Chapter – VIII

Summary of Major Findings, Policy Suggestions and Conclusion

8.1 Introduction

Agriculture is the backbone of the Indian economy. It provides employment and food for the majority of the masses. The contribution of agricultural sector to GDP was very low compared to other two sectors of the economy. The low production was attributed to inadequate agricultural infrastructure, faulty agricultural policies, unscientific farming and irrigation systems coupled with scanty and erratic rainfall. Given the low yields in agriculture, India has been making desperate efforts to enhance crop production in agriculture by adopting intensive cultivation or farming system which advocates judicious use of inputs such as high yielding varieties of seeds, chemical pesticides and fertilizers and other inputs. These inputs have significantly contributed towards crop production in order to ensure food security for the mounting Population.

In India nearly 25-30 percent of the yield losses occur owing to the presence of pests and diseases. To mitigate pests and diseases farmers need to apply pesticides in different stages of crop cultivation. Pesticides act as a protective umbrella for other inputs rather than yield enhancing input. Because, farmers investment on all other inputs will be futile if pesticides are not applied. India uses a low amount of pesticides per ha compared to other countries like USA and China. However, due to indiscriminate use of pesticides, unscientific handling practices and lack of awareness among the farming community has created environmental and human health problems in the recent years on the one hand, on the other it has significantly contributed in crop production.

Keeping this background the present study has made an attempt to investigate empirically the economic impact of pesticides application and assess the externalities associated with it, especially human health impact. The health problems due to the exposure to these chemicals may reduce the productivity of farmers apart from he/she incurring the health cost. The residue level of the chemicals in the agricultural commodities creates known and unknown health problems among the consumers of the produces. Consequently, these factors have lead to the welfare loss to the society
as a whole and are a social cost to the state. This study also focuses on the determinants of pesticides use by the sample farmers of the study area.

8.2 Major Findings of the Study:
The major findings of the study are as follows.

8.2.1 Findings based on Secondary Data
Major findings relating to Growth pattern of pesticide use is presented as follows,

8.2.1.1 Growth Pattern of Pesticide Application

- **Southern Region**

  The results of the Growth rate of pesticide consumption in southern region reveals that, declining trend of about 10.02 percent per annum in the period 1 (1990-1999) was recorded mainly due to the rationalization of subsidy on pesticides in the most of the pesticide consuming states of southern region. Whereas, consumption was stagnant at around 1.4 percent during period 2 (2000-2014) because of the increase in the area under pesticide consumption. Therefore, southern region as whole (1990-2014) experienced declining trend of 5.04 percent per annum. This shows that, highest declining trend was observed in period 1 compared to period 2 indicating that there is a gradual increase in the consumption of pesticides in the period 2.

- **Northern Region**

  The results observed that, pesticide application in northern region recorded negative growth of 2.3 percent per annum during 1990-99(period 1) on account of slowdown in the spiraling effects of green revolution. Whereas in period 2(2000-2014)northern region experienced stagnant growth at around 0.5 percent per annum mainly because of commercialization of agriculture and rice in the area under pesticide consumption. Consequently northern region as a whole there was slight increase in the consumption of pesticides by about 1.4 percent per annum. This shows that pesticide consumption is little more in the period 2 compared to period 1 of the whole period.
### All India Level

Trends and growth of pesticide use at the all India level (Includes southern and northern region) has been studied for the period 1990-2014. The results reveal that, in period 1 (1990-1999) India as a whole recorded declining trend of 4.3 percent per annum chiefly because drastic declining tendency observed in both the regions especially in southern region. As against this, in period 2 (2000-2014) India as a whole witnessed stagnant growth of 0.93 percent per annum exploring the fact that, there was steady growth as far as pesticide consumption is concerned. Hence, at the all India level for the whole period (1990-2014) witnessed a slight declining trend of 2.1 percent per annum.

#### 8.2.1.2 Trend and Growth of Pesticide Consumption in Four Southern States

- **Andhra Pradesh**
  
  As for as Andhra Pradesh was concerned it was found that, a negative growth of 9.2 percent per annum was recorded in period 1 (1990-99) and it was stagnant at around 2.8 percent in period 2 (2000-2014) because the state agricultural department attributes the decline in pesticide consumption to the adoption of Integrated Pest Management practices (IPM) and a growing awareness among farmers about the optimum use of agro-chemicals. As result Andhra Pradesh as a whole (1990-2014) witnessed declining trend of 6.9 percent per annum which is slightly below 9.2 percent and above 2.8 percent of the period 1 and period 2 respectively.

