CHAPTER - I

Introduction
Agriculture plays a predominant role in Indian economy since increased agricultural output has a growth inducing effect on other fronts of the economy. In our country, the agricultural production mostly depends on the vagaries of monsoons. More than 70 per cent of the cultivable area in the country is cultivated under rainfed conditions, contributing nearly 45 per cent of the total food grains production. It is under rainfed conditions that 80 to 90 per cent of the India's pulses and oil seeds are produced. Because of the poor management and low resources of the dryland farmers, the per hectare yields are low. Satabilising and increasing crop production in such areas would therefore, hold the key to stabilise agricultural production in our country.

During the mid-1960s' India witnessed the historic green revolution through the introduction of new varieties of wheat and rice. However, green revolution proved to be selective in nature and restrictive in scope, magnitude and impact. For instance in its scope, it is confined to a few crops such as rice and wheat, in it's magnitude it has not gone beyond irrigated areas and it has been restricted to relatively more prosperous and progressive areas leaving the large bulk of the less progressive rainfed areas.

Dryfarming refers to the system of crop production in low rainfall regions receiving 375-1125 mm annual precipitation. There are 123 districts in India classified as dryland areas which are classified as arid and semi-arid.
According to Swaminadhan, semi-arid areas have been plagued for centuries by frequent droughts, soil erosion, instability in production, drinking water scarcity, unemployment, under-employment and other forms of human suffering. These dryland regions are characterised by a diversity of climatic, agronomic, topographic, social and economic factors. The features associated with these areas are poor economic status and social backwardness of farmers, low fertility of the soil, ill-nourished farm cattle and low and unstable returns to farm investment. Rainfall intensify and its distribution, type of soil and its fertility level and different agronomic practices determine the success or failure of crops in these areas.

Erratic and inadequate rainfall adversely affects the agricultural production in drylands. Soil erosion is the serious problem on the productivity front. About 175 mha of the total geographical area suffers from various processes of land degradation. Drylands are becoming poorer day by day and this poses serious limitation on the moisture storage and sustainability of the crop productivity. It is estimated that about 30 per cent of the total precipitation remains unutilised and along with it about 8.4 millions of nutrients goes through soil and water run off.

Land holdings are very small and about 72 per cent of dryland farmers own less than two hectares, which may be scattered and fragmented in nature. Even limited mechanisation is difficult under such situations (Singh, 1989). The dryland farmer has an extremely fragile resource base. The dependable infrastructure is insufficient to support the crop production, livestock and marketing activities. The economic efficiency of crop production
has been low on account of the fact that the people operating in drylands could not adopt the technologies in full due to various bio-physical and socio-economic constraints.

Further, growing human population, gigantic industrial installations and rapid urbanisation have been, not only creating excessive pressures on the dwindling basic natural resources (viz. land water and vegetation) but also posing a serious threat to human and animal life through pollution levels of different kinds. Such indiscriminate exploitation of basic natural resources for development has began to flicker the signals of warning about the limited potential left over for future. Land, the most fundamental resource providing basic amenities of life, namely food, clothing and shelter is suffering from severe degradation through erosion, floods, droughts and famines and the loss of world vegetative cover is also unimaginable. In India, for example, the total per capita forest area was a meagre 0.11 ha. in 1980 while by now, has dwindled to less than 0.10 ha. There is hardly any doubt whether such a meagre area would be able to meet ever increasing fuel, food, fodder and timber demands of the country is population. Similarly, growing urbanization accompanied by industrialization, faulty land use, continuous degradation due to mounting natural and biotic pressures, have precariously brought down the land-man ratio in the country. The mismanagement of lands has considerably deteriorated the soil resource in India. According to some estimates, total soil loss during 1972 alone was to the tune of 6000 million tonnes and the annual loss of major nutrients (nitrogen, phosphors and potassium) was 5.37 million tonnes, which is worth of 700 crores in the year. The corresponding loss today would be much higher.
1.1 WATERSHED MANAGEMENT APPROACH

Realising the vital role and importance of rainfed farming in Indian economy and restoration of ecological and socio-economic balance, the Government of India has resolved to put an end for the neglect of vast rainfed and dryland areas and has adopted the watershed approach for integrated and comprehensive development of rainfed areas. The approach aims at scientific land-use through development of integrated rainfed farming systems on the principles of ‘WATERSHED’ management in each development block where there is more than 70 per cent arable area under rainfed condition.

Watershed essentially is a land surface area draining into a common outlet. The size of the watershed may vary from a few hectares to thousands of hectares depending upon the size of the river or stream passing through it and the location of the outlet. For providing conditions for optimum utilization of land, water, plant and animal resources for protecting the environment, it is necessary to treat the land from top to bottom or ridge to valley. Watershed management aims at minimizing risks associated with rainfed farming by the following steps.

i. Conserving soil and water resources through mechanical and/or cultural methods

ii. Draining out excess water at a safe velocity and directing it for safe storage for its utilization in dry season

iii. Preventing gully formation through mechanical and vegetative means and storage of water for recharging groundwater
iv. Utilizing land according to its capability and putting marginal land unsuitable for arable crop production to alternate land use

v. Developing a sustainable eco-system in harmony with the man-land-water-plant-animal complex of the watershed

vi. Optimising agricultural productivity per unit area, time and available water, and

vii. Improving the quality of life of the watershed inhabitants through infrastructure development.

The watershed approach benefits the farmer through improved soil health, better drainage and more efficient use of rain water with the possibility of excess water being stored in suitable structures for use during scarcity periods. With voluntary farmer participation, sustainable improvement in crop and animal production is possible. Government of India accepted watershed approach as a unit of area development on the recommendations of the Task Force on Integrated Agricultural Development in Drought Prone Areas, which submitted its report in 1973. It was from the Fifth Five Year Plan that the Government of India strongly recommended the planning and implementation of DPAP through watershed approach instead of taking the whole district as a unit. The approach was interested to achieve the twin objectives of optimum utilisation of natural resources and the integrated development of the area. Such use of agricultural and non-agricultural land could be ensured only if, the soil and water conservation measures, dryland farming practices, afforestation and pasture development, minor irrigation, livestock development are perceived and implemented by
taking watershed as a unit of development. The DPAP was initially launched in 74 districts covering 13 states of the country. During the successive Five Year Plans, the geographical coverage of drought area underwent a number of revisions following which 183 districts spread over 16 states have been presently brought under the fold of DPAP. The Programme was funded both by the central government and the respective state governments on 50 : 50 basis until March 1999. However, with effect from 1st April 1999, the allocation is shared on 75 : 25 basis between the centre and the state governments in respect of new projects sanctioned during and after 1999-2000. For completion of ongoing projects that were sanctioned prior to April 1999, the old funding pattern will continue. The World Bank also came forward to assist in the implementation of DPAP in six selected districts namely, Sholapur, Ahmednagar (Maharashtra), Jodhpur, Nagaur (Rajasthan), Anantapur (Andhra Pradesh) and Bijapur (Karnataka).

Apart from DPAP, the Government of India also emphasised the watershed approach in other land-based programmes. Under the Prime Minister's 20-point programme, it was planned to develop dryland technology on watershed basis to attain integrated development. During 1983, two schemes namely (i) Pilot Project for Propagation of Water Conservation/ Harvesting Technology for Rainfed Areas on watershed basis and (ii) Popularization of Seed-cum-Fertilizer Drills, were initiated covering 19 districts in 15 states. Indian Council of Agricultural Research was also
involved in providing technology and research support to these watersheds which were popularly known as "Model Watershed Development Projects". Another programme called "On Farm Dryland Development" (OFDLD) was launched by Government of India on watershed basis where in 100 per cent subsidy was extended for implementing the dryland development activities viz., soil conservation, water harvesting, tree planting and pasture development and use of suitable crop varieties. However, the programme could not yield expected results for want of effective inter-departmental coordination and organisational constraints.

