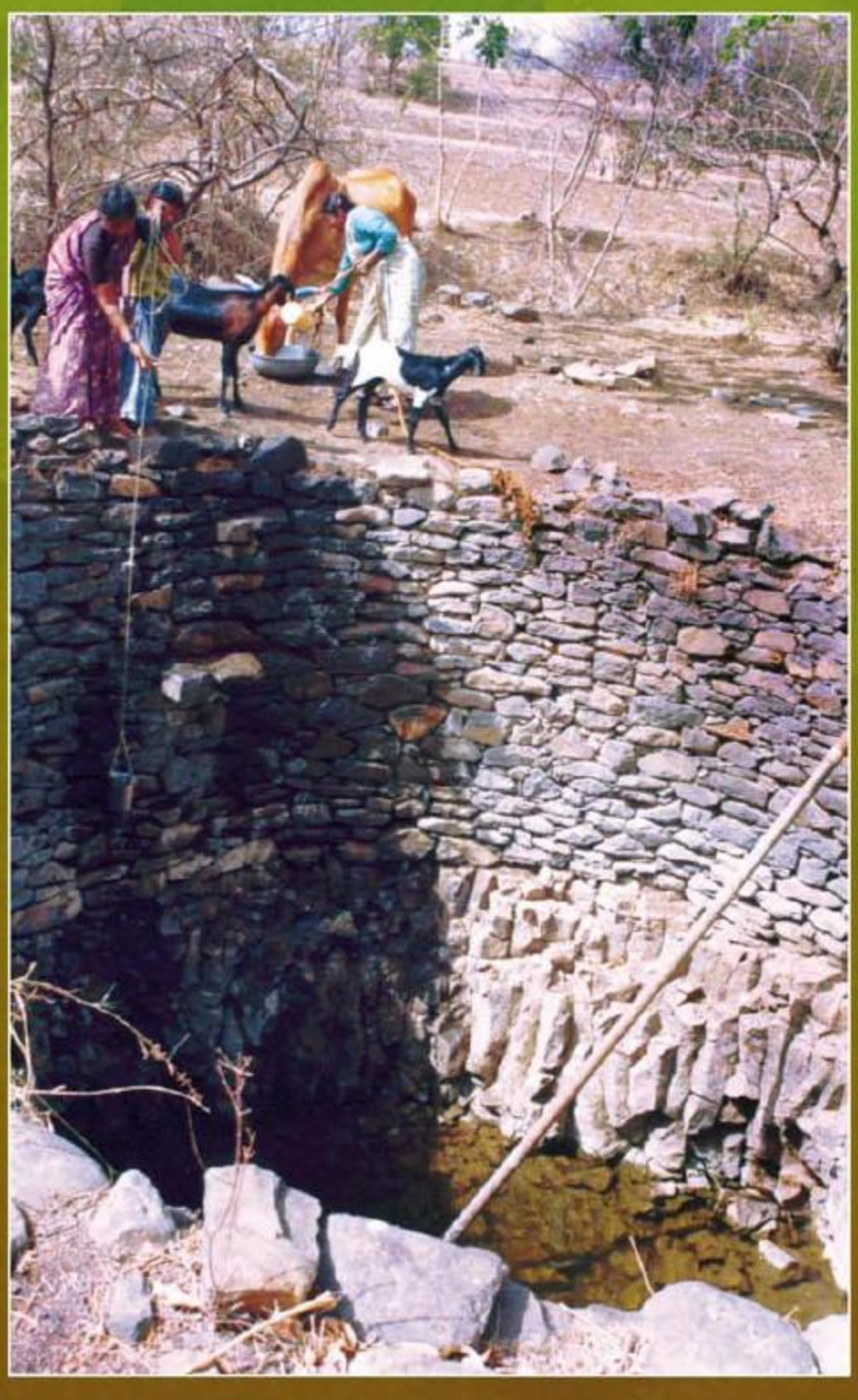
WATERSHED DEVELOPMENT PROGRAMME

UNDERSTANDING INVESTMENTS AND IMPACTS



Report of study of Impacts in Five Watershed Projects of Andhra Pradesh

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A. Ravindra

WASSAN

Mission Support Unit
AP Water Conservation Mission

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Several colleagues within WASSAN participated and contributed to the study. The Young Professional team consisting of Mythili Nerek, Prashanti, Janaki Rama Rao and Narasimha Rao have contributed largely to the field survey and analysis.

Hyderabad
October, 2004

Bakka Reddy C.
Ravindra A.

Watershed Learning Ground....

Watershed to many might seem to be a technical issue concerning subject matter specialists. However, now it is proven that it concerns people and their livelihoods and their involvement at all levels results in better implementation of the watershed development programme. Further, the community that is living in adverse conditions since ages has far better knowledge of the local situation and is aware of technical solutions that suit them and their resource context.

Issue of guidelines for participatory watershed development in 1994 has brought in a sea change in implementation of the government programmes. The current study, which focuses on the impacts – there are other studies on the processes – brings out certain interesting points. The watershed treatment works have brought fallow land into cultivation and resulted in increased ground water levels. The impacts were visible and returns both substantial and fast.

The study shows that availability of water at multiple locations for several uses has been succour to otherwise water starved villages. In the Benefit Cost ratios calculated it is evident that the investments are paid back to the community within 1 – 3 years.

The study raises important questions about who benefits by the increased ground water and the need for social norms for using the newly generated resources. While the public investments spurred private investments, in the absence of institutional credit, rich are the major gainers. The study strongly argues from the point of equity for planning for complete investments and group norms to access recharged ground water. Watershed programme has to integrate these concerns so as to achieve equity based sustained livelihoods for the rural people.

Hyderabad

S. Ray
Chairman
A. P. Water Vision Task Force

Part I

Analysis of watershed investments and impacts

Watershed Development Programme

Understanding Investments and Impacts

Participatory Watershed Development Program initiated in 1995 is a major landmark in the history of rainfed regions in India. Making a departure from the earlier programs it has brought about the following changes:

- Shift from dispersed to comprehensive investments
- Building community based institutions and their institutional capacities (user groups, self-help groups, watershed association and watershed committee)
- Transfer of development funds to the community institutions
- Participatory planning and implementation by the community based institutions.

In essence the watershed program envisaged a 'community centered process approach' as the core. The program was launched in 1995 and there is significant experience in operationalising the program; particularly in Andhra Pradesh where it was taken up in a large scale.

There are several studies on the operational issues in the program. However, very few studies are available on impacts of the program. Rigorous and intensive research efforts in understanding the impacts of watershed program are limited. The participatory process approach and centrality of community institutions call for a different methodology to understand the impacts. It is in this context that the need for a study of watershed impacts was felt by the Mission Support Unit of the Water Conservation Mission and WASSAN.

The study was carried out from May to August 2003 and the data refers to the year 2002 To 2003.

Watershed approach has been adopted for the area development programmes of the Government with the issue of Guidelines in 1994. These envisaged paradigm shifts such as top-down to bottom-up, sectoral to integrated and short term to long term. New peoples' institutions such as Self Help Groups, User Groups, Watershed Association and Committee were proposed so that watershed becomes a peoples' movement with long term perspective of natural resource management and sustainability. Accordingly budgets were provided under the Community organisation and capacity building heads. Objective of the programme was to build capable peoples' institutions which would take over the assets created in the programme and maintain them. The goal was to mitigate the effects of drought in the long run with reduced adverse conditions of drinking water (both for the community and livestock), adequate livelihood means, reduced migration and fulfillment of biomass based needs such as fodder, fuelwood, etc. Economic development, ecological balance and equity were key concerns of the programme. Approximately, 500 ha, was considered as one unit of watershed with overall budget provision of Rs. 4000/ ha (which was increased to Rs. 6000/ha in 2001).

In Andhra Pradesh the programme was facilitated by Commissioner, Rural Development at the State level and the Project Director, DWMA (earlier DPAP/DDP/DRDA) at the district level. These were assisted by Multi Disciplinary teams for every 50-60 watersheds. One Project Implementation Agency (PIA) was appointed for every 10-12 watersheds which appoints a four member Watershed Development Team. At the village level the planning for resource development was pegged in the primary groups, whereas the integrated plan is approved by the Watershed Association after resolving conflicts, if any, and prioritising the works. The day to day activities are taken care by the executive body termed Watershed Committee, assisted by a full time Secretary and volunteers.

1. Scope of the Study

The study attempts to capture and map the impacts and generate quantitative data for analysis of the watershed program. The study does not intend to be a statistically rigorous exercise based on sample, and hence has limitations to that extent. The analysis is intended to identify, assess, and flag several issues related to impacts of the program on a quantitative basis.

The study first looked at the profile of investments in the watersheds and based on this the major areas of investment were identified for assessing impacts. Instead of a predetermined questionnaire, participatory mapping and analysis of the impacts was done by involving the key stakeholder groups. Later, based on the observed impacts, quantitative surveys were carried out. Farmers, self-help groups, Watershed Committee and Panchayat members were involved in the process.

The study broadly looked at the impacts of investments on ***land development, plantations, water harvesting, livestock and institutions***. An attempt was made to compute cost-benefit analysis for each of these interventions. The analysis is limited to production systems and their economics and did not consider the long-term investment benefits of ecological services or livelihood benefits.

An overall cost-benefit analysis for the watershed is a more complicated exercise, which involves a detailed analysis of social capital and its impact and is not within the scope of the study. However the present study provides a basis for taking up such a comprehensive research.

2. Methodology

2.1 Sample villages

The study was taken up in the districts of Mahabubnagar, Ranga Reddy, Medak and Kurnool. The district administration suggested names of watersheds in three categories – good, moderate and poor in terms of performance, as subjectively perceived by them. Though the initial intention was to take two watersheds in each category, only five watersheds were taken up. In terms of the facilitation processes the villages Edulapally, Chityal fall under the 'Good' category, Kunkanur and Mailaram fall under the 'Moderate' category, Dadapur falls under the 'Poor' category. However, these categories are highly subjective. On the whole the watersheds studied were under 'Good' to 'Moderate' categories in the opinion of the researchers.

All these watersheds are funded under the Drought Prone Areas Program of the Ministry of Rural Development.

2.2 Study Process

Understanding and assessing impacts generated by a process centered program like watershed is a complex one. One of the contributions of the present study is its methodology. The study used a combination of an intensive process oriented participatory analysis and objective data generation based on field surveys.

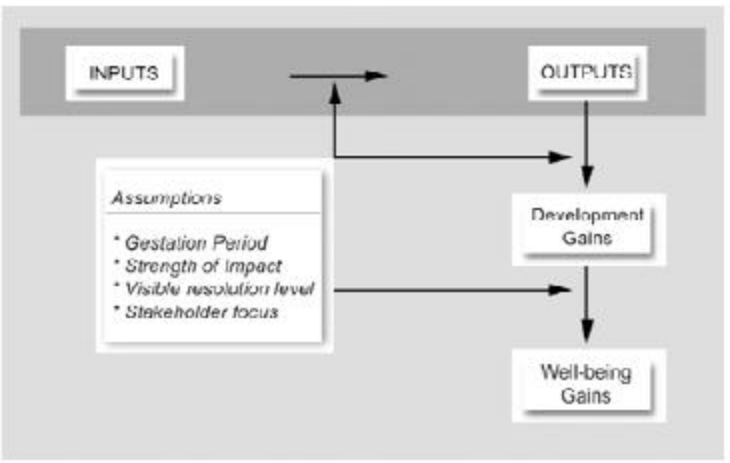
The process steps in the impact assessment study are as follows:

A. Analysis of Institutions

Collection of secondary data was first done from the implementing agency and the watershed committee. This was followed by preliminary discussion with Panchayat and watershed committee & mapping impact paths through participatory exercises. The watershed investments/ interventions were taken as a basis for further exploration. For such identified interventions the possible and observed impacts were mapped in a sequence. The exercise of impacts on SHGs was taken up along with the members of the SHGs / their representatives and Watershed committee. The steps included:

a. Identifying total, functioning and non-functioning groups
b. Draw out sample groups in these categories
c. Focussed Group Discussion with selected sample groups on the impacts
d. Compilation of data

Assessing impact paths



Project inputs lead to outputs, outputs to outcomes and outcomes to impacts. In the context of development interventions, this path from inputs to impacts can be better conceived by distinguishing outputs from development gains and well-being gains. Development here, is seen as an intermediary stage which, when certain assumptions are fulfilled, results in the well-being of humans or ecosystems. For instance, increase in income for the poor is a development gain, which when properly spent will result in better health of the family - a well-being gain. However, this distinction is only for analytical purposes and the dividing line is hazy and not sancrosanct. This seeks impacts in the context of actual development of the project area instead of what is designed in the project and makes the framework more flexible.

Source: Ravindra A (2000), A Framework for Impact Assessment of Community Based Natural Resources Management Programs, Aga Khan Foundation (India), New Delhi & Books For Change, Bangalore.

B. Resource mapping

This exercise was done in a large group to understand the variations in the land and soil types, the drainage pattern, the area of influence etc. This exercise helped in identifying the sample areas, water-harvesting structures etc. for the assessment. The steps included:

- Resource map to identify soil and land types, drainage, present land use etc.
- Mapping the watershed activities implemented
- Exploring the possible impacts and areas of impacts

C. Impact Mapping Exercise

This exercise was done in a workshop mode along with the watershed functionaries, concerned user group/ farmers. The exercise starts with a general discussion on the investments made in the watershed. This was followed by:

a. Mapping the impacts paths
b. Identifying possible (geographical) areas where such impacts are visible

D. Study of Sample patches

A representative patch of land (separately for area development, water harvesting and plantation) was selected for detailed data generation with the community. Farmers within the identified area were identified and mobilised and were given brief orientation on the purpose and methodology of the study. Plot by plot field survey was undertaken with farmers and volunteers in the selected patch. Some of the farmers and volunteers were formed into teams to survey the identified areas and compiling data plot-by-plot along with the research team.

E. Household survey on livestock & wells

A door to door survey with questionnaire by the volunteers in the watershed was carried out to understand the changes in the livestock numbers before and after the implementation of the watershed programme. The survey on wells included details like year of digging, discharge, area cultivated and present status.

F. Consolidation of the data at the watershed level

The data that was collected in the field was later compiled and analysed by the study team.

G. Analytical tools:

i) Assessment of Benefits

For measuring the extent of changes 'before' and 'after' comparison was used. The data was generated from the memory of the individual farmer on his/ her field in the surveyed area. Prices prevailing during the study period were used for computing the total value of production for both before and after situations.

ii) Incremental Value of Production

This was used in comparing the benefits over investments. It is computed by measuring the change in gross value of production before and after the project investments were made. The actual costs of production were not deducted. The ratio of Incremental Value of Production over the investments made on that particular structure was used as a proxy for benefit-cost analysis.

iii) Data on Wells and Borewells

This data was generated by a detailed field survey of each of the wells/ borewells. The year of digging the well/ borewell and the other data was collected for the entire watershed.

3. Limitations of the Study

Watershed program is a complex program centered around diverse range of processes. Much of the impacts depend on how the processes have been facilitated. The study looked at the impacts but did not attempt to relate them to the processes. The study attempted, wherever possible, to understand the impacts quantitatively. However a rigorous economic/ statistical analysis of the watershed investments was not attempted.

Another limitation is that the study year (2002 – 2003), representing the '*after*' situation was a deficit rainfall year, whereas normal rainfall prevailed in the '*before*' year. Thus there might be a downward bias on the benefits side.

The impacts result from a range of factors – isolating the impacts and attributing them to watershed investments alone is very difficult. Crop pattern shifts as a response to markets may also influence the impacts. The 'recall' method in the data generation has its own limitations. The cumulative impacts sparked off by watershed investments were considered in the study, with all these limitations.

The study was an intensive process and looked at the impacts in minute details moving from one plot to another. The observations made were validated by participation of farmers, members of various institutions in the participatory exercises. The sample is not a neutral or objective one and therefore, can not be extrapolated to the entire watershed program in Andhra Pradesh. But the methodology of the study and the initial observations and results do provide a basis for understanding the impacts of the program and also provides a basis for a detailed objective analysis of the watershed program in the state.

4. Structure of the Study Report

The study report is organized in two parts; Part I presents a combined analysis of all the five sample watersheds and Part II presents the invidividual study reportss of each of the five sample watersheds.

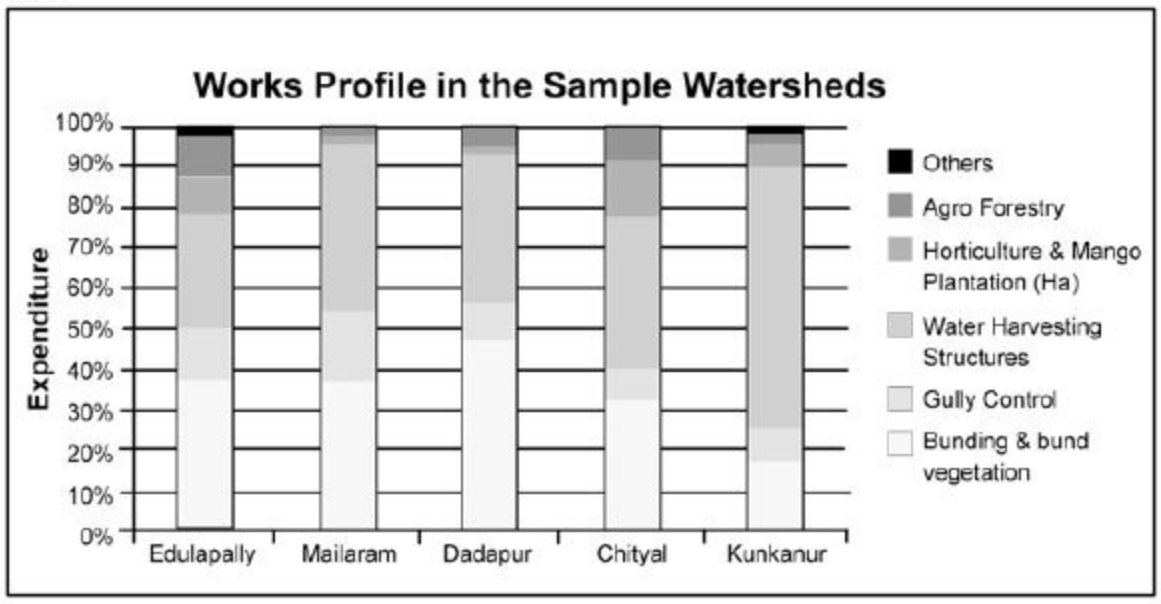
Part – I is organized into five chapters. The first chapter presents a detailed profile of watershed investments and the works taken up. Impacts were assessed for the major investments only. These are presented in Chapter 2, which covers impacts of water harvesting, land development and plantations, impacts on ground water and on livestock in four different sections. The institutions promoted and their analysis is discussed in Chapter 3. Based on the results and observations of the study, Chapter 4 discusses the implications for sustainability of the impacts of the program.The summary of the study and the major conclusions are presented in Chapter 5.

