CHAPTER –V
SUMMERY AND CONCLUSION

The International Water Management Institute (IWMI) forecasts that by the year 2025, 33 per cent of India’s population will live under absolute water scarcity condition. Further the World Bank estimates that by the year 2025, one person in three, i.e, 3.25 billion people in 52 countries will live under conditions of water shortage. Water is mainly used for (i) domestic consumption, (ii) agricultural production (iii) irrigation and (iv) for industrial production. Competition among agriculture, industry and cities for limited supply of water is constraining the development efforts. The statistics on water use by different sectors in India reveals that 82 per cent of water is used for irrigation, 10 per cent for domestic purposes and 8 per cent for industrial activities. With the rise in population, the demand for water has been increasing on all fronts throughout the world. Agriculture has been the single largest user of water, especially in the developing countries. In the Indian context, the projections made by the National Commission for Integrated Water Resource Development Plan indicate that water requirements for the irrigation sector would rise by more than 50 per cent by 2050 when compared to the level in 2000. It was estimated that by 2050, India’s population would be between 1349 million and 1980 million (United Nations Report, 2010). In India the food grain availability is at present around 525 grams per capita per day, whereas the corresponding figures in China and USA are 980 grams and 2850 grams respectively. Assuming the same level of consumption, which although is supposed to rise with improvement in economy and resultant higher standard of living, the annual food grain requirement will be about 315 million tonnes. If small raise is made in per capita consumption to 650 grams, the food grain requirement will be about 390 million tonnes. Taking the projection of about 1800 million by 2050 AD as reasonable, it would require about 430 MT of good grains annually at the present level of consumption, (Ministry of Agriculture, 2010).

The population cannot be contained and the requirement of water may go up. It was also shown that for lower population estimate of 1350 million, the water requirement is only 973 km$^3$/ year well within the estimated utilizable water resource of 1122 km$^3$/year (surface water 690 km$^3$ + groundwater 423 km$^3$). Therefore it is necessary that a
significant national effort has to be devoted to limit the population growth and further India as a nation has to initiate action on all fronts for developing its water resources. The priority of action, however, must be for rain water harvesting and groundwater recharge. Hence watershed intervention technology has the added relevance to conserve the scarce water resources and sustain the cultivation of crops (Sreedhar et.al. 2007). All these factors warranted a judicious use of ground water which is essential for livelihood. In this context, watershed development is gaining momentum and the farmers adopt various watershed intervention technologies for their farm activities. Hence this study is an attempt to assess how the watershed intervention technology is carried out in selected blocks in Coimbatore district.

**Specific objectives of the study are:-**

1. To study the socio-economic background of the sample farm households.
2. To analyse the land use pattern of the sample farm households.
3. To assess the farm and off-farm impacts of watershed intervention technology.
4. To estimate the benefit-cost ratio.
5. To elicit the expectations and realisations of the farmers on the adoption of watershed intervention technology
6. To estimate the economic surplus accrued to the farmers with the adoption of watershed intervention technology and
7. To find out the constraints in the implementation of watershed intervention technology.

**HYPOTHESES**

The hypotheses tested are:-

1. The usage of watershed intervention technology has led to
   (i) an increase the groundwater discharge and irrigated area.
   (ii) an increase in irrigation and cropping intensity.
   (iii) change in cropping pattern.
   (iv) an increase in crop productivity index.
   (v) an increase in employment and in owning live stock.
   (vi) an increase in farm income and value of land and
   (vii) an increase in the benefit cost ratio.
2. With the adoption of watershed intervention technology, the change in producers’ surplus exceeded the change in consumers’ surplus.

For the study, Thondamuthur and Periyanaickenpalayam blocks in Coimbatore district in which groundwater was over exploited were selected. From these two blocks, based on multistage stratified sampling technique, farm households who satisfy the following criteria were selected; the chosen farm households must be adopting watershed intervention technology since 2008-09. As this is an impact assessment study, impact of watershed intervention technology on these farm households was assessed by making a ‘before’ and ‘after’ study; i.e.; before the adoption of watershed intervention technology in 2007-08 and after the adoption of watershed intervention technology in 2008-09. In Thondamuthur block 140 small farmers, 88 medium farmers and 22 large farmers were selected. In the Periyanaickenpalayam block, 148 small farmers, 50 medium farmers and 52 large farmers were selected. Hence from each block 250 farm households making a total of 500 farm households. Data collection was carried out by administering a pretested interview schedule to the sample farm households from July to December 2009. The quantitative tools used in the study were calculation of irrigation intensity, cropping intensity, Cobb-Douglas production function, crop productivity index, crop diversification index, modified entropy index, hedonic pricing analysis, benefit cost ratio, scaling technique and economic surplus model.