1.2 NATIONAL WATERSHED DEVELOPMENT PROGRAMME FOR RAINFED AREAS (NWDPRA)

Realising the vital role of rainfed agriculture in Indian economy, a Committee of Secretaries was constituted in November 1987 to review the progress of the schemes mentioned above and devise the policy framework in respect of approach and strategy, agricultural structure, mode of financial requirements and pattern of subsidy, etc. Based on the directives provided by the Committee of Secretaries and the broad framework recommended by the above Working Group on Dryland Farming, NWDPRA was initiated with the twin objectives of sustainable production of biomass and restoration of ecological balance in the vast tracts of rainfed areas in the country. The project envisaged the selection of micro watersheds of the area ranging between 500 to 1000 ha. for the development in every block having assured irrigation of less than 30 per cent. The integrated development was
contemplated by adopting the approach with diverse production system (seasonal cropping, horticulture, forestry, animal husbandry, etc.) It was also attempted to incorporate the vital aspects in the project such as people's involvement both in planning and execution of activities, extension support through progressive farmers, training of all concerned and monitoring and evaluation process; which otherwise did not receive adequate attention in the previous watershed development programmes. The inclusion of the concept of "Mitra Kisan" (Farmers' Friend) and "Gopal" (Grazer) for facilitating the common property resources management was a right step in the direction of ensuring peoples' participation in watershed project. The ultimate goal envisaged in NWDPRA is to develop the natural resource base, sustain its productivity, improve the standard of living of millions of poor farmers and landless labourers and also endeavour for the restoration of ecological balance. An outlay of Rs.1330.37 crores has been allocated under the programme till the end of Eighth Plan. The watersheds under NWDPRA are to serve as models of comprehensive and integrated development in different agro-climatic regions of the country. During the eighth Five Year Plan the scheme was modified to provide a single window financing for both arable and non-arable lands, with 100 per cent finance (75 per cent grant and 25 per cent loan). Union Territories without legislature, received 100 percent grant-in-aid. The allocation during eighth plan was 1,100 crores spread over 2,479 watersheds covering 350 districts located in 25 states and two union territories.
The ministry of rural development through its revised guidelines in 1995 revamped Desert Development Programme (DDP), Drought Prone Area Programme (DPAP), and Integrated Wasteland Development Programmes (IWDP), and the focus has been watershed development based on the recommendation of Hanumantha Rao Committee (1994). Besides, 50 per cent of Intensified Jawahar Rozgar Yojana (IJRY) and Employment Assurance Scheme (EAS) funds are to be utilised for watershed development. The treatment plan should include all categories of land viz., private, village common and degraded forestlands. Emphasis was on low-cost, simple and easy-to-operate local technologies.

By the end of eighth plan through various initiatives under watershed development mentioned above, 9.6 m.ha. of arable land and 6.9 m.ha. of non-arable land could be treated leaving an area of 60 m.ha. of arable land and 15 m.ha. of non-arable land to be covered by the beginning of ninth plan period. In this context, the experience of the past two decades in implementation of this programme needs to be critically examined keeping in view, the objective of maximising the desired benefits under the programme and realising the best value for money and human effort.

1.3 REVIEW OF LITERATURE

A brief review of previous work done on various aspects of watershed management is presented under the following heads for convenience. Impact

1.3.1. Impact of watershed technology on cropping pattern and alternate land use systems

Various water harvesting measures adopted in the watershed programmes are known to increase the area under cultivation, and cropping intensity. Central Research Institute for Dryland Agriculture (CRIDA) (1987) reported that the cropping intensity in 18 model watersheds increased by 30 per cent over a period of three years. The study also reported an increase in area under silvi pasture with sesbania and stylo (70 hectares) in Mir watershed and area under afforestation with Acacia auriculiformis, Leucaena and Eucalyptus (227 hectares) in Mittermari watershed area.

Reddy and Walker (1987) from their study on "impact of watershed programmes on adoption and economics of technology and on economic conditions of rural people" reported 16 per cent of area under sole crops in Mittemari watershed area as against 12 per cent in non-watershed villages. It is also observed that the area covered under improved varieties in watershed villages was 92 per cent as against 69 per cent in non-watershed area villages during the kharif 1986.
The study of Atheeq and Venkataram (1989) revealed that the land use pattern of the farmers in the Kabbalanala watershed was closer to the optimum since a reorganisation of the existing resource use pattern would yield only 17 to 18 per cent higher net returns and the normative land use plan with existing technology could accommodate only 37 to 40 per cent higher cash.

Hanumanthaiah and Natraj (1989) observed a radical change in land use pattern in Chinnatekur watershed area of Kurnool district of Andhra Pradesh between pre and post-watershed period. The study revealed an increase in dry-cum-wet area while the dryland area had declined in the post-watershed period. The cropping pattern showed considerable variations. Mixed cropping and new crops like red gram were also introduced during the five-year period of watershed management.

Pagire (1989) stated that due to watershed development programme at Kolthewadi village in Maharashtra, there was an increase in the area under the kharif and rabi crops and diversification in the cropping pattern during the study period between 1984-85 to 1988-89. The gross cropped area increased to 15 per cent over 7.5 per cent of the base year 1983-84. Similarly the double cropped area also increased over the base year i.e., from 5.10 ha. to 41.76 ha.
The study conducted by Reddy and Walker (1990) revealed that on an average the percentage of irrigated area to total cultivated area was marginally higher in watershed villages compared to non-watershed villages. The intercropping system was practiced more in watershed areas accounting for 60 per cent of the total cropped area as against 40 per cent in non-watershed area in rainy season at Chevella watershed. While higher use of improved varieties of seeds was observed in Mittamari watershed area.

Singh et al., (1989) studied the effect of watershed technology on the cropping system and cropping intensity at the Chevella, and Pothulboguda villages in Medak district of Andhra Pradesh and found that cropping systems and cropping intensity underwent significant changes after implementation of the watershed programmes. The area under cereals and chillies had declined and these crops were replaced by oilseed crops like sunflower in kharif and safflower in rabi season. These oilseed crops were intercropped with pigeon pea in kharif and sorghum or chickpea in rabi season which had resulted in the increase of cropping intensity by 38 per cent.

Sing et al., (1989) from their study on the socio-economic impact of Kandi watershed development project in Punjab concluded that there were significant shifts in land use pattern from uncultivated to cultivated, uncultivated waste to cultivable one and from unirrigated to irrigated. The crop pattern analysis also indicated slight shifts in favour of commercial crops.
Barbier (1990) in his study on economics of soil conservation in the uplands of Java found that bench terraces for areas with 50 per cent slope and change in current cropping pattern improved economic incentives to the farmers. Further, four slopes at 45 to 50 per cent or more, forestry were recommended as soil and water conservation measure so that farmer can grow tree crops. A simple model was developed to show acceptance of soil conservation measures and the variables influencing such behaviour. The results indicated that the perennial crops accompanied by proper soil conservation measures appear to control the erosion.

Hafeez et al., (1990) from their studies on diversification of cropping systems and its economics in watershed programme indicated that the additional cost involved per hectare due to diversification was worked out to be Rs.19 in sorghum (CSH-5) and pigeon pea (HY-2), Rs. 104 in sorghum (local) at Chevella watershed village and Rs. 225 in groundnut (JL-24)+ pigeon pea (TTB-7) at Mittemari watershed villages. The additional gross returns accrued per hectare due to diversification was Rs. 60 in rabi sorghum (local), Rs. 156 in sorghum (CHS-5)+ pigeon pea (HY-2) and Rs. 1141 in sorghum (local)+ pigeon pea (load) at Chevella watershed villages and Rs. 991 in groundnut (JL-24)+ pigeon pea (TTB-7) at Mittemari watershed villages. The study further revealed that watershed management has made a clear impact on crop diversification and in stabilising the farm returns in addition to minimising the risk involved in dryland agriculture.
Reddy et al., (1990) from their study "Impact of dryland development programme on cropping pattern a case study" found that the total cropped area increased marginally by 0.43 per cent due to the adoption of dry farming development programmes. But the area under cereals and fibres showed a decline of 10.73 per cent and 9.37 per cent respectively. The area under pulses and oil seeds increased by 46.40 per cent and 46.14 per cent respectively which could be attributed to the shift from less remunerative crops to more remunerative crops like oil seeds and pulses in Yernal and Chandrakavate watersheds. Further, the study revealed that the cropping intensity of non-participant farmers worked out to only 104.64 per cent in contrast to 123.53 per cent for Yernal, 112.26 per cent for Chandrakavate watersheds.

Biradar (1991) stated that eight hectares of non-arable land under Muchkulla Nala watershed was brought under alternative land use by planting suitable forest trees of which 35 to 40 per cent have survived. In addition to the 35 to 40 per cent of plant area, the remaining land was brought under grass land which facilitated the farmers to feed their cattle and helped in infiltration of rain water. In the lower portion, nearly 10 hectares of land used to suffer from temporary waterlogging resulting in single crop in a year. The drainage congestion is cleared and the area is brought under double cropping.