Chapter 1

Profile of Watershed Works

Soil and moisture conservation works, water harvesting structures, gully control measures and biomass generation are the typical components of the watershed program in the sample watersheds. Figure 1. and Table 1. give an overview of the nature of investments in the sample watersheds. Investments on bunding ranges from 32 to 47% with the exception of Kunkanur watershed where most of the investment went for water harvesting structures. Investments on gully control range from 7 to 16% of the total while that on water harvesting ranges from 29 to 42% with the exception of Kunkanur (65%). Masonry checkdams and percolation tanks occupy the major share in water harvesting investments. Soil conservation and water harvesting works constitute about 80% of the investment. Horticulture investments range from 2 to 13%.

Fig 1.



Diversity of investments or components is low in all the watersheds except in Edulapally. Diversity in components is an indicator of site specificity and accommodation of local solutions and knowledge. The investment profile also indicates a total absence of focus on livestock. Very few efforts were made in improving biomass. There were almost no investments on diversifying crop patterns or on productivity enhancement related activities, which are also central to the watershed program as presented in the program guidelines.

The data on the distribution of investments across the caste and class groups discussed in the individual watershed reports in Part II, brings out that the investments on bunding and soil conservation were more accessed by the poor and SC, STs, while access to other investments is relatively skewed.

Table1. **Profile of expenditure on watershed works**

No	Activity	Expenditure (Rs. in lakhs)					% of Total Expenditure				
		Edulapally	Mailaram	Dadapur	Chityal	Kunkanur	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
1	**Soil Conservation**										
a)	**Bunding & bund vegetation**	**5.38**	**5.50**	**6.79**	**4.58**	**2.49**	**37.10**	**37.60**	**47.10**	**32.30**	**17.40**
	Bunding	5.20	5.50	6.79	4.54	2.33	35.80	37.60	47.10	32.10	16.30
	Stylo Hemata	0.06			0.04		0.40			0.30	
	Agave	0.06				0.16	0.40				1.10
	Palmyra	0.06					0.40				
b)	**Gully Control**	**1.92**	**2.46**	**1.35**	**1.04**	**1.10**	**13.20**	**16.80**	**9.40**	**7.30**	**7.70**
	Loose Boulder Checks	0.67					4.60				
	Rock fill dams	1.17	2.46	1.35	1.04	1.10	8.10	16.80	9.40	7.30	7.70
	Live Checks	0.08					0.50				
2	***Water Harvesting Structures***	***4.20***	***6.13***	***5.39***	***5.43***	***9.13***	***28.90***	***41.90***	***37.50***	***38.30***	***64.60***
	Check Dams & Katwas	4.14	2.90		0.67	4.60	28.50	19.80		4.70	32.20
	Percolation tanks Water ways		1.97	5.27	4.44	0.13		13.50	36.60	31.40	1.40
	Soak Pits	0.02					0.10				
	Recharged Bores	0.04				0.10	0.30				1.00
	Sunken ponds		0.50	0.04		0.19		3.40	0.30		1.30
	Dugout ponds			0.08					0.60		
	Farm ponds				0.20	3.69				1.40	25.80
	Diversion channels		0.76					5.20			
	Sub-surface dams				0.12					0.80	
	Tank renovation					0.42					2.90
3	**Horticulture (mainly Mango Plantation)**	**1.18**	**0.37**	**0.27**	**1.86**	**0.94**	**8.10**	**2.50**	**1.90**	**13.10**	**6.60**
4	**Strengthening of First Year Bunds**	**0.01**					**0.10**				
5	**Agro Forestry**	**1.68**	**0.18**	**0.60**	**1.22**	**0.35**	**11.60**	**1.2**	**4.2**	**8.6**	**2.4**
	Nursery	0.75					5.20				
	Plantation	0.57	0.18	0.60	1.22		3.90	1.2	4.2	8.6	
	Avenue Plantation	0.36				0.35	2.50				2.4
6	**Seri-culture**				**0.03**	**0.14**				**0.2**	**1.0**
7	**Vermi Compost**	**0.14**					**1.00**				
	TOTAL	**14.52**	**14.64**	**14.40**	**14.16**	**14.3**	**100**	**100**	**100**	**100**	**100**

Section 1

Impacts of Water Harvesting

The investments on water harvesting ranged from 4.0 lakh rupees (29% of total works expenditure) in Edulapally to 9 lakhs (65%) in Kunkanur. Checkdams and Percolation tanks share the bulk of the investments, while farm ponds have a substantial share in Kunkanur watershed.

As a result of these water harvesting structures apart from ground water recharge, water was available at multiple locations within the village and is used for multiple purposes. Drinking water for livestock, washing livestock, domestic uses, swimming, etc. are some of these uses. There is substantial *life* around these water harvesting structures in the otherwise water starved villages. Direct irrigation through diversion channels, lifts and pot irrigation are also practiced in some cases but is not predominant.

Box 1

Rejuvenating Drinking Water!

In Kunkanur a bore-well drilled by the Panchayat for drinking water was abandoned earlier as there was no water. This bore well rejuvenated after the construction of Yellamma Vanka checkdam. Panchayat is now supplying drinking water to the village by pumping water from this bore-well. This has boosted the confidence of the villagers.

Table 2 profiles the impacts and related information of Water Harvesting Structures across the five watersheds. It compiles the data and observations from an analysis of the sample structures in all the five watersheds. Works were completed recently in Kunkanur watershed and the minimum gestation period is not yet over.

Critical observations

Structures

The storage capacity created in the structures ranged from 1002 cubic meters in Mailaram to 25,680 cubic meters in Kunkanur watershed. The cost per cubic meter of storage created in checkdams varies from about 18 rupees in Kunkanur to about Rs.531 in Chityal. Generally, this cost is low in case of percolation tanks as compared to checkdams. Water is available in the structures till August-September in farm ponds and until December to March in most of the water harvesting structures.

The recharge of ground water is high. In Mailaram these structures have solved the drinking water crisis in the village and in several cases they provided water for domestic uses at multiple locations which is some respite for women who are forced to walk long distances for water. Of the sample structures surveyed very few have maintenance problems- but it is too early, as the previous years happen to be low-rainfall years; those which are breached are not repaired. Silt is removed in stray cases. That there are no institutional systems for maintenance of the structures in the sample watersheds is a major cause for concern. There are no instances of using Watershed Development Fund for the purposes of maintenance as the fund is locked up in fixed deposits. Some response and initiative from the administration is awaited.

Usage

Many of the structures are recharging ground water. In Kunkanur and Mailaram villages these structures have made substantial contribution in solving the drinking water problem. Geological features in Edulapally and Kunkanur make borewells unviable. In Edulapally 81% of the defunct open wells were revived. Kunkanur has not yet received any complementary investments from farmers. In all other watersheds a shift has taken place from open wells to borewells following the construction of water harvesting structures. This shift was a general trend accelerated with the watershed program. The recharge has stabilised some of the existing wells/ borewells.

The miracle called water...

Ratnaiah and Ramulamma, an SC family has 2 acres of degraded land in Mailaram. Ratnaiah custom hires his bullocks for ploughing and carting. He also works as a painter for 2 months in summer. As part of the watershed program two bunds and two rock fill dams were constructed in his 2 acres of land costing about Rs.6,000/-. Ramulamma invested an amount of Rs.5,000/- that she received as loan from her group for removing stones from the field.

Ratnaiah then invested on a borewell looking at the success of his fellow farmers. He invested Rs. 12,000/- on digging the borewell (135 ft), Rs.15,000 on getting electricity and a motor. The equipment costs (about Rs.20,000) were on uddera (the shop owner sells for deferred payment with interest). The family mobilised loans from the SHG and also used all the savings available in the family, including that of their children for digging the borewell. As they struck water, they then invested Rs.10,000/- in the first year on levelling the land.

First year paddy crop was taken in both kharif and rabi seasons and about 35 quintals of grain was harvested. In the second year another acre of land was levelled. In the second year the family invested Rs.1,500/- on organic manure. The family already has bullocks. Ratnaiah's family now has become full-fledged farmers.

Changes

There is considerable increase in the irrigated area in the influence zone[1] of the sample structures studied except in Kunkanur. Irrigated area increased by 64% in Edulapally and by 5 times in Mailaram. About 54% of the area under the influence zone is being irrigated in Dadapur.

Cropping intensity and net sown area increased substantially in Chityal reducing the fallow lands. In Mailaram also fallow lands are brought under cultivation. In Kunkanur this phenomenon has just started. Shift towards high value crops like cotton, potato and chillies is observed in Edulapally. Increase in acreage under paddy and vegetables is observed in Mailaram, Dadapur and Chityal. Productivity increase in Paddy is also observed in Chityal owing mainly to the shift to borewells from open wells.

Quantification of Benefits

In the sample structures an attempt was made to estimate the value of annual incremental production i.e. the value of increased production in the influence zone before and after construction of the water harvesting structures at the prevailing price.[2] In Kunkanur this assessment was not done as the crop patterns are still to establish in the influence zone. In other watersheds the values are as follows: Rs.5.5 lakhs in Edulapally, Rs.2.55 lakhs in Mailaram, Rs.8.62 lakhs in Dadapur and Rs.1.88 lakhs in Chityal.

These reported benefits far outweigh the costs of construction of these structures. The benefit to cost ratio in terms of incremental value of production to the investment from the project on water harvesting

[1] The influence zone was arrived at based on the perception of farmers in the selected area.
[2] The underlying assumption is that the cost of cultivation has not changed substantially.

structures and others ranges from 0.65 to 1.5. It means that each rupee of public investment on the structures will result in 0.65 to 1.5 rupees benefit to the farmer in the *first year* itself. This ratio would be substantial even after deducting the cost of incremental production. At this rate the investments on water harvesting structures in all the cases except Kunkanur will payback within the first two years, which is a very high rate of return. The above figures are for a low rainfall year as the study period coincided with a drought year. During normal rainfall years the rate of return may be higher.

Observations on Productivity, Equity and Sustainability

Once the ground water recharge is seen it invites substantial private investments from farmers. Farmers mobilized private investments in the range from 1.78 times in Mailaram to 3.1 times in Dadapur over the investments on water harvesting structures made by the project. No such investments were observed in Kunkanur. These investments were primarily for accessing ground water – for desilting existing open wells in Edulapally and for new borewells in Dadapur and other places. Investments were also made on bunding and land levelling by farmers once the area is under irrigation.

a. Complimentary Investments

In Dadapur out of a total of 26 structures 20 were constructed in the lands of large farmers. Once the structures are constructed the recharge is incidental and the complimentary investments mobilised by farmers determine access to ground water. Some farmers like Buchanna, a stone worker (with 5 acres) have completely shifted to agriculture after levelling their land using the bunding investment and accessing ground water through a bore-well. They now cultivate two crops in a year.

Location of the structure and the ability to mobilise complementary investments are the two critical factors that determine the equity in incremental benefits. To build more equity, the complementary investment plans should be made as an integral part of planning for water harvesting structures. Complementary investments are key to equity in addition to location of structures.

The criticality of complementary investments is brought out well in the case of Edulapally. Of the total 5.80 lakh rupees of complementary investments made by farmers after construction of water harvesting structures, S.C farmers could only mobilise 0.82 lakh rupees i.e.14%.

b. Complete Investments

Investments need to be complete. It is taking a while for farmers to mobilise private investments after the water harvesting structures expanding the gestation period. Kunkanur watershed is a case in point.

Planning for 'Complete Investments' is a necessity. Earmarking production enhancement budget head as in the case of the Process Guidelines for Watershed Development Programme may be useful for this purpose as a revolving fund. But, the planning methodology to integrate complementary investments with structures needs to be developed.

c. Irrigated Horticulture

Another important factor is competitive bore-well digging. There is a predominant shift towards borewells from the earlier open wells after the construction of water harvesting structures. Out of the 15 borewells dug after the structures, nine have become defunct resulting in considerable disinvestment in Chityal. Farmers like Venkataiah, with 6 acres land under one of the percolation tanks in this village started orchards during the program. His open well dried up after his neighbour dug a bore-

well. With the orchard at 2 years age, he had no option but to go for a bore-well. After 5 attempts of digging borewells he succeeded in getting water in one. Even this water is not sufficient to irrigate his orchard. In this process he incurred an expenditure of Rs.1.05 lakhs of which Rs.0.95 lakhs was borrowed at 36% rate of interest.

Irrigated horticulture imposes irretrievable situations with respect to water. This forces farmers to invest on borewells, which are very vulnerable. Though there are some 'successful' case studies, whether irrigated horticulture would benefit small and marginal farming situations or further burdens them with debt needs to be studied.

d. Security of Investments and Group Norms

Also, the phenomenon of shifting to borewells after ground water recharge need to be addressed upfront before the construction of the structure. Organising the users and building institutional norms for resource management should be made a prerequisite for making watershed investments in the village.

Paradox of Recharge Zones!!

It is often argued that watershed development should be taken up only in areas that are recharge zones. For e.g., WDF watershed program of NABARD has stringent criteria to select watersheds only in recharge areas.

Edulapally experience shows that watershed investments are economically viable even in areas where geological features restrict percolation. Conjunctive use of surface water and open wells made the water use efficient in this case. The geological constraint on deep bore-wells in fact helped positively in terms of wider distribution of water through many open wells.

e. Maintenance and Institutional Mechanisms

Very few structures were breached and it appears that the maintenance requirements are low in the sample structures. But two factors are causes for concern a) the breached structures are not repaired b) these are relatively low-rainfall years. ***More alarming fact is that there are no institutional mechanisms for maintenance.*** The assets are not transferred to Gram Panchayats as envisaged in the guidelines nor there are any user groups. There are no experiences of using the watershed development fund as it is locked up in fixed deposits awaiting a policy decision at the state level.

Establishing User Group norms in regulating and using ground water and in protecting existing infrastructure (open wells) need to be negotiated *a priori*. Complementary investments on Group Borewells tied up with the water harvesting structures may be a better choice. Water budgeting for the entire watershed as a basis for such investment, however, is the ideal choice.

To sum up, it can be said that the water harvesting structures have made significant impact. There are substantial intangible benefits of providing water at multiple locations in the village for multiple purposes including livestock, drinking and domestic uses. In two of the watersheds, which were facing acute drinking water shortage, the structures have provided succour. These are invaluable benefits in the water starved villages.

These water harvesting structures gave a spurt to private investments mainly in wells, borewells and land levelling. As a result there is considerable increase in irrigated area in the influence zone. The investments on these structures will payoff within two years in all the watersheds except in Kunkanur. The ratio of incremental value of annual production over the total investments on structures (benefit to cost) ranges from 0.65 to 1.5 in the first year itself. By any measure these investments have high rate of returns.

Lack of institutional mechanisms for maintenance and unplanned growth in borewells are threats to the security of investments; these are some of the causes for serious concern.

Table 2. **Summary of the Impacts of Water Harvesting Structures**

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
1	Total investment & %	4.2 lakhs (30%)	6.13 lakhs (41%)	5.4 lakhs (37%)	5.43 lakhs (38%)	9.13 lakhs (64%)
2	Major structures	5 checkdams and two katwas (diversion channels)	8 checkdams and 10 percolation tanks	26 percolation tanks, 2 each of dug out and sunken ponds	1 checkdam, 6 percolation tanks, 4 farm ponds and one sub-surface dam	Sunken ponds (45), checkdams (7), percolation tanks (1), tank renovation (2), farm ponds (17) and recharging wells.
3	Sample area/ structures	5 checkdams and one Katwa	3 checkdams of the total 8 and one percolation tank	8 percolation tanks (94 acres influence zone)	One checkdam and 2 percolation tanks	9 of the 17 farm ponds
4	Total storage capacity created in the sample structures (cubic meters)	1747	1002	8554	6031	25,680
5	Cost of creating storage capacity Rs./ cubic meter	Not Available	180	24	Rs.75 for percolation tanks and Rs. 531 per checkdam	17.90 (checkdams) 11.63 (farm ponds)
6	Main uses	Drinking water for livestock, domestic uses, swimming, bathing, direct irrigation by diversion channels.	Solved the drinking water crisis in the village. Domestic and livestock uses. Fishing in the percolation tanks, recharge of ground water.	Drinking water for livestock, washing clothes & recharge of ground water.	Livestock drinking and washing, recharging ground water	Check dams: Water is now available at several places in the village reducing the travel time for Domestic uses, tomato nurseries, livestock drinking water farm ponds: Started cultivating paddy in some cases– but not stabilised.
7	Water storage time	Water is there in the structures till January. Katwa (diversion drain) flows till March.			One checkdam is perennial and others dry in Jan-Feb.	