The summery of the major findings that emerged from the analysis are as follows:-

**General characteristics of the Farm Households**

- Community wise analysis reveals that both in the Thondamuthur and in the Periyanaickenpalayam blocks, MBCs constitute a major proportion with 45.60 and 50.80 per cents respectively, closely followed by BCs with 44 and 40.80 per cents respectively.
- The farm households are mostly headed by males, the percentages being 98.80 in the Thondamuthur block and 92.8 in the Periyanaickenpalayam block.
- The average size of a family in the Thondamuthur block and in the Periyanaickenpalayam block is three in each.
- Nuclear family system is practiced among 70 per cent of the farm households in the Thondamuthur and 75.60 per cent of the farm households in the Periyanaiickenpalayam blocks.
- The average age of the head of the farm households exceeds 55 years. The heads of the households had atleast primary level of education and are married.
- In both the blocks nearly 40 to 50 per cent of the head of the families had either primary or middle school education.

**Land use pattern**

- In the Thondamuthur block, on an average small farmers own 2.0176 hectares of land, medium farmers 6.4036 hectares of land and large farmers 11.2575 hectares of land. Among the land owned and used, orchards constitutes the major proportion across all the types of farmers (53.27 per cent) followed by arable land by 39.06 per cent of the farmers.

- In the Periyanaiickenpalayam block, on an average the farmers across all the groups own land in a larger measure compared to Thondamuthur block. The small, medium and large farmers on an average own 2.87, 6.45 and 12.86 hectares of land respectively. In Periyanaiickenpalayam block also, orchards constitutes a major proportion (58.12 per cent) followed by arable (34.11 per cent) and non-arable land (7.77 per cent).

**Type of Soil**

- About 98 per cent of the Thondamuthur block is covered by red soil and 97 per cent of the Periyanaiickenpalayam block is covered by black soil.

**Soil and water conservation**

- About 50 per cent of the gross cropped area in the Thondamuthur block and 38 per cent in the Periyanaiickenpalayam block are treated with summer ploughing.

- Per unit cost of summer ploughing varies from `1,266 in Periyanaiickenpalayam block to `1,409 in the Thondamuthur block.

- The other two measures such as contour bunding and land leveling are carried out in less than 25 per cent of the gross cropped area in the study blocks.
• Less than 10 per cent of the gross cropped area in the Thondamuthur block is treated with the land levelling measure. In the Periyanaiickenpalayam block about 14 to 24 per cent of the gross cropped area is treated with land levelling measure.

• On an average the total investment made on soil and moisture conservation measures worked out to be ` 4,658 in Thondamuthur block and ` 3,445 in Periyanaiickenpalayam block.

Watershed technology

• Different types of watershed conservation measures are carried out in the study area.

• ‘Farm ponds’ and ‘percolation ponds’ are the two main watershed technologies followed in both the study blocks. In the Thondamuthur block, about 76 per cent of the farmers have farm ponds. Percolation ponds are used extensively by the large farmers (95.4 per cent), closely followed by the medium farmers (72.7 per cent). About 36 per cent of the small farmers have percolation ponds. Renovation of tank was carried out by 7 per cent of the farmers in the Thondamuthur block. Rejuvenation of wells was carried out by only 2 per cent of the farmers.

• In the Periyanaiickenpalayam block only 4 per cent of the medium farmers do not have farm ponds. Percolation ponds are constructed by 42.3 per cent of the large farmers. Renovation of tanks was carried out by 20 per cent of the farmers in the Periyanaiickenpalayam block. None of the farmers in the Periyanaiickenpalayam block have rejuvenated their wells.

• The average cost incurred in the construction of farm ponds varied from ` 2,537 for the small farmers in the Thondamuthur block to ` 5,728 for the large farmers in the Periyanaiickenpalayam block.

• The average cost of construction of percolation ponds varied from ` 2,762 among the small farmers in the Thondamuthur block to ` 5,471 among the large farmers in the same block.

