AN ECONOMIC IMPACT OF INTEGRATED WATERSHED DEVELOPMENT PROGRAMME IN MEDAK DISTRICT OF TELANGANA STATE

BY

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M.Sc. (Ag.)

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2016

CERTIFICATE

Mr. V.PAVANKALYAN has satisfactorily prosecuted the course of research and that the thesis **"An Economic Impact of Integrated Watershed Development Programme in Medak District of Telangana State"** submitted is the result of original research work done and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.

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Hyderabad Chairperson

DECLARATION

I, **Mr. V.PAVANKALYAN** hereby declare that the thesis entitled **"An Economic Impact of Integrated Watershed Development Programme in Medak District of Telangana State"** submitted to **PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY** for the degree of **DOCTOR OF PHILOSOPHY IN AGRICULTURE** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

Date: **(V.PAVANKALYAN)**

Place: Hyderabad **I.D.No: RAD/2013-16**

CERTIFICATE

This is to certify that the entitled **"An Economic Impact of Integrated Watershed Development Programme in Medak District of Telangana State"** submitted in partial fulfillment of the requirements for the degree of '**Doctor of philosophy in Agriculture'** of **Professor Jayashankar Telangana State Agricultural University,** Hyderabad, is a record of the bonofide research work carried out by **V.PAVANKALYAN** under our guidance and supervision. The subject of the thesis has been approved by the Student Advisory Committee.

No part of thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been duly acknowledged by the author of the thesis.

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LIST OF CONTENTS

LIST OF TABLES

	district (2010-15).	
5.6.	Average size of the family and worker members	
5.7.	Educational pattern of the selected farmers	
5.8.	Land holding particulars of the selected farmers (Ha.)	
5.9.	Distribution of farmers based on type of soil (Numbers)	
5.10.	Soil and moisture conservation in selected blocks	
5.11.	5.11: Average fund investment and farmers benefited under watershed development programme in the study area (Rs.)	
5.12.	Problems faced by the farmers in adopting watershed development programme in the selected blocks	
5.13.	Water level in wells in the selected study blocks (in feet)	
5.14.	Sources of groundwater discharge in selected study blocks (2013-14) (In numbers)	
5.15.	Impact on land use pattern in selected study blocks (Ha.)	
5.16.	Average rise in well water level in the selected study blocks (in feet)	
5.17.	Impact on irrigated area and irrigation intensity	
5.18.	Cropping Pattern of cropped area and cropping intensities on sampled farms (Ha.)	
5.19.	Existing cropping pattern on the sampled farms (Ha.)	
5.20.	Total and average value of production of different crops in watershed	

	block (in rupees)	
5.21.	Parameter estimates of production function (watershed block)	
5.22.	Parameter estimates of production function (non watershed block)	
5.23.	Productivity index- Watershed block	
5.24.	Productivity index – non watershed block	
5.25.	Crop diversification index in the study blocks	
5.26.	Crop diversification indices (modified entropy index) in selected blocks	
5.27.	of Ranking of the farmer groups based on modified entropy index	
5.28.	Usage of inputs in farm activities in the study blocks (in numbers)	
5.29.	Impacts on livestock in selected study blocks (in numbers)	
5.30.	Average annual income per farm household in the study blocks (in Rupees)	
5.31.	Value of land per farm household in selected blocks (in Rs.)	
5.32.	Hedonic price estimates in the selected study block	
5.33.	Impact of watershed development programme on yield and cost in the selected blocks (from 2012-13 to 2013-14)	
5.34.	Benefit cost ratio	
5.35.	Expectations on overall impact of the watershed development programme in the selected block	

LIST OF SYMBOLS AND ABBREVIATIONS

σ	Standard deviation
Σ	Summation
B	Regression coefficient
e.g.	For example, for instance
et al.	And other people
etc.	And so on; and other people /things
H_0	Null Hypothesis
H_1	Alternate Hypothesis
N	Number of items
No	Number

R	Correlation Co-efficient
R	Multiple Correlation Co-efficient
R^2	Coefficient of Multiple Determination
t	Test criterion for significance
Viz.	Namely
$\overline{X}$	Grand Mean
Σx	Sum of all the items
RC_i	Relevancy Coefficient
N	Item
M_p	Mean of the total score of the respondents who answered the items correctly
M_Q	Mean of the total score of the respondents who answered the items incorrectly
P	Proportion of respondents giving correct answer to the item
%	Percentage
Q	Proportion of respondents giving incorrect answer to the item
X	Total score of the respondent for all items
Y	Response of the individual for the items
XY	Total score of the respondent multiplied by the response of the individual to the item
U_{ij}	Unit value of the i^{th} respondent on j^{th} component
Max	Maximum
Min	Minimum
Y_{ij}	Value of the i^{th} respondent on j^{th} component
Min.Yj	Minimum score on the j^{th} component
Max.Y_j	Maximum score on the j^{th} component
S_j	Scale value of the j^{th} component
APARD	Andhra Pradesh Agricultural Rural Development
APAU	Andhra Pradesh Agricultural University

APFAMGS	Andhra Pradesh Farmer Managed Groundwater System
BCR	Benefit Cost Ratio
CADA	Command Area Development Authority
CEO	Chief Executive Officer
CRIDA	Central Research Institute for Dry Land Agriculture
DC	Distributor Committee
DDP	Desert Development Programme
DPAP	Drought Prone Area Programme
DPR	Detailed Project Report
DWCRA	Development of Women and Children in Rural Areas
DWMA	District Watershed Management Agency
EC	Executive Committee
ERIA	Economic Research Institute for ASEAN
FAO	Food and Agricultural Organization
Fig	Figure
GO	Government Organization
GOI	Government of India
GP	Gram Panchayt
ICAR	Indian Council of Agriculture Research
ICRISAT	International Crops Research Institute for Semi Arid Tropics
IWDP	Integrated Waste Land Development Programme
IWDP	Integrated Watershed Development programme
IWMP	Integrated Watershed Management Programme
INRM	Integrated Natural Resource Management
KVK	Krishi Vigyan Kendra
Ha	Hectare
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Act
NABARD	National Agriculture Bank for Rural Development
NGO s	Non Government Organizations
NRM	Natural Resource Management
NWDPRA	National Watershed Development Project in Rainfed Areas
PC	Project Committee
PIA	Project Implementing Agency

PO	Project Officer
PRA	Participatory Rural Appraisal
PRIs	Panchayat Raj Institutions
RKC	Rural Knowledge Centre
SDA	State Department of Agriculture
SHG	Self Help Group
SLNA	State Level Nodal Agency
SWC	Soil and Water Conservation
TCS	Tata Consultancy Services
UAS	University of Agricultural Sciences
UG	User Group
VO	Voluntary Organizations
VWDC	Village Watershed Development Committee
WHS	Water Harvesting Structure
WC	Watershed Committee
WCC	Watershed Computer centers
WDC	Watershed Development Committee
WDP	Watershed Development Programme
WUA	Water User Associations
WUC	Water User Committee

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ABSTRACT

In India half of the population depending on agriculture. Indian agriculture is dependent on monsoons. Monsoons are erratic and undependable. Nearly 60% of the cultivable land in India is dependent on monsoons, which is contributing nearly 42% of the total production from agriculture. Watershed Development programme focus on rainfed regions because these areas represent 60 percent of arable land in India and 55 percent of the country's agricultural output, and provide food that supports 40 percent of the nation's population (Ahmad *et al*. 2011; Planning Commission 2012).

National watersheds implemented in each district along with the area treated in Telangana state so far (i.e., from 2010-2015). There are nearly 330 national watersheds in Telangana with 1393056 hectares of treated area. It revealed that maximum number of 8 watersheds each were in districts of Mahaboob Nagar, (103) were most of the land is of dry or rainfed followed by 59 in Adilabad, 48 in Nalgonda and 37 each in the districts of Ranga Reddy and Medak.In the case of treated area under the programme, maximum area of 427577 hectares was found with MahabubNagar district indicating a larger coverage under each watershed in the district compared to other watersheds in other districts. Adilabad with 249278 hectares and Medak with 161785 hectares and Ranga Reddy with 156957 are in the order of sequence, while Karimnagar District was with minimum (16653 ha)treated under the programme.

The size of the holding increased the area under rainfed conditions also increased, exhibiting a direct relationship in both watersheds as well as non-watershed categories of respondents. Similar trend was observed under tank and well irrigation among all the size groups of both watershed and non-watershed categories of farmers, excepting, those of small farmers in watershed area that owned less area (0.14 ha.) under tank irrigation accounting for 6.03 per cent of the total holding area. The watershed area is covered with red soil (98.4 per cent) and Non watershed area is covered with black soil (96.80 per cent).

The major portion of the farmers was benefit from the farm pond and percolation pond. About 37.13 per cent of the pooled farmers have farm ponds. Farm ponds were used as a water

conservation measure by about 54.2 per cent of the small farmers, 32.6 per cent of the medium farmers and 24.6 per cent of the large farmers. The farmers have more than one farm pond also.

The water level in the wells and bore wells was high during the north east monsoon period in both the blocks. The average well water level in the non watershed block was 36.96 feet, much lesser than the average water level in the watershed 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. Compared to Non watershed block more recharge of water levels in wells and bore wells in watershed block.

The watershed block before the watershed intervention technology in 2012-13 the water level in wells and bore wells were 32.58 feet and 100.88 feet respectively. This is rise to 47.57 and 122.82 feet respectively in 2013-14. The water level in the wells and bore wells were comparatively high in the watershed block across all farmers compared to the non watershed block. After the watershed development programme a rise in the water level in the wells and bore wells were seen in the watershed block. Compared to the Non watershed block, the rise in the water level was comparatively high in the watershed block across all the farmers. On an average, the rise in the well and bore well water levels in the watershed block was 15.16 feet and 24.08 feet respectively after the watershed Development Programme. The analysis reveals that ground water level has increased in the watershed block after the usage of watershed Development Programme.

In watershed block, the average net area sown and gross irrigated area during 2012-13 in the watershed block was 6.48 and 7.43 hectares respectively. This had increased to 8.51 and 10.19 hectares respectively in 2013-14. The percentage in irrigation intensity was 10.40 per cent in the watershed block and 3.93 per cent in Non watershed block. The analysis reveals that after the watershed intervention technology: In both the blocks the net area sown and gross irrigated area and Irrigation intensity had increased among all the farmers.´ In the watershed block, highest irrigation intensity was realized by the small and large farmers.

The largest improvement in cropping intensity in the watershed block was recorded by the medium farmers 139.02 and in the non watershed block it was realized by the medium farmers 125.72.Cropping intensity is more in watershed block compared to non watershed block in selected study area.

In the watershed area, the average yield had exceeded the potential yield for paddy for the three farmer groups, after watershed development programme in 2009-10. Similarly crop productivity index for paddy, maize, cotton and onion exceeded ‘one’ among small, medium and large farmers in 2013-14. Overall crop productivity index for paddy crop (1.31) is more than other crops are maize, cotton and onion. In Non watershed area also the crop productivity index for paddy and cotton crops had exceeded ‘one’ among small, medium and large farmers in 20013-14. But in the case of maize and onion crops, it shows a low level of crop productivity index for small, medium and large farmers with crop productivity index taking values for maize crop 0.92, 0.81 and 0.81 respectively, and the onion crop is 0.96, 0.99 and 0.82 respectively.

It shows that the overall crop productivity index had increased in all crops in watershed area compared to non watershed areas.

In the watershed block, there was an increase in the value of land for all groups of farmers. It could be seen from the table 5.26 that land value per farm house hold for small farmers had increased from 3,91,890 Rupees in 2012-13 to 5,11,890 Rupees in 2013-14. For the medium farmers it was from 3,41,480 to 4,61,480 Rupees and for large farmers from 3,88,080 to 5,82,120 Rupees 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 50.00 to large farmers. The overall percentage change in the land value per farm household in watershed block, after the application of watershed intervention technology accounted to 38.58. In the Non watershed block the land value per farm household had increased from 2,35,000 Rupees in 2012-13 to 3,92,840 Rupees in 2013-14. The value of land had highly increased in this block, for the medium farmers from 2,59,200 Rupees in 2012-13 to 3,82,200 Rupees in 2013-14, followed by medium farmers with increase in land value from 2,14,090 Rupees in 2012-13 to ` 3,34,090 Rupees in 2013-14. For small farmers the monetary benefit from land was 17.26 per cent.

The findings reveal that for all the farmers the land value in money terms had increased in watershed block compared to Non watershed block in study area. The increase was much realized by the large farmers in watershed block.

The Benefit Cost Ratio (BCR) ranged from 1.50 for the small farmers to 3.50 for the medium farmers and 4.99 for the large farmers in the watershed block. In the Non watershed block also similar results prevailed. It is noticed from the above table 5.34 that among the sample farmer groups BCR for small farmers was 2.08, for medium farmers 2.68 and for large farmers 3.87. The financial results on feasibility analysis revealed that the benefit cost ratio exceeded 'unity' for all farmer groups.

In the watershed block, the calculated economic surplus exceeded. Being the major rain fed crops, these four crops benefited from the implementation of the watershed development programme. The change in economic surplus due to watershed development programme was decomposed into change in "consumer surplus" and change in "producer surplus". It was evident that the producer surplus was higher than the consumer surplus for all the crops in watershed block. The producers surplus was high for onion which was worked out to be 75.56 per cent. The estimated producers surplus exceeded more than 50 per cent for paddy, maize and cotton crops. The analysis reveals that, the producers surplus exceeded that of the consumer surplus for all crops. The farmers as producers benefit from watershed development programme in watershed block.

Peoples' participation in watershed development and management programmes is crucial for their successful and cost-effective implementation. This is so because the watershed approach requires that every field/parcel of land located in a watershed be treated with appropriate soil and water conservation measures and used according to its physical capability. Moreover peoples' participation should be encouraged because they are aware of their own needs better. At the same time, it has been seen that non-involvement of people in the development programmes is also a great concern and challenge to rural development. No programme can be a success without the involvement of the people. Since the project emphasizes the participatory management, involvement of file beneficiaries right from planning stage helps in smooth and effective implementation of file programme.

The level of farmer's participation both at planning and implementation stages of the watershed project was satisfactory. However, some more technical information, training and guidance has to be provided to the farmers by project authorities in adoption of improved practices and maintenance of assets created even after withdrawal of project from the area.

CHAPTER I

INTRODUCTION

Land and water are the most precious natural resources, and its importance in human civilization needs no elaboration. The total available land area in the state sets the limits within which the competing human needs have to be met. The needs of agricultural, industrial, domestic and others often result in diversion from one use to the other. Diversion of land from agriculture to non- agriculture uses adversely affects the growth in agriculture sector. Even the available land is subjected to soil-erosion of varying degrees and degradation problems of different magnitudes. Water supports all forms of life on this mother earth. It is an essential constituent of all living organism. It forms about 75 per cent of the earth's crust. Unlike most other natural resources, water does not have any substitute in its main uses. Water seems over-abundant on this planet: three quarters of its area is covered by water. The 1,400 million km^3 of water so present can cover the entire area of the earth to a depth of 3,000 metres. However, around 98 per cent of the water is in the oceans. Only 2.7 per cent is fresh water. Of this 75 per cent lies frozen in the Polar Regions; 22.6 per cent is present as groundwater (Ministry of Water Resource, 2012).

Water plays a vital role in agricultural and industrial development and in sustaining human life. Rain fall is the only source of water. Rain water is confined as i) soil moisture, ii) stored water in surface storage like reservoirs, tanks, ponds, ooranies, temple tanks and in open wells etc., iii) groundwater in sub surface iv) sea water and v) waste water like sewage and effluents. Depending upon the rainfall, its intensities and frequencies, an area becomes drought or flood affected. Land or soil acts as storage for the water (Department of land Resource, 2012).

Land being the major non-renewable natural resource is inelastic in nature. There is lot of pressure on land due to increasing population from the agricultural, industrial and housing sector. On the other hand, land is subjected to soil erosion and land degradation problem due to rain or wind action and faulty cultivation practices resulting in loss of topsoil, which is the place where all nutrients are available. This leads to poor yields, uneconomic returns, reservoir sedimentation, and reduction in storage capacity, reduction in ayacut area, and shutdown of hydel power stations, ecological imbalance, environmental pollution, droughts and floods. Hence the conservation, development and management of the land resources which ensures the physical, chemical and bio-logical health of soil profile is of prime importance and also a sine qua non for water resources management, right from soil moisture conservation to flood control. In a predominantly agricultural system, the objective of improving the productivity, profitability and prosperity of the farmers and achieving agricultural development on an ecologically sustainable basis can be attained only when conservation, development and management of the land and water resources through construction of watersheds are assured (Ministry of Environment and Forests, 2010). As watershed supports the entire dry land agriculture/horticulture and also remain the catchments for tanks and reservoirs, the strength of the watershed development programmes will largely determine the growth in agriculture. Water conservation and rainwater harvesting is most effective when taken up as part of watershed management. Watershed management involves soil and water conservation efforts integrated with appropriate cropping pattern, proper agricultural practices combined with animal husbandry as a community effort to reap maximum economical gain (Ministry of Rural Development, 2010).

The planners are searching solutions to restore the ecological balance with human face. The community's demand for food, energy and many other needs has to depend on the preservation and improvement of the productivity of the natural resources. Ever since independence, India's planners and policy makers have shown concern for efficient use of land, water and other natural resources for accelerated and sustainable development (Ramappa, *et.al*, 2008).

However, notwithstanding these concerns, the problems of land degradation and ground water depletion have assumed serious proportions in many areas which threaten not only the sustainability of agriculture, but also the overall livelihood system of the people. In an agrarian economy like India, irrigation has played a major role in the agricultural production process. Agriculture is the source of life for majority of people living in rural areas of developing nations. Agriculture including crop and animal husbandry, fisheries, forestry and agro processing provides the underpinnings of food and livelihood security in India (Economic survey, 2012-13).

Agriculture provides the principal means of livelihood for over 58.4 per cent of India's population. It contributes approximately one-fifth of total gross domestic product. Agriculture provides significant support for economic growth and social transformation of the country. As one of the world's largest agrarian, India has a monsoon-dependent farming system, with large areas receiving inadequate rainfall. Moreover, much of this rainfall is restricted temporarily to few months while the rest of the year predominantly dries. In such circumstances, it is only with irrigation that cultivation on an annual basis is possible. Moreover, irrigation has acquired additional importance since the green revolution in India.

United Nations (2006) predicts that by 2025, two thirds of world population will experience water shortage, affecting lives and livelihoods of approximately 1.8 million people and by 2050, 7 billion people in 60 countries may have to cope with water scarcity. According to a report of the World bank (2010), if the present trend of groundwater exploitation continues, then in 20 years about 60 per cent of all aquifers in India will be in critical condition. This will have serious implications for the sustainability of agriculture, long-term food security, livelihoods and ultimately economic growth of the country.

In India, the total utilizable water resource is assessed as 1123 Billion Cubic Meters (BCM). Keeping a provision of about 71 BCM/year, out of 433 BCM of groundwater, 362 BCM/year of the resource is estimated to be available for irrigation. The net draft of groundwater for irrigation is around 150 BCM/year. The per capita availability of water at national level has been reduced from about 5177 cubic meters in 1951 to the estimated level of 1,820 cubic meters in 2001 with variation in water availability in different river basins. Given the projected increase in population by the year 2025, the per capita availability is likely to drop below 1000 cubic meters, which could be labeled as a situation of water scarcity (Government of India, 2010). India has a highly seasonal pattern rainfall, with 50 per cent of precipitation falling in just 15 days and over 90 per cent of river flows occurring in just four months. A total storage capacity of 212.78 BCM has been created in the country through major and medium projects. The projects under construction will contribute to an additional 76.26 BCM, while the contribution expected from projects under consideration is 107.54 BCM. The total availability of water in the 76 major reservoirs was 109.77 BCM at the end of the monsoon of 2005 (Government of India, 2010). The irrigation potential of the country has been estimated at around 139.9 M.ha without inter-basin sharing of water and 175 M.ha with inter-basin sharing. The Central Ground Water Board (CGWB) has estimated that it is possible to increase the groundwater availability by about 36 BCM, by taking up rainwater harvesting and artificial recharge over an area of 45 million hectare (M.ha) surplus monsoon runoff. Thus, the groundwater availability may correspondingly increase. The recent estimates (Government of India, 2010) on water demand are made by a) Standing Sub-Committee of the Ministry of Water Resources Development (MoWR) and b) the National Commission for Integrated Water Resources Development (NCIWRD); their estimates (shown in table 1.1) are made till the year 2050. Both of them have triggered warning bells on the intensity of the problem. The estimates by MoWR indicates that, by the year 2050, India needs to increase by 5 times more water supplies to industries, and 16 times more for energy production, while its drinking water demand will double, and irrigation demand will raise by 50 per cent. To address the water-related issues and thereby launch a massive awareness programme all over the country, the Government of India has declared year 2007 as “Water Year”.

Table-1.1 Water demand (in bcm) for various sectors

Sector / Year	**Standing Sub-Committee of MoWR**			**NCIWRD**		
	2010	**2025**	**2050**	**2010**	**2025**	**2050**
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111

Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	**813**	**1093**	**1447**	**710**	**843**	**1180**

Source: Government of India, 2010.

The total geographical area of India is about 329 Million Hectares (M. ha), out of which 184 M ha lands are used as cultivable lands.

The utilizable surface water potential of the country has been estimated to be 1869 cubic km. but the amount of water that can be actually put to beneficial use is much less due to severe limitations imposed by physiography, topography, interest issues and the present state of technology to harness water resources economically. The estimates made by the Central Water Commission indicate that the water recourse utilizable through surface structures are about 690 cubic km only (about 36 per cent of the total).

Groundwater is another important source of water which can be extracted economically from the ground water aquifers every year is reckoned as ground water potential. The estimates made by the Central groundwater board indicate that utilizable groundwater is about 432 cubic km. Thus total utilizable water resources are estimated to the 1122 cubic km. The Central Ground Water Board (CGWB) has proposed that it is possible to increase the groundwater availability by about 36 km^3, by taking up rainwater harvesting and artificial recharge over an area of 45 million hectare (m.ha) through a non-committed surplus monsoon runoff (Government of India, 2010).

In order to augment the depleting groundwater resources, it is essential that the surplus monsoon run off that flows into the sea is covered and recharged to augment groundwater resources. Central Groundwater Board has prepared a conceptual plan for artificial recharge of groundwater for the country. Out of the total geographical area of 3,28,7263 sq. km. of the country, an area of 4, 48,760 sq. km. has been identified suitable for artificial recharge. The total quantity of surplus monsoon runoff to be recharged has been worked out as 36.4 BCM. (Harender Raj, et al., 2010).

India is the world's largest exploiter of ground water. The Ministry of Water Resources suggested that around 2020, India will be a 'water stressed' state with per capita availability declining to 1600 cu m/person/year. World Bank report called for immediate action to save India's groundwater resources, the largest user of groundwater in the world, and said that 60 per cent of the aquifers will be in critical condition within the next 20 years. India uses an estimated 230 km of groundwater every year, making it the largest user in the world. This also amounts to more than a quarter of the global total groundwater usage. Today groundwater supports approximately 60 per cent of irrigated agriculture and more than 80 per cent of rural and urban water supplies in India. In fact, groundwater use has been steadily increasing in India over the last four to five decades. There is a need for better management of this resource to ensure its sustained availability for future generations (Muthamizh Vendan Murugavel, D. 2010). In India majority of the people living in rural areas still depend on rainfed agriculture for their livelihood. But large tracts of rainfed areas are prone to drought and characterized by low productivity, high risk and vulnerability to degradation of natural resources. Hence it is necessary to prevent the degradation of soil, water and other related resources in order to enhance agricultural productivity and incomes of the people of dry land areas.

Rainwater is being lost by surface runoff in rain fed areas and areas of waste levels which has to be harvested for conservation and utilization for productive purpose. Rain water harvesting is the process, to capture and store rainfall for its efficient utilization and conservation to control its run off, evaporation and seepage. Some of the benefits of rain water harvesting are:

It increases the water availability, it checks the declining water table, it is environmentally friendly and economically feasible. (Sandhya Suri, 2010). The following are some of the measures through which rainwater could be harvested.

- In agricultural lands, with less than 6 per cent slope, contour bunds and field bunds can be constructed to harvest rainwater for insides soil moisture conservation.
- In rainy seasons, surface runoff can be prevented / diverted to small check dams for percolation into the sub soil zone.
- Excess runoff from an area can be stored in percolation ponds / tanks for groundwater recharge.
- In agricultural rain fed areas, field ridges may be formed for better soil moisture conservation farm ponds may be constructed in frames to harness the excess rainwater and may be utilized for one or two supplemental irrigations.
- Excess rainwater can be stored in percolation ponds in needed areas. The site selection for percolation ponds will be decided based on the drainage area and the number of wells to benefit by the pond.
- In deep ground water table areas, recharge tube wells can be constructed for recharging

groundwater using surface run off during rainy season.

The overall objectives of these development programmes, by and large, are three fold, viz. promoting economic development of the rural area, employment generation and restoring ecological balance (Department of Land Resources, 2006). The watershed development programme assumes importance in India where 60 per cent of the cropped area is rain fed and is characterized by low productivity, water scarcity, degraded natural resources and widespread poverty. Under such situation, understanding the nature and extent of impact of these watershed development programmes on various domains in the rural economy is crucial for the development personnel/specialists, economists and policymakers. It would guarantee more food, fodder, fuel, and livelihood security for those who are on the bottom of the rural income scale.

Watershed development structures play a significant role in groundwater recharge. These structures enhance soil moisture regime, enrich soil fertility and thereby promote ecological balance through conservation of eco system.

Rainfed agriculture in India is characterised by low productivity, degraded natural resources and widespread poverty, most of the millions of people living in our country depend on agriculture and natural resource management for their livelihoods watershed has become an acceptable unit for planning soil and water resources conservation.

The World Bank has estimated that 25 per cent improvement both in water use efficiency (WUE 35 to 43 per cent) and crop yield would generate an additional food grain production of 85 m.t., which would be equivalent to 44 per cent increase in food grain production by 2025.

India needs to shift its focus from ‘water resources development’ to ‘water resources management’ by restructuring and strengthening existing institutions for better service delivery and resource sustainability. Planning for big water resources projects should be interdisciplinary with all environmental, ecological and human concerns internalized and thereby assessing the impacts by a concrete statute. At the national level, a number of National Commissions have been constituted by the central government to review specific water policy issues as well as plan for a long-term development of the water sector. Different ministries like Ministry of Agriculture (MoA), Ministry of Rural Development (MoRD) and Ministry of Environment and Forest (MoEF) are involved in the implementation of watershed development and has been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile eco-systems, experiencing soil erosion and moisture stress. Different types of treatment activities are carried out in a watershed. They include soil and moisture conservation measures in agricultural lands (contour/field bunding and summer ploughing), drainage line treatment measures (loose boulder check dam, minor check dam, major check dam, and retention walls), water resource development/ management (percolation pond, farm pond, and drip and sprinkler irrigation), crop demonstration, horticulture plantation and afforestation (Palanisami and Suresh Kumar, 2009).The DPAP was launched in 1973-74 to tackle the special problems faced by those areas that are constantly affected by drought conditions. In the year 2008, 972 blocks of 195 districts in 16 states are covered under the programme. IWDP has been under the implementation since 1989-90. The projects under the IWDP are generally sanctioned in areas that are not covered under DDP or DPAP. Since 1st April 1995 and IWMP progamme started from 2009, these four programmes are being implemented on the basis of common guidelines for watershed development. Details of the projects sanctioned and funds released from 1995-96 to 2015-16 are given in table 1.2.

Watershed development programmes depend upon the participatory approach. It envisages integrated and comprehensive plan of action for the rural areas, people's participation at all level of its implementation is very important. The watershed management approach requires every piece of land located in watershed to be treated with appropriate soil and water conservation measures (Palanisami *et.al*, 2009). For this to happen, it is necessary that every farmer having land in the watershed accepts and implements recommended watershed development plan.

Table-1.2 Project sanctioned and funds released for watershed development programmes 1995-96 to 2015-16

Name of scheme	No. of project Sanctioned	Area covered (in lack ha)	Total funds released by centre (Rs in crores)
DPAP	27439	130.20	2837.8
DDP	15746	78.73	2103.23
IWDP	1877	107.0	2797.56
IWMP	8210	49.26	29556.0
Grand total	53272	372.19	37294.6

Source: National Portal Content Management Team, 2015.

The studies in India by Erappa *et.al*, (2001), Palanisami (2003), Ramana (2005), Tapan Adikari (2006) and Ajaykumar (2008) analysed the role of watershed programmes on socio-economic development of rainfed and semi-arid rain fed areas.

Two important gaps were observed in the above studies. Firstly, the above studies did not analyse the impact of watershed development programme on individual farm level. Secondly, the above empirical studies had focused on outcomes of government watershed progrmmes and people participation. Studies focused on the impact of watershed intervention technology on farm production and crop diversification are very limited (Palanisami *et.al*. 2009).

The present study tries to cover these gaps, the major objective of the study is to analyse An Economic Impact of Integrated Watershed Development Programme in Medak District of Telangana State.

The objective of the present study is to analyse the impact of watershed management programmes in drought prone areas of Medak disrict.

1. To study the socio-economic impact of watersheds on the sample farmers in selected watersheds.

2. To evaluate the benefits and costs of different watershed programmes implemented by government.

3. To examine the role of farmers participation in watershed development programmes.

4. To suggest a suitable strategy for effective and sustainable development of watershed programmes suitable for drought prone areas.

1.1 Scope of the study

Day by day the natural resources which are highly essential in agriculture like water, land, animal, vegetation are being degraded, eroded and dwindling. It is high time that the farmers should be sensitized and empowered to judicially utilize these resources. Management of natural resources beyond watershed areas, particularly in irrigated areas is equally important. In fact, all the natural resources and the veritable water regimes – irrigated and arid, semi-arid and wet rainfed areas are all interlinked and interdependent. Therefore, this study focuses on watershed-based management of land and water; it also underscores the synergy among all natural resources and between watersheds. The study mainly contemplates to find out the impact on watershed activities of farmers in terms of selected indicators of people's participation at different stages of watershed development programme.

In the present study, impact on watershed activities has been developed which becomes a standard tool that can be used by the project implementing agencies, watershed development planners, administrators, scientists and extension workers aiming at sustainable natural resource management. The strategy developed based on the findings of the study could help the personnel involved in watershed development programmes to take appropriate measures to involve the people not only in all stages but also in all activities of the programme. The study also brings out constraints experienced by the farmers and project implementation officials. The appropriate suggestions to overcome the constraints would be of great use to implementing agencies, which aims at sustainable on watershed activities.

1.2 Limitations of the study

As the researcher had limited time and resources at his disposal, the study was confined to only ten watershed projects in selected district. As such, generalization of findings would be limited to this area and to the areas where similar conditions exist.

As the study used the *ex-post-facto* design all the disadvantages and short comings that are associated with the design set a limitation for the study. However, efforts were made through appropriate statistical tests and procedures to achieve the set objectives of the study. Most of the data collected was based on the expressed opinion of the respondents. Therefore, the study may not be free from usual bias involved with respondents in social investigation.

1.3 Hypotheses

The following hypotheses were tested in the course of the study. The usage of watershed intervention technology has led to

- An increase the groundwater discharge and irrigated area.
- An increase in irrigation and cropping intensity.
- Change in cropping pattern.

- An increase in crop productivity index.

- An increase in employment and in owning live stock.
- An increase in farm income and value of land and an increase in the benefit cost ratio.

With the adoption of watershed intervention technology, the change in producers' surplus exceeded the change in consumers' surplus.

The current study is an attempt to find out how an integrated approach on watershed management is the best way to minimize the hazards associated with dry land agriculture and overcome the problems of low productivity in agricultural production.

PRESENTATION OF THE STUDY

This study was presented in five chapters as follows

Chapter I: Deals with 'INTRODUCTION' which gave a brief account of the need and importance of the study, objectives, the scope as well as limitations of the study.

Chapter II: Deals with 'REVIEW OF LITERATURE' with extensive literature survey of the past related to the present study.

Chapter III: Devoted for describing the 'MATERIAL AND METHODS' of the study including statistical tools.

Chapter IV: Dealt with 'AGRO CLIMATIC FEATURES OF STUDY AREA' of the study

Chapter IV: Dealt with 'RESULTS AND DISCUSSION' of the study.

Chapter V: Dealt with 'SUMMARY AND CONCLUSIONS' consisting implications of the findings and suggestions for future research.

The literature cited is given at the end.

CHAPTER-II

REVIEW OF LITERATURE

A thorough review of literature is necessary to acquaint with the research area and was felt essential in developing sound research methodology and operationalzing the needed concept. This also helps to find out the available information related to the objectives of the proposed research and provides a basis for interpretation of findings. It helps to identify the gaps in research findings, the documentation and the events relating to a particular aspect of investigation. There are limited studies on the watershed development programmes. A brief review of the available literature has been incorporated in the light of the objectives of study under the following heads:

2.1. Historical Perspective of Water Resource Management and General Studies on Watershed Development Programme.

2.2. Importance of Watershed Management.

2.3. Impact of Watershed Development Programme.

2.4. Impact of farmer's participation in watershed development programmes.

2.5. Problems of Watershed Management and suggestions to improve Watershed Development Programme.

2.1. Historical Perspective of Water Resource Management and General Studies on Watershed Development Programme.

India is a vast country with very deep historical roots and strong cultural traditions. These are reflected in our social fabric and institutions of community life. In spite of social movement of varied nature through the millennia, we have retained the sprit and essence of these traditions and have remained attached to our roots. Some of our traditions, evolved and developed by our ancestors thousands of years ago have played important roles in different spheres of our life. One of the most important among these is the tradition of collecting, storing and preserving water for various uses.

The Satavahanas (1^{st} Century B.C. – 2^{nd} Century A.D) introduced brick and ring wells for extraction of water. Lake and well irrigation techniques were developed on a large scale during the time of Pandya, Chera and Chola dynasties in south India (1^{st} to 3^{rd} Century A.D) and large dams were built across Cauvery and Vaigai rivers. A number of Irrigation tanks were constructed by developing large natural depressions. Water resources development on a large scale took place during the Gupta era (300-500 A.D). In the south, the Pallavas expanded the irrigation systems in the 7th Century A.D. The famous Cauvery Anicut was built during this period. Large-scale constructions of tanks (Tataka) for harvesting rainwater were also done during this period in Tamil Nadu. The Chola period (985-1205 A.D) witnessed the introduction of advanced irrigation systems, which brought about prosperity in the Deccan region. Thi included not only anicuts across rivers and streams but also a number of tanks with connecting channels. This new system was more reliable in terms of water availability and provided better flexibility in water distribution (Chow V.T. 1964)

The Rajput dynasty (1000-1200 A.D) promoted irrigation works in northern India. The 647 sq km Bhopal Lake was built under King Bhoja. In eastern India, Pal and Sen Kings (760-1100 A.D) built a number of large tanks and lakes in their Kingdoms. Rajtarangini of Kalhana gives a detailed account of irrigation systems developed in the 12th Century in Kashmir. In the Medieval period, Mohammad Bin Tughlaq (1325-1351 A.D.) encouraged the farmers to build their own rainwater harvesting systems and wells. Feroze Shah Tughlaq (1351- 1388 A.D) built the Western Yamuna Canal in 1355 to extend irrigation facilities in the dry land tracts of the present-day Haryana and Rajasthan. Emperor Shahjahan built many canals, prominent among them being the Bari Doab or the Hasli Canal. Under the rule of Rangila Muhammad Shah, the Eastern Yamuna Canal was built to irrigate large tracts in Uttar Pradesh. The Vijaynagar Kings (1336-1548 A.D) in the south took keen interest in building large and small storage tanks. Anantraj Sagar tank was built with a 1.37 km long earthen dam across the Maldevi River. The well-known Korangal dam was built under king Krishnadeveraya. The Bahmani rulers (1388-1422 A.D) introduced canal irrigation for the first time in the eastern provinces of the Deccan. Sultan Zain Uddin (1420-1470 A.D) introduced extensive network of canals in Utpalpur, Nadashaila, and Bijbihara and Advin areas of Kashmir (Pathak, P.D. 1988).

Kanade *et al.,* (1989) focused the optimal utilization of available irrigation water in the command area of Mula Irrigation Project in Maharashtra using linear programming technique. The irrigation requirement of different crops considering the effective rainfall was calculated. The water availability from canal was worked out from the values of discharge. The study revealed that the available water was fully utilized during the three seasons in the optimal plan. The optimal plans were also developed deleting sugarcane, the heavy water requiring crop for four irrigation conditions. In those plans the utilization of water was 100 per cent. The cropping intensity was more than 200 per cent in these plans. However, per hectare net profit was reduced.

Ramakrishnan and Sivanantham (1989) studied the water use pattern in Tambaraparani irrigation systems. The study revealed that the cropping intensities were 300 per cent and 260 per cent in the head and tail reaches respectively, indicating significant difference between the farms in the two reaches in input use. The co-efficient of variation of water supplied in channels in tail reach was higher than that in the head reach indicating the uncertainty of water to the farmers at the tail reach. The crop water use efficiency and the field water use efficiency were higher in the tail reach due to low consumption of water. The farmers in the head reach had a surplus of water than their demand, which ranged between 21.20 to 33.25 per cent between the seasons. But the farmers in the tail reach faced deficit during both the seasons. Hence a longer percentage of farmers in the tail reach favoured the adoption of water management practices and formation of water user organization.