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
8	Maintenance	No breaches. Silt removed in only one structure.	2 checkdams have siltation problem – silt not removed. No maintenance mechanisms established.	Of 26 percolation tanks 2 breached; both of them are on one stream. No maintenance mechanisms in place.	No maintenance requirements by the time of the survey. No mechanisms in place for regular upkeep.	No maintenance required so far. & No mechanisms of maintenance observed. Silt removed and applied in farmers field only in 1 checkdam. One checkdam has settlement crack – not repaired.
9	Situation of using ground water	Open wells which were silted up were desilted by farmers themselves after seeing the recharge. Borewells are in general a failure due to geological features.	Sample structures supported 3 wells and 7 borewells dug after the program.	In the influence zone, field bunding took place before construction of water harvesting structures. Later farmers dug borewells	After the WHS shifted to borewells. About 60% of these dried up soon along with 50% of the open wells. Most of the irrigation through borewells now.	Very little use of ground water in the village. Only one checkdam has a well and a bore well – now supplying drinking water to the village. Direct manual pot irrigation for tomato nurseries.
10	Wells/borewells recharged under the sample structures	29 open wells in total. 81% of the defunct wells recharged and 90% of the wells were desilted.	These sample four structures supported (3 wells and 8 borewells) 10 irrigation borewells/ wells. - about 60 acres area. 7 of 8 borewells are new.	Percolation Tanks further stabilised these borewells (13 borewells and 4 wells)	5 functional open wells and 6 borewells.	Only one borewell and a well. – good recharge.
11	Changes that occurred	Increase in irrigated area by 14.5 acres (64%) and stabilisation in about 90.5 acres.	Gross irrigated area increased 5 times in the sample area. And net irrigated area increased by about 4 times- mostly of SC, ST and BCs.	Changes have taken place starting from bunding.	24% increase in net cultivated area and cropping intensity increased from 118 to 152%.	Reclaiming fallow land just started.

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
12	Changes in crop patterns	Cotton, potato and chillies increased.	Mostly paddy and vegetables. Fallow lands reclaimed by farmers.	With bunding crop shift from Jowar, redgram and ragi to double cropping (Paddy – Groundnut)	Increase in Mango orchards and area increased under Kharif paddy. Productivity also increased due to shift towards borewells.	Some have started cultivating the fallow lands – not yet stabilised.
13	Quantification of benefits	Annual value of incremental production is about Rs.5.5 lakhs while the project investment is about 3.5 lakh rupees on the sample structures.	Gross value of incremental production is rupees 2.55 lakhs in the sample area – while the cost of structures is Rs.1.8 lakhs. Net incremental benefits (after deducting cost of cultivation) is about 1.84 lakhs rupees.	About 700 and 340 qtls of paddy and groundnut approximating to Rs.8.62 lakh rupees of gross production (not incremental) Even assuming 50% change, the incremental value is higher than the 2.85 lakh rupees investment in this area from the project.	Total value of incremental production is about Rs.1.88 lakhs per annum while the total investments (WHS, bunding and Horticulture) was about 2.9 lakh rupees.	Assessment not done since only one year passed (a drought year). The production system yet to establish.
14	Ratio of incremental value of production to capital investment – as a proxy for Benefit – cost ratio	1.5 annually in normal years	1.42 during the first year itself.		0.65 during the first year	-do-
15	Payback period	One normal year	One year	2 years to pay off entire investments on water harvesting	2 years.	-do-

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
16	Complementary investments (stimulation of private investments)	About 5.8 lakh rupees of which SC farmers invested 14% and OC farmers 58%.	About Rs.3.2 lakhs mobilised by farmers for land levelling, digging borewells and energising the same.	Ratio of private to public investments is 1.78.	Mainly on levelling and bore wells – about 3.1 times to the project investment	Details not available Farmers yet to make complementary investments. Farmers are yet to visualise benefits
17	Summary picture	The structures were intact and had contributed to rejuvenating irrigated agriculture. Resulted in substantial benefits that far outweigh the investment costs.	These investments generated substantial benefits and solved the problem of drinking water in the village.	No maintenance mechanisms observed	Catalysed shift to borewells and as a result open wells dried up. Substantial increase in the incremental benefits.	It may need some more time for the impacts to mature at least one or two good rainfall years.
18	Others	No borewells were drilled due to geological features.				Only one rainfall season after construction – which also happened to be a drought year.

Section 2

Impacts Of Land Development and Plantations

Land (or area) development investments in the project include field bunding, improving vegetation on bunds (mostly distributing grass seeds and planting agave) and gully control structures like rock-fill dams, loose boulder structures. Most of these investments from the project were on the private lands. Investments on land development were in the range of 3.59 lakh rupees (25%) to 8.14 lakhs (56%); of these, field bunding had the major share.

For the purpose of the survey a sample area was selected in each watershed representing various soil types. Plot-wise data was generated by the study team for all the plots in the sample areas by transecting from one plot to another along with the farmers. The sample area surveyed ranged from 21 acres to 151 acres. Investments per acre were in the range of Rs.910 in Chityal to Rs.2300 in Dadapur watersheds.

Quality of Bunding

An assessment was made on the quality of the field bunding and the maintenance aspects. Table 3 below presents an aggregate picture of all watersheds. Table 5 provides an overview of different parameters across all the watersheds studied.

Table 3. **Summary of quality of bunds (aggregating all watersheds)**

S.No	Bund Characteristic	Quality	No.	%
1	Cross Section	Good (>40cm ht)	224	62
		Average (Up to 40cm height (ht))	87	24
		Poor (30cm ht)	50	14
2	Grasscover	Fully covered	114	32
		Partially covered	171	47
		Absent	76	21
3	Maintenance	Not Required	173	48
		Required	188	52
		Done	55	29
		Not Done	133	71
4	Soil Deposition behind the bund	Upto 45cm	79	22
		Upto 30cm	98	27
		Upto 20cm	184	51
5	Top Level	Uniform	250	69
		Not uniform	111	31
6	Spill Way provided	Yes	225	62
		No	136	38
7	Bunds Breached	Yes	134	37
		No	226	63

Of all the bunds surveyed 86% had average to good cross section even after completion of the watershed program. In about 21% of the cases grass cover was not established at all. About 37% of the bunds were breached. In 54% of the cases maintenance was not required while 46% needed it. Of the cases where maintenance is needed in 89% cases it was not attended to indicating the clear absence of any post-project maintenance institutional systems. However, most of the bunds that were not repaired were either in common property or in the lands not under use. It is observed usage of land is a major factor determining whether the bunds are maintained or not.
Though spillway is an important component of bunding, it was not provided in about 37% cases.

These observations were made at the completion of the watershed program i.e. the structures might have passed about 2 to 4 rainy seasons. The same needs to be assessed after some more seasons including some high rainfall years.

Land Development Impacts

Site specific treatment is important

The impacts of field bunding had been substantial wherever it was technically appropriate. As can be seen from Table 4, different soils/ lands need different types of treatment. Standardising technologies across the program resulted in losses for some.

In Dadapur watershed vertical seepage is very low in some of the lands; bunding here resulted in water stagnation and loss of crop productivity. Similarly in Chityal watershed bunding was inappropriately chosen for the saline soils resulting in loss of cultivated area. In spite of these problems soil conservation has resulted in substantial benefits.

In Edulapally watershed pebble bunding was not permitted in one of the patches with stony soils (assigned lands) and low soil depth. Consequently the bund sections could not be maintained owing to shortage of soil.

A major lesson emerging from the above experiences is that technological choice should be of prime importance. Standardising technical options at the district level and 'not allowing' local choices will only reduce the effectiveness of the impacts and undermine participatory processes.

Reclaiming fallow land

Where soil conservation was taken up fallow lands had been brought into cultivation except in Chityal village. The decrease in fallow land was around 30% in these watersheds. In Edulapally watershed 120 acres of assigned lands were brought into cultivation. While the program invested only on field bunding people mobilised complementary investments up to Rs.3000/ - per acre to clear the shrubs etc. and bring the land under cultivation. The complementary investment mobilised is about 49% of the total investments on soil conservation. The food grains produced from these reclaimed lands could provide 4 months food security to the households.

Impacts like bringing fallow lands into cultivation were incidental and not planned. Planning for complementary investments at the initial phase of land treatment itself would create more comprehensive impacts.

Table 4. **Impact of Land Development Investments: A comparison across the five watersheds**

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
1	Total investment (Rs. in lakhs). **(Investments on Bunding + Gully control)**	**7.31** (50.3%) **(5.39 + 1.92)**	**7.96** (54.4%) **(5.50 + 2.46)**	**8.14** (56.5%) **(6.79 + 1.35)**	**5.62** (39.7%) **4.58 + 1.04)**	**3.59** (25.1%) **(2.49 + 1.10)**
2	Major structures	Field bunding, Grass seeds, planting agave and palms Rock fill dams, loose boulder checks and live checks	Field bunding Rock fill dams	Field Bunding Rock fill dams	Field bunding and grass seeds, Rock fill dams	Field bunding, agave plantation Rock fill dams
3	Sample area/ structures	151 acres in 2 blocks	60 acres	25.5 acres	21 acres	73.5 acres
4	Approximate per acre investments on bunding	Rs.1984/-	Rs.1234/-	Rs.2300/-	Rs. 910/-	Rs.2280/-
5	Quality of structures (Bunds)	Cross section good in 99% bunds in red soils but poor in stony soils Bunds maintained where land is in use. Bunds breached in 16% in red soils and 78% in stony soils. Maintenance not done in 51% cases where it is required	About 72% bunds have good cross section. 54% bunds not breached. In 52% of cases maintenance was required – but attended to only in 18%.	Good cross-section. Bunds maintained in cultivated areas- 69% cases bunds were intact. In 56% of cases the ones needed repair were not attended to. In 31% bunds have breaches.	Bunding taken up in saline soils failed (79% poor quality) while the quality was good in 95% of bunds in red soils. 92% bunds were intact in red soils & only 11% survived in saline soils.	97% bunds have good to average cross section. 50% bunds needed repairs of which only 21% attended to. In 29% cases bund has breached-mainly in non-cultivated lands.
6	Fallow lands brought into cultivation	120 acres in total. In red soils decreased by 34%. Increase in food grains provides about 4 months food security.	Fallow lands decreased from 48% to 13%	Fallow lands reduced by 38%	Fallow lands increased as a result of failure of bunding in saline soils. In red soils not much fallow land to start with.	Fallow lands reduced from 59% to 33%. Moisture retention increased by 8 days.

SNo	Aspect	Edulapally	Mailaram	Dadapur	Chityal	Kunkanur
7	Issues	Pebble bunding (or removing stones) not allowed in stony soils – led to inappropriate earthen bunding Mango & teak plantations failed	Bunding has recharged ground water. It resulted in more borewells and a shift to irrigated paddy (33% area) and high value crops like cotton. Interest in dryland crops reduced. Wage rate increased by 3 times. Shift from Jowar, ragi and redgram & yields also reduced.	Bunding is not an appropriate intervention in low seepage areas- resulted in water stagnation and loss of crop productivity. Farmers' preference was for land levelling.	Bunding is an inappropriate activity in saline soils – cultivated area reduced by 87% in saline soils where bunding was taken up. Some area was brought under orchards (from Jowar and groundnut).	Shift to sunflower ` and cotton. Cotton productivity has fallen due to droughts.
8	Benefits – costs (total incremental value of production in the year surveyed over the total cost of /investments on soil conservation/) (Not annualised)	The ratio was 1.42 without fodder and 2.00 with imputed value fodder (ratio of total benefits in the 1st year over total costs of soil conservation)	The ratio of value of incremental production (after deducting the cost of cultivation) to the total program investments in area development works out to 3.78 i.e. every rupee invested on land development results in an incremental value of production of Rs.3.78. The benefits of irrigation widely spread across households.	Very marginal difference (negligible) in productivity.	Incremental value of production in saline soils was negative. On the whole the incremental benefits in the year surveyed over the costs of soil conservation was 0.44 & the same only for red soils is 1.1. A loss of 0.09 in saline soils. Drought year, gestation period of mango plantations have depressed the benefits. After deducting mango orchards c-b ratio is 0.58 (first year itself)	The ratio of incremental value of production in the surveyed year over total investments on soil conservation was 1.08. i.e. yields a return of 1.08 per year on every rupee invested.
9	Pay-back period	One year	One year	-failure-	3 years	One year

Table 5. **Watershed wise quality of bunds in sample area**

S.No	Bund Charac-teristic	Quality	Edulapally				Mailaram		Dadapur		Chityal				Kunkanur	
			Red soils		Stony soils		Red soils		Red soils		Red soil		Saline soil		Saline soil	
			No.	%	No.	%	No.	%	No.	%	No	%	No	%	No	%
1	Cross Section	Good (>40cm ht)	93	99	4	11	47	72	51	68	14	58	2	7	13	34
		Average (Upto 40cm ht)	1	1	13	35	18	28	18	24	9	37	4	14	24	63
		Poor (30cm ht)	0	0	20	54	-		6	8	1	5	22	79	1	3
2	Grass cover	Fully covered	23	25	0	0	35	53	52	69	3	12	0	0	1	3
		Partially covered.	66	70	35	95	29	45	23	31	6	25	0	0	12	31
		Absent	5	5	2	5	1	2	0	0	15	63	28	100	25	66
3	Mainte-nance	Not Required	53	56	6	16	31	48	50	67	12	50	2	7	19	50
		Required	41	44	31	84	34	52	25	33					19	50
		Done	20	49	5	16	6	18	11	44	9	37	0	0	4	21
		Not Done	21	51	26	84	28	82	14	56	3	13	26	93	15	79
4	Soil Deposition behind the bund	Upto 45cm	29	31	0	0	19	29	14	19	3	12	0	0	14	37
		Upto 30cm	43	46	2	5	24	37	19	25	6	25	3	11	1	2
		Upto 20cm	22	23	35	95	22	34	42	56	15	63	25	89	23	61
5	Top Level	Uniform	66	70	8	22	48	74	66	88	24	100	5	18	33	87
		Not uniform	28	30	29	78	17	26	9	12	0	0	23	82	5	13
6	Spill Way provided	Yes	79	84	2	5	57	88	24	32	16	67	10	36	37	97
		No	15	16	35	95	8	12	51	68	8	33	18	64	1	3
7	Bund Breached	Yes	15	16	29	78	30	46	23	31	2	8	25	89	11	29
		No	79	84	8	22	35	54	52	69	22	92	3	11	27	71

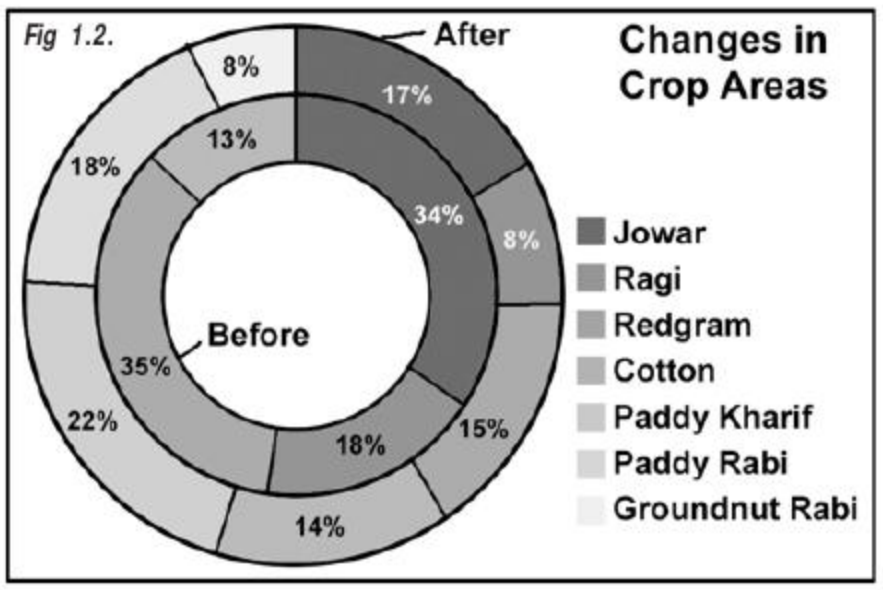
Shifts in crop patterns

In Edulapally watershed the mixed cropping pattern of Jowar and Redgram expanded to all the areas bunded. In Mailaram there was improvement in ground water levels resulting in more borewells. This had resulted in a shift towards paddy and high value crops like cotton. Fig 1.2 illustrates the crop pattern shifts in Mailaram. The wage rates also increased. As a result there was a neglect of the dryland crops. In Kunkanur farmers shifted to high value crops like cotton but the productivity decreased due to drought conditions. Chityal had a major focus on mango orchards.

Benefit – Costs

An attempt was made to estimate the benefits of the investments made on land development (bunding in particular). The value of change in crop outputs before and after watershed investments was computed taking the prices prevailing at the time of the survey. A benefit to cost ratio was arrived by dividing this value of incremental production with the total investments made on soil conservation. The values were not annualised and the benefit-flows were not calculated. The ratio only compares the benefits in the survey year over the costs of total investments. As the benefits of the investments will flow over a period and only one year's benefits are considered, the benefit-cost ratios arrived at are underestimates. Transaction costs are not included in the analysis. The 'memory recall' method used for the purpose may have some inherent biases. But the results are corroborated by discussions with the farmers.

Fig 1.2.



The ratios of value of incremental production to land development investments estimated as described above are 1.42 to 2.00 in Edulapally (excluding or including imputed value of fodder), 3.78 in Mailaram, negligible in Dadapur, 0.44 to 1.1 in Chityal and 1.08 in Kunkanur. Excepting Dadapur the investments will be paid back with in one year in all the watersheds. These indices show that every rupee invested on field bunding will give a return ranging from 0.44 to 3.78 rupees in one year. If the technology choice is appropriate (i.e. excluding cases like Dadapur, Chityal) the returns will be much higher compared to investments.