• The investment made on renovation of tanks and rejuvenation of wells ranged from ` 5,000 to ` 7,000. This increase in cost explains the reason for the farmers not going in a large percentage towards these two watershed technologies.
Distance from the cultivable land

- All watershed intervention technologies were constructed within 20 meters from the cultivable lands.

Problems

- In the Thondamuthur block about 86 per cent of the farmers stated ‘inadequate size of land holding’ as the major problem. ‘Outdated technology ‘was stated as a problem by about 70 percent of the medium farmers.

- In the Periyanaiickenpalayam block for 90 per cent of the farmers inadequate land holding was the major problem in carrying out the watershed intervention technology. For 62 per cent of the large farmers, apart from ‘size of land holding ‘, ‘lack of technical support’ was another problem.

Water level in the Wells

- The average well water level in the Thondamuthur block was 36.96 feet, much lesser than the average water level in the Periyanaiickenpalayam block (50.97 feet). During the summer period in both the blocks, there is no recharge in the water level in both the wells and the bore wells.

Source of groundwater discharge

- Among the various sources through which groundwater was discharged in Thondamuthur block, bore well submersible was used in large numbers.

- In Periyanaiickenpalayam also, bore well submersible motor (181) was used in large number followed by open well motors (108), compressors (84), electric motors (74) and oil engine.

Impact on land use pattern

- In the Thondamuthur block, the percentage of orchards in the total cultivable land has increased from 49.30 in 2007-2008 to 53.27 in 2008-2009. In the Periyanaiickenpalayam block, the respective increase was from 54.44 percentages to 58.12 percentages.

- The proportion of dry land under cultivation has declined from 11.51 per cent to 7.67 per cent in the Thondamuthur block and from 11.43 per cent to 7.77 per cent in the Periyanaiickenpalayam block.
Impact on water level in the wells

- On an average in the Thondamuthur block the water level in the wells before the use of watershed intervention technology was 28.33 feet and in the bore wells 76.10 feet in 2007-08. This increased to 43.49 and 100.78 feet respectively after the use of watershed intervention technology in 2008-09.
- In the Periyanaickenpalayam block before the watershed intervention technology in 2007-08 the water level in wells and bore wells were 32.58 feet and 100.88 feet respectively. This rose to 47.57 and 122.82 feet respectively in 2008-09.
- On an average, the rise in the well and bore well water levels in the Thondamuthur block were 15.16 feet and 24.08 feet respectively after the watershed intervention technology.
- These rises in the Periyanaickenpalayam block were 14.99 and 21.94 feet respectively. Ground water level has increased in both the blocks after the usage of watershed intervention technology.

Impact on groundwater discharge

- On an average the running hours of the bore well submersible motor was about 6.48 hours in 2008-09 increasing from 5.54 hours in 2007-08 in Thondamuthur block. In Periyanaickenpalayam block this increase was from 5.5 hours in 2007-08 to 6.46 hours in 2008-09.
- In Thondamuthur block bore well compressor motors, electric motors and open well motors had the running hours of 5.74 hours, 3.95 hours and 3.23 hours respectively in 2008-09, increasing from 4.77 hours, 3.09 hours and 2.54 hours in 2007-08 respectively. In Periyanaickenpalayam block, these running hours were 5.83, 3.65 and 3.3 hours in 2008-09, increasing from 4.94 hours 2.91 hours and 2.75 hours in 2007-08 respectively.
- On an average, area irrigated per day through the bore well compressor in Thondamuthur block was 1.7 hectares and in Periyanaickenpalayam block 1.5 hectares in 2008-09 increasing from 1.53 hectares in Thondamuthur block and from 1.33 hectares in Periyanaickenpalayam block in the year 2007-08.
- The percentage change in the irrigated area through these sources was calculated as 16.34 in Thondamuthur and 12.78 in Periyanaickenpalayam blocks.
Impact on irrigation

- The average net area sown and gross irrigated area during 2007-08 in the Thondamuthur blocks were 3.66 and 3.98 hectares respectively. This had increased to 6.20 and 7.28 hectares respectively in 2008-09. The percentage increases in the net area sown and gross irrigated area were around 69.39 and 82.91 respectively.
- In the Periyanaiickenpalayam block, the average net area sown and gross irrigated areas in 2007-08 were 4.58 and 5.16 hectares respectively. This had increased to 6.53 and 7.88 hectares respectively in 2008-09.