- **Tamil Nadu**
  
  The analysis of the Growth of pesticide consumption in case of Tamil Nadu represents that, a drastic declining trend to the tune of 19.5 percent per annum in the period 1 (1990-2014) was witnessed primarily because of the advocacy of the concept of economic threshold level and incorporation of Integrated Pest Management practices well. As against this in the period 2 (1999-2014) Tamil Nadu experienced stagnant growth at around 1.4 percent per annum due to the adoption of need based plant protection measures by the farmers, showing a rational increase in the consumption of pesticide in this period. Consequently
Tamil Nadu as a whole (2000-2014) noticed 3.7 percent downward trend in pesticide consumption.

- Karnataka

The study shows that, the trend and growth of pesticide consumption in Karnataka for the periods 1990-99 (period 1) and 2000-2014 (period 2) witnessed a declining trend of 4.9 percent and 3.7 percent per annum respectively. This tendency was due to the promotion of organic farming by the state government. However, Karnataka as a whole period (1990-2014) noticed the stagnant growth at around 0.41 percent per annum as for as pesticide consumption is concerned. From the above analysis it is evident that the consumption of pesticide is picking up gradually in Karnataka despite the advocacy of organic farming.

- Kerala

The analysis of Trends and growth of pesticide application in Kerala found that, in period 1 (1990-99) and period 2 (2000-2014) the growth was stagnant at around 1.8 and 0.5 percent per annum respectively. This explores the fact that, being a highly literate state of the country pesticide consumption has not come down to the desirable level. For the Kerala as a whole it is slightly declining at around 1.2 percent per annum, due to the awareness regarding negative externalities and adoption of IPM. This analysis regarding Kerala is different from other states of south because of its paradoxical situation. As the more educated the farmers are, more pesticides are applied.

8.2.2 Findings based on the Primary Data

Major findings regarding socio-economic background of respondents is presented as follows.

8.2.2.1 Socio Economic Background

Paddy

It is observed from socio-economic profile of sample respondents of paddy cultivation that, 42% of the respondents are in the age group of 31 to 40 years and 33% of them had primary education. 59% of the respondents are having 1 to 4 members in the family. 77% of the farmers possess less than 2 ha of land. 85 percent
were using cannel as a source of irrigation for cultivating paddy. Large number of farmers of about 33% belongs to backward caste followed by general category(27%). Significant proportion of farmers (76%) cultivate paddy during Kharif season. 62% of the farmers get information regarding pesticides to be used from Raitha Samparka Kendra. As for product identification is concerned 72% of the farmers identified chemicals by the product label on the container. As high as 89% of the farmers were aware of Integrated Pest Management Practices.

- **Cabbage**

  The analysis of socio-economic profile of sample respondents of cabbage cultivation shows that, 33% of the respondents are in the age group of 31 to 40 years and 34% of them had primary education. 48% of the respondents are having 1 to 4 members in the family. Nearly 82% of the farmers possess less than 2 ha of land. 92 percent were using drip irrigation as the source of irrigation for cultivating cabbage. More number of farmers of about 52% belongs to backward caste followed by general category (28%). Majority of the farmers (78%) cultivate cabbage during Rabhi season. About 49% of the farmers get information regarding pesticides to be used from pesticide dealers. Regarding product identification method, 93% of the farmers identified chemicals by the product label on the container. Nearly 63% of the farmers had no knowledge of Integrated Pest Management Practices.

- **Tobacco**

  The socio-economic characteristics of sample farmers of tobacco cultivation reveals that, 35% of the respondents are in the age group of 41 to 50 years and 17% of them had secondary education. 50% of the respondents are having 1 to 4 members in the family. About 69% of the farmers possess less than 2 ha of land. Nearly 79 percent were dependent on bore well as the main source of irrigation for tobacco cultivation. Majority of the farmers of about 41% belongs to backward category followed by general category (34%). Large number of the farmers (81%) cultivate Tobacco during Kharif season. Nearly 34% of the farmers get information regarding pesticides to be used from Raitha Samparka Kendra. With regard to product identification method, 57% of the farmers identified chemicals by the product label on the container. About 96% of the farmers were unaware of Integrated Pest Management Practices.
8.3 Economic impact of pesticide application

Major finding relating to economic impact of pesticide use on crop production are as follows,

8.3.1 Economics of crop cultivation

- **Paddy**

It was found from the result that, the share of pesticide expenditure was 3.2 percent and constituted small but important portion of the cost of cultivation. Among three categories of farmers namely small, medium and large farmers, the expenditure incurred by large farmers on pesticides observed to be greater at Rs2946. The large farmers due to better purchasing power and rational thinking applied higher doses of pesticides as opined by large farmers. Paddy farmers spent Rs 54,382 per hectare on paddy cultivation and realized Rs1, 08110 lakhs yielding the net profit of about Rs 53,727 which is a benefit to cost ratio of 1.99 (Benefit>cost). Benefit to cost ratio of small (1.98) and medium (1.99) farmers is in par with average benefit to cost ratio of 1.99. Whereas, large farmers benefit to cost ratio is slightly higher (2.14). Generation of greater profit by large farmers is owing to the operation of large scale production.