The above estimates need to be qualified. The ratios and percentages appear very high because of the lower productivity levels existing before the watershed program. In some cases they may not be very attractive in 'total' or significantly visible nor spectacular. But, nevertheless, these small increments are necessary value additions for people at the margin.

To sum up, the following lessons emerge:

- Field bunding would be very effective and has high rates of returns provided the technical choice is site specific.
- In saline soils and in areas where the vertical seepage is very low, bunding is not an appropriate

intervention and results in losses.

- Field bunding helps in reclaiming the fallow lands as the farmers mobilize complementary investments.
- Bunding also has a major impact on the recharge of ground water giving spurt to irrigation through wells/ borewells.
- Maintenance of bunds is highly linked to the usage of land. In the unused lands or in the common lands bunds are not maintained.
- Absence of institutional systems for maintenance is a cause for concern.

Impacts of Plantations

Horticulture and plantations together constituted 6% to 22% of the total investment. In Chityal watershed it was systematically taken up by SDDPA. The gestation period of the plantations was not complete at the time of the survey. Some observations were already presented in the analysis of investments on land development.

Plantations and horticulture were taken up in about 7% of area in the Chityal village. The reported survival rate is about 70%. While horticulture was taken up in private lands, plantations were taken up in the commons, bunds and homesteads. There was substantial regeneration in the protected common land in this watershed as watch and ward expenses were also built into the investments. The stream of benefits will flow in about 2 years.

In other watersheds the survival rate of plantations was very low. The growth of horticulture trees in Kunkanur was reasonable while the survival rates in the other villages were poor.

Impacts of the plantations could not be assessed as the gestation period was not complete in many situations.

Section 3

Impacts On Ground Water

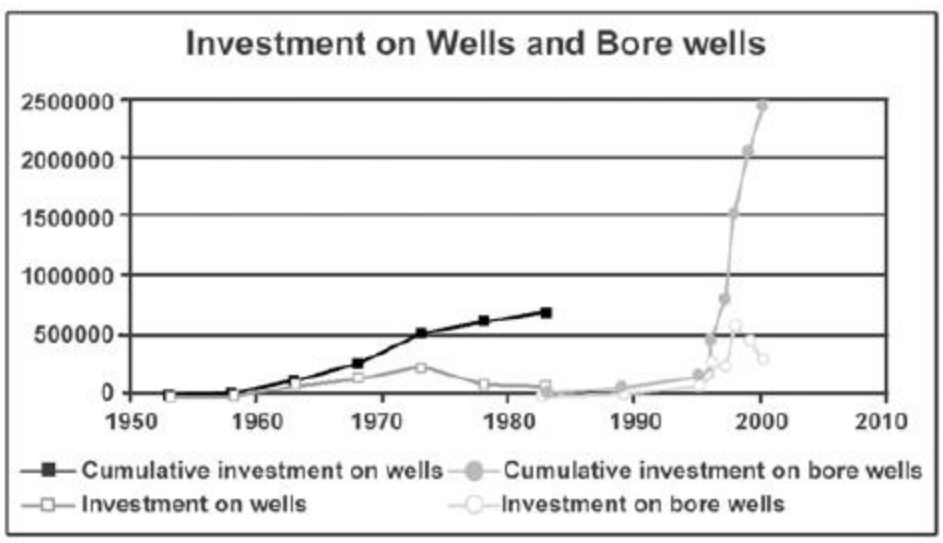
This section analyses the trends in extraction of ground water to look at the sustainability of the rejuvenated ground water. In Edulapally the geology of watershed does not permit digging of borewells. In Kunkanur, there are very few open wells and only two borewells as it is only one year since completion of the project. There are clear trends in the extraction of ground water in the other three watersheds.

Methodology

A survey of all the wells and borewells in the watershed was taken up. The survey included the present status of the borewell/ well, the year of sinking the well, year of drying up, investment made etc. The following analysis is based on the data. The trends are corroborated by case studies with individual farmers and group discussions. The year 2001-02 was a drought year, which may also have resulted in some of the borewell investments.

Detailed analysis of three watersheds are presented here followed by general conclusions.

Fig 1.3



Dadapur

There were 81 open wells and 91 borewells in the watershed. Out of the total, 79 open wells were non-functional at the time of the survey. The cumulative disinvestment (i.e. loss of investment on wells) was of the order of about Rs. 6 lakhs (actual investment figures without compounding).

The village shifted from open wells to borewells in the early eighties. Investment on open wells reached a peak during mid-seventies and declined drastically there after. There was a steep increase in the investments on borewells after 1996, which reached its peak in 1998-99, much before the investments were made on the percolation tanks. Field bunding contributed to visible recharge in ground water and triggered investments on borewells. The Figure 1.3 illustrates this point.

Table 6. **Investment on borewells (Rs.)**

	Annual Investment	Cumulative Investment
1983	10000	10000
1989	20000	38000
1995	95000	153000
1996	275000	463000
1997	245000	803000
1998	595000	1533000
1999	471000	2054000
2000	320000	2434000

As can be seen in the table 6, annual investments more than doubled during 1997 and 1998 – when most of the field bunding works were completed. During 1997

to 2000 a sum of 16.31 lakh rupees was invested on borewells by the community, which is 113% of the total investment on watershed works.

Chityal

In Chityal village, watershed program gave a new lease of life to the ground water extraction infrastructure.

The investments shifted from wells to borewells around the second year of the watershed program. About 68% of this investment became dysfunctional by the time of the survey. The total investment on wells was Rs.56.79 lakhs and the cumulative disinvestment was Rs.39.09 lakhs. Much of this disinvestment happened during the eighties.

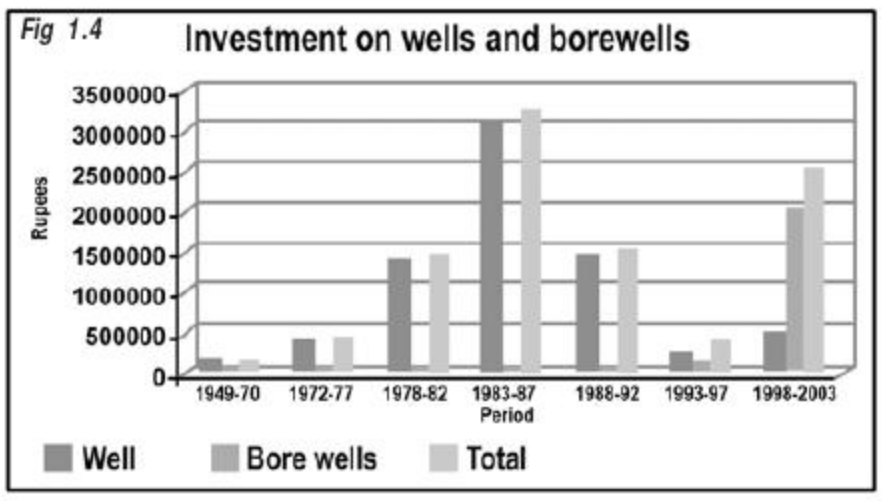
Table 7 **Growth in Borewells**

Year	Total Borewells	Functional	Non-Functional	Total Investment (Rs.)
1991-95	2	2	0	40000
1996	3	3	0	113200
1997	2	2	0	60000
1999	3	3	0	131000
2000	13	12	1	489000
2001	44	43	1	1364000
2002	14	14	0	405000

Investments on borewells started during 1993-2000 but reached a peak after the ground water recharge benefits of watershed became visible in 2001 (Table 7).

Borewells grew at a much faster rate from the 3rd and 4th year of the watershed program. In the year 2001 alone Rs.13.64 lakhs was invested on borewells. A total of about Rs.24 lakhs was invested on borewells by farmers since the second year of implementation of the program – an amount far exceeding the total investment on the watershed works (Rs.14 lakhs)! (Figure 1.4).

Fig 1.4

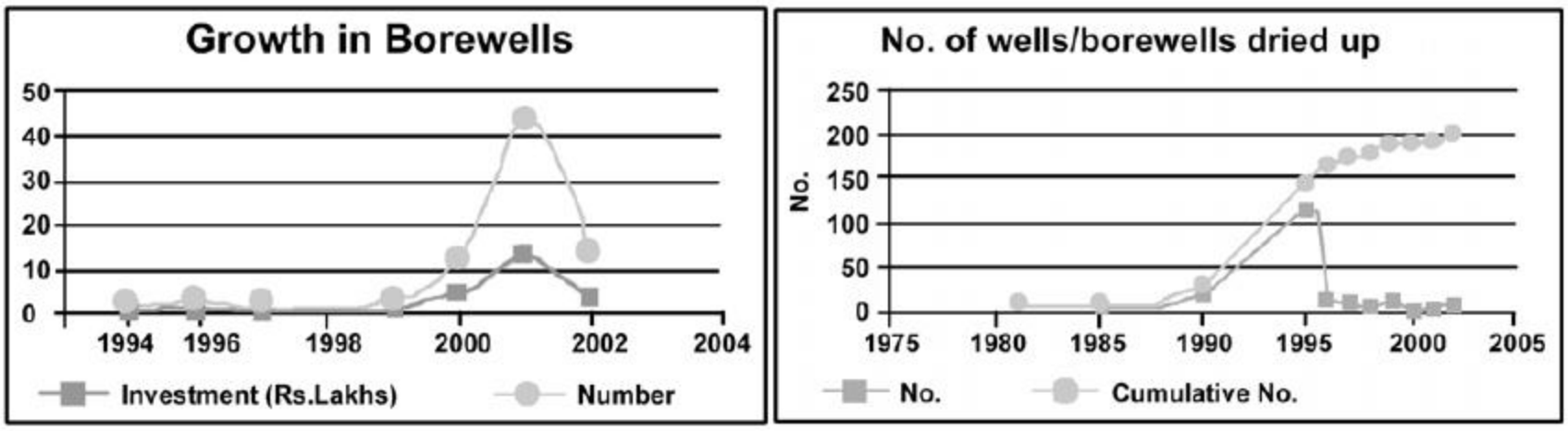


The open wells started drying up at a faster rate during the period 1990-95, just before the watershed program. While there was a total investment of Rs.56.79 lakhs on the wells up to 2002, 68% of this was non-functional by 1995. The crisis reached its peak.

This process of drying up of wells/ borewells almost stopped since the inception of the watershed program. Also, several new borewells came up as discussed earlier. Fig 1.5 shows the peaking of borewells, both in number and in investment during 2000 to 2001. These were years of low rainfall/ drought.

Watershed program thus gave a new lease of life for the ground water extraction infrastructure; but 'how long' it would last is the question.

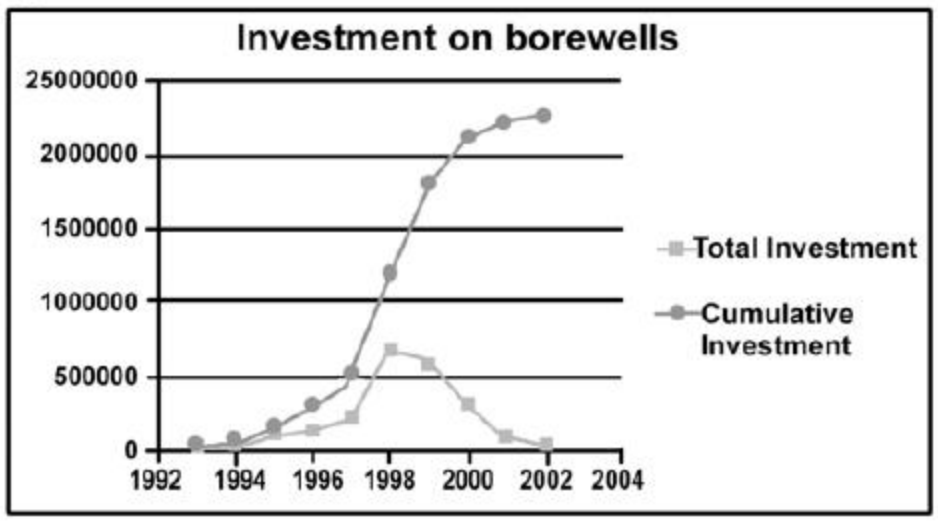
Fig 1.5 **Growth in borewells – No. of wells/ borewells dried up**



Mailaram

Watershed works catalysed spurt in borewell investments. Fig 1.6 clearly reveals this trend. Watershed works started in 1996-97 and borewell investments (including development of land under the borewell) started heavily from 1997-98 and within three years reached a peak. The investments during this period amounted to Rs.17.30 lakhs while the total investments on watershed works were at Rs.14 lakhs!

Fig 1.6



The source of investments were analysed in this watershed and are given in Table 8.

About 76% of the investments on borewells were made during the 5 years since the watershed program started. About 71% of

Table 8. **Year Wise Investment by Farmers on Bore Wells and related investments including land development (figures in Rs.)**

Year	Total Investment	Cumulative investment	Own / uddera*	Bank Loan	Private Loan
1993	10000	10000	10000	0	0
1994	46000	56000	36000	10000	0
1995	116000	172000	116000	0	0
1996	136000	308000	131000	5000	0
1997	215000	523000	170000	30000	15000
Pre-watershed	523000		463000	45000	15000
1998	685000	1208000	495000	115000	75000
1999	590000	1798000	415000	45000	130000
2000	320000	2118000	235000	40000	45000
2001	95000	2213000	60000	10000	25000
2002	40000	2253000	30000	0	10000
Post-watershed	1730000		1235000	210000	285000
%	100		71.38	12.14	16.47

* uddera: the traders and electrical shop owners invest on all the initial requirements and repayments are made from the crop harvests. If the payments are delayed interest is charged.

the investments came from own and deferred payments for the equipment (Uddera). Banks provided only 12% of the investments made by people.

Summary

Watershed program has substantial impacts on the groundwater recharge in spite of the weak processes in some of the watersheds. It also gave spurt to investments on borewells. In case of Chityal, watershed gave a new lease of life to the ground water discharging infrastructure and the rate of drying up of borewells declined. In the absence of institutional mechanisms for ground water regulation as part of the watershed program, the investments on borewells are prone to impending crisis.

There are no mechanisms to see that the recharged groundwater usage is equitable. Whoever are able to mobilise investments are accessing water. Only 12% of the investments in Mailaram were from institutional sources. Inequal access to credit may lead to inequal access to ground water.

The analysis suggests the need for dovetailing water-use regulation as an integral part of the watershed program. The regulatory instruments may be institutional norms like social regulation, building investments on ground water access as an integral part of the watershed program or an effective institutional credit linkage. These mechanisms should be established at the preparatory phase of the program itself.

Agreements on group borewells (and no private borewells) as a conditionality for watershed investments should be explored. There is a possibility, particularly with small and marginal farmers for whom mobilising investments on borewells will be an arduous task. The experience of A.P Well program provides a detailed process framework for this effort; but the critical point is to dovetail the borewell investments (credit linkage or convergence) with watershed program. The AP Water, Land and Trees Act (AP WALTA), albeit vague, provides a legal framework to work with. However, the experience of the study watersheds suggest the need for promoting local regulation on groundwater use as an essential component of implementing WALTA. The above analysis provides the contours of what could be an effective strategy.

Section 4

Impacts on Livestock

The general impacts on livestock observed during the participatory exercises were availability of drinking water sources at several locations within the watershed and increase in fodder. No clear trends were mentioned related to the changes in livestock population. During the course of the study a detailed household-wise livestock survey was carried out for Mailaram, Chityal and Kunkanur watersheds. The results are presented in this section. The data pertains to the entire village as it was difficult to separate households belonging to a particular watershed.

Mailaram

Tables 9 and 10 present the changes in the livestock before and after watershed program.

Substantial decline in the population of cows (60%) and buffaloes (46%) was observed. Bullock population increased by 16%; STs could get large numbers (42) of bullocks. This is attributed to increase in cultivated area of STs. Overall goat population remained relatively stable but the population shifted from BC households to STs. Sheep population also shifted from the traditional rearers to SCs and STs; their holdings increasing to about 75 to 85%. Overall livestock population increased by 4%. Though decrease in cows is observed in several other villages also, alarming rates of decrease in buffaloes mainly with BC community is a cause for concern. Reduction in buffaloes along with cows simultaneously is a trend contrary to the normal. The reasons are not clear.

Table 9. **Livestock (numbers) before and after the watershed in Mailaram**

Caste	Cows		Buffaloes		Oxen		Goats		Sheep		Total (Main)	
	B	A	B	A	B	A	B	A	B	A	Before	After
BC	40	14	62	24	59	35	51	19	150	122	362	214
OC	8	4	4	1	2	4	17	5	0	0	31	14
SC	63	25	13	14	48	45	73	50	8	82	205	216
ST	27	12	0	4	0	42	10	74	0	85	37	217
All	**138**	**55**	**79**	**43**	**109**	**126**	**151**	**148**	**158**	**289**	**635**	**661**
B: Before A : After												

Table 10. **Change in the livestock population (Nos.) : Mailaram**

	Cow	Buffaloes	Bullocks	Goats	Sheep	Total
BC	-26	-38	-24	-32	-28	-148
OC	-4	-3	2	-12	0	-17
SC	-38	1	-3	-23	74	11
ST	-15	4	42	64	85	180
All HH	-83	-36	17	-3	131	26
% Change	-60	-46	16	-2	83	4

These changes are complex to comprehend and their relation with respect to watershed interventions are not clear. No meaningful conclusions can be drawn from the analysis.

Chityal

Data analysed here (Table 11) pertains to the entire village and shows the impact of two watershed development programs implemented in the village.