Chaurasia and Singh (1991) using linear programming technique reported that farmers grew in Naurar watershed of Almora district (U.P.) a number of crops and diversification of crop was a common feature to minimise
the risk of crop failure on account of drought. The crop cultivation was extended even on lands which were not scientifically appropriate for crop cultivation. The maximum soil loss took place in unterraced unirrigated land. The existing soil loss from the kharif crop production was found to be 4,612 metric tonnes. The optimal cropping pattern indicated that the existing level of soil loss could be reduced to 992 tonnes. The optimal cropping pattern led to specialisation in crop production but fulfilled the minimum requirement of farmer's need as well as provided crop income equal to the existing level. Thus the optimal crop plan could be treated as socially acceptable as well in addition to being helpful in combating soil loss hazards.

Ghosh (1991) showed that the intensity of cropping which was 109 per cent before the introduction of the programme increased to 118 per cent in the post - introduction period as compared to 102 per cent in the non-command area. The importance of cereals, particularly paddy declined, while the area under vegetables, mustard and potato increased. The cropping pattern in the non-command area was predominated by paddy, accounting for 93 per cent of the total cropped area as against 79 per cent in the command area.

Hafeez et al., (1991) found that cultivation of intercrops with pigeon pea was most popular on the main crops of groundnut and finger millet in Chitravati watershed villages. The common crops that covered under crop diversification over different years under study were identified to be groundnut (JL-24) + pigeon pea (TTB-7) and finger millet (Indof-5) + pigeon pea (TTB-7) for which the benefit-cost ratios worked out were Rs.1.06 and
Rs.1.48 respectively indicating higher returns on each rupee invested in the cultivation of these crops.

Ingle and Kude (1991) conducted a study at Akola in Maharashtra and reported changes in cropping pattern over a period of five years from 1983-84 to 1988-89. The study indicated that the area under cereals, cotton and pulses in Kharif season had decreased by 3.09, 0.13 and 2.95 per cent respectively. However, the area under the rabi crops had increased by 1.11 per cent. Slight increase in area under fruit crops (0.93%), dry land fruit crops (0.94%) and forest crop (0.09%) was recorded. Under the total area of cereals the local sorghum decreased from 78.18 per cent to 4.72 per cent. Of the total cultivated area the area under hybrid sorghum has increased from 21.82 per cent to 95.10 per cent. Bajra was introduced in addition to sorghum. The area under improved cotton had increased by 4.90 per cent over the year 1983-84. Decrease in acreage under cotton by 49.64 per cent, green gram by 47.14 per cent, black gram by 61.14 per cent, pigeon pea by 54.63 per cent and groundnut by 100 per cent was recorded. The increase in area under oil seeds (i.e., 3.19 per cent of the total cultivated area) was mainly due to the introduction of sesame and sunflower in kharif. There was decrease in wheat area. The watershed programme helped to increase area under fruit plants replacing some of the traditional crops.

Jahagirdar (1991) stated that Manoli watershed which forms part of G.S.D.A. watershed number PGA-3 covers a geographical area of 25,403 hectares. Out of the culturable area of 22,604 hectares, 85.5 per cent of area was under cultivation. During 1985-86 to 1990-91, the area sown under
kharif as well as rabi crop increased. Cropping intensity increased from 104 to 115 per cent during the same period. The area under Well irrigation increased by 206 hectares. Adoption of in situ moisture conservation technologies and in particular vegetative barriers helped in increasing the yields of various crops.

Kallur (1991) stated that Muchkulla Nala Watershed Development Project has led to complementary land use system wherein dryland horticulture crops like mango, lime, etc., have been raised for the first time. Besides this, it has resulted in the popularisation of dairy activity in the village. Further, 'treatments' undertaken by the project authorities have increased the area under the vegetative cover which facilitated the infiltration rate of the soil and also helped in overcoming the hazards of floods during heavy monsoon.

Mahandule et al., (1991) in their study examined the changes in the resource use structure and returns in respect of crop production activities consequent upon the implementation of watershed development programme in the drought prone areas of western Maharashtra. They observed that watershed programme proved to be effective in soil and water conservation as a result of which the proportion of irrigated area and cropping intensity increased by 30 per cent and 53 per cent respectively. The substitution of high value crops for the low value crops was pronounced in the watershed area. This has resulted in the increase of gross returns more than proportionately as compared to the increase in production cost. The overall watershed programme could prove to be highly beneficial for generating
additional employment and income. They suggested for extending the programme over a larger area through creation of public awareness about the importance of soil and water conservation activities both among policy makers and farmers.

Misra (1991) from his micro level study of watershed in West Bengal reported that the availability of water from watershed works had resulted in diversification in cropping pattern. The study revealed that the provision of water led to substitution of less profitable crops by more profitable lucrative crops. The net contribution of watershed works with regard to increase in productivity of the farm land during the period was Rs.740 per acre. The labour employment had also significantly increased. Afforestation programme has also improved the fuel resources of the area.

Naik and Mohanty (1991) from their study on status of watershed in Phulbani district of Orissa stated that crops like paddy, pulses, alasi (linseed), turmeric and ginger crops were grown in medium lands, while the uplands were covered with early paddy, groundnut, mustard, arhar and turmeric in rainfed situation. The late duration crops were grown only in lowland watershed areas. The orchards grown in the watershed areas were covered mainly with mango.

Narasamma et al., (1991) from their survey at Mittemari watershed villages and non-watershed villages in Kolar district of Karnataka during 1984-85, 1986-87, 1987-88 and 1989-90 reported that the area under intercropping system especially groundnut + pigeon pea has gradually
increased over years and the area under ragi has declined mainly due to price
effect. Further, the study indicated that the productivity levels were high in
watershed area compared to non-watershed area villages.

Neema et al., (1991) from their study on impact of Barkhede Hat
watershed development programme in Guna district of Madhya Pradesh
found that the intensity of cropping in watershed farms was higher by 13 to
20 per cent than in non-watershed area. More than 50 per cent of the farmers
in the command area had opted for improved technology, fertilizer use,
improved seed, etc.

Randhir and Ravichandran (1991) from economic analysis of watershed
management in Anakkatti region of Coimbatore district concluded that new
crops like cotton and cowpea entered into the cropping system due to
watershed programme. There was an increase in cropping intensity by 12.68
per cent due to the programme.

Shrivastava et al., (1991) from their study stated that on the selected
farms the change in cropping pattern was quite substantial. Cash crops like
sesamum and sugarcane which did not find a place in the base year, were
grown in the current year. The area under jowar, bajra and moong decreased,
whereas the area under wheat, turgram, groundnut, soybean and spices
increased indicating a clear preference for more remunerative crops. Fodder
showed the highest increase in the area (7.32%) while the increase was 213.6
per cent in the case of spices. Among cereals, wheat made a tremendous
progress by recording a hundred per cent increase in area. This programme
offered an opportunity to the farmers to bring in more area under rabi crops and in a few cases under summer crops also. The gross cropped area increased by 38.31 per cent. There was a conclusive evidence of the change in farming practices. The cultivated area increased by 0.508 hectare per farm and the irrigated area by 1.49 hectare per farm.

Singh (1991) from his study showed that the gross cropped area increased by 4.31 per cent in post-implementation period over the base year. The net area sown also increased by 4.31 per cent i.e., from 115.46 hectares to 116.57 hectares. The study also revealed significant shifts in land use pattern due to reduction in the area under barren culturable waste lands and permanent fallows and decline in the acreage under coarse grains by 35 per cent besides shift in favour of paddy, soyabean and groundnut due to the introduction of watershed programme. During rabi season, wheat, gram, mustard and mixed crops were dominant before the programme was initiated but due to water development activities, there was increase in the area of wheat, pea and lentil.

Singh and Singh (1991) from their study reported that after the implementation of the watershed programme there was a phenomenal increase in cropping intensity and crop productivity, resulting in allround improvement in the area. The gross cultivated area increased from 696 hectares to 1088.5 hectares during 1983-84 to 1988-89 thus bringing about an increase of 56.4 per cent in cropping intensity.
Underwade *et al.*, (1991) from their study reported that various activities of watershed development proved to be effective in the conservation of soil and water resources. The project helped in increasing double cropped area by 577.38 per cent and cropping intensity increased from 104.97 to 134.06 per cent during 1984-85 to 1990-91.

Swarnalata *et al.*, (1994) observed a decrease in the wasteland area which is unfit for agriculture from 54 hectares to 10 hectares after the project period. The rainfed area with single cropping system decreased while the area under double cropping increased from 125 hectares to 601 hectares.

