do you can read the labels on the package?	Yes	1
		No	2
1.1	If no, do you seek help from others?	Yes	1
		No	2
2	Do you follow the instructions given on the label?	Yes	1
		No	2
2.1	If no, why?		
3	Do you contact any source for getting information about pesticide application	Yes	1
		No	2
3.1	If yes,	Govt. officials	1

		Land owner	2
		Fellow labourers	3
		Retail shop owners	4
4	In which direction you apply the spray?	Along the wind	1
		Across the wind	2
		Against the wind	3
5	Which equipment do you use?	Tractor sprayer	1
		Knapsack sprayer	2
6	Do you use mask during pesticide spraying?	Yes	1
		No	2
6.1	If no, do you feel some problem without mask?	Yes	1
		No	2
7	Do you use bare hands to mix pesticides?	Yes	1
		No	2
7.1	If no, do you feel some allergy to hands?	Yes	1
		No	2
8	Do you eat, drink or smoke while spraying pesticides?	Yes	1
		No	2
9	Do you take bath right after spraying?	Yes	1
		No	2
10	Do you change clothes right after spraying?	Yes	1
		No	2
11	How do you dispose of pesticide bottle?	In field	1
		Sell it to cooperatives	2
		Use it for other purpose	3
		Burn the bottle	4
12	Are you aware that you should not go to field after spraying?	Yes	1
		No	2
12.1	If yes, how oftenly you visit the field?	Next day	1
		Two days after	2
		After a week	3
		After 15 days	4

12.2	If no, What type of work you do?		
13	Had pesticides adversely affected your health	Yes	1
		No	2
13.1	If yes,		
Sr. No.	Particulars	Yes	No
1	Eye irritation		
2	Head ache		
3	Dizziness		
4	Vomiting		
5	Shortness breaths		
6	Skin irritation		