Table 11. **Change in livestock holding before and after the watershed program**

	OC	BC	SC	ST	Total	% Change
Buffaloes	35	46	-16	26	91	+42%
Cows	-2	-53	-50	-113	-218	(-)55%
Bullocks	-10	-45	-110	-17	-182	(-)31%
Total Bovine	23	-52	-176	-104	-309	(-)26%
Goats	0	0	0	0	0	0
Sheep	10	160	-1	18	187	+14%
% Distribution of the total change in livestock – Caste-wise						
	OC	BC	SC	ST	Total	
Buffaloes	38	51	-18	29	100	
Cows	1	24	23	52	100	
Bullocks	5	25	60	9	100	
Sheep	5	86	-1	10	100	

The buffaloes increased by 42%; they seem to be replacing cows, whose population drastically decreased by 55%. People attributed this change to increased demand for milk production and increased fodder availability with individual farmers. Bullock population decreased by 31%, which was attributed to increased use of tractors. The total bovine population decreased by 26%. Sheep population increased by 14%. Goats are absent in the village owing to a social regulation (commonly agreed ban on goats) in the village since 20 years.

More alarming was the decline in the livestock holdings of SCs. The bovine population of SCs decreased by 56%. The reasons need to be further explored in depth. The possible reasons, given in Table 12, could be:

1. Decline in the area (approximately 210 acres) available for common grazing.
2. Increase in horticulture which might have reduced the area under share cropping with others where SCs provide inputs in terms of plough bullocks.
3. Shift to tractors for transport and ploughing.

The above reasons however need to be ascertained.

Table 12. **Area lost for common grazing**

Area brought under Protection	:	70 acres
Horticulture	:	100 acres
Irrigated area (2 crops)	:	50 acres
Total	:	210 acres
(*This data is for one watershed – the village has a second watershed also*)		

Kunkanur

The livestock impacts in the village are significant. The data presented in Table 13 represents the entire village where four watershed projects were implemented. The impacts are as a result of all the watershed projects in the village.

Table 13. **% Changes in livestock population**

Type		Total (Nos.)		Change	% Change
		Before	Present	Numbers	
1	Cows	150	284	134	89
2	Buffaloes	89	189	100	112
3	Bullocks	204	361	157	77
4	Goats	257	491	234	91
5	Sheep	820	933	113	14
6	Poultry	233	238	5	2
7	Pigs	40	5	-35	-88
	Total	1793	2501	708	39

All the livestock except pigs increased during the period including goats; most impressive is the change in buffaloes population. The changes in the livestock population are also as a result of activities of the revolving fund made available through self-help groups. 50 cows, 45 buffaloes, 95 sheep were partly financed through the revolving fund. It was also observed during the impact mapping exercises that fodder availability and drinking water for livestock increased. Mechanisation in the village was very low and increase in crop area might be a reason for increase in bullocks; more so for reasons of dependency on bullocks for transport.

Summary

Livestock impacts in the three watersheds vary and there are no clear trends. Decline in total bovine population including buffaloes observed in Mailaram needs to be further analysed. In Chityal, buffaloes are replacing cows while in Kunkanur the population of both cows and buffaloes increased. Bullock population increased in the cases of Mailaram and Kunkanur probably with the increase in cultivated area. Reduction in the number of buffaloes owned by SCs in Chityal is a cause for concern.

Sheep population increased in all the watersheds. Goat population increased in Kunkanur and marginally decreased (by 2%) in Mailaram. In Chityal there was a commonly agreed ban on goats. The negative impacts on small ruminants seem to be not significant. The linkages of these changes with watershed program need further probing and analysis.

Chapter 3

Analysis of Institutions

Institutions are central to the process approach. Of the total project budget 5% is allocated for capacity building and 5% for community organisation. It is envisaged in the program guidelines that the community will be organised into user groups and self-help groups which then constitute the Watershed Association. A watershed committee would be formed as an executive body for facilitating the implementation. The watershed association will sustain in the long run and provide a basis for further development. The watershed assets are to be transferred to the Gram Panchayat/ Watershed Association/ User Groups at the completion of the project.

Methodology

Groups, Watershed Committee, Watershed Association and Gram Panchayat are the major institutional players in the program. The study looked at the functioning of these institutions with respect to watershed investments. The methodology of analysis includes:

a) Separate focused group discussions with members from all the institutions.

b) Participatory institutional assessment exercise for generating information and analysis of the institutions - function and their role in watershed program.

c) Analysis of sample groups.

Analysis of Institutions

SHGs

The Self Help Group concept in the watershed programme was intended to focuss on groups indirectly dependent on the watershed resources with strong livelihood linkages. However, Thrift and Credit groups, both for men and women were promoted emphasising on savings and access to revolving fund. The individual watershed cases give the details of the sample groups studied. Groups were formed in all the watersheds. Substantial facilitation inputs went into organising the groups. In Edulapally and Chityal where NGOs were the implementing agencies there was a special focus on SHGs. In Chityal SDDPA federated the groups and also established a *Grama Abhivruddi Nidhi.*

In Mailaram men groups were formed who took loans out of the revolving fund and defaulted. In all the watersheds (except Chityal) group formation was taken up or continued under the regular program of DRDA. In Kunkanur watershed the group building efforts were carried forward under the AP Rural Livelihoods Project.

Many of the groups were defunct for several reasons and the revolving fund was not revolving at the time of the study. In Edulapally there was no facilitation from the organisation after the completion of the program. The members of defunct groups attribute the present status to lack of facilitation inputs after the program. In almost all watersheds, most of the groups that have taken revolving fund

were defunct and there were defaults in many other cases also.

It is seen in all watersheds that the SHGs did not have any significant role in watershed program. Most of these SHGs members were labourers. In Edulapally they had taken up nursery raising. In essence, though there were substantial community organisation inputs into SHGs, no specific role was created for them in the program.

User Groups

User groups, formed with people directly dependent on the watershed resources, were expected to play key role in planning for the resource concerned. This planning exercise, apart from deciding what activities were to be taken up, should include resource use, distribution, regulations, operation and maintenance. They were also supposed to take responsibility for the implementation by involving the labour groups and monitor the quality. As a token of participation they were expected to pay to the village Watershed Development Fund an amount of 5 to 10% of the investments on their lands. The User Groups should take group action, like collective accessing of inputs or non-pesticide pest management, that would benefit them. Both Self-Help and Users Groups are instrumental in institutional sustainability.

However, the importance of the User Groups was not understood and there were no user groups in most of the watersheds. Wherever they were formed they were only nominal and limited to paper.

Watershed Committee & Watershed Association

The primary groups were to federate into Watershed Association, which is the decision making and conflict resolving body. A Watershed Committee with representatives from all the groups is responsible for day to day execution of the works.

In all the watersheds, decision making rested with the watershed committees during the project implementation phase. But, none of the committees were meeting formally/ regularly after the completion of the watershed program. Neither do they perceive any regular functions to perform after the program.

In Edualapally, even the government did not recognise the watershed committee/ association when a new watershed was given to the village; a new watershed committee and secretary were chosen for the purpose.

The role of watershed association was also nominal during the post-project phase. There were no formal meetings after the completion of the program.

Watershed Development Fund

This fund formed out of the contributions from the Users (for amounts see Table 14) is a main instrument for sustaining the project benefits and maintenance over time was locked up in fixed deposits. In Chityal the watershed committee passed a resolution to use the fund but was not

Table 14. **WDF amounts in sample watersheds**

No.	Watershed	WDF Amount (Rs.)
1	Edulapally	1,20,000
2	Mailaram	75,000
3	Dadapur	40,000
4	Chityal	1,30,000
5	Kunkanur	98,000

allowed by the district administration. At the state level there was a decision not to allow usage of the watershed development fund. The control is not in the hands of the people who have contributed the amounts.

Gram Panchayat

Program guidelines prescribe that the assets created during implementation have to be transferred to the Gram Panchayats/ Watershed Association at the completion of the program. This was not done in any sample watershed. Members of the Panchayat in Edulapally felt that their role was minimum during and after completion of the program. However, they also felt that they could not effectively facilitate revival of the self-help groups as Panchayat has a political character.

In Edulapally, the Panchayat took an active role in the entry point activity – laying a road and constructing a water tank. While in the case of Chityal and Mailaram, Panchayats took a proactive role in the entire program. Sarpanches were presiding over all the Gram Sabha meetings. With the change of leadership after the elections in Chityal, the new Panchayat did not take any formal role. In spite of such involvement during the implementation of the program, the Panchayat did not take any role in maintenance of the watershed assets.

In Mailaram, Panchayat members felt that Gram Sabha meetings became effective with the watershed program. Though the watershed committee members did not meet regularly they were mobilising programs at times, a road for example. In Chityal, the committee played an important role in the food for work program.

Watershed program also resulted in human resource development and leadership among the villagers. It is reflected in their being absorbed into higher capacities in some of the mainstream programs. In Edulapally, watershed secretary was taken into the Velugu program. In Chityal the secretary was taken as a Watershed Development Team member by the DWMA. Another woman became Anganwadi teacher. In Kunkanur the emerging leadership challenged the established one during the Panchayat elections.

To sum up, though some of the watershed institutions were vibrant during the implementation phase, they were dysfunctional after completion of the project. Their post-project role was not well defined. The Watershed Development Fund, which is central to post-project sustenance, is locked up in fixed deposits; no institutional mechanisms were developed to manage it. The asset transfer to Gram Panchayats did not take place. The institutions, though appearing dysfunctional, may be 'dormant' and may come to life with proper facilitation and developing a functional agenda. This is indicated by their contribution in some programs like food for work.

Chapter 4

Imperatives of an Exit Strategy

The study brings out the substantive impacts of the watershed program and weak institutions at the point of exit of the projects. Wherever the interventions were technically appropriate the program resulted in substantial production impacts. Role of the processes of community organisation, planning and involving the community in execution would be paramount in bringing out these impacts. An analysis of these processes however, is not within the scope of the present study.

The study identifies three major areas of concern viz.,

1. Weak institutions
2. No mechanisms for maintenance
3. Unstructured growth processes

Various issues emerging from the study are analysed in the following section within these three areas. These issues may constitute the basic elements of a sustainable exit strategy for watershed development programs.

1. Institutions

Even strong watershed institutions like in Edulapalli and Chityal, though dynamic during the project period, could not assume a functional role after the implementation is complete. Same is the case with active Panchayats. Neither the watershed committees nor the Panchayats have watershed related management as a functional domain with clear funds and functionaries earmarked. The following points emerge from the analysis:

1. The functionality of the institutions beyond the project implementation period is important.
    i. The institutions evolved during the program should have primary responsibilities of maintenance of assets created, natural resource management and furthering the development process. If the institutions are oriented only towards 'implementation' during the project period then the institutions would not be sustainable.
    ii. These functions need to be integrated into the institutions from the very beginning of the program. How to build the above agenda within the institutional systems from the beginning is a key question.
2. For the institutions to sustain beyond the project period, a continuous agenda is important. Regularity of meetings is an important functional element of institutions. Since asset maintenance and NRM are not 'regular' functions in nature, some binding elements like thrift and credit being part of the core of these institutions may improve sustainability. Though SHGs were formed during the project and some of them were functional, they did not have much role in the program. How these thrift and credit functions/ institutions are integrated into the natural resources development and management agenda is an important issue.

3. The 'depth' of institutions is a matter of concern. Nominated bodies like watershed committees have low sustainability compared to institutions built on a federated group structure (SHGs and UGs) as envisaged in the guidelines. If the groups do not function, the probability of watershed institutions to survive is scanty. Similar may be the case for Panchayats also i.e. unless there are functional and decentralized participatory bodies, Panchayat Raj Institutions may not be able to sustain the processes of watershed development.
4. The investments and focused efforts on building institutions as above are far below the requirements.

2. Watershed Development Fund

The Watershed Guidelines of 1995 and the revised Guidelines of 2001 envisages that the Panchayats will take over the maintenance functions of the assets along with the watershed committee/ Association. Apparently from the experience of the five watersheds studies, this has not been a practical experience. The Watershed Development Fund created as an instrument for sustainability was not used as it was locked up in the fixed deposits awaiting a state policy. The following points emerge:

1. Sound institutions are a prerequisite for operationalising the instruments like Watershed Development Fund.
2. Since the WDF is an accrual/ revolving fund – the ability of an institution to handle revolving fund is important.
3. Ownership on the WDF is not there when it is built up from wage cuts rather than genuine contribution.
4. Process of building norms for using the WDF during the early phase of the program is important.
5. The practice of freezing the account till the completion of project implementation period would not give adequate working experience for this instrument to be functional. The fund should be operational from the first rainy season. The intense facilitation available during the project period would also help in crystallizing the functions. In this way, the experience of managing the fund, enforcing the norms would take roots within the community before the completion of the project.

3. Development Processes

It is important to sustain the development processes unleashed during the project period. The project and institutions at present are only focused on the implementation of the project works or structures. The study clearly brought out the equity and sustainability aspects of these impacts. Three of these elements are important:

1. Mobilising complementary investments: those who could mobilize complementary investments like working capital or investments for borewell are benefiting faster. There should be focused attempt at bridging the investment gaps between building a structure and making use of it for production, particularly for the poor. Investments therefore, need to be comprehensive. Expecting convergence or bank linkages to bridge this gap is whimsical. Since this has major equity implications, the investments need to be built into the watershed development program.

2. The growth in ground water extraction is chaotic. Much of this growth was stimulated by watershed investments. Building local regulatory group norms and coordinating investments on wells/ bore wells are important pre-investment activities. Enforcing such norms is an institutional function. Sufficient working experience need to be generated on these aspects within the watershed program.
3. Biomass regeneration is the weakest link both during and after the project period. It is also a reflection of the weak institutional and facilitation processes. Watershed development without biomass augmentation is unsustainable.

The dynamics of the institutions evolved during the project period and their orientation towards long term development objectives of the watershed program would be of paramount importance.

The above are important elements of an exit strategy. Fundamental aspect of the exit strategy as the above analysis shows is that it should start on day one of initiating the project and be part of all the facilitation processes.

Chapter 5

Summary and Conclusions

The study attempts to identify and capture the impacts of participatory watershed development program in Andhra Pradesh. The purpose is to understand the impacts through a quantitative analysis. Watershed development being a process oriented, institutional centric and an area based approach the methodology needs to be different. The study analysed the profile of investments and followed a participatory method called 'Impact Paths'[3] to explore the possible impacts. The significant impacts were analysed based on a sizable survey of the sample plots to quantify the changes before and after the watershed program. In terms of the facilitation processes these watersheds fall in the categories of 'poor' (one), medium (two) and 'good' (two) as perceived by the district administration. They are spread in four districts viz., Medak, Ranga Reddy, Mahabubnagar and Kurnool. The scope of the study is to understand the impacts of watersheds.

Investments on bunding range from 32 to 47% of the total (excluding management budgets) except in Kunkanur. Investments on gully control range from 7 to 16% of the total while that on water harvesting ranges from 29 to 42% with the exception of Kunkanur (65%). Masonry checkdams and percolation tanks occupy the major share in water harvesting investments. Soil conservation and water harvesting constitutes about 80% of the investments, where much of the investments went for water harvesting structures. Investments on horticulture and plantations range from 2 to 13%. Diversity of investments or components (an indicator of site specificity and participation) is low in all the watersheds except in Edulapally. The investment profile also indicates a total absence of focus on livestock. Very little efforts were made in improving biomass and almost no investments were made on diversifying crop patterns or related investments for productivity enhancement. The investments on bunding and soil conservation are more accessed by the poor, SC and ST communities relative to other investments.

Availability of water at multiple locations within the village used for multiple purposes is a major impact of the water harvesting structures in addition to ground water recharge. Drinking water for livestock, washing livestock, domestic uses, swimming etc., are some of the uses. There is substantial life around these water harvesting structures in the otherwise water starved villages. Direct irrigation through diversion channels, lifts and pot irrigation is also practiced in some cases but is not prominent.

The cost per cubic meter of storage created is much higher in masonry checkdams (18 to 531 rupees) when compared with earthen percolation tanks. In Edulapally 81% of the defunct open wells are revived after the watershed works. In other watersheds (except Kunkanur) there is a shift from open wells to bore wells. Irrigated area under the influence zone of water harvesting structures increased substantially – 5 times in Mailaram and 64% in Edulapally. 54% of the area was brought under irrigation under the influence zone in the sample structures in Dadapur. Crop pattern is not stabilised in Kunkanur while in Chityal the shift is towards horticulture crops.

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[31] See Ravindra A (2000), A Framework for Impact Assessment of Community Based Natural Resources Management Programs, Aga Khan Foundation (India), New Delhi & Books For Change, Bangalore

There is a shift towards borewells and high value crops in the influence zone. Ratio of the value of incremental production to the total investment on water harvesting structures ranges from 0.65 to 1.5 rupees indicating a very high rate of return and a quick pay back period of one or two years[4]. The visible recharge of ground water gave a spurt to complementary investments in repair of old wells, new borewells and land development. These induced private investments ranged from 1.78 to 3.1 times the investments on the water harvesting structures. Many of the water harvesting structures were constructed in the large farmers' lands and access to the recharged water depends on the capacity to mobilise complementary investments.

For quick and comprehensive returns on water harvesting investments it is important to plan for 'complete investments' i.e. land development and irrigation *a priori*. Group norms are important to regulate access to recharged ground water. These two steps are necessary for ensuring equity.

Irrigated horticulture as observed in few cases is imposing new vulnerabilities as farmers are forced to dig borewells once the existing ones fail. This needs to be closely looked into.

Though very few of the water harvesting structures breached and the maintenance requirements were low, the breached structures were not repaired. There were no high rainfall events so far. The users are non-existent as a group and the watershed committees are not active. The assets were not transferred to the Gram Panchayat/ Watershed Association as envisaged in the program guidelines. All these factors indicate absence of any institutional mechanisms for maintenance. The watershed development fund supposedly contributed by the farmers is locked up in the fixed deposits pending decision from the state and district administration.