- **Tobacco**

The result reveals that, pesticide cost accounts for about 6.15 percent, slightly higher than paddy farmers. Among the categories of farmers the amount spent on the quantity of pesticide use was lowest for large farmers (Rs 4,936) compared to small (Rs 5,367) and medium farmers (Rs5, 099). Because as the larger the size of land holding, greater will be the application of pesticides but in a diminishing manner (economy of scale). As observed, total cost incurred for tobacco cultivation was greater than paddy at Rs. 85,318 per hectare. Total revenue accounts for Rs. 2.03122 lakhs fetching a net profit of Rs. 1.17,803 lakh per hectare and a benefit cost ratio of 2.38 (Benefit>cost). The benefit to cost ratio of small (2.37) and medium (2.38) farmers of is on par with the average benefit to cost ratio. Large farmers (Tobacco) benefit to cost ratio (2.59) is little higher compared to large paddy farmers due to economies of large scale in production.
• **Cabbage**

It was observed from the result that, unlike paddy and tobacco pesticide cost accounts for 24.57% and second largest component of cost of cultivation. As cabbage farmers opined that they need to apply pesticides desperately to mitigate diamond back moth pest. As a result, the amount of pesticides has substantially increased. However, revenue realized by cabbage farmers was Rs 1, 04145 lakhs yielding the net profit of Rs 81,399 and incurring the expenditure of Rs 22,745 as the total cost of cultivation per hectare. The benefit cost ratio of 4.58(Benefit> cost) makes cabbage the most profitable crop among the crops. The benefit to cost ratio of small (4.53) and medium (4.73) farmers was slightly below and little higher than the average. Whereas large farmers benefit to cost ratio (4.96) is much larger than paddy and tobacco farmers. This tendency was due to the working of economies of large scale in production.

8.3.2 **Role of pesticide use on output**

• **Paddy**

The results found that, fertilizers, irrigation and seeds significantly influenced the output of paddy. While the influence of fertilizers (positive co-efficient of 0.11) and seeds were positive and significant, the use of seeds was negative (negative co-efficient of -0.24) suggesting its overuse and statistically significant at 10% level. On the other hand there is lot of scope to increase the use of fertilizer (0.11) and irrigation (0.09) that is statistically significant at 5% level respectively. It is also found that use of large amount of pesticides (negative co-efficient of -0.003) and seed to the fixed land holding also have negative impact on the output. The results can be justified based on the law of variable proportion. Other variables in the model are found to be insignificant.

• **Tobacco**

It is revealed from the result that, Number of plants (negative co-efficient of -0.00097), fertilizer (-0.10), pesticide (-0.12), miscellaneous charge (-0.0044) and depreciation (-0.0087) had a negative sign indicating their overuse in the study area. While total labor cost (0.00013), bullock pair (0.0266), tractor (0.918), FYM (0.48) had positive coefficients. Factors that have positive sign indicating
high and significant impact on Tobacco production. Though these factors are over used on the fixed land holding, the resultant will be negative impact on the output. Hence, it is observed that none of the factors in the model are statistically significant.

- **Cabbage**

It is observed from the result that, only depreciation was the only significant variable (positive co-efficient of 0.059) and statistically significant at 1 percent level. Bullock power (-0.02), pesticides (-0.07), fertilizer (-0.02) and FYM (-0.03) had a negative sign suggesting its overuse while labor (0.04), tractor power(0.008) and seed(0.001) had positive coefficients. Otherwise, their overuse will not increase the produce beyond the particular level output. This can be justified based on the law of variable proportions. On the other hand there is ample scope to increase the use of seed. Bullock pair was overused as evidence by the fact that the coefficients were not significant.

