HIGH VALUE CASH CROPS AGRICULTURE IN HIMACHAL PRADESH: A STUDY IN DOCUMENTATION AND VALUATION OF ENVIRONMENTAL COSTS

THESIS

By

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CERTIFICATE -I

This is to certify that the thesis entitled **"High value cash crops agriculture in Himachal Pradesh : A study in documentation and valuation of environmental costs"** submitted in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy (Agriculture)** in the subject of Agricultural Economics of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out **by Shanta Kumari (A-2003-40-5)** daughter of **Shri Kishan Chand** under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been fully acknowledged.

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CERTIFICATE –II

This is to certify that the thesis **entitled "High value cash crops agriculture in Himachal Pradesh : A study in documentation and valuation of environmental costs"** submitted by **Shanta Kumari (A-2003-40-5)** daughter of **Shri Kishan Chand** to the CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in partial fulfillment of the requirements for the degree of **Doctor of Philosophy (Agriculture)** in the subject of Agricultural Economics, has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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CHAPTER-I

INTRODUCTION

Agricultural development in the mountain region is circumscribed by mountain specificities, namely, inaccessibility, marginality, fragility, niche and human adaptation mechanism created by unique vertical dimensions that distinguish them from plains and other ecosystem. While the first three features contribute in varying degree, *inter alia,* to physical isolation, distance and high transportation costs, the later two indicate positive features and the potential for agricultural development. The mountain agriculture in general is cereal based and characterized by low and stagnant productivity. The diversification of agriculture from cereal based systems towards high value cash crops including fruits and off-season vegetables, compatible with the comparative advantage of the region, is suggested as a viable solution to stabilize and raise farm income and increase employment opportunities. (Vyas 1996; Joshi et al 2004, Sharma, 2005).

The transition from subsistence-oriented, cereal-based agriculture to high-value cash crop-based commercial agriculture has both positive and negative impacts on the natural resource base. The positive aspect of commercialisation is that the adoption of high value cash crops, particularly fruit crops, helps the mountainous region in two ways. First, it promotes productive use of abundant marginal lands available in these regions which otherwise are either lying idle or are devoted to low value subsistence crops. Second, these crops help in maintaining and improving the

ecology and environment by promoting soil conservation and improving soil fertility. In economic terms, it leads to significant improvement in the quality of life of the people.

Negative aspects of agricultural commercialization is the excessive mining of the natural resource base coupled with excessive use of agro-chemicals leading to soil degradation and loss of rich agro-biodiversity available in these regions. Studies have shown that excessive use of chemical fertilizers and pesticides has impacted adversely on the soils. For example, according to (Oldeman *et al,* 1991) globally a total of 239 M ha is affected due to excessive and or imbalanced use of agro-chemicals. Out of such lands, 135 M ha is degraded due to loss of nutrients, 76 M ha is affected by salinity, 22 M ha is affected by chemical pollution and 6 M ha of land is affected acidity. These estimates give a rough idea about the extent of chemical–related soil degradation worldwide. The adoption of monoculture by the farmers and the use of high yielding varieties in place of traditional varieties in commercialized agriculture have led to a significant loss of genetic diversity. The contribution of monoculture and intensification towards the loss of nutrients, chemical pollution and acidification is, however, not known.

Agrochemicals used to increase agricultural productivity, have also been associated with many direct and indirect negative impacts on human health. These effects are increasingly manifested in loss of working efficiency resulting in higher cost of production. In recent times, the effects of commercialization of agriculture on environment and human health have attracted the attention of both the scholars and policy makers (Postel, 1989; Pingali *et al,* 1997; Pingali and Rosegrant, 1994). The

severity and risks of adverse impacts are higher in developing countries where users are quite often illiterate, ill trained, and do not possess appropriate protective equipments. It is estimated that only 0.1 per cent of applied pesticides reach the target pests, leaving the bulk of pesticides (99.9 percent) to impact the environment and human health (Pimental, 1995). The emphasis on organic agriculture is the direct outcome of the increasing awareness of the adverse effects of the excessive use of agro-chemicals.

Himachal Pradesh is a small mountainous state with a total geographical area of 55,673 square km. Its altitude ranges from 350 meters to 6,975 meters above the mean sea level. Situated in the heart of the Western Himalayas, the state is primarily an agrarian economy. More than two thirds of the population depends on agriculture for their livelihood. The process of crop diversification in the state started with the introduction of apple in the late fifties and sixties in district Shimla and Kullu. The process has now spread to different regions in many other districts, namely, Solan, Sirmaur and even to low and mid hill districts and encompasses cultivation of high value crops like seasonal and off-seasonal vegetables. Over the years, the state has emerged as a leading producer of temperate fruits and off- season vegetable. The area under fruit crops increased from 26,307 hectares in the triennium ending 1967-68 to 1.87 lakh hectares in the triennium ending 2005-06. The production of fruit during the period increased from 48 thousand tonnes to 6. 28 lakh tonnes. The area under vegetable crops increased from 23,000 hectares in 1990-91 to 50,000 hectares in 2006-07 and the production during the period rose from 3, 65,000 tonnes to

10,00,000 tonnes registering compound growth rates of 5.49 per cent and 5.90 per cent per annum respectively

A plethora of micro studies are available on different aspects like marketing, costs, returns, income, employment, ecological sustainability of the cultivation of high value cash crops. In net terms, these studies have shown that switching over to the cultivation of these crops from cereal crops has made a significant improvement in the economic status of the farmers in terms of their income and employment. More importantly, however, these studies have overlooked adverse impacts of the cultivation of these crops on the natural resource base, particularly soil and human health. Perhaps, this was also not required, *ab initio*, inasmuch as the policy makers and other development agencies were, primarily concerned with improving upon standard of living of the local people. However, over the period the mono-cropping without adequate nutrient replenishment of the soil and excessive use of agro-chemicals have started manifesting in terms of dwindling crop productivity and increasing incidence of health related problems, especially in areas where cultivation of high value cash crops started 25-30 years back. Over the past decade, farmers have been complaining about the decline in apple production despite using all agronomic inputs and following orchard management practices including irrigation, fertilizers and pesticides. Most of the farmers in Hindu Kush Himalayan region feel that productivity of apple has declined by as much as 50 per cent as a result of the decimation of the bees and other useful insects (Partap T. 1998). While the impacts of the mono-cropping and excessive use of chemical inputs are not so conspicuous in some areas, in others these are getting increasingly manifested in terms of reduced

life span of the orchards, in many cases by about five to ten years, decrease in the physical productivity, deterioration in the quality of produce and loss of arable land.

The anecdotal evidence from these areas suggests that mono-cropping and excessive use of agro-chemicals has started impacting adversely on the natural resource base, particularly soil and agro biodiversity. Agro biodiversity includes weedy populations, agricultural crops, crop pollinators, soil micro fauna and micro flora. Some land use practices, such as the indiscriminate use of pesticide, destroy some crop pollinators and have tangible effects on agro biodiversity. Overuse of pesticides has also led to the elimination of predators of crop pests, which then develop resistance to pesticides.

In brief, though environmental related issues have assumed importance, these aspects of the cultivation of high value cash crops have not been studied and looked into. In fact, we have not come across any study that did document and value the myriad of adverse impacts on the natural resource base and environment in those areas of the state where the cultivation of high value cash crops is in advanced stages. The present study is a modest attempt in this direction. Against this background, the present study aims at documenting the high value cash crops cultivation led adverse changes in the natural resource base, the strategies adopted by the local people to minimize the adverse impacts, monetary valuation of environmental costs, understand their implications for the livelihoods of the local people and suggest possible solutions. Such a study is essential in estimating the

true cost of the cultivation of these crops. Keeping this in view, the study has been undertaken with the following objectives:

1.1 Objectives

- To document the commercialized agriculture led adverse changes in the natural resource base and their impact on the production, productivity and human health;
- To document the strategies adopted by the farmers to minimize the adverse effects of these changes;
- To estimate the cost of these changes in terms of the losses in income and employment and;
- To understand the implications of these changes for the livelihoods of the farmers and suggest policy measures.

REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

The knowledge of scientific literature in the field of study is of great importance in the successful conduct of any research investigation. It provides insights in understanding the problem in precise, clear and comprehensive manner. Beside, it makes the researcher aware of the issues which are being debated, the issues which are largely resolved and the research gaps in the field. In the ultimate analysis, review of literature helps setting the research agenda to fill in gaps in the existing knowledge. Against this background, this chapter presents the review of research work related to different aspects of the present study. We have tried to review the literature as exhaustively as possible. Nevertheless, while there were large numbers of studies on some aspects of the problem, not many studies were available on others. In fact, we have not come across any study that had attempted the valuation of degradation of soils in monetary terms. The review has been arranged under the following broad heads:

2.1. Adverse impact of commercialized agriculture on natural resource base:
  2.1.1. Soil and agro-biodiversity
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2.4. Strategies adopted by the farmers

2.1 Adverse impact of commercialized agriculture on natural resource base:

Pingali (2001) reported that commercialization of agriculture can have both negative and positive impacts on the natural resource base. Higher opportunity cost of labor increases farmer reliance on herbicides for weed control, primarily for the staple crops. The use of insecticides and fungicides could also rise, especially for high value fruit and vegetable crops. The author argued that increased use of agricultural chemicals could lead to higher environmental and human health risks. On the other hand, global integration and the consequent rationalization of agricultural policies could have significant environmental benefits, especially in terms of a reduced rate of salinity build up and ground water depletion in irrigated environments. The extent to which positive environmental effects manifest themselves depends both on macroeconomic and microeconomic policy reforms

2.1.1 Soil and agro-biodiversity

2.1.1.1 Soil

According to UNEP estimates, salinity in irrigated areas was the primary cause and overall it is the second major cause of the loss of agricultural land (Umali, 1993). In India, an estimate suggests that 7 million hectares have been abandoned because of excess salts. In Mexico, (Yuldelman, 1989) more than 50,000 hectares have been abandoned due to salinity in the late 1980s'.The direct environmental consequences of abandoned land due to soil salinity problem was that it created demand for new land for cultivation. Thus, it impacted the environmental benefits in the form of potential land-savings, which resulted from productivity-enhancing technology.

Joshi and Jha (1991) in the Sharda Sahayak irrigation project in India, found that the yields of paddy and wheat were 41-56 per cent lower on the degraded soils and net income in salt affected land was 82-97 per cent lower than the unaffected land. Productivity losses were a result of increased costs of production: per unit costs for paddy rose by about 60 per cent, while for the wheat it increased by about 85 per cent in saline lands. The author also found that salinity accounted for as much as 72 per cent of the difference in gross income between normal and salt affected soils. Further, the farmers have reportedly reverted to low-input traditional varieties and practices as soil conditions deteriorated.

Oldeman *et al.*, (1999) studied the global estimates of different types of human-induced soil degradation. According to author, globally a total of 239 M ha suffer from chemical soil degradation. Out of this, 135 M ha suffer from soil degradation due to loss of soil nutrients, 76 M ha due to salinization, 22 M ha due to chemical pollution and 6 M ha due to acidification. Further, these estimates give a rough idea about the extent of chemical- related soil degradation problem existing world wide.

2.1.1.2 Agro-biodiversity

Srivastava *et al.* (1996) identified the critical issues surrounding agricultural development and biodiversity. The sound management of biodiversity is essential for improving agricultural and a host of other economic activities. However, the linkages between biodiversity and agriculture have been poorly understood, to the detriment of efforts to better conserve and utilize biodiversity. Some agricultural

practices also trigger down stream impacts on biodiversity, such as water pollution with agrochemicals. According to authors, agriculture was the key to saving agro biodiversity and farming and livestock practices can be protected to minimize environmental damages. The authors emphasized that agriculture and biodiversity were inter-linked and without biodiversity agriculture cannot progress. People in rural, and even urban areas, were intimately involved in using biodiversity to meet their needs. Further, both indigenous knowledge and scientific research were needed to meet the challenges of intensifying agriculture in an environment –friendly manner.

Underwood (1992) studied the human activities and found that these had an adverse impact on many aspects of the environment in the Himalayas. The decline in population of the Himalayan honeybees was just one example of that impact. The decline in colony number of *Apis laboriosa* which act as a pollinator did have negative consequences for agriculture, especially at high altitudes, in the Himalayas. They found that especially apple requires insect pollination.

Shetty (2000) found that the adoption of monoculture by farmers and the use of high yielding varieties in place of traditional varieties have led to a significant loss of genetic diversity. The high yielding varieties need more chemicals for the elimination of the natural enemies of the pest. The indiscriminate use of these chemicals resulted in the elimination of the natural enemies of pest, leading to increased outbreak and resurgence of insect pests.

Marendia and Pingali (2001) reported that water logging and salt affected soils caused decline in crop productivity and loss of arable land, which leads to loss of

habitat and reduction of biodiversity. They also found that affected soils severely limit the choice of crops and reduce crop diversity.

Shetty (2004) reported that over use of pesticides brought about a decline in the biodiversity of non-target organisms. About 70 per cent of the respondents in the study area reported a significant decline in the population of beneficial organisms.

Dasgupta and Meisner *et al.* (2005) in a recent survey studied 820 winter rice, potato bean, egg plant, cabbage, sugarcane and mango farmers in Bangladesh. They found that over 47 per cent of farmers were overusing pesticides, which was potentially a very threatening problem to farmers' health as well as environment. Only 4 per cent of farmers were formally trained in pesticide use or handling and over 87 per cent openly admitting to using little or no protective measure while applying pesticides. The result highlights the necessity of designing effective and targeted outreach programmes which deal specially with pesticide risk, safe handling and averting behaviour. Ideally the approach would be participatory in nature to address key informational gap, as well as increasing farmer awareness retention.

Sexena *et al.* (2005) studied the Himalayan mountain system and found that it was distinguished globally for a rich biodiversity and for its role in regulating the climate of the South Asia. Traditional crop-livestock mixed farming in the Himalaya was highly dependent on forests for fodder and manure prepared from forest leaf litter and livestock excreta. Apart from sustaining farm production, forests provide a variety of other tangible and intangible benefits, which are critical for sustainable livelihood of not only 115 million mountain people, but also many more living in the adjoining

plains. The land-use pattern changed with replacement of traditional staple food crops by cash crops and of multipurpose agroforestry trees by fruit trees. Cultivation of *Fagopyrum esculentum, Fagopyrum tataricum, Panicum miliaceum, Setaria italica* and *Pisum arvense* has been almost abandoned. Increasing stress on cash crops was driven by a socio-cultural change from subsistence to market economy facilitated by improvement in accessibility and supply of staple food grains at subsidized price by the government. Farmers have realized substantial economic benefits from cash crops. However, loss of agro-biodiversity implies more risks to local livelihoods in the event of fall in market price/demand of cash crops, termination of supply of staple food grains at subsidized price, pest outbreaks in a cash crop dominated homogeneous landscape and abnormal climate years. Indigenous innovations enabling improvement in farm economy by conserving and enhancing agro-biodiversity do exist. The changes in agro-biodiversity resulted into soil loss and run-off from the croplands have dramatically increased together with increase in local pressure on forests. Interventions including improvement in traditional manure and management of on-farm trees, participatory development of agroforestry in degraded forest lands and policies favoring economic benefits to local people from non-timber forest products could reduce the risks of decline in agricultural biodiversity and associated threats to livelihoods and Himalayan ecosystems.

Kevan (1975) found that fenitrothion, an organophosphorus insecticide, was being used as a larvicidal spray against spruce budworm over wide areas of forest in new Brunswick, Canada, since 1969. The important pollinators of low bush blue berries in the region were native wild bees. Populations of these insects

appeared to have been severely reduced on fields adjacent to those areas where fenitrothion was being sprayed. The crop failure was caused by indiscriminate application of pesticide in the fields.

Mclaughlin and Mineau (1995) found that agricultural activities have significant implications for wild species and crop rotation and intercropping in terms of maintaining wild species population. The study compared the ways in which inputs of fertilizers and pesticides impact on biodiversity at various levels including plant, invertebrate and vertebrate groups. The study further compared the ecological virtues of organic and inorganic fertilizers, and discussed the problems arising from excessive use of fertilizers. The study also reported that types and regimes of disturbances due to mechanical operations associated with agricultural activities can be modified to reduce negative impacts on particular groups of species like plants, birds and insects.

Partap (2003) found that agriculture in the Himalayan region is slowly shifting from traditional cereal crops to high-value cash crops farming such as fruits and vegetables. This transformation from subsistence systems to commercial agriculture poses new challenges for improving and maintaining productivity and quality. One of these challenges was crop failure due to inadequate pollination. This is caused by several factors, the most important of which include the lack of adequate number of pollinators as a result of decline in pollinator populations and diversity due to several factors such as decline in wilderness and loss of habitat, land use changes,

monoculture-dominated agriculture and excessive and indiscriminate use of agricultural chemicals and pesticides.

Kaihura, *et al.* (2003) found that there has been a change in biodiversity; some of the cropping systems have become extinct whereas others have emerged. The negative aspect of the changes has been the reduction of species diversity due to degradation and over exploitation.

2.2 Production and human health

2.2.1 Productivity and health

Antle and Pingali (1994) reported that pesticides use had a negative effect on farmers' health, though it had a positive effect on productivity. The study thus showed that there was a trade-off involved in the reduction of pesticides use. While the reduced use of pesticides may improve the farmer's health, the overall rice productivity may decline.

Nguyen and Dung, (1997) studied the productivity of paddy and its variable factors efficiency which was calculated on a farm survey basis. Logit regression was employed to relate econometrically a set of farmer characteristics to indicators of pesticide exposure to identify types of health impairments that may be attributed to prolonged pesticide use. Then, the pesticides' negative effects on farmers' health were estimated by means of dose-response function. The empirical results indicated that the amount of pesticides applied was far higher than the optimal level for profit maximization. Insecticides influenced negatively and significantly farmers' health via the number of contacts rather than the total dose. It was also

found that higher the number of doses and the number of applications of herbicides and fungicides, the bigger the health cost due to exposure. Since economic gains from input savings and a decrease in health cost outweighed productivity losses, a tax of 33.4 per cent of pesticide price was proposed.

Szmedra (2001) analysed the effects on farmers' health that are associated with pesticide use in sugarcane farming in Fiji. The author reported the results of a survey among sugarcane farmers who used pesticides and also of a control group of farmers who did not use pesticides. The results strongly suggested that farmers' health is negatively affected by exposure to pesticides and that impaired health might have a negative effect on farm productivity.

Shetty (2004) undertook detailed field investigation in four states (Karnataka, Andhra Pradesh, Maharashtra and Punjab) to determine the effects of the use of pesticides on the farming system, health of farmers and pest resistance. The respondents in the area had taken up cultivation of crops that gave them maximum returns even if they incurred loss for a season or two. They took into account the money saved from preventing crop loss against the cost of pesticide. Authors found that the farmers relied heavily on pesticides for pest control. Further, they suggested that by accepting the important role of pesticides in India's food security, proper education, adoption of safety norms and integrated pest management practices and reduction of monocropping should be encouraged to maximize the gain from the pesticides.

Rola and Pingali (1993) found that pesticide use has a significant positive association with the incidence of multiple health impairments among Philippine rice farmers, even after accounting for other effects (e.g. age, smoking, drinking habits and nutritional status). The average health cost for farmers exposed to pesticides was approximately 40 per cent higher than that for the unexposed farmers and health impairment lead to a loss in labour productivity.

Some authors found that vegetable farmers were more pesticide-dependent than rice producing farmers (Heong, *et al.,* 1997). The attack of insects and diseases was one of the main constraints to increase vegetable production (Lantican, 2000). Furthermore, the heavy pesticide use was due partly to the high cosmetic value demanded by consumers, forcing farmers to deliver damage-free produce. This market pressure to produce high-quality farm products encouraged vegetable farmers to adopt extreme measures to keep their harvest free from visible pest damage. This logic, similar to the rice, led to widespread pesticide misuse in vegetable farming (Medina, 1987; Adalla, 1990, Adalla and Hoque, 1991; Bernardo, 1992; and Tjornhom, *et al.*, 1996).

Lucas, *et al.* (1999) found that farmers were intensifying production systems by applying greater amounts of inorganic fertilizers, irrigation and pesticides, especially to cash crops. This study worked out economics and sustainability of an intensified rainfed rice-based system in Ilocos Norte, Philippines. Farmers use high levels of inorganic fertilizers for cash crops such as sweet pepper, garlic and tomato. Although these crops generate high levels of income, the high input systems may not

be sustainable in the long run due to adverse on-site and off-site effects. Preliminary estimates of total factor productivity that include on-site effects only, display no clear time trend. However, negative externalities created by high nitrate contamination of groundwater and high rates of pesticide usage could make the system unsustainable by adversely affecting human health and the environment.

Devi (2007) examined pesticides use in Kuttanad, India, an ecologically sensitive area often referred to as the rice bowl of Kerala. The study found that toxicity level and dose of pesticide exert a significant effect on health. The average expected heath cost from pesticide exposure was Rs. 37 per event of pesticide application per worker or 23 per cent of the average daily earnings of the applicator. If the dose of all pesticides was reduced by 25 per cent then expected average health cost decreases by 41 per cent. Dose reductions were feasible strategies for farmers in Kerala and could be achieved either by restricting the quantity of pesticide used or by diluting the amount sprayed with more water.

2.2.2 Exposure to pesticides

Pingali *et al.*, (1994) studied the impact of prolonged pesticide use on farmers' health. They quantified the magnitude of chronic health effects and health costs directly related to pesticide exposure. A set of medical indicators of pesticide exposure including farmers' characteristics was used. Their valuation of health costs of pesticide exposure was based on medical tests that looked at treatment cost (medication, doctors' fees and opportunity cost of time lost) required to restore

farmers' health. When the estimated health costs were incorporated in their benefit cost calculations, the net present value of pesticide use was found to be negative.

Rola (1997) studied the available evidence on the impact of pesticides use on farmers' health. The causes of pesticide exposure were inadequate protective clothing, unsafe handling practice and use of extremely toxic organochlorines and organophosphates. The results of the several studies revealed significant effects on farmers' health due to pesticide exposure. There was also an evidence to show that prolonged and frequent exposures to pesticides impair farmers' health, and hence, affect their productivity. Some policy actions to mitigate health risks due to pesticide use included restrictions on the use of the most hazardous pesticides, and the development of alternative pest management strategies in a broader health and ecological context.

Women have a particular susceptibility to pesticides due to their physiological characteristics, lifestyle, and behaviour. Farm women were at a greater risk of accumulated exposure because of long working hours from an early age and multiple exposures through working conditions, taking contaminated water, and intense use of a multitude of pesticides in agriculture (Rother, 2000).

The evidences from the Philippines, Vietnam, Thailand, China, Chile and India, where women were regularly exposed to pesticides because of their active participation in these field roles were documented by Paris, 1997. He found that some of those women who were performing field roles were pregnant or breastfeeding (Dinham, 2003 and Moses, 2003). The pesticide activities performed by women as

part of their household duties included cleaning pesticide containers, washing pesticide soaked clothes, or buying pesticides. Direct pesticide exposure was possible when they had first hand contact with the pesticides, especially when they cleaned containers and equipments. There was also indirect exposure through pesticide drift or residue such as when they were washing pesticide-soaked clothes. Overall, the potential for the exposure and contamination in handling pesticides was very high. Indeed, farmers' precautionary measures against exposure have been overlooked in pesticide management issues (Rola and Pingali, 1993).

The studies have also found empirical evidence that links pesticides with human deaths as a result of poisoning, deterioration in human health with long-term exposure to toxic chemicals and indirectly reducing the diversity by poisoning or contaminating complementary food sources in the fields (e.g. fish in a paddy field) treated with pesticides. (Forget *et al.*, 1993, Pingali and Roger, 1995)

2.2.3 Use of pesticides containers

Farmers disposed of pesticides containers and equipments in various ways. Most of the households leave the pesticide containers in the field, or throw in the bushes, irrigation canals, near streams, around the house, or in unused wells (Normiyah and chang, 1997; Rengam, 1999; Ajayi, 2000; Sodavy, *et al.*, 2000; Dinham, 2003). These practices can be dangerous such as when children play with used containers (Rengam, 1999). For some farm households, pesticides containers were reused by the households or by other persons, especially when sold (Dharamajal, 1997; Rengam, 1999; Ajayi, 2000). A study in Pakistan found that

containers were being used by the households for spices, oil and medicine (Rengam, 1999) which gives pesticide residue an easy entrance into body. In India, ice cream vendors buy these containers to transport ice cream, milk and other ingredients (Dharmajal, 1997; Dharamraj and Jayapraksh, 2003).

2.2.4 Symptoms of pesticide poisoning

There were also pesticide illnesses, though mild and moderate, that was reported by women farm workers. Some of the symptoms that were reported include headache, dizziness, tiredness, nausea, vomiting and coughs (Habib, 2003; Reeves and Rosas, 2003 and Vodouche, 2003).

Sakr, *et al.* (1994) tired to quantify interaction among production technology, environmental quality and human health in Ecuador. They reported a number of health consequences of pesticide use including acute poisoning, chronic dermatitis, and chronic central nervous system damage. These health problems caused loss of labour, considerable private health care costs, reduction in productivity and impairment in decision- making abilities.

Studies have also documented increased incidence of miscarriages, still births, and delayed pregnancy among women farm workers employed in pesticide mixing and spraying in agri-food industries (Ransom, 2002). Other recorded health effects from research with women in the field include acute effects such as dizziness, muscular pain, sneezing, itching, skin burns, blisters, difficulty in breathing, nausea, nail changing colour and sore eyes (Ransom, 2002; Jacobs and Dinham, 2003).There were also pesticides-related illness which were mild and moderate like headache,

dizziness, tiredness, nausea, vomiting, and cough (Habib, 2003; Reeves and Rosas, 2003; Vodouhe, 2003).

2.2.5 Knowledge of use of pesticides

In terms of reading labels before using the pesticides, women and men farmers' practices were almost the same. In a study of male Lao farmers, more than 90 per cent of the respondents did not read labels carefully (Rapusas *et al.*, 1997). The same practice was reported in a study of Indian women (Sawhney, *et al.*, 1995), in which most women farmers reported that they did not read information about pesticides given on the labels or packets of purchased pesticides. The study also added that these women were purchasing pesticides from their landlords thus they were not concerned with instructions.

With regard to avoiding eating or smoking while spraying, farmers have different practices. Lao farmers reported that they avoided eating or smoking while spraying (Rapusa, *et al.*, 1997). For vegetable farmers, it was noted that the farmers eat, drink or smoke in the field, while applying pesticides without washing hands (Sodavy, *et al.*, 2000; Dinham, 2003). And in a study in Sri Lanka, women farmers were found to be chewing betel at the time of spray (Rengam, 1999).

Maredia and Pingali (2001) found that in developing countries users were often illiterate, ill-trained, and do not possess appropriate protective equipments. Further it is estimated that only 0.1 per cent of applied pesticides reach the target pests, leaving the bulk of the pesticides (99.9 per cent) to impact the environment (Pimental, 1995).

2.3 Precautionary measures against pesticides exposure or poisoning

About acute pesticide poisoning, one study reported that crab and tamarind juices, salt solution, and excreta of pigs serve as first aid to the farmers, mostly being used to induce vomting (Dharmaraj and Jayaprakash, 2003). In Cambodia, the farmers reported that they had called for the doctor to cure them at home or they went to the hospital (Sodavy, *et al.*, 2000). Additionally, Korean rural farmers, both male and female, reported that they sought medical treatment for pesticides-related illnesses (Sohn and Choi, 2001). The majority of these farmers were required to be admitted to a hospital at least overnight. A few studies suggest that women do not do anything in case of pesticide poisoning for several reasons. Author found that (Habib, 2003) farm women do not think of going to a doctor or taking medicine, unless they were unable to move. In India, the women were found to have no recourse for action and were used to tolerating any discomfort in order to appease hunger each day. The study also added that medical facilities were beyond peoples' reach, in relation to both distance and money, and that no landowner provides first aid near the field. Therefore, it would seem that even though women would like to treat cases of pesticide poisoning, lack of resources or opportunities prevented them from doing so.

The women in Pakistan reported that (Habib, 2003) it was not possible to acquire medicine for small ailments. Other women in this study used local remedies such as applying mustard or butter oil for cases of skin burning. One respondent reported that they took medicine but after three or four days the health problems reoccurred. In another study in Pakistan, farmers ate pickles (Hussain, 1999). In the

case of Cambodia where 210 vegetable farmers (30 per cent of women) were interviewed, the farmers consumed sugar cane, lemon juice, honey, tamarind, medicinal and herbal tea to release the intoxication or illness (Sodavy, *et al.*, 2000). Studies show that most male farmers were aware that wearing protective clothing and equipment while applying and managing pesticides were important (Sakala, 1987; Sivayoganathan, *et al.*, 1995; Rapusas *et al.*, 1997; Ajayi, 2000; Hwang, *et al.*, 2000 and Nicol, 2003). However, knowing the importance of using protective equipment was not enough to convince farmers to use them.