Kalra and Singh (2000) evaluated the irrigation water use efficiency in canal command area. The study observed that the farmers having source of water with almost zero marginal cost of irrigation, own electric tube wells, provided enough soil moisture in their fields to produce maximum output per unit area. However, the yield per unit of water used was not the highest in that case. In contrast, when the changes were on a pro-rata basis as in the case of the diesel engine category of farmers, they acted rationally to under-irrigate crop, accept a lower yield per hectare but higher yield per cubic meter of water and possibly higher total yield from increased area irrigated. A mix of policies aimed at raising the productivity of water and investment in irrigation infrastructure to have better control on timely availability of water had a vast scope in improving the efficiency of existing surface water resources.

Sunil *et al.,* (2000) analysed the use and productivity of water through a canal irrigation system in Andhra Pradesh. The study pointed that irrigation intensity and cropping intensity were more in large sized farms. The per cent of area under wet crops was high if canal constitute the main source of irrigation. In the case of tube well irrigated farms, the per cent of area under irrigated dry crops were more predominant. The study revealed that with increase in the size of the farm, the area under irrigated dry crop also increased. The number of installation of tube wells increased with increase in the distance of the farm from the outlet of the supply channel. The farm size and location wise analysis revealed that the productivity of wet irrigated dry crops were higher, wherever irrigation from canal and tube well water existed. The study suggested large scale ground water development to supplement the canal water. Further farmers also needed a continuing programme of information, guidance and education on water management and irrigated agriculture under existing irrigation systems.

Tarique (2000) in his study on “Water Crisis in India” stated that the country had a singular habit of not making use of its blessings. By 2025 AD India would use only a fourth of the total annual rainfall. It was expected to face the threat of shortages two decades from now. The reason for that was simply that India cannot hold on to all the water it receives. Indian water policy was concentrated on highly visible large dams, reservoirs and canal systems, ignoring the cost-effective minor water projects, such as tube wells, dug wells and tanks.

However, impressive the dams sound in press handouts, it was a miserable fact that India had so far not managed to arrest the devastating annual cycles of floods and droughts.

Guilmato (2002) stated that the irrigation data from Census publications in India have been severely underutilized so far. The study suggested that even while other sources comprise important additional information, the Census offers an irreplaceable data set to examine local settings and study them on various scales, from a global perspective contrasting regional trends down to village-wise variations. The paper also offers a view on the issues that can be researched using village level statistics

Palanisami *et al*., (2004) in their case study on "Augmenting Groundwater Resource by Artificial Recharge in Kodangipalayam Watershed, Coimbatore District" analysed 60 respondents. The study revealed that the influence of recharge continued up to three months from the start of recharge structure filling. The maximum water level rise was found to be varying with the distance from the recharge structure. The nearest (64m) bore well (NBW 9) from the recharge structure, recorded maximum water level rise on 48 days after the start of filling.

Sivanappan (2004) in his study found the feasibility of farm ponds as a device to supply protective irrigation to rain fed crops at critical stages of growth. A pond was built in the middle of the study area where the upper part served as the catchments and lower part as cropped land, where a crop of finger millet was raised. Five critical phases were identified and water from the pond was supplied during three of them coinciding with rainless periods. An indigenous human powered lifting device was used to lift water. After harvest it was found that the grain yield in the largest area was higher by 90 per cent than in the control plots and straw yield by 80 per cent. The result indicated that farm ponds for dry land agriculture were a worthwhile proposition. Although pond occupies some area which was lost to cultivation, the net benefit obtained even in near normal rainfall year was substantial and in severe drought years it could make an enormous difference to crop production. Most wells are located in rural areas where water supply needs are fulfilled by farmers themselves without any public water supply system. In 2003, out of 4646 villages surveyed, only8.8 per cent had access to a public / community drinking water supply system, while the rest depended on wells or open water bodies. Similarly, for agriculture, for villages that used irrigation, only 17.3 per cent had access to a public irrigation system, the rest depending on wells, tube-wells, tanks and streams (Shah, 2005).

Kastha and Chandrakar (2006) made a work on "Economic Returns from Investment on Minor Irrigation Project under Rainfed Farming Situation of Raipur District in Chhattisgarh", in year 2005-2006. The study was conducted in Raipur district of Chattisgargh because most of the schemes on minor irrigation sources were running successfully in the district. Out of the 15 blocks of Raipur district, Tarpongs and Raveli Villages were identified and selected from, for the rainfed and tube well irrigation situations. Primary data were collected on the respective economic parameters for the year 2005-2006. Cropping intensity was significantly high under the farms of tube well irrigation as compared to farms under rain fed situation. It was suggested that the policy makers could promote long-term schemes for minor irrigation to achieve the state goal of crop diversification. The cultivation of summer paddy allowed overexploitation of ground water. In tube well irrigation situation needs to be banned or discouraged by introducing high value crops in state government, that the amount may be subsidized, if the water current was not available for digging of tube well to the farmers. In case of success in digging of bore wells, a minimum subsidy should be provided to the farmers for their encouragement. The public investment should be made available for strengthening the tube well source in favour of marginal and small farmer on co-operative basis managed by village panchayats.

Kumaracharyulu *et al.,* (2007) highlighted that every drop of water should be judiciously utilized and its reckless wastage must be eliminated. Human intervention was called for halting wastage and harnesses the surplus water to benefit the water-stress regions. Unless water problems were adequately addressed with sufficient planning and care, the authors cautioned that the living beings may be threatened in the years to come.

Pachuri (2008) in his article on "Impact on Agriculture and Water Resources", stated that agriculture production in many countries including India, would be severally compromised by climate variability. Basically yields of some crops like wheat, rice and pulses would go down. Evidences are found in the declining production of wheat in the country. This would present a major challenge to India's prospects of self-sufficiency in food production and its impact could affect global security with dire consequences, for the poorest societies in the world. Another major impact of climate change was in the form of growing scarcity of water in different parts of the world. In Africa, for instance, anywhere "between" 75 to 20 million people were projected to be exposed to increased water stress due to climate change by 2020. But, perhaps the most intractable impact of climate change for the world as a whole was that of the rise in the sea level which had dire implications for the small island states and coastal regions in different parts of the globe. The mega deltas of Asia, such as Dhaka, Kolkatta and Shanghai are particular at risk from coastal flooding, because they were not only centers of large populations, but also contain major physical assets and infrastructure.

Kumar (2008) made a study on "Planning of Watershed Projects in India: A Critical Review of Government Funded Projects". The study revealed that, the existing methods of planning in government funded watershed projects have scope for improvement. There was also a large gap in the provisions of policy and practice related to planning of watershed projects. To attain effectiveness of those large-scale interventions, those gaps must be addressed. Some of the gaps were of operational level, while some of them need to be addressed at organizational and policy level. The policy makers in the government should look beyond the existing procedures and build an enabling environment, where the project implementing agencies (government or non-government organizations) also should improve their existing capabilities and put people first while developing such action plans.

Singh *et al.*, (2010) examined that the impact of Khamenlok watershed project on changes in land use pattern, cropping pattern, income, employment and equity of the households in the watershed. The study indicated that the watershed project altered, the land use system favorably to horticultural crops mostly fruits with little attention to the development of field crops and livestocks including fisheries. The project could increase the income and employment opportunities of the households in the watershed.

Reddy *et al.*, (2012) stated that the impact of the Watershed Development Programme (WSD) after the introduction of the 1995 participatory guidelines covering a large sample of watersheds in Rajasthan. Specifically, it aims to (1) assess the biophysical, economic and institutional impacts of the WSD; (2) identify factors influencing the performance of watersheds, and (3) provide policy inputs for improving the performance of the WSD. The study covers a sample of 110 watersheds spread over 15 districts.

2.2. Importance of Watershed Development Programme

Watershed was defined as a topographically delineated area, draining into a single channel. It was a geo-hydrological unit draining at a common point by a system of streams. Conceptually, watershed development was nothing but a risk management strategy which was meant for protecting the inhabitants of the fragile and deplorable ecosystems of rural India from acute distress caused by recurring droughts and intensity of floods. Watershed management was the process of formulating and carrying out a course of a action in a right perspective to exploiting full potential of natural, agricultural and human resources of a watershed to provide resources that were desired by and suitable to watershed community (Reddy,1990). The basic objectives of watershed development programme are stated below:

- To improve the productivity of the soil under rain fed condition through improved soil and water management practices.
- To impart stability to crop yields through proper run-off management, restructuring of cropping pattern and land use.
- To restore the ecological balance through resource conservation, afforestation and pasture development and

- To improve the socio-economic conditions of the inhabitants.

Watershed development and management, rather a multi-disciplinary activity represents a dynamic strategy, which was much more multifaceted than mere soil and water conservation

Ratna reddy (2000) observed that watershed development programme had brought fortunes for the rural development in India by improving the socio-economic status of the rural people.

Watershed development were designed to harmonize the use of water, soil, forest and pasture resources in a way that conserves these resources while rising agricultural productivity, both through " in situ" moisture conservation and increased irrigation through water harvesting. Watershed development had been conceived basically as a strategy for protecting the livelihoods of the people inhabiting the fragile eco- systems experiencing soil erosion and moisture stress (Palanisami *et. al.*, 2002).

Watershed development had become the main intervention for natural resource management, watershed programmes not only protect and conserve the environment, but also contribute to livelihood security (Palanisami and Suresh kumar, 2002).

Pereira *et al.,* (2002) pointed, that harvesting refers to the small-scale concentration, collection, storage, and use of rainwater runoff for both domestic and agricultural use. The term water conservation was generally associated with management of water. Sudhirendar Sharma (2002) pointed that watershed development programmes aim to conserve rain water and recharge ground water for drought- proofing.

Reddy *et al.*, (2003) in their case study on "Role of Institutions and Institutional Constraints in Watershed Programmes-Karkara watershed Hazaribagh, Jarkand", stated that institutional development at village level as well as self help group level within the village should be promoted for mobilization of local resources. That would also be necessary for cultivating management and utilization of the resources generated and assets developed. Institution as development should also cover other villages which were not benefited by bigger efforts, such as irrigation and fisheries in storages behind check dams. Here thrust should be on promoting better management and utilization of small water storages for irrigation as well as fishery, horticulture, tree planting for fuel and fodder and for adopting planting based new income generating activities. Creation of revolving funds, opening of bank accounts and credit linkages should 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.

Niranjan (2004) in his study on “Trends in groundwater irrigation in Eastern and Western Utter Pradesh” revealed that, though public irrigation had diminished during the past 20 years in those areas, yet it remains important in combination with other sources such as own source or purchased water. Further, the study pointed out that, an overwhelming proportion of households depend on groundwater markets for their cropping with 40.8 per cent of sample respondents in the west depending on it now, compared with 28.3 per cent 20 years ago. In the east, about 16 per cent were depending on it in 1981 compared with the present situation of 40.5 per cent.

Narashiman (2008) suggested that ground water would be best managed cooperatively through local user groups and panchayathraj institutions with technical inputs from the groundwater boards at central and state level. Artificial recharge and rainwater harvesting should be actively encouraged through the use of modern methods.

Palanisami and Suresh kumar (2008) stated that the government policy focus must be for the development of water harvesting structures particularly percolation ponds where ever feasible. In addition to public investments, private investments (farmers) through construction of farm ponds may be encouraged as water harvesting structures helping a big way to harvest the available rain water and hence the groundwater recharge.

John Kurten (2009) in his study found that the artificial recharge structures were essential to harness rainfall and keep in storage the infiltration in shallow aquifers especially in semi critical, critical and over exploited areas.

2.3. Impact of Watershed Development Programme

The impact studies carried out by the experts, researchers and scientists in various parts of the country are analysed and findings are detailed below, especially how it had improved groundwater potential, cropping pattern, socio-economic status and increased the water table for a sustainable use.

Thamodaran *et al.,* (1982) made an analysis of water management systems in southern Tamil Nadu. The major objectives of the study were (1) to investigate the economic feasibility of the concrete and silt systems compared to the existing traditional field situation, (2) to examine the nature of production function relationships for paddy and banana crops under different water management systems and to compare the productivity of resources such as fertilizer, irrigation, and labour among systems, (3) to study whether there was any technological break-through in production function relationship, if so, whether it was factor-neutral or biased and (4) to obtain the profit maximizing combination of systems for small, medium or large farms under existing resources-production constraints and also for alternative expected resources scenarios.

The study pointed that, both concrete and silt systems were economically feasible in the agro climatic situation. The silt system was more profitable. The technological change in production relationships for paddy and banana was neutral. Under the existing resource constraints a farmer could bring all the land into the silt system with banana as the major crop to maximize profits. If there was any significant and favourable change in water prices or availability of water, a concrete system would be a competitive alternative to the silt system.

Chandra and Singh (1987) in their study on "Impact of Irrigation on Crop Production in Ram Ganga, Command Area" assessed the impact of an irrigation project coming under the Command Area Development Programme. The main objectives of study were to estimate the changes that took place in land use pattern, irrigation and cropping pattern and to measure the impact of an irrigation project on the growth of crop yields for the period 1971-72 to 1980-81.The study reported significant increase in the yields of specific crops.

Karam Singh *et al.*, (1989) studied "The Socio-Economic Impact of Kandi Watershed and Area Development Project in Punjab". The study examined the socio-economic impact of the project through evaluation surveys using "before" and "after" comparison. The study stated that there was a significant shift in land use pattern: from uncultivated to cultivated, uncultivable waste to cultivable one (though some more treatments were necessary to bring that under cultivation) and un - irrigated to irrigate. The crop pattern analysis indicated slight shifts in favour of commercial crops. Investment in farm machinery and implements had increased from 23 per cent of the total investments in 1979-80 to 44 per cent in 1986-87. The investments on milk animals and milk yields were significantly higher during 1986-87 than during 1979-80. The crop yields improved between 1979-80 and 1986-87 by 2.7, 2.8 and 6.2 per cent per annum for maize, wheat and oil seeds respectively. The corresponding growth rate figures for Punjab were 3.3, 1.2 and 3.5 per cent per annum. During the period per farm and per capita gross margins from agriculture recorded a growth rate of 6.1 and 5.4 per cent per annum at constant prices respectively. The study further revealed that, the gap between the rich and poor had widened as the Gini ratios for the post-project period were more than, the pre-project period. The project as a whole excluding irrigation and fisheries yielded a benefit-cost ratio of 1.7 at 12 per cent discount rate and internal rate of return (IRR) of 16.73 per cent. The IRRs for forestry, animal husbandry, soil conservation and horticulture components were 15.29, 13.16, 12.57 and 28.31 per cent respectively. The irrigation component gave a return of 3.38 per cent mainly due to considerable delays in the execution and cost escalations.

Nagaraj (1989) estimated the economics of investment in drip irrigation for coconut orchard of a 12 hectare farm. The investment in coconut was evaluated with drip irrigation and without drip over a 40 year time horizon, using discounted cash flow techniques. It was observed that the area covered under drip yielded better quality nuts in terms of size, copra content and quality which in turn was reflected in the price received per nut. Further, the area under irrigation had substantially increased on account of savings in water.

Pagine (1989) analysed the impact of watershed development programme on crop productivity and agricultural income. An operational research project was initiated for watershed development at Kohewadi village in Ahmednagar district of Maharashtra. The project involved implementation of programmes relating to soil and water conservation, crop production technologies and horticultural development. Due to watershed development activities, the changes in respect of cropping patterns and crop productivity and income generated in the watershed were studied. The information was pertained to the period 1984 to 1989. The cultivatable land in the watershed area was 336.68 hectares. In the watershed area, kharif and rabi crops were cultivated on 31 per cent and 68 per cent of the gross cropped area respectively. Due to watershed development activities, there was an increase in the area under the kharif and rabi crops and diversification in the cropping pattern during the study period. The gross cropped area increased by 7.5 to 15 per cent in different years over the base year. The double cropped area also showed an uptrend, i.e, from 14.92 ha to 41.76 ha over the base year area (5.10 hectare). The productivity of different crops cultivated in the watershed was low during the base year. 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. In the case of sorghum (Kharif) and wheat, the increase in per hectare yield was 85 per cent to 134 per cent and 12 per cent to 72 per cent respectively. Due to the impact of watershed development activities, the increase in agricultural income ranged from 33 to 187 per cent during the kharif and from 34 to 108 per cent during the rabi season in different years over the base year. Per hectare income from the agricultural production has also been increased and ranged from 1511 to 1675 in different years.

Prasad *et al.,* (1989) studied the impact of watershed management project on the productivity of crops in Uttar Pradesh. The main economic objectives of the project were (i) to optimize the productivity of different crops in the watershed area through soil and water management works and adopting improved crop production technology and (ii) to suggest new crops and alternative cropping sequences for efficient utilization of resources and higher returns. In order to increase the productivity of crops and returns in the project area, various soil and water conservation works along with improved crop production programmes were undertaken. Out of 748 hectares (ha) of watershed project an area of 739. 96 ha was treated during a span of five years, i.e., from 1984-1989, through (508.36 ha), land levelling (22.02 ha), water storage structure (197.58 ha) and water harvesting works- farm ponds (12 ha). To convince the farmers about the benefits of the use of improved crop management practices and in the adoption of new crops and cropping sequences, demonstrations were conducted at village and block levels. The overall impact of the project programmes resulted in a shift in the cropping pattern, increase in the productivity of crops, and in the adoption of some new crops and double cropping system. With the adoption of new crops like mustard, pea, paddy, soybean, moong and vegetables and savings of jowar, bajra and wheat as pure crops, the area under wheat + gram, jowar + arhar and gram declined considerably while the area under jowar, bajra, wheat, pea, mustard and paddy increased substantially. The cropping intensity increased to 156.61 per cent during 1987-88 as compared to 100.15 per cent during the base year (1983-84). The productivity of different crops increased by three to five times as compared to the base year and by two or four times as compared to the non-project area during 1987-88. The returns were also higher in the project area because of higher productivity. In jowar, bajra, wheat and mustard, the net returns were two times higher while in gram and barley four times higher than in non-project area. But the input output ratio did not show any marked difference for the project and non-project areas, which was due to higher additional cost incurred on crops because of various soil and water conservation works along with the recommended package of inputs used in the production of crops. The findings of the study suggested an integrated approach to the problem on watershed management basis as the best way to minimize the hazards associated with dry land agriculture and overcome the problems of low productivity and higher instability in agricultural production.

Rajesh and Acharya (1989) examined the extent of misdistribution of canal water between head and tail-end farmers, its impact on cropping pattern and efficiency of land and water use; and divergence of existing and optimal cropping patterns, in a sample of 150 farmers who were selected through stratified random sampling method during the period 1983- 86. Linear programming technique was used to develop optimal cropping plan. The study indicated that tail-end farmers were at a disadvantage in terms of actual number of irrigation available to them from the canal. There was great divergence between existing and optimal cropping plans. It was revealed that equitable distribution of water between head and tail-end farmers leads to increase in overall efficiency of both land and water.

Mahnot Singh *et al.,* (1992). In their case study on “Socio-Economic Evaluation of Watershed Management Project-A case study” analysed 198 respondents of Thakara village in Rajasthan. The study revealed that integrated watershed management approach including rainwater harvesting structure and soil and Watershed Intervention Technology adopted in the foothill of Aravalli region holds the key to the development of the area. Socio-economic evaluation of project revealed that, the programme had shown favourable response in agriculture as well as dairy sector by increasing employment opportunity. Improved agronomic practices which were a major part of the programme led to 44.84 to 73.7 per cent, increase in gross return from agriculture crops. The availability of more dry and green fodder from the watershed area increased milk production from 31.0 to 99.0 thousand liters per annum which gave gross return from 2.72 to 11.49 lakhs. The overall benefit –cost ratio worked out to 1.27 to

2.21 during 1986- 87 to 1989-90, respectively. The study established that watershed management project in the selected village was economically feasible helping the socio upliftment of tribal farmers.

Selvarajan *et al.,* (1992) in their case study on "Impact of Watershed Based Resource Conservation cum Production Management in Alfisals of Karnataka". The study revealed that benefit-cost ratio for the project as a whole was more than unity by 53 per cent with pecuniary benefits alone and justifies the economic worthiness of the project. The integrated watershed development programme as executed in G.R.Halli watershed though proved to be economically viable, there exist ample scope to widen the benefit - cost ratio in both agricultural and forestry sectors by motivating individual farm families

Panda *et al.,* (1998) analysed the impact of integrated watershed development programme on dry land farming in three districts of Orissa. The study revealed that potentials of watershed development in dry land areas had made a positive change on cropping pattern by means of crop shifting from traditional crops to more valuable cash crops. Perceptible changes were noticed in the yield rate of almost all the crops and the gross return per hectare of land was found satisfactory. Adoption of HYV seeds, though moderate, still marginal changes were encouraging. The overall impact of watershed on cropping pattern was encouraging; still there was very large-scale food insecurity, to the extent of 84 per cent in the project area and 100 per cent in the non-project area. The author suggested the IWDP project implementing agencies and the NGOs to be involved for the de-addiction of liquor among the tribal and beneficiaries in the project area were to be fiancé grants banks.

Thakur *et al.,* (2000) made a study on the "Impact of Irrigation on Farm Production of Sample Farmers in Himachal Pradesh". It revealed that after the installation of irrigation project the operational holding under cereal crops declined whereas there had been a significant increase in the areas under commercial crops. The resource use pattern had changed; the farmers were still using higher seed rates of crops and following traditional broadcasting method of sowing. However, the use of chemical fertilizers had increased significantly. The overall employment had increased in agriculture sector whereas in Kharif and Rabi vegetables the labour employment had decreased due to economics of scale by introducing more area under vegetables as well as technological improvements. The impact of irrigation was visible in terms of notable increase in the yields of all the crops and that increase was found higher in commercial crops (vegetables). Per farm production and marketable/marketed surplus of food grains after the project was quite higher than before the project installation. Similarly, the production and marketed surplus ofvegetables (kharif and rabi) had shown about two to three fold increase after the project. Besides that, the number of livestock owned by sample farms had increased significantly. Sheep rearing followed by drought and milk (milch) animals were the important livestock assets kept by the farmers. Majority of the farmers owned high breed cows instead of local cows and buffaloes as the contribution of high breed cows with respect to milk production were quite high as compared to local cows and buffaloes. Similarly, the cropping system and income had changed which led the improved livestock management for higher milk production, in the study area. About 60 percent change in household earning was observed after the installation of the project. The contribution of farm sector indicated 154 per cent increase over the pre-project period thereby representing the significant role of irrigation project in the study area. The per capita income too, increased by 60 per cent over the pre-project. This was attributed to the provision of well planned irrigation facilities and agro climatically best suited area provided to the farmers for the production of off-season vegetable crops and high yielding varieties of cereal crops. Also, the farmers in command area of the scheme shifted their cropping pattern and livestock rearing towards cash crops (both kharif and rabi vegetables) and cross-bred cows.

Arul Gnana Sekar (2001) in his study on “Micro Watershed and Agriculture”, analysed three blocks viz. Vadamadurai, Natham and Shanarpatti, of Dindigul district covering 4 micro watersheds. The study revealed that, the soil and moisture conservation programme were: changes in cropping pattern; and changes in the rate of yield. When soil and moisture were improved, crops yielding higher income like paddy, banana and sugarcane could be raised in the place of millets and the yield rate of crops also register growth. It was inferred, that there have been changes in cropping pattern in favour of crops, which require more irrigation and soil nutrients and which yield more income from millets. However, it was appropriate to attribute all the above benefits to the programmes of soil and moisture conservation alone, though these programmes have paved the ground for progress in farming. Extension of assistance under agricultural developmental programs for the department of agriculture had also contributed much to the above beneficial developments. It must be acknowledged, that the official of the forest department, in addition to their programme of soil and moisture, conservation also helped the villagers in getting assistance from the department of agriculture. It might be observed that, the cultivation of tree crops like mango and coconut was gradually gaining ground in all the three villages. That was because of the non-availability of farm labour for intensive agricultural operations. Because of the long time lag in tree crops, the rate of diversion was found to be very low. As those crops start yielding income, more land was likely to be diverted to the tree crops, the effect of the programme of soil and moisture conservation were measured in terms of variations in net area sown, intensity of cropping and cropping pattern. The analysis revealed that, those variations were determined largely by the level of rainfall and availability of existing irrigation facilities. The emerging scarcity of labour also caused a shift and diversification in cropping pattern in favour of long duration tree crops. The intervention of Inter Face Forestry Programme (IFFP) would make its impact felt in net area sown, intensity of cropping pattern in the longer run, even through soil and moisture conservation measures increased the availability of cultivable land.

Bisrat *et al.,* (2001) in their study on “The Impact of Watershed Development Programme in Augmenting Groundwater Resource in Drought Situation”, revealed that the watershed development programme had proved its contribution towards reducing the effect of drought. The negative externality due to partial and complete failure of irrigation wells had been reduced due to watershed development programme. Construction of water harvesting structures through watershed development approach enhances the groundwater recharge in hydrogeological situations even if there was cumulative interference effect among irrigation wells. The watershed development programme contributed richly to physical and economic access to groundwater resource for irrigation. It had helped to reduce the gap between the small and large farmers in respect of physical access to groundwater resource. The small farmer in fact was able to reap higher net returns per acre of gross irrigated area.

Palanisami (2001) analysed the geographical information system based decision support for Annur sub- watershed planning. The study results indicated that development works were urgently needed in most of the watersheds in Tamil Nadu. Exploitation of groundwater resources was increasing in many locations, without making any effort for their availability. Identification of those locations that need recharge measures and location of percolation ponds were done used the Geographical Information System (GIS) in the selected villages of Annursub- watershed. The land use and alternative land use with additional wells recharged by the percolation ponds were compared. It was observed that only in few ponds the additional wells were proved to be financially viable implying that additional wells were possible only in locations where number of existing wells was limited. Regarding social aspects, the type of beneficiaries, whether small, marginal or large farmers as well as whether BC, SC/ST and other groups, after the construction of additional wells and percolation ponds and adoption of alternative land use was also studied. Further employment generation to the labour class of the village was also quantified and included in arrived an index of social parameter for each percolation pond.

Erappa *et al.*, (2002) made a study on “Sustainable Development of NWDPRA Watershed: Case Study of Raichur District, Karnataka”. The NWDPRA project was assessed among four major sectors viz; (i) the production sector, (ii) the technology sector, (iii) the environment sector, and (iv) the participation sector. Among these, the impact on the production sector was effective. Although the incremental yield, as well as increased area under the crop had not been very significant, the changes were noticeable and had long term prospects. It was noted that the process of implementation had two important short comings viz; the savings in the allocations for primary activities were not fully utilized, and there was hardly any local level flexibility given to the implements for the effective implementation of the programmes. There was only fragmentary evidence of a watershed development team constituted in the region. These teams were not functioning as effective bodies to sustain the interventions. As regards the quality of life and employment sector, there was enough evidence to indicate increased employment and a visible improvement in the quality of life. This was accompanied by increased consumption and market participation. However, the quantum of increment was not as much as could be seen in irrigated agriculture. Therefore, it was obvious that the adoption of watershed treatment and their sustenance would take a back seat for some time. The environment impact of the treatment was quite visible especially in terms of increased moisture availability, bio-mass, fodder, fuel and fruits, water for irrigation and finally, increased food availability.

Shiyani *et al.,* (2002) in their study on "Socio-economic Impact of Watershed Development in South Saurashtra Region of Gujarat", stated that watershed development played pivotal role in increasing cropping intensity, productivity of various crops, profitability and employment generation. The watershed development also reduced the income disparity among the beneficiaries. Reduction in yield gap and in unit cost of production was the added advantages of watershed development.

Palanisami and Suresh Kumar (2003) analyzed the combination of "With" and "Without" approach and "before" and "after" approach to study the impact of watershed development activities in Kattampatti-I and Kodangipalayam –II watersheds of Coimbatore District. The study indicated that construction ofWatershed Intervention Technology (WIT) such as percolation ponds; check dams, farm ponds and renovation of tanks have enhanced the storage capacity in the watershed to store the excess runoff, which in turn had increased the groundwater recharge. The study revealed that the water levels in the wells have increased from 0.5 m to 4.4 m. The farmers in the watershed reported that the Watershed Intervention Technology were very useful in conserving rainwater and recharge the groundwater which reduced the water scarcity during most part of the year. Due to that, cropping intensity had increased from 100 per cent to 134 per cent and in many cases the productivity of major crops had increased from 31.7 per cent for sorghum to 127.3 per cent for maize. The water level in the open and dug wells had risen in the range of 2.5 to 3.5 m and 2 to 3 m.

Singh *et.al* (2004) in their case study on "Impact of watershed development on traditional tank systems in Karnataka", reported that the watershed development programmes had exerted a big impact on the viability and utility of traditional tank systems and on patterns of water use within the tank catchments and command area. The impact appeared to be most marked when increased ground water harvesting in the tank catchment area was coupled with increased ground water extraction.

Souvik *et.al.*, (2004) analysed the "Participatory Water Management for Suitable Development in the Coastal Belt Area of Orissa". The study reported farmers' participation was essential to make any programme sustainable. Participation of farmers by paying a portion of the cost of water resources development had provided them a kind of ownership rights. The groups of farmers have cultivated different crops irrigating them from created water resources. The irrigated area had increased about five times resulting into increased cropping intensity. The positive impact was realized with increase in productivity and income.

Budumuru and Gebremedian (2006) in their report on "Participatory Watershed Management for Sustainable Rural Livelihoods in India", pointed that participatory watershed management projects have been raising income, agricultural productivity, generating employment and conserving soil and water resources. The study suggested that watershed development brought several positive trends including diversification of the rural economy, development of new institutions, increasing cropping intensity, improved fodder production, increased availability of drinking water with rising ground water table, capacity development of the community etc. Based on the evidence found, it had been suggested that participatory watershed management could be a viable strategy of rural development for achieving sustainable rural livelihoods in India.

Mundinamani *et al.,* (2006) analysed the impact of different methods of irrigation on water use efficiency in sugarcane cultivation in Shedol tank command of Bihar district in northern Karnataka. The data required for the study were obtained from Water Management Demonstration Reports of Community Based Tank Management Consultancy Project, University of Agricultural Sciences, Dharwad for the years 2004-05 and 2005-06. The results of the study revealed that sugarcane was the major crop grown under irrigation in the selected tank command, which occupied nearly 40 per cent of the gross cropped area. Almost all farmers follow all furrow unscientific method. To educate the farmers on the most efficient method of irrigation in sugarcane cultivation, the demonstration was conducted on four methods of irrigation namely, alternate furrow, paired row, drip method and paired row drip method of irrigation considering all-furrow irrigation method. The sugarcane crop consumed only 16.10 lakh liters of water followed by drip method of irrigation. The cost of cultivation and net returns per hectare of sugarcane cultivation worked to be the highest in paired row drip method of irrigation followed by drip method and paired row drip method of irrigation considering all – furrow irrigation method. The sugarcane crop consumed only 16.10 lakh litres of water followed by drip method of irrigation. The cost of cultivation and net returns per hectare of sugarcane cultivation worked to be the highest in paired row drip method of irrigation followed by drip method. The results of water management demonstration conduced on different methods of irrigation in sugarcane cultivation showed that the drip method of irrigation not only enhanced the productivity and income of the sugarcane but also increased the water use efficiency, which promotes optimum utilization of nutrients applied to the crop besides overcoming environmental problems.

Satyendra Prakash Gupta (2006) in his case study on “Impact of the national watershed development programmes on income and employment generation in Chhattisgarh”, analysed 194 respondents on watershed area. The study revealed that ` 17.34 lakh was spent to create the basic activities in the project area which was 37.76 per cent of total investment. An expenditure of `14 lakh (30.49 per cent) was spent to improve the production system in available and non – available area which included crop demonstration, agro – forestry, dry land horticulture, organic farming system, poultry, piggery, goat rearing, basket and rope making, etc. The remaining part of the fund approved was spent to improve the soil and water conservation and livestock management activities. The watershed area had 28.02 per cent irrigation mainly due to relatively more public investments in that area while that figure was only 13.33 per cent in non watershed area.

Singh (2007) analysed the benefits from participatory watershed management among arid zone farmers. The study was conducted in Tibna watershed, located in Shergarh Community Development Block of Jodhpur district in the arid part of Rajasthan. The study concluded that the participatory watershed project managed natural resources properly and provided benefits to the villagers: the seasonal flood was controlled, more water, fuel, fodder, employment and income were available, the environment was improved with more greenery and the solar light, and the environment became healthier and scenic. The research institutes provided guidance in selection of the watershed, design of the engineering structure, survey of the watershed and selection of the appropriate agriculture practices. The NGO placed a great stress in educating the villagers about the watershed through various extension methods.

Ramappa *et al.,* (2008) on their case study on “Watershed development and its impact”, revealed that in India majority of the people living in rural areas still depend on rain fed agriculture for their livelihood. But large tracts of rain fed areas were prone to drought and characterized by low productivity, high risk and vulnerability to degradation of natural resources. Hence, it was necessary to present the degradation of soil, water and other related resources in order to enhance agricultural productivity and incomes of the people of dry land areas. In pursuance of this watershed development programme was viewed as the key programme which could meet the challenges of rain fed and drought-prone areas.

Jain (2008) in his study analysed that the impact of organaisational instruments on livestock activities of watershed developments in Andhra Pradesh. The study revealed that livestock population had increased varying from 68 to 83 per cent in cows, 57.5 to 73 per cent in buffalos and 63 to 149 per cent in sheep and goats across the watersheds. The milk yield improved by 84.5 , 62.7 and 73.2 per cent on number of milking days increased by 20,10 and 20 in NGO , government organisation and research organization managed watershed respectively. Across the watersheds, landless have improved their incomes through milk sales by 155 to 168 per cent. Similarly, small and marginal farmers have improved their incomes through milk sales making dairying as a viable alternative for improving their economy.

Palanisami and Suresh kumar (2008) assessed the impact of DPAP watershed in Coimbatore. They stated that watershed development activities have significant impact on ground water recharge, access to ground water and hence the expansion irrigated area.

Palanisami and Suresh kumar (2009) in their case study on "Impacts of Watershed Development Programmes": Experiences and evidences from Tamil Nadu", reported that watershed development programmes had become the main intervention for natural resources management. The study found that watershed development was a key to sustainable production of food, fodder, fuel wood and meaningfully addressed the social, economical and cultural status of the rural community.

Palanisami *et al.,* (2009) made a case study on "Evaluation of Watershed development Programmes in India Using Economic Surplus Method". The change in total surplus due to watershed intervention was decomposed into changes in consumer surplus and changes in producer surplus. It was found that the producer's surplus was higher than the consumer surplus for all crops. The authors also found that the watershed development activities alter crop pattern, increase in crop yields and thereby provide enhanced employment and farm income.

Senthil Nathan, (2008), estimated the impact of water harvesting structures and the value of land using Hedonic Pricing Analysis. The linear hedonic price model used in this study was:

$Y=a+b_1X_1+b_2X_2+\ldots\ldots\ldots+b_7X_7+\mu$

Y=Value of rain fed land in each farm in the watershed (` per acre)

X_1=Distance of village from the rain fed land (Meters)

X_2= Distance of main road from the rain fed land (Meters)

X_3= Distance of water harvesting structures from the rain fed land (Meters)

X_4= Percentage of garden land

X_5= Net return per acre from rain fed land (Rs.)

X_6= Stumpage value of trees on rain fed land (Rs.)

X_7= Adoption index

μ= error term

Hedonic price model indicated that variables such as distance to village and main road had negative coefficients indicating an inverse relationship with the hedonic land value. For one meter increase in the distance from the village (main road) to land, land value reduced by ` 8.08. The coefficient of 'distance to water harvest structure' implied that for one meter increase in the distance from WHS, land value falls by ` 12.6. For one per cent increase in proportion of (dry land horticulture crop) garden land on the farm, land value increases by ` 11.68. The variables 'distance to main road', water harvesting structures' and 'net returns per acre' were statistically significant. These results are in conformity with other studies (Sekar and Ramaswamy, 1998). Watershed programme resulted in an appreciation of land assets. The above observations and reports studied the impact of watershed development and water harvesting structures. It was proved that water harvesting structures play a complimentary role in augmenting yield and age and life of wells. Hence, a large proportion of water harvesting structures preferably must be located closer to cultivated lands, to realize greater economic impact on irrigated farms.

Amale *et al.*, *(*2011) stated that an economic evaluation of the watershed development project in the National watershed, Bahirwadi in Nagar tahsil, Ahmednagar district, Maharashtra. The achievements in the watershed development activities were to the extent of 88.50 per cent. A remarkable increase of about 21.69 per cent was observed in the case of irrigated area during the years under study. This was mainly because of the completion of watershed development works. The productivity of major crops had considerably increased over the base year.

Korous Khoshbakht *et al.,* (2012) he assessed that the impacts of watershed programs (WPs) on agro-ecosystems in Hamedan Province, Iran. The results revealed that WPs have contributed in raising the stability, productivity and relative acceptability of the agro-eco-system by improving the indicators for ecological sustainability, generating a better benefit-cost ratio and promoting the quality of life and access to public services for farmers in agro-ecosystems with a project.

Biswajit Mondal *et al.,* (2013) stated that the total change in production and productivity are the two important dimensions of benefits of watershed development programmes along with the conservation of land and water resources. To segregate out the impact of various watershed-based interventions on crop productivity, a study was carried out in Bundelkhand region of Madhya Pradesh state of India. Data were collected from 240 farmers' selected from eight watersheds and eight control villages in the region using a multi-stage random sampling technique.