Impact on cropping intensity

- In the Thondamuthur block, during 2007-08, the gross cropped area per farm household was 4.38 hectares and net area sown was 3.66 hectares. These two had increased to 7.64 and 6.20 hectares respectively in 2008-09. This increase was significant. The percentage changes in gross and net area sown were 74.43 and 69.39 respectively.
- In the Periyanaiickenpalayam block, a different picture prevailed. The gross cropped area and net area sown in 2007-08 were 5.53 and 4.58 hectares respectively. These increased to 8.14 and 6.53 hectares respectively in 2008-09. The increase in the net area sown (56.13 per cent) and gross cropped area (71.60 per cent) in the post watershed conservation activity was highly realized among the small farmers.
- In the Thondamuthur block, highest cropping intensity was realized by the medium farmers. In the Periyanaiickenpalayam block, small farmers recorded the highest cropping intensity.

Impact on cropping pattern

- In the Thondamuthur block the total cultivable area had increased from 933.21 hectares in 2007-08 to 1385.22 hectares in 2008-09. This reveals the percentage increase of 48.44 under cultivable area. After the watershed intervention technology the farmers started growing pulses and oilseeds. Cereals which occupied only 14.16 hectares of land in 2007-08 had occupied 85.38 hectares of land in 2008-09. There was an increase in the cultivated area under different crops in 2008-09 excepting for cash crops. This is an indication for the improvement of water retention capacity and quality of soil as vegetables need more water and better soil than other crops.
• As in the Thondamuthur block, in the Periyanaickenpalayam block also the farmers started cultivating pulses and oilseeds only after the application of watershed intervention technology in the year 2008-09. In the Periyanaickenpalayam block the total area under cultivation among the different crops had increased from 1146.08 hectares in 2007-08 to 1590.18 hectares in 2008-09 (38.75 per cent).

• The analysis thus reveals that after the usage of watershed intervention technology there is a shift to agro horticulture.

Impact on crop production

• In the Thondamuthur block, the farmers realized the highest monetary value from ₹95,60,450 coconut. This was the case across the different farmer groups. Next to coconut the highest monetary value of output was realized from the cultivation of banana ₹5,29,550 followed by paddy ₹34,67,500 and onion ₹24,02,750. After the application of watershed intervention technology in 2008-09 an increase in production was realized for all crops other than onion.

• In the Periyanaickenpalayam block the monetary value of coconut was the highest ₹1,45,62,900 in the year 2007-08 and also in 2008-09 ₹1,78,19,700. Next to it the cultivation of banana produced the highest output of ₹61,35,700 in 2007-08 and ₹79,50,100 in 2008-09. This was followed by flowers and vegetables and paddy.

• The percentage change in the production of the different crops in both the blocks showed an Increase after the watershed intervention technology.

Cobb Douglas production function

Cob-Douglas production function was estimated with the value of the agricultural output of the farmer as the dependent variable and bullock and machinery cost incurred; wages paid to the laborers and input used in agriculture and gross cropped area as the explanatory variables.

• All the farmer groups incurred diminishing returns to scale in the Thondamuthur and Periyanaickenpalayam blocks. The sum of the elasticity co-efficients of the parameter estimated was less than one for all the farmers. After the initiation of the watershed intervention technology the ‘returns to scale’ had increased for all the farmers from 0.808 to 0.857 in Thondamuthur block and from 0.822 to 0.836 in the Periyanaikenpalayam block.
• The positive co-efficient of the area brings out the fact that more area can be brought under cultivation or with optimum utilization of the area under cultivation output could be increased.

• The negative values of the co-efficient for machineries among the medium and large farmers in 2007-08 revealed the fuller utilization of the resources. Similarly, the negative co-efficients of labour wages for the small farmers in 2008-09 reveals the over exploitation of these resources in agricultural production.

• After the implementation of watershed intervention technology, the agricultural production in both the blocks across the farmer groups had shown an increasing growth. This is high in the Thondamuthur block, the percentage increase being 73.67, compared to the average annual increase of 54.51 per cent in the Periyanaiickenpalayam block. The large farmers in the Thondamuthur block had shown a significant increase of 84.86 per cent closely followed by the small farmers with the percentage increase of 80.22. In the Periyanaiickenpalayam block, the small farmers reported the highest average annual increase of 63.43 per cent.