Studies in west Africa and Sri Lanka found that men use protective equipments but the materials they use was substandard (Sivayoganathan, *et al.*,1995; Ajayi, 2000) or uncomfortable to use (Hussain, 1999). For women farmers, most of them did not use any protective clothing at all (Rengam, 1999; Garcia, 2003). Many of the women farmers thought that protective clothing meant a handkerchief over their face. The use of protective clothing has been found to retain residues (Coffman, *et al.*, 1999). And as a result, those who washed these clothes were potentially exposed to pesticides (Grieshop and Stiles, 1994 and Gladen, *et al.*, 1998)

2.4 Strategies adopted by the farmers

Partap, Partap and Yonghua (2000) in their papers discussed farmers' awareness about pollination failures and their strategies to cope with the crisis by hand pollination. Pollination-related productivity problems in apple crop and farmers' management strategies were studied in six villages (*Suangma Shidaguan, Mati Guangming, Daguo Jingzhou Fengyi, Jingzhou Fengyi, Zhongu Shiggu,* and

Jincu Nanxin) in the Maoxian County of Sichuan Province, China. The practice of farmers renting honeybee colonies from beekeepers, even though cheap bees were found in the area, was surprisingly absent. Two possible reasons for this were: first, it was not promoted; and second, beekeepers were hesitant to rent their bee colonies because of excessive use of pesticide sprays on apples. Authors found that hand pollination was a laborious and time-consuming method of pollination. On the other hand, using bees for pollination by these poor farmers can be about eight times cheaper than hand pollination.

Partap and Partap (2003) also found that farmers were adopting different approaches to inadequate pollination in their apple orchards which help to improve productivity. Management efforts included planting different varieties of pollinizer, increase the number of proportion of pollinizer trees and the number of pollinating insects in their orchards. According to authors, farmers in Himachal Pradesh were aware of the value of pollinizers in apple yield and quality and they were making efforts to increase the pollinizer proportion in their orchards by planting the pollinizer trees, grafting the pollinizers on the main variety tree and through bouquet pollination.

Kaihura, *et al.*, (2003) found that peoples were trying to manipulate the cropping system in order to efficiently use the scarce resources. Reduction in the number of animals per household, adoption of new techniques of land management, changes in the types of crops cultivated and intensive use of the available resources were some of the indicators describing farmers' efforts to cope up with the changes. The introduction of non- traditional cash crops e.g. flowers and the growth of various

horticultural crops such as cabbage and round potatoes in recent decades were some of the living examples. Sustainability of the farming system and the biodiversity was enhanced through peoples' efforts that included planting trees, use of fertilizers mostly on high value crops such as round potatoes and other horticultural crops.

In response to environmental degradation and pesticide misuse, an alternative known as integrated pest management (IPM) was developed during the 1970s. Integrated Pest Management is an ecosystem-based strategy that provides economical, long- term solutions to pest problems through a combination of biological, cultural, physical and chemical controls (Flint and Goveia, 2001). With IPM, pesticides were used only after crop monitoring indicates that they were needed, thus minimizing negative impacts on humans and ecosystem.

In sum, the review of different studies reveals that monocropping and intensification have led to adverse impact on natural resource base such as soil and biodiversity. This has led to decline in the productivity of crops. There were some empirical evidences and global estimates of the soil degradation. The loss of fertility due to monoculture and intensification was the main cause of reduction in yield and loss of arable land. The review of different studies for different regions of the world, however, reveals the dearth of empirical evidences. There are very few studies related to strategies adopted by the farmers in response to the changes that are taking place on account of the cultivation of high value cash crops. Empirical evidences of the impacts of excessive use of agrochemicals and also of decimation of agricultural bio-diversity are scarce. In fact, not a single study was available that had

estimated the true cost of production including costs arising from degradation of natural resource base especially soil and the adverse effect on human health. Similarly though negative impact of use of agro-chemicals on human health had been reported, concrete empirical evidences are lacking. This study is, therefore, a modest attempt to document the loss of agro biodiversity, estimate the monetary value of the adverse the impact of agrochemicals on human health due to pesticides exposure and degradation of soil health in terms of the loss of macro and micro nutrients and the strategies adopted by the farmers to minimize the adverse effects of these changes.

MATERIALS AND METHODS

CHAPTER-III

MATERIALS AND METHODS

Science is a body of knowledge which consists mainly of systematic observation, classification and interpretation of data. Careful and accurate classification of facts and their observations and discovery of scientific laws by creative imagination and self- criticism are the ways to arrive at final conclusions. These conclusions should closely resemble the functioning of real world situation and provide clues to understand the principles underlying functioning of human behavior. It is; therefore, essential to follow the scientific procedure, especially in an empirical study, to ensure the validity and acceptability of the results/findings. This is only possible if one follows a sound methodological procedure to conduct the study. This chapter has been devoted to discuss the methodology followed to select the sample households and different statistical tools employed to accomplish the objectives of study.

3.1 Selection of study area

Out of 12 districts of the state of Himachal Pradesh, two districts namely Kullu and Shimla were purposively selected for the study (Fig. 3.1 and Fig 3.2). The selection of the districts was influenced by two factors. First, in these districts the cultivation of high value crops namely apple and off- seasonal vegetable is being practiced since the late sixties and early seventies. Second, these two districts

together account for more than three-fourths of the total area under fruits and more than two-thirds of the total fruit production.

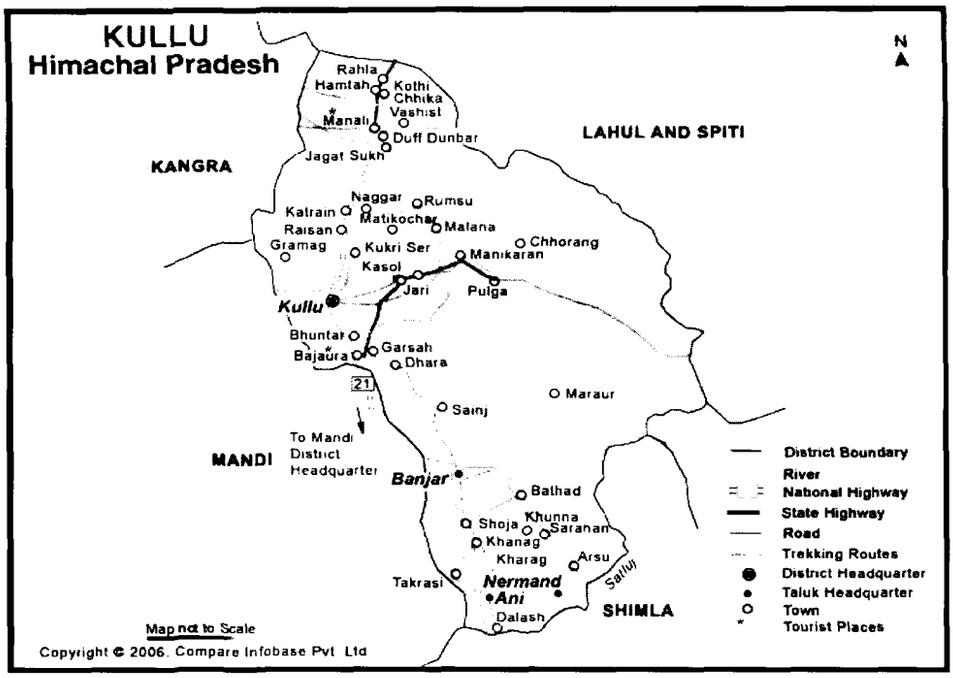

Fig. 3.1 Map of study area – Kullu, District Kullu (Himachal Pradesh)

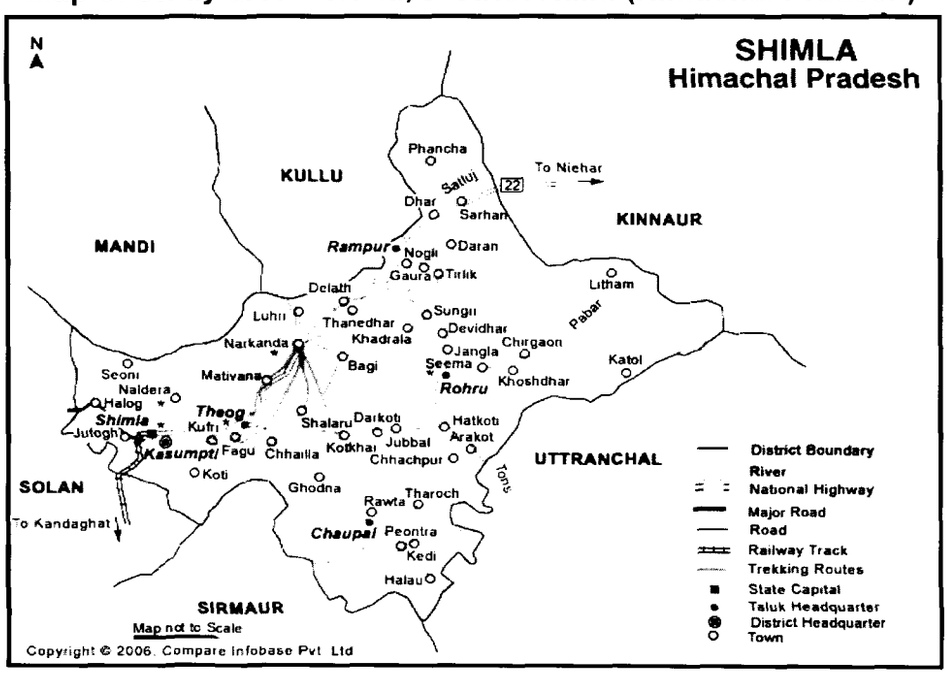

Fig. 3.2 Map of study area – Theog, District Shimla (Himachal Pradesh)

3.2 Sampling design:

Two blocks namely, Kullu block in Kullu district and Theog block in Shimla district were purposively selected for the study. Thereafter, a list of panchayats falling in each of the two selected blocks was prepared. At the first stage of the sampling, one panchayat from each of the two blocks was randomly selected. The selected panchayats were Jallugran from Kullu block and Matiyana from Theog block. In the next stage of sample selection, the list of the villages falling in each of the two panchayats was prepared. Thereafter, 50 per cent of the villages were selected randomly in each of the panchayats. The list of the selected blocks, panchayats and villages is given in Table 3.1.

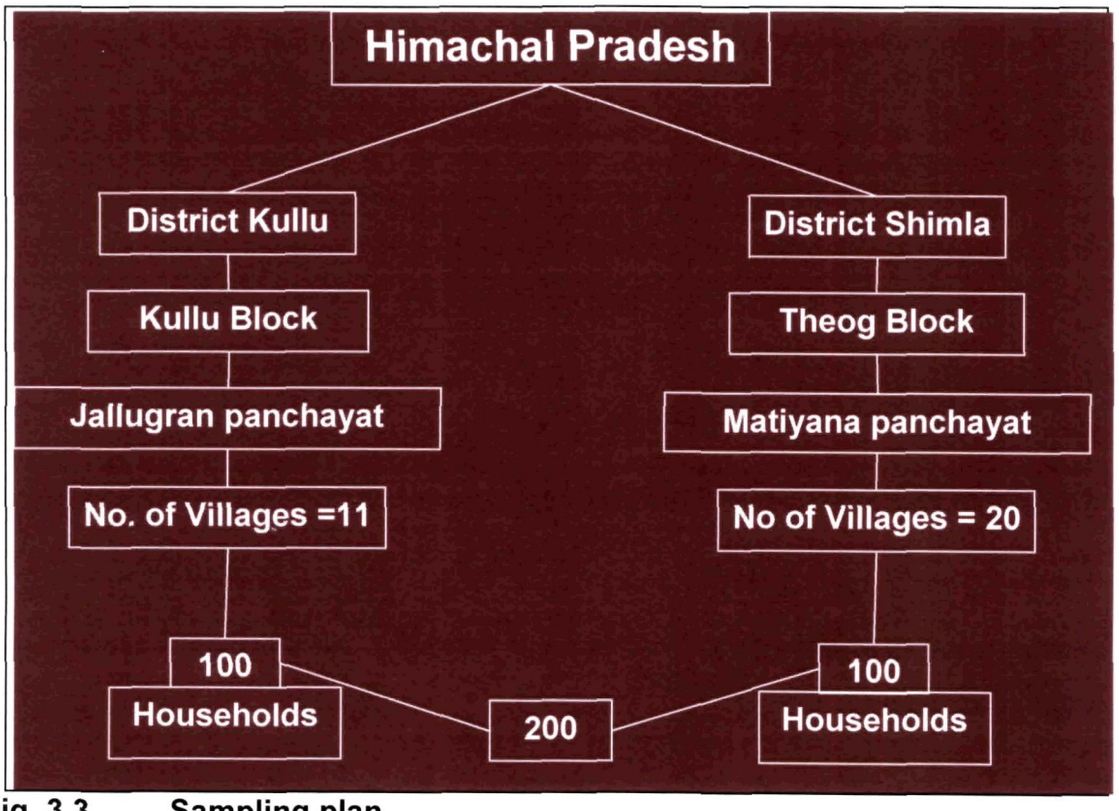

Fig. 3.3 Sampling plan

Table 3.1 List of the selected Blocks, Panchayats and Villages

Blocks	Panchayat	Village	No. of villages
Kullu	Jallugran	Rumus, Preyee, Kapri, Diyanthala, Jallugran, Tungadhar, Hesirashoran, Nakadhar, Sharani, Tapruwai, Seruthana	11
Theog	Matiyana	Kalinda, Taleen, Kalag, Bharmali, Kouthu, Kalzar, Pajeli, Sungra, Kajiwal, Mulyana, Mul matiyana, Katog, Sonarghati, Teer, Nanni, Sunthi, Katehr, Rauni, Kui, Dharaman	20

3.3 Selection of sample households:

In each of the two panchayats, hundred households were allocated among the selected villages through a proportional allocation method. Further for the collection of the village level data, one key informant was selected from the each of the sample village in both the panchayats. Thus, the total sample consists of 200 households, 100 from each panchayat, and 31 key informants, 11 from Jallugran and 20 from Matiyana. The complete sampling plan has been given in Fig 3.3.

3.4 Stratification of sample households:

For the construction of strata, cumulative square root frequency method was used (Singh and Mangat, 1975). The detailed procedure is given in Table 3.2.

The households were divided into two strata:

$$\textbf{First Strata: } = \frac{\sqrt{a}+\sqrt{b}+\ldots\ldots+\sqrt{m}}{2} = X \text{ (Say)}$$

X lies in between Class interval 21-25 in class E.

Second Strata: The remaining households fall in the second strata

Table 3.2 Stratification of households using cumulative cube root frequency method

Class No.	Class Interval (Bigha)	Frequency (n)	√n	Cumulative square root Frequency	Strata
A	1 to 5	a	√a	√a	Ist Strata
B	6 to 10	b	√b	√a+√b	
C	11 to 15	c	√c	√a+√b+√c	
D	16-20	d	√d	√a+√b+√c+√d	
E	21-25	e	√e	√a+√b+√c+√d+√e	
F	26-30	f	√f	√a+.....+√f	IInd Strata
G	31-35	g	√g	√a+.....+√g	
H	36-40	h	√h	√a+.....+√h	
I	41-50	i	√i	√a+.....+√i	
J	51-75	j	√j	√a+.....+√j	
K	76-90	k	√k	√a+.....+√k	
L	91-100	l	√l	√a+.....+√l	
M	101-180	m	√m	√a+.....+√m	

The classification of sample households into different categories viz. small and large, as obtained from the above table, and their number in respective category and the basis for classification is presented in the Table 3.3.

Table 3.3 Farm size (ha.) category of sample households

Category	Land holding (ha.)	Block and Sample size		
		Kullu	Theog	Total
Small	Up to 2.08	90	70	160
Large	>2.08	10	30	40
Total	-	100	100	200

The small farmers were those who had land upto 2.08 ha and the large farmers having land more than 2.08 ha.

3.5 Data collection

The study is based both on primary and secondary data. The primary data were collected from the sample households using a pre-tested schedule through a personal interview method for the agricultural year 2005-2006. The data were

collected on the following aspects : family size, educational status of the family, land holding size, land utilization pattern, cropping pattern, farm inputs and prices; pesticide exposure; farmers and family characteristics and other variables affecting health; symptoms due to prolonged exposure to pesticides; medicinal history and expenditures incurred in treating the illness of farmers particularly impacts caused by use of pesticide; farmers awareness of the change in health condition due to greater or prolonged use of pesticide; farm outputs and prices; and income from the farm etc. In addition the height and weight of the person in a household who was doing spray for most of the time and for the last many years was also recorded to construct Body Mass Index (BMI). The secondary data were collected from the Statistical outline of Himachal Pradesh, 2005-06 on demographic features of the study area.

3.6 Methods of analysis:

The following different methods were used to analyze the data:

3.6.1 Tabular analysis:

Tabular method was employed to present the results of the study.

3.6.2 Cost and returns analysis:

The cost and returns have been worked out following farm management cost concepts like Cost A_1, cost A_2, cost C_1, Cost C_2 and Cost D. The definitions of these concepts have been explained below.

Cost A_1:

1. Value of human labour
2. Value of Bullock labour
3. Value of seed
4. Value of manure

5. Value of fertilizer
6. Value of chemicals
7. Machinery
8. Depreciation of farm equipment, calculated as 10 per cent of total value of farm equipment, annually
9. Irrigation charges
10. Land revenue
11. Interest on working capital for half of the growth period of the crop.

Cost A_2: A_1 + Rent paid for leased-in land.

Cost B_1: Cost A_1 + imputed interest on owned fixed capital (excluding land).

Cost B_2: Cost A2 + imputed rental value of owned land (less land revenue) + imputed interest on owned fixed capital (excluding land).

Cost C_1: Cost B_1 + imputed value of family labour.

Cost C_2: Cost B_2 + imputed value of family labour.

Cost D: C_2 + 10 per cent of cost C_2 (management charges).

The net returns from different crops were estimated over different costs. The calculations have been made on per hectare basis. The details of procedure followed to compute the returns are explained below.

The net returns of the crop were calculated by using following method.

$$NR = GR - Costs$$

Where,

NR = Net return over cost

$$GR = Y_M P_M + Y_B P_B$$

Where,

GR = Gross returns per hectare of the crop

Y_M = Yield level of the main product of the crop

P_M = Price per quintal of the main product of the crop

Y_B = Yield level of the by-product of the crop

P_B = Price level of the by-product of the crop

P_B = Price per quintal of the by-product of the crop

and different costs over which net returns have been worked out and it include Cost A_1, Cost A_2, Cost B_1, Cost B_2,Cost C_1 and Cost C_2 and Cost D.

The profitability of fruit crops like apple, which is a perennial crop, has been computed by following the most commonly used approach i.e. by analyzing the cross sectional data on the value of inputs and outputs for different age groups of apple plantations. Standard project worth measures like net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) have been computed to work out the financial viability of apple plantation (Gittinger, 1976).

$$\text{Benefit cost ratio} = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t}};$$

$$\text{Net present value} = \frac{\sum_{t=1}^{n} \frac{Bt - Ct}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t}};$$

$$\text{Internal rate of return} = \frac{\sum_{t=1}^{n} \frac{Bt - Ct}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t}} = 0;$$

Where

B_t = returns in each year;

C_t = costs in each year;

i = the discount rate;

t = 1, 2, -----, n and

n= number of years

3.6.3 Functional analysis:

The logit regression was used to quantify the probability of different factors affecting human health in terms of body mass index being not normal.

The following form of the model was used:

$$Log\frac{p}{1-p} = b_0 + \sum_{j=1}^{n} b_j x_j + u$$

Where p = is the probability of the body mass index being not normal;

xj denotes the independent variables like the age of the respondents, education, number of years since spraying, number of sprays, Integrated Pest Management, use of protective equipments and having clinic access.

3.7 Collection and preparation of soil samples:

The soil samples were separately collected from the cultivated area of each of the 200 sample households. Since apple was the most important crop in Kullu and vegetables in Theog, the soil samples were collected from apple orchards in Kullu and vegetable fields in Theog. The representative soil samples were collected from 0-15 cm depth and tested under laboratory conditions. The samples were analyzed for soil P^H (Jackson, 1967), Organic carbon (Walkley and Black, 1934), available P (Olsen et al., 1954), available K (Mervin and Peech, 1951) and micro nutrient cations (Cu, Fe, Mn and Zn by Lindsay and Norvell, 1978).

The following formula was used to classify the soils into different status:

Overall Status of soil= (l*1+M*2+H*3)/100

The values used to classify the soils into low, medium and high through soil nutrient index are given below.

Low < 1.67, Medium 1.67 to2.33 and high >2.33 (Muhr et al. 1963).

The status of the availability of micro nutrients was considered sufficient if the availability was more than the following critical limits in mg per kilogram. If availability was less than these limits, the status was considered as deficient (Nayyar,and Chhibba, 1995).

Zinc = 0.60

Copper = 0.20

Iron = 4.50

Manganese = 1.00

3.8 Valuation of environmental cost

Environmental cost has been defined to include the cost of the effect on human health and soil degradation. The effect on human health is estimated to include the number of days lost, the loss in the work efficiency for those who experienced some health problems but did not take medicines, the yearly medical expenditure of the person who handled the pesticides and the value of kit. For computing monetary value of the degradation of soil health, the soil status was compared with the recommended doses in the packages of practices of horticulture and vegetable crops. If the status of a particular nutrient in the soil was high, then recommended dose, given in the package of practices, was reduced by 25 per cent. In case of medium status, the recommend was the same as given in the package of practices. If the status of a particular nutrient was low, 25 per cent was added to the recommended dose. These doses were now considered as optimum doses for a

particular nutrient. Thereafter, actual dose used by the farmer was compared with the recommended dose. The difference for different nutrients from their recommended doses could either be excess or deficit. The excess or deficit amount then was converted into monetary value by multiplying the price of a particular nutrient with the excess or deficit amount. The total environmental cost then was apportioned among different crops in proportion to the area under these crops. As mentioned above, all the soil samples in Theog were collected from the area under vegetable crops. Therefore, the environmental cost in Theog was apportioned only among vegetable crops.

RESULTS

CHAPTER-IV

RESULTS

A systematic presentation of results is essential to facilitate understanding and drawing of logical conclusions about the phenomenon being investigated. A step-by-step presentation of findings is also imperative for devising the logical reasons about the results and their usefulness. As mentioned earlier, the present study was planned to document the commercialized agriculture led adverse changes in the natural resource base (particularly soil health and changes in land use pattern - agro biodiversity), the strategies adopted by the farmers to minimize adverse effects arising because of soil degradation and climatic change, estimate the cost of these changes and suggest policy measures. The results of the study on the above mentioned aspects have been presented in this chapter under following sections:

4.1 Socio-economic profile of the sample households

4.2 Cost of cultivation and returns from high value cash crops

4.3 Changes in natural resource base

4.4 Impact of pesticide use on farmers' health

4.5 Farmers perception about pesticides and changes in productivity

4.6 Strategies adopted by the farmers' to minimize adverse effect

4.7 Valuation of environmental costs

4.8 Functional analysis

4.9 Implications for livelihood

4.1 Socio-economic profile

4.1.1 Demographic features:

Kullu is one of the twelve districts in Himachal Pradesh, India. The district stretches from the village of Rampur in the south to the Rohtang Pass in the North.The largest valley in the district is called the Kullu Valley, which is also known as the Valley of the Gods. There is also a town called Kullu which sits on the banks of the Beas River in the central part of the valley. Another important valley in the district is the Lug valley where the main forest contractors have been extracting timber from the forests for the last 150 years and continue to do so today. Farther north lies the town of Manali. Kullu is the capital town of the Kullu District. It is located on the banks of the Beas River in the Kullu Valley about ten kilometres north of the airport at Bhuntar. According to 2001 census, Kullu had a population of 3,81,571 (Table 4.1). Males constitute 54 per cent of the population and females 46 per cent. Kullu has an average literacy rate of 81 per cent, higher than the national average of 59.5 per cent: male literacy is 84 per cent and female literacy is 77 per cent. In Kullu, 10 per cent of the population is under 6 years of age.

Shimla district is located in the north-western ranges of the Himalayas at an average altitude of 2397.59 meters (7866.10 feet) above mean sea level. It lies between the longitude 77.00" and 78.19" east and latitude 30.45" and 31.44" north. It is surrounded by Mandi and Kullu in the north, Kinnaur in the east, Uttarakhand in the south, Sirmaur in the west. The elevation of the district ranges from 300 metres (984 ft) to 6,000 metres (19,685 ft). The topology is rugged and tough. Shimla district derives its name from Shimla town which used to be a small village. It

came into existence on 1st September 1972 as a result of reorganization of the districts of the state. The most commonly practiced religion in the district is Hinduism. Hindi and Pahari are the languages spoken here. Agriculture is the major source of income. As of 2001 census, Shimla had a total population of 7,22,502 with a population density of 141 per sq km and the sex ratio of 896 female per 1000 males (Table 4.1)

Table 4.1 General information of sample districts and blocks

Particulars	Kullu Block	Kullu Dist.	Theog Block	Shimla Dist.
Total Geographical area (Sq. Km)	207.92	5503	471.34	5131
Population	179646	381571	77954	722502
Male	93383	198016	39948	380244
Female	86263	183555	38006	341506
Population density (per Sq. Km)	864	69	165	141
Sex Ratio (female per 1000 males)	924	927	951	896

Source: Statistical Outline, 2006

4.1.2 Socio-economic status:

The socio-economic profile of selected households provides the background information and throws up the problems and prospects of the study area. Apart from agro-climatic conditions, the agricultural development of any region is highly dependent on the socio-economic characteristics of its inhabitants. The analysis of these features also offers vital clues and insights for devising appropriate developmental programmes for future. As a matter of fact, the failure of several developmental programmes in the past could, *inter-alia*, be attributed to their insensitivity and alienation from the grass roots socio-economic realities in terms of different parameters of its population. Perhaps, it is the need to understand socio-

economic features and situation at the grass roots level that has led to the emphasis on the bottom up approach in planning rather than the conventional top down approach. In sum, several economic phenomena of a particular region could be explained in terms of prevailing socio-economic features of the local population. The socio-economic features, among other things, include demographic structure, literacy, family size, age, land use pattern and cropping pattern. In view of above, present section attempts to analyze the salient socio-economic characteristics of the sample households in Kullu block and Theog block.

4.1.3 Age and educational status

The results of the analysis of data regarding different aspects of socio-economic profile are presented in Tables 4.2 to 4.8. To begin with, Table 4.2 presents the age and sex wise composition of population of sample households for different categories of households and also all households together. On overall farm situation, proportion of working population in the age group of 18-60 years was higher (62.37 per cent) in Kullu block compared to Theog block (53.86 per cent). The proportion of old age persons (above 60 years) was 13.96 per cent in Kullu, while in Theog it was 14.64 per cent. However, among male members in Kullu block, the proportion of old age persons (above 60 years) was 14.91 per cent and among female members it was 12.98 per cent. In Theog block, the proportion of working population (18-60) was significantly higher (65.30 per cent) compared to Kullu block. The average family size of sample households was 5.94 persons in Kullu block and 6.76 persons in Theog block. Small farm households had 6.63 persons in Kullu. In comparison, in Theog,

small farm households had 6.63 persons/household and large farm households had 7.77 persons.

Table 4.2 Age wise distribution of sample population

(Per cent)

Age (Yrs)	Kullu			Theog		
	Small	Large	All	Small	Large	All
Male						
Up to 6	3.63	11.11	4.30	7.77	2.11	5.82
6-18	20.46	29.63	21.29	7.77	8.46	8.01
18-60	61.72	37.04	59.49	48.45	55.60	50.91
Above 60 years	14.19	22.22	14.91	11.92	12.68	12.18
All	100.00 (3.03)	100.00 (2.70)	100.00 (3.00)	100.00 (3.86)	100.00 (4.73)	100.00 (4.12)
Female						
Up to 6	3.82	11.43	4.72	6.88	3.29	5.64
6-18	17.36	14.29	17.00	16.19	19.74	17.42
18-60	65.63	62.86	65.30	60.32	54.93	58.46
Above 60 years	13.19	11.43	12.98	16.60	22.04	18.48
All	100.00 (2.88)	100.00 (3.50)	100.00 (2.94)	100.00 (2.47)	100.00 (3.04)	100.00 (2.64)
All persons						
Up to 6	3.72	11.29	4.51	7.42	2.57	5.75
6-18	18.95	20.97	19.16	11.06	12.87	11.68
18-60	63.62	51.61	62.37	53.08	55.34	53.86
Above 60 years	13.71	16.13	13.96	13.74	16.34	14.64
All	100.00 (5.91)	100.00 (6.20)	100.00 (5.94)	100.00 (6.33)	100.00 (7.77)	100.00 (6.76)

Source: Field Survey, 2006

Note: The percentages have been computed on the basis of figures given in parentheses.

Table 4.3 presents the distribution of family members according to the levels of formal education. The perusal of this table reveals that in both the blocks, on all farm situation, majority of the family members had an education up to high school.