- From the results it was revealed that, in paddy, cabbage and tobacco the mean level of use of these inputs were at their optimum levels. This is true of pesticides as well as the coefficient of pesticides was not significant and in some cases negative. The non-significant coefficients of pesticides in the production function indicate that pesticide use in paddy, tobacco and cabbage is used to the optimum level and any additional use will not increase the output of the respective crop. Further, pesticide in not an input like labor and fertilizer and it is used only as a input when there is a pest or disease problem and not otherwise. Thus, it is used to arrests the decline in production of crops and does not aid in the increase in the output after a certain limit.

**8.3.3 Technical Efficiency of Production of Crops**

- **Paddy**

The results of the frontier production function of paddy cultivation found that seed (negative coefficient of -0.28) and irrigation (positive coefficient of 0.11) were significant factors influencing production. The average technical efficiency of production across farms was observed to be 93 percent suggesting that compared to most efficient farmer the average farmer was 93 percent efficient. The average
yield of paddy is 33.18 quintals, if the farmers become technically efficient he should get yield of 36 quintals per hectare with the same level of input use, through the better management of resources.

- Tobacco

The frontier production function of tobacco cultivation reveals that, depreciation (positive coefficient of 0.05) was the sole significant variable and statistically significant at 10 percent. The average level of efficiency in tobacco cultivation was 97 percent suggesting that compared to most efficient farmer the average farmer was 97 percent efficient. Among the selected crops tobacco farmers emerged as the technically efficient compared to paddy and cabbage farmers. The gamma co-efficient of 0.73 indicates that 73% of error can attributed to inefficiency of production.

- Cabbage

Frontier production estimates for cabbage found that, labor (negative coefficient of -0.98) appears to be a significant factor having negative co-efficient. Since cabbage crop is profitable as evident from an earlier result that, all the inputs are used at their optimum levels. The average level of efficiency was 90% and the figure indicates a fairly uniform distribution across forms. The gamma co-efficient of 0.56 indicates that 56% of error can attributed to inefficiency.

8.4 Empirical analysis of Negative Externalities of Pesticide Use

- From the analysis it is revealed that, 39.6 percent of the sample respondents of the selected crops got information regarding pesticides to be used from Raitha Samparka Kendra followed by neighbors (28percent). While few cabbage (16.3 percent) and tobacco farmers (13.3 percent) from pesticide dealers and tobacco board respectively.

- It was observed from the result that, majority of the sample respondents (74 percent) identified chemicals by mere looking at the label on the pesticide container without understanding the color code present on the label. Only few farmers (24 percent) are well aware of the color code on the pesticide container.
From the result it was observed that, about 54.6 percent of paddy, Tobacco and cabbage farmers used slightly hazardous pesticides in the study area, while only few farmers (9.3 percent) used highly hazardous pesticides (especially monocrotophous) which are based on the degree of hazard to human beings classified by WHO. But the cause of worry was these pesticides are applied in an unscientific way in all the stages of pesticide application.

However it was observed that, large portion of the sample farmers (58 percent) used partial protective gear while pesticide spraying. Whereas, few farmers (5.6 percent) wore full protective clothing which is a correct practice. As high as (78 percent) of the sample farmers used wooden stick to mix the pesticides in water, while 8 percent of the farmers used bare hands there by exposing themselves to pesticide residues. About 41.3 percent of the total respondents used gator sprayer to spray pesticides.

About 44.6 percent of the sample farmers did not consider the time pesticide application and applied during afternoon. While, 41.6 percent and 11 percent of the sample farmers sprayed pesticides during mornings and evenings that is a correct practice. As much as 73 percent of the respondents applied pesticides along the wind direction, the correct way of application. While eleven percent against the wind direction, thereby exposing themselves to pesticides residues.

It was found that, large number of farmers (58.6 percent) threw empty pesticide containers after pesticide spraying in the field itself, while 1 percent sells it. This resulted in exposing farmers and their family members to accidental pesticide poisoning. Even bulk of the respondents (49.3 percent) opined that, washed water of pesticide sprayer was disposed in to the field killing microorganisms present in the soil.

Nearly 81.6 percent of the sample respondents of the selected crops sprayed pesticides more than the recommended level, of which large number of farmers (28.7 percent) applied anticipating higher incidence of pests. Whereas, 15.6 percent of the sample farmers applied less than the recommended level, of which most of them (36.3) reported that they are aware of the bad effects of pesticides.
• It was observed that most of the farmers (80.6 percent) of the three crops reported that they revisited the pesticides sprayed field on the same day to carryout routine farm activities. Consequently, exposed them to pesticide residues leading to health problems. While 16.6 percent of the farmers were well aware of the re-entry period.