For the impressive benefits of water harvesting to be sustainable, the institutional mechanisms need to be streamlined along with the watershed development fund.

To assess the impacts of land development investments, sample areas were surveyed plot wise along with the farmers. Land development investments per acre ranged from Rs.910 in Chityal to Rs.2,300 in Dadapur. Of the total bunds surveyed, 86% have good cross section and in 48% cases maintenance was not required. Of the remaining 52% - maintenance was not attempted in 71% cases indicating absence of any post-project maintenance systems. Most of the bunds that were not maintained were in the common lands or in the uncultivated lands.

The impacts are substantial wherever the land development interventions are technically appropriate. Diversity of investments is low indicating low local specificity. Not allowing locally relevant interventions like pebble bunding in stony lands resulted in poor impacts in some cases– indicating the inappropriateness of standardised technologies across the program.

Land development in fallow lands resulted in good impacts. Since only conservation investments were allowed, people had to mobilise complementary investments for clearing the land, deep ploughing etc. The need is for comprehensive investments required for bringing the lands back to cultivations.

Land development also resulted in good groundwater recharge in addition to moisture conservation. In some places there was a shift towards high value crops. The benefit-cost ratio of value of incremental

[4] The study period was also a low rainfall year. The recharge benefits will be much high in normal rainfall years.

production over the costs (investments on land development) ranges from 0.44 to 3.78 i.e. every rupee invested will result in an incremental production of 0.44 to 3.78 rupees in the first year itself. The minimum payback period is 2.5 years.

The investments on plantations and horticulture ranged from 6 to 22%. Since the gestation period of horticulture is not complete impacts could not be assessed. But the survival rates are good in Chityal and Kunkanur. The survival rate of plantations in other watersheds is poor.

Though there were changes in the livestock- the trends are mixed and the relation to the watershed program could not be properly established. No negative impacts on small ruminants were observed. Increase in bullock population is a common observation. In Chityal watershed there is an unusual decline in the livestock population of SC community, which may be related to the grazing restrictions on commons and promotion of horticulture; this however needs to be validated.

The groundwater impacts are significant. The study analysed the data from the field survey of all the borewells/ wells in three watersheds. In the other two there was not much scope for borewells due to geological features.

There was a general shift from open wells to borewells much before the watershed program. There was a spurt in investment on borewells immediately after the watershed treatment. In Dadapur the investment on borewells was 113% of the total watershed investments (on works). In Chityal ground water recharge gave a new lease of life to the dried up wells and borewells. Around 14 lakh rupees were invested on borewells in one year in Chityal to access the recharged water- an investment almost equal to the watershed works investment; this investment was 17 lakhs in Mailaram watershed. Only about 12% of investments in Mailaram were from institutional credit, the rest is either from own sources or borrowed at high rates of interest.

The analysis suggests the need for dovetailing water-use regulation as an integral part of the watershed program. The regulatory instruments and positive inducements could be- institutional norms like social regulation, building investments on ground water access as an integral part of the watershed program, an effective institutional credit linkage etc. These mechanisms have to be established at the preparatory phase of the program itself. In the absence of such *apriori* conditionalities and regulation, individual pursuit to access ground water is resulting in the common failures.

In contrast to the significant impacts of the watershed the institutional landscape shows a relatively gloomy picture in terms of post-project sustainability. The institutions were vibrant during the project implementation phase. The watershed development fund contributed by farmers and in some cases cut from the wage labour ranged from Rs.40,000 in Dadapur to Rs.1,30,000 in Chityal. The project facilitation ended with the completion of the program except in Chityal facilitated by SDDPA. The SHG groups were linked to the mainstream development programs, but it has no implications for sustainability of assets or institutions created in the watershed.

The newly formed institutions at the watershed level, including the User Groups were expected to play critical in post project development and sustainability. The Watershed Development Fund was supposed to be vibrant with regular accruals and the money utilised for development and maintenance of community assets. However, the watershed community did not have any control over the watershed

development fund, which in fact belongs to them. It was in fixed deposits under the instructions from the administration 'not to use'. The assets were not transferred to the Gram Panchayat/ Watershed Association as envisaged in the program guidelines.

The case of Edulapally, where the existing watershed committee was not considered for implementation of a second watershed program within the village exemplifies the insensitivity of the administration towards institutional sustainability. The project facilitation suddenly ended with completion of the program without much plans for sustainability.

To conclude, the watershed program has resulted in substantial impacts in terms of recharge of groundwater, improvements in production, expansion of irrigation and mobilising complementary investments. It has also made water available at multiple locations and for multiple purposes. The causes for concern are institutional sustainability, maintenance of assets and chaotic conditions around groundwater use. In fact the program now has to move from 'works centricity' towards institutions and resource management. This shift will provide a continuous agenda/ functions for the institutions evolved during the program and thereby ensure sustainability.

** ** **

Part II

Individual Watershed Reports

1. Edulapally Watershed

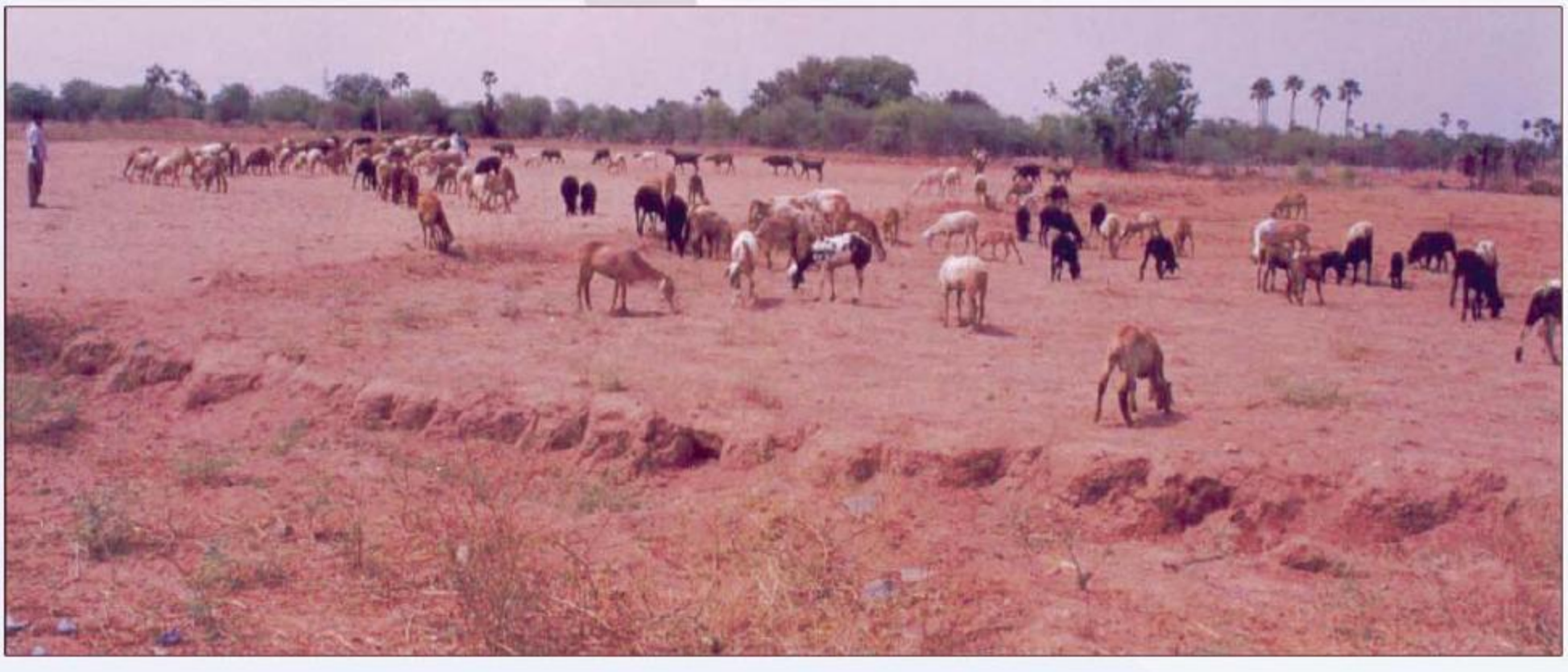
Village:***Edulapalli***

P.I.A:***DDS - KVK***

Mandal:***Jharasangam***

Period:***1996 - 2000***

District:***Medak***



Edulapally is one of the 12 watershed programs implemented by Krishi Vignan Kendra, DDS, Zaheerabad of Medak district. It's one of the first batch of DPAP watersheds in the state. Edulapally is situated on the Hyderabad –Mumbai national highway, 5 km away from Digwal village.

1. Village profile

The village has 403 households with one third of them being SCs. Marginal farmers constitute the largest percentage of the farming community (Table 1).

Of the total area of the village, 54% was taken up under watershed development in the first phase in 1996 (Table 2). This was completed in the year 2000. Rest of the area was developed under the second watershed program started in the year 2000 by another PIA.

Table 1. **Population details**

Total population	*1900*
SC	30%
BC & OC	70%
Households	*403*
Marginal Farmers	73%
Small Farmers	14%
Medium Farmers	8%
Large Farmers	5%

Table 2. **Details of village area**

	Details	Area (acres)	Area (ha)
1	Total area	2359	955
2	Cultivated area	2054	832
3	Selected watershed area	1285	520

Land use details

Out of 2359 acres, the major area is under Rain fed cultivation which is 77%. Irrigated land is 10%, fallow area is about 11% and others 2% (Table 3).

Table 3. **Land use profile**

Land type	Area		
	Acres	Ha	In %
Irrigated	247	100	10
Rain fed	1808	732	77
Fallow	264	107	11
Others	40	16	2

Soil Types

The watershed has predominantly black soils (Table 4). Map 1 presents the soil map of the village. During the resource map the black soils were classified into three types based on soil depth and fertility status – Type 1 has soil depth >3 feet, Type 3 with soil depth less than one foot and Type 2 with in between depth. The productivity status of these soils decreases from No.1 to 3.

Table 4. **Deatails of soil types**

Sl.No	Soil types	Area (acres)	%
1	B.C. – Type 1	500	21
2	B.C. – Type 2	500	21
3	B.C. – Type 3	700	30
4	Red	400	17
5	Stony	200	8.5
6	Gravel (Bardhu)	59	2.5

The slope is from west to east. Depth of soil decreases from west to east and there is sheet rock underneath the soil.

Drainage

The village has 3 streams draining the rain water. The watershed area is **not** clearly demarcated and is spread around these three streams. The watershed area of 520 ha is arrived basing on the treatment area. The Pedalonka Cheruvu (tank) in the south-west of the village receives water from Bidakanne forest situated outside the village.

Water Infrastructure

There are two main tanks (Pedalonka Cheruvu – on the south-west & Kappalakunta in the west) in the village. At present there is no irrigated area under these tanks. Main source of irrigation is through open wells. Though there are about 5 bore wells, they are not functioning. There is no potential for borewells due to some geological features (sheet rock underneath as per the villagers).

Drinking water for all the households in the village is supplied round the year through 3 surface water storage tanks with household and street tap connections. In addition there are 7 hand-pumps of which 4 are dried up (Table 5).

Table 5. **Water infrastructure**

Irrigation	
Total open wells	80
Working	11
Drinking	
Hand pumps	3
Taps	64

Major source of drinking water for the livestock is open wells, streams and tanks. Before watershed program, the tank in the nearby Medapally village provided drinking water for livestock during summer period.

Crops

The present cropping pattern is given in Map 2. There is negligible area under orchards, forest and pastures.

In the black soils (type 1 & 2) the following cropping systems are followed:

- Green gram (harvested by end August) followed by Sorghum
- Black gram followed by Bengal Gram
- Cotton – single crop; extends up to January – February

- Turmeric –with some irrigation
- Coriander
- Sugarcane - where irrigation is available

In the red soils and type 3 black soils the cropping patterns followed are:

- Pachha Jonna and Red gram as inter crop
- Sunflower / safflower
- turmeric, chillies, sugarcane - where irrigation is available.

2. Watershed Works - Investments Profile

Observations

Table 6 and Figures 1 and 2 give the details of the investments made in Edulapally watershed. Major part of the investments were made on soil conservation activities (38% on bunding and some part of the 13% on gully control). This is followed by the drainage line treatment and water harvesting structures. Major part of the investments (43%) went to SCs who are poor and who constitute 30% of the population. Gully control works are more in the ridge areas; these lands belong mostly to the SCs and BCs. Water harvesting structures (mainly checkdams) are mostly in the OCs lands (in the valley regions) and horticulture is more in the SCs lands. Map 3 shows the 4 year treatment plan, whereas Map 4 shows the actual treatment works carried out.

Fig 1.

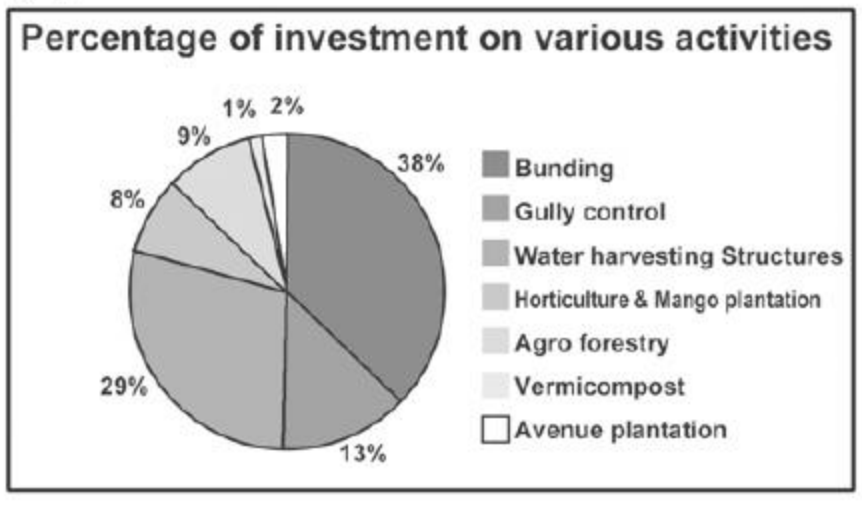
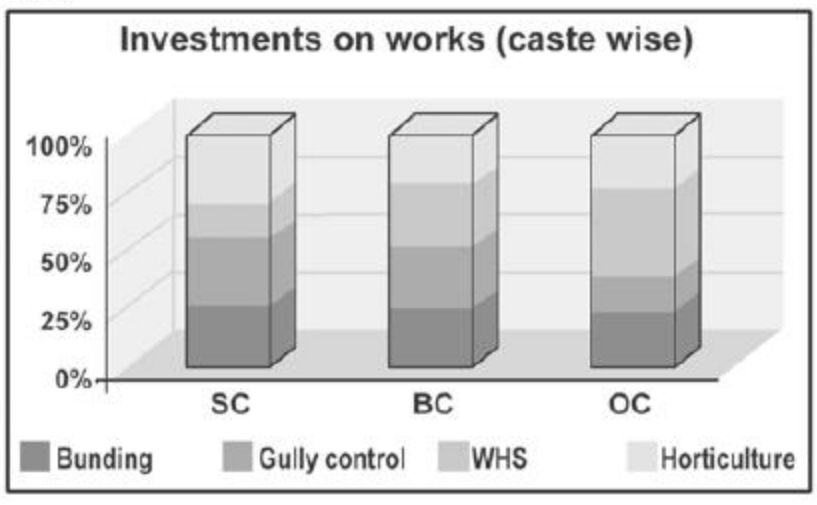


Fig 2.



3. Impact Assessment

Process

Analysis of Institutions

The study team had preliminary discussions with Panchayat, Watershed Committee and the PIA. The team also collected secondary data. The institutes that studied included Self Help Groups, Watershed Committee, Watershed Association and Gram Panchayat.

Impacts on SHGs were studied in detail. First total SHGs were identified and functioning and non-functioning groups were noted. Four sample groups in these categories were identified. Discussion

Table 6. **Watershed works - investments profile** *(financial figures in Lakh Rs.)*

S.No	Activity	Total village		SC		BC		OC		For all
		Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	
1	**Soil conservation**									
a)	**Bunding & bund vegetation**		**5.39**		**2.47**		**1.58**		**1.34**	
i)	Bunding (Ha)	281.05	5.2	123.22	2.28	85.38	1.58	72.4	1.34	
ii)	Stylo hemata (Ha)	84.93	0.064	84.93	0.064	0	0	0	0	
iii)	Agave (Ha)	66	0.063	66	0.063	0	0	0	0	
iv)	Palmyra (Ha)	75	0.064	75	0.064	0	0	0	0	
b)	**Gully control**		**1.92**		**1.02**		**0.57**		**0.33**	
i)	Loose boulder checks (Mts)	83	0.67	45.84	0.37	35.92	0.29	1.42	0.01	
ii)	Rock fill dams (Nos)	41	1.17	23	0.65	7	0.2	11	0.32	
iii)	Live checks (Nos)	73	0.077	0	0	73	0.077	0	0	
2	**Water Harvesting structures**		**4.20**		**1.14**		**1.33**		**1.73**	
i)	Check dams & katwas	6	4.14	0	1.08	0	1.33	0	1.73	
ii)	Soak pits (Nos)	2	0.02	2	0.02	0	0	0	0	
iii)	Recharged bores (Nos)	6	0.04	6	0.04	0	0	0	0	
3	**Horticulture & mango plantation (Ha)**	40	1.18	20	0.6	10	0.3	10	0.28	
4	**Strengthening of First year bunds**	0	0.013	0	0.013	0	0	0	0	
5	**Agro forestry**		**1.32**		**1.05**		**0.15**		**0.12**	
i)	Nursery (Nos)	75000	0.75	75000	0.75	0	0	0	0	
ii)	Plantation (Nos)	75000	0.57	40000	0.3	20000	0.15	15000	0.12	
6	**Vermicompost (Nos)**	1	0.14	1	0.14	0	0	0	0	
7	**Avenue plantation**	0	0.36	0	0	0	0	0	0	0.36
	Total		**14.52**		**6.43**		**3.93**		**3.8**	**0.36**

was organised with selected groups on the impacts of the watershed program on these groups. Group representatives, SHG members and watershed committee (about 60 persons- mainly women and 20 men) participated in these discussions and analysis.