Impact on crop productivity

• In the Thondamuthur block the average yield had exceeded the potential yield for paddy for the three farmer groups, after watershed intervention technology in 2008-09. Similarly crop productivity index exceeded ‘one’ for banana for all the three types of farmers. For coconut, it exceeded ‘one’ in 2008-09 for small, medium and large farmers. For maize it was closer to ‘one’ for small and medium farmers and 0.86 for large farmers. For cash crops it exceeded ‘one’ for small farmers, 0.79 for large farmers and 0.64 for medium farmers. For fruits, flowers and vegetables it was 0.79 for small farmers, 0.74 for medium farmers and 0.17 for large farmers.

• In the Periyanaiickenpalayam block also the crop productivity index for paddy, banana, coconut, maize, cereals, pulses and oil seeds had exceeded ‘one’ among small, medium and large farmers in 2008-09. But in the case of fruits, flowers and vegetables, it shows a low level of crop productivity index for small, medium and large farmers with crop productivity index taking values 0.18, 0.21 and 0.20 respectively. The percentage increase in crop productivity level varies from minimum of 11.76 for fruits, flowers and vegetables to a maximum of 61.54 per cent for cereals.
It shows that the overall crop productivity index had increased from 0.79 to 1.07 in the Periyanaiickenpalayam block. In this block both for the small and medium farmers the percentage change was 36.98 and 35.53 and for large farmers it was 23.86 In the Periyanaiickenpalayam block the percentage change in crop productivity index was 35.44.

**Impact on crop diversification (Spatio-temporal analysis)**

- In the Thondamuthur block after the implementation of the watershed intervention technology the crop diversification index has marginally, increased for paddy, fruits, flowers and vegetables and pulses for all the farmers groups. The increase in crop diversification index during 2007-08 to 2008-09 was from 0.986 to 0.991 for paddy, 0.657 to 0.952 for fruits, flowers and vegetables and from 0.943 to 0.986 for pulse respectively. In the Periyanaiickenpalayam block the crop diversification index has increased for paddy from 0.980 in 2007-08 to 0.983 in 2008-09, for cash crops from 0.954 to 0.963 and for pulses 0.932 to 0.968 respectively. In the Thondamuthur block, for the small farmers Modified Entrophy Index changes from 0.661 in 2007-08 to 0.809 in 2008-09. For medium farmers the diversification index rose from 0.654 in 2007-08 to 0.845 in 2008-09. For large farmers it was from 0.762 in 2007-08 to 0.899 in 2008-09. The Thondamuthur block about 73 to 83 per cent of the agriculture land had been diversified.

- In the Periyanaiickenpalayam block Modified Entrophy Index had changed for large farmers from 0.629 in 2007-08 to 0.787 in 2008-09. For the medium farmers diversification changed from 0.653 in 2007-08 to 0.800 in 2008-09 and for small farmers it was from 0.724 in 2007-08 to 0.830 in 2008-09. In the Periyanaiickenpalayam block, about 70 to 78 per cent of the agriculture land had been diversified.

- In the Thondamuthur block medium, small and large farmers occupied the first, second and third positions in terms of crop diversification in the year 2008-09. The changes in average diversification indices for these farmers are 0.191, 0.148 and 0.137 respectively. In the Periyanaiickenpalayam block, large, medium and small farmers occupied the first, second and third positions in terms of the calculated MEI. The
changes in the average diversification indices are 0.158, 0.147 and 0.106 respectively for these farmers.

**Off-Farm impacts of watershed intervention technology**

**Impact on input usage**

- On an average bullock labour was used for about 25 pair days. Before the use of watershed intervention technology bullock labour was used only for preparatory cultivation and for harvesting. During 2008-09 it was used in inter cultivation also. The percentage change in the usage of bullock labour was significantly high among the different farmer groups the in Thondamuthur block.

- In the Periyanaiickenpalayam block, the usage of bullock labour was lower compared to the Thondamuthur block. The bullock labour was used for about 18.58 pair days per household in 2007-08 and for about 27.04 pair days per household in 2008-09. The usage of bullock labour thus has increased in 2008-09 in Periyanaiickenpalayam block also.

- On an average in the Thondamuthur block machine labour was used for about 9.68 hours per household during farm activities in 2007-08 and this increased to 15.55 hours in 2008-09.