Krishnappa *et al.*, (1994) documenting the changes in Achaalu micro-watershed at Kabbalanala, Karnataka, found that agricultural production increased from 15.74 tonnes during pre-project period to 48.41 tonnes in the post-project period from an area of 28.45 ha. mainly due to change in cropping pattern.

Nalatwadmatha *et al.*, (1997) reported that the cropping intensity of the watershed area has increased from 93.55 per cent to 108.40 per cent, while the productivity of different crops increased by 1.36 to 1.70 times. The watershed management programme has not only increased the crop yield but also developed fodder resources in the area.

In their study, shiyani *et al.*, (2002) examined the differential impact of watershed development in South Saurashtra Region of Gujarat. Three watersheds managed by Gujarat State Land Development Corporation
(GLDC) and one by Non-Governmental Organisation (NGO) were studied. The study reveals that in GLDC watershed, rabi crops accounted for 22.59 and 14.60 per cent of gross cropped area for beneficiaries and non-beneficiaries respectively. The corresponding figures for Agakhan Rural Support Programme (AKRSP) watershed were 34.59 and 23.79 per cent for beneficiaries and non-beneficiaries respectively. It was also observed that the area occupied by summer crops was 9.01 per cent of the Grass Cropped Area (GCA) in case of beneficiaries of GLDC watersheds while no summer crop could be grown by the beneficiaries of AKRSP watershed as well as by all the non-beneficiaries. On the whole, it can be concluded that the rabi crops contributed as high as 28.40 per cent of GCA in respect of beneficiaries compared to 19.10 per cent of GCA in case of non-beneficiaries. In addition to this, the beneficiaries were able to grow groundnut, bajra, jowar, and maize during summer season. The increased irrigation facilities created by the watershed development have been utilised by the beneficiaries for bringing more land under rabi and summer crops.

1.3.2 Impact of Watershed Technology on Productivity

Importance of soil conservation practices in arresting soil loss and impact of supplementary irrigation at crucial periods of crop growth in boosting up yields in dryland agriculture has been amply demonstrated. The literature on impact of newly introduced watershed technology on productivities of various sectors that come under the watershed programme has been reviewed and presented.
Agnihotri et al., (1986) while studying the run-off from the watershed in Shivalik hills reported that an average seasonal runoff has decreased from 37.8 to 30.8 per cent. The gross yield from the catchment area has increased from 64.6 quintals (1981) to 85 quintals (1985) per hectare by conservation practices.

Government of Karnataka (1987) reported that yields per hectare under treated area with watershed concepts in Chitravathi watershed was 17.99 quintals of ragi and 10.29 quintals of groundnut as compared to 5.28 quintals and 3.94 quintals of ragi and groundnut respectively from the area outside the watershed.

Reddy and Walker (1987) indicated that the productivity of sole crops and intercrops was significantly higher in case of watershed area compared to non-watershed area. The increase varied from 10 to 40 per cent in different crops due to adoption of recommended practices.

Reddy and Sudha (1988) concluded that the yield levels were significantly higher in rainy season crops in watershed area at Chevella. But the difference in yield levels narrowed down in post-rainy seasons under watershed and non-watershed areas. The difference in yield levels of groundnut was marginal under the two situations but it was higher in case of finger millet in watershed area at Mittemari.

Bharadwaj et al., (1989) reported that in Aravali watershed the yield levels of wheat, barley and gram increased by 29 per cent, 49 per cent and
207 per cent respectively during the last three years and the yield of Kharif crops in demonstration fields has increased by 558 per cent in guar. Irrigated guar gave an yield increase of about 360 per cent in Bajar-Ganiyar watershed and 24 per cent in Siha watershed.

Grewal et al., (1989) from their study indicated that the total production of bhabbar grass from 1.17 hectares of catchment area increased from 13.7 quintals in 1980 to 34.4 quintals in 1986 due to adoption of soil and water conservation practices in forest watersheds.

Pagire (1989) from his study reported that as a result of the impact of watershed development programmes, almost all the crops showed an improvement in per hectare yield levels as compared to the base year 1984-85 at Kothewadi watershed of Maharashtra. In case of sorghum (Kharif) and wheat, the increase in yield was 85 per cent to 134 per cent and 12 per cent to 72 per cent respectively.

Rao (1989) found that the productivity of jowar, red gram and castor crops, constituting the typical cropping pattern in Maheswaram pilot project region was consistently higher on lands with bunding when compared with the lands without bunding. Simultaneously, an increase was observed in the variation in yield on lands with bunds.

Singh et al., (1989) revealed that due to Kandi watershed area development project, the crop yields improved between 1979-80 and 1986-87 by 2.7 per cent, 2.8 per cent and 6.2 per cent per annum for maize, wheat and
oilseeds respectively. The growth rates for corresponding crops in Punjab were 3.3 per cent, 1.2 per cent and 3.5 per cent per annum.

Singh et al., (1989) from their study "watershed technology stabilizes yield in Andhra Pradesh" concluded that the yield of green gram, black gram, sunflower and sorghum increased to 660 kg/ha, 456 kg/ha, 730 kg/ha, and 1068 kg/ha respectively with the adoption of recommended crop management practices with soil and water conservation methods.

Birdar's (1991) study at Muchkulla Nala watershed, with in three years of the management, noticed that the soil erosion of the fields in the area reduced considerably and the groundwater recharge has increased. Uniform soil moisture was also observed in the fields which helped uniform growth by maintaining crop population. The crop yields also increased by 80 to 100 per cent and income of the farmers has almost doubled.

Ghosh (1991) from his study "an evaluation of the national watershed development programme in West Bengal" reported that the average yield of all crops was markedly higher in the command area than in the non-command area. The per acre returns in the command area increased from Rs.1,788 in the pre-introduction period to Rs.2,776 in the post introduction period while the same was only Rs. 1,826 in the non-command area.

Kallur (1991) reported that with the implementation of Muchkulla Nala watershed development project, the yields of all crops increased and particularly in the case of red gram. The yield registered more than 100 per
cent. This was perhaps due to the factors like increase in the contour banded area which improved soil moisture regime of the cultivable area and adoption of improved dry farming practice by farmers in terms of short duration and drought resistant crops, helping in the utilization of available in-situ moisture.

Ramana (1991) from his study reported that yields of groundnut + single row red gram increased by 3.3 q/ha. + 3.5 q/ha. in 1987-88 and by 2.3 q/ha. + 2.0 q/ha. in 1988-89. The yield of groundnut + double row red gram increased by 3.8 q/ha. + 1.95 q/ha. in 1987-88 and by 1.25 q/ha. + 1.40 q/ha. in 1988-89. The yield of sole redgram increased by 3.3 q/ha. in 1987-88 and by 2.3 q/ha. in 1988-89. The yield of ragi & red gram in 8:1 ratio increased by 11.7 q/ha. and 6.2 q/ha. in corresponding years.

Shrivastava et al., (1991) from their study stated that the effect of the watershed development programme on yield levels was positive. The increase in yield was more in the case of rabi crops than in kharif crops. A maximum of 93.0 per cent yield increase was recorded in opium followed by 84.2 per cent in gram, 74.4 per cent in urid and 33.8 per cent in wheat. Among kharif crops, the yield increase in maize, groundnut and jowar was 43.3 per cent, 31.9 per cent and 25 per cent respectively.

Singh (1991) from his study at Rendhar watershed reported that the yield advantage of companion cropping (sorghum + pigeon pea in 2:1 ratio) was 60 per cent over the sole crops. The study also reported that the crop combinations of groundnut + sesamum, groundnut + pigeon pea, barley +
mustard, wheat + mustard, chickpea + mustard and lentil + mustard have shown yield advantages of 56 per cent, 15 per cent, 61 per cent, 20 per cent, 15 per cent and 2 per cent respectively.

Singh and Singh (1991) reported that there was a phenomenal increase of 300 to 600 per cent in crop productivity after the implementation of the Rendhar watershed project in Jalaun district of Uttar Pradesh, between 1983-84 and 1988-89. Cattle population and milk and fish production also reported to have increased. Milk production went up from 352.7 thousand litres during 1983-84 to 1,476.6 thousand litres during 1988-89.

Singh and Thapaliyal (1991) concluded that the average productivity of almost all the crops in both Kharif and Rabi, except arhar and barley increased after the implementation of national watershed development projects in Bundelkhand region of Uttar Pradesh. The yield of paddy, jowar and bajra increased tremendously during Kharif while in Rabi, higher productivity was noted in gram, wheat, lentil and potato.