2.4. Impact of farmer's participation in watershed development programmes.

The study by Napier and Camboni (1988) seemed to assess the farmer’s altitudes towards a proposed soil centre program in Ohio State of USA. Using a pre-developed likert-type attitude statements they ran a regression function. The results indicated that, majority of respondents had a positive attitude towards the proposed conservation program. Farm magazines were the most frequently used information about SWC programme.

Napier *et al.,* (1988) identity fled predictive factors associated with willingness to participate in soil conservation programs in six Ohio counties in U.S.A. Using a multivariate regression analysis and they showed that respondents who wish to adopt soil erosion control practices, should not be required to pay the cost of adoption, perceived that farmers should not have absolute right to land, they perceived soil erosion control practices to be relevant to-their farming situation.

Gould *et al.,* (1989) in his study revealed that 51 per cent of farmers in the Wisconsin state of U.S.A. used some form of conservation tillage in 1986 on their farms. The results of probity analysis indicated that for farms less than 808 acres, there was negative relationship. Contact between fanners and soil conservation personnel increased the awareness about soil erosion. It was found that perception of an erosion problem was inelastic with respect to changes in all explanatory variables.

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 .

Reddy (1993) concluded that most of the fanners in Kalyanakcre watershed project of Karnataka state had clearly perceived the ill effects of soil erosion on 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 large farmers were significantly influencing the adoption of soil and water conservation practices in the project area.

Krishna (2001) reported on the participation of farmers in WUA activities was low. The medium participation on the items was observed in their descending order were execution of work of WUAs, social-audit and supervision of works being executed. The high participation as opined by the respondents was in equitable distribution of water and controlling abuse of water.

The overall participation is in transition stage from low to high, which needs higher educational training.

Pandey *et al.,* (2001-2002) stated that an economical design plan of conservation measures was proposed, and a benefit cost analysis was performed on the Vagpura watershed in Jhadole Tehsil of Udaipur District, Rajasthan, India. The location and site specific soil and water conservation measures for the study watershed like contour bunding, stone wall terracing, contour furrows, pasture development, grass waterway, diversion channel, and earthen embankment reservoir for water harvesting are suggested.

Bagdi *et al.,* (2002) reported that peoples' participation in planning and designing of soil and water conservation programme was low (28.00%), implementation of the programme activities was medium level (62.00%) and repair and maintenance of soil and water conservation was also at medium level (57.00%). The overall peoples' participation index was low (43.87%).

Varadan (2002) stated that the success of watershed programme was only with people's participation which leads to better social mobilization.

Raghavendra (2003) reported that the average participation level of SHG members has been quite good. Officials of commercial banks and RRBs together account for 50.00 per cent of total participation followed by co-operative banks at 45 per cent and the balance 5.00 per cent by NGOs. Southern region accounts for over 2/3rd of total participation.

Sikka *et al.,* (2003) evaluated that the impact of the DPAP and CWDP watershed programmes in Coimbatore and Tirunelveli districts of Tamil Nadu, India. Changes in the extent of awareness, women's empowerment, people's participation index, community contribution for works/activities, credit utilization pattern, employment opportunities, participation in meetings and training and better performance of self-help groups and village development associations could be attributed to the positive impact of the project.

Arya (2003) stated that a paradigm shift in soil and water conservation measures from an isolated approach to integrated watershed development programmes (WDPs) in the early 1970s emphasised the active involvement or sense of ownership of the farming community for economic and social uplift on a holistic basis, particularly of the weaker sections and women. Guidelines issued by the Government of India have overlooked the divergent needs and interests that rural women have in relation to land and water.

Prasad (2004) reported that majority (61.60%) of the respondents had high participation followed by medium (36.80%) and low (11.60%) participation.

Joshi *et al*., (2005) found that with higher people participation there was considerable improvement in BCR, employment, cropping intensity, runoff reduction and even soil reduction.

Badal *et al.,* (2006) his study was conducted to identify the important factors that influence people participation in watershed development programmes and its performance. The data were gathered by administering a structured interview schedule to 300 farmers from six micro watersheds in Rajasthan, India, during 2002-03 and 2003-04. Results showed that people participation varied from 25 to 75% at various stages of the programme. The watersheds with higher level of people participation performed better in generating benefits as compared to those with lower participation.

Bisaria (2006) observed that he identify the important factors that influence people participation in watershed development programmes and its performance. The data were gathered by administering a structured interview schedule to 300 farmers from six micro watersheds in Rajasthan, India, during 2002-03 and 2003-04. Results showed that people participation varied from 25 to 75% at various stages of the programme.

Reddy *et al.,* (2006) stated that to understand the various facets of institutional arrangements with a focus on the project-implementing agency (PIA) in watershed development. Basically, it aims to understand the role of the PIA in the process of watershed development and management with an emphasis on its importance in influencing the impact of the programme. This would facilitate identifying appropriate strategies for sustainable watershed management. The analysis of eight selected watersheds in three regions of Andhra Pradesh (India) indicates that the selection of PIA appears to be critical in the whole process of watershed management, which takes into account the people, governmental agencies, non-governmental agencies, and their use of resources at the local level.

Chandran *et al.,* (2008) reported that people's participation and the influence of socio-psychological characteristics of the beneficiaries on their participation were assessed under a watershed development project in the State of Kerala, India. The results indicate a 'target-oriented' approach, without much attention to social organization for promoting people's participation. Most of the beneficiaries of the project have medium level of participation in watershed-related activities.

Sitaula (2008) revealed that participatory watershed development not only leads to environmental protection but also supports the poor and the disadvantaged segments by improving their livelihood.

Suresh and Ramesh (2008) indicated that majority of the respondents had medium extent of participation (64.77%) followed by high (28.33%) and low (7.50%) extent of participation. Majority of the respondents had medium extent of participation followed by high and low in the activities like motivational meetings (62.50%, 26.67% and 10.83%), planning (68.34%, 23.33% and 8.33%), implementation (62.50%, 25.00% and 12.50%), maintenance (67.50%, 28.33% and 4.17%) and evaluation (66.75%, 29.16% and 4.17%).

Gupta *et al.,* (2010) concluded that micro agro-ecosystems of Ghorbe WDP had medium extent of participation (46.00%) followed by low (33.00%) and high (31.00%).

Priya (2010) concluded that 48.30 per cent of the respondents had medium participation in FFS whereas, 29.20 per cent and 22.50 per cent of them had high and low participation respectively.

Prabhakar *et al*., (2011) indicated that majority of the farmers participate only partially in watershed programme activities of NGO. Percentage of partial participation ranged from 45.20 per cent (cooperation with the officials) to 69.70 per cent (participation in PRA activities like resource and social mapping *etc*.) full participation of farmers ranged from 13.80 per cent (maintaining the works by the user groups) to 41.30 per cent (bench mark survey.

Goudappa *et al*., (2012) observed that majority of the respondents (58.33%) expressed medium participation, while 24.17 per cent of them had high participation. Low extent of participation was expressed by 17.50 per cent of the respondents in tank irrigation management.

Shailendra (2012) his study was carried out in NWDPRA Solsinda watershed in Indore district of Madhya Pradesh during 2006-07 to assess the crop productivity and to identify the training needs of beneficiary farmers. Two hundred and ten participant farmers were interviewed for the purpose. It was found that there was a significant increase in both Soybean and ragi yield levels of participant farmers.

Prashanth (2015) indicated that, majority (51.66%) of the project tank users had medium level of extent of community participation in tank management followed by high (30.83%) and low (17.50%).

2.5. Problems of Watershed Development Programme and suggestions to improve Watershed Development Programme.

Problem of semi-arid land farmer is basically one of low and unstable yields caused by low and uncertain rainfall. Not much headway seems to have been made with regard to development of cheap possible labour intensive techniques for moisture conservation / water harvesting. Therefore it is very essential to pay greater attention in soil and water conservation and water harvesting measures, in order to increase production and sustainable agriculture.

Atheeq and Venkatram (1989) examined the existing land use pattern by the farmers of the Kabbalanala Watershed project in Karnataka in the year 1988. The study revealed that the land use pattern of the farmers in the watershed was closer to the optimum. The pattern of land use of both small and large farmers, which was found to be similar, was subsistence oriented. The institutional borrowings of both large and small farmers were insignificantly low and the normative land use plan with existing technology could accommodate only 37 to 40 per cent higher cash. Therefore, the scope for infusing more institutional funds in the area was limited to adoption of recommended crop practices.

Sisodia (1992) made a case study on "Performance of the Warabandi System of Irrigation Management in Chambal command area in Madhya Pradesh", for the period 1982-91. The study brought out the impact of Warabandi Programme on land use and cropping patterns, cropping intensity and yield levels of principal crops and the structure of input use, farm income and benefit-cost ratio of the Warabandi Programme. The study indicated that the Warabandi Programme gave commensurate benefits to the cultivators. The study recommended the acceleration of expansion of area under irrigation. The most important component for further improving the productivity of irrigation was better water management accompanied by upgraded agricultural extension, research and irrigation technology.

Swarn Lata Arya and Samra (1994) analysed Haryana's experience with four selected watershed development projects- Sukomajri, Bunga,Chowki and Tibbi. It revealed that, the determinant's of people's participation in them and drawing lessons useful for securing people's involvement in watershed development and management programmes. The paper indicated that farmers were not interested in long- terms gains from any project and were not willing to sacrifice especially if they were living on the margin of subsistence. Only with increased productivity of crops and increased milk yields resulting from supplemental irrigation made possible by the reservoir water the villagers would be ready to invest in the soil and watershed intervention technology and to participate in the programme.

Narayana Moorthy (1995) in his study on "Status of Indian Irrigation", pointed that Indian irrigation had been suffering from many serious problems in the recent past as indicated by various studies. Investment incurred to create one hectare of irrigation, especially in Medium and Multipurpose Irrigation (MMI), had been increasing alarmingly. The rate of increase in irrigated area created by MMI was much less than the increase in the rate of public sector investment in irrigation. The importance given to low-cost irrigation, namely, tanks had been going down. The gap between the potential created and utilised in MMI had been increasing and had widened a great deal in recent years. The revenue which was being collected from MMI was not enough for operational and maintenance costs. Since irrigation was essential for the development of agriculture and the economy, steps must be taken to put an end to the deplorable condition of the irrigation sector. The workings of farmer managed irrigation system in different countries had shown impressive results and were free from all irrigation-related problems. Hence, involving farmers in system management would partly help to reduce the present problems of our system. However, judicious designing of mega projects and their long term viability had to be considered seriously, before commencing projects to avoid cost escalation.

Sridhar and Ravindrababu (2000) in their study on “An Enquiry into the Working and Benefits of Micro Irrigation Systems in Andhra Pradesh” analysed 512 sample respondents in the agricultural year 1999-2000. The study revealed that the impact of micro irrigation systems could be termed positive, especially with regard to conservation of water, conservation of energy, improvement in crop productivity, and savings in labour costs as perceived by a majority of the sample user farmers. Provision of adequate funds, a rational policy for subsidy, arrangement for bank finance, and adequate support systems are required for the faster propagation of micro irrigation systems in the drought-prone areas. 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.

Kalyan Ganguly and Baldeo Singh (2000) in their report on “Participatory Irrigation Management in India”, pointed that controlled supply of water could check the soil salinity and soil degradation which had become a common feature in the command area of many large irrigation projects. As per the working group report, the physical programme of at least 2000 pilot projects should be taken up in the ninth plan. Some additional pilot projects could also be taken up in the areas where some up gradation and modernization of the systems had already been completed under the National Water Management Programme (NWMP). There was also a need for constant monitoring and evaluation of the performance of the Water User Associations (WUAs) for the success of the programme and for its replication in other areas. Training and motivation of officials and farmers should be the integral part of the programme.

Sivanappan (2004) analysed the status, scope, constraint and potential of micro irrigation in Tamil Nadu. He suggested adopting efficient irrigation methods that were economically viable, technically feasible and socially acceptable. Furthermore, micro-irrigation should be supported by the suppliers and extension staff to help farmers to maintain and operate their system properly.

Dasaratha Ramaiah and Jayaraju (2004) in their study on “Irrigation Potential on Agriculture”, stated that the level of groundwater depends on rainfall and tank irrigation. Due to the uneven rainfall in the country it was necessary to improve the canal source of irrigation through proper utilization of rainfall. By diverting the canal irrigation for various major, medium and minor irrigation tanks, the tank irrigation as well as well irrigation would be improved. Ultimately, it causes for overall agricultural development of rural India. The farmers of the drought prone district were not in a position to invest money on new irrigation methods. Further, the farmers have poor knowledge about the merits of sprinkler and drip irrigation methods. The government should educate the farmers to adopt the new methods in the management of irrigation especially in the management of groundwater facilities available through well irrigation in the district. They must adopt new techniques like sprinkler and drip irrigation. The government should advice the bankers to provide long term and medium term loans to the farmers for adopting sprinkler and drip irrigation in the district. Through the adoption of sprinkler/drip irrigation, the area under irrigation would be increased so that the production and productivity of agriculture is improved.

Sunil Agarwal (2006) studied the model, highlighted the role of NGOs and networking needs for interfacing with science and technology institutions and support agencies and system approach for technology based integrated watershed development. Hence, concerted efforts were urgently required to develop and adopt integrated approach through appropriate technological interventions in participatory mode to offset the looming crisis of natural resource degradation and increased demand of food for sustainable livelihood. The need was to convert weakness into strengths and threats into opportunities by involving people in all management aspects related to conservation measures and repair of structures, diversified agriculture farming activities and benefit should be shared to strength watershed development work. This builds a sense of self reliance rather than dependency in rural areas. It ensures social development, natural resource and infrastructural needs of the community by enabling them to work with all factors and developmental agencies to access multi- sectoral technical and financial inputs for solutions to meet their day-to-day activities or problems. The science and technology institutions also provides and voluntary groups as facilitators and should forge an alliance for nurturing rural livelihoods in different parts of the country through well designed integrated watershed development programmes focusing on area specific needs.

Souvik Ghosh *et al.,* (2007), analysed watershed programmes in Gujarat state. The authors stated that farmers' participation was essential to make any programme sustainable. Participation of farmer paying 40 per cent of the cost of water harvesting structures in the year 2005 and 67 per cent of the cost in the year 2006 gave them the ownership feeling and they do not take it as government donation or work. Farmer's paying capacity was increased from the system to make it more sustainable. Since participatory development and management of water resources had successful with resource poor farmers of coastal waterlogged area, it would also work in all similar areas. The groups of farmers have cultivated different crops irrigating from created water resources. The irrigated area had been increased about five times resulting into increased cropping intensity. The positive impact had been realized through the increase of productivity and income. That gives a new insight for development of small-scale water resources in risk prone waterlogged coastal areas to enhance the farm productivity and empower the socially and economically poor, small and marginal farmers.

Ajay Kumar Vashisht (2008) reported that the need for improvement in groundwater resources, to enhance the agriculture production, to meet stipulated food demand and ensure food security. In order to correct the imbalance in water budget and to restore sustainability to farming system, there was immediate need to revert, at least partially, to the cropping systems. The areas showing marked decline in water levels should practice artificial recharge. It was also essential to strengthen soil, water and groundwater institutions along with capacity building, training and quality monitoring and aquifer remediation on a continuous basis. The author cautioned that if immediate remedial measures were not taken to reverse the declining trend of water table, it would be difficult to sustain even the existing food grain production in the state, thereby, affecting the socio-economic condition of the farmers, specially the small and marginal farmers.

Souvik *et al.,* (2008) in their study on "Farmer Participation and Irrigation Management in Orissa", observed that proper education and training as well as interface with all categories of farmers was required to implement and sustain the idea of farmers assuming management and maintenance responsibilities of irrigation systems. The paper elucidated that efforts for motivation and mobilization of farmers for participatory approach as well as linkage and role of irrigation department were presently lagging which need to be strengthened to hasten the progress of farmer's participation in irrigation management.

Ganapathy *et al.,* (2001) identified the constraints faced by the beneficiaries of Integrated Watershed Development Programme (IWDP) and gave suggestions for effective functioning of programmes. The study revealed that the major constraints of IWDP farmers were (i) lack of qualified extension personnel available to them (ii) lack of printed materials, (iii) lack of training in farming and occurrence of drought, seedling mortality during transport, not having appropriate implements and lack of credit facilities. Assisting in marketing, giving importance to the allied fields of agriculture and commencing agro-based industries were the points suggested by the respondents for effective functioning of the scheme.

Singh *et al.,* (2006) in their study on "Maklang Watershed Development Project in Manipur", analysed 65 farm households in the year 2001. The study indicated that the watershed project altered the land use system favourably to horticultural crops, mostly fruits with little attention to the development of field crops and livestock including fisheries. Further study necessitated to give proper attention to the landless, marginal and small farmers while planning for watershed development projects. Self-employment schemes such as village level small scale – industries, post harvest technologies, marketing and livestock and poultry etc, need to be developed. People's participation in watershed development and management in general was poor due to lack of empowerment to local people and village institutions. Inappropriate technology intervention was observed in most cases due to non – prioritizing areas for watershed development and lack of on farm research and a multi – disciplinary perception of issues by research and development agencies. Institutional support such as credit, extension and technical support etc. were missing in most of the cases. Lack of flexibility in the watershed guidelines, the social issues such as traditional land institutions and tension between communities and poor, law and order problems and finally little or no attention on post watershed periods constraint the efficient management of the project. Empowerment of local people and village institutions, site – specific research and a multi disciplinary perception of issues by research and development agencies, institutional support such as extension and credit, enactment of suitable land reforms, joint operational partnership, flexibility in watershed guidance and attention on post watershed period were some of the policy options for successful implementation of the schemes.

Suresh and Keshava Reddy (2006) made a study on "The performance of a Minor Irrigation Project in Thrissur District of Kerala". The study revealed that the water supply in the canal was highly inequitable and the inequity in water supply was mainly due to overuse of irrigation water by upper reach farmers. The water users association formed was not functioning satisfactorily due to internal conflict and lack of motivation and remuneration. Over years, there was change of cropping pattern with the upper reach farmers substituting more remunerative banana for paddy. The farmers in the region were for introduction of rotationalsupply of irrigation water supply in the canal command.

Palanisami *et al.,* (2009) analysed that out of 385 blocks in Tamil Nadu, 180 blocks havealmost exploited the potential and out of the 1.8 million wells in the state about 12 per cent were dried up or abandoned due to ground over- exploitation. Among the 30 districts in the state ground water exploitation was more pronounced in Coimbatore district. There were about 1,23,468 wells in that district and well failure was about 47 per cent in case of dug wells and 9 per cent in the case of bore wells. It was expected that the well failure would be increasing over years due to over-exploitation of ground water resources.

Planisami *et al.,* (2009) in their book on "Groundwater Resources: Assessment, Recharge and Modeling", analysed the performance of the 525 farm household in Coimbatore in the year 2003. Out of 21 blocks in the district, 4 blocks fall under over exploited where extraction exceed 100 per cent category, 2 blocks were under critical 90 to 100 per cent category, 8 blocks fall under semi critical 70 to 90 per cent category and remaining 7 blocks were under safe less than 70 per cent category prescribed as per the revised norm of Ground water Resource Estimation Committee (GREC). During the last 10 years the average farm size had declined in all three categories of blocks viz. White, Grey and Dark and in the district the average farm size had declined from 2.09 hectare to 1.82 hectare. The average area irrigated per well had also declined over years both under the open and bore wells. Water conservation management and water harvesting programmes should be taken up in an integrated manner not only to increase the agricultural production but also in employment generation and reclaiming wasteland and preventing land degradation.

Sivanappan (2009) suggested that national governments and international agencies like World Bank, UNDP, Asian Development Bank etc., should pay more attention and sanction substantial amount for land development works (soil and water conservation and water harvesting) in dry and waste lands to increase agricultural production for food security in the coming years.

Tschopp *et al.* (2010) revealed that less than 2.00 per cent of the respondents perceived and understood land degradation and subsequent reduced land fertility were constraints for sustainable food production under dry land areas.

Prashanth (2015) revealed that the major constraints elicited by the officials of project area are lack of enthusiasm among TUGs to share responsibility (68.33%) and poor participation of farmers in tank management activities (62.50%), under the tank user related category; heavy work load in project management (75.00%) and cumbersome monitoring and evaluation (70.00%) under job related constraints category; insufficient man power (78.33%), and poor transport facility to attend the tank rehabilitation activities (75.83%) under organization related constraints category.

The various studies enumerated above covered various dimensions of watershed management. Based on the literature reviewed and interface drawn by an in-depth study, the researcher found that they had not concentrated much on the farm level watershed Development Programme. This gap motivated the investigator to analyse An Economic Impact of Integrated Watershed Development Programme in Medak district of Telangana state.

CHAPTER III

MATERIALS AND METHODS

The present study was carried out in Medak district of Telangana state. An attempt has been made in this chapter to explain the sampling procedure adopted for the selection of watershed villages, farm holdings, the sources of data and method of collection, various analytical tools both conventional and functional modelsemployed in achieving the objectives of the study, Different concepts followed in this study are also outlined in this chapter. The details are presented under the following heads.

3.1 Selection of the problem

3.2 Sample design

3.3 Collection of data

3.4 Analytical tools

3.5 Analysis of constraints and suggestions of the respondents

3.6 Terms and concepts used in the study

3.7 Methods of computation

3.1 Selection of the problem

Many of the country's problems seem to circle around water. 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) industrial production. Competition among agriculture, industry and cities for limited supply of water is constraining the developmental 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. The present productivity of irrigated land is about 2.5 t/ha (tonnes per hectare) and less than 0.5 t/ha for rainfed lands. Assuming that these levels can go up to 3.5 and 1.0 t/ha respectively by 2050, it is imperative that we create an irrigation potential of atleast 130 m.ha for food crop alone and 60m.ha all crops to be able to meet demand of the country by 2050 AD, (Ministry of Water Resources, 2013). Various studies by demographers in India and abroad suggest that world population will continue to rise atleast till 2050 AD, (National Institute of Hydrology, 2013). It was estimated that by 2050, India's population would be between 1349 million and 1980 million (United Nations Report, 2013). 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 food grains annually at the present level of consumption, (Ministry of Agriculture, 2013).

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 (Sreedharet.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 development programmes for their farm activities. Hence this study is an attempt to assess as to how the watershed development programmes are carried out in selected areas in Medak district.

3.1 Sample design

3.1.1 Selection of the District

A number of watershed programmes are being implemented by various government and non-government agencies in Medak district. National Watershed Development Project for Rainfed Areas (NWDPRA) under Ministry of Agriculture, Government of India is implementing 37 micro-watershed projects presently in the district.Among the districts of the state, Medak district is one of the drought area in Telangana state, having more watershed projects with best impact on watershed activities compared to other districts. Ranked first in area treated with 10,122 ha. under the 37 watershed projects covered by IWMP. Considerable importance has been also given in fixing physical and financial targets and allocation of funds by the Government in the district. Out of the total financial progress made so far in the watershed projects of Telangana state, nearly 12 per cent was on the Medak district watersheds alone. It has also achieved far higher i.e. (37.24 per cent) of the total financial target fixed so far for the district compared to the other districts in the state. Considering these facts, Medak district was purposively selected for the present study.

3.1.2 Selection of Watersheds

A total of 37 watershed projects are implemented in the district. Among these 10 watershed projects were selected based on the watershed having maximum dry land area of 7500 hectares.Besides they have occupied the first place in terms of percentage of financial target (59.38%) fixed as compared to the other projects. Therefore the following watersheds were purposively selected for the field investigation.

Sl. N0.	Name of the watershed villages	Project name and Batch	Name of the mandal
1	Hasnabad, Singitham	Hasnabad (2010-11)	Raikode

2	Algole, Didigi	Satwar (2010-11)	Zaheerabad
3	Peddagopularam, Busareddypally	Munipally (2010-11)	Munipally
4	Kuppanagar,Bardipur	Kuppanagar (2009-10)	Jarasangam
5	Atmakur,Bobbiligoan	Atmakur (2010-11)	Sadasivpet

3.1.3 Selection of villages

3.1.3.1 Watershed villages

From each watershed project 2 villages were randomly selected

3.1.3.2 Non-watershed villages

For an effective comparision two villages from each mandal were randomly selected in the area outside the watershed but in close vicinity where similar agro climatic conditions prevail. The 10 selected villages were Raipalle and Mogdampally from Zaheerabad mandal, Siddapur and Vanampally from Jarasangam mandal, Budhera and Lingampalle from Munipally mandal, Dharmapur and Yousufpur from Raikode mandal and Suraram and Thangadpalle from sadasivpet mandal

3.1.4 Selection of farmers

3.1.4.1 Watershed farmers

Multistage stratified random sampling method was employed to select the respondents for the present study. The list of the farmers from all the selected villages was collected and the farmers were stratified into three groups based on operational holdings i.e. marginal (less than 1ha), small (1 to 2 ha) and large (above 2 ha.). from the groups so stratified, fifty farmers from each group will randomly selected thus making the total sample respondents to 150.

3.1.4.2 Non-watershed farmers

From the list of farmers who were not exposed to watershed technology and did not derive benefits directly or indirectly from watershed programmes, a total of 150 farmers representing 50 marginal, 50 small and 50 large were randomly selected.

3.2 Collection of data

The data for the study were collected from both secondary and primary sources.

3.2.1 Secondary Data

Secondary data regarding the growth of watersheds in India, Telangana and Medak district were collected from different published records which included reports of the Department of Land Resources and reports of the Department of Rural Development, Government of India, Telangana, reports of NABARD, annual reports and records of (2012-13) DWMA, (2014-15) Medak district, records of selected Mandal Praja Parishads, Statistical Abstracts of Government of Telangana and Hand Book of Statistics, Medak district etc. The data included the information on list of beneficiary and non-beneficiary farmers along with their size of holding and agro-economic aspects of selected watershed and non-watershed areas in the district.

3.2.2 Primary Data

The selected farmers formed the main source of primary data. Data relating to cropping pattern, farm inventory, cost of cultivation of crops and their returns, minimum and maximum area under different selected crops, irrigation particulars, livestock, labour force, financial position, borrowing capacity, sources of finance, marketing activities, details of watershed activities undertaken in the farmers fields, farmers attitude towards watershed development etc., were obtained through personal interview using specially designed pre-tested schedules for watershed and non watershed beneficiaries and PIA level of the purpose.

3.4. Quantitative Tools

The following quantitative tools were applied in the study.

3.4.1. Irrigation intensity and Cropping intensity

Irrigation intensity an index of irrigated area was calculated as

$$\text{Irrigation intensity (\%)} = \frac{\textit{Gross irrigated area}}{\text{Net irrigated area}} \text{x}100$$

Cropping intensity an index of agricultural development was calculated as

$$\text{Cropping intensity(\%)} = \frac{\textit{Gross cropped area}}{\text{Net area sown}} \text{x } 100$$

3.4.2. Cobb-Douglas type of production function

To find out the contribution of each factor of production on the value of output produced and also to estimate whether the farmers were producing the output under increasing or diminishing or constant returns to scale, Cobb-Douglas type of production function was estimated. The dependent variable in the estimation of the production function was the value of the agricultural output for the i^{th} farmer (Q_i). The function was estimated with four factors of production namely land, labour, input and capital. The estimated model is of the form:

$$\ln Q_i = \ln \beta_{oi} + \beta_{1i} \ln (M_i) + \beta_{2i} \ln (L_i) + \beta_{3i} \ln (I_i) + \beta_{4i} \ln (A_i) + U_i$$

Where,

Q_i = Value of the agricultural output for the i^{th} farmer (Rs.)

M_i = Bullock and machinery cost incurred by the i^{th} farmer (a proxy for machinery) (Rs.)

L_i = Wages paid to the labourers by the i_{th}farmer (Rs.)

I_i = Inputs used in agriculture (Rs.)

A_i = Gross cropped area (in acres)

U_i = Error term

3.4.3. Crop Productivity Index

$$\text{Crop Productivity Index(\%)} = \frac{\textit{Actual yield}}{\text{Normal yield}} \text{ x } 100$$

Normal yield crop was calculated as per the standard package of practices to evaluate change in crop productivity.

3.4.4. Crop Diversification Index

Crop Diversification Index = 1- H

Where,

H is the Hirschman-Herfindhal diversification Index measured as

$$H = \Sigma [(P_{ij}/\Sigma P_{ij})]^2;$$

P_{ij} being the value of production of the i_{th} crop for the j_{th} farmer.

The crop diversification index value lies between 0 and 1. The value nearer to 0 indicates there is complete diversification.

3.4.5. Modified Entropy Index (MEI)

To find out the extent of dispersion and concentration of different crops at given point of time and space Herfindhal Index (HI), Entropy Index (EI) and Modified Entropy Index (MEI) can be used. The formulae for finding these indices and the characteristics of these indices are shown in the Table 3.1.

TABLE –3.1 Characteristic features of different measures of diversification

Index	Formula	Measure of	Value at Perfect Diversification	Value at Perfect Concentration	Is ranking of activities possible
HI	i=N Σp_i^2 i=1	Concentration	1/N	1	No
EI	N -Σpi ln(p) i=1	Diversification	Ln(N)	0	No
MEI	i=N -Σpi logN(pi) i=1	Diversification	1	0	Yes

Where,

P_i = Average proportion of i^{th} crop in total cropped area.

N = Total number of crops.

It can be shown that Herfindhal Index attains a minimum value equal to 1/N where p_i =1/N (i=1,2,3…N), and N is the total number of crops, that is, when maximum diversification occurs. It attains a maximum value of 1 when N= 1, that is, when there is a single crop or whencomplete specialization occurs.

Entrophy Index reaches a maximum value of log (N) when p_i = 1/N n (i=1, 2, 3…N), that is, when maximum diversification occurs. It reaches a minimum value of 0 when there is only one crop, that is, when specialization happens. The EI has limitations. Since the upper limit of EI is log (N) (which depends on N), it can’t be used to compare the degree of diversification in different locations where different number of crops are grown. This limitation is overcome bydefining a Modified Entropy Index.

Modified Entropy Index is same as EI except that the base of the Logarithm is N. It can be shown that at maximum diversification, this index takes a value of 1 and at maximum specialization it attains a value of 0. The MEI provides a uniform and fixed scale, so it isused as a norm to compare and rank the extent of diversification spatially. Hence in the presentstudy this index was used to rank the different crop indices.

As Modified Entropy Index provides a uniform fixed scale and ranking activities ispossible in this index, for the current study Modified Entropy Index was applied.

3.4.6. Hedonic Pricing Analysis

Hedonic price function relates an individual’s willingness to pay for environmental attributes, specified between the market prices and all the relevant attributes of the commodity. For the estimation of the hedonic price, the small implicit price of the environmental attributes needs to be considered. Thus it includes a price paid for a better environmental attributes, in the absence of which the value of land is equal to the cost of land without appropriate mark ups for environmental benefits (Sekar, 2001).

The preliminary analysis inferred from the primary data revealed that the prices of the agricultural land had shown variations with respect to the extent of water conservation area. Hence, the hedonic pricing function was employed to study the impact of distance to the village from the agricultural land, output and depth of water level in the farm wells on the price of the agricultural land.

The hedonic price function was employed to estimate the small price of the differentattributes of the watershed intervention technology. The Hedonic Price function was calculatedas,

Price = f (DISVI, OUTPUT, WTDEP)

Where,

Price = Value of agricultural land (in per hectare).

DISVI = Distance to village from the agricultural land (kms).

OUTPUT = Value of farm products (in Rupees).

WTDEP = Depth of water level in the farm wells (feet).

In hedonic pricing analysis, the implicit prices for the various qualitative and environmental characteristics were estimated by looking at the real markets in which that distinctiveness are effectively traded. Differences in these qualitative features of the land were expected to affect the flow of benefits from the property implicitly. Hence to appraise the qualitative attributes of the enhanced land used for agriculture and also to evaluate the improved values of the crop land, the data collected were subjected to hedonic pricing analysis using the ordinary least squares technique, the models were estimated.

3.4.7. Benefit cost ratio

A farm household's decision to invest in the watershed intervention technology is based on the anticipated benefits. The benefit cost ratio of the Watershed Intervention Technology is analyzed to compare the present value of benefits to the present value of cost. If the benefit cost ratio of the Watershed Intervention Technology is greater than unity, then the adoption and the implementation of the watershed intervention technology is found to be economically sound. If the benefit cost ratio of the watershed intervention technology is less than unity, then the adoption and the implementation of the watershed intervention technology is found to be economically unappealing. The ratio is expressed in the following form:

$$\text{Benefit-cost ratio} = \frac{\sum_{i=1}^{n} Bt}{\sum_{i=1}^{n} Ct}$$

B_t= Benefits realized in the sample farmers in terms of output produced in the operational area in the year 2013-14.

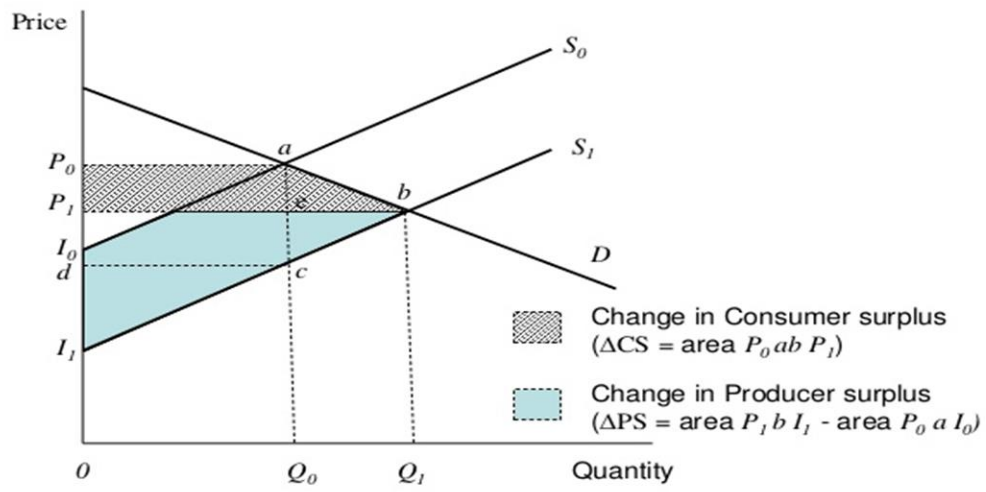
C_t = Costs accrued the sample farmers in the watershed intervention technology in the year 2012- 13.

3.4.8. Scaling Technique

Three point rating scale was used to find out from the farmers the impact of watershed intervention technology. The opinions were marked as ‘very good’, ‘good’ and ‘poor’. For very good score of ‘2’, for good score of ‘1’ and poor score of ‘0’ were assigned.

3.4.9. Economic Surplus Model

The Economic Surplus (ES) approach is widely followed for evaluating the impact of technology on the economic welfare of households (Moore *et.al.* 2000; Maredia *et al.,* 2000; Swinton, 2002 and Wander *et al.,* 2004). The economic surplus method measures the aggregated social benefits of a research project. With this method it is possible to estimate the return to investments by calculating a variation of consumer and producer surplus through a technological change originated by research. Afterwards, the economic surplus is utilized together with the research costs to the Benefit-Cost Ratio (BCR) (Maredia *et al.,* 2000).



Surplus distribution in the basic model of research benefits

Source : Alston, Norton and Pardey, p209

The mathematical model used was based on the scheme proposed by Pachico *et al.* (1987), in which supply and demand functions were nonlinear with constant elasticity, i.e. loglinear. The supply function for a product market was assumed that supply curves of the following functional form:

$S_o = c\,(P_o - P_{Io})^d$ …………………………….(3.1)

S_o = initial supply before watershed intervention technology

C&d = constants

P_o = price of product and

P_{Io}= maximum price that producers are willing to offer.

The advantage of the economic surplus approach lies in that the fact that distribution ofbenefits to different segments of the society could be estimated. The watershed development could be treated as a ‘public good’ and covers both the private and public lands. Moreover, thebenefits due to watershed development activities are not restricted to the producers alone. Increased supply and hence changes in price of the agricultural products will also benefit the consumers positively. In this context, the economic surplus approach captures the impact ofwatershed development activities in a holistic manner.

3.4.10. Application of Economic Surplus Method to Watershed Evaluation

Watershed programmes play a dual role of safe guarding the interest of the producers aswell as consumers, as in several locations, the drought-proofing aspects of the watershed programmes are easily felt (Palanisami and Suresh Kumar, 2007). In the case of producers, theycan change the crop pattern due to increased water levels in their wells, moisture conservation inthe soil, increase water use for the existing crops, and increase the number of livestock and fodder production. There is also a change in the cost of production of the commodities in the watershed.

Over the years, there is an increase in technology adoption due to watersheds programmes. In the case of consumers, the increased crop production in the watershed results in availability of produce at lower prices. Consumption levels also get increased among the consumers. Labour employment is increased due to increased land and crop production and processing activities inthe watershed. Hence, for the purpose of the analysed, it was assumed that, the output supplycurve shifts gradually over time when the benefits from the watershed development activitiesstart benefitting the agricultural sector through water resource enhancement. The supply shiftfactor due to technological change, in our case, watershed intervention, is known as K. Thisfactor varies in the time depending on the dynamics of the rainfall, adoption, dissemination ofsoil and moisture conservation technologies and maintenance activities undertaken in thewatershed. The supply shift factor (K) can be interpreted as a reduction of absolute costs foreach production level, or as an increase in production for each price level (Libardo *et al.*, 1999).Micro economic theory defines consumer surplus (individual or aggregated) as the areaunder the (individual or aggregated) demand curve and above a horizontal line at the actual price (in the aggregated case: the equilibrium price). Following IEG, World bank, 2008, the demand curve is assumed to be log-linear with constant elasticity. Thus, the demand equation for thisdemand function can be written as:

$$P = g\, Q^{\eta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Where, ŋ is the elasticity and g is a constant. Once, the parameters ŋ and g are estimated, thenconsumer surplus could be estimated by equation (3.3):

$$CS = \int_{Q_0}^{Q_1} g Q^{\eta} dQ - (Q_1 - Q_0) P_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

Combined, the consumer surplus and the producer surplus make up the total surplus.