- In the Periyanaiickenpalayam block also the percentage change in machine labour varied from 29.42 per cent for large farmers to 63.78 per cent for medium farmers and to 59.43 per cent for small farmers.

- After watershed intervention technology in both blocks bullock and machine laboures were used in intercultivation also.

- Taking all the farm house holds together in Thondamuthur block about 150 man days were used per farm house hold in farm activities. The same trend prevailed in Periyanaiickenpalayam block also.

- An increase in the employment generation after the use of watershed intervention technology in both the blocks.

**Impact on livestock**

- The entire farm households in the selected two blocks have cows and buffaloes. On an average each household has about 3 units of cows and buffaloes in Thondamuthur block and about 4 units in the Periyanaiickenpalayam block before the watershed
intervention technology were implemented in 2007-08. After the implementation of watershed intervention technology the average number of cows and buffaloes per household in both the blocks have increased substantially. This has increased from 3 to 4 in the Thondamuthur block and from 4 to 5 in the Periyanaiickenpalayam block.

- On an average in the Thondamuthur block, the average milk yield was 15.76 litres in 2007-08 and this has increased to 22.87 litres in 2008-09. The corresponding figures for the Periyanaiickenpalayam block were 16.11 litres and 22.59 litres respectively.

- The percentage change in the net income after the watershed intervention technology was significantly high in both blocks exceeding 80 per cent. The average net income earned from cows and buffaloes had increased from ₹36,535 in 2007-08 to ₹71,906 in 2008-09 in the Thondamuthur block. The corresponding figures for the Periyanaiickenpalayam block were ₹37,108 and ₹69,241 respectively.

- All the farmers in both the blocks own bullocks in their farms. This figure increased from about 5 bullocks per household in 2007-08 to 6 in 2008-09 in the Thondamuthur block. In the Periyanaiickenpalayam block the increase was from about 4 to 5 bullocks per farm household.

- The net income from sheep rearing was high for the medium farmers (₹4,013 and ₹5,825) in the Thondamuthur block. In the Periyanaiickenpalayam block, the net income from sheep was high among the small farmers (₹9,639 and ₹14,783) closely followed by the large farmers (₹8,657 and ₹11,150) respectively.

- Goat rearing was carried out by all the farmers in both the blocks. On an average each household own about 14 goats in the Thondamuthur block and about 16 goats in Periyanaiickenpalayam block before watershed intervention technology was adopted. In 2008-09, this had increased to about 20 goats per farm household in the Thondamuthur block and about 23 goats in the Periyanaiickenpalayam block.

**Impact on income**

- Per household farm income has significantly increased among the small farmers in the Thondamuthur block with the percentage change in per capita income being 95.78.

- In the Periyanaiickenpalayam block, per farm household crop income has increased from ₹1, 21, 422 in 2007-08 to ₹1, 74, 455 in 2008-09, with an increased annual income of 43.68 per cent.
Impact on consumption expenditure

- In both the blocks the monthly household expenditure had shown an increase after using the watershed intervention technology. In the Thondamuthur block, the monthly household expenditure was `1,347 in 2007-08 and `1,777 in 2008-09.
- In the Periyanaickenpalayam block, on an average the monthly household consumption expenditure was `1,264 in 2007-08, which increased to `1,607 in 2008-09.

Impact on value of land

- In the Thondamuthur block, there was an increase in the value of land for all groups of farmers.
- The land value per farm household for small farmers had increased from `3,91,890 in 2007-08 to `5,11,890 in 2008-09. For the medium farmers it was from `3,41,480 to `4,61,480 and for large farmers from `3,14,090 to `4,34,090 respectively. The percentage changes in the value of land per farm household among all farmer groups range from 30.62 for small farmers to 35.14 for medium farmers and 38.20 to large farmers.
- In the Periyanaickenpalayam block the land value per farm household had increased from `3,30,080 in 2007-08 to `4,50,080 in 2008-09.

Hedonic pricing analysis

- After watershed intervention technology the value of land has increased in both the blocks with reference to distance from the village, output produced and water level in the farm wells.
- For every kilometer away from the village the value of land in Thondamuthur block has declined by `2,194 before watershed intervention technology and by `1,926 after the watershed intervention technology.
- Similar trend was witnessed in Periyanaickenpalayam block also. Before watershed intervention technology was employed the value of land has declined by `2,161 with every kilometer away from the village and after watershed intervention technology by `2,086.
- In the Thondamuthur block for every `1,000 increase in the output level the value of land increased by `60 before watershed intervention technology and by `80 after the
watershed intervention technology. In the Periyanaiickenpalayam block the increase was from ₹37 to ₹71 respectively.