Table 4.3 Educational status of sample population

(Per cent)

Particulars	Kullu			Theog		
Male	Small	Large	All	Small	Large	All
Non school going	3.63	7.41	3.97	7.77	2.11	5.82
Illiterate	4.29	3.70	4.24	9.84	11.84	10.53
School going	20.46	11.11	19.62	22.54	21.14	22.06
Primary	14.52	3.70	13.55	12.44	9.51	11.43
Middle	11.88	3.70	11.14	17.10	9.94	14.63
High School	18.15	22.22	18.52	15.03	24.31	18.22
+2	13.53	20.37	14.15	8.03	10.99	9.05
Graduate	10.89	14.81	11.24	3.89	8.25	5.39
Post Graduate	2.64	12.96	3.57	3.37	1.90	2.86
All	100.00 (3.03)	100.00 (2.70)	100.00 (3.00)	100.00 (3.86)	100.00 (4.73)	100.00 (4.12)
Female						
Non school going	4.17	11.43	5.03	6.88	3.29	5.64
Illiterate	8.68	5.71	8.33	13.77	11.18	12.87
School going	33.33	44.29	34.64	31.58	23.03	28.63
Primary	13.89	1.43	12.41	20.24	13.16	17.80
Middle	6.94	4.29	6.63	10.12	10.86	10.37
High School	7.64	8.57	7.75	8.91	19.74	12.65
+2	10.42	4.29	9.69	4.45	11.18	6.78
Graduate	7.99	8.57	8.06	3.64	6.58	4.66
Post Graduate	6.94	11.43	7.48	0.40	0.99	0.61
All	100.00 (2.88)	100.00 (3.50)	100.00 (2.94)	100.00 (2.47)	100.00 (3.04)	100.00 (2.64)
All Persons						
Non school going	3.89	9.68	4.50	7.42	2.57	5.75
Illiterate	6.43	4.84	6.26	11.37	11.58	11.45
School going	26.73	29.84	27.06	26.07	21.88	24.62
Primary	14.21	2.42	12.98	15.48	10.94	13.92
Middle	9.48	4.03	8.91	14.38	10.30	12.97
High School	13.03	14.52	13.18	12.64	22.52	16.05
+2	12.01	11.29	11.94	6.64	11.07	8.16
Graduate	9.48	11.29	9.66	3.79	7.59	5.10
Post Graduate	4.74	12.10	5.51	2.21	1.54	1.98
All	100.00 (5.91)	100.00 (6.20)	100.00 (5.94)	100.00 (6.33)	100.00 (7.77)	100.00 (6.76)

Source: Field Survey, 2006,

Note: The percentages have been computed on the basis of figures given in parentheses.

This was followed by primary, +2 level, graduate, middle and post graduate in Kullu block, and primary, middle, +2, graduate and post graduate in Theog block. In Kullu, 5.51 per cent of the family members were educated up to the post graduate level; the proportion of such members was 1.98 per cent in Theog. The proportion of females educated up to primary, was followed by +2, graduate, high school and post graduate in Kullu block.

In so far as education up to graduate level was concerned, the proportion of male graduates was more in both the blocks compared to female graduates. But, the proportion of those educated up to post graduate level was higher among females than male in Kullu. The incidence of illiteracy was higher in Theog than in Kullu. Further while the proportion of illiterates was more among female members in both the blocks, among male members, it was higher in Kullu.

4.1.4 Land use pattern:

Land is the most important asset and basic resource for the farmers in as much as all farming activities are dependent on the type and magnitude of the farm land holdings. Tables 4.4 and 4.5 present the land use pattern of the sample households. It is evident from the table that, on overall farm situation, more than 99 per cent of the total land was under cultivation in Kullu whereas the percentage of such land was 75 per cent in Theog. About 16.70 and 7.28 per cent of land was under pasture and forest respectively in Theog, whereas in Kullu block their share was 0.17 and 0.41 per cent. The overall holding size was 1.43 hectares in Kullu and 3.32 hectares in Theog. Out of total holdings, (1.43 hectares) only 0.014 hectares in Kullu

was irrigated and whole of the land was unirrigated in Theog. It was observed during the survey that around half of the operated area was under intercropping in Kullu while in Theog only one fourth of the total area was under inter –cropping.

Table 4.4 Land use pattern of sample households.

(ha/farm)

Particulars	Small		Large		All	
	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
	Kullu					
Total Land owned	0.013	1.181	0.020	3.520	0.014	1.415
Leased-in	-	-	-	-	-	-
Leased out	-	-	-	-	-	-
Orchards	0.009	1.163	0.020	3.472	0.010	1.393
Other crops	0.004	0.012	0.000	0.024	0.004	0.014
Pastures	0.000	0.000	0.000	0.024	0.000	0.002
Forest	0.000	0.006	0.000	0.000	0.000	0.006
	Theog					
Total Land owned	0.902	0.926	3.745	3.072	1.754	1.570
Leased-in	0.006	0.002	0.000	0.000	0.004	0.001
Leased out	0.006	0.002	0.013	0.007	0.008	0.003
Orchards	0.515	0.172	2.048	1.024	0.975	0.427
Other crops	0.374	0.125	1.683	0.842	0.767	0.340
Pastures	0.000	0.451	0.000	0.800	0.000	0.555
Forest	0.000	0.175	0.000	0.400	0.000	0.242

Source: Field Survey, 2006

The table 4.5 shows that 71.43 per cent of irrigated and 98.46 per cent of unirrigated area was under fruit farming in Kullu in comparison to Theog block where only 42.19 per cent of unirrigated area was under fruit farming. There was no practice of leasing-in and leasing-out land in Kullu, primarily because of scarcity of land due to high population pressure. In Kullu block, on small farms 66.67 per cent of the irrigated area was under orchard and 33.33 per cent was under other crops, whereas of the

total unirrigated area, 98.40 per cent was under orchard and 1.05 per cent was under other crops.

Table 4.5 Land use pattern of sample households.

(Per cent)

Particulars	Small		Large		All	
	Irrigated	Un-irrigated	Irrigated	Un-irrigated	Irrigated	Un-irrigated
	Kullu					
Total Land owned	100.00 (0.013)	100.00 (1.181)	100.00 (0.020)	100.00 (3.520)	100.00 (0.014)	100.00 (1.415)
Leased-in	-	-	-	-	-	-
Leased out	-	-	-	-	-	-
Orchards	66.67	98.40	100.00	98.64	71.43	98.46
Other crops	33.33	1.05	0.00	0.68	28.57	0.96
Pastures	0.00	0.00	0.00	0.68	0.00	0.68
Forest	0.00	0.54	0.00	0.00	0.00	0.41
	Theog					
Total Land owned	100.00 (0.902)	100.00 (0.926)	100.00 (3.745)	100.00 (3.072)	100.00 (1.754)	100.00 (1.570)
Leased-in	0.67	0.22	0.00	0.00	0.24	0.09
Leased out	0.67	0.22	0.36	0.22	0.47	0.22
Orchards	57.15	18.56	54.69	33.33	55.58	27.23
Other crops	41.51	13.48	44.95	27.40	43.72	21.65
Pastures	0.00	48.68	0.00	26.03	0.00	35.38
Forest	0.00	18.85	0.00	13.03	0.00	15.43

Source: Field Survey, 2006

Note: Figures in parentheses indicate the total land owned on the basis of which percentages have been calculated.

On large farms, 100 per cent of the irrigated and 98.64 per cent of the unirrigated area was under orchard and only 0.68 per cent was under other crops. There was no area under pasture on small farms but on large farms it was 0.68 per cent. In Theog block, on small farms 18.56 per cent of the un-irrigated area was under orchard and 13.48 per cent area was under other crops. In comparison, on large farms, 33.33 per cent of the area was under orchard and 27.40 per cent was under other crops. The area under pasture on small farms was 48.68 per cent while

under forest it was 18.85 per cent, the respective figures for large farms were 26.03 per cent and 13.03 per cent was under forest.

4.1.5 Cropping pattern

Cropping pattern gives information about the allocation of total cultivable land under different crops, cropping intensity and also cropping sequence being followed in a particular area/region. It also provides information regarding the extent of crop diversification and its nature whether it is commercial or subsistence.

Table 4.6 shows the two cropping patterns. In each season, cultivable area was divided under the following three heads:

1. *Kharif* season
    a) Sole crop
    b) Intercrop with non-bearing apple
    c) Intercrop with bearing apple
2. *Rabi* season
    a) Sole crop
    b) Intercrop with non-bearing apple
    c) Intercrop with bearing apple

On overall farm situation, in *Kharif* season, area under sole crop was 0.86 per cent in Kullu and as high as 23.72 per cent in Theog. Area under non-bearing apple was 12.88 per cent and 4.86 per cent in Kullu and Theog, respectively. While that under bearing apple was 17.53 per cent and 17.66 per cent, respectively.

In *Khaif* season, among sole crops, cauliflower was the important crop which accounted for 0.64 and 10.12 per cent of the total cropped area in Kullu and Theog, respectively. The second important crop grown as sole crop was cabbage covering 0.22 per cent in Kullu and 4.87 per cent in Theog block.

Table 4.6 Cropping pattern on sample farms

(Per cent)

Crops	Kullu			Theog		
	Small	Large	All	Small	Large	All
Sole crops	***Kharif* Season**					
Maize	0.00	0.00	0.00	0.00	0.00	0.00
Cauliflower	0.69	0.47	0.64	9.01	10.69	10.12
Cabbage	0.29	0.00	0.22	2.87	5.88	4.87
Beans (*Zaid* crops)	0.00	0.00	0.00	10.48	7.83	8.72
Sub total	0.98	0.47	0.86	22.36	24.40	23.72
Intercrops (With non-bearing apple)						
Maize	6.36	6.59	6.42	0.00	0.00	0.00
Maize + Mash	0.19	1.25	0.45	0.00	0.00	0.00
Maize + Rajmash	0.93	3.41	1.54	0.00	0.00	0.00
Cauliflower	3.47	1.87	3.07	6.99	3.63	4.76
Cabbage	1.16	0.00	0.87	0.11	0.00	0.04
Tomato	0.65	0.17	0.53	0.00	0.00	0.00
Beans (*Zaid* crops)	0.00	0.00	0.00	0.22	0.00	0.07
Sub total	12.75	13.29	12.88	7.31	3.63	4.86
Intercrops (With bearing apple)						
Maize	8.56	7.48	8.29	0.04	0.00	0.01
Maize + Mash	1.73	3.27	2.12	0.00	0.00	0.00
Maize + Rajmash	2.59	4.07	2.96	0.18	0.00	0.06
Cauliflower	3.24	2.26	3.00	16.71	12.47	13.89
Cabbage	0.00	0.00	0.00	0.29	5.41	3.70
Tomato	1.34	0.62	1.16	0.00	0.00	0.00
Sub total	17.46	17.72	17.53	17.21	17.89	17.66
Total	31.19	31.48	31.26	46.88	45.92	46.24
	***Rabi* Season**					
Sole crops						
Cauliflower	0.60	0.47	0.57	13.22	12.71	12.88
Cabbage	0.40	0.00	0.30	3.76	5.88	5.17
Pea	0.00	0.00	0.00	0.29	5.81	3.96
Potato	0.00	0.00	0.00	5.09	0.00	1.70
Sub total	1.01	0.47	0.87	22.36	24.40	23.72
Intercrops (With non-bearing apple)						
Wheat	5.20	7.62	5.80	0.00	0.00	0.00
Cauliflower	1.25	0.00	0.94	6.32	2.09	3.50
Cabbage	0.00	0.00	0.00	0.99	0.00	0.33
Pea	6.20	5.67	6.07	0.00	1.35	0.90
Potato	0.09	0.00	0.07	0.00	0.19	0.13

Oil seeds	0.00	0.00	0.00	0.00	0.00	0.00
Sub total	12.75	13.29	12.88	7.30	3.63	4.86
Intercrops (With bearing apple)						
Wheat	3.70	3.74	3.71	0.00	0.00	0.00
Barley	7.52	7.95	7.63	0.00	0.00	0.00
Cauliflower	2.22	0.57	1.81	10.75	7.55	8.62
Cabbage	0.00	0.00	0.00	3.58	1.26	2.04
Oates	0.00	0.00	0.00	0.00	1.93	1.29
Pea	2.31	4.21	2.78	2.69	4.44	3.86
Potato	1.43	0.94	1.31	0.18	2.71	1.86
Oil seeds	0.28	0.31	0.29	0.00	0.00	0.00
Sub total	17.46	17.72	17.53	17.21	17.89	17.66
Total	31.22	31.48	31.28	46.87	45.92	46.24
Perennial crops – Fruit Crops						
Apple	34.12	35.46	34.45	6.25	5.96	6.06
Plum	2.31	0.78	1.93	0.00	0.54	0.36
Pear	0.56	0.31	0.49	0.00	1.65	1.10
Walnut	0.05	0.31	0.11	0.00	0.00	0.00
Cherry	0.23	0.03	0.18	0.00	0.01	0.01
Pomegranate	0.32	0.16	0.28	0.00	0.00	0.00
Sub-total	37.59	37.05	37.45	6.25	8.16	7.52
Grand Total	100.00 (1.72)	100.00 (5.13)	100.00 (2.06)	100.00 (2.23)	100.00 (10.34)	100.00 (4.66)
Net sown area	1.19	3.51	1.42	1.18	5.59	2.50

Source: Field survey, 2006

Note: Figures in parentheses indicate the gross cropped area (ha/farm) on the basis of which percentages have been calculated.

Among crops grown as intercrops with non-bearing apple in Kullu, maize was the most important one accounting for 6.42 per cent of the gross cropped area followed by cauliflower with 3.07 per cent. In Theog, main crop under non-bearing apple was cauliflower which covered 4.76 per cent of the cropped area followed by pea with 0.07 per cent. In so far as intercrops with bearing apple in Kullu were concerned, maize was an important crop covering 8.29 per cent of the gross cropped area followed by cauliflower with 3.00 per cent In Theog block, cauliflower (13.89 per cent) followed by cabbage (3.70 per cent) were important crops.

In *Rabi* season, cauliflower accounted for 0.57 and 12.88 per cent of the gross cropped area in Kullu and Theog block, respectively. The cabbage was next important crop in both blocks. Among intercrops with non-bearing apple, the area under pea was higher (6.07 per cent) followed by wheat (5.80 per cent) in Kullu block, where as in Theog block, cauliflower (3.50 per cent) and pea (0.90 per cent) were relatively more important crops. In intercrops with bearing apple, cauliflower was the main crop covering 8.62 per cent of the gross cropped area followed by pea with 3.86 per cent.

Apple was the main perennial crop, which accounted for nearly one-third of the total cultivated area. The area under other fruits like plum and pear was negligible, around one per cent or even less in both the blocks.

4.1.6 Crop production and yield

The production of different crops per farm has been given in Table 4.7. In Kullu block, on all farm situation, production of maize and wheat was 10.43 quintals and 6.66 quintals, respectively. Among vegetable crops, the production of cauliflower was 47.25 quintals distantly followed by pea, cabbage and potato. The production of beans was not observed in Kullu block. Among two farm categories, the production of different crops was higher on large farms compared to small farms. In Theog block, the production of cauliflower was 590.81 quintals followed by cabbage (196.68 quintals), pea (54.91 quintals), beans (22.79 quintals) and potato (11.78 quintals).

Table 4.7 Average production and market surplus of major crops

(q/ farm)

Crop	Kullu			Theog		
	Small	Large	All	Small	Large	All
Production						
Maize	8.80	25.09	10.43	0.15	0.00	0.11
Wheat	5.78	14.58	6.66	0.00	0.00	0.00
Cauliflower	45.24	65.31	47.25	351.50	1149.21	590.81
Cabbage	8.64	0.00	7.78	72.46	486.54	196.68
Pea	18.11	63.38	22.64	8.96	162.14	54.91
Potato	1.32	1.50	1.34	7.35	22.13	11.78
Beans	0.00	0.00	0.00	14.33	42.53	22.79
Market Surplus						
Maize	-	-	-	-	-	-
Wheat	-	-	-	-	-	-
Cauliflower	40.24	60.31	42.25	347.50	1144.21	586.51
Cabbage	6.64	0.00	5.98	69.00	480.54	192.46
Pea	12.00	58.00	16.60	5.96	157.14	51.31
Potato	0.00	0.00	0.00	0.35	22.13	6.88
Beans	0.00	0.00	0.00	14.33	42.53	22.79

Source: Field survey, 2006

Table 4.8 and Fig. 4.1 show yield levels of different crops. As may be seen from the table, in Kullu the yield of maize was 24 quintals per hectare and yield of wheat was 36 quintals per hectare. Among vegetable crops, the yield of cabbage, on all farm situation, was 243 quintals per hectare followed by cauliflower (228 quintals). In Theog, maize yield was 28 quintals which was very high both in comparison to Kullu and state average of 21 quintals per hectare. Among vegetable crops, the yield of cabbage was highest, 273 quintals per hectare, followed by cauliflower, 243 quintals per hectare. The yield levels of these crops were significantly higher in Theog compared to those in Kullu. Among small and large farms, there was no neat pattern in Kullu while in Theog the yield levels were higher in respect of large farms compared to their small counterparts.

Table 4.8 Average yield of major crops of the sample household

(q/ha)

Crops	Kullu			Theog		
	Small	Large	All	Small	Large	All
Maize	25	19	24	31	0	28
Wheat	38	25	36	0	0	0
Cauliflower	228	226	228	250	226	243
Cabbage	270	0	243	280	255	273
Pea	123	125	123	135	135	135
Potato	50	31	48	63	74	66
Beans	0	0	0	60	53	58

Source: Field Survey, 2006

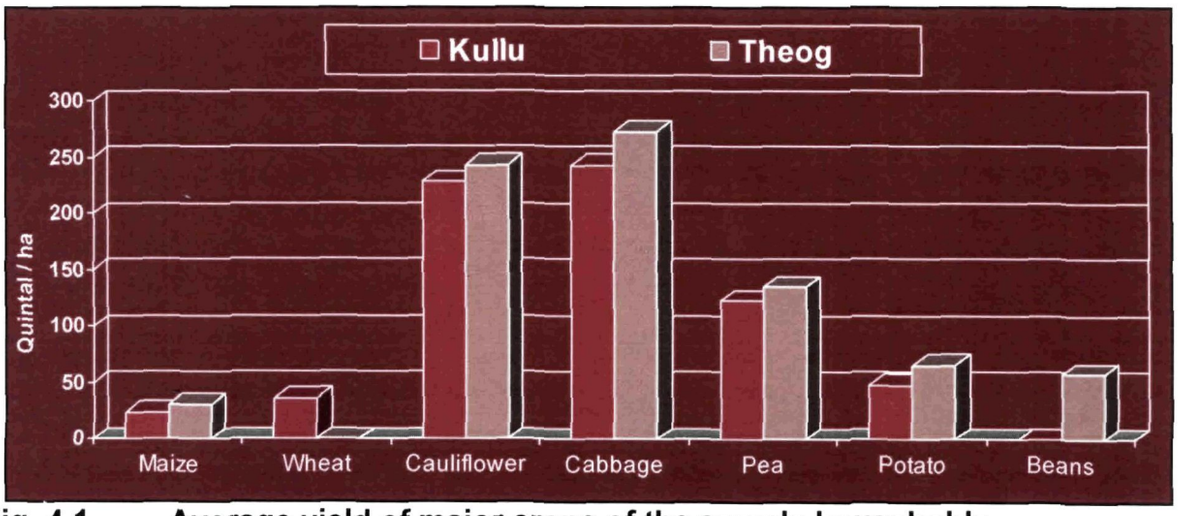

Fig. 4.1 Average yield of major crops of the sample households

4.2 Cost and returns from high value cash crops:

Continuity and expansion of any business activity depend upon its profitability, which in turn is highly influenced by the expenditure incurred to carry out the activity. In case of farming, cost of cultivation of different crop operations thus becomes very important from the point of view of its economic viability and ecological sustainability. In the present context, as seen in the previous section, high value cash crops are grown extensively in both the blocks. Among fruits, apple is the most important crop in Kullu block both in terms of allocation of area as well as returns from

the crop. In Theog among vegetable crops, cauliflower is comparatively more important. Given the importance of horticultural crops in the farming system, it would be proper to term these farming systems primarily as horti-agricultural systems. In the following section, cost of cultivation of major fruit and vegetable crops viz., apple, cauliflower, cabbage and beans have been discussed. Farm management cost concepts viz., A_1, A_2, B_1, B_2, C_1, C_2 and D have been used to work out the cost of cultivation of these crops. Since apple is a perennial crop unlike vegetable which are seasonal, the costs have been computed in terms of fixed and variable costs and the net returns have been computed over these costs. Besides, measures like cost benefit analysis, internal rate of return and net present value have also been computed.

4.2.1 Fruit crop: Apple

Table 4.9 reveals the costs and returns from per hectare of apple plantation. The table shows that, on overall farm situation, in Kullu and Theog blocks net returns per hectare were Rs. 91,730 and Rs. 67,180, respectively. The returns per box, on an average, were Rs. 260 in Kullu block and Rs. 228 in Theog block. The total cost was Rs 45,142 per hectare in Kullu and Rs. 40,858 per hectare in Theog.

The per cent share of different costs in Kullu shows that the share of variable costs to the total cost was 82.00 per cent. The share of fixed costs was 18.00 per cent. In comparison in Theog block, the share of variable costs was 88.69 per cent and fixed costs accounted for 11.31 per cent.

Table 4.9 Cost and returns from apple plantation

(Rs./ha)

Kullu								
Age of trees (Years)	Average production (boxes)	Total fixed cost	Total variable cost	Total cost	Total cost per box	Gross returns	Net returns	Returns per box
Small								
0-8	0	9450	8970	18420	0	0	-18420	-
9	75	1830	7740	9570	128	28500	18930	252
10	120	2520	12000	14520	121	45600	31080	259
11 to 20	426	9398	44175	53573	126	161880	108307	254
21-30	370	7730	38760	46490	126	140600	94110	254
31-40	1480	27524	150635	178159	120	562400	384241	260
41-50	40	475	3725	4200	105	15200	11000	275
Average	418.50	8418.14	38000.71	46418.86	121.00	159030.00	89892.57	259.00
Large								
0-8	0	7800	17533	25333	0	0	-25333	-
9	80	928	4664	5592	70	27200	21608	270
10	126	1302	6668	7970	63	42840	34871	277
11 - 20	351	4011	23530	27541	78	119340	91799	262
21-30	484	5752	32045	37797	78	164560	126763	262
31-40	775	9124	49375	58499	75	263500	205001	265
41-50	1106	9741	63085	72826	66	376040	303214	274
Average	487.00	5522.57	28128.57	33651.14	71.67	165580.00	108274.71	268.33
All								
0-8	0	9285	9826	19111	0	0	-19111	-
9	76	1740	7432	9172	122	28370	19198	254
10	121	2398	11467	13865	115	45324	31459	261
11 -20	419	8859	42111	50970	121	157626	106656	255
21-30	381	7532	38089	45621	121	142996	97375	255
31-40	1410	25684	140509	166193	116	532510	366317	260
41-50	147	1402	9661	11063	101	51284	40221	275
Average	425.67	8128.57	37013.57	45142.14	116.00	159685.00	91730.71	260.00
Theog								
Small								
0-8	0	6250	14124	20374	0	0	-20374	-
9	30	870	5573	6443	215	11400	4958	165
10	100	1240	12950	14190	142	38000	23810	238
11 to 20	223	3015	29760	32775	147	84550	51775	233
21-30	406	5166	51660	56826	140	154280	97454	240
31-40	848	12087	107060	119147	141	322240	203093	239
41-50	500	6210	59500	65710	131	190000	124290	249
Average	351.17	4976.86	40089.57	45066.43	152.67	133411.67	69286.57	227.33
Large								
0-8	0	6250	13860	20110	0	0	-20110	-
9	25	725	4219	4944	198	8750	3806	152
10	75	930	8438	9368	125	26250	16883	225

11 - 20	250	3380	29195	32575	130	87500	54925	220
21-30	480	5456	50863	56319	117	168000	111681	233
31-40	900	11500	94700	106200	118	315000	208800	232
41-50	445	5528	45390	50918	114	155750	104832	236
50-60	216	2439	19467	21906	101	75600	53694	249
Average	341.57	4526.00	31534.00	37792.50	129.00	119550.00	69327.63	221.00
All								
0-8	0	6250	14045	20295	0	0	-20295	-
9	29	827	5167	5993	210	10605	4612	161
10	93	1147	11597	12743	137	34475	21732	234
11 -20	231	3125	29591	32715	142	85435	52720	229
21-30	428	5253	51421	56674	133	158396	101722	238
31-40	864	11911	103352	115263	134	320068	204805	237
41-50	484	6005	55268	61272	126	179725	118453	245
50-60	216	2439	19467	21906	101	75600	53694	249
Average	335.00	4619.63	36238.50	40857.63	140.43	123472.00	67180.38	227.57

Source: Field survey, 2006

Note: (i) One box contains 20 kilogram of apple. (ii) 0-8 years is non-bearing age.

The perusal of the intra farm scenario shows that in Kullu per hectare net returns on large farms were Rs. 1,08,275 whereas on small farms Rs. 89,893. Further, in Theog block, per hectare returns were almost equal to Rs. 69,286 on small farms and Rs. 69,328 on large farms. In case of small farms variable costs contributed 81.86 per cent and fixed costs 18.14 per cent while on large farms the contribution of variable costs was 83.59 per cent and fixed costs accounted for 16.41 per cent. In Theog block, on small farms, variable costs was 88.96 per cent and fixed costs 11.04 per cent while on large farms their respective shares were 83.44 per cent and 16.56 per cent. The profitability of apple cultivation was also evident from the results of different project worth measures (Table 4.10 and Fig-4.2). The results show that, on an average, net present value per hectare in Kullu was Rs. 50,347, where as in Theog, it was Rs. 29,275.

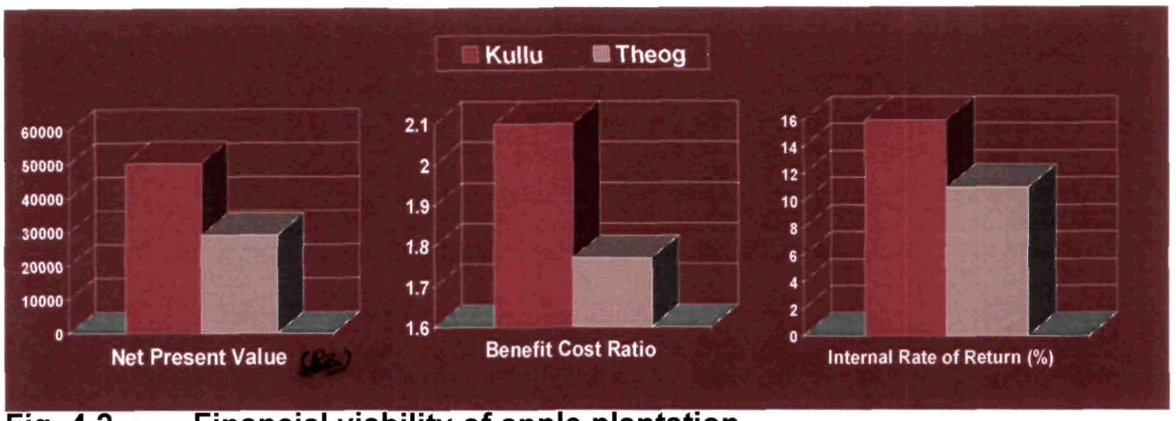

Fig. 4.2 Financial viability of apple plantation

The values of benefit cost ratios were 2.10 and 1.77 in Kullu and Theog respectively. The internal rate of returns were 16 per cent in the former and 11 per cent in latter.

Table 4.10 Financial viability of apple plantation

Measures	Kullu			Theog		
	Small	Large	All	Small	Large	All
Net Present Value (Rs/ha)	50532	48675	50347	29829	27982	29275
Benefit Cost Ratio	2.06	2.48	2.10	1.77	1.79	1.77
Internal Rate of Return (Per cent)	16	17	16	12	10	11

Note: The net present value and benefit -cost ratio have been estimated at a discount rate of 10 per cent.

Among small and large farms, in Kullu, net present value was more Rs. 50,532 on small farms compared to large farms Rs. 48,675. The reverse pattern was found in Theog where on large farms the net present value was Rs. 27,982 while on small farms it was Rs. 29,829. The benefit cost ratio in Kullu was higher on large farms (2.48) in comparison to small farms (2.06) while in Theog these were nearly same, 1.79 on large farms and 1.77 on small farms.

4.2.2 Vegetable crops

Cost of cultivation and returns from important vegetable crops being grown in the study area i.e. cauliflower, cabbage and pea were calculated. The same are given are in Tables 4.11 to 4.19. To recall, these vegetables crops were grown as inter crops mostly with non-bearing apple in Kullu, whereas in Theog these were grown both as a sole crops, and inter crop with non-bearing and bearing apple.

4.2.2.1 Returns and cost of cauliflower

Table 4.11 shows use of different input use in cauliflower. As may b seen from the table owned human labour contributed nearly two-fifths of the total variable costs in Kullu while hired human labour accounted for 28.39 per cent of the total variable costs in Theog.