Estimation of Benefits

Following the theory of demand and supply equilibrium, economic surplus (benefits) as aresult of watershed development intervention is measured by equation

$$B= K * P_0 * A_0 * Y_0 * (1 + 0.5 Z * \square_d) \text{ ……………………….(3.4)}$$

Where, K is the supply shift due to watershed intervention.

Z represents the change in price due to watershed interventions. Mathematically, Z canbe defined by equation (3.5):

$$Z = K * \square_s / (\square_d + \square_s) \text{ ………………………..(3.5)}$$

Where,

p_0, A_0 and Y_0 represent prices of output, area and yield of different crops in the watershed before implementation of watershed development programme. If we use the ‘before’ and ‘after’ approach, then these represent area, yield and price of crops in control village. Change in consumer surplus was calculated as

$$\Delta CS= P_0 Q_0 z (1+0.5 Z\eta)$$

Change in producer surplus was calculated as

$$\Delta PS= P_0 Q_0 (K-Z) (1+0.5 Z\eta).$$

And change in total or economic surplus was calculated as

$$\Delta TS= \Delta CS+ \Delta PS = P_0 Q_0 K (1+0.5 Z\eta).$$

3.4.11. Averages, Percentages and Graphs

Averages, percentages and graphs were also used in the study for better presentation of results. To carry out the calculations S.P.S.S. 16.0 version, SAS and Mintab software were used.

3.4.12. People’s participation of watershed farmers at different stages of watershed management programme

People’s participation was operationalised as the degree of participation of watershed farmers at different stages of watershed management programme and sharing the responsibilities during each and every management activity for efficient functioning of watershed project in a sustainable manner.

A schedule was developed with 30 statements for eliciting the response on people's participation of watershed farmers at different stages of watershed management programme.

Scoring: The response on each statement was recorded on three point continuum i.e. agree, undecided and disagree with the scores of 3, 2 and 1 respectively. The maximum and minimum possible scores are 90 to 30, whereas the obtained scores were 80 and 50 respectively.

$$Extent\,of\ participation = \frac{Actual\,score\,obtained}{Maximum\,possible\,score}\ x100$$

Categorisation:

Based on the people's participation, the watershed farmers were grouped in to following three categories by using exclusive class interval technique.

Category	Class interval
Low extent of participation	50-60
Medium extent of participation	60-70
Highextent of participation	70-80

3.5Analysis of constraints and suggestions of the respondents

3.5.1 Garrett's ranking technique

This technique was used to rank the constraints. Accordingly rank were given to the constraints spelt out for the farmers participation in with watershed and without watershed activities , by a sample number of 300 farmers for constraints involved in with watershed and without watershed activities, were converted into percent position and percent position transformed to scores for which mean values were calculated to identify the rank of constraints.

The percent position was calculated using the formula,

$$100(R_{ij}-0.5)/N$$

Where

R_{ij}= the raking assigned to i^{th} constraint by j^{th} respondent

N= number of constraints

Based on this method the following constraints were identified with their ranks.

3.6. Definitions of the terms used.

Watershed/Beneficiary Farmer

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

Non-watershed / Non-beneficiary Farmer

Farmers 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.

Marginal Farmer

Farmer having less than one hectare of dryland is grouped as a marginal farmer.

Small Farmer

Farmer who's holding falls in between one and two hectares of dryland is considered as a small farmer.

Large Farmer

Farmer having more than two hectares of dry land is termed as a large farmer.

Operational Holding

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

Arable land (wet land)

Arable land is land under annual crops, such as cereals, cotton, other technical crops, potatoes, vegetables, and melons; also includes land left temporarily fallow.

Orchards (Garden Land)

Orchards and vineyards refer to land under permanent crops (e.g. fruits plantations).

Non-Arable (sand)

Non-arable lands are water deficient areas in the crops without irrigation.

Soil and Water Conservation Interventions

Soil and water conservation works comprised of bunding (mechanical and mechanical cum-vegetative barriers and terracing, gully plugging, *in situ* moisture conservation practices (e.g.deep ploughing, dead furrow, leveling and smoothening) and these are maintained based on theneed, convenience, time availability, etc. Water harvesting components include water ways, diversion channels, farm ponds, sunken ponds, percolation tanks/wells, check dams, Nalabunds, etc.

Soil Conservation

Soil conservation is a set of management strategies for prevention of soil being erodedfrom the earth's surface or becoming chemically altered by overuse, acidification, salinization orother chemical soil contamination. It is a component of environmental soil science.

Summer Ploughing

In the summer, apart from weed-control it is also important to regularly aerate the earth.Keeping the surface of the earth broken (and very dusty and this time of the year) also serves tokeep the moisture in the soil, which is particularly important after the recent dry (and very hot) spell.

Water Conservation

Water conservation refers to reducing the usage of water and recycling of waste water fordifferent purposes such as cleaning, manufacturing, and agricultural irrigation.

Rejuvenation ofWell

A drilled well of deficient performance due to accumulation of scales on the water-intakeparts of its well pipe is rejuvenated at low cost by inserting a cleaning pipe of smaller diameterthrough the well pipe to supply concurrently to the water-intake parts an aqueous solution of aharmless washing agent and high-pressure air, which produce a cooperatively combined agitationaction by which the scales are chemically dissolved, loosened, and washed off and can besubsequently removed by pumping through the well pipe.

Watershed Intervention Technology

Watershed Intervention Technology is a composite approach to an efficient use of landand water resources so as to get optimum production from them and also to preserve the soil fromdeterioration and future utility.

Irrigation

Irrigation is an artificial application of water to the soil. It is used to assist in the growingof agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areasand during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growing in grainfields and helping in preventing soil consolidation. In contrast, agriculture that relies only ondirect rainfall is referred to as rain-fed or dry land farming. Irrigation systems are also used fordust suppression, disposal of sewage, and in mining.

Net area sown

This represents the total area sown with crops and orchards. Area had sown more than once inthe same year is counted only once.

Total/Gross cropped area

This represents the total area sown once and/or more than once in a particular year, i.e., the area is counted as many times as there are sowings in a year. This total area is known as grosscropped area.

Area sown more than once

This represents the areas on which crops are cultivated more than once during theagricultural year. This is obtained by deducting Net Area Sown from Total Cropped Area.

Irrigated Area

The area is assumed to be irrigated for cultivation through such sources as canals (Govt.& Private), tanks, tube-wells, other wells and other sources.

Net Irrigated Area

It is the area irrigated through any source once in a year for a particular crop.

Total/Gross Irrigated Area

It is the total area under crops, irrigated once and/or more than once in a year. It is counted as many times as the number of times the areas are cropped and irrigated in a year.

Cropping Intensity

It is the ratio of Net Area Sown to the Total Cropped Area.

Irrigation Intensity

It is the ratio of Net Area Sown to the Total Irrigated Area.

Actual yield

Actual yield means "the yield per acre for a crop year calculated from the productionrecords or claims for indemnities. The actual yield is determined by dividing total production (which includes harvested and appraised production) by planted acres for annual crops or byinsurable acres for perennial crops."

Normal yield

Normal yield is an agricultural term referring to the average historic yield established fora particular farm or area. It is also used to describe average yields. Normal production would be the normal crop acreage planted multiplied by the normal yield.

Potential Yield

Potential yield is defined as the yield of a cultivator when grown in environments to whichit is adapted, with nutrients and water non-limiting and with pests, diseases, weeds, lodging, andother stresses effectively controlled. As such, it is distinguished from potential yield, which wedefine here as the maximum yield which could be reached by a crop in given environments, asdetermined.

Farm Cultivation Expenses

Farm cultivation expenses include expenses on seeds, labour, fertilizers, pesticides and maintenance and hiring expenses of farm machineries on the cultivation of crops.

Gross Farm Income and Net Farm Income

Gross farm income is the sum of all agricultural commodities produced in the farm whichincludes cost of cultivation. Net farm income is derived by detecting expenses on seed, labour, fertilizers, pesticides and maintenance and hiring expenses of farm machineries and equipments.

CHAPTER IV

AGRO-ECONOMIC FEATURES

The nature of farming in a locally depends largely on location of the farm, rainfall, soil type, climate and irrigation facilities. Thus, it is desirable to have a general view on the agro-climatic features of the area under study, so as to have a comprehensive knowledge of the area. This chapter deals with the agro-economic scenario of the study area.

4.1 The district in brief

4.1.1 Historical background

The study was undertaken in Medak district of Telangana state. Medak district is originally known as Methukudurgam which subsequently changed into methuku due to the growth of fine and coarse rice in this area. Medak is one of the ten districts of Telangana state with a geographical area of 9,699 km^2. It forms a part of Deccan Plateau under Godavari basin and lies between North Latitudes 17' 27' and 18' 19' and East longitudes 77' 28' and 79' 10'.

Medak district is bounded on the north by Nizamabad and Karimnagar district, on the east by Warangal and Nalgonda district, on the south by Rangareddy and on the west by Bidar District of Karnataka state. The district is divided into 46 revenue mandals, with its Headquarters at Sangareddy. The details of the of the district glance is presented in Table 4.1

Table: 4.1 Particularsof Medak district glance

Sl. No	Particulars	Numbers
1.	Mandals	46
2.	Revenue divisions	3
3.	Villages in-habited	1548
4.	Revenue villages	1267
5.	Gram panchayats	1065
6.	Total villages and towns	1265

Source: Chief Planning Officer, Medak district.

The district has a population of 30, 31,877 (as per 2011 census), which is 3.57% of the State population. The forest cover is 96,267 hectares and the net area sown is 4,23,000 ha and the total cropped area is 5,25,000 ha. There are no major surface irrigation projects worth mentioning except for minor irrigation projects like Ghanpur, RanapalGangakathwam, Bollampalle, Nallavagu and Pocharam. The main river of the District is Manjeera. The normal annual rainfall of the District is 873 mm, which ranges from 635 mm at Kondapaka mandal to 1036 mm at Medak mandal.

4.1.2 Particular of watersheds in Medak district.

Out of 46 mandals, only 28 mandals are covered under watershed development programme in this district. Total area treated under watershed development programme in the details of the IWMP statistics of the district is presented in Table 4.2.

Table: 4.2 Total watershed report of Medak district

Sl. No	Particulars	Sanctioned in district
1	No of Batches	5
2	No of WCCs	14
3	No of Projects	37
4	No of Mandals	28
5	No of Gram Panchayats	230
6	No of MWS	246
7	Project Area(ha)	1,61,785
8	Project Cost(Rs. In lakhs)	19414.15
9	Area Treated so far(ha)	32197

Source: District Water Management Agency, Medak 20014-15

4.1.3 Demographic features

Human resource is the greatest social asset to accelerate the process of economic development. The population supplies this vital resource.

The total population of the district as per 2011 census is 30.33 lakhs, of which 15.23 lakhs are males and 15.10 lakhs are females. The setting of Medak district is the typically rural. The scheduled caste and scheduled tribe population together constituted about 23.23 percent of the total population. The percentage of literates in the total population was about 53.97.The details of the population statistics of the district is presented in Table 4.3.

From the table 4.3, it can be understood that male population is more than female population. Cultivators and agricultural labour constitute 11.63 and 18.82 per cent of total population respectively. Per cent of the workers to total population is 47.54.

Table 4.3: Population particulars in Medak district (2011)

Particulars	Population (in lakhs)	Percentage to total population
Male	15.23	50.21
Female	15.10	49.78
Rural population	23.05	77.48
Urban population	7.28	24.00
Literate	16.37	53.97
Workers	14.42	47.54
Cultivators	3.53	11.63
Agricultural labour	5.71	18.82
Scheduled castes	5.37	17.70
Scheduled tribes	1.68	5.53
Total population	30.33	100.00

Source: Hand Book of Statistics, Medak district (2011).

4.1.4 Temperature

It is observed from the temperature data that the monthly maximum and minimum temperatures increase at the beginning of the dry season (March to June) and reach the highest in April and May. The warmest month in the district is May, which recorded maximum temperature of 40.8°C. The decline in the maximum temperature is observed during the months from June (35.7°C) to October (33.6°C). Further decline in the monthly maximum and minimum temperatures is seen in November, December and January. November to February is the cool season in the district. The coldest month in the disrict is December which recorded 11.8°C of mean minimum temperature. By and large, the temperature of the district is highly suitable for growing a variety of crops.

The district has the benefit of receiving rainfall during both the south-west and north-east monsoon periods. While the normal rainfall of the district for the south-west monsoon period is 675.8 mm and that of north-east monsoon period is 132.4 mm. The annual normal rain fall of the district is 910 mm. The details of the rainfall was presented in Table 4.5.

Table 4.4: Monthly mean Temperatures in Medak district

Month	Normal (^{0}C)	
	Mean maximum temperature	Mean minimum temperature
January	32.0	11.8
February	33.8	16.4
March	38.4	19.2
April	39.3	22.1
May	40.8	24.9
June	35.7	23.7
July	31.4	22.5
August	31.0	22.4
September	32.0	21.7
October	33.6	19.5
November	32.8	15.0
December	32.8	12.2

Source: Chief Planning Officer, Medak

4.1.5 Rainfall

Table: 4.5 Details of the rainfall in Medak district (2010-11)

l.no	Year	South west monsoon					North east monsoon			
		June	July	August	September	Total	October	November	December	Total
	Normal	25.6	18.9	13.3	18.0	75.8	9.9	6.7	.9	32.4
	2006-07	3.4	07.1	35.6	33.3	59.5	6.2	7.3	.00	0.6

	2 007-08	51.4	00.7	44.9	94.1	91.1	2.6	3.8	.0	6.5
	2 008-09	3.4	19.4	29.6	58.3	70.8	0.4	.7	.2	5.3
	2 009-10	9.7	2.1	89.6	64.1	85.5	0.2	0.1	.3	3.6
	2 010-11	4.3	85.7	38.9	58.9	57.8	8.8	1.4	.7	21.8

Source: Chief Planning Officer, Medak

The rainfall received from the south-west monsoon is more copious compared to north-east monsoon in the western mandals and in the central part of the district whereas the rainfall received from north-east is comparatively copious in the eastern mandals of the district. Title incidence of rainfall is not uniform and certain. Therefore the district is frequently prone to drought conditions.

4.1.6 Rivers

The Manjira River is a perennial river, a major project Singoor which is dedicated to drinking water supply. There are no major irrigation projects in the District. An area of 9325 ha is being irrigated by surface water sources and an area of 1,45,452 ha is being irrigated by ground water, which indicates that, ground water plays a major role when compared to surface water. The Manjira also spelled Manjra is a tributary of the river Godavari. It passes through the states of Maharashtra, Karnataka and Andhra Pradesh. It originates in the Balaghat range of hills at an altitude of 823 metres (2,700 ft) and empties into the Godavari River. It has a total catchment area of 30,844 square kilometres (3,084,400 ha).

The Singur Reservoir on Manjira River in Medak District is a sustained drinking water source of Hyderabad. The Manjira River is the main drinking water source for the Medak and Nizamabad districts as well as the adjoining twin cities of Hyderabad and Secunderabad.

4.1.7 Soils

The soils are predominantly sandy loams (55%), followed by black clay loams (44%) and laterite soils (1%). The soils of the district are, in general, shallow , less fertile, except in parts of Sadasivapet , Munipally , Kohir , Jarasangam , Zaheeerabad , Nyalkal, Manoor mandals and parts of Toopran mandals , Wargal, Mulugu, Miridoddi, Dubbak and Kondapak mandals.

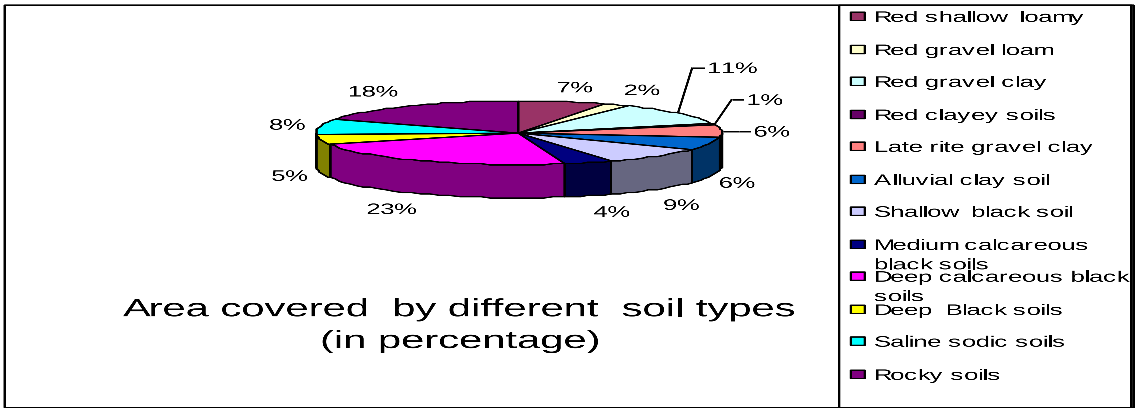
The soils however, respond well to the management practices and balanced use of manures and fertilizers. The shares of different types of soils in Medak district are presented below in table 4.6.

Table: 4.6 particulars of different soils in Medak district (2014-15).

Sl.No	Type of soil	Percentage to total area
1	Sandy loams	55
2	Black clay loams	44
3	Laterite soils	1

Source: Chief Planning Officer, Medak

Fig 1 Area covered by different soils in the district



4.1.8 Land Utilisation

Table 4.7: land use pattern in Medak district (2014-2015).

S.No	Type of soil	Area in '000' hectares	Percentage to total geographical area
1	Total geographical area	970.0	100.00
2	Forests	91.4	9.42
3	Barren and uncultivable land	59.8	6.17
4	Land put to non-agricultural use	70.3	7.24
5	Cultivable waste	20.0	2.10
6	Permanent pastures and other grazing lands	30.2	3.11
7	Current fallows	131.5	13.55
8	Land under miscellaneous tree crops	3.8	0.40
9	Other fallow lands	105.1	10.83
10	Net area sown	424.8	43.80

Source: Chief Planning Office, Medak

The amount of land and its quantity, the intensity of its use for plants and animals. The degree to which it was modified by man to increase production of land utilisation. The pattern of the utilisation of land reflects the utilisation potential and also the extent to which it can be fully exploited. The land utilisation in Medak district during the period 2010-11 is presented in Table 4.7.

It is perceptible from the particulars provided in the table that, barren and uncultivable land is as much as one-third of net sown area indicating that, much is to be done in the district to bring more land under cultivation. Cultivable waste which accounts for 2.10 percent and Land under miscellaneous tree crops which accounts for 0.40 of total geographical area of the district. Forest area accounts for 9.42 per cent of the total geographical area. The net area sown was 424.8 ha, which forms 43.80 per cent of the total geographical area. Can easily be brought under cultivation with proper planning and development, so that the district can be made as one of the agriculturally advanced districts in the state.

4.1.9 Irrigation facilities

The main sources of irrigation in the district are wells and tanks. In addition, there are canals, tube wells, filter points and other sources of minor irrigation supplying water for cultivation of crops.There are no major reservoirs in the district. Only 2 medium irrigation projects namely Ghanpooranicut located in Kulcharammandal, with existing registered ayacut of 8,752 ha and Nallavagu project in Kalhermandal with an ayacut of 2,436 ha

Table 4.8: Irrigation sources in Medak district (2010-11)

S.No	Source of irrigation	Area in '000' hectares	Percentage to total geographical area
1	Canals	3.03	1.25
2	Tanks	12.41	5.14
3	Tube wells	209.83	86.96
4	Dug wells	13.66	5.66
5	Other sources	0.80	0.33
6	Net area irrigated	150.42	62.33
7	Area irrigated more than once	90.87	37.66

8	Gross area irrigated	241.29	100.00

Source: Chief Planning Office,Medak district.

Both these reservoirs irrigate a total area of 10,752 ha during kharif (6619 ha.) and rabi (4138 ha) seasons.The other sources of irrigation in the district are minor irrigation tanks and tube wells.

There are 5756 minor irrigation tanks with a total ayacut of 1.02 lakh hectares. The relevant data concerning source-wise area irrigated in the district is presented in Table 4.8.

4. Cropping pattern

The cropping pattern usually is determined by many factors, the more important of which are climate, soil, topography and distance from market etc. It is evident from the details furnished in Table 4.9 that the principal food crops grown in the district are Paddy, Maize, Sugarcane, jowar, cotton and pulses. Paddy is the major crop accounting for 27.15 percent of the total cropped area. Besides pulses, cash crop like sugarcane and fruits and vegetables are grown accounting for 26.20 percent, 8.67 percent and 6.00 respectively.

Table 4.9: Cropping pattern in Medak district (2010-11)

Sl. No.	Crop	Area in '000' hectares	Percentage to gross cropped area
1	Paddy	144.55	27.15
2	Maize	100.13	18.81
3	Sugarcane	46.20	8.67
4	Jowar	37.25	7.00
5	Potato	3.82	0.71
6	Pulses	139.41	26.20
7	Cotton	25.00	4.70
8	Ginger	1.56	0.30
9	Fruits and vegetables	31.42	6.00

10	Gross cropped area	532.3	100.00

Source: Chief Planning Officer, Medak

4.1.11 Livestock

The total livestock population in the district is 26.25 lakhs as per 2011 census. Out of which the cattle population is around 4.82lakhs, buffaloes 4.51lakhs, sheep and goat 16.18 lakhs. The poultry population is around 98.00 lakhs. The animal husbandry schemes are well developed in the district and there is a good potential for the development of animal husbandry as a subsidiary occupation. The details of livestock in the district according to 2011 census are presented in Table 4.10.

Table 4.10: Livestock statistics of Medak district (2010-11)

Sl.No	Particulars	Number in lakhs
1	Cattle	4.82
2	Buffaloes	4.51
3	Sheep	10.68
4	Goats	5.50
5	Total livestock	26.25
6	Poultry	98.00

Source: Chief Planning Officer, Medak

4.1.12 Agricultural Implements and Machinery

Table 4.11 presents data on agricultural implements and machinery available in the district.

Table 4.11: Agricultural implements and machinery (2011 census)

.No	Particulars		Number in lakhs
	Ploughs	Iron	48402
		Wooden plough	76430

	Cultivators	57776
	Seed-cum-fertilizers drill/seed drill	27332
	Tractors	256
	Sugarcane crushers:	1809
	Sprayers and dusters	25690
	Bullock carts	30120

Source: Chief Planning Officer, Medak

An examination of the Table 4.11, revealed that the farmers are using both the traditional and improved implements and machinery. However, there is every need to popularize the improved machinery and implements.

4.2 Particulars of selected mandal

For the study, selected five mandals in Medak district, i.e., Zaheerabad, Jarasangam, Munipally, Raikode and Sadasivpet mandals. These mandals were selected based on the watershed project expenditure and area.

4.2.1 Particulars of watershed projects in selected mandals

Particulars of IWMP in the selected mandals are presented in the table 4.12. It is evident from the table that the Zaheerabad and Sadasivpetmandals were highest area and project cost compare to other selected mandals. The number of micro watershed villages are highest in Zaheerabad(15) and Sadasivpet(13) mandals.

Table 4.12 particulars of IWMP in selected mandals

Sl. No.	Mandals	No. of Projects	No. of MWS	Project Area(ha)	Project cost (lakhs)
1	Zaheerabad	2	15	9037	1084.44
2	Jarasangam	1	8	5100	612.00
3	Munipally	1	7	4623	554.76
4	Raikode	1	8	4961	575.32
5	Sadasivpet	2	13	9529	1143.48

Source: District Water Management Agency, Medak 20014-15

4.2.2 Demographic features of Selected mandals

Demographic features of the selected mandals are presented in the Table 4.13. It is evident from the table that, the male population (50.61%) in Zaheerabad mandal is higher than female population. The literacy rate is 58.27 per cent in Zaheerabad mandal. There are 346 persons for every 100 sq.kms in Zaheerabad mandal.

In Jarasangam mandal the male population (50.98%) is higher than female population. The literacy rate is 47.26 per cent. There are 193 persons for every 100 sq.kms and in Munipally, Raikode and Sadasivpet mandals male population is 50.43 per cent, 51.23 per cent and 50.08 per cent respectively higher than female population. The literacy rate in Munipally, Raikode and Sadasivpet mandals are 47.98 per cent, 59.87 per cent and 42.02 per cent respectively. There are 175 persons, 128 persons and 348 persons for every 100 sq.kms respectively in Munipally, Raikode and Sadasivpet mandals.

Table 4.13 Demographic features of the Zaheerabad, Jarasaangam, Munipally, Raikode and Sadasivpet Mandals (2011)

S.No	Particulars	Zaheerabad	Jarasangam	Munipally	Raikode	Sadashivpet
1.	Population					
	Male	60186 (50.61)	22731 (50.98)	20661 (50.43)	20871 (51.23)	25739 (50.08)
	Female	58733 (49.39)	21852 (49.02)	20304 (49.57)	19861 (48.77)	25648 (49.92)
	Total	118919 (100.00)	44583 (100.00)	40965 (100.00)	40732 (100.00)	51387 (100.00)
2.	Density	346	193	175	128	348
3.	Sex ratio (female per ‘000’ male)	953	943	950	949	967
4.	Literacy rate (%)	58.27	47.26	47.98	59.87	42.02

Source: Chief planning officer, Medak, 2010-11

4.2.3 Land utilisation pattern in selected mandals

The land utilization pattern of Zaheerabad, Jrasangam, Munipally, Raikode and Sadasivpet mandels were presented in Table 4.14. It is evident from the table that the Net sown area occupies the maximum share of 58.10 per cent, 68.90 per cent, 46.38 per cent, 72.33 per cent and 50.90 per cent to the total geographical area of Zaheerabad, Jrasangam, Munipally, Raikode and Sadasivpet mandels. While the forest occupy 9.10 per cent, 1.2 per cent, 0.57 per cent, 1.7 per cent and 1.95 per cent Zaheerabad, Jrasangam, Munipally, Raikode and Sadasivpet mandals to the total geographical area and Permanent pastures and other grazing land contributing to only 0.4 per cent in jarasangam mandal and other mandals were contributing without permanent pastures and other grazing land of the total geographical area.

4.2.4 Sources of irrigation

It is observed that under bore wells constituted the major source of irrigation in Zaheerabad, Jrasangam, Munipally, Raikode and Sadasivpet mandals are accounting to about 69.71 per cent, 61.30 per cent, 71.87 per cent, 50.00 per cent and 70.29 per cent of gross area irrigated. Without source of irrigation from canals in all selected mandals. No source of irrigation from tanks in Zaheerabad and jarasangam mandals. Only Munipally(0.11%), Raikide(4.21%) and Sadasivpet(5.19%) mandals occupy irrigation under tanks of gross irrigated area. Area irrigated by different source of irrigation was presented in Table 4.15.

4.2.5 Cropping pattern

The cropping pattern usually is determined by many factors, the more important of which are climate, soil, topography and distance from market etc. It is evident from the details furnished in Table 4.16 that the principal food crops grown in the selected mandals are Paddy, Maize, Sugarcane, jowar, onion, pulses and cotton. Pulses are major crop in Zaheerabad, Jrasangam, Munipally and Raikode mandals are accounting to about 40.00 per cent,35.90 per cent, 38.23 per cent and56.40 per cent of gross area sown. Sugarcane is the major crop in Zaheerabad mandal, accounting for 21.03 percent of the total cropped area. Cotton is major crop in Munipally and Sadasivpet mandals accounting for 34.88 percent and 54.40 percent respectively.

4.2.6 Irrigated Area under principle crops

Only Sugarcane crop occupies 78.95 percent of the total irrigated area in Zaheerabad mandal, followed by Jarasangam (36.00%), Munipally (74.70%),Raikode (75.53%) and Sadasivpet (76.63%) of cotton crop. Maize occupies only 61.18 per cent to the Gross Irrigated area in all mandals. The other crops Viz., paddy and onion form only 16.78 per cent and 6.64 per cent to the Gross Irrigated Area. Irrigated area of Principle crops were presented in Table 4.17.

4.3 Selected villages

Ten villages namely, Algole, Didigi, Burdipur, Kuppanagar, Peddagopularam, Busareddypally, Hasnabad, Singitham, Atmakur and Bobbiligoan in withwatershed area and ten villages Raipalle, Mogdampally, Siddapur, Vanampally, Budhera, Lingampalle, Dharmapur, Yousufpur, Suraram and Thangadpalle in without-watershed area were selected for the study. A brief discussion of the selected villages is presented in the following paragraphs. Details are presented in Table 4.18, 4.19.

Watershed villages

1. **Algole Village**; With initiation of the programme in this village the watershed was named after this village. The village is situated at a distance of 9 km away from Zaheerabad town. The total population of the village is 2784 with 1356 males and 1428 females. The total geographical area is about 780 hectares. The net cropped area is 484 hectares About 354 hectares is under unirrigated condition whereas 130 hectares is under irrigation Regarding land utilisation in the village, about 20.38 per cent ofthe total geographical area is forest land. Only about 62.05 per cent of the total geographical area is net sown area. The major crops are sugarcane and turmeric grown under irrigation condition. Pulses grown under dryland condition in this village. Vegetables are also taken to a small extent under wells. Most of the farmers belong to marginal and small categories. There is good potential for dairy and dryland horticulture development in the village.

2. **Didigi village**; The village is situated 8 km away from Zaheerabad i.e., mandal head quarter. The total population of the village is 2073 with 1020 males and 1053 females. The total geographical area is about 975 hectares. The net cropped area is 419 hectares About 324 hectares is under unirrigated condition whereas 85 hectares is under irrigation Regarding land utilisation in the village, about 15.58 per cent of the total geographical area is forest land. Only about 42.97 per cent of the total geographical area is net sown area. The major crops are sugarcane and turmeric grown under borewell irrigation. Pulses grown under dryland condition in this village. Vegetables are also taken to a small extent under wells. Most of the farmers belong to marginal and small categories. There is a good marketing facilities available in this village.

3. **Burdipur Village**; The village is situated at a distance of 7 km away from Zaheerabad town and 5 km away from Jarasangam mandal head quarters. The total population of the village is 1878 with 946 males and 932 females. The total geographical area of the village is 1006.8 hectares with net cropped area of 746 hectares. 546.8 hectares was under dryland condition, while 450 hectares was under wells. As usual in other watershed villages, in this area sugarcane in dryland and

irrigated, and to a small extent vegetables in irrigated land are grown. About 3.97 per cent of the total geographical area is forest land. About 60 hectares was under mango orchards i.e. dryland horticulture. Besides this, the village is provided with minimum educational and health care facilities. Most of the farmers in the village are small and large size category. This village is one of the best village in Medak district. Maximum of all activities works done in this village.

4. **Kuppanagar Village**; The village is situated 10 km away from Zaheerabad town. The total population of the village is 2940 with 1488 males and 1452 females. The total geographical area of the village is 1205.97 hectares with arable and non-arable lands. Most of the land i.e. about 79.95 per cent is under rainfed and irrigated conditions, with sugarcane as the important crop occupying 137.2 hectares of the total geographical area of the village. Most of the farmers are small and marginal categories.

5. **Peddagopularam Village**; The village is situated 5 km away from Munipally i.e., mandal head quarter. The total population of the village is 1961 with 996 males and 995 females. The total geographical area is about 1217 hectares. The gross cropped area is 960 hectares About 730 hectares is under rainfed condition whereas 110 hectares is under irrigation. There is no forest land in this village.About69.84 per cent of the total geographical area is net sown area. The major crop iscotton grown under rainfed condition. Pulses grown under dryland condition in this village. Vegetables are also taken to a small extent under wells. Most of the farmers belong to marginal and small categories. There is a good marketing facility available in this village.

6. **Busareddypally Village**; The village is situated at a distance of 6 km away from munipally mandal head quarter. The total population of the village is 1835 with 906 males and 929 females. The total geographical area is about 956 hectares. The gross cropped area is 840 hectares About 740 hectares is under rainfed condition whereas 50 hectares is under irrigation land in the village. Only about 82.63 per cent of the total geographical area is net sown area. The major crop is paddy grown under irrigation condition. Pulses grown under dryland condition in this village. Vegetables are also taken to a small extent under wells. Most of the farmers belong to marginal and small categories.This village is very near of singur reservoir.

7. **Hasnabad Village**; The village is situated at a distance of 7 km away from Raikode mandal head quarter. The total population of the village is 2416 with 1218 males and 1198 females. The total geographical area of the village is 1,429.16 hectares with net cropped area of712.16 hectares. 619 hectares was under dryland condition, while 93 hectares was under wells. As usual in other watershed villages, in this area also cotton in dryland, paddy and to a small extent of vegetables in irrigated land are grown. There is 5.23 per cent forest land in the village. About 90 hectares was under mango orchards i.e. dryland horticulture. Besides this, the village is provided with minimum educational and health care facilities. Most of the farmers in the village are small size category.

8. **Singitham Village**; The village is situated 8 km away from Raikode mandal head quarter. The total population of the village is 2660 with 1356 males and 1304 females. The total geographical area of the village is 1358.67 hectares with arable and non-arable land. Most of the cultivable land i.e. about 87 per cent is under dry condition, with cotton as the important crop occupying 46 hectares of the total geographical area of the village. Most of the farmers are small and marginal categories. After implemention of watershed development programme increase their livelihoods. In this village is all govt. implementing the progammes are smoothly running and farmers are best utilizing of the govt. programmes.

9. **Atmakur Village**; The village is situated at a distance of 10 km away from Sadasivpet town. The total population of the village is 3749 with 1852 males and 1897 females. The cultivated area of the village is 1,483 hectares. Out of which about 1,123 hectares under dryland condition. The majority of the farmers found to be in the farm size group of I to 2 hectares. Cotton crop grown under rainfed condition. Paddy is the most important crop taken under wells. The important feature of this village is the development of dry land horticulture. Mango orchards are taken in about 150 acres after the implementation of watershed programme. In addition to 20 borewells are also providing irrigation to crops. This village farmers good aware of all govt. implemented programmes.

10. **Bobbiligoan Village**; The village is situated at a distance of 7 km away from Sadasivpet town. The total population of the village is 1854 with 912 males and 942 females. The total geographical area is about 1,250.79 hectares. The net cropped area is 572.91 hectares About 475 hectares is under rainfed condition whereas 89 hectares is under irrigation condition. There is no forest land in the village. Only

about 61 per cent of the total geographical area is net cultivated area. Like any other village in the watershed, paddy under irrigated conditions, cotton crop under dryland conditions are the major crop grown. Vegetables are also taken to a small extent under wells. Most of the farmers belong to marginal and small categories. There is good potential for dairy and dryland horticulture development in the village.

i) Non-watershed Villages.

The ten selected non-watershed villages viz., Raipalle, Mogdampally, Siddapur, Vanampally, Budhera, Lingampalle, Dharmapur, Yousufpur, Suraram and Thangadpalle are situated outside the watershed area. The agriculture continues to be traditional and backward in these villages. The crops are grown in dryland is cotton, sugarcane and pulses, whereas under wells paddy is grown. To a very small extent of vegetable crops that too for household consumption are grown. The irrigation facilities available are meager. The farmers of these villages had the least exposure to the latest techniques. The adoption of technology either horizontal or vertical is found to be at a very low level. The facilities for the supply of inputs and credit are far from satisfactory.

CHAPTER- V

RESULTS AND DISCUSSION

An attempt has been made in the previous chapter to present various agro economic characteristics of the study area. In this chapter made to analyse the results that emerged from the study undertaken with critical discussion.

The results and discussion are presented in two sections. The first section deals with the progress of watersheds at all India, Telangana state and Medak district levels. The data collected from the secondary sources particularly from the official records of National Watershed Development Programme for Rainfed Areas (NWDPRA) formed the source for this review. The second section deals with primary data of 300 farmer respondents and secondary data collected from the project officials of the watersheds in the district, which has been processed and analyzed as per the specific objectives of the study.

The results of the study on "An Economic Impact of Integrated watershed Development Programme in Medak District of Telangana State" are analysed under the following heads.

5.1. Review of the progress of watersheds in India, Telangana and Medak district

5.2. General characteristics of the Farm Households

5.3. Land use pattern

5.4. Watershed Development Programme

5.5. Water level in the Wells

5.6. Farm impact of watershed intervention technology

5.7. Off-Farm impact of watershed intervention technology

5.8. Benefit-Cost Ratio

5.9. Expectations and Realisations

5.10. Economic Surplus Model

5.11. Peoples' participation

5.12. Constraints and suggestions faced by the farmers on watersheds

5.13. Strategy for an effective IWMP in watersheds

5.1 Review of the progress of watersheds in India, Telangana and Medak district

Watershed Development Projects have been taken up under different programmes launched by the Government of India from time to time. The Drought Prone Area Programme (DPAP) and the Desert Development Programme (DDP) adopted the watershed approach in 1987. The Integrated Wasteland Development Projects (IWDP) schemes were taken up by the National Wasteland Development Board in 1989 for developing wastelands on a watershed basis. This programme has now been brought under the administrative jurisdiction of the Department of Wastelands Development of the Ministry of Rural Development. Further major programmes initiated were the National Watershed Development Programme for Rainfed areas (NWDPRA) under the ministry of Agriculture based on the watershed concept.