- For every feet increase in the water level in the farm wells the value of land had increased by ₹79 and by ₹48 in the Thondamuthur and Periyanaiickenpalayam blocks respectively before the watershed intervention technology. After the watershed intervention technology this had increased to ₹96 and to ₹61 in the Thondamuthur and Periyanaiickenpalayam blocks respectively.

**Benefit-Cost Ratio**

- In the Thondamuthur block the change in the yield due to watershed intervention technology across crops varied from 7.61 per cent for onion to 29.41 per cent for paddy. Reduction in marginal cost due to supply shift ranged from 2.3 per cent in fruits, flowers and vegetables to 76.8 per cent in onion. Reduction in marginal cost was the ratio of relative change in yield to price elasticity of supply. Net cost change varied from 1.8 per cent in fruits, flowers and vegetables to 65.2 per cent in onion. In the case of Periyanaiickenpalayam block the change in yield due to water shed intervention technology across the crop varied from 11.76 per cent in fruits, flowers and vegetables to 61.54 per cent in cereals. It was maximum change in the yield due to watershed intervention technology. Reduction in marginal cost due to supply shift ranged from 8.2 per cent in fruits, flowers and vegetables to 63.4 per cent in cereals. Net cost changed varied from 3.4 per cent in fruits, flowers and vegetables to 58.2 per cent in cereals.

- The Benefit Cost Ratio (BCR) ranged from 1.37 for the small farmers to 4.96 for the medium farmers and 5.20 for the large farmers in the Thondamuthur block. In the Periyanaiickenpalayam block also similar results prevailed.

**Expectations and Realisations**

- About 70 to 90 per cent of the farmers in the Thondamuthur block, expected that watershed intervention technology would (i) reduce wastage of water, (ii) increase groundwater recharge, (iii) bring more availability of water, (iv) increase in pumping hours and silt trap and (v) improved soil fertility and soil erosion, change in the cropping pattern, crop yield and farm diversification. About 50 to 60 per cent of the
farmers expected an ‘increase fuel wood supply’, ‘availability of fodder’ and ‘farm employment’.

- For more than 80 per cent of the farmers in the Thondamuthur block, their expectations on the overall impact of watershed intervention technology was ‘fully’ realised on ‘reduced wastage of water’, ‘increased groundwater recharge’, ‘adequate’, ‘availability of water’, ‘increase in pumping hours’, ‘silt trap’, ‘improved soil fertility’, ‘reduced soil erosion’, ‘change in cropping pattern’, ‘increase in cropping intensity’, ‘increase in yield’ and ‘farm diversification’. Only 60 to 70 per cent farmers reported that their expectation were ‘partially’ realized for ‘increased fuel wood supply’, ‘increased fodder availability ‘ and ‘increased in farm employment’.

- The same pattern prevailed in Periyanaikenpalayam block also.

Opinion survey

- All the farmers in the Thondamuthur block, recorded their opinion as ‘very good’ for ‘Increase in water level’, ‘change in cropping pattern’, for ‘ground water recharge’ and for ‘environment improvement’, the assigned scores ranging from 1.94 to 2 (maximum score being ‘2’ and minimum ‘0’).

- For the impact on the ‘fodder improvement’ the score assigned was 1.62.

- Only for the impact on ‘increase in employment’ the score was 1.42 implying that the impact on this factor was ‘good’. None of the farmers considered the impact of on the stated factors to be ‘poor’.

- In the Periyanaikenpalayam block, the farmers felt that the impact of watershed intervention technology on ‘ground water recharge’ (score=1.98), ‘change in cropping pattern’ (score=1.91), ‘Increase in water level’ (score=1.79), ‘improvement on environment’ (score=1.76) and ‘fodder improvement ‘(score=1.58) to be ‘very good’, the scores ranging from 1.58 to 1.98. For the impact of watershed intervention technology on ‘employment’ the farmers assigned a score of 1.29, implying that the impact is ‘good’.