Table 4.11 Input use in cauliflower

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Human labour						
Owned	42.45	42.77	42.48	13.28	6.36	11.17
Hired	0.00	0.00	0.00	26.55	32.61	28.40
Bullock labour						
Owned	1.31	2.82	1.46	2.90	2.74	2.85
Hired	2.19	0.74	2.04	0.00	0.00	0.00
Seed	12.38	13.35	12.48	11.69	12.08	11.81
FYM	16.23	17.19	16.33	14.78	15.50	15.00
Fertilizer	5.73	5.74	5.73	4.81	4.57	4.74
Plant protection	14.95	12.63	14.72	21.23	19.41	20.67
Interest on working capital	4.76	4.76	4.76	4.76	6.72	5.36
Total variable cost	100	100	100	100	100	100

Source: Field survey, 2006

The contribution of other important inputs in Kullu block was FYM (16.33 per cent), plant protection (14.72 per cent), seed (12.48 per cent), and fertilizers (5.73

per cent), interest on working capital (4.76 per cent), hired bullock labour (2.04 per cent) and owned bullock labour (1.46 per cent).

In comparison, the contribution of different inputs in Theog in order of their importance was plant protection (20.67 per cent), FYM (15.00 per cent), seed (11.81 per cent), owned human labour (11.17 per cent), interest on working capital (5.36 per cent), fertilizers (4.74 per cent) and owned bullock labour (2.85 per cent). In terms of farm management costs, Table 4.12 and Fig-4.3 show that on overall farm situation, in Kullu block cost D in cauliflower was Rs 2,38,722,. cost B_1 was Rs. 1,37,780 followed by cost B_2 (Rs.1,58,796), cost C_1 (Rs. 1,96,004) and cost C_2 (Rs. 2,17,020). In Theog block cost D was Rs. 3,38,535 followed by cost C_2 (Rs. 3,07,759), cost B_2 (Rs. 2,89,352, cost A_2 (Rs. 2,14,939), cost C_1 (Rs. 1,84,160), cost B_1 (Rs. 1,65,753) and cost A_1 (Rs. 1,63,950). Among small and large farms, costs were more on small farms rather than on large farms. On the other hand, in Theog block cost C_1 (Rs. 1,87,374) and cost C_2 (Rs. 3,32,224) were higher in respect of small farms while remaining costs were higher on the large farms.

Table 4.12 Cost of production in cauliflower

(Rs./ha)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Cost A1	134622	134011	134561	163843	164200	163950
Cost A2	134622	134011	134561	236685	164200	214939
Cost B1	138042	135421	137780	165646	166003	165753
Cost B2	158805	158712	158796	310496	240016	289352
Cost C1	196326	193105	196004	187374	176662	184160
Cost C2	217089	216396	217020	332224	250675	307759
Cost D	238798	238035	238722	365446	275742	338535

Source: Field survey, 2006

Table 4.13 and Fig. 4.4 show that, on overall farm situation, net returns over cost D from cauliflower were Rs. 11,858 in Kullu block. On small farms, returns over cost A_1 and cost A_2 were same, Rs. 1, 16,178. The returns over the remaining costs were Rs, 1, 12,758 over B_1, Rs, 91,995, over $B_{2,\ Rs}$. 54,474, over C_1, Rs. 33,711 over C_2 and Rs, 12,002 over cost D. On large farms, cost A_1 and cost A_2 was Rs. 1,16,178, followed by cost B_1 (Rs. 1,13,179), cost B_2 (Rs. 89,888), cost C_1 (Rs. 55,495), cost C_2 (Rs. 32,204) and cost D (Rs. 10,565). Similarly, in Theog block, on overall farm situation, cost D was Rs.15, 605. The table shows that cost A_1 was Rs.1, 90,190 followed by cost B_1 (Rs 1, 88,387), cost C_1 (Rs. 1, 69,980), cost A_2 (Rs.1, 39,201), cost B_2 (Rs. 64,788) and cost C_2 (Rs. 46,381). Cost D on small farm was Rs.14,554 and on large farms it was Rs.18,058. The cost of production was more on small farms compared to large farms.

Table 4.13 Returns in cauliflower

(Rs./ha)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Gross Returns	250800	248600	250580	380000	293800	354140
Net returns over costs						
Cost A1	116178	114589	116019	216157	129600	190190
Cost A2	116178	114589	116019	143315	129600	139201
Cost B1	112758	113179	112800	214354	127797	188387
Cost B2	91995	89888	91784	69504	53784	64788
Cost C1	54474	55495	54576	192626	117138	169980
Cost C2	33711	32204	33560	47776	43125	46381
Cost D	12002	10565	11858	14554	18058	15605

Source: Field survey, 2006

4.2.2.2 Returns and cost of cabbage

It may be recalled that cabbage is being grown both in *Kahrif* and *Rabi* seasons in both the blocks. Table 4.14 shows that important inputs in order of their

share in total variable costs in Kullu block were owned hired labour (47.25 per cent), followed by FYM (18.04 per cent), plant protection (14.59 per cent), fertilizer (6.36 per cent), seed (5.13 per cent), interest on working capital (4.73 per cent), hired bullock labour (2.27 per cent) and owned bullock labour (1.62 per cent). On the other hand, in Theog block, important inputs according to their contribution towards total variable costs were hired human labour (29.61 per cent), followed by owned human labour (19.31 per cent), FYM (17.85 per cent), plant protection (14.13 per cent), fertilizer (5.81 per cent), interest on working capital (4.93 per cent), seed (4.82 per cent) and owned bullock labour (3.53. per cent).

Table 4.14 Input use in cabbage production

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Human labour						
Owned	47.50	44.99	47.25	23.87	8.75	19.31
Hired	0.00	0.00	0.00	25.17	39.89	29.61
Bullock Labour						
Owned	1.45	3.17	1.62	3.57	3.43	3.53
Hired	2.42	0.84	2.27	0.00	0.00	0.00
Seed	5.04	6.05	5.13	4.70	5.10	4.82
FYM	17.90	19.37	18.04	17.44	18.79	17.85
Fertilizer	6.35	6.41	6.36	5.92	5.57	5.81
Plant protection	14.62	14.30	14.59	14.39	13.54	14.13
Interest on working capital	4.72	4.87	4.73	4.93	4.93	4.93
Total variable cost	100.00	100.00	100.00	100.00	100.00	100.00

Source: Field Survey, 2006

In terms of farm management costs (Table 4.15 and Fig.4.3), on overall farm situation, the cost D was Rs.198738 in Kullu block. In Theog block, it was Rs. 2,06,819. The cost C_2 was Rs. 1,88,017 followed by cost B_2 (Rs. 1,62,289), cost C_1 (Rs. 1,54,174), cost A_2 (Rs. 1,40,615), Cost B_1 (Rs. 1,28,446) and cost A_1 (Rs.

1,26,643). In Kullu block, cost B_2 was Rs. 1,21,478, followed by cost B_1 (Rs.1,17,489) and cost A_1 and A_2 was Rs.1,14,270.

Table 4.15 Cost of production of cabbage

(Rs./ha)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Cost A_1	114601	0	114270	126473	127039	126643
Cost A_2	114601	0	114270	146434	127039	140615
Cost B_1	118021	0	117489	128276	128842	128446
Cost B_2	121815	0	121478	167808	149412	162289
Cost C_1	176877	0	175845	160004	140570	154174
Cost C_2	180671	0	179834	199536	161140	188017
Cost D	198738	0	197818	219489	177254	206819

Source: Field Survey, 2006

Table 4.16 and Fig.4.4 show that on overall farm situation, returns over Cost D were Rs. 3,777 in Kullu. The returns over cost A_1 and Cost A_2 were RS. 87,325 followed by cost B_1 (Rs. 84,106), cost B_2 (Rs. 80,117), cost C_1 (Rs. 25,750) and cost C_2 (Rs. 21,761).

Table 4.16 Returns from cabbage

Rs./ha

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Gross Returns	202500	-	201595	224000	183600	211880
Net returns over						
Cost A1	87899	-	87325	97527	56561	85237
Cost A2	87899	-	87325	77566	56561	71265
Cost B1	84479	-	84106	95724	54758	83434
Cost B2	80685	-	80117	56192	34188	49591
Cost C1	25623	-	25750	63996	43030	57706
Cost C2	21829	-	21761	24464	22460	23863
Cost D	3762	-	3777	4511	6346	5061

Source: Field Survey, 2006

In Theog block, returns over cost D were Rs. 5,061. The returns over cost A_1 were Rs. 85,237 followed by cost B_1 (Rs. 83,434), cost A_2 (Rs. 71,265), cost C_1

(Rs. 57,706), cost B_2 (Rs. 49,591) and C_2 (Rs. 23,863). The returns over costs on small farms were higher on large farms.

4.2.2.3 Returns and cost of pea

In the production of peas, the input used and per cent share of different inputs in total variable costs, given in Table 4.17, show that in Kullu block owned human labour had maximum share (49.36 per cent) in the variable costs followed by hired human labour (16.45 per cent), seed (14.38 per cent), fertilizer (7.86 per cent), interest on working capital (4.76 per cent), hired bullock labour (4.19 per cent) and owned bullock labour (2.99 per cent). In Theog block, plant protection accounted for maximum share (31.47 per cent) in total variable cost followed by hired human labour (30.71 per cent), owned human labour (15.35 per cent), seed (8.70 per cent), interest on working capital (4.76 per cent), fertilizers (4.75 per cent) and owned bullock labour (4.26 per cent).

Table 4.17 Input use in pea production

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Human labour						
Owned	48.60	40.73	49.36	15.80	14.17	15.35
Hired	16.20	19.49	16.45	31.60	31.00	30.71
Bullock labour						
Owned	2.65	6.74	2.99	4.43	4.09	4.26
Hired	4.42	1.77	4.19	0.00	0.00	0.00
Seed	14.15	17.20	14.38	0.93	8.53	8.70
FYM	0.00	0.00	0.00	0.00	0.00	0.00
Fertilizer	9.21	9.30	7.86	6.38	6.44	4.75
Plant protection	0.00	0.00	0.00	36.10	31.03	31.47
Interest on working capital	4.76	4.76	4.76	4.76	4.76	4.76
Total variable cost	100.00	100.00	100.00	100.00	100.00	100.00

Source: Field Survey, 2006

Table 4.18 and Fig.4.3 show amount of different farm management costs in Pea production. As may be seen from the table, in Kullu block, cost D was Rs. 1,30,564 followed by cost C_2 (Rs. 1,18,695), Cost C_1 (Rs. 1,01,926), cost B_2 (Rs. 86,728), cost B_1 (Rs. 69,959) and cost A_1 (Rs. 66,740). On small farms, cost D was Rs. 1,30,668 and on large farms it was Rs. 1,29,629. In Theog block, cost D was Rs. 1,58,834 followed by the cost C_2 (Rs. 1,44,394) cost B2 (Rs. 1,27,742), cost C_1 (1,27,383), cost A_2 (Rs. 1,12,337), cost B_1 (Rs. 1,10,731) and cost A_1 (Rs. 1,08,928). Among small and large farms, most of the costs were higher on large farms.

Table 4.18 Cost of production of pea

(Rs./ha)

Particulars	Kullu			Theog		
	Small	Large	Total	Small	Large	Total
Cost A1	67885	56438	66740	107336	112643	108928
Cost A2	67885	56438	66740	112206	112643	112337
Cost B1	71305	57848	69959	109139	114445	110731
Cost B2	85822	94877	86728	127612	128046	127742
Cost C1	104272	80815	101926	126091	130397	127383
Cost C2	118789	117844	118695	144564	143998	144394
Cost D	130668	129629	130564	159020	158398	158834

Source: Field Survey, 2006

Table 4.19 Returns from pea

(Rs/ha)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Gross Returns	136530	137500	136627	170100	171450	170505
Net Returns over						
Cost A1	68645	81062	69887	62764	58807	61577
Cost A2	68645	81062	69887	57894	58807	58168
Cost B1	65225	79652	66668	60961	57005	59774
Cost B2	50708	42623	49899	42488	43404	42763
Cost C1	32258	56685	34701	44009	41053	43122
Cost C2	17741	19656	17932	25536	27452	26111
Cost D	5862	7871	6063	11080	13052	11671

Source: Field Survey, 2006

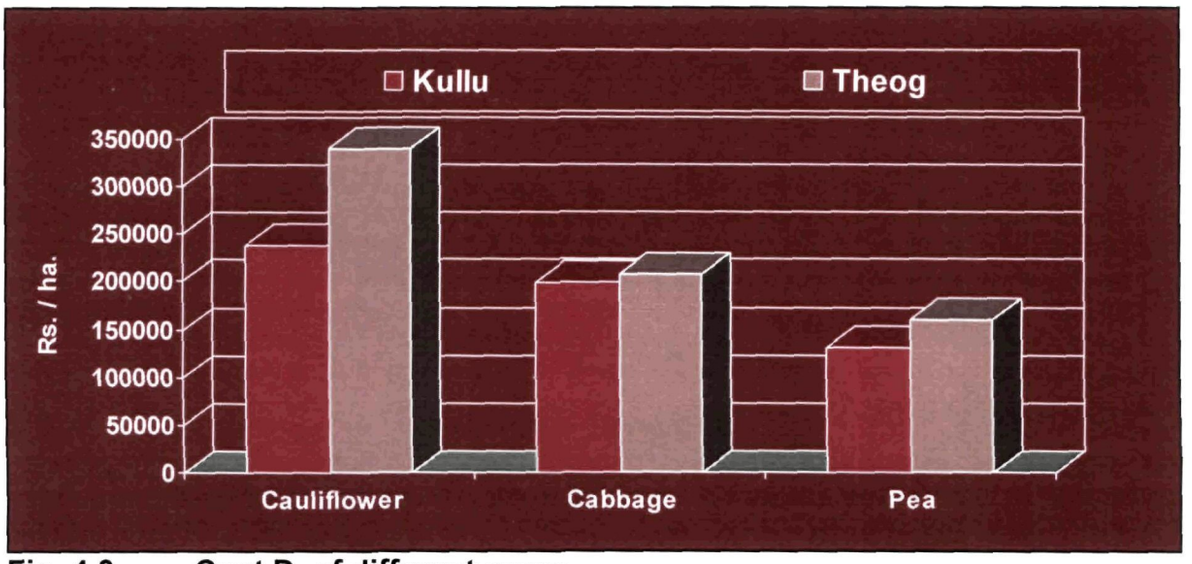

Fig. 4.3 Cost D of different crops

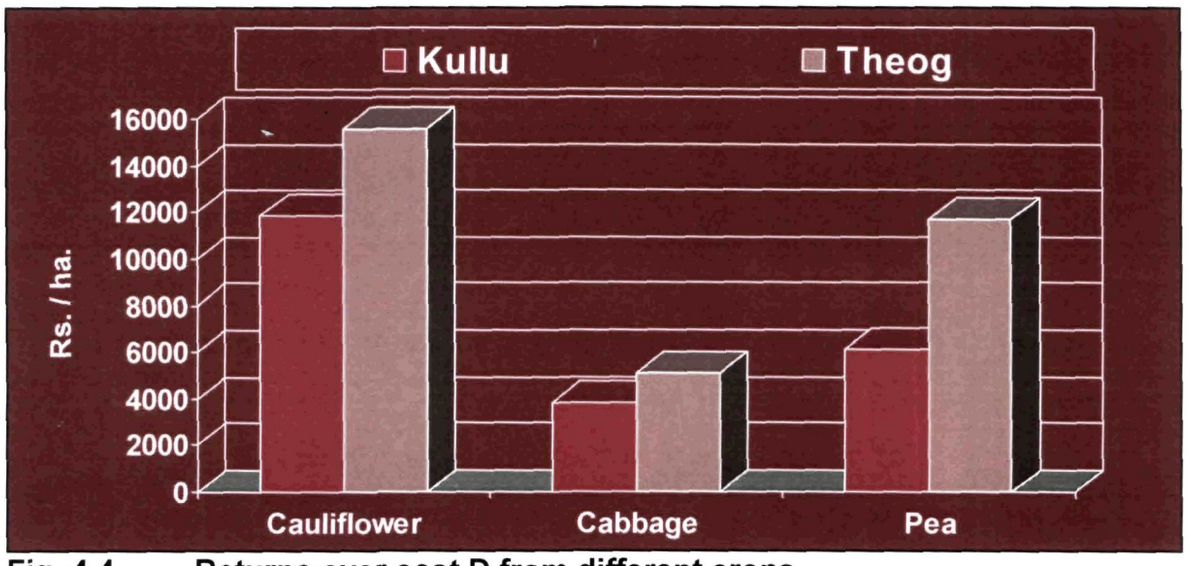

Fig. 4.4 Returns over cost D from different crops

Table 4.19 and Fig. 4.4 give the returns from pea cultivation. The table shows that on overall farm situation in Kullu block per hectare net returns over cost D were Rs. 6,063. The returns over costs A_1 were Rs. 69,887, followed by returns over cost B_2 (Rs. 49,899), cost C_1 (Rs. 34,701) and cost C_2 (Rs. 17,932). The returns over different costs were higher on large farms except returns over cost B_2, whereas in Theog block, the returns over cost D were Rs. 11,671. The returns were higher on

cost A_1, cost B_1, and cost C_1 in case of small farms whereas on cost A_2, cost B_2 and cost C_2 these were higher in case of large farms.

4.3 Changes in the natural resource base

As alluded to earlier, continuous cultivation of high value cash crops and monoculture for the last 25-30 years is believed to have impacted adversely on the natural resource base like soil and agro biodiversity. For the present study, soil status has been analyzed to know about the status of primary macro (N,P,K) and micro nutrients (Cu, Zn, Fe and Mn) on the farm land.

4.3.1 Soil status

To know about the present status of soil, we analyzed soil samples of study area in lab conditions and studied about the pH, primary macronutrients (available nitrogen, available phosphate and available potassium) and micronutrients (Cu, Fe, Zn and Mn) of soils.

4.3.1.1 Soil types, pH, available primary macronutrients and available micronutrients

As per the information given by the respondents, the type of soils and their forms was given in Table 4.20. On overall farm situation, table shows that in Kullu block 55.12 per cent of households reported that they had loamy soil, followed by 11.71 per cent who reported clay soil and 33.17 per cent farmers reported sandy soil. In Theog block, 50 per cent farmers reported loamy soil, followed by 35.34 per cent households reporting clay soil and 14.66 per cent households sandy soil.

Intra farm comparison in Kullu block shows that 60 per cent of households reported clay soil, followed by 20 per cent of households each reporting in sandy and loamy soil. Where as in Theog block, 50 per cent of households reported loamy soils, 33.33 per cent and 16.67 per cent households had clay and sandy soils, respectively.

Table 4.20 Response of households about soil types

(Per cent)

Soil type	Kullu			Theog		
	Small	large	All	Small	large	All
Sandy	33.33	20.00	33.17	14.29	16.67	14.66
Clay	11.11	60.00	11.71	35.71	33.33	35.34
Loam	55.56	20.00	55.12	50.00	50.00	50.00

Source: Field Survey, 2006

Table 4.21 and Fig -4.5 show that in overall farm situation, in Kullu block, 66.71 per cent farmers reported that most of the soils were neutral which was followed by slightly acid (12.44 per cent). In Theog block, most of the soils were slightly acid (34.66 per cent) and medium acid (34.14 per cent) in over all farm situation. Table also shows that majority of the soils were neutral and slightly acid on both the categories of farms in Kullu. In Theog block, majority of the soils were slightly acid and medium acid.

Table 4.21 Soil pH in the study area

(Per cent)

Soil reaction (pH)		Kullu			Theog		
		Small	Large	All	Small	Large	All
Strongly acid	(5.1-5.5)	4.44	0.00	4.39	4.29	13.33	5.69
Medium acid	(5.6-6.0)	8.89	0.00	8.78	34.29	33.33	34.14
Slightly acid	(6.1-6.5)	12.22	30.00	12.44	34.29	36.67	34.66
Neutral	(6.6-7.3)	66.67	70.00	66.71	27.14	16.67	25.52
Mildly alkaline	(7.4-7.8)	7.78	0.00	7.68	0.00	0.00	0.00

Source: Field Survey, 2006

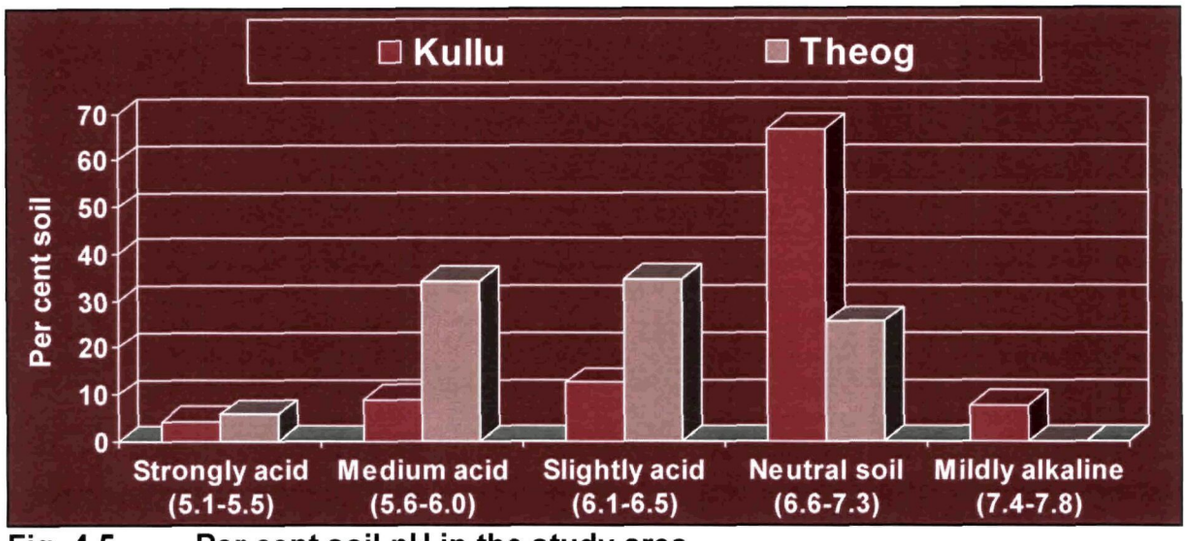

Fig. 4.5 Per cent soil pH in the study area

Table 4.22 Available primary macronutrients

(Per cent)

Particulars	Kullu			Theog		
	Small	large	All	Small	large	All
Organic carbon/ Nitrogen						
Low	1.11	0.00	1.10	4.29	3.33	4.14
Medium	4.44	10.00	4.51	5.71	0.00	4.83
High	94.44	90.00	94.39	90.00	96.67	91.03
Overall	H* (2.93)	H* (2.90	H*(2.93)	H* (2.86)	H* (2.93)	H* (2.87)
Phosphorus						
Low	6.67	0.00	6.59	12.86	10.00	12.41
Medium	11.11	20.00	11.22	14.29	30.00	16.72
High	82.22	80.00	82.20	72.86	60.00	70.86
Overall	H* (2.76)	H* (2.80)	H* (2.76)	H* (2.60)	H* (2.50)	H* (2.58)
Potassium						
Low	97.78	100.00	97.80	90.00	86.67	89.48
Medium	2.22	0.00	2.20	10.00	13.33	10.52
High	0.00	0.00	0.00	0.00	0.00	0.00
Overall	L*(1.02)	L*(1.00)	L*(1.02)	L*(1.10)	L*(1.13)	L*(1.11)

Source : Field Survey, 2006

Note : L*- Low (< 1.67), M- Medium (1.67-2.33) and H*- High (>2.33)

Table 4.22 shows that in Kullu block 94.39 per cent of the soils had high status of nitrogen, 4.51 per cent had medium and 1.10 per cent had low status of nitrogen. In Theog block, 91.03 per cent of the soils had high status of nitrogen

followed by 4.83 per cent medium and 4.14 per cent low status. On overall farm situation, the status of nitrogen was high both in Kullu and Theog blocks. In case of phosphorus, 82.20 per cent of the soils had high status, 11.22 per cent had medium status and 6.59 per cent had low status in Kullu, while in Theog 70.86 per cent had high status of phosphorus, 16.72 per cent had medium and 12.41 had low status. On overall farm situation, phosphorus was also high in both the blocks. In so far as availability of potassium was concerned, it was reported that 97.80 per cent of the soils had low status and 2.20 per cent medium in Kullu block while in Theog block 89.48 per cent of the soils had low status of potassium and 10.52 per cent had medium status. Also on overall farm situation, the availability of potassium was low in both the blocks.

The availability of micro nutrients in soils is given in Table 4.23. The table shows that in Kullu block, there was 100 per cent sufficiency of Cu on intra farm and as well as on overall farm situation. In Theog block, farmers reported that 91.03 per cent of the soils were sufficient in Cu whereas 8.97 per cent of the soils were deficient of Cu. In intra farm situation, 90 per cent of the soils were sufficient in Cu and 10 per cent were deficient on small farms, whereas on large farms, 96.67 per cent of the soils were sufficient and 3.33 per cent were deficient.

In case of Fe, 52.32 per cent of the soils were sufficient and 47.68 per cent were deficient in Kullu whereas in Theog, 56.72 per cent of the soils were sufficient of Fe and 43.28 per cent were deficient. Intra farm status shows that in Kullu 52.22 per cent of the soils were sufficient of Fe and 47.78 per cent of the soils were

low on small farms and on large farms 60 per cent were sufficient and 40 per cent were deficient. In Theog block, 58.57 per cent were sufficient and 41.43 per cent were deficient on small farms and 46.67 per cent sufficient and 53.33 per cent deficient on large farms.

Table 4.23 Available micronutrients

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Cu						
Sufficient	100.00	100.00	100.00	90.00	96.67	91.03
Deficient	0.00	0.00	0.00	10.00	3.33	8.97
Fe						
Sufficient	52.22	60.00	52.32	58.57	46.67	56.72
Deficient	47.78	40.00	47.68	41.43	53.33	43.28
Mn						
Sufficient	97.78	100.00	97.80	74.29	80.00	75.17
Deficient	2.22	0.00	2.20	25.71	20.00	24.83
Zn						
Sufficient	73.33	80.00	73.41	32.86	40.00	33.97
Deficient	26.67	20.00	26.59	67.14	60.00	66.03

Source: Field Survey, 2006

In Kullu block, 97.80 per cent of the soils were sufficient in Mn and 2.20 per cent were deficient, whereas in Theog block, 75.17 per cent of the soils were sufficient in Mn and 24.83 per cent were deficient. In Kullu, on small farms, 97.78 per cent of the soils were sufficient of Mn and 2.22 per cent of the soils were deficient and on large farms 100 per cent of soils were sufficient. In Theog block, 74.29 per cent of soils were sufficient and 25.71 per cent were deficient in small farms while on large farms, 80 per cent soils were sufficient and 20 per cent deficient. In case of Zn, 73.41 per cent of the soils were sufficient and 26.59 per cent were deficient in Kullu and in Theog, 33.97 per cent of the soils were sufficient of Zn and 66.03 per cent were

deficient. Intra farm status shows that in Kullu, 73.33 per cent of the soils were sufficient of Zn and 26.67 per cent of the soils were deficient in Zn in case of small farms and on large farms 80 per cent were sufficient and 20 per cent were deficient. In Theog block 32.86 per cent were sufficient and 67.14 per cent were deficient in small farms and 40 per cent sufficient and 60 per cent deficient in large farms.

4.3.2 Changes in agro-biodiversity

The change in land use clearly depicts the loss of agro biodiversity and narrowing of genetic base as a result of monoculture and wide spread adoption of high yielding varieties of food crops and intensification of agriculture. The process of transformation from traditional subsistence agriculture to commercial agriculture based on high value cash crops has led to significant changes in crop diversity during the past two-three decades, in both the study areas.

Table 4.24 shows that in 1970s, among food crops, barley, wheat, rice and maize were most important crops. However now only wheat, barley and maize are being grown and among these crops, maize was only important crop. In pulses, in both the blocks, rajmash, mash, rongi, soyabean, moong and masoor were being grown earlier but now only rajmash and mash in Kullu and rajmash in Theog were being grown. Likewise, out of 22 species of vegetables, only four species, namely, potato, cauliflower, cabbage and peas were being grown in both the blocks. However, in Theog, in addition to other vegetables, capsicum was also being grown. In apple, there were Golden delicious and Red delicious varieties. Now in addition to these two

varieties, new varieties like Golden spur, Vance delicious, Red spur, Richard, Star crimson and Red chief have also been introduced in both blocks.