• It was reported that, a large portion of the farmers (39.3 percent) smoke while spraying pesticides. Whereas, a few farmers (14.3 percent) inculcated the habit of alcohol consumption which is a dangerous practice. Regarding health problems faced by the farmers, headache dizziness (31 percent), vomiting (30.6 percent), were the major problems observed among the sample farmers. Whereas, few farmers (16 percent) of tobacco reported neurological problems.

• It was reported that, most of the sample farmers (74.6 percent) did not consult doctor for the health problems after pesticide spraying as they opined that, they would be alright after taking rest. While only few farmers (22 percent) consulted the doctor. On medical issues, as much as 45.6 percent of the sample respondents spent Rs 150, while 2.3 percent of the sample farmers spent Rs 400 and more as the medicine cost, because treatment is given free of cost in government PHCs.

• The average cost incurred by paddy, cabbage and tobacco farmers is Rs 155, Rs 240 and Rs 160 respectively.

• It was found that, about 54.6 percent of the sample farmers are not aware of IPM practices. Whereas, 42 percent farmers have better knowledge of it.

8.5 Impact of pesticide use on health of selected farmers

Paddy

• It has been found (Logistic Regression model) that, in paddy cultivation, probability of health damage was higher by an amount of 1.15 times for the farmers who applied red and yellow type of pesticides compared to farmers who used blue and green type of pesticides alone and the value of odds ratio is statistically significant at 5% level. In case of mixing of pesticides the probability of health damage was low at 0.41 times for the farmers who used
wooden stick compared to those who used bare hands and the value of odds ratio is statistically significant at 5% level.

- In case of not wearing protective gadgets like face masks, glows, shoes etc. by farmers to protect themselves from pesticide inhalation, witnessed greater probability of health damage with an odds ratio of 1.91 times compared to farmers who wore protective gear and the value of odds ratio is statistically significant at 5% level. Time of application of pesticides has shown slightly lower probability of health damage by an amount 0.04 times for the farmers who applied pesticides in the afternoon and the value of odds ratio is statistically significant at 1% level. Other variables of the model such as wind direction, smoking and education were found to be insignificant.

**Cabbage**

- It is observed from the result that, in case of cabbage all the variables in the model are statistically significant except the time of application. The probability of health damage was greater by an amount of 1.79 times for the farmers who have applied red and yellow category pesticides compared to the farmers who have applied blue and green. The value of odds ratio is statistically significant at 1% level. Regarding mixing of pesticides the probability of health damage is greater by an amount of 94.86 times for the farmers who used bare hands to mix the pesticides compared to the farmers who used wooden stick. The value of the odds ratio is statistically significant at 1% level.

- The probability of health damage is low by 0.51 times for the farmers who applied pesticides in the correct wind direction, compared to the farmers who have applied pesticides against the wind direction. The value of the odds ratio is statistically significant at 5% level. The probability of health damage is greater by an amount of 1.55 times for the farmers who are well educated compared to uneducated farmers. Thus the values of odds ratio are statistically significant at 5 percent level.

- With regard to the protective gadgets, the probability of health damage is higher by an amount of 1.38 times for the farmers who did not wear protective
gadgets like face masks, hand glows, shoes, etc. compared to other farmers who wore any protective gadgets. The odds ratio is statistically significant at 5 percent level. The probability of health damage is greater by an amount of 5.76 times for the farmers who practice the habit of smoking at the time of pesticide spraying in the field compared to the farmers who did not smoke and the value of odds ratio is statistically significant at 10 % level.

**Tobacco**

- The probability of health damage was low as the odds ratio of 0.84 indicated that tobacco farmers who applied pesticides of red and yellow category have a reduced impact on health and the odds ratio is statistically significant at 5 percent level. The probability of health damage is marginally higher by an amount of 1.01 times for the farmers who mix the pesticides with bare hands, compared to the farmers who used wooden stick and the value of odds ratio is statistically significant at 5 percent level.

- The probability of health damage was lesser by an amount of 0.81 times for the farmers who adopted precautionary measures by wearing face masks, shoes etc. compared to the farmers who did not wear protective clothing during spraying and the value of odds ratio is statistically significant at 5 percent level. The probability of health damage is as high as 1.24 times greater for the farmers who applied the pesticides against the wind direction which is not correct practice compared to the farmers who applied pesticides along the wind direction and the value of odds ratio is statistically significant at 10 percent level. Whereas, influences of education, smoking and time of application are not statistically significant.