Economic Surplus Model

- The economic surplus was calculated for ten major crops cultivated in the two study blocks. The ten crops selected for calculation are paddy, banana, coconut, maize, cash crops, fruits, flowers and vegetables, pulses, cereals, onion and oil seeds.
• In the Thondamuthur block, the calculated economic surplus exceeded ` 3,00,000 for all the crops excepting for the cash crops. The producer surplus was higher than the consumer surplus for all the crops excepting for cereals.

• In the case of Periyanaiickenpalayam block this trend was different. The change in economic surplus for exceeded ` 3,00,000 for banana, coconut, fruits, flowers and vegetables, pulses, maize, paddy and oilseeds. Being the major rain fed crops, these crops benefited from the application of the watershed intervention technology. The producer surplus was higher than the consumer surplus for banana (76.98 per cent), fruits, flowers and vegetables (74.25 per cent), cash crops (72.57 per cent), coconut (66.63), maize (55.82 per cent) and pulses (51.05 per cent). But for the crops like, cereals, paddy and oilseeds the consumer surplus exceeded the producer surplus. The producers’ surplus exceeded that of the consumer surplus for most of the crops.

• The farmers as producers benefit from watershed intervention technology.

**Conclusion**

The watershed intervention technology has made a significant shift in land use pattern. Further it has made a positive impact on ground water level and its recharge level leading to increased irrigation and cropping intensities. The average yield for all the crops had invariably been either nearer to or exceeding the normal yield resulting in higher benefit cost ratio. The crop diversification, which is made possible for the farmers with watershed intervention technology, helps them from facing various risks associated with crop farming. The study established that with watershed intervention technology the farmers as ‘producers’ realise ‘surplus’ compared to farmers as ‘consumers’, leading to socio economic upliftment of the farmers. Further it reveals that participatory watershed management could be a viable strategy of rural development for achieving sustainable rural livelihoods in India.
SUGGESTIONS

Based on the foregoing analysis, the following suggestions are evolved for future consideration and action.

1. Institutional development at village level as well as self help group level within the village can be promoted for mobilization of local resources to promote watershed programmes.

2. Creation of revolving funds, opening of bank accounts and credit linkages can be included in the list of activities of a WSM (Water Shed Management) project for providing impetus to local organizations. That would encourage them to take new initiatives on income generation within the watershed.

3. Artificial recharge and rainwater harvesting can be actively encouraged through the use of modern methods.

4. It is essential to pay attention in soil and water conservation and water harvesting measures, to increase production and sustainable agriculture.

5. The mechanism for monitoring the implementation of schemes for promoting micro irrigation needs to be incorporated in the existing administrative framework at the district level to facilitate the faster spread of these systems in an effective manner.

6. Training and motivation of officials and farmers can be the integral part of the watershed management programme.

7. People must be the focal point of watershed management programmes and innovations should be planned with their needs. Researchers and planners must take the ideas and experiences of the farmers for making sustainable development.

8. There should be intensive research on

   • Optimizing production with limited water supply.
   • Reducing cash inputs.
   • Refinement of the technology for water harvesting, storage and efficient use of stored water.
   • Developing drought resistant and high yielding crop varieties.
• Development of dry lands on watershed basis. Developing energy efficient and low cost irrigation method.

• Cheap/cost-effective soil and water conservation structures.

9. Farmers need a continuing programme of information, guidance and education on water management and irrigated agriculture under existing irrigation systems.

10. To have transfer of technology to the needed people – Training on water management to extension staff, farmers, politicians, administrators and policy makers.

11. As more than 85 per cent of the water consumed is used for agriculture, there is a need for Irrigation Extension Officers in every village/block to advise the farmers to utilize the water judiciously.

12. Necessary changes in the cropping pattern, as well as crop diversification can also be encouraged in favour of low water consuming crops.

**Suggested areas for future research:**

1. Location specific integrated packages for rainwater harvesting on watershed basis can be the focus for further research.

2. Research on comprehensive catchment treatment is needed.

3. Research investigations are also needed for developing design procedures/specifications for sub-surface water harvesting structures.

4. To have research on efficient water applications methods such as drip and sprinkler irrigation, which can be carried out especially for plantation and row crops to cover an area under irrigation with the harvested water resources.

5. To create a reliable data base of short term and long term impacts on in situ rain fall and moisture conservation practices.

6. To have a macro level comparative study on the economic impact of watershed intervention technology.