SUMMARY

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.

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:

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

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

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

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

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 Kullu block used vermi-compost fertilizers and none of the farmers did so in 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 health to protect the livelihoods of multitudes of small and marginal farmers.

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.