In this section an attempt has been made to review the progress of watersheds in India, Telangana and Medak district. However, due to in accessibility of detailed information on various watersheds implemented by different agencies in the entire country it is restricted to discuss only the progress of national watersheds implemented by NWDPRA under Ministry of Agriculture and also the DPAP programme which has undergone a major change from 1995-96 onwards based on the recommendations of the Technical Committee with emphasis on peoples participation on watershed development basis on top down approach.

INDIA

5.1.1 NWDPRA-Particulars of net arable rainfed area and Targeted area

The data presented in Table 5.1 revealed State-wise Physical Target and achievement under National Watershed Development Project in Rainfed Area (NWDPRA) in India from 2010-2011 to 2012-2013 is nearly 171846 ha government of India has fixed certain targeted areas for every state for implementation of watershed programmes, and thus the total achievement area 201277 ha was on all India basis for the 2012-2013 period. The above targeted areas have been fixed proportionately to the net rainfed arable areas in each state.

Table 5.1: Selected State wise Physical Target and Achievement under National Watershed Development Project in Rainfed Area (NWDPRA) in India (2010-2011 to 2012-2013)

States	2010-2011		2011-2012		2012-2013 (Area in Hectare)	
	Target	Achievement	Target	Achievement	Target	Achievement
Andhra Pradesh	4200	4166	2000	3143	3750	3945
Arunachal Pradesh	10455	12139	7650	4250	0	0
Assam	-	0	-	0	-	0
Bihar	3325	2792	4167	4361	0	5874
Chhattisgarh	9852	8282	10000	17067	11600	9599
Goa	500	1129	533	2483	0	4558
Gujarat	13333	9419	6666	7603	8870	6754
Haryana	1430	2865	3286	2132	2956	870
Himachal Pradesh	3300	4913	3335	2823	3344	3033
Jammu and Kashmir	4584	4986	6830	7915	12000	6758
Jharkhand	10486	9286	7520	7245	7946	7946
Karnataka	10417	14503	10240	12228	10000	19126
Kerala	4243	8784	2440	12711	4000	5330
Madhya Pradesh	20748	17867	16000	16454	14167	13216
Maharashtra	17292	22325	15434	15434	15893	15434
Manipur	6151	8862	4970	7122	5720	7506
Meghalaya	11200	8788	9983	7761	7000	6000
Mizoram	21000	20834	4900	5000	5043	10634
Nagaland	14600	14600	7800	8583	5200	4333

Odisha	11250	11385	7800	7315	11385	4832
Punjab	11562	4190	0	0	4445	0
Rajasthan	13542	11500	20834	9598	11667	6621
Sikkim	4860	4860	732	736	0	16806
Tamil Nadu	5464	9487	67970	11067	11864	21264
Tripura	10648	10375	6320	5983	3330	3333
Uttar Pradesh	49745	48612	31647	40890	0	0
Uttarakhand	10000	14487	24716	10995	11666	8200
West Bengal	17300	1659	12250	125	0	9305
India	301487	293095	296023	231024	171846	201277

Source: Guidelines – National Watershed Development Project for Rainfed Area – Ministry of Agriculture, Government of India.

The table also indicated that combined Andhra Pradesh State occupied 18th in target area and 21st place in net rainfed arable area (area to be treated under watershed programme) with 3750 ha and 3945 ha respectively. Whereas Tamil Nadu state with 21264 ha and net achievement area and Maharashtra state with 15893 ha occupied first targeted area. It is father observed from the table that the targeted area was around 2.83 per cent of net rainfed arable are for each state as well as for the total under NWDPRA.

TELANGANA

5.1.2 Number of Watersheds and Area Treated in Telangana State

The details of number of national watersheds implemented in each district along with the area treated in Telangana state so far (i.e., from 2010-2015) are presented in Table 5.2. There are nearly 330 national watersheds in Telangana with 1393056 ha of treated area. It revealed that maximum number of watersheds in districts of Mahabubnagar, (103) were most of the land is of dry or rainfed followed by 59 in Adilabad, 48 in Nalgonda and 37 each in the districts of RangaReddy and Medak.

In the case of treated area under the programme, maximum area of 427577 hectares was found with Mahabubnagar district indicating a larger coverage under each watershed in the district compared to other watersheds in other districts. Adilabad with 249278 hectares and Medak with 161785 hectares and Ranga Reddy with 156957 are in the order of sequence, while Karimnagar district was with minimum (16653 ha)treated under the programme.

Table 5.2.Details of watersheds in Telangana state (2010-2015).

. No	District	No. of watershed projects sanctioned	Total sanctioned Area
			Absolute (ha)
	Ranga Reddy	37	156957
	Nizamabad	-	-
	Medak	37	161785
	Mahabubnagar	103	427577
	Nalgonda	48	196083
	Warangal	14	63342
	Khammam	28	121381
	Karimnagar	4	16653
	Adilabad	59	249278
Total		330	1393056

Source: IWMP reports, Telangana state.

5.1.3 Financial Targets and Achievements made so far in Telangana.

The total financial target fixed for the five year period (i.e., from 2010-2015) along with the year wise financial achievements made so far by national watersheds in Telangana state are presented in Table 5.3.

Table 5.3. Financial targets and achievements made by IWMP in Telangana state (2010-2015).

S . No	Years	Financial target(2010-2015) (in lakhs)	Financial achievement
			Absolute (in lakhs)
1	2010-11	14084.17	8063.55
2	2011-12	16693.97	8063.55
3	2012-13	20386.21	8063.53
4	2013-14	25305.37	12891.05
5	2014-15	33024.33	23825.79

Total	109494.05	60907.47

Source: IWMP reports, Telangana state.

The amount pertains to total financial target for all the five years (2010-2015). The total financial target fixed for the five year period (*i.e.*, from 2010-2015) for the state was Rs. 109494.05 lakhs, of which Rs. 60907.47 lakhs was achieved during the above period.

It is further evident from the table that during 2014-15 year maximum of Rs.23825.79 lakhs were achieved out of the total financial target fixed for five year period. The lowest achievement being Rs. 8063.53 lakhs during 2010-13 the year of implementation. The higher achievements during 2014-15 might be due to the active participation and interest shown by the farmers towards the new programme as well as the good coordination and supervision of the officials concerned.

MEDAK DISTRICT

5.1.4 IWMP glance and Financial Targets and Achievements in Medak District

5.4. Details of IWMP watersheds in Medak district from (2010-15)

S. No	Particulars	Details
1.	No. of watersheds covered under IWMP	37 projects
2.	No. of villages covered	236
3.	Allocation of funds (in rupees lakhs)	
	a. Central	17472.735
	b. State	1941.415
	Total	19414.15
4.	Release of funds (in rupees lakhs)	
	a. Central	17472.735
	b. State	1941.415
	Total	19414.15
5.	Total available funds (in rupees lakhs)	14024.08
6.	Expenditure(in rupees lakhs)	5390.07
7.	Per centage expenditure to total funds	27.76

Source: IWMP reports, Telangana state

It is evident from the earlier Table 5.4 that in Telangana state, Medak district occupied fourth place in area treated under the national watershed programme. The details of financial targets and achievements made under national watersheds in Medak district during 2010-2015 are presented in Table 5.5.

Table 5.5. Financial targets and achievements made by IWMP in Medak district (2010-15).

Sl. No	Years	Financial target(2010-2015) (in lacks)	Financial achievement Absolute (in lacks)
1	2010-11	1623.32	0.37
2	2011-12	1928.92	78.53
3	2012-13	2360.54	442.17
4	2013-14	2948.29	943.27
5	2014-15	3808.58	1037.34
Total		8505.08	2653.22

Source: IWMP reports, Telangana state

It is clear from the Table 5.5 that Rs. 2653.22 lakhs of the total financial targets fixed (Rs. 8505.08) for the period from 2010-2015 were achieved by the national watersheds in Medak district. During the year 2014-15 a maximum of Rs. 3808.58 lakhs of financial targets were found to be achieved followed by the year 2014-15 with Rs. 1037.34 lakhs when compared with the other years of implementation of the programme.

The plausible reasons for these low financial achievements by national watersheds might be due to inadequate and untimely allocation and release of the funds for various activities, which hindered the succesmful implementation of the programmes.

5.2. General particulars of sample farms

5.2.1 Family composition and family labour contribution

Man power is one of the most important resources in agriculture. It is provided in agriculture mostly from farm families. Although some hired labour is also engaged, family labour constitutes an important resource for agricultural production. The status of the family of all categories of farms in both watershed and non- watershed areas in respect of male, female and children is shown in Table 5.6 along with farm family workers available for farms operations.

The average family size in the watershed area increased with size of holding indicating a positive relationship between the different size groups, whereas in non-watershed area it was maximum on marginal farm (7.23) followed by large (6.57) and marginal (4.94) farm. The average family size of the farms was 6.05 in watershed areas at the pooled level as against 6.15 in the case of the farms in non- watershed area.

It is further revealed from the data presented in the Table 5.6 that the average number of farm family workers was 3.52 on pooled watershed farms, whereas it was 3.31 on pooled non- watershed farms. The average number of farms family workers in watershed area was maximum on marginal farm with 4.42 followed by large (3.13) and marginal farms (3.00). This might be due to the fact that the holdings being marginal almost all the members of the marginal family had to work. The average number of family workers was directly related to the farms size in non- watershed area. Within the family the male members were more available for farms work followed by female and children in all size groups of both watershed and non- watershed area.

5.2.2 Educational status

The development of any sector of the economy depends up on the educational status of the people. Hence, the need for education conscious for rural development in general and agriculture development in particular. If the people are educated, they are more exposed to sources of knowledge and access to information and thus they would be more innovative and enterprising.

From the details furnished in Table 5.7, it is observed that 38.1 (47.50%) and 26.3 (32.50%) farmers of watershed area studied up to the primary school and secondary school levels respectively and only 8.5 (10.00%) had studied up to college. Ten per cent of the watershed farmers were illiterates. About 31,21and 5 non-watershed farmers accounting for 38.75 per cent and 6.25 per cent respectively studied up to primary, secondary school and college levels and the rest (23.1 farmers accounting for28.75%) were illiterates among the respondents. Thus, it is apparent that literacy level of watershed farmers was higher as compared to non-watershed farmers.

This factor might have helped the farmers in understanding and adopting new farm practice. It is in conformity with the findings of the studies conducted by Reddy *et al.,* (2012), Singh *et al.,* (2010) and Vittala*et.al.,*(2008) Further, it is found in both watershed and non-watershed areas the education level of marginal and marginal farmers were lower, when compared with large farmers.

Table 5.6: Average size of the family and worker members

l.No	Particulars	Watershed block				Non watershed block			
		Marginal	Small	Large	Pooled	Marginal	Small	Large	Pooled
	1. Family composition								
	a) Male	1.33 (28.54)	2.00 (33.00)	2.26 (33.83)	1.98 (32.73)	2.31 (31.95)	1.56 (31.58)	2.39 (36.38)	2.08 (33.82)
	b) Female	1.33 (28.54)	1.82 (30.03)	2.31 (34.58)	1.94 (32.07)	2.38 (32.92)	1.69 (34.21)	2.61 (39.73)	2.24 (36.42)
	c) Children	2.00 (42.92)	2.24 (36.97)	2.11 (31.59)	2.13 (35.20)	2.54 (35.13)	1.69 (34.21)	1.57 (23.89)	1.83 (29.76)
	Total	4.66 (100.00)	6.06 (100.00)	6.68 (100.00)	6.05 (100.00)	7.23 (100.00)	4.94 (100.00)	6.57 (100.00)	6.15 (100.00)

2. Family farm workers									
	a) Male	1.33 (44.33)	1.98 (44.80)	1.81 (57.83)	1.76 (50.00)	1.34 (56.54)	1.42 (47.34)	1.93 (47.54)	1.62 (48.94)
	b) Female	1.33 (44.33)	1.63 (36.88)	1.24 (39.62)	1.39 (39.49)	0.97 (40.93)	1.33 (44.33)	1.93 (47.54)	1.50 (45.32)
	c) Children	0.34 (11.34)	0.81 (18.32)	0.08 (2.55)	0.37 (10.51)	0.06 (2.53)	0.25 (8.33)	0.20 (4.92)	0.19 (5.74)
Total		3.00 (100.00)	4.42 (100.00)	3.13 (100.00)	3.52 (100.00)	2.37 (100.00)	3.00 (100.00)	4.06 (100.00)	3.31 (100.00)

Figures in parentheses are percentages to their respective totals.

Table 5.7: Educational pattern of the selected farmers

Sl. No	Particulars	Watershed block				Non watershed block			
		Marginal	Small	Large	Overall	Marginal	Small	Large	overall
1.	Illiterates	3.1 (17.65)	4.2 (15.39)	1.2 (2.70)	8.3 (10.00)	8.2 (44.44)	9.2 (32.14)	6.2 (17.65)	23.1 (28.75)
2.	Primary	13.2 (61.47)	12.4 (46.15)	13.5 (35.14)	38.1 (47.50)	10.1 (55.56)	11.2 (39.29)	10.1 (29.41)	31.1 (38.75)
3.	Secondary	1.2 (5.88)	7.5 (26.92)	18.2 (48.65)	26.3 (32.50)	- -	6.2 (21.43)	15.1 (44.12)	21.1 (26.25)
4.	College	4.65 (15.54)	3.1 (11.54)	5 (13.51)	8.5 (10.00)	- -	2.2 (7.14)	3.1 (8.82)	5.2 (6.25)

	Total	17.2 (100.00)	26.3 (100.00)	37.2 (100.00)	80.1 (100.00)	18.1 (100.00)	28.2 (100.00)	34.2 (100.00)	80.1 (100.00)

Figures in parentheses are percentages to their respective totals

Similar observations were made by Reddy (1992) and Ramappa et al., (2008), in which about 90 per cent of the farmer households were headed by males and a maximum of 37 per cent were from backward classes closely followed by most backward classes.

5.3. Land Use Pattern

Out of the total geographical area of 329 million hectare of the country, the land-use statistics are available for about 306 million hectares, constituting 93 per cent of the total area. The arable land (the net area sown plus the current and other fallow land) was estimated at 166.09 million hectare (54.2 per cent of the total reporting area). With the increasing demand for various agricultural, forestry and livestock products for consumption and export, it is imperative that each piece of land is put for its best use. Further, intensification of various developmental progrmmes such as soil-water conservation, the extension of irrigation facilities, and the adoption of scientific agricultural practices have resulted in an element of dynamism in the land use and cropping patterns (SohanLal and Gajbhiye, 2007).

Farm size is one of the crucial factors that affects the magnitude and efficiency of production and income for the farm families. Farm size is measured in physical units of land in hectares or acres. The average holding sizes of sample farms were classified into 3 types *i.e.,* dry land, tank irrigated land and well irrigated land. The land holding particulars of the selected farmers is presented in Table 5.8

The average size of land holding was 1.9, 2.32 and 5.31 hectares among marginal, small and large watershed farms respectively as against 0.59, 1.34 and 3.16 hectares for respective groups in non-watershed farms respectively. The same on pooled farms was 3.17 hectares in watershed area and 1.79 hectares in non-watershed area. It is observed that the percentage of dry land was 50.78 followed by well irrigated land 44.16 in the total cultivated land in watershed block.

In comparison among the size groups of both watershed as well as non- watershed farmers, it is evident that the large farmers had more area under rainfed conditions in non-watershed areas accounting for nearly 67.59 per cent (1.21 ha) of the total area respectively.

As the size of the holding increased the area under rainfed conditions also increased, exhibiting a direct relationship in both watershed as well as non-watershed categories of respondents. Similar trend was observed under tank and well irrigation among all the size groups of both watershed and non-watershed categories of farmers, excepting, those of marginal farmers in watershed area that owned less area (0.14 ha.) under tank irrigation accounting for 6.03 per cent of the total holding area.

Table 5.8: Land holding particulars of the selected farmers (ha.)

Particulars	Watershed block				Non watershed block			
	Marginal	Small	Large	Pooled	Marginal	Small	Large	Pooled
Dry land	0.60 (31.57)	0.96 (41.37)	3.27 (6.58)	1.61 (50.78)	0.48 (81.35)	1.03 (76.87)	2.12 (67.08)	1.21 (67.59)
Tank irrigated land	0.15 (7.89)	0.14 (6.03)	0.21 (3.95)	0.16 (5.04)	0.06 (10.16)	0.08 (5.97)	0.15 (4.74)	0.11 (6.14)
Well irrigated land	1.15 (60.52)	1.22 (52.58)	1.83 (44.16)	1.4 (44.16)	0.05 (8.47)	0.23 (17.16)	0.89 (28.16)	0.47 (26.25)
Total	1.9 (100.00)	2.32 (100.00)	5.31 (100.00)	3.17 (100.00)	0.59 (100.00)	1.34 (100.00)	3.16 (100.00)	1.79 (100.00)

Figures in parentheses are percentages to their respective totals

5.3.1. Type of Soil

Cropping pattern depends on the type of the soil, climatic conditions, and irrigation facilities. The soil in India may be classified into four groups according to the availability of the rain water and evaporation. They are (1) alluvial soil, (2) black cotton soil, (3) red soil and (4) laterite soil. Soil which is the topmost layer of the earth’s surface consists of four layers. The first topmost layer of soil is vital for the cultivation of crops. Medak district has mainly five types of soil viz; red loam, black soil, sandy coastal alluvium, red sandy soil and calcareous soil. Each type of soil benefits different types of crops through their unique physical, chemical and biological properties. The details of the soil in the study areas are presented in Table 5.9.

Table 5.9: Distribution of farmers based on type of soil (Numbers)

Type of soil	Watershed block				Non watershed block			
	M	S	La	A	M	S	L	A
Red soil	31 (62.00)	34 (68.00)	30 (60.00)	95 (63.33)	21 (42.00)	21 (42.00)	20 (40.00)	62 (41.33)
Black soil	19 (38.00)	16 (32.00)	20 (40.00)	55 (36.66)	29 (58.00)	29 (58.00)	30 (60.00)	88 (58.66)
ALL	50	50	50	150	50	50	50	150

Figures in parentheses are percentages to their respective totals

Watershed area is covered with red soil (63.33 per cent) and non watershed area is covered with black soil (58.66 per cent). Red soil has iron content and is fit for crops like red gram, bengal gram, green gram, groundnut and castor. Black soil is rich in calcium, potassium and magnesium. Crops like cotton, tobacco, chilly, oilseeds, jowar, ragi and maize grow well in it.

5.4. Watershed Development Programme

Watershed Development Programme is a composite approach to an efficient use of land and water resources so as to get optimum production from them and also to preserve the soil from deterioration and future utility, (Ministry of Water Resources, 2008).

5.4.1. Soil and Water Conservation

Land and water are the natural resources that are essential for the existence of life. They are under tremendous stress due to the ever-increasing biotic pressure. Land degradation is mainly due to soil erosion caused by natural and manmade causes such as deforestation, overgrazing, reckless mining and general mismanagement. Physical and biological deterioration of land with associated fertility depletion also occurs due to water logging, salination, alkalination, acidification etc. To help reduce the pace of degradation and accelerate the process of development and conservation of land, water and vegetation in an integrated manner- the watershed approach has been considered the most appropriate in recent times. It was often assumed that investing in water conservation is automatically beneficial, without looking in detail at the costs and benefits, and particularly the on-farm versus off-farm costs of soil degradation (Charlotte Bgyd*et.al*, 2000). Soil and watershed intervention technology include summer ploughing, contour bunding, gully plugging, land levelling, diversion channels and drainage ditches. Of these, all the sample farmers in the selected study blocks use 'summer ploughing', 'contour bunding', and 'land levelling'. The application of these methods leads to conservation of soil, increase water retention capacity of soil, recharging of ground water levels and increase in vegetative cover (SulbhaKhanna, 2008). Table 5.10 gives the details of the total and average area per farmer under these measures and also the average investment made on these measures by the farmers.

Though all the farmers follow these three soil and moisture conservation measures, the per cent of gross cropped area under these measures were less than 80. About 50 per cent of the gross cropped area in the watershed block was treated with summer ploughing. Large farmers practice this measure comparatively in a larger measure. About 60 per cent of the total gross cropped area of the large farmers in the watershed block was treated with summer ploughing.

Per unit cost of summer ploughing is Rs. 1,409 in the watershed block. Across the farmers it is the lowest among the marginal farmers with Rs. 1,275. 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. Contour bunding is carried out in about 13 per cent of the gross cropped area in the watershed block.

The percentage of gross cropped area, under land levelling was 7.64, 9.68 and 8.8 per cent for marginal, small and large farmers respectively. 10 per cent of the gross cropped area in the selected block is treated with the land levelling measures. The unit cost of land levelling was Rs. 1,542 in the selected block. On an average, the total investment made on soil and moisture conservation measures worked out to Rs. 4,658 in selected block. The results revealed that across the farmers, the investment incurred was high among the small farmers.

Sikka*et al.*, (2000) reported that the watershed treatment activities improved conservation of soil and moisture; improved and maintained the fertility status of soil. Ramasamy*et al.*, (2002) and Palanisami*et al*., (2002) also supported the same through their works.

Table 5.10: Soil and moisture conservation in selected blocks

Particulars	Watershed Block			
	Marginal	Small	Large	All
SUMMER PLOUGHING				
Average area (ha)	1.25	4.03	7.15	2.74
Total area (ha)	175.02	354.90	157.42	687.35
Per cent to gross cropped area	44.13	51.06	59.58	50.69
Average investment (Rs.)	1275	1540	1261	1409
No. of samples	50	50	50	150
Average area (ha)	0.37	0.96	1.61	0.69
Total area (ha)	53.05	84.68	35.40	173.44
Per cent to gross cropped area	13.38	12.18	13.40	12.77
Average investment (Rs.)	1624	1772	1674	1707
No. of samples	50	50	50	150
LAND LEVELLING				
Average area (ha)	0.22	0.76	1.06	0.48
Total area (ha)	30.31	67.27	23.26	120.85
Per cent to gross cropped area	7.64	9.68	8.8	8.91
Average investment (Rs.)	1806	1436	1507	1542
No. of samples	50	50	50	150
Total investment (Rs.)	4705	4748	4442	4658

Source: Field survey, 2015.

5.4.2. Integrated Watershed Development Programme

Water harvesting is usually employed as an umbrella term describing a whole range of method of collecting and conserving various forms of runoff from different sources. In particular, for dry land agriculture, it was collection of excess runoff water in storage tank and using it for the betterment of crop production in the collected and other areas. There are three types of collected tanks, namely, farm ponds, percolation ponds and silt detention tanks. The water collected in the farm pond is directly used for protective irrigation. The water stored in other structures will recharge the ground water and is used for protective or supplementary irrigation by providing open/tube wells (Sivanappan, R.K. 2004).

Different types of watershed conservation measures are carried out in the study area. They include 'farm pond ', 'percolation pond', 'renovation of tank', 'check dams/check walls' and 'rejuvenation of wells'. The details of the various measures are given in the following Table 5.11. As the data reveals 'farm ponds', 'percolation ponds' and 'check dams/check walls' is the main watershed intervention technologies followed in the study areas. The major portion of the farmers was benefit from the farm pond and percolation pond. About 37.13 per cent of the pooled farmers have farm ponds. Farm ponds were used as a water conservation measure by about 54.2 per cent of the marginal farmers, 32.6 per cent of the small farmers and 24.6 per cent of the large farmers. The farmers have more than one farm pond also. Percolation ponds were used extensively by the large farmers (59.2 per cent), closely followed by the small farmers (44.2 per cent). About 29.4 per cent of the marginal farmers have percolation ponds.

Renovation of tank was carried out by 5.66 per cent of the pooled farmers; Among the 4.3 small farmers (8.6 per cent) have renovated their tanks. The check dams are one of major water storage structure to benefit by the marginal, small and large farmers were 8.6 per cent, 2.85 per cent and 11.8 per cent respectively.

The average cost incurred in the construction of farm ponds varied from Rs. 12,537 to Rs.22,134 for the marginal, small and large farmers. The size of the farm ponds constructed by the large farmers being high explains this increase in cost. The average cost of construction of percolation ponds varied from 0.50 lakhs to 1.00 lakhs for marginal, small and large farmers. As percolation ponds are larger in size compared to the farm ponds the expenses incurred in the construction of percolation ponds are also high.

Compared to the farm ponds and percolation ponds, renovation of tanks, Check Dams and rejuvenation of wells require huge investment. The investment made on renovation of tanks, Check dam and rejuvenation of wells ranged from 1.5 lakhs to 2.5 lakhs. This increase in cost explains the reason for the farmers not going in a large percentage towards these watershed activities.

In water harvesting structure investment was lower, on marginal farms compared to small and large farms.

The results revealed that farm ponds and percolation ponds are the two major watershed intervention technologies among all the farmers in the watershed block, while farm ponds are the major watershed intervention technology for most of the farmers, percolation ponds are also used by the small and large farmers.

Table –5.11: Average fund investment and farmers benefited under watershed development programme in the study area (Rs.)

Water harvesting structures	Physical No. of structures	Avg. Fund Investment (Rs. in Lakhs)			No. of farmers Benefited			
		Marginal	Small	Large	Marginal	Small	Large	Pooled
Farm pond	348	5.20	3.22	3.00	31 (62.00)	27 (54.00)	28 (56.00)	28.66 (57.33)
Percolation pond	281	9.36	11.50	21.70	11 (22.00)	14 (28.00)	14 (28.00)	13 (26.00)
Renovation tank	120	1.30	2.80	1.35	2 (4.00)	1 (2.00)	1 (2.00)	1.33 (2.66)
Rejuvenation wells	63	-	-	-	-	-	-	
Check Dams/Check Walls	159	12.00	17.5	19.25	4 (8.00)	5 (10.00)	7 (14.00)	5.33 (10.66)
Other structures	238	1.00	1.25	-	2 (4.00)	3 (6.00)	-	1.66 (2.66)

No. of samples	50	50	50	150	50 (100.00)	50 (100.00)	50 (100.00)	150 (100.00)

Source**:** Figures in parentheses are percentages to their respective totals

Palanisami*et al.,* (2009), reported that the watershed development generated significant positive impacts on the environment and the treatment activities helped in conservation and enhancement of water resources. The structures like farm ponds, percolation ponds and renovation of irrigated lands helped to enhance the surface water storage capacity. On an average, about 92 hectare centimeters (ha cm) additional capacity was created and it varied from 63 ha cm to 136 ha cm.

5.4.3 Problems

Some of the problems that the farmers faced in adopting watershed Development Programme were (i) size of holding, (ii) inadequate supply of labour, (iii) lack of technical support; (iv) outdated technologies, (v) heavy investment and (vi) damage by wild animals. Table 5.12 presents the number of farmers who were faced with the above problems while implementing the watershed intervention technology.

In the selected block about 95.33 per cent of the farmers stated 'inadequate size of land holding' as the major problem. Infact all the marginal farmers have stated this. For about 92.00 per cent of the marginal farmers, apart from 'size of land' getting labour was yet another major problem. 'Outdated technology 'was stated as a problem by about 80.00 per cent of the large farmers.

Table 5.12: Problems faced by the farmers in adopting watershed development programme in the selected blocks

	Particulars	Marginal	Small	Large	All
1	Size of holding	50	45	48	143
		(100.00)	90.00	96.00	95.33
2	Inadequate supply of labour	46	41	43	130
		92.00	82.00	86.00	86.66
3	Lack of technical support	43	39	40	122
		86.00	78.00	80.00	81.33
4	Outdated technologies	38	35	32	105
		80.00	70.00	64.00	70.00
5	Heavy investment	34	31	28	93
		68.00	62.00	56.00	62.00
6	Damage by wild animals	23	27	19	69
		46	54.00	38.00	46.00
	Sample size	50	50	50	150

Source: Figures in parentheses are percentages to their respective totals

The analysis reveals that size of land holdings was the major problem in adopting watershed intervention technology in selected block.

5.5. Water Level in the Wells

The district has the benefit of receiving rainfall during both the south-west and north-east monsoon periods. While the normal rainfall of the district through south-west monsoon period is 675.8 mm and that of north-east monsoon period is 132.4 mm. The annual normal rain fall of the district is 910 mm. The rainfall received from the south-west monsoon is more copious compared to north-east monsoon in the western mandals and in the central part of the district, whereas the rainfall received from north-east is comparatively copious in the eastern mandals of the district. The incidence of rainfall is not uniform and certain. Therefore the district is frequently prone to drought conditions.

Accordingly, the water level in the wells also showed an increase or decrease. The average water level in the wells and bore wells of the sample farmers is given in Table 5.13.

Table 5.13: Water level in wells in the selected study blocks (in feet)

Monsoon	Wells				Bore wells			
	Marginal	Small	Large	All	Marginal	Small	Large	All
Watershed block								
South West Monsoon	31.19	28.78	37.04	32.33	55.94	54.95	53.73	54.87
North East Monsoon	52.48	46.68	50.76	49.97	113.50	112.44	104.47	110.13
Winter	5.34	5.12	3.01	4.49	6.03	6.64	5.89	6.18
Non watershed block								
South West Monsoon	19.18	18.72	15.94	17.94	43.86	44.84	48.47	45.72
North East Monsoon	37.94	36.30	33.94	36.06	64.88	63.47	72.95	67.10
Winter	2.65	2.58	2.41	2.54	4.35	3.82	4.87	4.34

Source: Dept. of Ground water, Medak.

The water level in the wells and bore wells was high during the north east monsoon period in both the blocks. The average well water level in the non-watershed block was 36.06 feet, much lesser than the average water level in the watershed block (49.97 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. There was more recharge of water levels in wells and bore wells in watershed block compared to non watershed block.

Similar observations were made by Palanisami and Suresh kumar (2009). They observed that on an average, the water columns of wells have ranged between 2.32 metres (m) to 3.54 metres and 1.52 m to 3 .05m. It was mainly due to the construction of water resources development structures like farm ponds, percolation ponds, check dams etc, to help to reduce variation in water level of the wells in watershed village.

5.5.1. Sources of ground water discharge

Efficiency of pumping units plays an important part in the adoption of pumps and its utilization for the groundwater development. Ground water irrigation is one of the major factors in the agricultural production. Ground water can be discharged from the wells and bore wells through open well motors, oil engines, electrical motors, bore well compressors and bore well submersibles. The different sources using which groundwater was discharged by the farmers are given in Table 5.14.

Table 5.14: Sources of groundwater discharge in selected study blocks (2013-14)

(In numbers)

Particulars	Watershed block				Non-Watershed block			
	Marginal	Small	Large	All	Marginal	Small	Large	All
Open well Motor	71	38	19	128	47	19	3	80
Oil engine	5	0	0	5	2	5	0	3
Electric Motor	56	34	54	144	32	39	16	107
Submersible	108	61	32	201	77	51	18	146
Compressor	50	48	26	124	39	22	10	71

Source: Field survey, 2015.

Among the various sources through which groundwater were discharged in non-watershed block, bore well submersible was used in large numbers. There are 146 bore well submersible motors used for pumping ground water. Out of 146 bore well submersible motors used; a maximum of 77 (52.74 per cent) were used by the marginal farmers; 5 1(34.93 per cent) by the small farmers and 18(12.33 per cent) by the large farmers. Next to it electric motors were the major source (107 in number) of discharging ground water followed by open well motor (80), and compressor motor (71). Only 3 oil engines are being used. The marginal farmers used these sources in large number. In watershed block also, bore well submersible motors (201) were used in large number followed by open well motors (128), compressors (124), electric motors (144) and oil engine.

5.6. Impact of Integrated Watershed Development Programme on the farms

The farm level impact of watershed Development Programme is assessed in this section in terms of its impacts.

5.6.1. Impact on Land Use Pattern

The particulars of land use pattern in the study area were analysed and presented in Table 5.15. The land was categorised as 'forest', 'cultivable land' and 'un cultivable land'. As the data revealed, in the watershed block, the proportion of cultivable land has increased after the use of watershed development programme in selected the block. In watershed block forest land was less than the non-watershed block. The highest percentage of cultivable land of small farmers was 71.35, forest land under large farmers was 37.02 and uncultivable land under marginal farmers was 20.45 under watershed block.

In the non-watershed block the highest percentage of cultivable land of large farmers was 37.26 per cent, forest lands under marginal farmers was 40.09 per cent and uncultivable land under marginal farmers was 53.67 per cent respectively. In the land use pattern watershed block created more impact than non-watershed block.

The findings revealed the positive impact of watershed intervention technology in the area under cultivable lands. Almost the same findings were observed by Tripathi and Katre (2008).

Table 5.15: Impact on land use pattern in selected study blocks (Ha.)

Type of land	Watershed block				Non-watershed block			
	Marginal	Small	Large	All	Marginal	Small	Large	All
Forest land	0.981 (34.21)	1.2707 (19.69)	4.7628 (37.02)	1.8259 (34.11)	0.878 (40.09)	1.5338 (35.19)	2.6973 (37.16)	1.7030 (43.90)
Cultivable land	1.300 (45.34)	4.6053 (71.35)	6.8252 (53.06)	3.1105 (58.12)	0.0586 (26.75)	1.1547 (26.49)	3.0769 (37.26)	1.4300 (29.31)
Un cultivable land	0.5865 (20.45)	0.5787 (8.96)	1.2763 (9.92)	0.4159 (7.77)	1.0853 (53.67)	1.669 (38.30)	2.4833 (30.07)	1.7458 (35.78)

All	2.8675 (100)	6.4547 (100)	12.8643 (100)	5.3523 (100)	2.0219 (100)	4.3575 (100)	8.2575 (100)	4.8788 (100)

Figures in parentheses indicate percentages to the total

5.6.2. Impact on water level in the wells

Water is an important factor of production of crops in agricultural sector. Intensive and extensive cultivation of land depended mainly on the availability of water. The various sources of irrigation are open wells, dug wells and bore wells. The watershed intervention technologies are carried out to conserve the ground water. Table 5.16 gives the details on the water level in the wells and bore wells after the watershed development programme in watershed block and water levels in non-watershed block also.

On an average in the non-watershed block the water level in the wells was 18.75 feet and in the bore wells 76.10 feet in 2012-13. This increased to 43.49 and 100.78 feet respectively in 2013-14.

Table 5.16: Average rise in well water level in the selected study blocks (in feet)

Particulars \ Farmers	Watershed block				Non-Watershed block			
	Marginal	Small	Large	All	Marginal	Small	Large	All
2012-13								
Wells	33.63	30.00	31.92	31.85	17.88	18.56	19.83	18.75
Bore wells	100.51	100.89	102.19	101.19	55.09	56.17	60.61	57.29
Sample size	50	50	50	150	50	50	50	150
2013-14								
Wells	48.89	43.53	47.64	46.68	23.26	23.52	24.54	43.49
Bore wells	129.45	123.89	122.87	125.40	68.18	61.54	65.69	65.13
Sample size	50	50	50	150	50	50	50	150
Change in percentage								
Wells	23.12	21.10	19.19	21.11	31.21	31.10	32.99	31.76

Bore wells	19.19	8.72	7.73	12.03	22.35	18.56	16.83	19.30

Source: Field survey, 2015, AWL- Average Water Level.

In the watershed block before the watershed intervention technology in 2012-13 the water level in wells and bore wells were 31.85 feet and 101.19 feet respectively. This rose to 46.68 and 125.40 feet respectively in 2013-14. The water level in the wells and bore wells were comparatively high in the watershed block across all farmers compared to the non watershed block. After the watershed development programme a rise in the water level in the wells and bore wells was seen in the watershed block. Compared to the non-watershed block, it was observed that the rise in the water level was comparatively high in the watershed block across all the farmers.

On an average, the water is well and borewells rose to 46.68 feet and 125.40 feet respectively after the watershed Development Programme. The percentage increase in wells and bore wells was 21.11 and 12.03 in watershed block. The results were revealed that the ground water level has increased in the watershed block after the implementation of watershed Development Programme.

In the studies of Sikka*et al*.,(2000), Palanisami and Suresh kumar (2004) and Ajay kumar Vashisht (2008), they observed that after the adoption of watershed technology recharge rate had increased in the range of 16 per cent to 39 per cent.

5.6.4. Impact on irrigation

Raising the water table level to promote irrigation development is a primary objective of watershed development programmes. The watershed Development Programme improves conservation of soil and moisture and maintains the fertility status of soil (Sikka*et al;* 2000, Ramasamy and Palanisamy; 2002, Palanisamy and Suresh Kumar, 2002) and reduce soil and water erosion. Wells are the principal source of irrigation in Medak. Open wells, tube wells and bore wells continue to be the principal sources of irrigation. The net area irrigated by open wells, tube wells and bore wells together accounted for 1593681 hectares (about 64.81 per cent of the total net area irrigated) in watershed block and 866207 hectares(35.19 per cent of the total net area irrigated) in non-watershed block.

Table 5.17 gives the data on the gross and net area sown and irrigation intensity of the watershed development programme in the watershed block and non-watershed blocks of the study area. In watershed block, the average net area sown and gross irrigated area during 2012-13 in the watershed block was 6.48 and 7.43 hectares respectively. It had increased to 8.51 and 10.19 hectares respectively in 2013-14. The percentage increase in the net area sown and gross irrigated area were around 28.26 and 30.54 respectively. As the data revealed that the percentage increase in the net area sown and gross irrigated area were highest among the marginal farmers and the lowest among the large farmers in the watershed block.