Resource mapping

There were about 25 participants in this exercise, which included both men and women farmers, agricultural labourers and representatives of Gram Panchayat and Watershed Committee. In this exercise present resource map was drawn by the villagers which helped in identifying activities taken up in the watersheds. This also helped in exploring the possible impacts of the watershed activities.

Impact Mapping Exercise

There were 50 to 60 participants in this exercise out of which only 5 to 6 were women. This exercise resulted in identifying activities for impact study and mapping the impacts (development to well-being) – see Annex.1. Possible (geographical) areas where such impacts are visible were also identified during this exercise.

Sample survey

About 60 to 70 farmers were selected for this purpose. Watershed activities fall under three main areas : soil conservation, water harvesting and plantation. Representative patches of land which reflect the impacts of these three main areas were identified. The farmers belonging to these patches were identified and mobilised to cooperate in the study. Field survey in the selected patches were taken up in 4 teams with 6 volunteers from the village in each team.

Apart from the above exercises **Household survey on livestock & wells** was conducted as part of the study. **Meeting with labour group** which was planned did not materialize. The information and data collected were consolidated at the PIA level.

3.1 Analysis of Institutions

The following institutions are related to watershed development program in the village.

a. Self Help Groups
b. Watershed Committee
c. Watershed Association
d. Gram Panchayat

Self Help Groups

13 SHGs were formed as part of the watershed program of which 5 groups are of men – i.e. labour groups. Motivated by this, later 8 more groups were formed on their own with the help of watershed secretary taking the number of groups to 21. Eight groups were formed in the year 1997; followed by 6 in 1998; 2 in 1999 and 3 in 2000. Of these Men groups are 7; women groups are 14. The total number of members in all the groups is 297. The membership profile is as follows: SC - 38% (112), BC -52% (154) and OC 10% (31). About 50% of the households in the village were covered under these

groups.

Following are the broad observations on the Self Help Groups in the watershed programme based on the field interactions and study. Table 7 gives the details of the four SHGs that were studied in detail.

Women members' role in watershed was limited to wage earners by doing work. Some women took up activities like raising nursery and plantation. These groups joined other villages to form a Federation of SHGs.

When the study team visited the village only 3 women and all men groups were working. It is important to point here that the groups that were formed on their own initiative are functioning well. Another critical observation is that these groups are functioning well as they have not taken external loans. These groups are implementing the norms of a thrift and credit group strictly. There is no equal disbursement of loans and there is peer pressure for repayment of the loans. The new groups are not interested in availing the loan facility, as the old groups are defunct for this reason. Loans taken were utilized for consumption needs in majority of the cases.

Revolving fund (RF) was given to 13 SHGs in the watershed programme. This amount was divided pro-rata based on the membership in each group and distributed to each group. This RF initially revolved within the group but later the groups became dysfunctional. In the groups that have become defunct non repayment of loans is the basic cause, non-functioning of the watershed committee is also one of the reasons. Groups got defunct due to default of loans by 2 to 3 members. The bank loans also were not repaid. Debt amount (including bank loans) with the groups is around Rs. 8.7 lakhs. Revolving Fund of Rs.1,20,000 from DRDA given to 12 groups was kept in fixed deposit as the groups were not functioning. The self help group members expressed willingness to work together for revival if KVK (PIA) takes interest. The non-functioning groups are looking forward for support from the KVK and expressed that their intervention and support would help in reviving the groups.They felt leadership should be changed once the old debts are cleared and groups are revived. Gram Panchayat has not been able to influence the groups to revive them.

Research team could not interact with labour groups as they were not interested. They said that they have spent the watershed earnings based on the necessity.

Moulana, the watershed secretary who has facilitated the SHG formation in the Edulapally watershed later became a District Resource Person for the SHG and Manager of the MACS in Digwal. Two others who were active in Self Help Groups were absorbed into DDS in its works.

Table 7. **Details of sample self help groups studied**

	1	2	3	4
Name of the group	Dhanalakshmi	Minority	Mariamma	Mary Matha
Date of formation	10.02.97	24.02.97	28.02.97	13.06.00
No. of members	17	12	16	10
Caste	OC-14, BC-3	BC	SC	SC
Savings	10/- Weekly	50/- Monthly	10/- Weekly	10/- Weekly
Regular meetings	Weekly	Monthly 2nd night	No	Monthly for 2 Years
Internal lending	5000/- to 8000/- based on the needs	Within the group (min-500, max-5000 with 2/- interest	Based on the needs	Based on the needs with 2/- interest
Revolving fund	Nil	W/S – 98 –5000/- DRDA-99 – 10 000/-	W/S – 98 – 10 000/-	MG – 5000/- (Sarojini MACS)
Bank linkages	1-25 000/- 2-25 000/-	98-40 000/- 00-25 000/- 02-25 000/-	1-10 000/- 2-25 000/- 3-30 000/-	1-15 000/-
Amount distribution	Equal Distribution	Based on the necessity	Equal Distribution	MG-5 members: Bank Loan Equal Distribution
Usage	For personal needs	For t individual needs	For consumption needs	For individual livelihoods and personal consumption
Repayment	8 terms: but paid only 2 terms and stopped due to conflicts	3 terms: if not paid keep pressure on the person	No schedule	No schedule
Leadership rotation	No	No	No	No
Norms	Fine for not attending the meetings or late coming	Fine for late payment. If savings is not paid Rs.50/- fine is imposed in the next month	No norms	No specific norms
Role in W/S	No role and no relationship & participation	Some of them worked as labourers & also taken up works in their own fields	Taken up the activity of Nursery and Plantation and as labourers	Some worked as labourers, some near the check dam, also taken up nursery
Other activities	No	Participated in road laying and drainage works for 6 days (through W/S)	No	No
Functionality	Defunct	Working	Defunct	Stopped in the middle and restarted recently
Reasons	Misuse of powers by group leaders	Norms, understanding. Monthly one person goes to the bank for depositing with his own expenses	Non-payment of loans. Only leaders responsible for everything.	Personal conflicts between two members of the group.
Remarks	Bank loan now is Rs.9728/-	Properly working group	Now bank loan is Rs.40 000/- with interest. First group to be formed.	This Groups was formed by inspiration from other groups.

Watershed Committee

The Watershed Committe in the village Edulapally was formed with 11 members. Out of 11 Members, castewise representation is as follows: OC-4, BC-5, SC-2 + 1 WDT. The broad observations are as follows:

Women and men representation is almost equal in the Committee(Men-6, Women-5). During the implementation of the watershed project , regular meetings of Watershed Committee were held and decisions taken regarding various issues. These were later approved by the Watershed Association. Quarterly grama sabha meetings were conducted during which expenditure, balance amount and plans for future works were discussed.

Watershed Development Fund (WDF) was formed with contributions from the users. At present there is an amount of Rs.1 20 000 in the WDF. However, this fund is not being utilised for post project maintenance and / or activities. As there are no clear cut instructions on utilising this amount any decision regarding WDF is to be taken by the PD, DWMA. Interest can be used for repairs, but is not used till now.

Watershed Committee does not have any role in any village development activities other than watershed. At present the committee is not functioning. The committee met for the last time in early 2001 for giving a representation to the PD to nominate their committee for the second watershed that was sanctioned for the village in the year 2005. There are no separate user groups and labour groups in the village. Some of the SHG groups (men and women groups) have worked as labour groups and user groups.

Gram Panchayat

Gram Panchayat (GP) with 8 members has representation from SHG's, and WC . The entry point activity in the watershed project was implemented with the Panchayat along with WC. Laying roads and digging of a well for drinking water purpose was taken up as entry point activity. Later, a water tank was constructed with pipelines and tap connections.

GP felt that it has no role in watershed. They feel that PIA is an external agency and will leave after the programme. If the watershed is given to GP it knows the village conditions well, as it is a local body, and works can be implemented more effectively. They felt that their role is limited to conducting gram sabha and getting the required information for the PIA. If given some role in the process they can take up some village developmental activities. They've expressed that formation of CBO's like watershed association has reduced their role.

As of now GP has no responsibility in maintaining the assets. The Panchayat expressed that they can not take the role of the watershed committee to revive the groups. As Panchayat is a political body it can not resolve the conflicts within the groups.

Summary on Institution Analysis

- ❑ Most of the SHGs are not functioning at the time of the study excepting those formed on their own. Non re-payment of the loans is the reason for the groups becoming non-functional. Absence of an external facilitator is also shown as a major reason for being non-functional.
- ❑ The revolving fund meant for the SHGs is also not being revolved among groups/ within groups.
- ❑ The watershed committee is also not functioning. Last time it met was in early 2001.
- ❑ The WDF amount of Rs.120,000/ - is in fixed deposit with a local bank and is not being used for any purpose.
- ❑ The Panchayat has not taken any role during or after the program. The Panchayat expressed that they can not take the role of the watershed committee to revive the groups as it is a political body and therefore it can not resolve the conflicts within the groups.

In essence, the institutions created are dynamic during the program but are dormant/ non-functioning later on. They are expressing the need for strong facilitation inputs.

4. Impact Mapping (for general impacts)

This exercise was done with the users of the soil and water conservation structures. Some agricultural labourers also participated. Table 8 gives the uses of various structures as identified by the farmers in impact mapping.

Table 8. **Uses of various structures (as given by farmers in impact mapping)**

Structure	Identified uses
CCT, Bunding, LBC's, RFD's	❖ Land Leveled. ❖ Waste lands brought into cultivation in survey numbers169, 171, 172, 177 ❖ Increase in crop yields ❖ SC's were benefited most as labourers in these works. ❖ Some families purchased bullocks ❖ Income from labour is mostly used for consumption needs – not much asset creation has taken place. ❖ Migration reduced even after the program. ❖ Cleared the debts.
Check dams	❖ Water level in the wells increased. ❖ Rainfall was good in the year 2000-1. This has recharged the wells. There is water in the wells situated in the influence zone even though there are drought conditions for the next two consecutive years. (eg., Bangarappa Checkdam) ❖ Crop yield increased.
Katwa (Diversion dam)	❖ Crops grown (Chilli, Cotton, Turmeric). ❖ During summer also few wells did not dry up. ❖ Water levels in wells increased. ❖ Before the dam motor pump could be run only for 1 hour and now it is working for 3 hours continuously.
Nursery	❖ Earned wages.

4.1 Impacts on livelihoods

This exercise was done separately with the Gram Panchayat, Watershed committee and SHG leaders. Many of the following points emerged during the focused group discussions with the SHGs.

- ❑ People dependent on labour for their livelihoods were mostly involved in the watershed works.
- ❑ As a result of the watershed there is increase in wage days and daily wage rates and decrease in migration even after the program.
- ❑ Wages for agriculture labour has increased from Rs 25/ - to Rs 50/ -.
- ❑ The wages earned in the watershed program helped them not only to meet their consumption needs but also repay their debts.
- ❑ There is increase in demand for agricultural labour.
- ❑ Through loans one woman purchased a pair of goats and now she has 30 goats (till now sold 200) and another woman purchased buffalo and now there are three buffaloes.
- ❑ There are about 100 new houses constructed during the program, the wages and loans taken from SHGs are one of the sources of resource mobilization.
- ❑ Villagers are of the opinion that not much impact could be seen, as there are no rains since two years.

4.2 Impacts on the Village

- ❑ Before the watershed project there was no pucca road to the village and transportation was difficult even with little rainfall. Approach road was laid as part of the watershed entry point work (the labour component was contributed by the villagers). This made transportation to the village easy.
- ❑ A drinking water well was dug which reduced the scarcity of drinking water. An overhead water storage tank was constructed but is not yet operationalised. The Panchayat has taken this initiative (not related to watershed).
- ❑ Ground water level increased resulting in increase in the cultivable area.
- ❑ SCs were given assigned lands (pattas) long back and were left fallow. In the watershed project they brought these fallow lands (survey no-169) to cultivation by a combination of gully control and bunding works.
- ❑ Land was leveled in some fields due to bunding and crop yields increased.
- ❑ After watershed was completed, few people got employed in different government programs and DDS at various levels because of their active participation.

5. Impacts on Water

The major water related activities taken up were construction of checkdams and diversion dams (Katwa). The following exercises were taken up by the study team:

1. Impact mapping

2. Primary survey of three of the four checkdams and two Katwas. The survey methodology is as follows: First the demarcation of the influence zone was undertaken and farmers in the influence zone were identified. For mapping the changes participatory mapping exercise of the influence zone was done which included wells, total area of the influence zone and the irrigated area (before and after the construction of checkdams). Data was generated with all the farmers on well details, crop areas, production etc; before and after the construction of the structures.

5.1 General Impacts on Water Availability

Following broad observations emerged during the resource mapping exercise where about 30 persons participated. Table 9 analyses the purpose wise utility of the water bodies, before and after watershed programme. Table 10 gives the assessment of checkdams and katwas, which were studied in detail.

- Before watershed the main source of water was tanks and other wells in the village.
- After watershed ten bore wells were dug, but only two are working.
- Water from these bore wells is used for drinking, washing clothes and utensils.
- Farmers dug wells in their individual fields, near the check dams. Water from these wells is used for irrigation and also for livestock.
- Bore wells dug after watershed programme have almost failed, because of geological features. But dug wells are functioning.

Table 9. **Tabulation and analysis of water bodies**

No.	Main purpose	Source of the water body		Problems faced if any
		Before	Present	
1	Drinking water for livestock	Pond (Medapalli pond in neighboring village about 5 kms distance), wells	Three wells near Bangarappa Checkdam where major grazing land is located, provide water during the peak summer. During rainy season all WHS provide drinking water. A drinking water trough was also constructed.	These three wells are privately owned. It may be a problem in course of time.
2	Washing livestock	Tank and wells	Tank & Wells	Number of water bodies increased
3	Washing clothes	Tanks, wells	Hand-pumps, taps Also a checkdam constructed in another watershed.	
4	Cleaning utensils	Wells	Bore wells, taps	
5	Irrigation	Bore wells, wells, earthen seasonal diversion dams	Wells, pucca diversion dam - increased irrigated area.	

Table 10. **Qualitative assessment of the WHS**

Sl.no	Name of the water body	Approximate water storage capacity(cu. m)	Dries up in the month of	Silt depth	Desiltation	Recharged wells	Uses	Remarks
1	Bangarappa Checkdam-1	680	January	0.3	not done	4	Livestock :drinking & washing, Human: swimming, washing clothesby nearby farmers	No repairsneeded till now
2	Errolla Ramulu Checkdam-2	237.6	January	0.3	not done	4	Livestock: drinking, washing, Human: swimming	No repairsneeded till now
3	Isaka vagu Checkdam-3	171.6	March	0.3	first year taken up and later not done	7	Cattle drinking water, bathing	No rainfall since two years& hence no water storage (fed by over flow from a percolation tank above)
4	Gundu baavi Checkdam-4	520	March	No silt	Not necessary	6	Washing clothes, swimming, cattle-drinking & washing	trees were grown up along the stream & useful for the birds
5	Pittala vagu Katwa-1	107.25	March/ April	0.3	done	4	Cattle-drinking, washing clothes , direct irrigation	used for seepage water harvesting, no maintenance needed till now
6	Mottagu Katwa – 2	30	March/ April	0.3	not done	5	cattle-drinking, washing clothes, direct irrigation	used for seepage water harvesting, no maintenance needed till now
	Total	**1746.45**				**30**		

5.2 Impacts of Investment on Water Harvesting Structures

All the structures were intact and there was no need for repairs. There is siltation in all the structures excepting one; the quality of silt is good in all the structures. Only in one of the structures desiltation was done once. The checkdams are providing drinking water for livestock and for household chores like washing clothes, bathing and swimming (see Table 10).

There is water in all the structures till January. The Katwas flow till March/ April irrigating a total of 41.50 acres in normal rainfall years (2001 in this case). The period of survey was a drought year. For checkdam -1 the data was collected for the current drought year while for others the reference year is 2001-02, which is a normal year. The Check dam-1 received water even during the drought year. During the current year there was no water in all other structures and hence no irrigation. Particularly the lands irrigated by Katwas were left uncultivated; in anticipation of water they did not even cultivate the dry crops.

Table 11. **Summary of the wells in the influence zone of all (five) the surveyed water harvesting structures.**

Total farmers			Wells (Nos.)					
			Before		After the structures			
Caste	%	No. of farmers	Functioning	Defunct	Functioning	Rejuvenated	New	Defunct
SC	28.85	15	5	5	9	4	0	1
BC	30.77	16	0	5	6	5	1	0
OC	40.38	21	5	6	11	4	2	2
Total	***100***	***52***	***10***	***16***	***26***	***13***	***3***	***3***

The details of wells and irrigated areas under the WHS surveyed are given in Tables 11 and 12. The wells have a depth of 18 to 20 meters in the upper regions (near checkdam 1 and 2) and the others have 5 to 7 meters depth, but have sheet rock underneath.