Table 4.24 Change in agro biodiversity

Particulars	1970s	No.	2005-06	No.
Kullu				
Food crops	Finger millet, Foxtail millet, Barley, Wheat, Rice and Maize	6	Wheat, Barley and maize	3
Pulses	Rajmash, Mash, Rongi, Soyabean, Moong and Masur	6	Rajmash and Mash	2
Vegetable	Potato, Tomato, Cauliflower, Cabbage, Lady finger, Onion, Garlic, Pea, Mustard, Buckwheat, Pumpkin, Brinjal, Spinach, Capsicum, Bean, Colocassia, Turmeric, Garlic, Beans, Chillies, Lonki and Karela	22	Potato, Tomato Cauliflower, Cabbage and Pea	5
Main apple varieties	Royal delicious, Red delicious,	2	Royal delicious, Red delicious, Golden spur, Vance delicious, Red spur, Richard, Star crimson, and Red chief	8
Pollinizers	Golden delicious, Red gold, Granny smith Commercial and Janathan	5	Golden delicious, Red gold, Granny smith, Tydeman's early, Worcester, Manchurian, Malus floribunda and Crimson gold.	8
Other fruits	Plum, Pear, Peach, Apricot, Almond, Persimon, Grapes, Walnut and Quince	9	Plum, Pear, Persimon , Walnut, Cherry, Quince, Pomgranate, Grapes and Kiwi	9
Wild fruits	Kainth, Fiagra, Rubus	3	Kainth, Fiagra, Rubus	3
Pollinator	Honeybees, Wildbees, Butterflies and Months	4	Honeybees, Butterflies and Months	3
Theog				
Food crops	Barley, Wheat, Rice and Maize	4	Maize	1
Pulses	Rajmash, Mash, Moong, Rongi, Soyabean and Masur	6	Rajmash	1

Vegetable	Potato, Tomato, Cauliflower, Cabbage, Lady finger, Onion, Garlic, Pea, Mustard, Pumpkin, Brinjal, Spinach, Amaranth, Buckwheat, Chenopod, Brassica, Ginger, Colocassia, Turmeric, Garlic and Bean	22	Potato, Cauliflower, Cabbage, Pea, Beans and Capsicum	6
Main apple varieties	Royal delicious, Red delicious,	2	Royal delicious, Red delicious, Golden spur, Vance delicious, Red spur, Richard, Star crimson, and Red chief	8
Pollinizers	Golden delicious, Red gold, Granny smith	3	Golden delicious, Red gold, Granny smith, Tydeman's early, Worcester, Manchurian, Malus floribunda and Crimson gold.	8
Other fruits	Pears and Walnut	2	Pears, Persimon, Walnut, Cherry, Pomgranate and Kiwi	6
Wild fruits	Kainth	1	Kainth	1
Pollinator	Honeybees, Wildbees, Butterflies and Months	4	Honeybees, Wildbees, Butterflies and Months	4

Source: Field Survey, 2006

Among the pollinizers, out of five varieties, two varieties viz. commercial and Janathan have been abandoned and instead three new varieties like Tydeman's, Worcester, Manchurian, Malus floribunda and Crimson red have been introduced. In Theog, same varieties were being grown with the difference that Commercial and Janathan are no longer grown. Other fruit crops include plum, apricot, almond, persimon, grapes, walnut and quince but now peach and apricot have been replaced by cherry, pomegranate, grapes and kiwi. In Theog, pears, plum and walnut were the old fruit crops but now in addition to these, persimon, cherry, pomegranate and kiwi have also been introduced.

Table 4.25 Silviculture biodiversity

(No. / farm)

Name of Tree	Kullu			Theog		
	Earlier			Now a days		
	Small	Large	All	Small	Large	All
Kullu						
Deodar	-	-	-	-	-	-
Oak	20	25	21	0	15	5
Khirak	5	8	5	0	0	0
Kainth	30	45	32	25	40	30
Fiagra	10	15	11	0	0	0
Robinia	0	0	0	0	25	8
Theog						
Deodar	45	55	46	40	50	43
Oak	50	80	54	55	65	58
Khirak	0	0	0	0	0	0
Kainth	20	30	21	5	10	7
Fiagra	0	0	0	0	0	0
Robinia	7	0	6	0	0	0

Source: Field Survey, 2006

Table 4.25 shows that, on overall farm situation, in Theog block during 1970s there were more number of oak trees (54) followed by deodar trees (46), kainth (21) and robinia (6). In Kullu block, kainth (32) followed by oak (21), fiagra (11) and Khirak (5) were important trees. It was also noticed from the table that the number of trees was higher on large farms higher in comparison to small farms. In 2005-06, in Theog block, oak (58), followed by Pine (43) and Kainth (7) were important trees. While in Kullu block, kainth (30), robinia (8) and oak (5) were important. In both, Kullu and Theog blocks, more numbers of trees were found on large farms in contrast to small farms.

4.4 Impact of pesticide use on farmers' health

Though the use of agrochemical has lead to an increase agricultural productivity, their use has also been associated with many negative direct and indirect impacts on human health resulting in loss of working efficiency. Pesticides as such are toxic chemicals and represent risk to users. The level of risk increases, where users are often illiterate, ill trained and do not possess appropriate protective equipments. This leads to higher incidences of ill effects of pesticides. Therefore, human pesticide poisoning and illnesses are clearly the largest "environmental costs" paid by the society for their use. This section presents different aspects of pesticides use by the sample households like the respondents' characteristics, pesticides' impact on farmers' health, use of protective clothing while spraying pesticides, sources of awareness, knowledge of the households related to pesticides use, level of safety/precautionary measures, health impact or symptoms of diseases, and treatment measures of pesticide poisoning.

4.4.1 Characteristics of respondents:

Table 4.26 reveals that average age of a person who did spray was 40 years, weight was 58 kg and height was 1.62 meters in Kullu block while in Theog block, these features were 41 years, 60 kg and 1.66 meters.

Table 4.26 Physical characteristics of respondents

(Person/farm)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Age (Year)	40.66	37.40	40.33	40.59	42.00	41.01
Weight (Kg)	57.58	58.20	57.64	58.20	65.00	60.24
Height (m)	1.61	1.64	1.62	1.64	1.71	1.66

Source: Field Survey, 2006

It may also be seen from Table 4.27 and Fig-4.6 that a majority of the farmers were having normal weight in Kullu block. However, a majority of the farmers in Theog had the problems of underweight, overweight and obese.

Table 4.27 Physical characteristics of the respondents in terms of body mass index

(Percentage of respondents)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Under weight	8.89	10.00	8.90	18.57	13.33	17.76
Normal	77.78	90.00	77.93	67.14	66.67	67.07
Overweight	11.11	0.00	10.98	14.29	16.67	14.66
Obese	2.22	0.00	2.20	0.00	3.33	0.52

Source: Field Survey, 2006

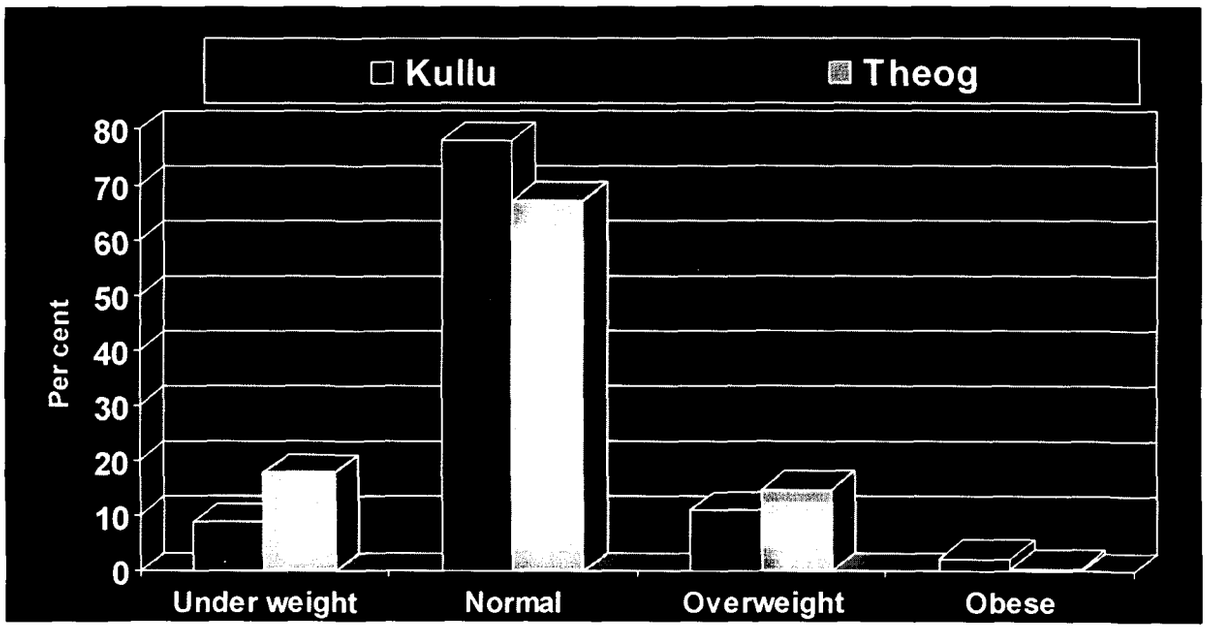

Fig. 4.6 Body mass index

In so far as incidence of smoking and drinking was concerned, Table 4.28 shows that the proportion of regular smokers and drinkers was significantly higher in Theog as compared to Kullu. For example, on overall farm situation, while the proportion of regular smokers was around 78 per cent in Kullu, it was 100 per cent in

Theog. Likewise, the proportion of regular drinker was as low as 2.20 per cent in Kullu in comparison to as high as 71 per cent in Theog.

Table 4.28 Incidence of smoking and drinking

(Percentages of respondents)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Smoke						
Regular	77.78	70.00	77.68	100.00	100.00	100.00
Irregular	22.22	0.00	21.95	0.00	0.00	0.00
Non – smoker	0.00	10.00	0.37	0.00	0.00	0.00
Drink						
Regular	2.22	0.00	2.20	74.29	55.17	71.40
Irregular	97.78	90.00	97.68	25.71	44.83	28.60
Non-drinker	0.00	10.00	0.12	0.00	0.00	0.00

Source: Field Survey, 2006

4.4.2 Pesticides impact on health:

The data presented in Table 4.29 shows that farmers in Theog block had been using pesticides for a long time. For example, two fifths of them (40.34 per cent) were using pesticides for the last 25 to 30 years. In both the blocks, 50 per cent or more farmers had been using pesticides in the range of 20-25 years.

Table 4.29 Years and frequency of spraying pesticides and adoption of IPM

(Per cent)

Year	Kullu			Theog		
	Small	Large	All	Small	Large	All
10-15	1.11	0.00	1.10	0.00	0.00	0.00
15-20	21.11	60.00	21.59	11.43	0.00	9.66
20-25	53.33	20.00	52.93	50.00	50.00	50.00
25-30	24.44	20.00	24.39	38.57	50.00	40.34
Frequency of spraying (No.)	7	8	7	9	8	9
Adoption of IPM						
Yes	20.00	100.00	28.00	11.43	25.00	13.65
No	80.00	0.00	80.00	88.57	75.00	86.35

Source: Field Survey, 2006

The table also reveals that frequency of spraying was a little higher in Kullu compared to Theog. It was interesting to find that 21 per cent and 14 per cent of the households had adopted integrated pest management in Kullu and Theog blocks, respectively.

Table 4.30 Pesticide use and its impact on pollinators

(Per cent of responses)

Factors	Kullu			Theog		
	Small	Large	All	Small	Large	All
No. of spray						
1-2	0.00	0.00	0.00	4.29	0.00	3.62
3-5	12.22	0.00	12.07	24.29	0.00	20.52
6-8	42.22	100.00	42.93	71.43	100.00	75.86
9-10	45.56	0.00	45.00	0.00	0.00	0.00
Pesticides sprayed during flowering						
Type of pesticides						
Insecticide	100	100	100	100	100	100
Fungicides	100	100	100	100	100	100
Time of spray						
Before flowering	100.00	100.00	82.00	71.43	100.00	44.00
During flowering	77.78	20.00	63.20	92.86	83.33	53.00
During fruiting	100.00	100.00	100.00	100.00	100.00	100.00
After fruiting	100.00	100.00	100.00	100.00	100.00	100.00
For colour	61.11	60.00	60.99	0.00	6.67	2.00
Do pesticides kill insect pollinators and bees?						
Yes	88.89	100.00	89.02	57.14	73.33	59.66
No	2.22	0.00	2.20	28.57	10.00	25.69
Don't know	8.89	0.00	8.78	14.29	16.67	14.66

Source: Field Survey, 2006

Table 4.30 shows different aspects of pesticide use like frequency of spray, type of pesticides, time of spray, etc. The table reveals that 45 per cent of the households were resorting to 9 to 10 sprays in Kullu block while around 43 per cent of households were caring out 6-8 sprays. On the other hand, in Theog a little more than three fourths of the farmers were spraying pesticides from 6 to 8 times while one-fifth

of households were doing so 3 to 5 times. Further, 100 per cent of the large households reported using insecticides and fungicides for the spray in both the blocks.

All farmers in both the blocks applied pesticide at the time of flowering, fruiting and after fruiting. In Kullu block, 50 per cent of the households applied pesticides for colour, but barely 2 per cent of the farmers did so in Theog. That the use of pesticides kill insects, pollinators and bees was reported by 89 per cent of the farmers in Kullu and 60 per cent in Theog.

Table 4.31 Farmers' perception about the effect of prolonged use of pesticides

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Yes	81.11	100.00	81.34	71.43	66.67	70.69
No	18.89	0.00	18.66	28.57	33.33	29.31
Degree of effects						
Very little	5.56	0.00	5.49	11.43	0.00	9.66
High	22.22	20.00	22.20	74.29	16.67	65.34
Very high	72.22	60.00	72.07	14.29	76.67	23.97
Extremely high	0.00	20.00	20.00	0.00	6.67	6.67

Source: Field Survey, 2006

Table 4.31 presents response of the farmers about the effect of prolonged use of pesticides on health. The table shows that 81.34 per cent of the farmers in Kullu were aware of fact that prolonged pesticides use can effect health. The proportion of such households was 70.69 per cent in Theog. In Kullu block, on overall farms, 72.07 per cent of the farms reported that pesticides had very high effect on

their health followed by 22.20 per cent of households who reported high effect of pesticide use.

Table 4.32 shows that majority of the farmers reported to have experienced acute illnesses due to pesticides exposure. Most of them (86 per cent) opined that they had experienced eye irritation (86 per cent) followed by 81 per cent who reportedly experienced fatigue, 66 per cent skin irritation, head ache and back pain, 56 per cent vomiting, 22 per cent dizziness and 1 per cent eye discharge. In Theog block, 77.5 per cent of the respondents reported eye irritation and back pain, 77.30 per cent fatigue and headache, 41 per cent vomit and skin irritation, 31 per cent eye discharge and 9 per cent dizziness..

Table 4.32 Pesticide poisoning: symptom of pesticides

(Per cent of respondents)

Symptom	Kullu			Theog		
	Small	Large	All	Small	Large	All
Eye irritation	84.44	100.00	86.00	74.29	85.00	77.50
Headache	58.89	60.00	59.00	75.71	80.00	77.00
Dizziness	20.00	40.00	22.00	8.57	10.00	9.00
Vomit	55.56	60.00	56.00	51.43	16.67	41.00
Back pain	58.89	60.00	59.00	75.00	83.33	77.50
Skin irritation	64.44	80.00	66.00	30.00	66.67	41.00
Eye flu	0.00	10.00	1.00	30.00	33.33	31.00
Fatigue	80.00	90.00	81.00	77.00	78.00	77.30
Availing clinic facilities						
Yes	82.22	100.00	82.44	74.29	80.00	75.17
No	17.78	0.00	17.78	25.71	20.00	24.83

Source: Field Survey, 2006

The clinic facilities were availed by 82 per cent and 75 per cent of the respondents after the illness caused by pesticide exposure in Kullu and Theog blocks,

respectively. In Kullu, 17.78 per cent farmers and in Theog block 24.84 per cent farmers had not availed clinic facilities after the illness due to pesticides exposure

4.4.3 Use of protective clothing/kit:

Regarding precautionary measures being adopted for protection while using pesticides, the data presented in Table 4.33 shows that more than two- thirds of the farmers reportedly used protective clothes at the time of spray in both the blocks. In Kullu block, the same response of the farmers was also found for the partial use of kit which was provided by the department of horticulture.

Table 4.33 Use of protective measures while spraying pesticides

(Per cent of respondents)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
User	66.67	100.00	67.07	64.29	100.00	69.83
Non-user	33.33	0.00	32.93	35.71	0.00	30.17
Use of kit						
Fully	0.00	0.00	0.00	0.00	0.00	0.00
Partially	66.67	100.00	67.07	64.29	100.00	69.83
No	33.33	0.00	32.93	35.71	0.00	30.17
Measures used						
Gloves	8.33	40.00	8.91	17.78	23.33	19.01
Boots	33.33	100.00	34.55	22.22	16.67	20.99
Old clothes	100.00	100.00	100.00	100.00	100.00	100.00
Cover nose and mouth with Polythene	16.67	70.00	17.64	4.44	16.67	7.16
Reasons for non-use						
Not interested	50.00	0.00	50.00	40.00	0.00	40.00
Uncomfortable	100.00	0.00	100.00	100.00	0.00	100.00
Unnecessary	33.33	0.00	33.33	48.00	0.00	48.00

Source: Field Survey, 2006

The response of farmers for the partial use of kit was more (69.83 per cent) in Theog block. It was also found that all the farmers were wearing old clothing at the time of spraying and 17.64 per cent of the farmers in Kullu and 7 per cent in Theog block used the polythene to cover nose, eyes and mouth. Table also shows that farmers were not willing to adopt any protective measure at the time of spraying because they felt uncomfortable. Half of the farmers in Kullu and two- fifths in Theog also reported that they were not interested in using protective measures.

Table 4.34 Sources of information regarding pesticide application

(Per cent of respondents)

Source	Kullu			Theog		
	Small	Large	All	Small	Large	All
Co- farmers	88.89	20.00	82.00	78.57	33.33	65.00
Extension worker	32.22	70.00	36.00	85.71	50.00	75.00
Television	56.67	80.00	59.00	41.43	33.33	39.00
Radio	56.67	70.00	58.00	57.14	50.00	55.00
Magazine, newspapers	11.11	60.00	16.00	42.86	33.33	40.00
Pesticide sales agent	98.89	90.00	98.00	92.86	66.67	85.00
Own experience	60.00	40.00	58.00	71.43	33.33	60.00

Source: Field Survey 2006

Table 4.34 shows that the sources of information which influenced application of pesticides by the farmers were very diverse. Nearly all farmers in Kullu and more than four-fifths in Theog block received information from the pesticide sales agents. Co-farmers, television and radio were other three important sources of awareness in both the areas. The role of extension workers was more important in Theog as compared to Kullu.

4.4.4 Awareness of farmers about different aspects of pesticides use

Table 4.35 presents six statements that measured the respondents' level of awareness about impact of pesticides on health and symptoms of poisoning. On

overall farm situation, in Kullu block, 100 per cent of the households reported that contact with pesticides cause eye injuries followed by 75 per cent of the households who reported that pesticide use causes blister or skin rash. Further, 74 per cent of the households reported that eating, drinking and smoking in the field increases the possibility of pesticides entering the body and that vomiting diarrhea, salivation and cramps are signs of pesticides poisoning. Nearly three - fifths of the households reported that pesticides exposure can cause cancer and that pesticides create many health risks to pregnant women and children.

Table 4.35 Awareness about the impact of pesticides use on human health

(Per cent)

Particular	Kullu			Theog		
	Small	Large	All	Small	Large	All
Eating, drinking and smoking in the field increases the possibility of pesticides entering the body	72.22	90.00	74.00	78.57	66.67	75.00
Vomiting, diarrhea, salivation and cramps are signs of pesticides poisoning	72.22	80.00	73.00	78.57	83.33	80.00
Pesticide exposure can cause cancer	55.56	100.00	60.00	82.86	83.33	83.00
Pesticide may cause blister or skin rash	72.22	100.00	75.00	92.86	90.00	92.00
Contact with pesticides cause eye injuries	100.00	100.00	100.00	100.00	100.00	100.00
Pesticides create many health risks to pregnant women and children	55.56	100.00	60.00	68.57	83.33	73.00

Source: Field Survey, 2006

In Theog block, all households reported that contact with pesticides cause eye injuries followed by 92 per cent who opined that pesticide cause blister or skin rash and 83 per cent who reported that pesticide exposure causes cancer and that

vomiting diarrhea, salivation and cramps are signs of pesticides poisoning. Three-fourths of the households reported that drinking and smoking in the field increases the possibility of pesticides entering the body and that pesticides exposure causes cancer and increases health risk to pregnant women and children.

Table 4.36 Awareness of immediate treatment practices for pesticide poisoning

(Per cent)

Particular	Kullu			Theog		
	Small	Large	All	Small	Large	All
Pesticides come in contact with the eyes, eye flushing should be done	100.00	100.00	100.00	100.00	100.00	100.00
A person who had swallowed pesticides it is important to take						
Water	100.00	80.00	98.00	85.71	83.33	85.00
Medicine	77.78	100.00	80.00	92.86	100.00	95.00
Victims who inhaled pesticides should be shifted from pesticide area to fresh air immediately	88.89	100.00	90.00	85.71	100.00	90.00

Source: Field Survey, 2006

From Table 4.36 it can be observed that farmers' knowledge about the treatment practices was high in both the blocks. For example, on all farm situation, all farmers reported that when pesticides come in contact with the eyes, eye flushing should be done. The response of households that a person who swallow pesticides should take water and medicine was also very high in both the blocks. Victims who inhaled pesticides should be shifted from pesticides area to fresh air immediately was reported by 90 per cent of the households in both blocks. It was observed from the table that the per cent of framers' having knowledge about the treatment practices

was more among large farm households in comparison to small farm households in both blocks.

Table 4.37 Awareness of precautionary measures against pesticides exposure

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Pesticides should be stored out of reach of children and animals	100.00	100.00	100.00	100.00	100.00	100.00
Pesticides are dangerous for people and animals	77.78	100.00	80.00	85.71	83.33	85.00
It is important to read instructions/warning labels on pesticides containers	44.44	80.00	48.00	78.57	66.67	75.00
It is important to bath and change clothes after handling pesticides	100.00	100.00	100.00	100.00	100.00	100.00
Protective clothing should be worn when mixing or applying pesticides	100.00	100.00	100.00	100.00	100.00	100.00
It is not safe to store water in containers that have been used for storing pesticides	100.00	100.00	100.00	100.00	100.00	100.00
It is not good to apply pesticides on a windy day	44.44	50.00	45.00	42.86	33.33	40.00
It is not safe to bring young children to the field after pesticide application	55.56	100.00	60.00	71.43	83.33	75.00
Empty pesticide container should not be kept for reuse	33.33	70.00	37.00	57.14	33.33	50.00
Eating fruits directly from the tree is not safe	22.22	30.00	23.00	28.57	16.67	25.00

Source: Field Survey, 2006

Table 4.37 shows that, on all farm situation, all farmers were of the view that pesticides should be stored out of reach of children and animals, should take bath and change clothes after handling pesticides, that protective clothing should be worn while mixing or applying pesticides and that it is not safe to store water in containers that had been used for storing pesticides. One-fifth of the households reported that pesticides were dangerous for people and animals followed by 60 per cent of the households who said that it was not safe to bring young children to the field after pesticide application. Nearly half of the farmers were of the view that important instruction /warning labels on pesticides containers should be read and 45 per cent felt that it was not good to apply pesticides on a windy day.

4.5 Farmers' perception with respect to pesticides and changes in productivity

The response of farmers to questions on problems in apple productivity has been summarized in Table 4.38. The table shows that in Kullu block 88.66 per cent of the farmers felt that productivity was decreasing while 11.83 per cent felt that it was increasing. Similarly in Theog, 38.8 per cent farmers felt that the productivity of apple was increasing and 61.20 per cent farmers responded by saying that it was decreasing. Further, 94.51 per cent of the farmers reported that the cost of production had increased while 5.49 per cent felt that it was decreasing. In Theog block, 86.38 per cent of the households responded by saying that cost of production had increased while the 13.62 per cent opined that it had not. In both blocks, it was important to note that all sample households felt that change in climate and degradation of natural resource base was mainly responsible for decrease in productivity of different crops.

Table 4.38 Changes in productivity as result of changes in natural resource base

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Productivity						
Increased	11.11	30.00	11.83	42.86	16.67	38.80
Decreased	88.89	70.00	88.66	57.14	83.33	61.20
Cost of production						
Increased	94.44	100.00	94.51	85.71	90.00	86.38
Decreased	5.56	0.00	5.49	14.29	10.00	13.62
Factors affecting productivity						
Climate	100.00	100.00	100.00	100.00	100.00	100.00
Disease and pest	33.33	30.00	33.00	28.57	33.33	30.00
Lack of pollination	100.00	100.00	100.00	21.43	16.67	20.00

Source: Field Survey, 2006

Table 4.39 Farmers' perception about change in different parameters of climate

(Per cent)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Temperature						
Increase	77.78	60.00	77.56	57.14	33.33	53.45
Decrease	0.00	0.00	0.00	0.00	0.00	0.00
Fluctuation	22.22	40.00	22.44	42.86	66.67	46.55
Rainfall						
Increase	8.89	0.00	8.78	14.29	6.67	13.10
Decrease	22.22	40.00	22.44	28.57	66.67	34.48
Fluctuation	68.89	60.00	68.78	57.14	26.67	52.41
Humidity						
Increase	11.11	0.00	10.98	7.14	6.67	7.07
Decrease	66.67	80.00	66.83	64.29	66.67	64.66
Fluctuation	22.22	20.00	22.20	28.57	26.67	28.28
Snowfall						
Increase	0.00	0.00	0.00	0.00	0.00	0.00
Decrease	100.00	100.00	100.00	100.00	100.00	100.00
Fluctuation	0.00	0.00	0.00	0.00	0.00	0.00

Source: Field Survey, 2006

Table 4.39 summarizes the response of farmers with respect to their perceptions about the change in different parameters of climate which had contributed towards change in climate. Table shows that 77.56 per cent of the households reported that there was an increase in the temperature while 22.44 per cent reported that there were fluctuations. Further, 8.78 per cent of farmers responded by saying that there was an increase in temperature and 22.44 reported that there was decrease in it. The increase, decrease and fluctuation in humidity were reported by 10.98 per cent, 66.83 per cent and 22.20 per cent of the households, respectively.

All sample households reported that there was a decrease in snowfall. In Theog, an increase in temperature was reported by 53.45 per cent, a fluctuation in temperature was reported by 46.55 per cent. The fluctuation in rainfall as a reason of climate change was reported by 52.41 per cent, followed by 34.48 per cent who reported decrease in rainfall and 13.10 per cent who reported an increase in rainfall. The decrease in humidity was reported by 64.66 per cent followed by fluctuations in humidity 28.28 per cent and increase in humidity by 7.07 per cent.

4.6 Strategies adopted by the farmers

The farmers of the study areas have adopted different strategies like soil management, pollination management and orchard management to cope up with the adverse effects on soils and problems of decreasing productivity. Table 4.40 shows that under soil management practices all farmers had resorted to manuring in both the blocks. On overall farms, use of crop residue and droppings of sheep and goat

were resorted to by 23 per cent of the households each in Kullu block but it was done by 43 and 35 per cent of the respondents respectively, in Theog block.

The practice of sloping land agricultural technology was being adopted by only 9 per cent of farmers in Kullu block where as in Theog block it was adopted by 50 per cent of the farmers. It was also noticed during the survey that only 2 per cent of the farmers of Kullu block used vermi-compost fertilizers. None of the farmers used vermicompost in Theog block. Table further shows that the extent of adoption of these technologies was higher on large farms in comparison to small farms in both the blocks. To overcome the problem of pollinator, it was found during the survey that few farmers (5 per cent) of the small families in Kullu block and 12 per cent in Theog block were rearing honey bees. But their sole emphasis was on honey extraction.

Table also shows that a small proportion of large farm households (10 per cent) were hiring honey bees from commercial beekeeping entrepreneurs in Kullu, but no such farm household was found in Theog block. In pollination management, the technique of bouquet pollination was reported by 75 per cent of the households in Kullu block. This technique was not being used by the respondents of Theog block. In orchard management, the pruning of plants and basin preparation was done by all the farmers in both blocks. On overall farm situation, mulching was done by 23 per cent of the households, where as in Theog block it was done by 100 per cent of the households.