In the non watershed block, the average net area sown and gross irrigated areas in 2012-13 were 3.30 and 3.64 hectares respectively. It increased to 5.20 and 5.67 hectares respectively in 2013-14. In this block the percentage increase in the net area sown and gross irrigated area were 35.45 per cent and 38.79 per cent respectively. The irrigation intensity was 108.06 per cent in the watershed block and 109.42 per cent in non-watershed block.

The results revealed that after the watershed intervention technology in both the blocks, the net area sown and gross irrigated area and irrigation intensity had increased among all the farmers. In the watershed block, highest irrigation intensity was realized by the small and large farmers. The same findings were observed in the studies of Mahandule *et.al* (1989), Ramasamy and Palanisami (2002) and Palanisami and Suresh kumar (2005).

Table 5.17: Impact on irrigated area and irrigation intensity

Particulars	Watershed block				Non Watershed block			
	Marginal	Small	Large	All	Marginal	Small	Large	All
2012-13								
NAS(ha)	3.35	5.55	10.62	6.48	2.12	3.94	3.85	3.30
GIA (ha)	3.64	6.15	12.54	7.43	2.20	4.47	4.25	3.64
IRI (%)	108.68	110.81	118.08	114.66	103.77	113.45	108.25	110.30
2013-14								
NAS(ha)	3.31	7.73	14.50	8.51	3.96	5.43	5.7	5.20
GA (ha)	3.95	9.03	17.59	10.19	4.53	5.98	7.05	5.67
IRI (%)	119.33	116.81	121.31	119.74	114.39	110.12	123.68	109.03
Change in percentage								
NAS(ha)	29.85	28.20	26.75	28.26	46.46	27.44	32.45	35.45
GA (ha)	31.05	31.89	28.70	30.54	51.43	28.04	39.71	38.79
IRI (%)	104.02	113.08	107.28	108.06	110.69	102.18	122.37	109.42

Source: Calculations based on Field Survey, 2015, NAS- Net Area Sown, GA- Gross Area, IRI- Irrigation Intensity.

5.6.5. Cropping Intensity

Factors such as fertility of land, monsoon behaviour, rain fall, irrigation, application of fertilizers, climatic conditions, marketing facilities, prices, availability of agricultural labours etc., determine the area and the productivity of any crop. Adoption of soil and watershed intervention technology leads to the better use of land, which is measured in terms of cropping intensity. The following table gives the net area sown and gross cropped area in the study blocks both before and after the watershed intervention technology was adopted. The particulars of copped area, area cultivated more than once, gross cropped area and cropping intensity are presented in Table 5.18.

It could be observed from Table 5.18, in watershed block, the net cropped area of the farms ranged from 11.84 hectares on marginal farms to 44.10 hectares for large farms with an average net cropped area of 27.84 as a whole. It was 27.57 hectares on small farms. Cropping intensity is a good yard stick for land use planning. Through this measure, the production on the farm can also be assessed easily.

In non-watershed block, the net cropped area of the farms ranged from 11.64 hectares on marginal farms to 43.10 hectares for large farms with an average net cropped area of 26.18 as a whole. It was 23.79 hectares on small farms. The cropping intensity was the highest on small farms (125.72%) and the lowest on marginal farms (118.21%). The same was noticed for large and pooled farms are 124.26 per cent and 123.79 per cent respectively.

The cropping intensity was the highest on small farms (139.02%) and the lowest on marginal farms (130.15%). The same was observed for a large and pooled farm was 134.53 per cent and 134.19 per cent respectively. By and large, it was more than 100 implying that all the available area was made use of.

Table 5.18: Pattern of cropped area and cropping intensities on sampled farms (ha.)

Particulars	**Watershed block**				**Non Watershed block**			
	Marginal	Small	Large	Pooled	Marginal	Small	Large	Pooled
Net cropped area	11.84	27.57	44.10	27.84	11.64	23.79	43.10	26.18
Area cultivated	3.57	10.76	14.23	9.52	2.12	6.12	10.45	6.23

more than once								
Gross cropped area	15.41	38.33	59.33	37.36	13.76	29.91	53.56	32.41
Cropping intensity (%)	130.15	139.02	134.53	134.19	118.21	125.72	124.26	123.79
CI Telangana (%) 2013-14	126.83							

Source: calculations based on Field Survey, 2015.

Crop intensity is an index of agricultural development and is directly related to irrigation. After the implementation of the watershed intervention technology the cropping intensity has shown an increase among all types of farmers in both the blocks. The largest improvement in cropping intensity in the watershed block was recorded by the small farmers 139.02 and in the non watershed block it was realized by the small farmers 125.72.Cropping intensity was more in watershed block compared to non-watershed block in selected study area. The results revealed that after implementation of the watershed intervention technology the cropping intensity was increased.

Palanisami and Suresh kumar (2005) reported that the cropping intensity had increased from 120 per cent to 146.88 per cent in Kattampatti watershed and 102.14 per cent in Kodangipalayam watershed.

5.6.6. Impact on cropping pattern

Cropping pattern means the proportion of area under different crops at a particular point of time. A change in the cropping pattern means a change in the proportion of the area under different crops. Cropping pattern in any region is the outcome of the trials and adjustments, depending on physical, sociological and economical factors. Physical factors such as soil, climate, irrigation, drainage etc. determine the type of crops to be grown. Economic factors such as allocation of scarce land resources, conditions of production including the tenurial system, development of markets, demand and supply situation etc. determine the crops to be produced. Cropping pattern assumes significant place in the economic analysis as it has direct influence on the employment, expenditure, gross and net returns from agriculture

The impact of watershed intervention technology in the cropping pattern of the sample farmers is discussed in this section. Table 5.19 revealed the total, average and the proportionate area under different crops in both the watershed and non-watershed blocks after implementation of the watershed development programme.

The important crops grown on the sample farms were cotton, maize, paddy and onion. From the figures shown in the table, in watershed, it is observed that the area allocated for important crops such as cotton, maize, paddy and onion constituted 32.71 per cent, 19.07 per cent, 27.29 per cent and 20.93 per cent of total cropped area on the marginal farms. The farmers have increased the area under paddy requires higher investment for cultivation but at the same time yields more gross returns too. In the case of small farms, the area allocated for cotton, maize, paddy and onion constituted 32.74 per cent, 12.94 per cent, 32.66 per cent and 21.66 per cent of total cropped area respectively.

In non-watershed block the area allocated for important crops such as cotton, maize, paddy and onion constituted 36.75 per cent, 15.39 per cent, 42.73 per cent and 5.13 per cent total cropped area on the marginal farms. In the case of small farms, the area allocated for cotton, maize, paddy and onion constituted 49.22 per cent, 16.92 per cent, 29.20 per cent and 4.66 per cent total cropped area respectively. It is observed that the area under cotton for small farms was more than the other crops, since cotton is comparatively higher income yielding crop. It is seen that large farms allocated 56.14 per cent, 20.14 per cent, 19.18 per cent, and 4.54 per cent respectively to the total area under cotton, maize, paddy and groundnut crops. It could be further observed from the results that, on the sample as a whole, cotton was the predominant crop followed by paddy, maize and onion crops, each accounting for 51.00 per cent, 18.70 per cent, 25.72 per cent, and 4.58 per cent respectively.

Table 5.19: Existing cropping pattern on the sampled farms (ha.)

Particulars	Watershed block				Non Watershed block			
	Marginal farms	Small farms	Large farms	Pooled farms	Marginal farms	Small farms	Large farms	Pooled farms
Cotton	1.75 (32.71)	3.87 (32.74)	5.12 (28.51)	3.58 (30.60)	1.29 (36.75)	3.17 (49.22)	6.91 (56.14)	3.79 (51.00)
Maize	1.02 (19.07)	1.53 (12.94)	2.67 (14.87)	1.74 (14.87)	0.54 (15.39)	1.09 (16.92)	2.48 (20.14)	1.39 (18.70)

Paddy	1.46 (27.29)	3.86 (32.66)	6.25 (34.80)	3.85 (32.91)	1.50 (42.73)	1.88 (29.20)	2.36 (19.18)	1.91 (25.72)
Onion	1.12 (20.93)	2.56 (21.66)	3.92 (21.82)	2.53 (21.62)	0.18 (5.13)	0.30 (4.66)	0.56 (4.54)	0.34 (4.58)
Total	5.35 (100)	11.82 (100)	17.96 (100)	11.7 (100)	3.51 (100)	6.44 (100)	12.31 (100)	7.43 (100)

Figures in parentheses indicate percentage of the total

It was observed that the area allocated under cotton for small farms was more as compared to other crops since cotton was a high revenue yielding crop. It is seen that large farms allocated 28.51 per cent, 14.87 per cent, 34.80 per cent, and 21.82 per cent to the total area under cotton, maize, paddy and onion crops respectively. It can be further observed from the results that, on the sample as a whole, cotton was the predominant crop followed by other crops each accounting for 30.60 per cent, 14.87 per cent, 32.91 per cent, and 21.62 per cent respectively.

The results revealed that after implementation of the watershed development programme in selected blocks, the cultivation of paddy, maize, cotton and onion crops had increased under watershed block as compared to non-watershed block.

The views of Palanisami *et al.*, (2009) and Radhamani (2008) supported the above findings. They found that the cropping pattern changes have taken place both in additional area brought under well irrigation from the fallow land and in area under rain fed cultivation. The crops under high water consuming increased by 25.3 per cent in first crop and 29.4 per cent in second crop period.

5.6.7. Impact on crop production

Agricultural production denotes the quantum of agricultural crops produced in the economy during the course of the period. This is the total available agricultural product produced with the available resources in the economy. On the other hand productivity is the capacity to produce with a unit resources. In other words, it tells as to how much of agricultural production takes place in the economy with one unit of land, capital or labour; or of productivity per hectare of individual crops.

The total and average outputs produced from the cultivation of different crops in the two blocks studied are given in the Tables 5.20 and 5.21. The monetary value of the products produced was calculated using the prices prevailing for the products during the respective season.

In the watershed block, the farmers realized the highest monetary value (Rs.7224690) from paddy on pooled farms. This was the case across the different farmer groups. Next to paddy the highest monetary value was realized from the cultivation of onion (Rs. 4586900) followed by cotton (Rs. 2872650) and maize (Rs.2301200). The percentage change in the output realized by these crops showed that output from maize (52.14) had a higher percentage increase of large farmers after the implementation of the watershed Development Programme in 2013-14 an increase in production was realized for all crops.

In the non-watershed block the monetary value of paddy was the highest (Rs. 6468800) in the year 2013-14. Next to the cultivation of paddy yielded highest output (Rs. 3912800). This was followed by maize and cotton. The percentage change in the output realized by these crops showed that output from paddy (44.52) had a higher percentage increase in respect of large farmers.

Table 5.20: Total and average value of production of different crops in watershed block (in Rupees/ha.)

Crops	Watershed block (2013-14)				Non watershed block (2013-14)			
	Marginal	Small	Large	All	Marginal	Small	Large	All
Paddy	2036950 (40739) ((28.19))	2746750 (54935) ((38.01))	2440990 (48818 ((33.78))	7224690 (144492) ((100.00))	1480800 (29616) ((22.89))	2107650 (42153) ((32.58))	2880350 (57607) ((44.52))	6468800 (129378) ((100.00))
Maize	405500 (8110) ((17.62))	695700 (13914) ((30.23))	1200000 (24000) ((52.14))	2301200 (46024) ((100.00))	364900 (7298) ((30.21))	440650 (8813) ((36.49))	401950 (8039) ((33.28))	1207500 (24150) ((100.00))
Onion	978600 (19572) ((21.33))	1555150 (31103) ((33.90))	2053150 (41063) ((44.76))	4586900 (91738) ((100.00))	987800 (19756) ((25.24))	1375000 (27500) ((35.14))	1550000 (31000) ((39.61))	3912800 (78256) ((100.00))
Cotton	566250 (11325) ((19.71))	941800 (18836) ((32.78))	1364600 (27292) ((47.50))	2872650 (57453) ((100.00))	794950 (15899) ((33.60))	620700 (12414) ((26.23))	950000 (19000) ((40.15))	2365650 (47313) ((100.00))

(Source: Calculations based on Field Survey, 2015) Figures in parentheses ( ) indicate – Average value of Production in Rs. While figures in (( )) indicate - percentage.

The results revealed that the percentage change in the production of the different crops in both the watershed and non watershed blocks showed an increase inoutput. In non-watershed block there was decrease in the output compared to watershed block.

Similar observations were made by SulbhaKhanna (2008), Planisami*et al.*, (2009). They observed that the productivity of crops increased from 16.59 per cent to 25.83 per cent in the watershed villages.

5.6.7.1. Production function analysis

Watershed block

In 2012-13 the significant variable in respect of marginal farms was gross cropped area, while bullock and machinery cost in the case of small farms and regarding all farms. Bullock and machinery cost and gross cropped area were the significant variables.

In 2013-14 on marginal farm the significant factors were bullock and machinery cost, labour wages and gross cropped area. On all farms, bullock machinery cost, labour wages and gross cropped area were the significant factors.

Table 5.22: Production elasticities (watershed block)

Year	2012-13				2013-14			
Variable	MF	SF	LF	ALL	MF	SF	LF	ALL
Constant	9.727* (15.514)	11.137* (5.489)	8.062* (3.751)	8.776* (15.649)	7.066* (9.687)	11.297* (3.406)	5.201* (1.228)	8.371* (11.604)
Bullock and machinery cost	0.001 (0.018)	0.527* (3.187)	-0.284 (-0.94)	0.13* (2.002)	-0.293* (-3.448)	-0.162 (-0.567)	0.424* (1.2)	-0.242* (-2.886)
Labour wages	0.1 (1.033)	-0.345 (1.449)	0.046 (0.226)	0.035 (0.433)	0.572* (5.002)	0.082 (0.229)	-0.284 (-0.473)	0.437* (3.916)
Agricultural input	-0.1 (-0.098)	-0.098 (-0.399)	0.409 (1.385)	-0.013 (-0.17)	0.091 (0.886)	-0.022 (-.082)	0.53 (1.097)	0.04 (0.423)
Gross cropped area	0.873* (11.685)	0.074 (0.196)	0.581 (0.99)	0.67* (8.803)	0.528* (6.631)	0.629 (1.384)	0.13 (0.274)	0.501* (6.471)
R^2	0.735*	0.205*	0.299*	0.772*	0.624*	0.049*	0.166*	0.673*
$\bar{R}^2$	0.727	0.134	0.24	0.768	0.614	-0.035	0.095	0.667
F	99.024	2.9	5.022	207.035	59.399	0.583	2.335	125.96
N	50*	50*	50*	150*	50*	50*	50*	150*
Σβi	0.874	0.158	0.752	0.822	0.901	0.329	0.80	0.836

Source: calculations based on Field Survey, 2015, Figures in brackets denote 't' estimates of the parameters * significant at one per cent level MF- Marginal Farmers, SF– Small Farmers , LF – Large Farmers.

Non-Watershed block

In 2012-13 a marginal the significant variable was green cropped area, on small farms, agricultural input use and gross cropped area and in large farm the same was agricultural input use. On all farm gross cropped area and agricultural input use were positively significant. In 2013-14 the significant variables were bullock labour and machinery cost and green cropped area on marginal farms, labour wages and gross cropped area on small farms, bullock and machinery labour on large fams and gross cropped area on all farms. The estimated Cobb-Douglas production function for watershed block is given in the Table 5.22.

Table5.23: Production elasticities (Non-watershed block)

Variables	2012-13				2013-14			
	MF	**SF**	**LF**	**ALL**	**MF**	**SF**	**LF**	**ALL**
Constant	8.005* (16.774)	7.831* (12.906)	9.545* (5.002)	7.879* (22.743)	9.637* (13.227)	8.017* (10.968)	8.658* (5.284)	8.697* (18.181)
Bullock and machinery cost	0.021 (0.416)	-0.017 (-0.214)	-0.053 (-.642)	-0.008 (-0.229)	0.193* (2.752)	-0.094 (-1.158)	0.208* (2.301)	0.080 (1.64)
Labour wages	0.095 (1.347)	0.061 (0.749)	-0.374 (-.311)	0.077 (1.537)	-0.002 (-0.013)	0.201* (2.873)	-0.064 (-.369)	0.126 (1.882)
Agricultural input use	0.091 (1.424)	0.213* (3.266)	0.509* (2.283)	0.148* (3.535)	-0.090 (-1.017)	0.153 (1.559)	0.174 (0.913)	-0.019 (-0.316)
Gross cropped area	0.666* (10.049)	0.513* (4.587)	0.417 (1.494)	0.663* (15.082)	0.618* (7.660)	0.581* (4.709)	0.26 (1.528)	0.67* (13.73)
R^2	0.883*	0.652*	0.537*	0.935*	0.638*	0.636*	0.558*	0.885*
$\bar{R}^2$	0.828*	0.636*	0.428*	0.934*	0.627*	0.616*	0.454*	0.883*
F	168.359*	38.946*	4.933*	885.819*	59.387*	35.88*	5.36*	471.044*

N	50	50	50	150	50	50	50	150
Σβi	0.719	0.77	0.499	0.808	0.873	0.841	0.578	0.857

Source: calculations based on Field Survey, 2015, Figures in brackets denote ‘t’ estimates of the parameters * significant at one per cent level MF- Marginal Farmers, SF– Small Farmers , LF – Large Farmers.

The estimated Cobb-Douglas production function for the watershed block reveals that the entire farmer’s experience to diminishing returns to scale. The returns to scale was as low as 0.158 for the small farmers in 2012-13. After the implementation of the watershed development programme the returns to scale has increased for all the farmer groups from 0.874 to 0.901 for the marginal farmers, from 0.158 to 0.329 for the small farmers and from 0.752 to 0.80 for the large farmers. All the farmers could increase the agricultural products by using more area. For marginal farmers all the chosen variables had shown significant impact on production. But after the watershed development programme, it was found that with increase in labour, other inputs cross cropped area and agricultural output had shown significant increase. But the negative sign of bullocks and machineries imply the over usage these inputs. The same was seen in the case of small farmers. Apart from this, for small farmers after the watershed development programme, there was over usage of other inputs also. In the case of large farmers output could be increased with increased usage of machineries and inputs.

Using the estimated Cobb-Douglas production function the agricultural output produced by the different farmers groups in the two blocks were estimated.

In the watershed area the agricultural output produced per acre was estimated as 36.54 per cent during 2012-13 and in non watershed area is 39.29 per cent. This had increased to 63.45 per cent and to 60.70 per cent respectively in 2013-14. After the implementation of watershed development programme, the agricultural production in watershed areas across the farmer groups had shown an increasing growth.

This is high in the watershed area, the percentage increase being 73.67, compared to the average annual increase of 54.51 per cent in the non watershed area. The large farmers in the watershed area had shown a significant increase of 84.86 per cent closely followed by the marginal farmers with the percentage increase of 80.22. In the non watershed area, the marginal farmers reported the highest average annual increase of 63.43 per cent. Similar findings were made by Gajja *et al.*, (1994), who reported that the input variables included in the production explained 73 to 85 per cent of the variation in land productivity, after the water harvesting structures in their study areas.

Table 5.24: Crop productivity index – watershed block (in 2013-14 over 2012-13)

Crops	Average yield (kg/ha)				Crop productivity index			
	Marginal	Small	Large	Overall	Marginal	Small	Large	Overall
Paddy	5033	4875	4807	4905	1.34	1.29	1.27	1.30
Maize	6330	5856	6588	6258	1.20	1.11	1.25	1.18
Cotton	3278	3198	3638	3370	1.06	1.02	1.70	1.26
Onion	11996	11712	12436	12048	1.02	1.08	1.06	1.05

Source: calculations based on Field Survey, 2015.

Table 5.25: Crop productivity index – non watershed area (in 2013-14 over 2012-13)

Crops	Average yield (kg/ha)				Crop productivity index (2013-14)			
	Marginal	Small	Large	Overall	Marginal	Small	Large	Overall
Paddy	4356	3996	3836	4063	1.15	1.06	1.02	1.07
Maize	4860	4256	4276	4464	0.92	0.81	0.81	0.84
Cotton	3220	3156	3228	3202	1.03	1.00	1.04	1.02
Onion	11304	11560	9848	10904	0.96	0.99	0.82	0.92

Source: calculations based on Field Survey, 2015.

5.6.8. Impact on crop productivity

Crop yields were improved depending up on the crops and the watershed development programme. Crop productivity index was calculated as the ratio of the actual yield to normal yield of the crop as per the package of practices. The calculated crop wise productivity index is shown in Table 5.24 and 5.25. In the watershed block, the average yield had exceeded the potential yield for paddy for the three farmer groups, after watershed development programme. Similarly crop productivity index for paddy, maize, cotton and onion exceeded 'one' among marginal, small and large farmers in 2013-14. Overall crop productivity index for paddy crop (1.30) was more than other crops are maize, cotton and onion.

In non-watershed block also the crop productivity index for paddy and cotton crops had exceeded 'one' among marginal, small and large farmers in 20013-14. But in the case of maize and onion crops, it shows a low level of crop productivity index for marginal, small and large farmers with crop productivity index taking values for maize crop 0.92, 0.81 and 0.81 respectively, and the onion recorded 0.96, 0.99 and 0.82 respectively.

It shows that the overall crop productivity index had increased in all crops in watershed block compared to non-watershed block.

5.6.9. Impact on crop diversification (Spatio – Temporal Analysis)

Socio- ecological system of arid and semi – arid areas are usually fragile and sensitive to vagaries of weather. They are more vulnerable to the impact of climatic changes. For such a society faced with diminishing natural resources and ever increasing demand for food consumption and food security due to increase in population growth, agricultural intensification is the only course of action for future growth of agriculture. Agricultural intensification can be achieved by changes in the cropping pattern or crop diversification. It is certainly an important component of the overall strategy for marginal farm development. It is usually viewed as a risk management strategy. It also provides for self provisioning in the context of non-monetized traditional system. As market opportunities develop and/or risks are somehow reduced, the enterprise mix begins to respond to market forces and it was this perspective which is more relevant in the context of altered economic environment (Palanisami*et al* 2008). Agricultural diversification really started in the early eighties in India and it has picked up momentum over the recent past and farmers are always quick to diversify into higher value crops as market opportunities developed. In this section, it is shown that there exists wide spatio-temporal disparity in the diversification of crops in the watershed and non-watershed areas. This is done by constructing a crop diversification index which provides a basis for ranking the different farmer groups.

Watershed development programme can be achieved by changes in cropping pattern or crop diversification. It is certainly an important component of the overall strategy for marginal farm development. Crop diversification has lot of benefits such as food and nutrition security, income growth, poverty alleviation, employment generation, judicious use of land and water resources, sustainable agricultural development and environmental improvements. To improve the incomes, to provide gainful employment and to stabilize the income flow, diversification of crops emerges as a major strategy. In several instances, cropping systems have been diversified or new cropping systems have been introduced to retain or to enhance the value of natural resources principally land and water. There is also the claim that diversification tends to stablise farm income at a higher and higher level.

Crop diversification among the farmers during the pre and post watershed development programme was measured using the Hirschman-Herfindhal diversification index. The diversification index was calculated as DI = 1-H;

Where H is the Hirschman-Herfindhal diversification index measured as,

$$H = \Sigma [(Pij/\Sigma Pij)] ;$$

Pij being the value of production of the ith crop for the jth farmer. The higher diversity index indicates greater crop diversity in production pattern. This is a means to reduce risk in terms of individual farm income risk. With only one or two food crops, farm income is much riskier to natural hazards than with a more diversified cropping system (Hedley, 1987). Timmer (1990) has identified three reasons for policy makers to pay more attention to agricultural diversification: (i) when output prices are highly un-stable, a well diversified and flexible agriculture provides more stable farm income, (ii) diversification of rural economy is a significant source of income growth for rural people, provide better living standards and reducing rural-to-urban migration, (iii) in the long run, a diversified cropping pattern is more sustainable than the intensive cultivation of a single crop. The crop diversification index, for the different crops cultivated in watershed areas after the implementation of watershed development programme, were calculated using the Hirschman-Herfindhal and are shown in the following Table 5.26.

In the watershed block after the implementation of the watershed development programme the crop diversification index has increased for paddy, maize, cotton and onion crops for all the farmers groups compared to non watershed blocks. The crop diversification index for paddy was 0.983, 0.981 and 0.915 of marginal, small and large farmers respectively in watershed blocks. Whereas the overall crop diversification index for paddy, maize, cotton and onion was 0.959, 0.908, 0.976 and 0.931 respectively in watershed blocks.

In the non-watershed block the crop diversification index has decreased compared to the watershed blocks. It can be seen that non watershed block, the crop diversification index for paddy is 0.871, 0.844 and 0.883 of marginal, small and large farmers respectively in watershed blocks. Whereas the overall crop diversification index for paddy, maize, cotton and onion were 0.869, 0.858, 0.867 and 0.850 respectively in non-watershed block.

In the watershed block, crop diversification index has marginally increased for all crops after implementation of the watershed development programme. The diversified cropping pattern emerges due to allocation of arable land resources for cultivation of a number of alternative crops. In the watershed blocks, the farmers started growing large portion of paddy and cotton crops after the watershed development programme. To find out the extent of dispersion and concentration of different crops at a given point of time and space, Modified Entropy Index (MEI) was calculated. This index is defined as,

$$MEI = - \sum_{i=1}^{i=N} pi \log N (pi)$$

Table 5.26: Crop diversification index in the study blocks

Crops	Watershed block				Non-watershed block			
	Marginal	Small	Large	All	Marginal	Small	Large	All
Paddy	0.983	0.981	0.915	0.959	0.871	0.844	0.894	0.869
Maize	0.973	0.814	0.937	0.908	0.847	0.832	0.897	0.858
Cotton	0.990	0.988	0.951	0.976	0.882	0.857	0.863	0.867
Onion	0.976	0.967	0.851	0.931	0.862	0.857	0.831	0.850

Source: calculations based on Field Survey, 2015.

Modified Entropy Index takes a value of 1 and at maximum specialization it attains a value of 0. The MEI provides a uniform and fixed scale and hence it is used as a norm to compare and rank the extent of diversification spatially. Hence in the present study this index has been used to rank the different crop indices (wide discussion made in methodology). For calculating MEI four major crops grown in the selected study blocks were chosen they are, (i) paddy, (ii) maize, (iii) cotton(iv) onion. The following table 5.27 gives the calculated crop diversification indices in the selected study blocks.

Table 5.27: Crop diversification indices (modified entropy index) in selected blocks

Category	Watershed block			Non watershed block		
	2012-13	2013-14	Δ CDI	2012-13	2013-14	Δ CDI
Marginal	0.661	0.809	0.148	0.524	0.630	0.106
Small	0.654	0.845	0.191	0.553	0.600	0.047
Large	0.762	0.920	0.158	0.629	0.687	0.058

Source: calculations based on Field Survey, 2015. ΔCDI - Change in Crop Diversification Index.

In the watershed block, for the marginal farmers Modified Entropy Index changes from 0.661 in 2012-13 to 0.809 in 2013-14. For small farmers the same changed from 0.654 in 2012-13 to 0.845 in 2013-14. For large farmers it increased from 0.762 in 2012-13 to 0.920 in 2013-14. The largest an increase in diversification was for the small farmers with increase of 0.191, for marginal farmers 0.148, and large farmers 0.158.

In the non-watershed block Modified Entropy Index had changed for large farmers from 0.629 in 2012-13 to 0.687 in 2013-14. For the small farmers diversification changed from 0.553 in 2012-13 to 0.600 in 2013-14 and for marginal farmers it was from 0.524 in 2012-13 to 0.630 in 2013-14. The changes in diversification were 0.058 for large farmers, 0.047 for small farmers and 0.106 for marginal farmers. The following table 5.28 provides ranking of the selected blocks based on the changes in the

Modified Entropy Index (MEI).

Table 5.28: Ranking of the farmer groups based on modified entropy index

Category	Watershed block(2013-14)		Non watershed block(2013-14)	
	Δ CDI	Rank	Δ CDI	Rank
Marginal	0.148	3	0.106	1
Small	0.191	1	0.047	3
Large	0.158	2	0.058	2

5.7. Off– Farm Impact of Watershed Development Programme

The off-farm impact of watershed development programme is assessed in this section in terms of its impacts on input usage, livestock, income, consumption expenditure and value of land.

5.7.1. Impact on input usage

Agricultural sector in India is the largest sector, absorbing lot of employment force and hence all programmes of unemployment alleviation have been made rural-centric. It is evident that, agricultural sector in India is in a dominant position to offer scope for a lot of employment opportunities in the economy, and more than 50 per cent of the employed force is engaged in agriculture or its allied occupations. This section studies the impact of watershed intervention technology in generating employment in farm activities. Bullocks and machines are used in preparatory cultivation, inter-cultivation and in harvesting. Apart from this human labour is used in transplanting and for applying fertilizers and pesticides. Table 5.29 gives the usage of bullocks, machines and human labour in farm activities both in watershed and non watershed blocks.

In the watershed block during the year 2012-13, bullock labour was used by marginal farmers for 14.79 pair days per household. The small and large farmers used bullock labour for about 35 and 50 pair days. 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 20013-14 it was also used in inter cultivation operations. The percentage change in the usage of bullock labour was significantly high among the different farmer groups in watershed block. This was high as 105.59 per cent for the small farmers closely followed by the marginal farmers with 95.47 per cent and by the large farmers with 76.43 per cent. In the watershed block the usage of bullock labour was lower compared to the non-watershed block. In non watershed block the bullock labour was used for about 18.58 pair days per household in 2012-13 and for about 27.04 pair days per household in 2013-14. The usage of bullock labour thus has increased in 2013-14 in non watershed block also.

Next to bullock labour, machine labours (tractor) was used for preparatory cultivation and for harvesting in both blocks this was used in inter cultivation also. On an average in the watershed block machine labour was used for about 9.68 hours per household during farm activities in 2012-13 and this increased to 15.55 hours in 2013-14. The percentage increase in the usage of machine labour was significantly higher among the marginal farmers (121.28 per cent). In the non-watershed block also the percentage change in machine labour varied from 29.42 per cent for large farmers to 63.78 per cent for small farmers and to 59.43 per cent for marginal farmers. The results revealed that after watershed development programme technology in watershed block bullock and machine laboures were also used in inter cultivation.

In the watershed block, during 2012-13 labourers were used by the marginal farmers for 60 man days, by the small farmers for 141 man days and by the large farmers for 209 days. On an average each farm household used 102 man days in farm activities. This had shown an increase in the year 2013-14. Taking all the farm house holds together in watershed block about 150 man days were used per farm household in farm activities.

Table 5.29: Usage of inputs in farm activities in the study blocks (in numbers)

Year	2012-13				2013-14				Percentage change			
Particulars	MF	SF	LF	ALL	MF	SF	LF	ALL	MF	SF	LF	ALL
Watershed block												
Bullock labour												
Preparatory	9.11	21.88	30.45	15.48	13.89	28.95	39.36	21.43	52.47	32.31	29.26	38.44
Inter-cultivation	-	-	-	-	5.97	13.69	19.77	9.90	-	-	-	-
Harvesting	5.68	12.81	19.32	9.39	9.05	28.68	28.68	14.73	59.33	58.31	48.45	56.87
Total	14.79	34.69	49.77	24.87	28.91	71.32	87.81	46.06	95.47	105.59	76.43	85.20
Machine labour												
Preparatory	1.8	4.39	7.59	4.83	2.86	6.34	11.36	6.26	58.89	44.42	49.67	29.61
Inter-cultivation	-	-	-	-	3	2.36	3.92	2.70	-	-	-	-
Harvesting	2.43	4.45	8.12	4.85	3.5	6.89	12.6	6.59	44.03	54.83	55.17	35.88
Total	4.23	8.84	15.71	9.68	9.36	15.59	27.88	15.55	121.2	76.36	77.47	60.64

Human labour												
Preparatory	12.52	29.66	47.59	21.64	17.24	36.98	53.36	27.36	37.70	24.68	12.12	26.43
Plants &planting	17.82	41.5	59.18	29.81	24.84	50.38	69.05	37.78	39.40	21.39	16.68	26.74
Fertilizer&	2.07	5.73	9.73	4.04	2.84	8.03	12.45	5.51	37.20	40.14	27.15	36.39
Inter-cultivation	-	-	-	-	11.81	20.99	29.91	16.64	-	-	-	-
Harvesting	27.49	64.51	92.45	46.24	38.59	85.31	120.13	62.21	40.38	32.24	30.14	34.54
Total	59.99	141.4	208.9	101.73	95.32	201.69	284.9	149.5	59.13	42.64	36.35	46.96
Non-watershed block Bullock labour(in pair days)												
Preparatory	9.31	14.88	23.13	13.3	8.66	18.92	21.04	13.3	-6.98	27.15	-9.04	0
Inter-cultivation	-	-	-	-	4.35	7.5	17.33	7.68	-	-	-	-
Harvesting	3.49	4.77	9.86	5.28	3.80	5.56	12.5	6.06	8.88	16.56	26.77	14.77
Total	12.8	19.65	32.99	18.58	16.81	31.98	50.87	27.04	31.33	62.75	54.20	45.53
Machine labour												
Preparatory	2.88	3.47	14.4	6.70	4.22	4.95	16.48	7.92	46.53	92.65	14.44	18.21
Inter-cultivation	-	-	-	-	1.95	1.88	2.48	2.16	-	-	-	-
Harvesting	3.11	4.15	7.05	5	3.38	5.65	8.8	5.81	8.68	36.14	24.82	16.2
Total	5.99	7.62	21.45	11.7	9.55	12.48	27.76	15.89	59.43	63.78	29.42	35.81
Human labour												
Preparatory	11.51	21.62	44.80	20.42	13.78	28.02	48.48	23.84	19.72	29.60	8.21	16.52
Plants &planting	17.47	24.86	54.5	24.65	21.27	31.58	65.23	32.48	21.75	21.03	19.69	31.76
Fertilizer&	2.61	5.56	7.81	4.28	3.70	7.88	11.46	6.14	41.76	41.73	46.73	43.46
Inter-cultivation	-	0.8	-	0.8	9.86	26.78	38.31	19.16	-	32.47	-	22.95
Harvesting	27.74	42.62	103.9	46.57	36.22	57.06	123.71	58.59	30.57	33.88	18.99	25.81
Total	59.33	95.46	211.0	96.76	84.83	151.32	287.19	140.21	42.98	58.52	36.06	44.90

Source: Field survey, 2015. MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers

The results thus revealed that there was an increase in the employment generation after the use of watershed Development programme in watershed block.

Mahnot *et.al*, (1992) reported that the human labour utilization in watershed area was 96 per cent higher than the non treated area. Employment generation due to agricultural, forest and off farm in water shed area was 20268 man days as against 12892 man days of non watershed area. All categories of farmers had higher income. Singh *et.al,* (2006), Panda (2007) and Palanisami *et al.*, (2009) also reported the same findings in their studies.

5.7.2. Impact on Livestock

Livestock plays a dominant role in Indian economy. It is greatly used for the purpose of cultivation, as well as transportation; and the production of milk is more or less considered as a by-product by the Indian cultivators. India posses the largest number of cattle of any country in the world. Its share is 17 per cent of the total livestock population of the world. India has about one-fifth of cattle. The buffalo population of the India is nearly 50 per cent of the world buffalo population. Sheep and goats also constitute nearly one-fifth of the world's total. China comes second with only ten per cent (Agricultural Statistical at a Glance 2002). In the year 2001-02 the total milk production exceeded 84.5 million tonnes. India is the largest milk producing country in the world. Out of the total income generated by the livestock resources in India, about 79 per cent is contributed by milk and milk products.

Livestock sector is a prominent sector among agricultural and allied activities in India. The annual rate of growth in GDP from livestock and agriculture had been 7.3 per cent and 3.1 per cent respectively. The details on the livestock owned by the farm households and the net income earned from the livestock are furnished in the following table 5.30.

Cows, buffaloes, bullocks, sheep and goats are maintained as important sources of income for the livelihood of farmer households. Further they also provide the liquid capital resources. It could be seen from the table 5.30 that 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 watershed block and about 3 units in the non watershed blocks. After the implementation of watershed development programme the average number of cows and buffaloes per household in the watershed block have increased substantially. This has increased from 5 to 7 in the watershed block and decreased from 3 to 4 in the non watershed block.