The study by Swarnalatha et al., (1994) revealed that the area under irrigation increased from 125 hectares to 601 hectares under the watershed project, and consequently resulted in the reduction of rainfed area from 741 ha to 265 hectares. The increase in yields varied between 20 and 44 per cent, 55 and 89 per cent and 41 and 67 per cent in rainfed gram, guar and bajra respectively. Similarly, the yield of irrigated wheat increased from 20 q/ha. to 43 q/ha. while that of irrigated mustard and barley registered an increase from 11.3 q/ha. and 17.4 q/ha. in 1983-84 to 17.3 and 31 q/ha. in 1988-89.
respectively. With increased feed and fodder availability, the farmers could maintain improved breeds of cows and buffaloes, which resulted in the increased milk production from 2,626 litres per day in 1983-84 to 7,146 liters per day in 1988-89.

Rajput et al., (1996) conducted an economic evaluation of watershed programme in Madhya Pradesh and found that the net returns and BC ratio from crop production were higher in watershed areas being Rs.5607 and 2.51 respectively compared to Rs.2965 and 1.83 respectively in non-watershed area.

Nalatwadamath et al., (1997) conducted a study on Jaladarsy model watershed development programme in Bellary of Karnataka. He reported that the per capita income has gone up by Rs.1285, 1259, 1266, 1394, 1468 and 1342 for the years of 1987-88 through 1992-93 respectively as compared to Rs.675 in the basic year. Due to the increase in income, number of assets like improved tillage equipment, seed drill, etc., were purchased which was a clear indication of motivation and prosperity brought in the area by watershed management programme.

The study on the impact of watershed development at Narora watershed of Madhya Pradesh by Jally et al., (1995) revealed that the yield of groundnut, paddy and wheat increased by 30, 25 and 10 per cent during the post-project period compared to the pre-project period.
According to Rajput et al., (1996) from their study "Impact of watershed programmes on crop yields in Madhya Pradesh" found that the crop yields were higher in watershed areas compared to non-watershed areas. The yield of soyabean, sorghum, wheat and gram were 14.60, 19.60, 16.66 and 14.33 q/ha. respectively with in the watershed compared to 11.00, 14.00, 50.60 and 8.66 q/ha. outside the watershed.

Naidu et al., (1999) in their study observed that rice and groundnut yields have increased by 8.6 q/ha. and 8.64 q/ha. respectively in 1995-96 indicating the impact of transfer of technology and making available high yielding variety seed. Similarly, the yields of remaining major crops viz. sesamum, Redgram, Blackgram, Greengram, Bajra and Ragi were increased considerabably during the period under reference indicating adoption of better management practicies.

Rathnakumari and Padmavathi (1999) conducted a study on impact of watershed management of dryland farming in Kommaddi watershed. They concluded that the yield of groundnut as a monocrop has increased by 21.67 per cent while as an intercrop with redgram rose by 17.39 per cent. The yield of redgram as an intercrop with jowar, and sunflower increased by 25 per cent and 50 per cent respectively. The productivity of jowar and sunflower increased by 26.87 per cent and 12.50 per cent respectively. Though there was an improvement in the crop yields in non-watershed area, the incremental yields were relatively more in watershed area than in non-watershed area.
Shiyani et al. (2002) in their study examined the differential impact of watershed development in South Saurashtra Region of Gujarat. Three watersheds managed by GLDC and one by NGO were studied. The study revealed that the average yield per hectare was comparatively higher in case of beneficiary group in all the seasons compared to non-beneficiary group. During kharif season maximum increase in yield per hectare was reported for groundnut crop (45.18 per cent), followed by sesamum (36.63 per cent), Cotton (19.07 per cent), fodder Jowar (11.59 per cent), bajra (7.58 per cent) and castor to non-beneficiaries. Similarly an increase in yield of rabi Jowar (fodder), wheat and garlic was found to be 19.54, 15.19 and 14.22 per cent respectively. This could be possible due to rainwater harvesting which supplied life saving irrigation to important crops at critical stage of growth.

1.3.3 Impact of Watershed Technology on Income

Alon et al., (1982) found that the soil loss could be reduced by almost 25 per cent through watershed management practices and this would result in 40 per cent increased returns to farmers by altering the cropping pattern in Arkansas North Lake Chicol watershed.

ICRISAT (1983) reported that the improved watershed technology options tested in the "On Farm Verification Trials" (OFVT) in the dependable rainfall vertisol region continued to perform well in 1982-83. The marginal rate of return of additional investment ranged from 26 to 381 per cent with an average of about 240 per cent.
The study of Sarin and Ryan (1983) indicated that the average net profits from the improved watershed plots were more than three times compared to traditional fields and the difference was statistically significant at 5 per cent probability level. The cereal/castor intercrops under the improved watershed based technology generated average net profit of Rs. 319/ha. whereas loss of Rs. 86/ha. was recorded when sole castor was grown using traditional technology.

Mittal et al., (1986) observed that Sukhomajri watershed project implementation had resulted in an extra food production of 1170 quintals valued at Rs. 2 lakhs and increased milk production from 248 to 1000 liters per day. The total net extra monetary benefit from the project was Rs. 13 lakhs per annum.

According to the study conducted by Reddy and Sudha (1988) at Chevella watershed in Medak district of Andhra Pradesh and Mittemari watershed in Kolar district of Karnataka, the income per household from all sources was higher by Rs. 463 at Chevella and Rs. 1, 046 at Mittemari watershed areas compared to non-watershed areas.

Bharadwaj et al., (1989) through his study in Aravali watershed area observed doubling of irrigated area, four-fold increase in the number of wells, sprinkler sets, dramatic increase in crop yields and 166 per cent increase in farmer's income.

Nataraj (1989) reported 179.45 per cent increase in gross income of large beneficiary farmers in Chinnatekur watershed over non-beneficiary
farmers. Small and marginal farmers obtained 189.86 per cent of additional
gross income respectively over non-beneficiaries. The beneficiary farmers
under watershed programme had lesser income inequalities compared to
corresponding categories in non-beneficiary group.

Pagire (1989) observed an increase in agricultural income ranged from
33 to 187 per cent during kharif and from 34 to 108 per cent during rabi due
to watershed development at Kothewadi village in Maharashtra. The per
hectare income from agriculture also increased and ranged from Rs. 1,511 to
Rs. 1,675 in different years.

Prasad et al., (1989) reported higher returns in the project area at
Rendhar watershed because of higher productivity. In Jowar, bajra, wheat
and mustard the net returns were two times higher, while in gram and barley
it was four times higher than the non-project area.

Reddy and Walker (1990) observed that on an average the total income
and agricultural income per household were higher by Rs. 248 and Rs. 278
respectively in watershed villages compared to non-watershed villages at
Chevella and by Rs. 1,595 and Rs. 1,394 respectively at Mittemari and they
were directly proportional to the size of holding at both locations.

According to Singh and Rahim (1990) optimum land use plans prepared
for the land fit for cultivation and owned privately in Uttar Pradesh hills
showed that the Returns Over Variable Cost (ROVC) could be increased by
as much as 89 per cent with improved technology and adequate credit
availability compared to existing technology. The total ROVC from community orchards and pastures amounted to Rs. 48,350 which was Rs. 2,178 per hectare.

Alshi et al., (1991) from their study at Gunj watershed development project reported that the per hectare gross income at 1989-90 prices increased from Rs. 1,579 to Rs. 2,772 between 1985-86 and 1989-90. The study also reported that as a result of soil reclamation activity, per hectare gross income increased by 88 per cent i.e., from Rs. 1,778 in 1985-86 to Rs. 3,344 in 1989-90.

Norman et al., (1991) from their study on National Watershed Development Programme in Palakkad district of Kerala state concluded that on an average each beneficiary received Rs. 2,281 in the reference year of which 78 per cent was for land development works, 18 per cent for fertilizer and 4 per cent for seeds/seedlings. The study also indicated that about 25 per cent of the beneficiaries were benefited by the land development works by way of increased yields, irrigation potential and subsequent change in cropping pattern.

The study of Singh and Singh (1991) at Rendhar watershed project revealed that per capita income has increased from Rs. 94 to Rs. 1401 and poverty declined considerably with the implementation of watershed programme.