Table 4.40 Strategies adopted by the farmers to minimize adverse effect

(Per cent response)

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
1. Soil management						
a) To increase soil fertility						
Crop residue harvesting	18.89	60.00	23.00	34.29	63.33	43.00
Manuring	100.00	100.00	100.00	100.00	100.00	100.00
Dropping of sheep and goats	18.89	60.00	23.00	34.29	36.67	35.00
Vermi compost fertilizers	2.22	0.00	2.00	0.00	0.00	0.00
b) Soil erosion and water management						
Sloping agricultural land technology	5.56	40.00	9.00	42.86	66.67	50.00
Multiple cropping	100.00	100.00	100.00	57.14	40.00	52.00
2. Pollination management						
Bouquets pollination	72.22	100.00	75.00	0.00	0.00	0.00
Branch grafting	100.00	100.00	100.00	71.43	100.00	80.00
3. Pollinator Management						
Rearing honey bees	5.56	0.00	5.00	14.29	6.67	12.00
Rented honey bees	0.00	10.00	10.00	0.00	0.00	0.00
4. Orchard Management						
Pruning	100.00	100.00	100.00	100.00	100.00	100.00
Basin preparation	100.00	100.00	100.00	100.00	100.00	100.00
Basin mulching	55.56	100.00	60.00	100.00	100.00	100.00
Rainwater harvesting structure such as a mud pond	0.00	0.00	0.00	42.86	50.00	45.00
Concrete ponds for water storage	38.89	100.00	45.00	50.00	73.33	57.00
Mulching of nursery	22.22	30.00	23.00	100.00	100.00	100.00
Protection from hailstorm	0.00	0.00	0.00	2.86	6.67	4.00
Replacement of delicious varieties	22.22	20.00	22.00	42.85	63.33	48.99
Switching over to new crops	22.22	30.00	23.00	0.00	0.00	0.00

Source: Field Survey, 2006

The practice of formation of mud pond (with plastic sheet) was reported only in Theog block, where 42.86 per cent of the small households and 50 per cent of large farm households were practicing formation of mud pond. This practice was not found in Kullu block. The building of concrete ponds for water storage was reported by 45 per cent of the households in Kullu and 57 per cent of the households in Theog. Multiple cropping was being practiced by all respondents in Kullu block, where as in Theog block it was being followed by nearly half of the respondents. Mulching of nursery was being done by 23 per cent farmers in the former block while in latter block it was being done by all households. The measure to protect crop from hail storm was adopted by a very small proportion of households (2 per cent) in Theog. The replacement of delicious varieties with "Vance" was, more or less the same in small and large farms in Kullu block, whereas in Theog replacement was done by 42.85 per cent in case of small households and 63.33 in respect of large households. The proportion of farmers switching over to new crops was more on large farms than small farm households in Kullu block. This practice was not found in Theog block.

4.7 Valuation of environmental costs

In this section, the monetary valuation of environmental costs due to pesticides exposure and degradation of soil heath due to less and excess use of agrochemicals has been done and the returns over the production and environmental costs have been computed.

4.7.1 Monetary valuation of the adverse effects of pesticides application on human health

Table 4.41 shows number of days lost and their monetary value due to pesticides application, cost of kit and medical expenditure.

Table 4.41 Monetary valuation of the adverse effects of pesticides application/exposure on human health

(Person/ household))

Particulars	Kullu			Theog		
	Small	Large	All	Small	Large	All
Days lost (Days/Person)	5	6	5	6	7	6
Loss in monetary terms (Rs./person)	450	522	457.2	540	630	567
Loss in work efficiency because of not taking medicines (Rs/person)	113	131	115	135	158	142
Cost of kit (Rs./person)	3	0	3	10	27	15
Medical expenditure (Rs./person)	1129	19771	2993	620	868	694
Total	1700	20430	3573	1311	1690	1424
Area for spray (ha)	1.128	3.434	1.359	1.186	5.369	2.441
Rs./ha.	1507	5949	2630	1105	315	583

Source: Field Survey, 2006

Table 4.41 reveals that on all farm situation a person doing spray lost 5 days in one season in Kullu block and 6 days in Theog block. Table also shows that total monetary loss including days lost, loss in work efficiency in the event of not taking medicines and value of kit was Rs. 3573 in Kullu and Rs. 1424 in Theog. Among two categories of farms, monetary loss was more on large farms in both blocks. The cost per hectare on account of adverse effect on health amounted to Rs. 2630 in Kullu block and Rs 583 was in Theog block.

Table 4.42 shows that in Kullu, maximum expenditure, on all farm situation, was Rs. 5685 in 2005 followed by Rs. 5,684 in 2004, Rs. 3,544 in 2003, Rs.

2,026 in 2002, Rs. 1,116 in 2001 and Rs. 1,064 in 2000. In Theog, maximum expenditure was Rs. 5,152 in 2003 followed by Rs. 4,685 in 2005, Rs. 4,684 in 2004, Rs. 1,441 in 2002, Rs. 1,414 in 2001 and Rs. 195 in 2000.

Table 4.42 Yearly expenditure on medicine from 2000 to 2005

(Rs./household)

Year	Kullu			Theog		
	Small	Large	All	Small	Large	All
2000	1021.11	1450.00	1064.00	135.97	333.33	195.18
2001	1078.89	1450.00	1116.00	1527.14	1150.00	1414.00
2002	2034.44	1950.00	2026.00	1508.57	1283.33	1441.00
2003	3487.78	4050.00	3544.00	2484.29	11376.67	5152.00
2004	5732.22	5250.00	5684.00	2591.43	9566.67	4684.00
2005	5732.60	5254.50	5684.79	2592.19	9569.63	4685.42

Source: Field Survey, 2006

Table 4.43 Expenditure on medicine in other diseases

(Rs./households)

Diseases	Kullu			Theog		
	Small	Large	All	Small	Large	All
Skin effects	0.00	2400.00	2400.00	0.00	166.67	166.67
Heart attack	0.00	17000.00	17000.00	0.00	11333.33	11333.33
Neurological effects	111.11	0.00	111.11	0.00	6666.67	6666.67
Stone	0.00	0.00	0.00	971.43	0.00	971.43
Sugar	777.78	1200.00	820.00	0.00	333.33	333.33
Rasoli	444.44	0.00	444.44	1428.57	0.00	1428.57
Leg pain	1233.33	0.00	1233.33	0.00	1166.67	1166.67
Gangrin	1666.67	0.00	1666.67	0.00	0.00	0.00
Motiya	0.00	0.00	0.00	1342.86	2800.00	1780.00
Arthritis	0.00	0.00	0.00	664.29	1216.67	830.00
Blood pressure	388.89	0.00	388.89	171.43	913.34	394.00

Source: Field Survey, 2006

Table 4.44 shows that in Kullu block maximum expenditure was incurred on heart diseases (Rs. 17,000) followed by skin diseases (Rs. 2,400), gangrin (Rs. 1,667) and leg pain (Rs. 1,233), while in Theog block maximum expenditure was on

heart disease (Rs. 11,333), neurological disorders (Rs. 6,667), motiya (Rs. 1,780) and rasoli (Rs. 1,428)

Table 4.44 Status and requirement of macronutrients and micronutrients in the study area

Primary macronutrients	Kullu	Theog
Available Nitrogen (kg/ha)	H*(2.93)	H*(2.87)
Dose recommended as per high status (kg/ha)	1863	225
Doses applied by farmers	189.9796	1115.42
Nitrogen environment status	-1673.02	890.418
Available phosphorus (kg/ha)	H*(2.76)	H* (2.58)
Dose recommended as per high status	3271.8	183
Doses applied by farmers	92.13	535.738
Phosphorus environment status	-3179.67	352.738
Available Potassium (kg/ha)	L* (1.02)	L*(1.11)
Dose recommended as per low status	977.55	228.75
Doses applied by farmers	51.2525	267.869
Potassium environment status	-926.298	39.1188
Status and requirement of Micronutrients		
Zn	26.59 (D)	66.03 (D)
Requirement (Kg/hac)	25	25
Cu	0	8.97 (D)
Requirement (Kg/hac)	25	25
Fe	47.68 (D)	43.28 (D)
Requirement (Kg/hac)	25	25
Mn	2.20 (D)	24.83 (D)
Requirement (Kg/hac)	25	25

Source: Field Survey, 2006 Note: L*-Low, H*-High, D -Deficient

Table 4.44 shows that among macro nutrients while the status of available nitrogen and phosphorus was high in both the blocks, that of potassium was low. Thus, in view of the actual availability of these nutrients in the soils, there recommended doses worked out to be 1863 kg/hectare of nitrogen, 3271.8 kg/hectare of phosphorus and 977.55 kg/.hectare of potassium in Kullu. The respective doses for Theog were 225 kg/hectare of nitrogen, 183 kg/hectare of phosphorus and 228.75 kg/hectare of potassium. In comparison, the doses of these

three macro nutrients applied by the farmers were 189.98 of nitrogen, 92.13 of phosphorus, 51.25 kg/hectare of potassium in Kullu and 1115.42 kg/hectare of nitrogen, 535.74 of phosphorus and 267.87 of potassium kg/hectare in Theog. In respect of micro nutrients, the results show that except copper, other nutrients like zinc, iron and mn were deficient in Kullu whereas in Theog soils were found deficient in all the four micro nutrients. The extent of soil degradation was estimated depending on the excess or deficit of macro and micro nutrients. Table 4.45 shows that in monetary terms, the cost degradation of soil health, both macro and nutrients, amounted to Rs. 44,977 per hectare in Kullu and Rs. 2,98,556 in Theog. In terms of macro and micro nutrients, it was Rs. 32,509 and Rs. 12,468, respectively in Kullu and Rs. 10,188 and Rs. 19,668 respectively in Theog.

Table 4.45 Monetary valuation of deterioration in soil health

(Rs./ha)

Nutrients	Kullu block	Theog block
1. Primary Macronutrients		
Available Nitrogen	16295	8673
Available Phosphorus	12083	1340
Available potassium	4131	174
a) Sub total	32509	10188
2. Micronutrients		
Zn	4500	4500
Cu	-	7200
Fe	2430	2430
Mn	5538	5538
b) Sub total	12468	19668
Total (a+b)	44977	29856

Table 4.46 and Fig. 4.7 give the total environmental including cost of the adverse effect on human health and degradation of soil. The table shows that these costs together amount to Rs. 47,607 in Kullu and Rs.30,439 in Theog. Among these

two costs, more than 95 per cent was accounted for by the cost of degradation in soil health in both the areas.

Table 4.46 Monetary valuation of total environmental costs

(Rs./ha)

Environmental cost	Kullu block	Theog block
Cost of the adverse effect on human health	2630	584
Cost of the degradation of soil health	44977	29855
Total cost	47607	30439

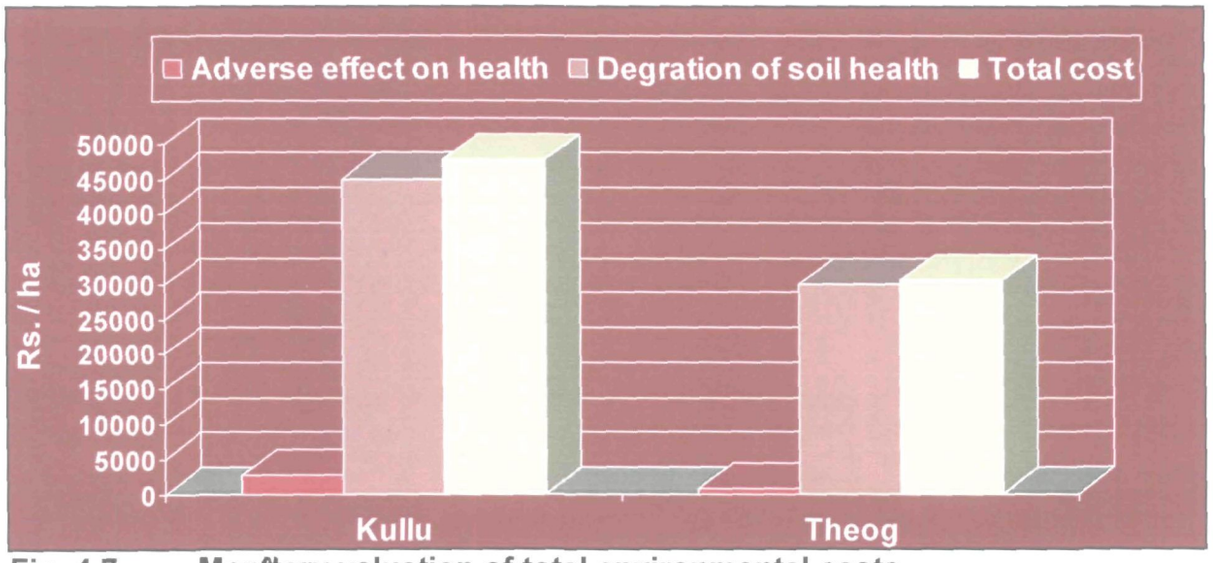

Fig. 4.7 Monetary valuation of total environmental costs

Table 4.47 and Fig.4.8 show that total production and environmental cost was Rs. 6, 581, 43 in Kullu block and Rs. 7,749,02 in Theog block. Out of that total cost, the production cost was Rs. 6,13,166 and Rs. 7,45,046 in Kullu and Theog block respectively. Total environmental cost was Rs. 44,977 in Kullu block and. Rs. 29,856 in Theog block. In percentage terms, the share of cost of production was as high as 93.17 in Kullu and 96.15 per cent in Theog.

The per cent share of environmental cost was less than 7 per cent in Kullu and 4 per cent in Theog. Apportioning the environmental costs to different crops

according to their share in the cultivated area, Table 4.47 shows that in Kullu block, cost of apple was Rs. 22,883, followed by cauliflower (Rs. 10,928), pea (Rs. 9,649) and cabbage (Rs. 1,517). In Theog block, cost of cauliflower was Rs. 20,416, followed by cabbage (Rs. 6,130) and pea (Rs. 3309).

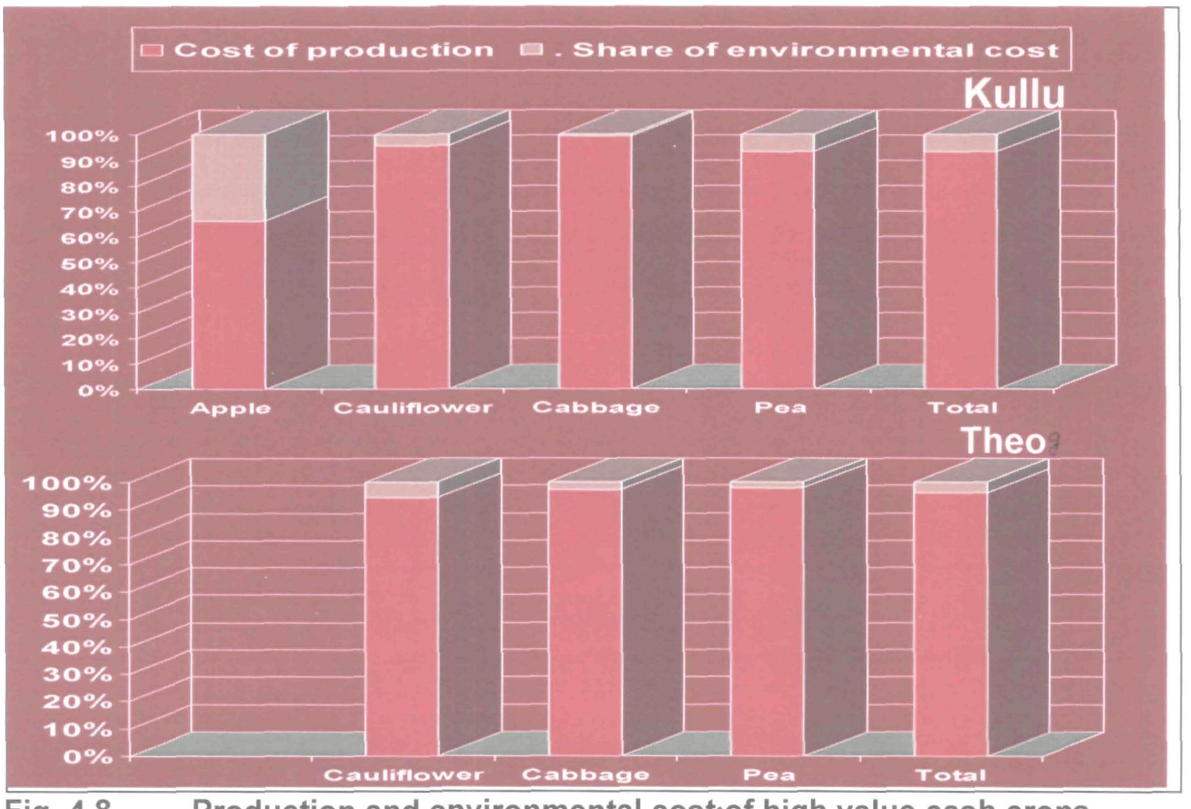

Fig. 4.8 Production and environmental cost of high value cash crops

The total returns over production and environmental costs, given in Table 4.48 and Fig.4.9, were Rs. 91,610 per hectare in Kullu block and Rs. 77,034 in Theog block. The returns from apple, cauliflower, cabbage and peas were Rs. 92,022, Rs. 930, Rs. 2245 and pea Rs. -3586 respectively in Kullu while in Theog these were Rs. -4,811.25, Rs. -1,069.16, Rs. 8,362 respectively.

Table 4.47 Production and environmental cost of high value cash crops

(Rs./ha)

1. Cost of production	Kullu	Theog
Apple	45142	40858
Cauliflower	238722	338535
Cabbage	198738	206819
Pea	130564	158834
a) Sub-total	613166	745046
2. Environmental cost of different crops		
Apple	22883	-
Cauliflower	10928	20416
Cabbage	1517	6130
Pea	9649	3309
b) Sub-total	44977	29856
Total (a+b)		
Apple	67663	38119
Cauliflower	249650	358951
Cabbage	200255	212949
Pea	140213	162143
Total	658143	774902

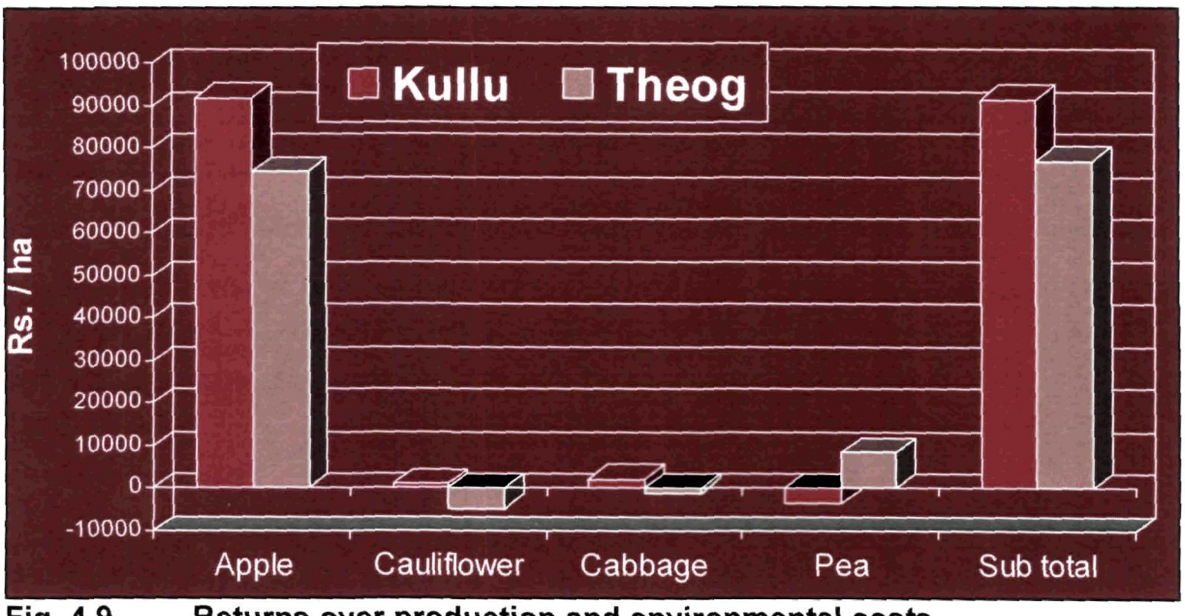

Fig. 4.9 Returns over production and environmental costs

Thus, the results show that if both the costs are taken into account, the cultivation of peas in Kullu and cauliflower and cabbage in Theog are economically non-viable. Therefore, in both the areas, urgent measures need to be taken to restore

the health of the soils to promote ecological sustainability and economic viability of high cash crop cultivation.

Table 4.48 Returns over production and environmental costs

(Rs./ha)

Returns over cost of production and environmental costs		
	Kullu	Theog
1. Returns over cost of production		
Apple	114905	74553
Cauliflower	11858	15605
Cabbage	3762	5061
Pea	6063	11671
Sub total	148446	122495
2. Return over environmental costs		
Apple	136802.35	112672
Cauliflower	239651.74	333723.7
Cabbage	200982.91	205749.8
Pea	126977.72	167195.9
Sub total	704414.74	819341.4
3. Returns over cost of production + Environmental costs		
Apple	92022.35	74553
Cauliflower	929.74	-4811.25
Cabbage	2244.91	-1069.16
Pea	-3586.27	8361.87
Total	91610.74	77034.45

4.8 Functional analysis

In this section, an attempt has been made to quantify the contribution of different factors that affect the body mass index of the person who was responsible for maximum number of sprays in a household in both the areas.

As explained in methodology, the dependent variable was binary in terms of 0 and 1. The 1 was given to those persons who were not having normal body mass index and 0 to all others. Since dependent variable was in binary form, the logit regression model was fitted to estimate the contribution of different factors towards the probability of a person not having normal body mass index. Different

combinations of variables were tried and the combination which gave better results was retained. The results are reproduced in Table 4.49.

Table 4.49 Results of logit regression

Variables	Kullu	Theog
Constant	4.4352 (3.1315)	-9.120 (3.392)
Age	-0.0045 (0.0261)	0.029 (0.025)
Education	1.3136** (.5915)	-
Years of spraying	-0.1164 (0.0855)	0.160*** (0.096)
Dummy for protective equipments	3.7577* (1.4036)	-8.236 (21.806)
Number of sprays	-0.6406* (0.2691)	0.357*** (0.242)
Dummy for IPM	-3.7472 (1.1583)	1.150*** (0.749)
Dummy for availing clinic access	-4.0702*** (2.3118)	-0.471 (0.632)
-2 log likelihood	60.616	96.669
Goodness of fit	74.584	78.688
Cox & Snell R^2	0.307	0.221
Nagelkerke - R^2	0.493	0.313

Note:
i. *, ** and *** denote the level of significance at 1 per cent, 5 per cent and 10 per cent respectively.
ii. Figures in parenthesis are standard errors.

The results show that in Kullu factors like age, education, use of protective equipments, number of sprays, use ov integrated pest management and clinic access affected the probability of person having body mass index not normal. Regarding the signs and significance of different variables, the results show that regression coefficients associated with age, number of sprays, access to clinic facilities and adoption of integrated pest management had expected signs and was statistically significant as well. However, the signs of the coefficients associated with

education, years of spray and use of protective equipments were in variance with the expected signs though the coefficients were statistically significant. The unexpected signs of these coefficients were difficult to explain. In case of Theog, variables like years of sprays, use of protective equipments and availability of clinical facilities had theoretically expected signs and were statistically significant also. However, the sign of the coefficient associated with adoption of integrated pest management was theoretically inconsistent and difficult to explain. The other variables were statistically insignificant.

4.9 Implications for livelihoods

The results presented in above tables show that the cultivation of high value cash crops has made a significant impact on the natural resource base of the study areas It was evident from the adverse effect on human health and the degradation of soil health in terms of the excess/deficit of the macro and micro nutrients available in the soils. Also there has been a reduction in the agro-biodiversity in terms of number of crops and trees that have disappeared as a result of the adoption of mono-cropping and a cropping sequence year after year. All these changes have serious ramifications towards the livelihoods of the local population. If these adverse effects on health and soil fertility are not checked, the livelihoods may be endangered. It is, therefore, important that policy measures, given in the last chapter, are undertaken to minimse the adverse effects both on human health and soil fertility to ensure ecological sustainability and economic viability of high value cash crops agriculture in the state.

DISCUSSION

CHAPTER V

DISCUSSION

This chapter has been devoted to describe the results emerging out of the present investigation in a systematic and logical manner. It is required to decipher the broad patterns and policy implications that follow from the results. The discussion of the results has been presented under the following broad sections:

5.1 Socio-economic profile of the sample households

5.2 Cost of cultivation and returns from high value cash crops

5.3 Changes in natural resource base

5.4 Impact of pesticide use on farmers' health

5.5 Farmers perception about use of pesticides and changes in productivity

5.6 Strategies adopted by the farmers to minimize adverse effect

5.7 Valuation of environmental costs

5.1 Socio-economic profile of the sample households.

In any study of farming/agriculture, it is extremely important to understand different aspects of socio-economic profile of the sample households. For example, it is well known by now that the level of agricultural development of any region is

conditioned by different attributes of the farming community like the risk bearing attitude, attitude towards new innovations, the general awareness which depends upon the level of education, etc. The studies have shown that high growth rate of Punjab agriculture owes very much to the innovative and hardworking nature of the *Jat* community of Punjab (Chadha, 1986). Likewise, the farmers' spirit of innovativeness and their eagerness to experiment with new crops/enterprises has been one of the important factors responsible for the successful adoption of high value cash crops in the state of Himachal Pradesh. The studies have shown that the farmers in Shimla and Kullu districts have acquired a spirit of innovativeness and are always ready to experiment with new crops/enterprises that promise high economic returns. It was evident from the fact that when potato ceased to be a cash crop in the fifties and the early sixties due to dwindling yields and falling demand, the farmers in these districts switched over to fruit cultivation mainly apple, and subsequently to off-season vegetables. Likewise, in recent times, when apple production is fluctuating and becoming uncertain because of erratic weather, farmers in these areas have started experimenting and switching over to new high value cash crops like garlic and off-season vegetables and even to more risky crops like floriculture (Sharma, 1996). Against this background, different aspects of socio-economic profile of the sample households in terms of their age and education status have been studied. *Ceteris peribus*, the region whose inhabitants are young and more educated shall have a high level of agricultural development compared to those regions where majority the inhabitants are in the higher age group coupled with high incidence of illiteracy. The level of education also plays an important role in decision making and managerial

skill. Further, since female population plays an important role in hill agriculture, the status of female education is also one of the important determinants of the level of agricultural development of any region.

5.1.1 Age wise distribution of sample population

In this context, the results on the age wise distribution of sample population presented in the last chapter indicate that in both regions more than half of the work force was relatively young i.e. in the age group of 18-60 years which augur well for their agricultural development. Another distinguishing feature was that the there was a significant difference in the male and female members in Kullu whereas in Theog the number of female was almost half than their male counterparts. The household size was, however, higher in Theog compared to Kullu. It needs to be mentioned here that the family size is generally higher in mountainous regions compared to low hill regions and plains. The higher family size in these regions could be attributed to the fact that joint family system has not completely broken down in these regions.

5.1.2 Educational status:

Coming to the level of education in the study areas, the incidence of illiteracy was 6.26 per cent in Kullu and 11.45 per cent in Thoeg. These levels of illiteracy are significantly lower than those at the state and districts levels (Statistical Outline of Himachal Pradesh, 2005). Further, conforming to the broad patterns at the state and national levels, the level of illiteracy was significantly higher among female members compared to male members in both the areas. The higher incidence of

illiteracy in Theog could perhaps be attributed to difficult mountain terrain compared to Kullu. The level of higher education above plus two was higher in Kullu than Theog. The most important feature, however, was that proportion of female with post graduation was higher compared to male in Kullu.

5.1.3 Land use and cropping patterns

The land utilization pattern of any region reveals the extent of land available for different uses like cultivation, orchards, pastures, forests, etc. The results in this regard show that practically whole of the land in Kullu was under crops compared to Thoeg where the proportion of land available for cultivation was around three-fourths of the total land. This peculiar situation could be explained in terms of the dominance of apple plantation in the cropping pattern. The spread of high value cash crops, primarily apple, has benefited the study areas in two ways. First, it promoted the productive use of abundant marginal/pasture lands available in these regions. Second, these crops helped in maintaining and improving the ecology and environment by promoting soil conservation and improving soil fertility. The area under forest was almost negligible in Kullu and 7.28 per cent in Theog. The very high incidence of apple plantation in Kullu has, however, compensated for the lack of area under forests to a large extent. The practice of leasing- in and leasing- out land was non-existent in Kullu primarily due to scarcity of land resources and higher population pressure compared to Thoeg where these were marginal, the proportions of leased-in and leased-out lands were 0.17 per cent and 0.35 per cent respectively. Another interesting feature observed during the survey in Theog was that the pasture lands

(*ghasnies*) were being leased-out to the Nepali labourers and when the land becomes fit for cultivation after 4 to 5 years, they start paying rent to the land owners.

Cropping pattern indicates the allocation of available cultivable land under different crops. It also indicates the extent of intensification of agriculture. Different studies have shown that crop diversification promotes more intensive use of land. The cropping pattern in the two areas brings out the intensive use of the scarce land resources. It was evident from the fact that the area under sole crops was very small. Practically whole of the area under apple plantation was being intercropped both during *Khariff* and *Rabi* seasons in Kullu. And in Thoeg, in addition to *Kharif* and *Rabi* crops, *Zaid* crops were also being grown on quite a significant proportion of the cultivable area. Further, while as many as eleven crops (Apple, maize, mash, rajmash, cauliflower, cabbage, tomato, potato, peas and wheat and barley) were being grown in Kullu, seven crops (apple, maize, Cauliflower, cabbage, potato, peas and beans) were being grown in Theog. An important aspect which becomes evident from the cropping patterns of these two areas is that a sequence of cropping system is being followed which on the one hand, helps in maximizing the profits from the limited area and, on the other, replenishes the soil fertility. The difference between the cropping patterns of the two areas in terms of the dominance apple in Kullu and its less importance in Theog could be explained in terms of the fact that there were huge fluctuations in weather in Theog as compared to Kullu. The wild fluctuations in the temperature at the time of flowering result into low fruit setting. Thus, the farmers in this region are forced to grow vegetables for sustenance of their livelihood. The farmers of the Kullu block also face such type of climatic problems but not very

frequently. It is perhaps to mitigate the problem of fluctuations in apple production that the farmers in Kullu have extensively adopted the practice of intercropping.