**8.6 Factors determining pesticide use**

**Paddy**

- It was found that, education, availability of credit, expected rate of return, and age have negative impact on the pesticide use. Whereas, other factors such as use of hired labor, number of pests, number of diseases and quantity of crop raised have positive impact on the pesticide use. Factors that significantly influence pesticide use are, Education is negatively associated with pesticide use (negative co-efficient of -23) indicating educated farmers are aware of
excessive and indiscriminate use of pesticides that does not lead to increased production and statistically significant at 1% level.

- Another significant variable family labor (positive co-efficient of 10.14) it is found that, as the number family members increase, they tend to use more pesticides owing to higher scale of production and statistically significant at 10 percent level. The cost of pesticides significantly positively associated (positive co-efficient of 5.78) with pesticide use indicating that with increase in pesticide price, farmers also use more of the pesticide and statistically significant at 10 percent level.

**Tobacco**

- Factors determining pesticide use in tobacco cultivation, it is observed that, variables such as age, education, number of pests and diseases, availability of credit, expected rate of return and main produce have negatively associated with the use of pesticides. As against this, hired labor, family labor, pesticide price (solid), pesticide prize (liquid) have positive impact on pesticide use.

- Education has a negative relationship (negative co-efficient of -406.28) with the pesticide use, because educated farmers can better predict the nature and type of damages likely to be caused by the pest attack. Pesticide price is significantly directly related (positive co-efficient of 4.73) to the use of pesticides which indicates higher the price of pesticides, higher will be the application of pesticides. Therefore, education and pesticide price are statistically significant at 1 percent level.

**Cabbage**

- It was observed that, age, (negative co-efficient of -10.14) education (negative co-efficient of -68.72), hired labor (-57.34) and family labor (-3.57) have negative association with the pesticide used. Whereas, other factors of the model such as number of pests (116.02), diseases (151.08), availability of credit (112.73), expected rate of return (322.41), yield (146.50), have positive impact on pesticide use.

- Of the eleven factors, pesticide solid price and pesticide liquid price are statistically highly significant factors. This in other words, means higher
application of said factors keeping others constant, pesticide usage increases and vice-versa. Pesticide price (solid) (positive co-efficient of 6.70) and pesticide price (liquid) (positive co-efficient of 4.77) have significant influence on the use of pesticides, and are statistically significant at 5 percent level and 1 percent level respectively.
### 8.7 Hypotheses Testing

Hypothesis has been tested for the following three aspects of the selected crops namely paddy, tobacco and cabbage.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Hypotheses</th>
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<th>Results</th>
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<tr>
<td>1 To analyze the economic impact of pesticide application.</td>
<td>H0. The use of pesticides in crop cultivation or production in long run is economically viable.</td>
<td>Average, percentage and Benefit to cost ratio, multiple linear regression analysis by using the method of OLS, technical efficiency measured by stochastic frontier production function.</td>
<td>In the economics of paddy, tobacco and cabbage cultivation, pesticide cost appears to have low share of 3.19 percent, 4.43 percent and 24.57 percent of the total cost of cultivation respectively. Though pesticide constitute low share, it is very important portion of it. The benefit to cost received by our sample farmers of the said crops is 1.99, 2.38 and 4.58 respectively. This shows that sample respondents of the selected crops used lesser quantity of pesticides and received higher share of profits as evident in the result. This tendency of reduced use of pesticides was due to higher incidence of pests and pest resistance as reported by sample farmers of the respective crops. Another aspect is that, reducing pesticide use is estimated to have a small net effect on productivity because the productivity loss from reduced pest control would largely offset by the productivity gain from improved farmer health(Rola and Pingali 1993). Further, as evident in the present study large scale use of pesticides in cabbage cultivation has resulted in the development of resistance among pests. Diamond back moth a major pest in cabbage develops resistance to pesticides. To destroy this pest sample farmers desperately applied pesticide at higher doses with which yield could not be increased beyond particular limit. Hence, above result obtained in the study area, the hypothesis namely use of pesticides in production is not economically viable in the long run is accepted.</td>
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<tr>
<td>2 To study the negative externalities of pesticide use.</td>
<td>H0. Pesticide use results in Positive externalities</td>
<td>Average, percentage and Logistic regression model</td>
<td>Pesticide use in the study area resulted in the negative externalities. The result obtained in the study supports the above hypothesis. The result of health impact of pesticide use on the farmers of selected crops indicates that, probability of health damage was higher or greater by an amount of 1.15 times and 1.79 times for the farmers of paddy and cabbage cultivation respectively who used red and yellow</td>
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| 3 | To study the determinants of pesticide use in the study area. | H0. Education, pesticide price, and family labor are not the major determinants of the pesticide use.  
H1. Education, pesticide price, and family labor are the major determinants of the pesticide use. | Average and percentage linear multiple regression model  
Hypothesis education, pesticide cost, family labour are the significant factors influencing pesticide use. Education (with inverse relation with pesticide use) significantly influenced pesticide use in paddy and tobacco cultivation and not a significant factor in cabbage cultivation but negatively associated with pesticide use. The co-efficient of education is negative in paddy (-23.58), Tobacco (-40.28), and cabbage (-68.72), suggesting higher the level of education, lower will be the application of pesticides and vice-versa. pesticide price is significantly positively associated with pesticide use in all the three crops. The co-efficient of pesticide price is positive in paddy (5.78), Tobacco (4.73) and cabbage (5.73) which indicates that, with the increase in price, farmers will use more pesticides (to combat neck blast disease in paddy and diamond backmoth pest in cabbage cultivation) (Tijani, Sofoluwe 2012). This shows that, in paddy, cabbage and tobacco, pesticide price and quantity relationship is against to the law of demand. Another variable family labor significantly positively influenced pesticide use in paddy (10.04) that indicates, as the family members increase, they tend to use more pesticides owing to higher scale of production (Selvarajah and Thirucheluvam 2007). Hence, we can say that, results obtained in the study, the hypothesis namely, education, pesticide cost, and family labor are the significant factors influencing pesticide use is accepted. |
8.8. Suggestions for Policy Implications