The study of Singh (1991) at Mittemari watershed area revealed that the project had a positive impact on crop yields. The average incremental net
benefit from all the crops was Rs. 1,300 per hectare in 1984-85 and Rs. 1970 per hectare in 1986-87 and the incremental benefit-cost ratios for crops ranged from 1.84 to 7.3 in 1986-87.

Mahnot et al., (1992) from their study observed that the watershed programme had favourable impact on both agriculture and dairy sector by increasing employment opportunities. Improved agronomic practices which were a major part of the programme led to 44.84 to 73.70 per cent increase in gross return from agricultural crops. The availability of more dry and green fodder from the watershed area increased milk production from 31 to 99 thousand litres per annum with corresponding increase in gross return from Rs. 2.72 to 11.49 lakhs.

In their study, Shiyani et al., examined the differential impact of watershed development in South Saurashtra Region of Gujarat. Three watersheds managed by GLDC and one by NGO were studied and concluded that the beneficiaries of watershed development in the study area enjoyed the benefits of the higher profitability in all the crops grown in different seasons, compared to their counterparts. The increased investment on modern farm inputs including irrigation brought out increases in net income of the beneficiaries of watershed development. This implies that there had been a positive impact of watershed development programme in raising the level of farm income in watershed area.
1.3.4 Impact of Watershed Technology on Employment

ICRISAT (1983) concluded from its study, at Aurepalle watershed area, that net returns under purely rainfed conditions were Rs. 193 per hectare and provided 29 mandays of employment.

Singh et al. (1989) reported that new crop management technology at Mir watershed in Jammu and Kashmir generated more employment due to increased intensity of cultivation, top dressing of fertilizers and other production practices. New crop management technology created an additional 55 mandays and three bullock pair days of employment per hectare over the traditional system. The alternate land use system needed about 25 mandays per hectare for clearing the site, pit making, planting and refilling. The soil and water conservation programmes required about 60 mandays per hectare.

Reddy and Walker (1990) reported that the number of days of employment available per person was higher by 32 days for male workers and 18 days for female workers in watershed area compared to non-watershed area at Chevella. While they were 23 days and 26 days respectively at Mittemari. It was also observed that the employment available were higher on marginal and small farms compared to medium and large farms.

According to Bhatia (1991), watershed approach opens up new vistas of productive and remunerative employment and therefore increases agriculture incomes. The construction and repairs of storage structures, gullies, canals, terraces, etc., involved in watershed development generate
direct employment opportunities. The increase in the intensity of cropping due to supplementary irrigation also increased employment opportunities in the farming sector. Afforestation, another component of watershed project, generates employment in nursery development and maintenance, plantation, follow-up and maintenance activities. Further, the increase in the forest area would provide opportunities for the development of several agricultural and allied activities like dairy and poultry farming, sericulture, apiculture, horticulture and agro-based industries like herbal medicines, paper-pulp, lac, resins and oils, and silk and silk dyes, leather and leather products, etc. Soil and water conservation programmes themselves would induce employment generation to a large extent not only in the form of survey staff, etc., but also indirectly by increasing the productivity and cropping intensity and thus the incomes of the people.

Neema et al., (1991) from their study at Barkhedha Hat watershed found that employment of human and bullock labour was higher by 28 and 14 per cent respectively in watershed area as compared to non-watershed area.

Reddy (1991) revealed that employment was higher by nine days for male and 37 days for female workers in watershed area compared to non-watershed area at Mittermari.

Undirwade et al., (1991) reported that various activities of watershed development have proved to be effective in the conservation of soil and water resources in Gunj watershed area. The use of human labour increased by 2 to 60 per cent and that of bullock labour by 7 to 46 per cent. The use of
nitrogen, phosphorus and potash also increased by 8 to 20.5 per cent during the same period.

Dhyani et al., (1993) from their study concluded that soil and water conservation works executed on watershed basis in the Operational Research Project, Fakot had ample scope to generate employment opportunities in hills to the extent of 22,880 mandays for casual and 1,21,979 mandays for regular labour through various sectors during the project life (25 years).

The study of Swarnalata et al., (1994) revealed generation of employment opportunities to the extent of 70,606 mandays for casual and 2,08,606 mandays for regular labour through various sectors like rainfed agriculture, irrigated agriculture, animal husbandry, ber-cultivation, agro-forestry plantations and engineering measures under watershed project over a period of 24 years in Aravali foot hills of Haryana, which will be helpful in checking migration from rural to the urban areas in search of livelihood.

Krishnappa et al., (1994) in their study at Kabbalanala, Karnataka reported that employment of human labour for crop production in 28.45 ha. of the Achalu micro-watershed increased from 2,041 mandays during the pre-project period to 3,558 mandays during the post-project period with per ha. increase in labour during the corresponding period from 72 to 125 mandays.

In their study Shiyani et al., (2002) examined the differential impact of watershed development in South Soursatra Region of Gujarat. Three watersheds managed by Gujarat Land Development Corporation (GLDC) and one by Non-Governmental Organisation (NGO) were studied. The study revealed that the per hectare labour of bullocks increased to a greater extent
in respect of beneficiaries of different watersheds compared to non-beneficiaries. In case of Gujarat Land Development Corporation watershed, the average male and female labour utilisation per hectare for beneficiaries was 21.79 and 22.04 days respectively while the corresponding figures for non-beneficiaries were 16.44 and 17.38 days. The average male and female labour utilisation per hectare for the beneficiaries of Agakhan Rural Support Programme (AKRSP) watershed was 23.69 and 24.12 days respectively whereas it was 18.32 and 20.09 days respectively for non-beneficiary group. Similar trend was observed for all the watershed beneficiaries.

1.3.5 Economic Viability / Performance of Watershed Programmes

Agnihotri et al., (1989) worked out the benefit-cost ratio for the increased agricultural production and dairy development sectors in a Shivalik foothills at 3.89 and 2.42 respectively, while the overall BC ratio worked out to 2.05 with a discount rate of 12 per cent assuming a project life of 30 years. Thus, results reiterate that investment in watershed management project all along the shivalik foothills for increasing agricultural production, dairy development, rehabilitating denoted hilly catchment, etc., found to be economically feasible.

Mahandule et al., (1989) attempted an economic analysis of watershed management in drought prone areas of western Maharashtra and arrived at a benefit-cost ratio of 1.28 and internal rate of return of 12.33 per cent of the project as a whole.
Sharma and Garg (1989) from their study on "the ex-ante appraisal of the forestry component of the Khandi watershed and area development project, Punjab" brought out that the total cost of the sub-project at 1978 market prices amounted to Rs. 51.25 million and the total benefits of Rs. 432 million with a margin of Rs. 380.75 million. The financial analysis showed that the Net Present Worth (NPW) of the subproject was positive and the cost-benefit (CB) ratio more than one at 10 per cent discount rate. The economic analysis indicated that the NPW at efficiency prices was positive and the CB ratio was more at 12 per cent discount rate. The Internal Rate of Return (IRR) was estimated at 11.38 per cent and the Economic Rate of Return (ERR) at 13.01 per cent. The sensitivity analysis revealed that the IRR was about 11 per cent and the ERR over 12 per cent even when the cost of the sub-project increased by 10 per cent without any corresponding increase in its benefits. Thus, the forestry component was estimated to be an economically viable sub-project of the Khandi watershed area development project of the Punjab state.

Singh et al., (1989) reported that the Khandi watershed project as a whole excluding irrigation and fisheries yielded a benefit-cost ratio of 1.7 at 12 per cent discount rate and IRR of 16.73 per cent. The IRR for forestry, animal husbandry, soil conservation and horticulture components was 15.29 per cent, 13.16 per cent, 12.57 per cent and 28.31 per cent respectively. The irrigation component gave a miserable return of 3.38 per cent mainly due to considerable delays in the execution and cost escalations.
Raju et al., (1991) from their study on "economic evaluation of watershed based technology - a case study of Chevella watershed in Medak district in Andhra Pradesh" reported that though the productivity of crops varied from year to year under both watershed and non-watershed situations, the yields were higher during 1986-87 and 1989-90 in watershed villages compared to non-watershed villages. Benefit-cost ratios for crops were on the higher side in watershed programme villages. There was no clear trend in additional benefit-cost ratio. It is greater than one for most of the crops from 1986-87.

Sandhu et al., (1991) from the economic analysis of Kandi watershed and area development project concluded that the rate of return was 15.2 per cent for forestry, 13.1 per cent for livestock and 12.6 per cent for soil conservation and a benefit-cost ratio of more than unity at 12 per cent discount rate while the overall rate of return was found to be 14.5 per cent.