5.1.4 Crop production and yield

The level of agricultural development of any region is ultimately manifested in production and productivity of different crops. In his regard, among two areas the production and productivity of vegetable crops was much higher in Theog compared to Kullu. This could be attributed to the fact that these crops were not important in Kullu where farmers depend mostly on the apple crop. The productivity of apple was 85 quintals per hectare in Kullu and 61 quintals per hectare in Theog. The productivity of apple was lower in Theog because of weather as there are wild fluctuations in temperature at the time of flowering and if the weather remains favourable at the time of flowering, apple crop is affected by hailstorms. The farmers opined that this problem has assumed serious proportions for the last five-six years. However, notwithstanding, these fluctuations in weather, the overall climate for apple production is more conducive in Theog as compared to Kullu. Insofar as the productivity on small and large farms was concerned, the data threw up no neat pattern. For example, while the productivity of cabbage and cauliflower was higher on small farms, the productivity of other crops was higher on large farms. In respect of apple, the production was higher on large farms compared to small ones. These results are, therefore, in variance with conclusions of the most of the studies on inverse farm size productivity relationship (Sharma and Sharma 2000). However, these results are in confirmation with a large body of emerging studies which argue that inverse farm size relationship does not hold true in case of high value cash crops

because, *inter alia*, these crops are more market input intensive to which large farmers have better access and affordability compared to their small brethren (Sharma and Sharma 2000).

5.2 Cost and returns from high value cash crops:

The economic viability of any crop is contingent upon its cost of production and net returns. The cost production depends upon the quality and quantity of different inputs being used for cultivation. As alluded to above, high value cash crops are input intensive and most of the inputs like seeds, fertilisers and chemicals are purchased from the market. It is, therefore, in the fitness of things to understand the contribution of different inputs towards total variable cost. In this context, the data presented in the last chapter show that, on an average, the cost of apple production was Rs. 44,780 and Rs. 38,119 per hectare in Kullu and Theog block respectively. Insofar as the contribution of fixed and variable costs towards total cost was concerned, fixed costs, which included cost of maintenance, plantation, preparation of pits, etc accounted for less than one-fifth of the total cost in Kullu. The variable costs which include the costs of variable inputs and transportation costs, contributed the remaining costs. It needs to be mentioned here that the transportation costs accounted for as high as nearly three-fourths of the total variable costs and around three-fifths of the total costs in Kullu because these crops are marketed in far off markets like Delhi. In comparison, in Theog, contribution of fixed costs and variables costs were 11.33 per cent and 88.68 per cent, respectively. The cost of transportation accounted for 69.40 percent of the total variable costs and 67 per cent of the total costs. The transportation cost was lower in Theog because of its close

proximity to neighbouring states' markets compared to Kullu. Among two categories of farmers, different marketing systems were prevalent in Kullu where most of the small farmers prefer to sell their produce at Azadpur market Delhi because of three reasons. First, small amount of marketable surplus which make it difficult for them to arrange means of transportation. Second, according to them, it was difficult to save money if they sell in the local markets as they receive payment within two three days which they immediately spend. Third, in local market these farmers allege that they face price discrimination in the hands of the local *arhiyas*.

Coming to the financial viability of apple plantation, the results reveal that apple cultivation continued to be profitable. For example, the net returns per hectare amounted to Rs 92,093 in Kullu and Rs. 60, 469 in Theog. The cultivation of apple was also a paying proposition in terms of project worth measures. It was evident from the fact that, on overall farm situation, one rupee investment on apple plantation promised a return of Rs. 2.10 in Kullu and Rs. 1.77 in Theog. The values of internal rate of return also showed the financial viability of apple plantation.

Since vegetable crops are more labour intensive compared to cereals, the contribution of different inputs towards the total cost shows that the cost of labour, both owned and hired, was significantly higher compared to the cost of other inputs in all the crops. The other important inputs contributing towards the total costs were FYM, plant protection, seed and fertilisers. The findings of our study support the conclusions of a number of other studies which have shown high returns from the cultivation of high value cash crops (Sharma, 2005, Joshi, *et al.*, 2004). Among two

study areas, the returns over cost D were higher in Theog for all vegetable crops compared to Kullu. And among different crops, cauliflower followed by pea and cabbage yielded higher returns.

5.3 Changes in the natural resource base

As mentioned above, there is an anecdotal evidence to indicate that the continuous cultivation of these crops has started taking toll on the natural resource base. The natural resource base is a comprehensive term encompassing soil, water, forests and agro-bio-diversity. In a study of social science, where conclusions are drawn from the data collected from the farmers, it is difficult to quantify the exact impact on the above mentioned natural resources. It is perhaps because of this reason that environmental economists have devised different methodologies to value the impact on natural resource base. The willingness to pay approach and contingent evaluation methods are some of the methodologies that are currently in vogue in environmental economics (Pearce and Turner, 1990). However, in the present context, the objective was to document and value the environmental cost caused by the cultivation of high value cash crops in two study areas. Therefore, in the present study, an attempt was made to value the loss in the soil fertility and the impact on human health. In addition, the extent of loss of agro-biodiversity and the strategies adopted by the farmers to minimize these losses were also documented. As stated in the methodology, while the extent degradation of soils was estimated by collecting and testing the soil samples from the cultivated land of each of the sample household, the effect of on health was quantified using the data collected from the sample households. The results about the physical health of the soils showed that while

farmers reported clay soils, followed by sandy and loamy soils in Kullu, the farmers in Theog reported loamy soils, clay and sandy soils respectively. Regarding chemical health of the soil, most of the soils were neutral followed by slightly acid, medium acid, mildly alkaline and strongly acid in Kullu. In comparison, in Theog block, soils were slightly acid, medium acid, neutral and strongly acid in over all farm situation. The results further show that while majority of the soils had pH neutral and slightly acid both on intra farm and overall farm in Kullu block, in Theog majority of the soils reported pH slightly acid and medium acid on both intra farm as well as overall farm situation.

The process of agricultural transformation in the study area has led to significant changes in crop diversity during the last two-three decades. The number of cereal crops that were being currently grown in both the regions was far less than the crops grown twenty-thirty years back. In fact, most of the pseudo cereals have completely disappeared. However, in case of vegetable crops, new crops have been introduced in both areas. There has also been a significant reduction in the number of species of trees that are available now compared to the early seventies when these crops were being introduced. For example, in Theog block farmers have maintained only oak trees for the purpose of fodder trees whereas in Kullu farmers had cut even these trees to expand area under apple plantation.

Regarding changes in apple varieties, in Kullu block Janathan and commercial varieties have been replaced due to their low market value. The flowering branches of Golden delicious variety are being used by the farmers for the formation

of bouquet to over come the pollination problem in orchards due to lack of pollinizers. However, due to excessive cutting the Golden delicious plants had started withering. For the replacement of the plants of royal delicious and red delicious, farmers have started planting Vance delicious alongside other varieties to over come the effect of less snow and non fulfillment of the chilling requirement in that Vance delicious does not require chilling and perform well in the absence of less or no snowfall. This variety starts flowering after 4 to 5 years. Other fruit crops like peach, apricot and almond have been completely replaced with apple plantation in Kullu. In some cases, old trees of almond have been replaced with new variety called *Kagji akhrot*. In Kullu there was loss of wild bees due to loss of their habitat. Other fruit crops which are now being introduced include cherry, pomegranate, grapes and Kiwi. More or less similar changes were noticed in Theog.

5.4 Impact of pesticide use on farmers' health

As mentioned in the chapter on review of literature, there are number of studies from other countries to suggest that excessive use of agro-chemicals has started impacting adversely on human health. In the present context, the results from both the study areas show that among two blocks, the health problems like under weight, over weight and obese were more pronounced in Theog block compared to Kullu. And this could be attributed to the fact that not only the use of pesticides was more in the former compared to the latter block, the frequency of spraying was also higher in Theog. This was due to intensive cultivation of vegetable crops which require more intensive and frequent use of agro-chemicals. The farmers reported that because of excessive spray of chemicals, the environment around them remains

highly polluted for most of the time in a year. The problem of pollution also becomes more acute because their residential houses are in very close proximity to the orchards/vegetable fields. The data showed that the proportion of farmers using pesticides for the last 25 to 30 years was higher in Theog in comparison to Kullu block where more than fifty per cent of the farmers had been using these for the last 20 to 25 years. In case of apple production, however, the frequency of spraying pesticides was higher in Kullu block in comparison to Theog block. A preponderant majority of the farmers in both regions, however, opined that pesticides did have an adverse affect on their health. The problem of adverse impact on health gets compounded because less than one-fifth of the farmers follow integrated pest management practices in both the blocks. Also field workers smoke and eat in the same field where they work and even at a time when they apply pesticides. The majority of them also reported that they seldom wash their hands before eating because of the non-availability of water. Most of the farmers also did not take pre-caution for the safe storage of the pesticides. In some case, these were stored along with other agricultural implements. The farmers were aware of the ill effects of pesticide use on health. This is evident from the response of the farmers about the various problems and diseases associated with the use of pesticides. The knowledge of farmers whether a particular pesticide was safe or not for use was however, very limited.

Most of the farmers also reported to have experienced acute illnesses due to pesticides exposure and other problems like eye irritation, fatigue, skin irritation, headache and vomiting in both the blocks. More importantly, however, the

incidence of such diseases like rasoli, mal functioning of heart, paralysis, motiya, arthritis and stone was very high in Theog compared to Kullu. To what extent these diseases are caused by the excessive use of pesticides remains to be ascertained by testing blood samples of these patients. Therefore, this is a very important researchable issue for the health scientists. The use of measures to protect themselves from the harmful effects of pesticides was very low among the farmers. The measures used by most of the farmers include the use of old clothes, gloves and shoes. Very few farmers, however, covered nose and mouth with polythene while spraying. The low adoption of these measures was because they do not feel comfortable while using. Around one-third of the farmers of both blocks partially used the kit provided by the horticultural department with the spray pump. The main reason for not using the kit was that, at the time of spraying farmers get sweating and do not feel comfortable by wearing protective equipment at the time of spray. The important sources of information which influenced farmers' application of pesticides were radio, television, co-farmers, extension workers, television, magazine, newspapers, and pesticides' sales agent. Out of them, most important sources of information were sales agent and co-farmers. These results are in conformity with the sources of information about new agriculture technology given in one of the NSS Reports (Some Aspects of Farming) brought out as result of Situation Assessment Survey (Bhalla, 2007).

5.5 Farmers perception about the use of pesticides and changes in productivity

A preponderant majority of the farmers reported that over the period there has been a decrease in the productivity of different crops primarily as a result of

changes in climate, emerging disease and pest and lack of pollination. The productivity of apple crop has particularly been affected because of depletion of agro-biodiversity and destruction of the natural habitat of bees and insects. The excessive and frequent use of pesticides has affected both the diversity and the abundance of pollinating insects. Regarding change in different parameters of climate, the majority of the farmers reported that over the years there has been an increase in temperature, fluctuations in rainfall and decrease in the amount of snowfall. All these factors have adversely affected the productivity of different crops, particularly that of apple.

5.6 Strategies adopted by the farmers

The farmers of the study areas have adopted different strategies such as soil management, pollination management and orchard management to mitigate the adverse effect on the natural resource base. For example, for maintaining the soil fertility, manuring was being done by all the farmers. The use of crop residues and dropping of sheep and goat was being followed by nearly one-fourth of the households in both the areas. Among other strategies, sloping land agricultural technology was being followed by fifty percent of the households in Theog, especially to convert grasslands into cultivable land. This practice was not very common in Kullu because most of the land did not have steep slopes. The practice of using vermi compost fertilizers' was however, not popular; the proportion of household using this fertliser was negligible (2 per cent) in Kullu and zero in Thoeg. Most of the farmers in Kullu were aware of the problem of failed pollination in apple crop. The awareness about the problem of pollination in Theog was very low because of very high

frequency of crop failure due to fluctuations in temperature at the of flowering and hailstorms at the time of fruit setting.

The main pollinizer varieties in Kullu included commercial and golden, while in Theog block these were golden, red gold and tiedemann's early worester. Some varieties of crab apple are also gaining popularity in Kullu block for grafting since these produce many flowers and has long flowering period of more than a month. Until the early 1990s, pollination of apple crops in Kullu block was dependent largely upon naturally occurring pollinating insects. Though, the role of honey bees in ensuring better pollination and fruit set is a well known, very few farmers (4 per cent in Kullu block and 8 per cent in Theog block) maintain wall beehives. The farmers hire honey bee boxes from the department of horticulture on a short term basis with minimal rent charges during flowering time. Some farmers have also reduced the number of pesticide application from 10 sprays to 6 to 7 spray in a season and were using the less toxic chemicals to promote pollination by bees. They also sprayed before the flowering to prevent insect from killing. Most of the farmers have adopted strategies like pruning, basin preparation and basin mulching to maintain the productivity of their apple orchards.

5.7 Valuation of environmental costs

The monetary valuation of environmental costs, which in the present case include the cost of adverse effect on human health and cost in terms of the degradation of soil health, revealed that the environmental cost was higher in Kullu both in terms of the cost of adverse effect on human health and soil degradation

compared to Theog. More importantly, however, the results show that the cultivation of apple continues to be paying and economically viable even after including both production and environmental costs in Kullu. However, in Theog the two most important vegetable crops, namely, cauliflower and cabbage yielded negative returns when allowance for environmental costs was also made. The situation may be far more serious if the long term effect of the use of pesticides on health is considered. As stated above, the incidence of diseases like stone, blood pressure, motia, rasoli is very high in Theog which may assume serious proportion if due attention is not paid towards promoting scientific use of these agro-chemicals. These findings of the study, therefore, put a huge question mark on the ecological sustainability and economic viability of these crops in Theog where these crops are being cultivated extensively and for the last 25 to 30 years. These findings also have serious ramifications towards the livelihood of the local population and also for the population of all other areas which are fast switching over to the cultivation of these crops. The policy conclusion emanating from the study is, therefore, loud and clear: pay attention towards promoting scientific and rational use of pesticides and other agro-chemicals to avoid ill effects of human health and promote balanced use of fertilizer for restoring soil heath to protect the livelihoods of multitudes of small and marginal farmers.

5.8 Functional analysis

The results of logit analysis shows that factors like age, education, integrated pest management, clinic access and number of pesticides sprays, number of years since spraying and use of protective equipments affected the probability of a household being not having normal body mass index.

SUMMARY

CHAPTER-VI

SUMMARY

6.1 Introduction

A plethora of empirical studies from different countries of the world has shown that diversification of agriculture towards high value cash crops has made a significant impact on the economic status of the farmers in terms of their income and employment. It is, therefore, no wonder that policy makers are busy devising strategies to promote agricultural diversification. However, while crop diversification has resulted in higher income and employment to the farmer households, it has also promoted indiscriminate use and unscientific handling of toxic chemicals which is causing degradation of natural resource base and also affecting human health. There is an imposing evidence to indicate that as the process of agricultural diversification towards these crops gets intensified and gains momentum, the extent, severity and frequency of associated health problems are increasing at an alarming rate. According to World Health Organization, agrochemicals cause 30,00,000 cases of poisoning and 2,20,000 deaths annually across the globe, the majority of which are reported from the developing countries. Occupational exposure to pesticides has resulted in short term and chronic disease among exposed farmers and farm workers. Agro-chemicals related health and environment damages are often very difficult to identify due to problems in diagnosis and segregation of effects. These problems multiply due to inherent problems of poverty, inadequate health care facilities, poor training support to health-care personnel and unsatisfactory access to health care

system. Even more important, the major victims of indiscriminate use are the most vulnerable sections of the population. The small and marginal farmers, farm women and farm workers, who are most often exposed owing to occupational factors neglect health hazards and damage to the agro-ecosystem, due to either lack of awareness and/or due to financial factors. Likewise, there is also an evidence to indicate that excessive and imbalanced use of agro-chemicals has adversely impacted on the soil heath resulting into decline in soil fertility and, in the ultimate analysis, decrease in crop productivity.

The state of Himachal Pradesh, over the years, has emerged as a leading producer of temperate fruits and off-season vegetable thanks to the availability of bewildering variety of agro-climatic niches. The area and production of fruit and vegetable crops have increased manifold. For example, while the area under fruit crops increased from 26,307 hectares in the triennium ending 1967-68 to 1.87 lakh hectares in the triennium ending 2005-06, the production during the period increased from 48 thousand tonnes to 6.28 lakh tonnes. Likewise, while area under vegetable crops increased from 23,000 hectares in 1990-91 to 50,000 hectares in 2006-07, the production during the period rose from 3,65,000 tonnes to 10,00,000 tonnes registering compound growth rates of 5.49 per cent and 5.90 per cent per annum respectively. The increase in area and production of fruits and vegetable is more pronounced in areas enjoying temperate climate. And among different districts of the state, Shimla and Kullu are the two leading districts accounting for most of the area and production of fruits. There are number of empirical studies on the economic impact of these crops like costs and returns, marketing, financial viability, etc. Though

there is no empirical study on the effect of the cultivation of these crops on natural resource base and human health, the available anecdotal evidence emerging from field visits and interaction with the producers of these crops, especially in those regions where the cultivation of these crops is being practiced for the last 25-30 years indicate that this has started impacting adversely on the natural resource base like soil and agro-biodiversity and also on human health due to excessive use of agro-chemicals. The available anecdotal evidence needs to be put to scientific scrutiny to value the extent of degradation in soil health and the severity of the effect on human health. In other words, it would be interesting to know the extent of degradation in natural resource base and adverse effect on human health in those areas where the cultivation of these crops is in advanced stages.

6.2 Objectives

Keeping in view the above background, the present study seeks to document adverse changes in natural resource base and value the environmental costs in the production of these crops. In brief, the study has the following objectives:

- To document the commercialized agriculture led adverse changes in the natural resource base and their impact on the production, productivity and human health;

- To document the strategies adopted by the farmers to minimize the adverse effects of these changes;

- To estimate the cost of these changes in terms of the losses in income and employment and;

- To understand the implications of these changes for the livelihoods of the farmers and suggest policy measures.

6.3 Methodology

Out of 12 districts of the state of Himachal Pradesh, two districts, namely, Kullu and Shimla were purposively selected for the study inasmuch as these account for a very high proportion of area and production of these crops. From these districts, again, two blocks namely Kullu and Theog were selected purposively. After the selection of the blocks, the list of panchayats falling in each of the selected block was prepared. One panchayat was selected randomly from each of the selected blocks at the first stage of sampling. After the selection of the panchayats, the list of the villages falling in each of the two panchayats was prepared. And at the second stage of sampling, 50 per cent of the villages were selected randomly from both the selected panchayats. A sample of 100 households was then proportionately allocated among the selected villages in each of the panchayats. The sample size thus consists of 200 households. Further, one key informant was also selected from the each of the selected villages in both the panchayats for the collection of the village level data, The total sample size thus consists of 200 households and 31 key informants.

The data was collected from the selected households using pre-tested schedule through a personal interview method for the year 2005-06. In addition, for the estimation of soil health, soil samples were also collected from the cultivated area

of each of the sample household. In Kullu block, soil samples were taken from the apple orchard (cultivated orchard) and in Theog block these were taken from vegetable fields. The main reason for collection of soil samples from apple orchards in Kullu block and vegetable fields in Theog was that the use of agrochemicals was higher in apple orchards and vegetable fields. The height and weight of the person who was primarily responsible for spraying and was more exposed to agro-chemicals were also taken from each of the selected household to construct the Body Mass Index.

The data has been analyzed using appropriate statistical tools to accomplish the objectives of the study. Primarily Tabular analysis was done. In addition, logit analysis was also done to quantify factors affecting probability of an individual being not having normal Body Mass Index. For the estimation of soil health, soil samples were analyzed under lab conditions to know the status of primary macro-nutrients and micronutrients (Cu, Zn, Fe and Mn) in agriculture soil testing lab, Kullu. The overall status of N, P and K has been measured through soil nutrient index table and the soils have been classified into low, medium and high status. In order to estimate the soil health due to high/low status of N, P and K in the soil, the values of optimum quantity of fertilizers for the orchards and vegetable crops were taken from the package of practices for horticulture and package and practice for vegetable crops. The environmental cost was defined to include the cost of degradation of soil health and the loss of days due to exposure to pesticides and the cost of pesticides kit.

6.4 Main findings

The main findings emanating from the study are summarized below:

1. The average family size of sample households was 5.94 persons in Kullu block and 6.76 persons in Theog block. Small farm households had 5.91 persons in Kullu and 6.33 persons in Theog. The size of the family on large farm households in Kullu was 6.20 persons and 7.77 persons in Theog.

2. The proportion of illiterate persons was higher in Theog than Kullu and majority of the family members had an education up to high school. At graduate level, the proportion of male graduates was more in both the blocks compared to female graduates. But, the proportion of those educated up-to post graduate level was higher among females than male in Kullu but the pattern was reverse in Theog.

3. There was no practice of leasing-in and leasing-out land in Kullu, primarily because of scarcity of land due to high population pressure. More than 98 per cent of the total land was under cultivation in Kullu whereas the percentage of such land was 75 per cent in Theog. The overall holding size was 1.43 hectares in Kullu and 3.32 hectares in Theog. Out of total holdings, (1.43 ha) only 0.98 per cent in Kullu was irrigated and in Theog, out of total holdings of (3.32 ha) the irrigated area was around 70 per cent. In Kullu block , 71.43 per cent of irrigated and 98.46 per cent of un-irrigated area was under fruit farming in comparison to Theog block where

only 41.98 and 42.68 per cent of irrigated and unirrigated area was under fruit farming. On overall farm situation, in *Kharif* and *Rabi* seasons, area under sole crop was 0.86 per cent in Kullu and as high as 23.72 per cent in Theog. Area under non-bearing apple was 12.88 per cent and 4.86 per cent in Kullu and Theog, respectively. The area under bearing apple was 17.53 per cent and 17.66 per cent, respectively. Apple was the main crop which accounted for one-third of the total cultivated area. The area under other fruits like plum and pear was negligible, around two per cent or even less in both the blocks.

4. In Kullu block, production of maize was 10.43 quintals and wheat was 6.66 quintals per farm. Among vegetable crops, the production of cauliflower was 47.24 quintals distantly followed by pea, cabbage and potato. In Theog block, the production of cauliflower was as high as 590.81 quintals followed by cabbage (196.69 quintals), pea (54.92 quintals), beans (22.79 quintals) and potato (11.78 per cents). The yield levels of different crops were significantly higher in Theog compared to those in Kullu. Among small and large farms, there was no neat pattern in Kullu while in Theog the yield levels were higher in respect of large farms compared to their small counterparts.

5. In Kullu, the returns from apple were higher while in Theog these were higher from cauliflower. The net returns in Kullu and Theog blocks from apple were Rs. 92,093 and Rs. 60,469 per hectare respectively. The returns per box, on an average, were Rs. 260 in Kullu block and Rs. 227

in Theog block. The returns from different crops on different categories of farms show that in Kullu per hectare net returns on large farms were higher (Rs. 1,08,275) compared to small farms (Rs.89,893). In Theog block, per hectare returns were almost same on both the categories of farms, Rs.69,287 on small farms and Rs. 69,327 on large farms. The profitability of apple cultivation was also evident from the results of different project worth measures. For example, on over farm situation, the net present value per hectare in Kullu was Rs. 50,347, whereas in Theog it was Rs. 29,275. The values of benefit cost ratios were 2.10 and 1.77 in Kullu and Theog, respectively. The internal rate of returns were 16 per cent in the former and 11 per cent in latter.

6. The composition of total costs shows that in Kullu owned human labour followed by hired labour accounted for a significant proportion of total variable cost in all the crops in both the blocks. The other inputs according to their contributions towards total variable cost FYM, plant protection, seed, fertilizers, interest on working capital, hired bullock labour and owned bullock labour.

7. In Kullu block, 55.12 per cent of households reported that most of their land had loamy soils, followed by 11.71 per cent who reported clay soils and 33.17 per cent farmers reported sandy soils. In Theog block, 50 per cent of the farmers reported that most of their land had loamy soils, followed by 35.34 per cent households reporting clay soils and 14.66 per cent households reported sandy soils. Most of the soils were neutral and

slightly acid on both the categories of farms in Kullu. In Theog block, majority of the soils were pH slightly acid and medium acid. On overall farm situation, the status of nitrogen and phosphorus was high both in Kullu and Theog blocks. Also on overall farm situation, the availability of potassium was low in both the blocks. In Kullu, the availability of micro nutrients in soils shows that there was 100 per cent sufficiency of Cu both on intra farm as well as on overall farm situation. In Theog block, farmers reported that 91.03 per cent of the soils were sufficient in Cu. In case of Fe, 52.32 per cent of the soils were sufficient and 47.68 per cent were deficient in Kullu, whereas in Theog 56.72 per cent of the soils were sufficient of Fe and 43.28 per cent were deficient. In Kullu block, 97.80 per cent of the soils were sufficient in Mn and 2.20 per cent were deficient whereas in Theog block, 75.17 per cent of the soils were sufficient in Mn and 24.83 per cent were deficient. In case of Zn, 73.41 per cent of the soils were sufficient and 26.59 per cent were deficient in Kullu, whereas in Theog, 33.97 per cent of the soils were sufficient of Zn and 66.03 per cent were deficient.

8. The process of transformation from traditional subsistence agriculture to commercial agriculture based on high value cash crops has led to significant changes in crop diversity during the past twenty to thirty years in both the study areas. Many cereal crops especially pseudo cereals have disappeared. Likewise, out of 22 species of vegetables, only four species potato, cauliflower, cabbage and peas were being grown in both

the blocks. In apple, there were Golden delicious and Red delicious varieties. Now in addition to these two varieties, new varieties like Golden spur, Vance delicious, Red spur, Richard, Star crimson and Red chief have also been introduced in both blocks. Among the pollinizers in Kullu, out of five varieties, two varieties Commercial and Janathan have been abandoned and instead three new varieties like Tydeman's, Worcester, Manchurian, Malus floribunda and Crimson red have been introduced. In Theog block, other varieties were the same but Commercial and Janathan have been abandoned. Other fruit crops include plum, apricot, almond, persimon, grapes, walnut and quince but now peach and apricot have been replaced by cherry, pomegranate, grapes and kiwi.

9. Agrochemicals used to increase agricultural productivity have also caused many negative direct and indirect impacts on human health resulting in loss of working efficiency of labour. The results shows that while majority of the farmers were having normal weight in Kullu block, a majority of the farmers in Theog had the problems of underweight, overweight and obese. The proportion of regular smokers and drinkers was significantly higher in Theog as compared to Kullu. In both the blocks, 50 per cent or more farmers have been using pesticides for the last 20-25 years. It was interesting to find that 21 per cent and 14 per cent of the households had adopted integrated pest management in Kullu and Theog blocks respectively. Different aspects of pesticide use like frequency of spray, type of pesticides, time of spray reveal that 45 per cent of the households

were resorting to 9 to 10 sprays in Kullu block while around 43 per cent of households were carrying out 6 to 8 sprays. On the other hand, in Theog a little more than three fourths of the farmers were spraying pesticides from 6 to 8 times while one-fifth of households were spraying 3 to 5 times. In both the blocks, 100 per cent of the large households reported using insecticides and fungicides for the spray. All farmers in both the blocks applied pesticide at the time of flowering, fruiting and after fruiting. In Kullu block, 50 per cent of the households applied pesticides for colour, but barely 2 per cent of the farmers did so in Theog. Further, 89 per cent of the households in Kullu and 60 per cent in Theog reported that the use of pesticides kill insects, pollinators and bees. Further, in Kullu 81.34 per cent of the households were aware of fact that prolonged pesticides use could affect health. The proportion of such households was 70.69 per cent in Theog. Majority of the farmers reported to have experienced acute illnesses due to pesticides exposure. In Kullu, most of them (86 per cent) opined that they had experienced eye irritation (86 per cent) followed by those who reportedly experienced fatigue (81 per cent), skin irritation, head ache and back pain (66 per cent each), 56 vomiting (56 per cent) and dizziness (54 per cent). In Theog block, 77.5 per cent of the respondents reported eye irritation and back pain, 77.30 per cent fatigue and headache, 41 per cent vomit and skin irritation, 31 per cent eye discharge and 9 per cent dizziness. The clinic facilities were availed by 82 per cent and 75 per cent of the respondents after the illness caused by

pesticide exposure in Kullu and Theog blocks respectively. Farmers were not willing to adopt any protective measure at the time of spraying because it was uncomfortable. Half of the farmers in Kullu and two- fifths in Theog also reported that were not interested in the use of the protective measures.