The study makes few suggestions based on the observations made from the survey results that have policy implications.

- During period 1 (1990-99) there was drastic decline in pesticide application, while period 2 (2000-14) indicates a gradual increase. Therefore, it is suggested that, in order to ensure food security for the growing population, efficient use and growth of pesticides through improved practices need to be encouraged.

- In all the four southern states namely Andhra Pradesh, Kerala, Karnataka and Tamil Nadu pesticide application came down drastically during period 1 while in period 2 pesticide applications witnessed a gradual increase. Therefore it is recommended that area treated with pesticides should replace synthetic pesticides with the pesticides which are economical and eco-friendly.

- Labour cost emerged as the largest component of cost of cultivation in the study area for all the three crops. Therefore efforts should be made to rationalize labour cost and recommended balanced investment on other inputs, so that benefit to cost ratio be increased. Pesticide cost is the second largest component of cost of cultivating cabbage since it is inevitable to avoid pests and diseases. Therefore, Horticulture department need to supply nontoxic and cost-effective pesticides.

- For the production of paddy, tobacco, and cabbage, pesticide was used to the optimum level in the study areas and any additional use will not increase the output of the respective crop. Therefore, policy must aim at creating awareness among farmers about the menace of overuse which leads to high cost of production and reduced crop yield.

- Our analysis indicates that, farmers applied pesticides more than the recommended levels. However, a positive aspect is that, farmers in the study area applied some of the slightly hazardous pesticides. At the same time, micro level explorations show the use of pesticides which are banned or restricted for sale in the state like monochrotophos, phorate etc. are still being
used. So there is a need for effective policy interventions to regulate the use of pesticides in agriculture, while aiming at the food safety and security issues.

- There is a need for Shift from highly hazardous Category. Many of the selected farmers in the study area used either highly hazardous or moderately hazardous pesticides as classified by WHO. Studies/Research need to be carried out to shift from the hazardous pesticides to the least hazardous categories of pesticides.

- Micro level analysis suggests that, pesticide use is often unscientific at all levels of use in the study area. There is an urgent need to educate our farmers with regard to classification of pesticides on the basis of their toxicity, the use of protective covering on the body, correct method of mixing of pesticides in water, handling practices like time and direction of application, color identification method printed on the pesticide container etc…

- Farmers suffered many health problems in the study area. In order to provide good treatment, health infrastructure needs to be developed. Because of the lack of health facilities in the study area at government hospitals farmers often treated in OPD. As a result no case sheets are maintained in government hospitals regarding occupational pesticide poisoning cases. Therefore, measures should be taken to maintain case sheets, so that agricultural department and health department will be able to ascertain the number of occupational pesticide poisoning victims.

- Policy makers need to focus on Integrated Pest Management Practices (IPM), organic farming and alternative farming systems for sustainable agricultural development.

- The act and the insecticides rules 1971 and central insecticides board and other regulations need to be strictly enforced against any kind of violations like selling and using banned or substandard pesticides to avoid possible environment and human health effects. Furthermore, collective efforts are needed from all the stake holders in the light of food security.