Sindhu et al., (1991) revealed that the Makkowal and Katour-Manhota projects proved to be economically viable and contributed significantly to enhancing land productivity and income of the beneficiaries in the command area through increased cropping intensity and bringing fallow land under high productivity crops. Whereas the Atwarpur dam proved to be totally non-viable with miserably low benefit-cost ratio and has not generated any significant benefits to the beneficiaries due to its inappropriate location, heavy cost, very low command area and seasonal nature of the rivelet feeding this dam.
Singh et al., (1991) revealed that the forestry, animal husbandry, soil conservation and horticultural components of the integrated watershed development project in the Kandi tract of Punjab were economically justifiable. The IRR was more than 12 per cent in all cases except soil conservation in Maili watershed where it was not adequately complemented by the irrigation component.

According to Suryawanshi et al., (1991) the economic assessment of the Kolhewadi watershed project indicated an increase in the income. The payback period of the project was 3 to 4 years.

Dhyani et al., (1993) concluded that adoption of soil and water conservation technologies on farmers' fields on watershed basis in the outer Himalayan region are highly economical (B-C ratio of 1.93:1). Further, the relative efficiency indices of the sectors indicated that irrigated agriculture (1.11) was most rewarding followed horticultural development (1.03). The fuel-fodder plantation sector (0.85) and rainfed agriculture (0.90) were economically non-viable.

Swarnalatha et al., (1994) revealed that agriculture, animal husbandry, forestry and horticultural components of the project to be economically justifiable. The B-C ratios for all the sectors were more than 1.6 and for the whole project it was 1.9 which clearly indicated the economic viability of the soil and water conservation measures taken on watershed basis. Ber-cultivation was found to be the most paying enterprise as indicated by the cost effectiveness criterion, followed by the animal husbandry and irrigated agriculture sectors. Rainfed agriculture was the least paying proposition. The
pay-back period for the whole project was eight years and the internal rate of return was 24 per cent.

Ram Mohan Rao et al., (1996) indicated from their study at Chinnatekur Watershed, Andhra Pradesh that the activity of the project had a discounted B.C ratio ranging between 1.41 to 1.51 with a discount rate of 20 per cent and the investment on soil and moisture conservation works was paid back in just one year with increased returns from crop production alone.

Rajput and Verma (1997) from their study concluded that the average benefit-cost ratio was higher at 1:2.51 in watershed development programme as compared to 1:1.83 in non-watershed development programme area. The returns on per rupee of investment was also higher in watershed development programme as compared to non-watershed development programme area.

1.3.6 People's Participation in the Watershed Management Programme

Chowdary (1980) stated that people are the most important 'factor' in implementation of the watershed management programme. People's motivation depends upon the socio-economic benefits which are expected to accrue to them. He emphasized the need for education, training and extension for mobilizing the people to make them participate actively in the watershed programmes.
Jaiswal et al., (1985) revealed that people's participation was totally absent at all stages of watershed management, except that at implementation. They expressed that the farmers had no direct involvement in the planning of watershed activities. It was observed that almost all respondents (98%) reported to have given consent to the soil conservation works. They further indicated that regarding their involvement in the bunding work, majority of them (86%) did not participate at all. The watershed people had no part to play in designing the watershed plan (project formulation), maintenance of assets and evaluation of programme.

Sen et al., (1985) observed that the participants came to know about the social farm forestry programme from the local forest officials and 64 per cent respondents could not even remember the issues discussed in the pre-planning meetings which were held mainly for creating awareness among the villagers.

Suresh (1990) in his study on participation of beneficiaries in the development programmes of non-governmental organisation in Kerala, reported that only 38 per cent of the beneficiaries had a satisfactory level of participation. No one had attained high degree of participation. The rate of participation was highest in secular, followed by co-operative NGOs. About 62 per cent of the beneficiaries had not attained the desirable degree of participation in the developmental programme initiated and implemented for them. The author further stated that most important method of participation was receiving the benefits. Beneficiaries were hardly taken in to confidence
for monitoring, supervision, evaluation and follow up. They were least consulted even during pre-planning period. Participation in monitoring, evaluation, and planning received lower priority.

Singh and Gupta (1991) revealed that the watershed development project at Mandsaur district of Madhya Pradesh made a drastic change in the attitude of people towards the hills, trees and rain water and protected the hills from further degradation after adopting social forestry. By direct involvement, people became self-reliant and they managed irrigation pipelines laid in their fields for the conveyance of water, maintenance of water harvesting by the embankments and other soil conservation works done either in the common land or in their own land.

Singh (1991) stated that the most important pre-requisite for people's participation is that the expected private benefits from participation must substantially exceed the expected private costs of participation. Programme interventions or measures that seek to enhance the expected benefits to people or reduce the expected costs are likely to elicit more of people's participation than those that do not seek to do so. Other important determinants of people's participation include organisation of people into small groups, good local leadership, existence and enforcement of rules for equitable sharing of benefits from collective action, and willingness and ability of government to make the needed investment in watershed development and provide technical information, training, and guidance. Non-governmental organisations are better oriented to enlist people's participation and have necessary skills and patience to work with people, to organise them,
to motivate them and to train them and thereby to empower them so that they could identify their problems and resolve them on their own eventually. It is high time that governmental organisations engaged in watershed development and management programmes learnt from the experience of the non-governmental organisation, involving people and incorporating the lessons into their strategies. Otherwise, huge amounts of scarce resources would continue to be wasted on ill conceived, ill designed and badly executed programmes as before.

Reddy (1993) concluded that most of the farmers in Kalyanakere watershed project of Karnataka state had clearly perceived the ill effects of soil erosion on various aspects and adopted a combination of soil and water conservation practices. Further, the results of multivariate analysis revealed that farm income in case of small farmers and size of holding and number of fragments per acre in case of large farmers were significantly influencing the adoption of soil and water conservation practices in the project area.

Swarnalatha and Sarma (1994) revealed that people's participation in watershed development programme was initially very high but after two years, they also lost their interest and started sending their animals for grazing in the catchment area. They further stated that people's participation was one of the most baffling problems confronting the planners of the programme.

Sharma (1995) reported that majority of participants (48.00 per cent) exhibited high level of participation followed by low level (30.00 per cent) and
medium level (22.00 per cent) of participation in total literacy campaign. Level of participation was higher among males than females and there was a direct relationship between availability of time and level of participation.

The main findings of the Kallur (1997) study are notwithstanding the fact that farmers are being cajoled by sanghas to adopt the improved agricultural practices. They have succeeded in their attempt only partially. It is, therefore, concluded that people's participation in adopting environment friendly techniques in farming with reference to three mini-watersheds is more or less a failure.

Some studies were restricted only to economic appraisal of the watershed projects while some to study the impact of watershed programme on cropping pattern, production and productivity, income and employment. Besides these, the studies made so far on change in physical asset structure of beneficiaries due to watershed programme implementation and people's participation in such programmes were also inadequate.

1.4 PROBLEM AND PURPOSE

1.4.1 Need for the study

The review of literature has brought out certain deficiencies and limitations in the studies conducted by the earlier research workers. Although several studies were made on watershed programmes implemented in India, most of them were limited to Operational Research Project, ICAR implemented model watersheds, and World Bank aided projects. Only a few
studies were made on recently implemented national watersheds under NWDPRA under Ministry of Agriculture. Among the available few studies on NWDPRA, majority of the studies mainly dealt with the impact of watershed management on land use pattern, cropping intensity, cropping pattern, crop production, income and employment. No study is comprehensive covering various aspects of watershed management programme and also no systematic study is available on people's participation, knowledge and adoption of watershed technology. Knowledge and adoption of technology is very crucial in the absence of which the programme will not be successful in achieving the objectives. Further, while evaluating the impact of watershed management, most of the studies looked at the working of watershed management programme by considering participation of all the farmers as a single entity which would not bring out the likely differential rates of impact on the farmers in so far as they are not homogenous in terms of their personal attributes. The heterogeneity inherent in the beneficiary farmers and the consequensial differential rate of impact will not surface unless the evaluation of the programme is conducted at some levels of disaggregation. One way of disagregating the watershed farmers is to distinguish them across different operational land holding size groups. The present study is a modest attempt to overcome the above limitations of the earlier studies.

1.4.2 Focus of the Study

The present investigation is initiated with the prime purpose of examining the adoption of watershed development technology and its impact on production, productivity, income and employment generation. The specific objectives of the study are
1. to assess the physical and financial progress of National Watershed Development Programme for Rainfed Areas (NWDPPRA) in India and Andhra Pradesh.