10. Regarding sources of information about pesticides use, all households in Kullu and more than four-fifths in Theog block received information from the pesticide sales agents. Co-farmers, television and radio were other three important sources of information in both the areas. The role of extension workers was more important in Theog as compared to Kullu. In Kullu block, 100 per cent of the households reported that contact with pesticides caused eye injuries followed by 75 per cent of the households who reported that pesticide use cause blister or skin rash. Further, 74 per cent of the households reported that eating, drinking and smoking in the field increases the possibility of pesticides entering the body and that vomiting diarrhea, salivation and cramps are signs of pesticides poisoning. Nearly three-fifths of the households reported that pesticides exposure can cause cancer and that pesticides create many health risks to pregnant women and children. On all farm situations, all farmers reported that when pesticides come in contact with the eyes, eye flushing should be done. The per cent of the households reporting that a person who swallowed pesticides should take water and medicine was very high in both the blocks. One-fifth of the households reported that pesticides were

dangerous for people and animals followed by 60 per cent who said that it was not safe to bring young children to the field after pesticide application. In Theog block, 85 per cent of the households considered pesticides dangerous for people and animals followed by those who said that it was important to read instructions/warning labels on pesticides containers and that it was not safe to bring to bring young children to the field after pesticide application. Fifty per cent of the households opined that empty pesticide container should not be kept for reuse. The knowledge about precautionary measures was more among large farm households compared to their small counterparts in Kullu. The pattern was just reverse in Theog block.

11. The farmers of the study areas have adopted different strategies like soil management, pollination management and orchard management to cope up with the adverse effect on soils and associated problems of decreasing productivity. In soil management practices, all farmers had resorted to manuring in both the blocks. On overall farms, use of crop residue and droppings of sheep and goat were resorted to by 23 per cent of the households each in Kullu block but it was done by 43 and 35 per cent of respondents respectively, in Theog block. The practice of sloping land agricultural technology was adopted by only 9 per cent of the farmers in Kullu block where as in Theog block it was adopted by 50 per cent of the farmers. It was also noticed that only 2 per cent of the farmers of Kull block used vermi-compost fertilizers and none of the farmers did so i

Theog block. To overcome the problem of pollinator, it was found that few farmers (5 per cent) of the small families in Kullu block and 12 per cent in Theog block were rearing honey bees. But their sole purpose was on honey extraction. In orchard management, the pruning of plants and basin preparation was done by all the farmers in both blocks. On overall farm situation, mulching was done by 23 per cent of the households, where as in Theog block it was done by all sample households. The practice of formation of mud pond (with plastic sheet) was reported only in Theog block, 42.86 per cent of the small households and 50 per cent of large farm households reported to have been practicing formation of mud pond. This practice was not found in Kullu block. The building of concrete ponds for water storage was reported by 45 per cent of the households in Kullu and 57 per cent in Theog. Multiple cropping was being practiced by all respondents in Kullu block, where as in Theog block it was being followed by 52 per cent of the respondents. Mulching of nursery was being done by 23 per cent farmers in the former block while in latter block it was being done by all households.

12. On overall farm situation, each household lost 5 days due to pesticide exposure in one season in Kullu block and 6 days in Theog block. In monetary terms, it amounted to Rs. 457 per farm in Kullu and Rs. 567 in Theog. Total health cost due to pesticide application was Rs. 2,630 in Kullu but Rs.584 only in Theog. Total cost for the degradation/depletion of macro-nutrients amounted to Rs. 32,509 per hectare in Kullu and

Rs.10188 per hectare in Theog. The cost in terms of degradation/depletion of micro-nutrients amounted to Rs. 12,468 per hectare in Kullu and Rs.19,668 in Theog.

13. The total production cost of the crops in Kullu was Rs. 6,12,804 per hectare and Rs.7,42,307 in Theog. The environmental cost for the high value cash crop was estimated to Rs. 44,977 in Kullu and Rs. 29,856 in Theog. The returns over cost of production were Rs. 1,48,446 per hectare in Kullu and Rs. 1,22,495 in Theog block. And the returns from all crops over both the costs were Rs. 91, 610 in Kullu and Rs.77, 034 per hectare in Theog.

14. Further most of the farmers are not adopting strategies available to maintain soil health, conserve water and increase productivity. However, between two areas, the proportion of farmers adopting such strategies was more in Theog as compared to Kullu. The problem of farmers' health is emerging as an important issue in both the areas as is evident from the days lost due to use of agro-chemicals and the incidence of diseases. The study further shows that while the cultivation of apple continues to be economically viable even after including environmental costs in both the areas, the cultivation of important vegetable crops like cauliflower and cabbage in Theog and Peas in Kullu yielded negative returns when environmental costs were also considered along with the production costs.

15. The results of logit analysis shows that factors like age, education, integrated pest management, clinic access, number of pesticides spray, number of years since spraying and use of protective equipments affected the probability of a household being not having normal Body Mass Index.

16. In sum, the analysis shows that the cultivation of high value cash crops has made an adverse effect both on human health, soil fertility and agro-biodiversity. These findings of the study, therefore, put a huge question mark on the ecological sustainability and economic viability of these crops in Theog where these crops are being cultivated extensively for the last 25 to 30 years. These findings have serious ramifications towards the livelihood of the local population and also for the population of all other areas which are fast switching over to the cultivation of these crops. The lesson is loud and clear: pay attention towards promoting scientific and rational use of pesticides and other agro-chemicals to avoid ill effects of human health and promote balanced use of fertilizers including bio-fertilizers for restoring soil heath to protect the livelihoods of multitudes of small and marginal farmers.

6.5 Policy implications

1. The farmers should be educated about the impending health problems due to the use of agro-chemicals. Enhancing farmers' perceptions about the health consequences of pesticide exposures and the use of protection equipments during spraying is crucial. The extension agencies should, therefore, educate the farmers to adopt precautionary measures like use

of kit to minimize these problems. They should also be educated about the adoption of integrated pest management.

2. The farmers should also be educated about the importance of integrated nutrient management in maintaining the soil health. So, there is a need to strengthen the extension facilities to educate farmers about the balanced use of chemical fertilizers and also to switch over to use of bio-fertilizers to restore and maintain soil health.

3. In addition, the government should encourage pesticide companies to distribute one of these protection equipments to farmers rather than promotional items such as cap and handbag which are not useful in protecting farmers from pesticide exposures during spraying. There is also a need to devise more comfortable kit which the farmers find convenient to use.

4. The study shows that the majority of the farmers in both areas are not adopting most of available strategies to maintain soil health, conserve water resource and to minimize the adverse impact of climate change. Therefore, the farmers need to be trained and educated in the use of such strategies.

5. Efforts should also be made to conserve available species of agro-biodiversity in-situ and ex-situ.

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APPENDICES

Appendix I. Inventory of agricultural biodiversity

English Name	Vernacular Name	Crop species
Food crops		
Barley	Jau	*Hordeum vulgare*
Finger millet	Koda	*Eleusine coracana*
Foxtail millets	Kauni	*Setaria italica*
Maize	Choli	*Zea mays*
Rice	Paddy	*Oryza sativa*
Wheat	Gehun	*Triticum aestivum*
Pulses		
Black gram	Mash	*Vigna mungo*
Cow pea	Rongi	*Vigna unguiculata*
Green gram	Moong	*Vigna radiata*
Kidney beans	Rajmash	*Phaseolus vulgaris*
Lentil	Masur	*Lens esculenta*
Soyabean	Bhatt	*Glysin max*
Vegetable crops		
Bean	Bean	*Vicia faba*
Brinjal	Began	*Solanum sp.*
Buckwheat	Oggal	*Fagopyrum esculentum*
Cabbage	Band gobhi	*Brassica oleracea var. capitata*
Capsicum	Shimla mirch	
Carrot	Gajar	*Daucus carota*
Cauliflower	Phool gobhi	*Brassica oleracea var. botrytis*
Chillies	Mirch	*Capsicum frutescens*
Cucumber	Khira	*Cucumis sativus*
Garlic	Lahsun	*Allium sativum*
Lady finger	Bhindi	
Mustard	Sarsoon	*Brassica compestris*
Onion	Pyaz	*Allium cepa*
Pea	Matar	*Pisum sativum*
Petha	Ghiya	*Benincasa hispida*
Potato	Alu	*Solanum tuberosum*
Radish	Muli	*Raphanus sativus*
Spinach	Palak	*Spinacea oleracea*
Spinach	Palak	*Spinacea oleracea*
Tomato	Tamater	*Lycopersicon esculentum*
Turmeric	Haldi	*Curcuma longa*
Turnip	Salgum	*Brassica rapa*
Fruit crops		
Almond	Badam	*Prunus amygdalus*
Apple	Seb	*Malus domestica*
Apricot	Khurmani	*Prunus armeniaca*
Cherry	Cherry	*Prunus avium*

Peach	Aaru	*Prunus persica*
Pear	Nashpati	*Pyrus communis*
Perimon	Japaniphal	*Diospyros kaki*
Pomgranate	Anar	*Punica granatum*
Walnut	Akhrot	*Juglans regia*
Silviculture Trees		
Ban oak	Bone	*Quercus leucotrichophora*
Deodar	Diar	*Cedrus deodara*
Fig	Fiagra	*Ficus palmata*
Kainth	Shegal	*Pyrus pashia*
Khirak	Khidak	*Celtis australis*
Mohru oak	Mohru	*Quercus dialatata*
Robinia	Robinia	*Robinia pseudocacia*

Appendix II. Soil pH, macro and micro-nutrients in Kullu

		Macro-nutrients			Micro-nutrients			
Code		Per cent	ppm		ppm			
	pH	OC/AN	P2O5	k2O	Mn	Zn	Cu	Fe
1	6.70	1.43	29.12	78.58	5.96	0.76	0.86	9.10
2	6.82	1.50	65.88	38.91	8.08	0.84	1.22	5.90
3	6.75	1.60	29.12	47.15	5.92	0.78	1.08	58.86
4	7.00	1.61	54.88	47.71	3.68	1.12	1.30	9.23
5	7.16	1.43	56.45	39.29	10.16	0.88	0.52	4.54
6	7.19	1.20	65.45	37.04	12.42	1.04	1.00	5.54
7	6.15	0.80	44.73	55.38	7.76	0.94	0.58	1.98
8	6.70	1.76	9.44	50.51	8.78	0.70	0.36	1.32
9	7.34	1.35	60.21	114.50	5.18	0.38	0.18	2.58
10	7.00	2.25	45.13	73.34	9.30	0.64	0.56	6.52
11	7.34	1.35	50.12	114.50	13.14	0.78	0.30	9.82
12	6.23	1.55	35.06	58.37	13.64	0.64	0.28	2.74
13	7.02	2.35	50.77	92.05	1.84	0.80	0.50	9.06
14	6.86	1.84	26.88	49.39	5.18	0.84	0.30	4.07
15	6.80	1.95	63.84	68.47	7.76	0.64	0.28	2.96
16	7.28	1.85	64.47	47.15	12.42	0.64	0.56	1.96
17	6.81	2.18	8.96	51.64	8.08	0.78	0.18	0.52
18	6.88	2.10	70.13	38.76	10.16	0.68	0.36	4.89
19	6.88	2.10	63.14	0.13	5.96	0.70	0.58	3.50
20	7.16	1.30	17.91	73.34	5.18	0.94	1.00	0.96
21	6.79	0.15	7.92	51.64	1.25	1.04	0.56	1.06
22	5.68	1.88	34.11	55.00	7.76	0.88	0.62	1.51
23	7.22	1.73	51.52	37.60	8.76	0.94	0.58	3.69
24	5.87	2.20	18.17	32.18	5.18	0.70	0.36	3.64
25	6.71	1.90	11.25	51.64	9.30	0.38	0.18	6.52
26	5.42	1.85	24.93	50.89	13.14	0.64	0.56	9.82
27	5.95	1.65	41.25	22.45	2.64	0.78	0.30	2.74
28	6.58	1.55	2.24	81.57	3.84	0.80	0.28	9.06
29	7.02	1.35	45.12	61.74	5.18	0.64	0.50	5.90
30	7.22	2.29	40.16	43.78	7.76	0.64	0.30	8.83
31	7.13	1.50	35.16	62.86	5.96	0.78	0.30	9.34
32	6.77	1.60	85.99	56.13	12.42	0.68	0.28	9.44
33	7.11	1.30	30.12	35.24	8.08	0.70	0.56	4.22
34	6.73	2.25	15.98	79.70	10.16	0.94	0.18	9.06
35	6.56	1.80	61.03	83.07	5.96	1.04	0.36	7.10
36	7.22	1.95	40.58	75.21	5.18	0.88	0.58	4.56
37	6.90	1.43	20.87	11.33	1.08	0.68	1.00	4.56
38	7.85	1.80	78.62	38.17	8.68	1.12	0.56	5.54
39	6.95	1.95	80.23	50.89	5.96	0.78	0.62	1.98
40	5.57	1.65	40.21	35.92	8.78	0.78	0.85	1.16

41	7.10	1.73	70.13	52.76	5.18	0.78	0.56	2.70
42	6.89	1.65	43.12	42.66	8.30	0.70	0.96	0.03
43	6.56	1.80	48.13	35.92	3.13	0.54	1.22	1.44
44	6.03	2.10	38.42	33.68	3.07	0.49	0.52	7.99
45	5.81	1.80	25.38	26.19	5.96	0.36	0.64	5.82
46	6.29	2.03	35.95	75.21	5.18	0.36	0.76	0.96
47	6.60	1.80	35.84	0.27	8.08	0.25	0.53	5.16
48	6.06	1.80	10.24	31.43	7.76	0.47	1.02	1.37
49	6.53	2.10	38.45	35.92	8.76	0.32	0.38	2.16
50	6.80	0.75	45.73	0.09	5.18	0.48	0.26	4.07
51	6.95	0.68	60.11	44.90	9.30	0.34	0.27	2.96
52	6.06	1.80	10.24	31.43	13.14	0.79	0.30	1.96
53	6.80	0.75	45.78	0.09	13.64	0.49	0.67	5.90
54	6.53	2.10	38.45	35.92	3.84	0.57	0.46	8.83
55	6.66	1.35	67.20	47.00	7.76	0.76	1.36	9.44
56	6.61	1.80	2.24	45.00	5.96	0.56	0.80	9.06
57	6.85	2.10	33.60	90.00	12.42	0.52	0.53	7.10
58	7.32	2.10	33.60	74.00	8.08	0.42	0.70	4.56
59	6.13	1.85	33.94	24.70	10.16	0.42	1.41	5.54
60	6.78	1.45	55.75	32.99	2.56	0.36	0.82	1.98
61	6.60	1.60	59.13	64.36	2.96	0.34	0.70	1.32
62	6.35	1.50	33.56	6.74	5.96	0.20	1.06	12.77
63	6.98	1.65	45.13	0.20	8.08	0.30	1.02	10.87
64	6.35	1.50	33.56	6.74	8.68	0.16	0.62	9.45
65	6.48	1.80	50.14	53.88	5.96	0.64	0.71	10.43
66	7.31	2.03	52.14	48.27	10.16	0.46	0.73	4.68
67	6.05	1.35	38.14	65.11	12.42	0.43	0.76	3.50
68	6.85	2.10	33.60	90.00	7.76	0.45	0.62	3.27
69	7.34	1.50	24.64	101.00	8.78	0.75	0.96	0.96
70	7.10	1.15	45.75	30.75	8.30	1.12	0.36	1.37
71	5.83	1.85	37.25	49.39	3.13	0.68	0.33	2.16
72	7.04	0.90	26.88	51.64	0.62	0.88	0.28	4.07
73	5.35	2.10	35.84	94.29	3.08	0.94	0.30	1.96
74	6.64	0.75	29.12	52.76	3.84	0.70	0.28	0.52
75	6.56	1.35	73.15	53.88	0.62	0.38	0.56	4.89
76	6.91	1.30	36.59	86.06	5.96	0.84	0.18	3.50
77	7.04	0.90	26.88	51.64	8.08	0.64	0.36	1.51
78	7.30	2.03	42.56	29.19	5.92	0.64	0.58	3.69
79	7.04	0.90	26.88	51.64	3.68	0.78	0.58	3.64
80	6.70	1.58	25.76	28.06	5.96	0.64	0.36	6.52
81	6.98	1.39	45.78	26.00	10.16	0.78	0.18	9.45
82	6.85	2.10	33.60	90.00	12.42	0.64	0.56	10.43
83	7.23	1.70	25.12	86.00	7.76	0.80	0.30	4.68
84	5.66	1.80	20.13	47.15	8.78	0.80	1.00	1.32

85	5.35	2.10	35.84	94.29	5.18	0.84	0.56	2.58
86	7.04	0.90	26.88	51.64	9.30	0.76	0.62	6.52
87	6.61	1.80	34.16	55.50	13.14	0.84	0.58	9.82
88	7.09	2.10	33.60	82.00	13.64	0.78	0.36	2.74
89	7.14	1.50	40.32	54.33	3.84	0.90	0.18	8.06
90	7.48	1.20	4.48	64.00	1.47	0.10	0.56	9.34
91	7.11	1.43	48.26	62.86	3.84	0.80	0.96	9.44
92	6.98	1.35	90.14	34.88	1.62	0.84	0.56	4.22
93	6.97	1.85	30.61	15.87	5.96	0.68	0.62	7.10
94	7.03	0.60	75.16	17.29	10.16	0.84	1.30	1.32
95	5.79	1.58	39.31	31.43	1.42	0.76	1.08	2.85
96	6.90	2.03	45.16	39.29	7.76	0.80	1.22	6.52
97	6.48	2.10	62.72	56.00	5.18	0.64	1.50	9.34
98	6.81	1.05	85.16	76.33	5.18	0.29	0.81	16.70
99	7.20	1.95	24.64	74.00	5.18	0.47	0.37	5.16
100	5.66	1.80	20.13	47.15	2.96	1.04	0.50	2.96

Appendix III. Soil pH, Macro and Micro-nutrients in Theog

		Macro-nutrients			Micro-nutrients			
Code		Per cent	ppm		ppm			
	pH	OC/AN	P2O5	k2O	Mn	Zn	Cu	Fe
1	6.24	1.35	17.92	43	2.66	0.62	1.37	3.66
2	6.18	1.8	11.2	53	3.28	0.58	1.27	8.26
3	6	2.1	24.64	162	0.35	0.69	0.91	8.96
4	6	2.4	15.68	47	0.77	0.79	2.56	9.28
5	7.05	2.25	4.48	74	0.06	0.42	1.23	2.01
6	6.96	2.7	4.48	101	2.38	0.44	0.05	6.81
7	6.18	1.8	11.2	53	2.66	0.62	1.37	3.66
8	5.94	2.75	45.78	45	0.79	0.42	2.2	14.45
9	6.01	2.55	40.23	22	3.81	0.25	0.63	16.46
10	6.87	2.7	89.6	43	5.86	0.05	1.17	22.87
11	6.61	2.85	78.23	79	1.86	0.3	0.08	9.8
12	7.39	2.15	45.63	51	3.08	0.95	0.86	12.8
13	6.59	2.7	78.53	224	3.22	0.36	1.16	7.91
14	5.94	1.95	56.23	31	2.05	0.97	2.24	17.69
15	6.77	1.65	45.86	22	1.31	0.45	0.72	13.34
16	6.22	2.85	86.32	27	3.6	0.49	1.3	13.03
17	6.36	2.7	85.23	27	4.44	0.43	0.75	0.31
18	6.2	2.1	45.36	45	3.44	0.38	0.69	1.69
19	6.67	2.55	87.23	45	3.97	0.76	0.27	7.38
20	6.8	2.1	42.36	85	2.8	0.06	0.1	6.16
21	6.22	2.25	65.21	76	6.23	0.1	0.66	6.77
22	6.67	2.55	67.52	45	2.05	0.97	2.24	17.69
23	5.24	2.7	61.28	22	1.6	0.9	0.41	4.93
24	6.02	2.4	74.86	27	2.28	1.36	1.09	6.16
25	6.26	2.4	72.36	81	5.95	0.11	0.5	1.72
26	6.86	2.4	53.6	58	3	0.16	0.39	4.91
27	6.57	2.7	89.6	27	5.42	0.83	0.5	0.68
28	6.2	2.85	15.68	96	3.01	0.05	1.01	4.56
29	6.09	2.85	15.68	90	2.24	0.57	1.25	7.64
30	6.39	2.7	24.64	70	1.7	0.56	1.91	10.49
31	5.38	0.45	8.96	96	0.48	0.93	1.75	6.17
32	6.13	1.8	24.64	81	4.54	0.24	0.29	5.4
33	5.62	1.65	45.23	49	1.1	0.09	0.1	1.95
34	5.73	2.1	45.78	43	1.89	0.33	0.29	5.29
35	5.82	2.1	40.12	92	4.14	0.13	0.41	6.86
36	6	0.6	87.36	49	1.42	0.92	0.27	3.89
37	6.07	2.1	35.23	90	0.53	0.43	0.05	3.41
38	6.3	1.05	80.64	51	2.7	0.61	0.24	4.68
39	6.11	1.95	98.56	119	4.43	0.5	0.24	6.49
40	5.76	2.1	60.48	60	4.7	0.35	0.16	7.47

41	5.92	2.55	27.23	56	2.03	0.24	0.18	4.72
42	5.97	1.65	29.63	6	1.95	0.19	0.27	3.75
43	5.98	1.95	60.48	51	1.97	0.19	0.24	4.32
44	6.33	2.75	74.23	114	1.02	0.49	0.4	2.48
45	6.55	1.35	78.48	105	0.31	0.42	0.21	0.92
46	7.04	2.4	87.36	166	0.06	1.09	0.4	1.02
47	6.57	2.4	61.23	123	1.35	0.77	0.8	12.12
48	6.36	1.5	76.16	79	0.38	1.02	0.4	0.92
49	6.87	2.85	24.64	103	0.02	0.26	0.68	0.72
50	6.29	2.4	8.96	56	2.15	0.28	1.42	6.29
51	6.28	1.95	4.48	72	1.86	0.25	1.34	10.56
52	7.24	1.5	4.48	74	0.02	0.33	1.02	2.47
53	6.37	2.1	4.48	51	0.44	0.17	1.09	0.17
54	6.5	2.75	8.96	60	0.24	0.16	0.72	2.82
55	6.34	0.75	69.63	51	3.44	0.38	0.69	1.69
56	6.48	2.35	65.23	62	3.97	0.76	0.27	7.38
57	7.06	2.55	37.23	159	2.8	0.06	0.1	6.16
58	6.34	2.55	76.16	40	0.77	0.79	2.56	9.28
59	6.17	1.05	71.68	38	0.06	0.42	1.23	2.01
60	6.57	1.65	67.2	70	1.24	0.15	0.97	0.17
61	6.09	1.95	123.2	45	2.15	0.28	1.42	6.29
62	5.48	1.05	76.16	49	1.6	0.03	0.11	0.96
63	5.67	0.45	71.68	49	2.15	0.17	0.18	5.18
64	5.81	0.15	69.44	58	2.36	0.17	0.24	3.29
65	5.8	0.6	76.16	62	2.54	0.07	0.28	1.35
66	5.81	0.6	89.63	29	0.86	0.17	0.06	0.08
67	5.58	2.15	85.23	38	0.5	0.61	0.34	4.77
68	5.91	1.2	87.36	51	4.85	0.39	0.16	3.32
69	6.56	2.55	45.86	27	1.97	0.51	0.8	16.03
70	6.07	1.8	8.96	76	0.66	0.24	0.68	4.05
71	6.3	2.1	15.68	81	2.63	0.2	0.25	0.44
72	5.79	1.95	24.64	43	1.7	0.33	3.46	17.45
73	6.4	2.1	78 .88	114	3.74	0.13	0.33	1.13
74	5.34	1.8	34.86	53	3.54	0.64	1.32	16.72
5	6.04	2.1	85.56	60	1.45	0.38	5.17	16.12
	5.99	1.65	45.23	36	2.7	0.63	1.12	17.16
	5.56	2.1	47.23	31	4.41	0.25	1.53	13.34
	6.61	2.85	58.23	79	2.05	0.97	2.24	17.69
	7.03	2.1	45.23	90	1.26	1.03	0.27	2.14
	6.31	2.1	60.23	43	6.03	0.22	0.47	5.74
	6.27	3	64.23	85	2.92	0.09	0.43	3.26
	6.75	2.85	75.23	87	4.46	0.57	1.02	1.73
	6.15	3	65.23	67	4.48	0.74	1.12	2.93
	5.62	2.1	8.96	38	1.64	0.6	1.39	5.03

85	5.74	1.8	15.68	72	1.04	0.22	0.82	4.05
86	5.84	0.4	11.2	40	0.1	0.37	1.58	4.15
87	5.93	1.95	15.68	70	3.73	0.69	1.22	7.22
88	5.68	2.4	8.96	110	0.83	0.28	1.18	3.95
89	6.04	2.1	24.64	53	0.15	0.29	0.7	0.65
90	5.14	1.95	65.23	34	1.27	0.15	0.12	3.08
91	5.73	1.5	49.28	36	3.93	0.87	0.52	11.13
92	5.8	2.55	45.23	119	3.77	0.58	0.29	6.57
93	6.79	2.7	24.64	96	1.47	0.28	0.91	2.87
94	6.36	2.85	4.48	58	0.19	0.23	0.99	1.92
95	6.23	2.85	15.68	51	2.85	0.42	1.8	2.78
96	6.72	2.1	15.68	53	0.95	0.62	1.08	0.55
97	6.55	1.2	42.23	114	4.54	0.24	0.29	5.4
98	6.17	1.95	76.16	47	0.35	0.69	0.91	8.96
99	6.48	1.65	98.56	14	1.97	0.51	0.8	16.03
100	6.17	2.25	28.36	49	1.24	0.15	0.97	0.17

Appendix IV. Age and BMI of Kullu and Theog farmers

	Kullu		Theog	
Code	Age	BMI	Age	BMI
1	51	17.08	49	14.01
2	61	17.26	37	16.13
3	33	17.79	52	16.91
4	34	17.79	43	17.08
5	26	17.79	41	17.08
6	27	17.79	45	17.08
7	34	17.98	47	17.08
8	28	18.15	41	17.71
9	60	18.34	51	17.79
10	58	18.65	67	17.79
11	18	18.86	44	17.79
12	20	18.92	31	17.91
13	27	18.92	42	17.94
14	51	18.95	53	17.94
15	30	18.95	46	17.94
16	45	19.08	46	18.15
17	55	19.14	25	18.23
18	31	19.30	49	18.76
19	33	19.57	46	18.76
20	41	19.68	50	18.86
21	38	19.68	49	18.99
22	35	19.68	53	19.06
23	64	19.68	50	19.11
24	25	19.81	28	19.14
25	28	19.81	45	19.14
26	26	19.99	46	19.38
27	38	20.06	44	19.38
28	48	20.06	40	19.43
29	50	20.16	49	19.53
30	28	20.16	60	19.61
31	45	20.16	31	19.68
32	27	20.43	49	19.68
33	50	20.54	60	20.06
34	55	20.56	31	20.18
35	38	20.70	40	20.28
36	24	20.81	40	20.28
37	40	20.81	32	20.43
38	45	20.81	29	20.43
39	35	20.81	63	20.43
40	40	20.81	35	20.43
41	32	20.81	43	20.43

42	55	20.91	31	20.51
43	45	20.97	37	20.70
44	27	21.06	52	20.70
45	34	21.06	38	20.81
46	41	21.35	52	20.81
47	37	21.35	62	20.81
48	32	21.35	40	20.91
49	33	21.37	52	21.09
50	47	21.41	68	21.35
51	52	21.48	19	21.35
52	42	21.53	25	21.35
53	39	21.53	30	21.48
54	27	21.57	42	21.51
55	34	21.57	23	21.57
56	29	21.57	27	21.65
57	35	21.57	40	21.96
58	30	21.65	52	21.96
59	25	21.75	30	21.96
60	51	21.79	34	22.01
61	32	21.79	32	22.01
62	43	22.01	35	22.01
63	36	22.12	33	22.06
64	24	22.14	22	22.10
65	38	22.14	24	22.18
66	63	22.39	42	22.44
67	62	22.58	37	22.71
68	24	22.71	39	22.71
69	49	22.77	23	22.82
70	41	23.08	27	23.11
71	65	23.11	40	23.13
72	59	23.13	55	23.13
73	75	23.13	41	23.13
74	70	23.13	54	23.46
75	53	23.13	49	23.82
76	31	23.43	26	23.82
77	48	23.46	43	23.82
78	48	23.46	46	23.84
79	50	23.48	46	23.85
80	32	23.68	28	24.21
81	25	23.68	43	24.91
82	32	24.17	46	24.91
83	35	24.19	38	24.91
84	45	24.21	37	24.95
85	40	24.58	56	25.12

86	40	24.58	49	25.62
87	45	24.95	60	25.68
88	50	24.95	55	25.73
89	55	25.68	56	26.17
90	60	25.73	43	26.17
91	38	25.83	25	26.21
92	40	25.83	28	26.48
93	26	25.83	52	27.25
94	35	26.15	30	27.42
95	27	26.26	45	27.51
96	55	26.56	28	27.56
97	49	26.56	30	27.62
98	38	26.69	50	28.00
99	39	30.25	26	29.35
100	27	18.34	35	31.10