- In our study two factors namely education and age of the farmers are negatively associated with the pesticide use. Therefore, it is suggested that
agricultural department make use of the services of farmers who are progressive, more educated and old-experienced farmers who have good farming experience can make all the difference in educating other farmers regarding excessive and unscientific pesticide handling practices.

- Farmers need to be educated regarding the importance of color code present on the container and their severity level. Farmers should be educated with regard to Crop wise and decease wise application of pesticides.

8.9 Conclusion:

Trends and growth rate of pesticide application recorded significant decline during period 1(1990-99).compared to period 2(2000-2014)in both southern and northern regions. But decline was more drastic in southern region. Therefore similar tendency was reflected in the country as a whole. As for as trend and growth of pesticide application among four southern states is concerned, Tamilnadu witnessed drastic decline in pesticide application during period 1(1990-99).Whereas, Kerala state, though negative growth is recorded, the rate of negative growth was very little exploring the fact that, being a highly literate state in the country pesticide application has not come down despite Endosulfan tragedy in kasargod. From this we can infer that at all India level that includes both southern and northern regions and among the four southern states growth pattern of pesticide consumption is showing a gradual increase especially during period II onwards. Economics of crop cultivation reveals that, labour appears to be the largest component of cost of cultivation in all the three crops namely paddy, tobacco and cabbage in the study area. The share of pesticide cost was lowest in paddy and highest in cabbage cultivation and realization of revenue from cabbage was much higher. Therefore, the benefit to cost ratio of cabbage farmers appears to be larger compared to the farmers of paddy and tobacco. This generation of larger profits is owing to the working of economies of large scale production.

Regression model was estimated to study the role of pesticides on output. The analysis shows that, labour and fertilizers were not significant variables affecting the output. This is true of pesticides as well, as the co-efficient of pesticides was not significant and in some cases negative. The non-significant co-efficient of pesticides in the production function indicate that, pesticide use in paddy, tobacco and cabbage
was used to the optimum level and any additional use will not increase the output of the respective crop. Technical efficiency was estimated for selected crops. In case of paddy average technical efficiency of production across farms was observed to be 93 percent and significant variables affecting production are seeds and irrigation. While average technical efficiency of tobacco was 97 percent and depreciation was the sole variable. In case of cabbage cultivation average level of efficiency was 90 percent and significant variable affecting productivity was labor. From this we can infer that tobacco farmers emerged as the most efficient farmers compared to paddy and cabbage farmers. In logistic regression for paddy all the variables are significant except education, smoking and wind direction which are non-significant. In cabbage except time of application all the variables in the model are significant. In tobacco, time of application, smoking and education are non-significant variables. In factors determining pesticide use, education and age of the farmers were negatively associated with the pesticide use, while pesticide cost is positively related with pesticide use in the study area.

Despite India uses low quantity of pesticides in agriculture, the externalities due to pesticide use have been reported high in most of the developing countries. It may be attributed to the level of awareness, handling and use pattern of pesticide. As it is evident from our study that trend and growth of pesticide consumption is showing a slightly declining and slightly increasing trend and farmers of selected crops were using slightly hazardous pesticides. This does not mean that pesticide use is positively contributing towards crop production and health of the farmers. Because intensive cultivation promotes high yielding verities of inputs like synthetic pesticides, fertilizers, etc. these inputs as expected increased the agricultural production and resulted in occupational health problems of farmers. These results are reflected in our study that says that as the sample farmers apply more and more variable inputs on the fixed land holding the output increases up to certain limit and diminishes with additional use of variable inputs. Furthermore unscientific and irrational application of pesticides has caused several health problems among sample farmers of the selected crops at the time of pesticide spraying.

Therefore in order to promote rational use of pesticide in agriculture government role is needed to stipulate certain educational qualification among distributors and retail sellers of pesticides, establishment of IPM units in each Taluks
to monitor crop pests on periodically. It is also needed that pesticide industry require to promote chemicals which are effective environment friendly to reduce negative externalities. It is also very important on the part of farmers to follow safety norms while pesticide handling practices. Hence, there is an urgent need for encouraging and promoting mixed farming, organic farming and alternative farming systems which are cost effective and environment friendly in the light of sustainable agricultural development (SAD).

8.10. Scope for further research

1. Research is needed regarding externalities of pesticide application in the areas environment, soil health, underground water etc.

2. Efforts are needed to conduct research on integrated pest management (IPM) practices and other sustainable agricultural system.

3. Research is required in pesticide legislation in India.

4. Research is needed in the area of pesticide exports in India