2. to examine the knowledge of the beneficiary farmers on watershed technology.

3. to examine the extent of people's participation in the implementation of NWDPPRA watersheds.

4. to find out the extent of adoption of recommended watershed management practices by the farmers.

5. to assess the impact of watershed development programme on cropping pattern and cropping intensity, and

6. to evaluate the impact of watershed development technology on crop yield, crop income and employment generation.

1.4.3 Hypotheses

With the objectives in view the following hypothesis have been formulated.

1. The knowledge of the beneficiary farmers on watershed technology is not adequate.

2. The participation of the farmers in the implementation of NWDPPRA watersheds is not significant.

3. The adoption of recommended watershed management practices by the farmers is not significant.
4. NWDPRA has no significant impact on cropping pattern and cropping intensity.

- The impact of NWDPRA is not identical on cropping pattern and cropping intensity among small, medium and big farmers.

5. There is no significant impact of NWDPRA on crop yield, crop income and employment generation

- NWDPRA has no uniform impact on crop yields, crop income and employment generation of different land holding groups.

1.5 METHODOLOGY

The methodology adopted for the study is discussed here under.

1.5.1 Data Base

To examine the objectives of the study, relevant data were collected from both primary and secondary sources. The primary data were collected directly from the sample respondents who belong to two groups viz., beneficiaries and non-beneficiaries through a field survey in Chittoor District of Andhra Pradesh State. For this study, two types of schedules were designed viz. 1. Schedule for the beneficiaries and 2. Schedule for non-beneficiaries. The schedules were pretested and necessary improvements were made before conducting the survey. In addition to the primary data, information was collected from secondary sources also. The data relating to progress of watershed development programme were collected from annual...
reports of Department of Rural Development, Government of India, Department of Rural Development, Government of Andhra Pradesh and Department of Agriculture, Government of Andhra Pradesh. The data pertaining to Chittoor district were collected from DPAP office and DRDA, Chittoor.

1.5.2 Reference period

As the study aims at analyzing the performance of NWDPRA, it was felt that the reference period selected should be after completion of all the watershed management works. In the selected watersheds, the project work was completed in 1998-99. Hence, 1999-2000 agricultural year has been chosen as the reference period.

1.5.3 Selection of the district

A number of watershed programmes are being implemented by various government and non-government agencies in Chittoor District. Under NWDPRA, Six micro watersheds were implemented during 1990-91 to 1996-97 in Chittoor District. Among the districts of the state, Chittoor ranked first in area treated under the six watersheds covered by NWDPRA. (i.e. from 1990-91 to 1998-99). Considerable importance has been also given in fixing physical and financial targets and allocation of funds by the government to the district. Out of the total financial progress made in the watershed project of Andhra Pradesh nearly 6.91 per cent was in the Chittoor District.
watersheds alone. The district also achieved higher i.e., 51.04 per cent of the total financial targets fixed so far for the district compared to the other districts in the state. Considering these facts, Chittoor district was purposively selected for the present study.

1.5.4 Selection of watersheds

Under NWDPRA, six micro watersheds are taken up in Chittoor Dist. during eighth five year plan. They are 1. Irala 2. Bheemiganipalli 3. Kalikiri 4. Kalakada 5. Gorantlapalli and 6. Udayamanikyam. Out of six watersheds two watersheds were selected for the study on the basis of proportion of dryland area in net cropped area. Two watersheds with high proportion of dryland area i.e., udayamanikyam and Kalakada watersheds are selected for the study. The Kalakada watershed covered two Mandals (i.e. Kalakada and K.V. Palli) and nine (9) revenue villages. Udayamanikyam watershed covered one Mandal (i.e. Yarravaripalem) and four revenue villages.

1.5.5 Selection of Farmers

These farmers are well exposed to watershed technology and derived benefit from it. The list of beneficiaries along with their operational holdings was obtained from the watershed authorities and they were stratified in to three farm size groups viz small farmers, (below 5 acres) medium farmers (5 to 10 acres) and large farmers (above 10 acres). From each group, 10 per cent were selected on the basis of simple random sampling. In two watersheds in total 158 small farmers, 66 medium farmers and 79 large farmers were sampled for the study.
A. Selection of (Beneficiaries) Watershed farmers

Farmers who come under the Udayamanikyan and Kalakada watersheds are considered as beneficiary farmers. The list of beneficiaries along with their operational holdings was obtained from watershed authorities, pooled and arranged in ascending order based on area of operational holding. The sample beneficiaries were drawn by simple random sampling method. Later they were stratified into three size groups viz. small farmers (below 5 acres), medium farmers (5 to 10 acres) and large farmers (above 10 acres). The proportionate random sampling technique was followed for selecting 8 per cent from each group of beneficiary farmers in two watersheds. In total 158 small farmers, 66 medium farmers, and 79 large farmers were sampled for the study.

B. Selection of Non-Beneficiaries

To evaluate the impact of the NWPRA, there is need to compare beneficiaries with non-beneficiaries. For this purpose, farmers belonging to the area outside the watershed were selected as a control group care was taken to see that the non beneficiaries were similar to beneficiaries in all respects except for the fact that the latter is exposed to the scheme. For an effective comparison, the farmers outside the watershed but in the close vicinity where similar agro-climatic conditions prevail were considered. The non-beneficiaries were also stratified into small, medium and large farmers. Equal representation was given to all the three groups. For this study, 120 non-beneficiaries were sampled covering 40 farmers from each group on the basis of simple random sampling.

Thus the total number of farmers selected for the study were 423 i.e 303 farmers from watershed area and 120 farmers from non-watershed area as detailed in table 1.1.
1.5.6 Tools of Analysis

The collected data are analysed with the help of appropriate statistical techniques. Besides, simple methods of analysis such as Mean, Percentages, Standard Deviation, Other econometric tools such as ‘t’ value, Analysis of variance, and Gini concentration ratio are used.

1.6 CONCEPTS USED

The following concepts were used in the study

1. Watershed/Beneficiary farmer

Any farmer benefited through one or more activities of watershed programme is termed as watershed/beneficiary farmer.

2. Non-Watershed/Non-Beneficiary farmer

Farmer who have not received any benefit from watershed activities and are engaged in agriculture outside the watershed area where similar agro-climatic conditions prevails except the watershed programme is termed as non-watershed/non-beneficiary farmer.
3. Small farmer

Farmer having less than 5 acres of dryland is grouped as a small farmer.

4. Medium farmer

Farmer whose holding size falls in between 5 and 10 acres of dryland is considered as medium farmer.

5. Large farmer

Farmer having more than 10 acres of dryland is termed as large farmer.

6. Operational Holding

It is the total holding including leased in and leased out lands cultivated by a farmer.

7. Net Cropped Area

It is the actual area under cultivation in an agricultural year.

8. Gross Cropped Area

It is the net cropped area plus area sown more than once in an agricultural year.

9. Cropping Intensity

It is the ratio of gross cropped area to the net cropped area and is expressed as a percentage.
10. **Manday**

   It refers to the work accomplished by a normal human being in a day of 8 hours.

11. **Net Income**

   It is the gross income over commercial cost i.e. the surplus over and above total cost.

12. **Net Farm Income**

   Net income from farming

1.7 **LIMITATIONS**

   As the study area was restricted to one district, the results would therefore, be applicable to the areas with similar conditions. The data were collected through personal visits to the farmers and particulars were obtained based on recall memory of farmers which has many inherent limitations. Further, the data pertains to a single agricultural year 1999-2000. What one gets from this data is a cross sectional picture at one point of time. Therefore the generalisation has to be made cautiously. Hence, there might be some inaccuracies. However, utmost care was taken to obtain accurate information by checking and cross checking with the respondents, the project officials and neighbouring farmers.
ORGANISATION OF THE STUDY

The thesis is presented in seven chapters. The first chapter is devoted to succinct introduction where in the statement of the problem, review of literature, objectives, the scope, limitations and methodology followed in the study area are discussed. The theoretical aspects of watershed management are presented in the second chapter. Agro-economic features of the study area are presented in the third chapter. The progress of watersheds in India, Andhra Pradesh and study area are analysed in the fourth chapter. The fifth chapter critically examines people's participation in watershed management and the extent of adoption of watershed technology by the watershed farmers. The sixth chapter examines, the impact of NWDPRA on cropping pattern, cropping intensity, crop yield, farm income and employment. The last chapter presents summary, conclusions and policy implications of the study.
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