Table 5.30: Impact on livestock in selected study blocks (in numbers)

Farmers	2012-13				2013-14				Percentage Change			
	MF	SF	LF	ALL	MF	SF	LF	ALL	MF	SF	LF	ALL
Watershed block												
Cows and buffaloes												
Number owning	50	50	50	150	50	50	50	150	-	-	-	-
Average owned	2.98	2.99	2.72	2.88	4.01	3.84	3.72	3.92	34.56	28.43	36.26	36.11
Milk yield (litre)	15.84	15.47	16.45	15.76	22.86	22.73	23.50	22.87	44.32	46.93	42.86	45.11
Average net income	3689	3564	3775	3653	7246	7050	7390	71906	96.39	80.21	90.43	96.81
Bullocks												
Number owning	50	50	50	150	50	50	50	150				
Average owned	3.67	4.54	3.98	3.79	4.06	4.54	4.98	4.88	32.43	22.03	25.13	28.76
Sheep												
Number owning	3	2	3	8	3	2	3	8	-	-	-	-
Average owned	0.74	1.68	1.73	1.14	1.05	2.4	2.12	1.54	41.89	42.86	22.54	35.09
Average net income	9825	9454	1159	9850	1369	1469	1692	14329	39.37	55.43	45.98	65.47
Goat												
Number owning	50	50	50	150	50	50	50	150	-	-	-	-
Average owned	16.20	13.77	16.78	15.87	23.55	21.18	23.7	23.14	45.37	53.81	41.24	45.80
Average net income	1113	7161	1141	1045	1885	1229	1742	17331	6926	71.67	52.60	65.78
Non Watershed block												
Cows and buffaloes												
Number owning	50	50	50	150	50	50	50	150	-	-	-	-
Average owned	1.54	1.18	1.34	1.35	2.56	2.18	2.34	2.36	28.81	31.45	23.27	27.75
Milk yield (litre)	9.32	9.56	10.04	9.64	13.00	11.64	12.25	12.29	41.11	39.04	38.72	40.22
Average net income	2925	2739	2170	2710	4146	4004	3307	49241	82.05	77.30	88.92	76.59
Bullocks												
Number owning	50	50	50	150	50	50	50	150	-	-	-	-
Average owned	4.7	4.64	4.59	4.67	6.00	5.86	5.95	5.95	27.66	26.29	29.63	27.41
Number owning	9	8	7	24	9	8	7	24	-	-	-	-
Average owned	0.08	0.16	0.55	0.15	0.14	0.20	0.68	0.21	7.5	27.5	23.64	31.65
Average net income	1483	4013	1800	2788	2750	5825	2750	4288	85.43	45.15	52.78	53.80
Goat												
Number owning	50	50	50	150	50	50	50	150	-	-	-	-
Average owned	13.29	13.76	16.36	13.71	19.06	20.34	22.91	19.85	43.42	667.5	40.04	44.78
Average net income	9639	6394	8657	8271	1478	9306	1115	11898	53.37	45.54	28.80	43.85

Source: Field survey, 2015, MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers**.**

The farmers group wise results revealed that the percentage increase in the number of cows and buffaloes owned by a household ranged from 28.43 per cent for the small farmers in the watershed block to 36.26 per cent for the large farmers in the same block. The percentage increase for the marginal farmers was 34.56.

In the non watershed block, the percentage change in the number of the cows and buffaloes owned per household was the lowest of 23.27 per cent for the large farmers to the highest of 31.45 per cent for the small farmers.

A substantial increase was seen in the milk yield from cows and buffaloes in the watershed block after the watershed development programme. On an average in the watershed block, the average milk yield was 15.76 litres in 2012-13 and this has increased to 22.87 litres in 2013-14. The corresponding figures for the Non watershed block were 9.64 litres and 12.29 litres respectively. Comparatively Non watershed block more milk yield in watershed block in both the years,

After deducting the cost in maintaining the cows and buffaloes the average net income from these two sources were calculated and are given in the above table. The percentage change in the net income after the watershed development programme was significantly high in both blocks exceeding 80 per cent. The average net income earned from cows and buffaloes had increased from Rs.36,535 in 2012-13 to Rs.71,906 in 2013-14 in the watershed block. The corresponding figures for the Non watershed block were Rs.27,108 and Rs.49,241 respectively.

All the farmers in both the blocks own bullocks in their farms. This figure increased from about 5 bullocks per household in 2012-13 to 6 in 2013-14 in the watershed block. In the non watershed block the decrease was from about 3 to 2 bullocks per farm household. It could be seen that only 1.54 per cent in the watershed block and 0.21 per cent of the farmers in the non watershed block own sheeps.

Goat rearing was carried out by all the farmers in both the blocks. On an average each household own about 16 goats in the watershed block and about 14 goats in non watershed blocks. In 2012-13, this had increased to about 23 goats per farm household in the watershed block and decreases about 5 goats in the non watershed block. The average net income had shown an increase in both the blocks in 2013-14. The percentage change in net income from goat in the watershed block in the year 2013-14 was 65.78 and non watershed block 45.47.

The results was revealed that the positive impact of watershed development programme on the farm households to maintain livestock in their farms to derive additional income. It further revealed that the farm households in the watershed block maintain milch animals to derive additional income for their livelihood. Additional income generated from milch animals was also substantially high in watershed block compared to Non watershed block.

The view of Ramappa *et.al,* (2008) and Shiyani *et.al*. (2002) supported the above findings. They reported that after watershed development programme the number of animals owned increased significantly.

5.7.3. Impact on income

Irrigation facilities play a dominant role in determining the crop of a region. It can change the pattern of crops. Assured water supply will enable the farmers to have two or three crops in a year. As a result of which, the farm income were increases. The farm income derived by the farmers includes income from crop cultivation and income from livestock maintenance as shown in the table 5.31. The average annual crop income across the farmers revealed that it was high among the large farmers followed by small farmers and marginal farmers. Per house hold crop income was 911313, 190724 and 231310 for marginal, small and large farmers respectively in watershed block. The changes in watershed block an annual income increase of 27.59 per cent in 2012-13. It was observed in 2013-14 the per house hold crop income was increases was 143850, 222390 and 340401 for marginal, small and large farmers respectively in watershed block.

The average annual crop income across the farmers was revealed that compared to watershed block less annual income of non watershed block. Per household crop income was Rs. 171115 in the watershed block in 2012-13 and it was increases in 2013-14 of 235547 and an annual income increase of 27.59 per cent. The crop income has significantly increased among the marginal farmers from Rs. 143850, to Rs. 340401 large famers in 2013-14 with an increase of 32.56 per cent.

Income from livestock has increased from marginal to large farmers in 2013-14 in watershed block with an increase of 27.79 per cent. Here also the marginal farmers had realized a significant increase in the live stock income from small to large farmers was Rs. 141359 to Rs. 146248 in 2013-14.The per household farm income has significantly increased among the marginal farmers in the watershed block with the percentage change in per capita income being 33.13.

Table 5.31: Average annual income per farm household in the study blocks (in Rupees)

Sl. No	Particulars	Watershed block (2012-13)				Non watershed block (2012-13)			
		MF	SF	LF	ALL	MF	SF	LF	ALL
1	Crop income	91313	1,90,724	231310	171115	50647	134550	206205	130467

2	Livestock income	96411	103859	114812	105027	53286	62696	70235	62072
3	Total farm income	202872	294583	306112	267855	103944	190355	292253	195534
4	Per capita income	85426	105789	95380	95531	43634	68651	63314	58533
		Watershed block (2013-14)				Non watershed block (2013-14)			
	Crop income	143850	222390	340401	235547	69522	140659	263138	157773
	Livestock income	149132	141359	146248	145579	70629	81196	91048	80957
	Total farm income	232984	337220	356398	308867	140151	215746	333733	229876
	Per capita income	127752	119780	141305	129612	64644	77730	91803	78059
	Change in percentage								
1	Crop income	36.52	14.23	32.04	27.59	27.14	4.34	21.63	17.70
2	Livestock income	35.35	26.52	21.51	27.79	24.55	22.78	22.85	23.39
3	Total farm income	27.45	12.64	14.10	18.06	25.83	11.76	12.42	16.67
4.	Per capita income	33.13	11.68	32.50	25.77	32.50	11.68	31.03	25.07

Source: Field survey, 2015.MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers.

In the non-watershed block also a similar trend prevailed .The per farm household annual crop income across the farmers revealed that, it was high among the large farmers followed by small and large farmers. Per farm household crop income has increased from Rs. 91803 in 2013-14, with an increased annual income of 21.63 per cent. Income from livestock has also significantly decreased compared to watershed block in study area. The results revealed the positive impact of watershed development programme on the farm house hold income in the watershed study block.

Palanisami *et.al*, (2005) observed that the watershed intervention was found to help the rural farm households in enhancing their income level.

5.7.5. Impact on value of land

The impact of watershed intervention technology on value of land in the two study blocks for the period 2012-13 and 2013-14 was assessed by calculating the monetary value of land both in watershed and non-watershed blocks. The details are given in Table 5.32. The monetary value of land was calculated using the prices prevailing for the land during the respective years. In the watershed block, there was an increase in the value of land for all groups of farmers. It could be seen from Table 5.26 that land value per farm house holds for marginal farmers had increased from Rs.3,91,890 in 2012-13 to Rs.5,11,890 in 2013-14. For the small farmers it was from Rs.3,41,480 to Rs.4,61,480 and for large farmers from Rs.3,88,080 to Rs.5,82,120 respectively. The per centage changes in the value of land per farm household among all farmer groups range from 30.62 for marginal farmers to 35.14 for small farmers and 50.00 to large farmers. The overall per centage change in the land value per farm household in watershed block, after the application of watershed intervention technology accounted to 38.58.

In the non-watershed block the land value per farm household had increased from Rs.2, 35,000 in 2012-13 to Rs.3, 92,840 in 2013-14. The value of land had highly increased in this block, for the small farmers from Rs.2, 59,200 in 2012-13 to Rs.3, 82,200 in 2013-14, followed by small farmers with increase in land value from Rs.2, 14,090 in 2012-13 to Rs.3, 34,090 in 2013-14. For marginal farmers the monetary benefit from land was 17.26 per cent.

The findings reveal that for all the farmers the land value in money terms had increased in watershed block compared to non watershed block in study area. The increase was much realized by the large farmers in watershed block.

Table 5.32: Value of land per farm household in selected blocks (in Rs.)

Farmers	2012-13	2013-14	Percentage change
Watershed block			
Value of land			
Marginal Farmer	3,91,890	5,11,890	30.62
Small Farmer	3,41,480	4,61,480	35.14
Large Farmer	3,88,080	5,82,120	50.00
All	373816	518496	38.58

Non watershed block			
Value of land			
Marginal Farmer	2,35,000	3,92,840	17.26
Small Farmer	2,59,200	3,82,200	24.24
Large Farmer	2,14,090	3,34,090	38.20
All	235096	369710	26.56

Source: Calculations based on Field Survey, 2015.

5.7.6. Hedonic Pricing Analysis

Hedonic price function relates an individual's willingness to pay for environmental attributes, specified between the market prices and all the relevant attributes of the commodity. For the estimation of the hedonic price, the marginal implicit price of the environmental attributes needs to be considered. Thus it includes a price paid for a better environmental attributes, in the absence of which the value of land is equal to the cost of land without appropriate mark ups for environmental benefits (Sekar, 2001).

In the present study, the hedonic price function was employed to estimate the marginal price of the different attributes of the watershed development programme. The preliminary analysis inferred from the primary data revealed that the prices of the agricultural land had shown variations with respect to the extent of water conservation area. Hence, the hedonic pricing function was employed to study the impact of distance to the village from the agricultural land, output and depth of water level in the farm wells on the price of the agricultural land.

Price = f (DISVI, OUTPUT, WTDEP)

Where,

Price = Value of agricultural land (in per hectare).

DISVI = Distance to the village from the agricultural land (kms).

OUTPUT = Value of farm products (Rs.).

WTDEP = Depth of water level in the farm wells (feet).

In hedonic pricing analysis, the implicit prices for the various qualitative and environmental characteristics were estimated by looking at the real markets in which that distinctiveness are effectively traded. Differences in these qualitative features of the land were expected to affect the flow of benefits from the property implicitly. Hence to appraise the qualitative attributes of the enhanced land used for agriculture and also to evaluate the improved values of the crop land, the data collected were subjected to hedonic pricing analysis using the ordinary least squares technique, the models were estimated. The results of the hedonic pricing estimates are presented in the following table 5.33.

As the Table 5.33 reveals in both the watershed and Non watershed blocks distance from the village had a negative impact on the value of farm land after the adoption of watershed development programme. For every kilometer away from the village the value of land in watershed block has declined by 2,161 before watershed development programme and by 2085 after the watershed development programme.

An increasing trend was seen in the value of land with every unit increase in the output after watershed development programme. For every Rs.1,000 increase in the output level the value of land increased by 37 before watershed development programme and by 71 after the watershed development programme in the watershed block. For every feet increase in the water level in the farm wells the value of land had increased by 48 in before watershed development programme and by 69 in the non watershed blocks. After the watershed development programme this had increased to 71 in watershed block, and 75 in the Non watershed blocks respectively. All the chosen three variables could explain about 50 and 23 per cent of the variations in the value of land in the watershed and non watershed blocks respectively before the watershed intervention technology. After the watershed intervention technology these three variables could explain about 52 per cent of the variations in the value of land in the watershed block and 13 per cent of the variations in the Non watershed block respectively. All the estimated parameters were statistically significant at one per cent level signifying the impact of the chosen variables on the value of land.

Table – 5.33: Hedonic price estimates in the selected study block

Sl. No	Variable	Parameter Estimates	
		2012-13	2013-14
	Watershed block		
1	Intercept	1,78,980.12* (7.367)	2,33,590.43* (9.504)
2	DISVI	-2161.06* (-4.043)	-2085.69* (-4.208)
3	OUTPUT	0.037* (6.79)	0.071* (7.359)

4	WTDEP	47.945* (3.623)	60.96* (5.763)
5	R^2	0.433	0.527
N	SAMPLE SIZE	150	150
Non watershed block			
1	Intercept	170000.65* (13.762)	290320.866* (14.232)
2	DISVI	-2193.86* (-3.38)	-1926.53* (-2.876)
3	OUTPUT	0.06* (6.79)	0.08* (6.242)
4	WTDEP	69.09* (4.924)	75.95* (4.984)
5	R^2	0.495	0.515
N	SAMPLE SIZE	150	150

Source: calculations based on Field Survey, 2015; Figures in parenthesis indicate the “t” value * significant at one per cent level. DISVI-Distance to village from the agricultural land, OUTPUT-Value of farm products (in Rs), WTDEP- Depth of water levels in the well (in feet) in the farm. Dependent variable = value of agriculture land (per hectare).

The results were revealed that, after watershed development programme the value of land has increased in the watershed block with reference to distance from the village, output produced and water level in the farm wells.

Sekar *et.al*, (2008), also observed that the variables such as distance to village and main road had negative impact on the value of land indicating an inverse relationship with the hedonic land value.

5.8. Benefit cost ratio

A farm household’s decision to invest in the watershed development programme is based on the anticipated benefits. The benefit cost ratio of the watershed development programme is analyzed to compare the present value of benefits to the present value of cost. This helps to determine whether the watershed development programme is economically a viable proposition or not. If the benefit cost ratio of the watershed development programme is greater than unity, then the adoption and the implementation of the watershed development programme is found to be economically sound. If the benefit cost ratio of the watershed development programme is less than unity, then the adoption and the implementation of the watershed development programme is found to be economically unappealing. In the selected blocks, the impact of watershed and Non watershed blocks on crop yields and cost were estimated and are presented in the following table 5.34.

Table 5.34: Impact of watershed development programme on yield and cost in the selected blocks (from 2012-13 to 2013-14)

Crops	Change in Yield (%)	Reduction in marginal cost (%)	Reduction in unit	Net cost change (%)
Watershed block				
Paddy	29.41	32.6	4.4	28.2
Maize	40.86	42.3	2.2	40.1
Cotton	35.42	24.0	0.4	23.6
Onion	7.61	76.8	11.6	65.2
All	28.32	43.92	4.65	39.27
Non watershed block				
Paddy	18.01	24.8	4.5	20.3
Maize	12.05	11.3	0.6	10.7
Cotton	8.19	6.4	1	5.4
Onion	11.76	8.2	4.8	3.4
All	12.50	12.67	2.72	9.95

Source: calculations based on Field Survey, 2015, MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers.

To find out the net cost change, first reduction in marginal cost Cm and then reduction in unit cost Cu were calculated using the following formulae,

$$\text{yield Reduction in marginal cost Cm} = \frac{\text{Relative change in}}{\text{Price elasticity of supply (es)}}$$

$$\text{Reduction in unit cost Cu} = \frac{\text{Change in costs of inputs per hectare (Ci)}}{\text{1+ change in yield}}$$

Net cost change #Cn = Cm - Cu

Taking all the crops together, in the watershed block the change in the yield due to watershed development programme 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 24.0 per cent in cotton 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 23.6 per cent in cotton to 65.2 per cent in onion. In the case of Non watershed block the change in yield across the crop varied from 8.19 per cent in cotton to 18.01 per cent in paddy. Reduction in marginal cost due to supply shift ranged from 6.4 per cent in cotton to 24.8 per cent in paddy. Net cost changed varied from 3.4 per cent in onion to 20.3 per cent in paddy. The estimated benefit cost ratio for the different farmer groups in the study area are shown in Table 5.34.

From Table 5.34 it could be elaborated that the Benefit Cost Ratio (BCR) ranged from 1.50 for the marginal farmers to 3.50 for the small farmers and 3.85 for the large farmers in the watershed block. In the non-watershed block also similar results prevailed. It is noticed from the above Table 5.34 that among the sample farmer groups BCR for marginal farmers was 2.08, for small farmers 2.68 and for large farmers 3.87. The financial results on feasibility analysis revealed that the benefit cost ratio exceeded 'unity' for all farmer groups.

Table 5.34: Benefit cost ratio

Particulars	MF	SF	LF	ALL
Watershed block				
Total Benefit(Rs.)	13,350	62,057	97,341	67233
Total Cost(Rs.)	8,892	17,701	25,273	17288
Benefit Cost Ratio	1.50	3.50	3.85	2.95
Non-watershed block				
Total Benefit(Rs)	8,905	21,258	56,159	28,774
Total Cost(Rs)	4,280	7,930	14,483	8897
Benefit cost ratio	2.08	2.68	3.87	3.23

Source: Field survey, 2015, MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers.

The results were revealed that, watershed development programme is an economically feasible measure for the farmer to realize benefits.

Senthil Nathan *et.al*, (2008), in their study reported that the BCR ranged from 1.08 for percolation pond to 1.71 for minor check dams.

5.9. Expectations and Realisations

The famers were asked to report their expectations on the over impact of watershed development programme on various issues related to the usage and availability of water and soil. They were asked to give their expectations as ‘yes’ or ‘no’. The various issues are listed in Table 5.35.

From Table 5.35 it can be seen that about 80 to 90 per cent of the farmers in the watershed block, expected that watershed development programme would (i) reduce wastage of water, (ii) increase groundwater recharge, (iii) increase in pumping hours and silt trap and (iv) improved soil fertility and soil erosion, change in the cropping pattern, crop yield and farm diversification. About 60 to 70 per cent of the farmers expect an increase more availability of water.

Table 5.35: Expectations on overall impact of the watershed development programme in the selected block

S.No	Particulars	Watershed block			
		MF	SF	LF	ALL
1	Reduced wastage of water	34 (68.00)	44 (88.00)	47 (94.00)	125 (83.33)
2	Increased ground water recharge	41 (82..00)	43 (86.00)	42 (84.00)	126 (84.00)
3	Adequate availability of	37	38	43	118

	water	(74.00)	(76.00)	(86.00)	(78.66)
4	Silt trap	46 (92.00)	44 (88.00)	41 (82.00)	131 (87.33)
5	Reduced soil erosion	47 (94.00)	44 (88.00)	40 (80.00)	131 (87.33)
6	Change in cropping pattern	43 (86.00)	45 (90.00)	47 (94.00)	135 (90.00)
7	Increase in cropping intensity	33 (66.00)	47 (94.00)	41 (82.00)	121 (80.66)
8	Increase in yield	41 (82.00)	39 (78.00)	44 (88.00)	124 (82.66)
9	Crop diversification	44 (88.00)	46 (92.00)	48 (96.00)	138 (92.00)
10	Increase in farm employment	48 (96.00)	41 (82.00)	43 (86.00)	132 (88.0)
Sample size		50	50	50	150

Source: Field survey, 2015, MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers, (Figures in parenthesis indicate percentages to the total)

The farmers were asked to report whether their expectations on the overall impact of watershed development programme on the above stated issues were either ‘fully’, ‘partially’ or ‘not at all’ realized. Tables 5.35 and 5.36 give the level of realization of the farmers in the selected study block on the overall impact of watershed development programme. For all the farmers the expectations were either ‘fully’ or ‘partially’ realized.

Table-5.36: Realization on overall impact of the watershed development progrmme in watershed block

S.No	**Particulars**	**Level of Realization**							
		Fully				**Partially**			
		MF	SF	**LF**	**ALL**	**MF**	SF	**LF**	**ALL**
1	Reduced wastage of water	35 (70.00)	42 (84.00)	47 (94.00)	124 (82.66)	5 (10.00)	8 (16.00)	3 (6.00)	16 (10.66)
2	Increased ground water recharge	32 (64.00)	38 (76.00)	48 (96.00)	118 (78.66)	8 (16.00)	12 (24.00)	2 (4.00)	22 (14.66)

3	Adequate availability of water	33 (66.00)	41 (82.00)	45 (90.00)	119 (79.33)	7 (14.00)	9 (18.00)	5 (10.00)	21 (14.00)
4	Silt trap	39 (78.00)	45 (90.00)	47 (94.00)	131 (87.33)	11 (22.00)	5 (10.00)	3 (6.00)	19 (12.66)
5	Reduced soil erosion	41 (82.00)	43 (86.00)	48 (96.00)	132 (88.00)	9 (18.00)	7 (14.00)	2 (4.00)	18 (12.00)
6	Change in cropping pattern	43 (86.00)	47 (94.00)	49 (98.00)	139 (92.66)	7 (14.00)	3 (6.00)	1 (2.00)	11 (7.33)
7	Increase in cropping intensity	40 (80.00)	41 (82.00)	46 (92.00)	127 (91.33)	10 (20.00)	9 (18.00)	4 (8.00)	23 (15.33)
8	Increase in yield	43 (86.00)	45 (90.00)	47 (94.00)	135 (90.00)	7 (14.00)	5 (10.00)	3 (6.00)	15 (10.00)
9	Crop diversification	31 (62.00)	43 (86.00)	44 (88.00)	118 (78.66)	19 (38.00)	7 (14.00)	6 (12.00)	32 (21.33)
10	Increase in farm employment	48 (96.00)	47 (94.00)	46 (92.00)	141 (94.00)	2 (4.00)	3 (6.00)	4 (8.00)	9 (6.00)
Sample size		50	50	50	150	50	50	50	150

Source: Field survey, 2015, MF- Marginal Farmers, SF– Small Farmers, LF – Large Farmers, N- number stated, C- Percentage to column total. Figures in parenthesis indicate percentages to the total.

For more than 80 per cent of the farmers in the watershed block, their expectations on the overall impact of watershed development programme was ‘fully’ realised on reduced wastage of water, silt trap, improved soil fertility, reduced soil erosion, change in cropping pattern, increase in cropping intensity, increase in yield, farm diversification and increase in farm employment

.Only 70 per cent farmers reported that their expectation ‘partially’ realized for increased groundwater recharge and adequate availability of water.

The analysis thus reveals that, the expectations of the farmers on the positive impact of watershed development programme were realized.

5.9.1. Opinion Survey on the Impact of Watershed Development Programme

The farmers were asked to state their opinion on the impact of watershed intervention technology on the following factors viz, ‘ground water recharge’, ‘fodder improvement’, ‘increase in water level’, ‘change in cropping pattern’, ‘improvement on environment’ and ‘increase in employment’ as ‘very good’, ‘good’ and ‘poor’. For ‘very good' score of '2', for good score of '1' and poor score of '0' were assigned. Table 5.37 gives the average scores assigned per house hold on the impact of watershed development programme on the above stated factors.

Table 5.37: Scores assigned on the impact of watershed and non watersheds in the selected blocks

Sl. No	Impacts	Watershed block				Non watershed block			
		MF	SF	LF	ALL	MF	SF	LF	ALL
1	Increase in water level	2	2	2	2	0.78	0.66	0.96	0.8
2	Groundwater recharge	2	1.97	2	1.98	0.2	0.2	0.96	0.45
3	Change in cropping pattern	2	1.99	2	1.99	0.92	0.92	0.87	0.91
4	Fodder improvement	1.55	1.72	1.73	1.62	0.61	0.44	0.63	0.56
5	Improvement of Environment	1.96	1.93	1.95	1.95	0.80	0.64	0.77	0.73
6	Increase in employment	1.44	1.33	1.59	1.42	0.34	0.2	0.23	0.25

Source: Field survey, 2015. MF-Marginal, Farmer, SF -Small Farmer,LF-Large Farmer .

All the farmers in the watershed 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. This means the farmer groups in the watershed block felt that the impact of watershed intervention technology on these is very good. For the impact on the 'fodder improvement' the score assigned was 1.62. For the five above stated factors, the impact was felt to be closer to 'very good' the score ranging from 1.72 to 2. 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 non-watershed block, the farmers felt that the impact on 'ground water recharge' (score=0.45), 'change in cropping pattern' (score=0.91), 'Increase in water level' (score=0.8), 'improvement on environment' (score=0.73) and 'fodder improvement '(score=0.56) to be 'poor'. Compared to non watershed block more realization impact in watershed block.

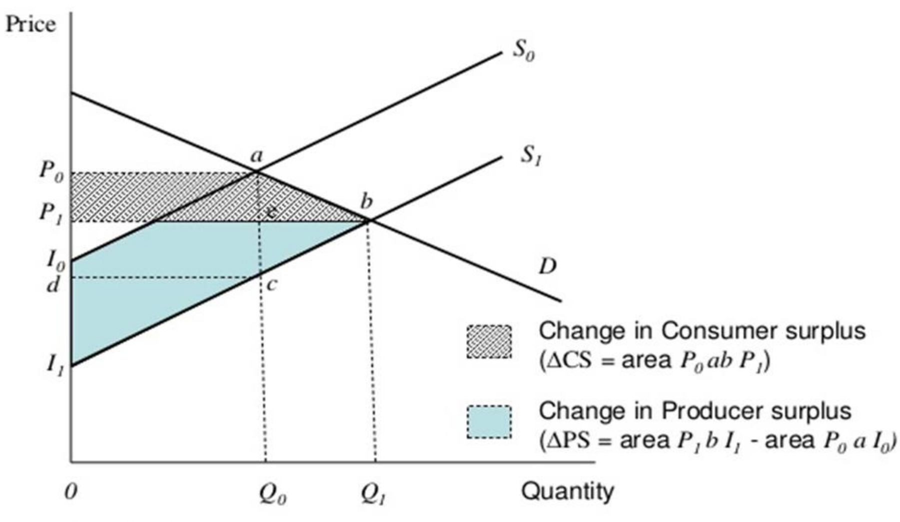
The findings reveal that, all the farmers felt that the impact of watershed development programme on groundwater recharge, increase in water level, fodder improvement, cropping pattern change and improvement on environment was very good. The impact of watershed development programme on the 'increase in employment' was to be considered as 'good'.

Similar findings were made by Palanisami and Suresh kumar (2004). They observed that the respondent's opinion of watershed development activities. The 'groundwater recharge' appears to be the most important due to the highest mean score of 75.33 followed by yield increase 75.53, 'soil fertility improvement' 62.90 per cent 'soil and moisture conservation' 56.53 per cent.

5.10. Economic Surplus Model

To evaluate the impact of watershed development programme on the economic welfare of the farm households (Moore et al., 2000, Maredia *et al.*, Swinton 2002 and Wader et al., 2004) the Economic Surplus Approach is widely used (Palanisami, K. *et. al.*, 2009). The model is based on the Marshallian theory of economic surplus (demand and supply).

The economic surplus method measures the aggregated social benefits of a research project. With this method it is possible to estimate the return to investments by calculating a variation of consumer and producer surplus through a technological change originated by research. Afterwards, the economic surplus is utilized together with the research costs to the Benefit-Cost Ratio (BCR).



Surplus distribution in the basic model of research benefits

Source : Alston, Norton and Pardey, p209

The term surplus is used in economics for several related quantities. The consumer surplus is the amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay. The producer surplus is the amount that producers benefit by selling at a market price mechanism that is higher than they would be willing to sell for. In the case of watershed programmes, producers are mainly the farm households who produce the goods using the benefits of the watershed interventions such as soil and moisture conservation, water table increase and livestock improvement activities and consumers are mainly the other stakeholders in the region, viz. non-farm households representing the labourers, business people and people employed in non-agricultural activities

In figure, the rightward shift (S1) of the original supply curve (S0) generates economic surplus for producers and consumers. Such a shift from changes in production technology, in the present case watershed development intervention. Given that the demand function remains constant, the original market equilibrium a (P0, Q0) is tranmferred by the effect of technological change to b (P1, Q1). Consumers gain because they are able to consume a greater amount (Q1) at a lower price (P1). The area P0abP1 represents the consumer surplus. The watershed development intervention affects agricultural producers in two ways: (i) Lower marginal costs (according to the theory, the supply curve corresponds to the curve of marginal costs as of the minimum value of the curve of average variable costs), and (ii) Lower market price (P0 reduced to P1). Thus, the producers' surplus is defined as the P1bI1- Area P0aI0.

The advantage of the economic surplus approach lies in the fact that the distribution of benefits to different segments of the society could be estimated. The watershed development could be treated as a 'public good' and covers both the private and public lands. Moreover, the benefits due to watershed development activities are not restricted to the producers alone. Increased supply, changes in price of the agricultural products will also benefit the consumers positively. The economic surplus approach captures the impact of watershed development activities in a holistic manner (Palanisami*et.al*, 2009).

The supply curve equation is calculated as

$$So = c\,(Po-Pio)^{d} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.1)$$

Where, So = initial supply before watershed development programme.

C&d = constants

Po = price of product and

Pio = maximum price that producers are willing to offer.

The demand equation written as

$$P = g\,Q^{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5.2)}$$

Where, n is the elasticity and g is a constant. Once the parameters n and g are estimated then the consumer surplus could be estimated by equation (5.3).

$$CS = \int_{Q_o}^{Q_1} gQ^{n}\,dQ - (Q_1 - Q_o)\,P_I \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5.3)}$$

Combined, the consumer surplus and the producer surplus make up the total surplus (economic surplus). The economic surplus was calculated for four major crops cultivated in the two study blocks. The four crops selected for calculation are paddy, maize, cotton and onion crops. The estimated total surplus due to watershed development programme was presented in the following Tables 5.39 for the selected major crops produced by the farmers. The calculation of change in consumer surplus and producer surplus was discussed in methodology.

In the watershed block, the calculated economic surplus exceeded. Being the major rain fed crops, these four crops benefited from the implementation of the watershed development programme. The change in economic surplus due to watershed development programme was decomposed into change in "consumer's surplus" and change in "producer surplus". It is evident that the producer surplus was higher than the consumer's surplus for all the crops in watershed block.

Table-5.38: Impact of watershed intervention technology and economic surplus in watershed block

Sl.no	Crops	Change in economic Surplus (ΔTS)	Change in consumer surplus (ΔCS)	Change in producer surplus (ΔPS)
1	Paddy	619542 (100.00)	287123 (46.35)	332419 (53.65)
2	Maize	559152 (100.00)	247016 (44.18)	312136 (55.82)
3	Cotton	355500 (100.00)	143100 (40.25)	212400 (59.75)

4	Onion	917168 (100.00)	224200 (24.44)	692968 (75.56)

Figures in the parenthesis indicate the percentages to the total

The producer surplus was high for onion which was worked out to be 75.56 per cent. The estimated producer surplus exceeded more than 50 per cent for paddy, maize and cotton crops.

The analysis reveals that, the producers surplus exceeded that of the consumer surplus for all crops. The farmers as producers benefit from watershed development programme in watershed block.

Thakur, D. *et.al* (2000), observed that the impact of irrigation was viable in terms of notable increase in the yields of all the crops and that increase was found higher in commercial crops (vegetables). Per farm production and marketable / marketed surplus of food grains after the project was quite higher than before the projects installation. Similarly, the production and market surplus of vegetables (Kharif and rabi) had shown about two to three fold increase after the watershed project.

5.11. Peoples participation

Peoples' participation in watershed development and management programmes is crucial for their succesmful and cost-effective implementation. This is so because the watershed approach requires that every field/parcel of land located in a watershed be treated with appropriate soil and water conservation measures and used according to its physical capability. For this to happen, it is necessary that every farm having land in the watershed accepts and implements the recommended watershed development plan. There are some components of a watershed development plan such as bunding, leveling etc., which can be implemented by the farmers involved acting individually and there are many other items such as check dams, waterways etc., that can be implemented only through collective action of the farmers. This means that for succesmful implementation of watershed development plans, peoples' participation is necessary for action on their individual farms as well as on common property land resources in the watershed.

Moreover peoples' participation should be encouraged because they are aware of their own needs better. At the same time, it has been seen that non-involvement of people in the development programmes is also a great concern and challenge to rural development. No programme can be a success without the involvement of the people. Since the project emphasizes the participatory management, involvement of file beneficiaries right from planning stage helps in smooth and effective implementation of file programme.

An integrated plan was prepared for this watershed by an inter-disciplinary, comprising grass root level workers from agriculture, horticulture and forestry sectors in consultation with the local farming community by conducting series of group meetings with the farmers and village committees to make the programme a peoples' movement. The whole programme was implemented through the beneficiaries by public participation.

People's participation of watershed farmers at different stages of watershed management programme

People's participation was operationalised as the degree of participation of watershed farmers at different stages of watershed management programme and sharing the responsibilities during each and every management activity for efficient functioning of watershed project in a sustainable manner.

A schedule was developed with 30 statements for eliciting the response on people's participation of watershed farmers at different stages of watershed management programme.

Scoring: The response on each statement was recorded on three point continuum i.e. agree, undecided and disagree with the scores of 3, 2 and 1 respectively. The maximum and minimum possible scores are 90 to 30, whereas the obtained scores were 80 and 50 respectively.

$$Extent of\ participation = \frac{Actual\, score obtained}{Maximum\, possible score}\ x100$$

Categorisation:

Based on the people's participation, the watershed farmers were grouped in to following three categories by using exclusive class interval technique.

Category	**Class interval**
Low extent of participation	50-60
Small extent of participation	60-70
Highextent of participation	70-80

Table-5.39. Rank wise analysis of people participation at different stages of watershed management programme

	Item	Response categories			T.S	M.S	Rank
		Marginal	Marginal	Large			
I	**Pre-project stage**						
1	Participation by attempting to gain information about objectives of the programme.	60	40	50	322	2.15	VI
2	Participation in formal and informal meetings to discuss about village problems.	60	60	30	306	2.04	X
3	Participation in PRA techniques like resource mapping, social mapping, transact walk etc.	70	40	40	263	1.75	XVIII
4	Participation in preparation of bench mark survey report	80	30	40	237	1.58	XXI
5	Participation in deciding the demarcation of watershed boundary	10	70	70	218	1.45	XIV
6	Participation by co-operating with the officials in formulating watershed associations/sanghs/societies.	65	35	50	235	1.57	XXII
7	Participation in decision making for contribution of resources like land, labour, money and animal etc.	30	80	40	330	2.20	IV
II	**Planning stage**						
8	Participation in discussion to identify the production problems of village and technological options.	70	50	30	314	2.09	IX
9	Participation in formal and informal meetings to approve the proposals for activities in work plan.	50	40	60	303	2.02	XI

	Item	Response categories			T.S	M.S	Rank
		Marginal	Marginal	Large			
10	Participation in deciding the location and design of proposed soil and water conservation structures/measures like bunds, waterways, farm ponds, nala bunds, check dams, gully checks etc	70	70	10	281	1.87	XVI
11	Participation in deciding the choice of species for forest, fodder, horti-silvi plantation, pasture and nursery development.	80	80	35	278	1.85	XVII
12	Participation in discussion for setting of norms for distributing and sharing of benefits among people coming from community lands.	30	90	30	346	2.31	III
III	**Implementation stage**						
13	Participation by contributing resources like land, labour, money, animal, etc.	60	40	50	208	1.39	XXV
14	Participation by attending meetings to review the progress of works/activities.	50	60	40	217	1.45	XXIV
15	Participation by supervising on-going activities/works undertaken in the fields and community lands.	65	35	50	316	2.11	VII
16	Participation by adopting graded, contour bunds, gully checks, diversion channels, farm ponds, check dams etc, in the field.	45	65	40	399	2.66	I
17	participation while planting forestry species in community lands	75	25	50	280	1.87	XVI
18	Participation by adopting crop production and other improved practices recommended by watershed development officials.	40	50	70	350	2.33	II
19	Participation in income generation, thrift and credit and other related activities of programme	70	50	30	295	1.97	XIII
20	Participation in training programmes conducted by IWMP	20	10	120	315	2.10	VIII

	Item	Response categories			T.S	M.S	Rank
		Marginal	Marginal	Large			
21	Participation by helping officials during implementation of watershed activities.	100	30	20	280	1.87	XVI
22	Participation by actual utilization/sharing of benefits under the watershed management programme	30	50	70	286	1.91	XV
IV	**Maintenance stage**						
23	Participation by publicizing the importance of maintenance of assets developed under the programme.	120	20	10	249	1.66	XX
24	Participation by fixing responsibility among user groups to maintain the works/activities taken up under the programme.	100	30	20	249	1.66	XX
25	Participation in maintaining soil and water conservation works/structures taken up under the programme.	20	100	30	327	2.18	V
26	Participation by protecting the trees in the developed forest plots.	35	80	35	289	1.93	XIV
V	**Evaluation stage**						
27	Participation in determining the success of programme by supplying information on the benefits received from the programme.	100	30	20	280	1.87	XVI
28	Participation by expressing problems encountered in the programme to officials.	40	30	80	302	2.01	XII
29	Participation by assisting the officials in collection of feedback	70	40	40	225	1.50	XXIII
30	Participation by suggesting suitable modifications for future programme implementation.	80	40	30	253	1.69	XIX

Further, the rank wise analysis is presented in Table5.39, the peoples participation of watershed farmers at different stages of watershed management programme indicate that the first rank was obtained on the statement of participation by adopting graded, contour bunds, farm ponds, check dams, percolation tanks, check walls etc, in the field followed by participation by adopting crop production and other improved practices recommended by the watershed development officials (II rank), participation in discussion for setting of norms for sharing of benefits among the people coming from community lands (III rank), Participation by attempting to gain information about objectives of the programme (IV rank), Participation in maintaining soil and water conservation works/structures taken up under the programme (V rank)and least ranked statements were participation by assisting the officials in collection of feedback (XXIII rank), participation by attending meetings to review the progress of works/activities (XXIV rank) and participation by contributing resources like land, labour, money, animal, etc (XXV rank).

Majority of the respondents has low level of participation followed by small and high. The reason could be low levels of team work, group communication, group norms and information seeking behavior. Most of the time, the succesmful implementation of watershed activities dependent on collective action of the intended users. But, seldom had the farmers participated in various stages of designing process under watershed. The results accrued through implementation of watershed activities can not be visualized immediately, which also makes farmers not to attach much weightage to the watershed designing process. An examination of the information provided in the table revealed that the involvement of the people in the programme planning and implementation received the best attention of the project authorities. Almost all the selected farmers reported that they were fully consulted at the time of planning and also before implementation of the programme. More than 80 per cent of farmer respondents of three size groups attended all the meetings conducted by the project staff before the initial planning and also after the implementation of the programme in their villages. There was no resistance observed from farmers against any activity undertaken in their fields by the project authorities. Hundred per cent of the sample beneficiaries also reported that the treatment measures taken on their fields were meeting their parity needs. However, each respondent was exposed to only few activities

Among all the watershed practices, highest participation was seen in adopting contour bunds, farm ponds, check dams *etc* followed by adopting crop production and other improved recommended practices under watershed. The visibility and utility of these practices can be assessed easily where as lowest participation was seen in contributing resources like land, labour, money, animals *etc* and attending the meetings to review the progress of work. It is quite natural that the degree of liking by any individual to share his/her resources for the benefit of community was very poor and the culture of attending meetings especially to review the progress of various watershed activities was poor as farmers were not owning the programme in terms of realizing the value of participation especially during periodical assessment on the progress of various watershed activities taken up under watershed. This kind of combined review involving individual farmers, groups and officials helped to impose strictness in designing and implementing various watershed activities to draw maximum dividends. In this connection the government and concerned organizations like state department of agriculture, department of micro irrigation, DWMA and KVK should sensitize the farmers on need and importance of participation, techniques and types of participation.

5.12. Constraints faced and suggestions offered by the farmers on watersheds

5.12.1 Constraints faced and suggestions offered by the watershed farmers

5.12.2 Constraints faced by the watershed farmers

Constraints and suggestions of the sample farmers in watersheds are presented in Tables 5.40 and 5.41. The constraints expressed and suggestions were analyzed through the Garrett's ranking technique, where in their responses were initially converted into per cent positions and later converted to scores. Thus, for each factor the scores of the various respondents were added and the mean values were estimated. The constraints with the highest mean score value was considered as the most important one.

The Table 5.40 illustrated the constraints faced by the watershed farmers and these constraints were grouped under six categories namely watershed related, user groups, situational, technical, socio-economic and financial constraints. The constraints under each category were ranked based on the highest mean score value and was considered as the most important one.

It is pointed out from Table 5.40 that the major constraints faced by the watershed farmers under watershed related category were lack of regulatory arrangement on watershed activities (67.91%) and lack of maintenance of watershed activities (58.33%); the constraints like lack of team spirit among the watershed user groups (71.66%) and poor participation in group discussions (62.50%) were covered under user group category; marginal and marginal land holdings (80.83%) and political interference in watershed management (62.50%) under situational category; poor technical support to the farmers to take up watershed activities

(51.66%), poor technical knowledge of watershed farmers on watershed activities and skills followed in watersheds were obsolete and traditional (39.16%) under technical constraints; whereas lack of financial and legal powers to the watershed committee (52.91%) and higher costs involved in establishing the irrigation structures (42.91%) under socio-economic category; local bodies were not empowered to use the budget allotted for watershed activities (31.66%) and no transparency in allocation of budget for various watershed activities (31.66%) under financial constraints category.

Table 5.40.Constraints faced by the watershed farmers

S. No	Constraints	Garrattee mean score	Rank
I	**Watershed related constraints**		
1	Lack of regulatory arrangement on watershed activities	67.91	I
2	Lack of maintenance of watershed activities in IWMP	58.33	II
3	Lack of linking mechanism among the nearby watershed areas	27.91	VI
4	Too many activities under watershed	33.33	III
5	Watershed activities were taken up for community benefit than benefiting the individual members	29.16	V
6	Top down approach is followed in designing and implementing the watershed activities	31.25	IV
II	**User groups constraints**		
1	Lack of team spirit among the watershed user groups	71.66	I
2	Poor participation in group discussions	62.50	II
3	More conflicts and rivalry among the watershed user group members	56.25	III
4	Easy group disintegration	37.50	VI
5	Lack of focused group approach in watershed management	50.00	IV
6	Poor integration between watershed users and officials	25.00	IX
7	Lack of regular meetings by the watershed user groups	33.33	VII
8	No concrete output from the deliberations of meetings	29.16	VIII
9	Not following stipulated guidelines in programme formulation and implementation	17.91	XI
10	Lack of knowledge on record keeping to document the watershed activities	41.66	V
11	Poor knowledge on finance management by the members in groups	25.00	IX
12	Women participation in watershed activities is poor	41.66	V
13	Lack of trust on watershed committee	20.83	X
14	No cross sectional learning among the farmers about the usage of watershed activities	62.50	II
III	**Situational constraints**		
1	Marginal and marginal land holdings	80.83	I
2	Too many groups	48.33	IV
3	Lack of sensitivity among officials towards watershed management	29.16	VI
4	Political interference in watershed management	62.50	II
5	Lack of adequate support from PRI	54.16	III

6	Poor follow-up action by the officials	40.41	V
7	No innovative practices were introduced	40.41	V
IV	**Technical constraints**		
1	Poor technical support to the farmers to take up watershed activities	51.66	I
2	Poor technical knowledge of watershed farmers on IWMP activities	39.16	II
3	The skills followed on watersheds are obsolete and traditional	39.16	II
4	Lack of coordination among various concerned departments in taking up IWMP activities	15.83	III
V	**Socio-economic constraints**		
1	Lack of enough social organizations in the villages	18.75	V
2	Low income levels	37.50	III
3	Poor social and economic framework in the village	29.16	IV
4	More cost is involved in establishing the irrigation structures	42.91	II
5	Lack of financial and legal powers to the watershed committee	52.91	I
VI	**Financial constraints**		
1	No transparency in allocation of budget for various watershed activities	31.66	I
2	Local bodies are not empowered to use the budget allotted for watershed activities	28.75	II
3	Miss utilization of allotted funds	21.66	II

5.12.2 Suggestions offered by the watershed farmers

The Table 5.41 envisages the suggestions expressed by the watershed farmers on watershed activities. As seen in the table the suggestions were grouped into six categories namely watershed related user groups, situational, technical, socio-economic and financial suggestions. The suggestions under each category were ranked based on the highest mean score value was considered as the most important one.

The major suggestions expressed by the watershed farmers with regard to the watershed related category are a regulatory mechanism should be created comprising both officials and watershed user group members to act as an advisory body at various levels of implementation of watershed activities (66.66%) and database has to be created in terms of progress on implementation of various watershed activities for effective maintenance of watershed area (57.08%); in the case of user groups category the suggestions offered were efforts must be made to inculcate a spirit of team work among the farmers to attend various watershed activities (70.83%) and farmers should be told the importance of attending and participating in various group discussions and interface meetings to unearth the problems and to finalize the watershed activities to be taken up (61.25%); under situational category, the suggestions offered were - political interference should be minimized as much as possible to percolate the benefit through implementation of watershed activities to the needy people (62.50%), more extension activities like training programmes interface meetings, group discussions, exposure visits, network among the innovative farmers should be established to disseminate latest information on watershed activities to the farmers (62.50%) and the local bodies especially gram panchayats should support morally, ethically and financially to take up various watershed activities under watershed area (54.16%); with regard to technical category the suggestions given are more no. of institutions should be brought under the umbrella of watershed activities to provide much needed technical support to attend various watershed activities by the farmers (39.16%) and much emphasis should be given to improve the knowledge and skills of the farmers on importance/ relevancy /utility of various watershed activities under watershed area by conducting different kinds of knowledge and skill based training programmes (37.50%); under socio-economic category, the suggestions offered was the watershed committees working in different watersheds should be entrusted with financial and legal powers to take watershed activities (52.91%) and low cost water harvesting structures should be designed and advised to the farmers (42.91%); the suggestions offered under financial category are the members of the watershed user group should be taken into cognisance while distributing budget to various watershed activities (31.66%) and the local bodies should be financially empowered to take up some of the location specific and need based and customized watershed activities (30.83%).

5.12.2 Suggestions offered by the watershed farmers

5.41 Suggestions expressed by the watershed farmers

Sl.No	Suggestions	Garratte mean score	Rank
I			
1	A regulatory mechanism should be created comprising both officials and watershed user group members to act as an advisory body at various levels for implementation of NRM activities under watershed	66.66	I
2	A database has to be created in terms of progress on implementation of various NRM activities for effective maintenance of watershed area	57.08	II
3	Much attention should be made by the government in strengthening the NRM system by pooling up financial and non financial resources on community mode	41.66	III
4	All the activities under each watershed area should be consolidated into few categories in order not to diffuse the efforts on unnecessary activities	35.41	IV
II			
1	Efforts must be made to inculcate the spirit of team work among the farmers to attend various NRM activities	70.83	I
2	Frequently the farmers of nearby watershed area should be brought together to exchange the succesmful intervention of NRM activities in their own watershed area	60.41	III
3	Farmers should be told the importance of attending and participation in various group discussions and interface meetings to unearth the problems and to finalize the NRM activities to be taken up	61.25	II
4	The women folk should be sensitized to participate in various NRM activities	41.66	IV
III			
1	Farmers should be motivated to take up NRM activities on a community mode in a large area to derive more benefits from implementation of NRM activities	20.00	V
2	The officials should take up more follow up actions after completion of the implementation of NRM activities	40.41	IV
3	The local bodies especially GPs should support morally, ethically and financially to take up various NRM activities under watershed area.	54.16	II
4	The political interference should be minimized as much as possible to percolate the benefits through implement of NRM activities to the needy people	62.50	I
5	The groups with overlapping interests should be merged to bring down the no. of groups to work effectively for the cause of NRM	48.33	III
6	More extension activities like training programme interface meetings/ group discussions/exposure visits, networking of innovate farmers should be organized to disseminate latest information on NRM activities to the farmers	62.50	I

IV			
1	Much emphasis should be given to improve the knowledge and skills of the farmers on importance/ relevancy /utilization of various NRM activities under watershed area by conducting different kinds of knowledge and skill based training programmes.	37.50	II
2	More no. of institutions should be brought under the umbrella of NRM to provide much needed technical support to attend various NRM activities by the farmers	39.16	I
3	A mechanism has to be evolved to work concerned departments collectively and cooperatively and with more co-ordination to guide the farmers effectively on NRM activities to be taken up in watershed area	15.83	III
V			
1	Organizations like youth clubs, SHGs, UGs, FIGs and different other associations work towards NRM consisting of organizational set up of their own in rural areas	18.75	III
2	Low cost water harvesting structures should be designed and advised to the farmer	42.91	II
3	The WCs working in different watersheds should be entrusted with financial and legal powers to take up NRM activities	52.91	I
VI			
1	The members of the watershed user groups should be taken into cognisance while distributing budget to various NRM activities	31.66	I
2	The local bodies should be financially empowered to take up some of the location specific, need based and customized NRM activities	30.83	II

5.12.3. Constraints and suggestions faced by the watershed officials in IWMP

5.12.4. Constraints faced by the watershed officials in IWMP

The Table 5.42 illustrated the constraints faced by the watershed officials on IWMP and these constraints were grouped under six categories namely watershed related, organizational, technical, financial, job related and capacity building constraints. The constraints under each category were ranked based the highest mean score value was considered as the most important one.

Table 5.42. Constraints faced by the watershed officials on IWMP

Sl.No	Constraints	Garattee	Rank

		mean score	
I	**Watershed related constraints**		
1	Poor cooperation from local bodies	60.00	I
2	Poor cooperation for the officials from water user associations	26.66	V
3	Lack of participation of farmers in deciding the location and design of proposed soil and water conservation structures	23.33	VI
4	Lack of participation in deciding the contribution of resources like land, labour and money	50.00	II
5	Lack of enthusiasm among the watershed user groups to share the responsibility in IWMP activities	43.33	III
6	No sharing mechanism between officials and farmers with regard to the benefits received through IWMP activities under watershed areas	33.33	IV
7	Low attendance of farmers during the meetings organised to review the progress of work	26.66	V
8	Occurrence of climatic adversaries to implement the IWMP activities	20.00	VII
II	**Organizational constraints**		
1	More etiquette and redtapism	23.33	IX
2	Lack of guidelines in project formulation and implementation	16.66	X
3	Excessive political interference in implementation of IWMP activities under watershed area	66.66	II
4	Insufficient man power for carrying out the IWMP activities	80.00	I
5	Lack of coordination between the officials of various departments	36.66	V
6	Poor cooperation and timely support from higher authorities	33.33	VI
7	Unable to take up works in time due to delayed administrative approval	43.33	IV
8	Incapability of the watershed committee members to perform their duties	30.00	VII
9	Lack of sufficient engineer staff	26.64	VIII
10	Lack of infrastructure to organize meetings and training programmes	66.66	II
11	Poor knowledge on giving publicity about the assets generated through IWMP activities under watershed area	56.66	III
12	No legality of fixing the responsibility among the user groups to implement the IWMP activities under watershed	30.00	VII
III	**Technical constraints**		
1	More emphasis is given for establishing water harvest structures rather than taking up other watershed activities under watershed area	56.61	I
2	More time is consumed to implement the IWMP activities through participatory mode	23.33	V
3	Poor skills on designing, constructing and operating the irrigation structures in watershed area	43.33	III
4	Often approval of design is delayed for constructing various irrigation structures in watershed area.	50.00	II
5	Lack of skills to motivate the farmers to take up various IWMP	33.33	IV

	activities in watershed area		
6	Poor technical competency to initiate innovative IWMP activities under watershed area	43.33	III
IV	**Financial constraints**		
1	No incentives for extra efforts of the officers	33.33	III
2	Untimely release of funds to take up IWMP activities	60.00	I
3	No knowledge on financial management	33.33	III
4	No financial power to the project officers to take up IWMP activities	50.00	II
5	Less transparency in showing the details of allotted budget to the watershed user group members about the IWMP activities to be taken up under watershed area	10.00	IV
V	**Job related constraints**		
1	Less scope to upgrade the technical knowledge on implementing IWMP activities	66.66	II
2	Heavy work load in terms of project designing and implementation	76.66	I
3	Poor efficiency of officials due to mismanagement by the top administration	23.33	VI
4	Poor communication mechanism among the officials	50.00	IV
5	Poor skills on programme development and assessment	60.00	III
6	More time is consumed on monitoring and evaluating the IWMP activities	33.33	V
7	More vested interests among the watershed user group members	60.00	III
VI	**Constraints on Capacity building**		
1	Poor knowledge on various tools and techniques to disseminate the information on IWMP activities	73.33	I
2	Poor skills on planning and preparation of agriculture information materials	50.00	III
3	Poor skills on conducting field trials, demonstrations, focused group discussions etc for the farmers	26.66	IV
4	Lack of skills on assessing the needs of the farmers to organize various training programmes	63.33	II
5	No knowledge on procedure of taking up follow-up action on IWMP activities conducted under watershed area	63.33	II

It is pointed out from Table 5.42 that the major constraints faced by the watershed officials were poor cooperation from local bodies (60.00%) and lack of participation in deciding the contribution of resources like land, labour and money (50.00%) under watershed related category; insufficient man power for carrying out the IWMP activities (80.00%) and excessive political interference in implementation of IWMP activities under watershed area (66.66%) under organizational category; more emphasis is given for establishing water harvest structures rather than taking up other IWMP activities under watershed area (56.61%) and often approval of design is delayed for constructing various irrigation structures in watershed area

(50.00%) under technical category; untimely release of funds to take up IWMP activities (60.00%) and no financial power to the project officers to take up watershed activities (50.00%) under financial category; heavy work load in terms of project designing and implementation (76.66%) and less scope to upgrade the technical knowledge on implementing IWMP activities (66.66%) under job related category; poor knowledge on various tools and techniques to disseminate the information on IWMP activities (73.33%) and lack of skills on assessing the need of the farmers to organize various training programmes (63.33%) and no knowledge on procedure of conducting follow-up action on IWMP activities under watershed area (63.33%) under capacity building constraints category.

5.12.4. Suggestions offered by the watershed officials on IWMP

Table 5.43.envisaged the suggestions expressed by the watershed officials on IWMP. As seen in Table 5.43, the suggestions were grouped into six categories namely watershed related, organizational, technical, financial, job related and capacity building constraints. The suggestions under each category were ranked based on the highest mean score value was considered as the most important one.

The major suggestions offered by the watershed officials with regard to watershed related category were more cooperation from the grass root level PRIs like grampanchayats morally and ethically, contributing both financial and non financial resources (60.00%) and as IWMP is considered as a group activity the presence of more no. of farmers in appraising the progress of work will generate more desired results (43.33%); under organizational category the suggestions offered were all the vacant posts should be filled up to create a large pool of manpower for carrying out the IWMP activities (80.00%) and the political interference should be minimized to take up IWMP activities with more transparency and impartiality (66.66%); in case of technical category the suggestions given were equal importance should be given to all the activities under IWMP deviating the customary of giving more weightage to water harvesting structures (56.66%) and more refresher training programmes should be organized on new initiates of watershed activities to improve technical competency of the officials (43.33%); the major financial suggestions are the financial power should be decentralized to delegate financial powers partly to the project officers to have leverage in implementing innovative IWMP initiatives (66.66%) and the allotted funds should be released in time to facilitate to implement the IWMP activities as per the schedule and to derive the maximum benefit (60.00%); the job related suggestions are optimum workload should be given to all the officials by filling the vacant posts and also distributing the work rationally to all the officials (76.66%) and specialized training programmes should be organized to inculcate the skills on programme development and assessment among the officials concerned in implementation of IWMP activities (66.66%); with regard to the extension category the suggestions expressed are the officials should be enlightened on the importance and usage of various tools and techniques followed to disseminate the latest information on IWMP activities (73.33%) and the officials concerned with the implementation of IWMP activities should be trained on acquiring the skills on planning, preparation and usage of agriculture information material like leaflets, pamphlets, folders, wall posters etc. (50.00%).

Table 5.43. Suggestions offered by the watershed officials on IWMP

S. NO	Suggestions	Garratee mean score	Rank
I	**Watershed related suggestions**		
1	More cooperation is sought from the grass root level PRIs like grampanchayats morally and ethically and contributing both financial and non financial resources	60.00	I
2	Much participation is invited from the farmers in deciding the contribution of both financial and non financial resources like land, labour, money and also deciding the design and place of taking up IWMP activities	23.33	IV
3	As IWMP is considered as a group activity the presence of more no. of farmers in appraising the progress of work will generate more desired results	43.33	II
4	A mechanism has to be evolved the accrued benefits through the implementation of IWMP activities	33.33	III
II	**Organizational suggestions**		
1	All the vacant posts should be filled up to create a large pool of manpower for carrying out the IWMP activities	80.00	I
2	The political interference should be minimized to take up IWMP activities with more transparency and impartiality	66.66	II
3	The officials should be trained to get the knowledge on giving wide publicity in different forms on assets generated through IWMP activities	56.66	III
4	The electronic gadgets like marginal phones, computers with broadband connectivity, toll free number etc. should be provided to the officials to strengthen the facility for disseminating information	50.00	IV
5	Immediate administration approval should be given to hasten up the implementation of IWMP activities	43.33	V
6	More no. of engineering staff should be provided in irrigation department to take up various water harvesting structures under watershed	26.66	VI
III	**Technical suggestions**		
1	Equal importance should be given to all the activities under IWMP deviating the customary of giving more weightage to water harvesting structures	56.66	I
2	More refresher training programmes should be organized on new initiates of IWMP activities to improve technical competency of the officials	43.33	II
3	Training programmes should be conducted on skills of motivating and enabling the farmers to participate at various	33.33	III

	phases of implementation of IWMP activities		
IV	**Financial suggestions**		
1	The allotted funds should be released in time to facilitate to implement the IWMP activities as per the schedule and to derive the maximum benefit	60.00	II
2	Rewards in terms of appreciation, certificates, monitory benefits etc., should be given to the officials who made extra effort to implement the IWMP activities	33.33	III
3	The financial management procedure in terms of record keeping, cash book maintenance and auditing should be taught to the officials not to commit any financial irregulatory in spending the budget	26.66	IV
4	The financial power should be decentralized to delegate financial powers partly to the project officers to have leverage in implementing innovative IWMP initiatives	66.66	I
V	**Job related suggestions**		
1	Optimum workload should be given to all the officials by filling the vacant posts and also distributing the work rationally to all the officials	76.66	I
2	Specialized training programmes should be organized to inculcate the skills on programme development and assessment among the officials concerned in implementation of IWMP activities	66.66	II
3	The members of watershed user groups should be sensitized to think in a broader perspective to take up IWMP activities on a community mode rather than in isolation	23.33	IV
4	An open and transparent communication should be evolved to disseminate and exchange the information among the officials with a much more speed and accuracy	50.00	III
VI	**Suggestions on Capacity building**		
1	The officials should be trained on a specialized topic on training management involving the aspects of need assessment, conducting the training, curriculum development and follow up action etc	26.66	III
2	The officials concerned with the implementation of IWMP activities should be trained on acquiring the skills on planning and preparation of usage of agriculture information materials.	50.00	II
3	The officials should be enlightened on the importance and usage of various tools and techniques followed to disseminate the latest information on IWMP activities	73.33	I

5.13. Strategy for an effective IWMP in watersheds

A strategy has been designed with the following interventions for effective implementation of IWMP activities under watershed

Interventions by the IWMP

1. The IWMP should evolve mechanization to share the benefits accrued through implementation of watershed activities between officials and farmers.
2. Watershed user groups should feel responsible to make their members to attend various meetings to assess the progress of work on IWMP activities under watershed area
3. Officials of IWMP should organize more specialized training programmes to improve the knowledge level of the farmers on various watershed activities.

Interventions by the DWMA

1. More transparency has to be maintained in allocation of sanctioned budget to various IWMP activities under watershed areas.
2. The staff of DWMA, IWMP and other concerned departments should be trained on various tools and techniques used in dissemination of information on watershed activities to the farmers.
3. The officials should deviate from the track of conducting customary meetings rather organize the meetings and panel discussions among the farmers to design programmatic IWMP policy.

Interventions by the Government

1. The government should think seriously to fill all the vacancy posts in IWMP, DWMA and department of minor irrigation to have round the clock vigilance on watershed activities.
2. The government should delegate financial powers to the project officers for effective implementation of IWMP activities at grass root level
3. The government should not encourage much political interference in implementing various IWMP activities in watershed areas.

Interventions by the SDA

1. Frequent interactions should be arranged by the SDA and WCC in between the farmers of contiguous watersheds to improve the efficiency in attending the IWMP activities.
2. The officials of SDA and DWMA should mediate to make the farmers to perceive and understand the value and importance of the concepts like community participation and group dynamics.

3. Trainings should be organized for the officials on planning and preparation of various agricultural information material
4. More no. of extension activities like focused group discussions, PRA, interaction meetings would be organized to assess the needs to take up IWMP activities under watershed areas.
5. All the concerned departments, especially department of minor irrigation, SDA, NGOs and KVK should work in tandem for effective implementation of IWMP activities under watershed areas.

Interventions under Individual level

1. Farmers should actively participate in contributing resources like land, labour, money, animals etc., for the benefit of community
2. Farmers should attend meetings conducted by the WCC regularly to review the progress of implementation of IWMP activities under watershed.
3. Farmers should realise the importance of participation especially during supervising the ongoing IWMP activities at individual farm level and in community lands
4. Participation of farmers is of immense use in deciding the location and design of proposed soil and water conservation structures/measures like bunds, waterways, farm ponds, nala bunds, check dams, gully checks etc.,

Interventions at Local bodies

1. The local bodies especially GP should ensure maximum participation of farmers in attending various IWMP activities.
2. The Village panchayat should take an initiative to merge the groups with overlapping interests.

CHAPTER VI

SUMMARY 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 marginal 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 can not 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 km3 + 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.

6.1 Specific objectives of the study are:-

1. To study the socio-economic impact of watersheds on the sample farmers in selected watersheds.

2. To evaluate the benefits and costs of different watershed programmes implemented by government.

3. To examine the role of farmers' participation in watershed development programmes, and

4. To suggest a suitable strategy for effective and sustainable development of watershed programmes suitable for drought prone areas.

6.2 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 Development Programme, the change in producers' surplus exceeded the change in consumers' surplus.

For the study, watershed and non watershed blocks in Medak district in which groundwater was over exploited were selected. From the watershed block, based on stratified sampling technique, farm households who satisfied the following criteria were selected; the chosen farm households must be adopting watershed intervention technology since 2009-10. As this is an impact study, An Economic Impact of integrated watershed development programme in Medak district of Telangana state was assessed by making a before and after implementation of watershed activities for the study; i.e.; before the adoption of watershed intervention technology in 2012-13 and after the adoption of watershed intervention technology in 2013-14. In watershed block 50 marginal farmers, 50 small farmers and 50 large farmers were randomly selected. In non-watershed block 50 marginal farmers, 50 small farmers and 50 large farmers were also randomly selected. The total sample size was 300. Data collection was carried out by administering a pretested interview schedule. 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 entrophy index, hedonic pricing analysis, benefit cost ratio, scaling technique and economic surplus model.

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

6.3 Land use pattern

The average size of holding was 1.9, 2.32 and 5.31 hectares among marginal, small and large watershed farms respectively as against 0.59, 1.34 and 3.16 hectares for respective farms in non-watershed farms. It is observed that the percentage of dry land was 50.78 followed by well irrigated land 44.16 in the total cultivated land in watershed block.

After implementation of watershed Development Programme in watershed block the cultivation area increased under dry land cultivation.

6.4 Soil and water conservation

- About 50 per cent of the gross cropped area in the watershed block is treated with summer ploughing. The other two measures such as contour bunding and land leveling are carried out in less than 25 per cent and less than 10 per cent of the gross cropped area in the study block. The total investment made on soil and moisture conservation measures worked out to be Rs. 4,658 in watershed block.
- The analysis reveals that, across the farmers, the investment incurred was high among the small farmers

6.5 Watershed technology

- Different types of watershed conservation measures are carried out in the study area.
- The major portion of the farmers benefited from the farm pond and percolation pond.
- Renovation of tank was carried out by 5.66 per cent of the pooled farmers;
- The analysis reveals that farm ponds and percolation ponds were the two major watershed intervention technologies among all the farmers in the watershed block, while farm ponds were the major watershed intervention technology for most of the farmers. Percolation ponds are also used by the small and large farmers.

6.6 Water level in the Wells

The water level in the wells and bore wells was high during the north east monsoon period in both the blocks. The average well water level in the non-watershed block was 36.06 feet, much lesser than the average water level in the watershed block (49.97 feet). During the summer period in both the blocks, there was no recharge in the water level in both the wells and the bore wells. More recharge of water levels in wells and bore wells was found in watershed block compared to non watershed block.

6.7 Impact on land use pattern

In watershed block forest land ws less than the non watershed block. The highest percentage of cultivable land of small farmers was 71.35, forest lands under large farmers 37.02 and uncultivable land under marginal farmers was 20.45 under watershed block. In the non watershed block the highest percentage of cultivable land of large farmers was 37.26 per cent, forest lands under marginal farmers was 40.09 per cent and uncultivable land under marginal farmers was 53.67 per cent respectively.

The findings revealed the positive impact of watershed Development Programme in the area under cultivable lands in watershed block.

6.8 Impact on water level in the wells

In the watershed block before the watershed intervention technology in 2012-13 the water level in wells and bore wells was 31.85 feet and 101.19 feet respectively. This rose to 46.68 and 125.40 feet respectively in 2013-14. The water level in the wells and bore wells were comparatively high in the watershed block across all farmers compared to the non watershed block. After the watershed development programme a rise in the water level in the wells and bore wells were seen in the watershed block. Compared to the non watershed block, it was observed that the rise in the water level was comparatively high in the watershed block across all the farmers.

6.9 Impact on irrigation

. In watershed block, the average net area sown and gross irrigated area during 2012-13 in the watershed block was 6.48 and 7.43 hectares respectively which increased to 8.51 and 10.19 hectares respectively in 2013-14. The percentage increase in the net area sown and gross irrigated area were around 28.26 and 30.54 respectively. As the data revealed, the percentage increase in the net area sown and gross irrigated area were high among the small farmers and the lowest among the marginal farmers in the watershed block.

6.10 Impact on cropping intensity

In watershed block, the net cropped area of the farms ranged from 11.84 hectares on marginal farms to 44.10 hectares on large farms with an average net cropped area of 27.84 hectares as a whole. It was 27.57 hectares on small farms. Cropping intensity was a good yard stick for land use planning. Through this measure, the production on the farm can also be assessed easily.

In non-watershed block, the net cropped area of the farms ranged from 11.64 hectares on marginal farms to 43.10 hectares on large farms with an average net cropped area of 26.18 hectare. It was 23.79 hectares on small farms. The cropping intensity was the highest on small farms (125.72%) and the lowest on marginal farms (118.21%). The same was noticed for large and pooled farms were 124.26 per cent and 123.79 per cent respectively.

The cropping intensity was highest on small farms (139.02%) and the lowest on marginal farms (130.15%). The same for large and pooled farm was 134.53 per cent and 134.19 per cent respectively. By and large, it was more than 100 implying that all the available area was made use of.

6.11 Impact on cropping pattern

In watershed, it can be observed that the area allocated for important crops such as cotton, maize, paddy and onion constituted 32.71 percent, 19.07 percent, 27.29 percent and 20.93 percent total cropped area on the marginal farms. The farmers who have increased the area under paddy had to spend more for cultivation but at the same time they were rewarded with greater returns. In the case of small farms, the area allocated for cotton, maize, paddy and onion constituted 32.74 percent, 12.94 percent, 32.66 percent and 21.66 percent of total cropped area respectively.

The analysis thus reveals that after the introduction of watershed development programme in selected blocks, the cultivation of paddy, maize, cotton and onion crops has increased compared to non-watershed block.

6.12 Cobb Douglas production function.

- The estimated Cobb-Douglas production function for the watershed block reveals that, after the implementation of the watershed development programme the returns to scale have increased for all the farmer groups. This rose from 0.874 to 0.901 for the marginal farmers, from 0.158 to 0.329 for the small farmers and from 0.752 to 0.80 for the large farmers.
- The significant 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 machinery

among the small and large farmers in 2012-13 revealed the fuller utilization of the resources.

- After the implementation of watershed intervention technology, the agricultural production in watershed block across the farmer groups had shown an increasing growth.

6.13 Impact on crop productivity

In the watershed block, the average yield had exceeded the potential yield for paddy for the three farmer groups, after watershed development programme in 2009-10. Similarly crop productivity index for paddy, maize, cotton and onion exceeded 'one' among marginal, small and large farmers in 2013-14. Overall crop productivity index for paddy crop (1.30) was more than other crops viz., are maize, cotton and onion.

In non-watershed block also the crop productivity index for paddy and cotton crops had exceeded 'one' among marginal, small and large farmers in 20013-14. But in the case of maize and onion crops, it showed a low level of crop productivity index for marginal, small and large farmers with crop productivity index taking values of 0.92, 0.81 and 0.81 for maize crop respectively, and for the onion crop the same were 0.96, 0.99 and 0.82 respectively.

- It shows that the overall crop productivity index had increased in all crops in watershed area compared to non-watershed areas.

6.14 Impact on crop diversification (Spatio-temporal analysis)

- In the watershed block after the implementation of the watershed development programme the crop diversification index has increased for paddy, maize, cotton and onion crops for all the farmers' groups compared to non-watershed blocks. The crop diversification index for paddy was 0.983, 0.981 and 0.915 for marginal, small and large farmers respectively in watershed blocks, whereas the overall crop diversification index for maize, cotton and onion were 0.983, 0.994 and 0.987 respectively in watershed blocks. In the watershed block, about 73 to 83 per cent of the agriculture land had been diversified for the four crops under study.
- In the non-watershed block Modified Entrophy Indices were 0.058 for large farmers, 0.047 for small farmers and 0.106 for marginal farmers.

6.15 Benefit-Cost Ratio

The Benefit Cost Ratio (BCR) ranged from 1.50 for the marginal farmers to 3.50 for the small farmers and 3.85 for the large farmers in the watershed block. The BCR for marginal farmers was 2.08, for small farmers 2.68 and for large farmers 3.87. The financial results on feasibility analysis revealed that the benefit cost ratio exceeded 'unity' for all farmer groups.

6.17 Economic Surplus Model

- The producers' surplus was high for onion which worked out to be 75.56 per cent. The estimated producers' surplus exceeded more than 50 per cent for paddy, maize and cotton crops.
- The analysis revealed that, the producers' surplus exceeded the consumer surplus for all crops. The farmers as producers benefited from watershed development programme in watershed block.

6.18 Impact on people participation

Moreover peoples' participation should be encouraged because they are aware of their own needs better. At the same time, it has been seen that non-involvement of people in the development programmes was also of great concern and poses challenges to rural development. No programme can be a success without the involvement of the people. Since the project emphasizes the participatory management, involvement of beneficiaries right from planning stage helps in smooth and effective implementation of IWMP programme.

Among all the watershed practices, highest participation was seen in adopting contour bunds, farm ponds, check dams *etc* followed by adopting crop production and other improved recommended practices under watershed. The visibility and utility of these practices can be assessed easily whereas lowest participation was seen in contributing resources like land, labour, money, animals *etc* and attending the meetings to review the progress of work.

6.19 Strategy for an Effective IWMP in Watersheds

Taking into cognizance the findings generated on selected objectives of the study, a suitable economic and extension strategy was formulated by suggesting possible interventions for the IWMP, DWMA, Government, SDA, SAU, individual farmers and local bodies in the state of Telangana.

Conclusion

The watershed Development Programme 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 Development Programme, helped them from facing various risks associated with crop farming. The study established that with watershed intervention technology the farmers as ‘producers’ realised ‘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.

The level of farmer’s participation both at planning and implementation stages of the watershed project was satisfactory. However, some more technical information, training and guidance have to be provided to the farmers by project authorities in adoption of improved practices and maintenance of assets created even after withdrawal of project from the area.

Policy Implications

On the basis of the findings cited above, the following policy implications have emerged.

1. Watershed programme should aim at higher adoption of new technology, increase in labour employment opportunity and minimization of disparity in income distribution. So the government with the limited resources available with it should divert its priority investment towards integrated development of dry land agriculture on watershed basis to sustain and increase agricultural production on these lands.

2. Conservation works, animal husbandry and livestock enterprises should be totally integrated to reap the fuller benefits in a sustained manner.

3. The watershed management technology is observed to be quite expensive and hence it is difficult to replicate the same in other watersheds. Hence, alternatively, low-cost or cost-effective technology will have to be evolved by the interaction of scientists, engineers, extension personnel and farmers.

4. Because of high risk involved in dry land farming, it is necessary to develop a combination of farm plans for each holding size based on varying levels of expected net farm income and risk involved. It will provide a good range of choice for the farmers to choose from on the basis of their resource structure, financial position and risk bearing capacity.

5. The extension agencies involved in the area have to play an active role in providing input supplies i.e., better quality seeds of crops like pulses and oilseeds which are grown predominantly in rainfed areas and also expansion of facilities for soil testing etc., to watershed farmers.

6. Farmers may be encouraged to adopt the watershed technologies on their own and governmental intervention should be limited to the provision of technical guidance and credit. In order to convert the uneconomic farm activity to a viable proposition, not only credit facilities should be extended to farmers but also the adoption of improved technology must be encouraged to generate additional income and employment. Emphasis should be laid on the creation of permanent assets by taking up activities such as land and water resource development through agro-forestry, dry land horticulture programmers and farm ponds, percolation tanks, check dams, etc., both at the individual and community levels, which enhances the productivity as well as the quality of environment.

7. People's participation is essential for successful implementation of watershed management programmes. Involving people in rural development programmes has been and continues to be the most difficult challenge for rural development professionals. Organising the farmers into some form of informal or formal association around some economic activities seems to be one of the approaches for enlisting their participation in rural development projects and also for better utilization of funds for which they were meant.

8. Unless the allocation and release of the funds for various watershed development activities by the government are adequate and timely, the successful implementation of the project would be hindered. So there is a need for greater coordination between the Ministries of Agriculture, Rural Development, Rural Employment and Water Resources in the implementation of watershed projects in rain fed areas.

Watershed management is a continuous process. Monitoring and frequent evaluation of the development efforts of watersheds help to identify the weaknesses and strengths in the programme and thus it helps to plug the loopholes in the implementation of watershed programmes and to make agriculture a profitable proposition without causing damage to the environment, especially, land and water.

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 integrated watershed Development programme.

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