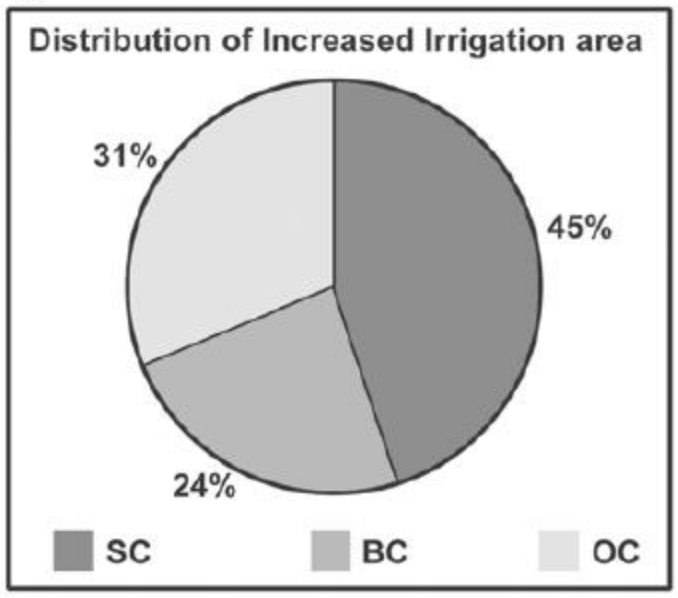
There are 52 farmers in the influence zone of all the 5 structures. These farmers have 26 open wells of which 61% are defunct. Three new open wells were dug after the water harvesting structures were constructed. 13 of the defunct 16 wells (81%) were rejuvenated while 3 are still defunct. During the drought year all the wells had some water but the yield was not sufficient for irrigation. The checkdams gave life to these wells.

Table 12. **Summary of the irrigated area in the influence zone of the surveyed water harvesting structures.**

	Total in the influence zone		Irrigated area before structures	Present irrigated area	Increase in Irrigated area	Increase irrigated area over 'before'	Distribution of irrigated area across castes
Caste	No. of farmers	Area acres	Acres	Acres	Acres	%	%
SC	15 (29%)	44.5 (27%)	20.5	27	6.5	32%	45%
BC	16 (31%)	34.4 (21%)	30.5	34	3.5	12%	24%
OC	21 (41%)	86.0 (52%)	39.5	44	4.5	11%	31%
Total	**52 (100%)**	**164.9 (100%)**	**90.5**	**105**	**14.5**	**16%**	**100**

After the construction of water harvesting structures 26 of the 29 open wells were desilted by the farmers on their own. Two of the three wells that are defunct were silted up and no maintenance was attempted. The experience shows that maintenance (costs about Rs.6000 to 8000 for 2 years) is a critical factor for keeping the wells functional. These defunct wells belong to the poor farmers who were unable to mobilize resources for maintenance. 11 of the desilted wells belongs to SCs and none of the new wells belong to SCs.

Fig 3.



For the 52 farmers in the influence zone of the WHS, the irrigated area increased by 14.5 acres i.e. by 16%. The percentage irrigated area in the influence zone increased from 55% to 64%. The irrigated area under SCs increased from 46% to 61% of their total area. Of the total increase in irrigated area 45% was in SC holdings (see Fig. 3). In addition, the structures also stabilized irrigation in an area of 90.5 acres already being irrigated by wells.

Of the total irrigated area of 105 acres 41.5 acres was under diversion dams (Katwas). These Katwas irrigate fields directly or fill-in the wells (for further lifting) from August to February. The checkdams only recharge wells but do not irrigate directly. The water from wells and Katwas is used mainly to

Table 13. **Changes in crop area, yield and production for the irrigated plots under the influence zone of five structures**

Sl No	Crop	Area				Production in quintals		Yield (q/acre)		Increase in yield (q/acre)
		Before		Present		Before	Present	Before	Present	
		Acs	%	Acs	%					
1	Sugarcane	8	9	3	3	2552	1050	319.0	350.0	31.0 (10 %)
2	Chilli	10.5	12	29.5	28	43.05	120.95	4.1	8.5	4.4 (107 %)
3	Turmeric	18	20	15.5	15	55.80	75.95	3.1	4.9	1.8 (58%)
4	Potato	0	0	4	4	0.00	168.00	0.0	42.0	No Crop Before
5	Wheat	9	10	6.75	6	51.30	47.25	5.7	7.0	1.3 (23%)
6	Cotton	0	0	19.5	18	0.00	156.00	0.0	8.0	No Crop Before
7	Bengal Gram	29.5	32	12.25	12	109.15	61.20	3.7	4.8	1.1 (30%)
8	Neella Jowar (Neella jonna) in summer*	1	1	7.5	7	7.00	49.00	7.0	7.0	0.0
9	Maize	0	0	1	1	0.00	Not Harvested	0.0	Not Harvested	No Crop Before
10	Green Gram	7	8	4	4	21.70	16.00	3.1	4.0	0.9 (29%)
11	Green Jowar (Pacha Jonna)	5	5	2	2	36.00	16.00	7.2	8.0	0.8 (11%)
12	Yevvalu (Oats)	2.5	3	0	0	20.00	0.00	8.0	0.0	Present no crop
	Total	**90.5**	**100**	**105**	**100**					

** Mainly for fodder & grain- a summer crop harvested in May*

provide critical irrigation before the watershed project. After construction of the water harvesting structures the quantum of water availabile increased.

5.3 Changes in Crops

The crop patterns were mapped for all the irrigated plots in the influence zone which were later aggregated for each structure. Table 13 presents consolidated data for all the five structures surveyed.

Data on total production for each irrigated plot surveyed was collected and per acre yield figures were computed by dividing the total area of the plot. This method was used because it is easy for farmers to remember production rather than give data on yield.

Table 14. **Production difference and its value in the irrigated plots in the influence zone of the five structures**

Sl.No	Crop	Increase in production (Qt.)	Rate Rs./Qt (current)	Value of production (Rs.)
1	Sugarcane	-1502.00	85	-127,670
2	Chillies	77.90	3000	233,700
3	Turmeric	20.15	2500	50,375
4	Potato	168.00	500	84,000
5	Wheat	-4.05	800	-3,240
6	Cotton	156.00	2500	390,000
7	Bengal gram	-47.95	1600	-76,720
8	Neela jowar	42.00	500	21,000
9	Green gram	-5.70	1400	-7,980
10	Green jowar	-20.00	400	-8,000
11	Yevvalu	-20.00	0	0
	Total			**555,465**

Table 14 gives the changes in cropping pattern in terms of production changes and the values thereof. Cotton and potato were the new crops accounting for 22% of irrigated area after the structures. There is substantial decrease in area under Bengal Gram compensated by increase in area under chilies (28% area) and cotton. Substantial yield improvements were reported in Chillies, turmeric, Bengal gram and wheat. Part of the yield improvement in Chillies and turmeric was due to varietal shift. Relatively assured availability of water is a factor behind crop and varietal shifts.

The annual value (gross) of increased production is Rs.5.55 lakhs. This increase pertains to a normal year. The project

Paradox of recharge zones!! *Box 1*

It is often argued that watershed development should be taken up only in areas that are recharge zones. For e.g., WDF & IGWDP watershed programs (implemented by NABARD) have stringent criteria to select watersheds only in recharge areas.

To the contrary Edulapally experience shows that watershed investments are economically viable even in areas where geological features restrict percolation. A conjunctive use of surface water and open wells make for efficient water use. The geological constraint on deep bore-wells also helps positively in terms of wider distribution of water through many open wells.

investment on the five water-harvesting structures was Rs. 3.5 lakhs (Rs.4.14 lakhs for 6 – Rs. 0.64 lakhs for 2nd). At this rate, the investments on WHS were recovered in terms of gross value of increase in production in the first year itself. The investments pay back in the first normal year even after discounting 30% of the increased value of production due to varietal shifts.

5.4 Complementary Investments

Capital formation in agriculture, particularly dry land agriculture is an important factor for sustaining growth in these regions.

The public infrastructure investments as in watershed projects usually give a spurt to the private investments in dry land areas. Table 15 presents the private investments made by the farmers in the influence zone of the WHS.

Table 15. **Complementary investment by farmers in the influence zone of the water harvesting structures**

		Unit cost	SC		BC		OC		Total	
No	Resource	Rs.	No	Amount	No	Amount	No	Amount	No	Amount
1	Desilting of open wells	7500	11	82500	6	45000	11	82500	28	210,000
2	New wells & electrical connection	60000	0	0	1	60000	2	120000	3	180,000
3	New bore wells	20000	0	0	0	0	2	40000	2	40,000
4	Steining of wells	60000	0	0	1	60000	0	0	1	60,000
5	Pipe lines	300 each pipe	0	0	0	0 pipes	300	90000	300	90,000
	Total			**82500 (14%)**		**165000 (28%)**		**332500 (58%)**	**334**	**580,000 (100%)**
6	Rejuvenated wells	30000	4	120000	2	60000	5	150000	11	330,000

The farmers' investments were substantial in desiltation of 28 wells. Of the total private investments (Rs.5.80 lakhs), one farmer invested Rs.1.50 lakhs in a failed borewell, an openwell, and 1800 meters pipe line to take water to his land (see Box 1). Private investments made by SC farmers was 14% while OCs invested the maximum i.e. 58% of total.

This is an area of great importance. The SCs benefited from watershed project. However, they could not mobilize the required private investments. The need is therefore, to provide access to supplementary investments to the poor farmers following public infrastructure investments. The institutional linkages particularly with banks, and group building process is of utmost importance in ensuring equity.

6. Land Development

Soil and Moisture Conservation Works

A total of Rs.7.31 lakhs was invested on about 281 ha for soil and moisture conservation. The nature of investments is given in Table 16.

Table 16. **Nature of investments in land development**

No	Activity	Total village		SC		BC		OC	
		Phy	Fin (Lakhs)	Phy	Fin (Lakhs)	Phy	Fin (Lakhs)	Phy	Fin (Lakhs)
a	**Soil conservation, Bunding & vegetation on bunds**		**5.391**		**2.471**		**1.58**		**1.34**
	Bunding (Ha)	281.05	5.2	123.22	2.28	85.38	1.58	72.4	1.34
	Stylo hemata (Ha)	84.93	0.064	84.93	0.064				
	Agave (Ha)	66	0.063	66	0.063				
	Palmyra (Ha)	75	0.064	75	0.064				
b	**Gully control**		**1.917**		**1.02**		**0.567**		**0.33**
	Loose boulder checks (Mts)	83	0.67	45.84	0.37	35.92	0.29	1.42	0.01
	Rock fill dams (Nos)	41	1.17	23	0.65	7	0.2	11	0.32
	Live Checks (Nos)	73	0.077	0	0	73	0.077	0	0

Note: Phy: Physical; Fin : Financial (in lakh rupees) (table with uniform decimal placing)

6.1 Sampling and study of impacts

In the resource mapping exercise three soil types were identified viz., red soils, stony soils and black cotton soils. The investments on black soils were very low (about 5%) and hence were ignored, in which drainage and field bunds were taken up. In the remaining two soil types gully control and field bunds were taken up. A sample of 151.5 acres (61.3 ha) i.e. about a ***sample of 22%*** of the total area where such works had been taken up was selected. This sample area was in two survey numbers 169 (red soils with 89.5 acres) and S. No. 177 (stony soils with 62 acres). These two blocks of area were taken up for impact assessment study.

The survey team has taken the help of local volunteers in surveying the area. A list of the farmers in the block was prepared. All the plots were mapped. Survey of the area was done along with the farmers for each plot in the area (similar to Net-Planning exercise). Bund quality, land use, crops and production changes were assessed for each plot. The data was compiled and consolidated. Five volunteers and about 50 farmers participated in this exercise along with the survey team.

6.2 Quality Assessment of Bunds

Good cross section, uniform top level, good grass cover and a spillway are the basic quality parameters of field bunds. Breaches, maintenance requirement, soil deposition behind the bund are the other indicators for quality assessment. The assessment of the bunds based on these parameters for the two sample blocks with a total area of 151.5 acres is presented in Table 17.

1. **Cross section:** The cross section was good in 99% of the bunds in the Red soils, but was of poor quality in the stony soils. Availability of soil for bunding depends on soil depth. As the soil depth

Table 17. **Quality assessment of sample bunds that were studied**

No	Bund characteristic	Quality	Red soils		Remarks	Stony soils		Remarks
			No.	%		NO.	%	
1	Cross section	Good (>40cm ht)	93	99.00	Soil depth is good	4	11.00	
		Average (Upto 40cm ht)	1	1.00		13	35.00	
		Poor (30cm ht)	0	0.00		20	54.00	Stony soil
2	Grass cover	Fully covered	23	25.00	Proper maintenance	0	0.00	
		Partially covered	66	70.00	Due to less amount of clay soil	35	95.00	Due to stone mixed soil
		Absent	5	5.00	No proper maintenance No rainfall after sowing	2	5.00	No proper maintenance No rainfall after sowing
3	Maintenance	Not Required	53	56.00	Less slope	6	16.00	
		Required	41	44.00		31	84.00	
		Done	20	49.00		5	16.00	
		Not Done	21	51.00	Economic backwardness Non-utilization of land	26	84.00	Economic backwardness Non-utilization of land
4	Soil deposition behind the bund	Upto 45cm	29	31.00		0	0.00	
		Upto 30cm	43	46.00		2	5.00	
		Upto 20cm	22	23.00	Less slope - hard soil	35	95.00	Less slope - hard soil
5	Top Level	Uniform	66	70.00		8	22.00	
		Not uniform	28	30.00	Undulated fields,stony soil	29	78.00	Stony soils, shallow depth of top soil.
6	Spill Way provided	Yes	79	84.00		2.0	5.00	
		No	15	16.00		35.0	95.00	
7	Bund Breached	Yes	15	16.00	No spillway provided	28.0	78.00	No spillway provided
		No	79	84.00		8.0	22.00	

is good in red soils the cross section could be maintained. The earthen bunds are inappropriate in the Stony soils as the soil is not available sufficiently. Since stone bunds/ pebble bunds were not encouraged (due to higher cost) only earthen bunds were taken up. This has resulted in poor quality bunds in the stony soil block.

2. **Grass cover:** About 70% of bunds in Red soils area and 95% in stony soils were partially covered by grass. This grass cover is mainly of local species. *Stylo hamata* sown on the bunds did not establish.

3. **Maintenance:** About 44% of the bunds required maintenance, out of which in 51% cases maintenance was not attempted. This percentage was higher in the stony soils. This points to lack of any institutional mechanism or individual drive to maintain the bunds. *The team observed that bunds were maintained where the land was under cultivation.*
4. **Soil deposition:** It was high in red soils and almost nil in stony soils. About 77% of the bunds in red soils had soil deposition of more than 0.30 mts. More soil deposition helps in quick leveling of the land; it may be through erosion or through farmers' own practices. The breached bunds (16%) obviously did not have any deposition.
5. **Top level, Spill way and Breaches:** About 16% of the bunds in red soils and 78% in stony soils were found breached. Lack of a spill way (in 16% of the cases), non-uniformity of the top level of the bund (in 30% of the cases) were the main reasons for breaches. Erosion of soil in between stones in the stony soils was the reason for higher percentage breaches in these lands.

6.3 Impacts of Soil and Moisture Conservation

The data related to these impacts pertain to the current year (2002-03), which happens to be a drought year.

Extended moisture retention capacity is a major impact of the soil conservation measures helping in the crops coping with small gaps in rainfall. Farmers observed that the moisture retention has doubled from 10 to 20 days in stony soils while this increased by 5 days in red soils.

Table 18. **Moisture retention and land use changes in the sample area**

Sample area	Moisture retention (days)		Remarks	Land use pattern (acres)				
	Before	Present		Before		Present		
				Fallow	Cultivated	Failed plantation	Fallow	Cultivated
Red soil (89.5 acres)	10	15	More percolation	56.5 (63%)	33 (27%)	14.5 (16%)	26 (29%)	49 (55%)
Stony soil (62 acres)	10	20	Less percolation	16 (26%)	46 (74%)	-	16 (26%)	46 (74%)

Stony soil block is a patta land where as the red soil block is an Assigned Land mainly belonging to SCs. Much of the area (74%) in stony soils was already under cultivation. There was no change in the land use pattern in the case of stony soils. Farmers observed that the area would have improved if the project helped them in removing small stones & bunding with these stones. This is called pebble/ stone bunding.

Fallow lands in the red soils decreased from 63% to 29%. The farmers in the assigned land in red soils also used bunding to demarcate individual plots in the assigned land. The gully control structures also helped in controlling erosion and diverting the small gullies which were causing erosion. The mango and teak plantations taken up in the cultivated area failed completely. Of the total 33 acres cultivated before, 14.5 acres that were brought under plantation remained fallow later on. Lack of

water source for critical irrigation was a reason attributed for the failure of plantation.

Of the total 56.5 acres of fallow land, 30.5 acres (54%) was brought under cultivation. The remaining 26 acres remained fallow as the owners of these lands could not mobilize further investments for bush clearance and deep ploughing. The investment needed was to the tune of about 3000 rupees per acre.

The changes in cropping patterns and production in the above sample area are given in Table 19. Intercropping of Red gram with Jowar expanded to almost all the cultivated area. Area under Jowar – Redgram intercropping increased from 30 to 48 acres in the red soil area. Two acres in stony soil area shifted to Safflower.

The production of Jowar in the total sample area increased by 212% (124.5 qt) and Red gram production increased by 93 qt. For the 50 farmers surveyed this increase in food grains amount to an average increase of 2.49 qt of Jowar and 1.86 qt of Red gram for each family. This increase in food grains would provide food security for about 4 months to a family with 5 members.
Yield of jowar increased by 1.17 qt per acre (55%) in red soils and 0.73 qt (70%) in stony soils; in Red gram the increase was 1.17 qt per acre and 0.31 qt in red and stony soils, respectively.

6.4 Value of the increased production

To arrive at the total benefits in the area where SMC works were taken up the following methodology was adopted.

Increase in the yield was taken as 1.17 quintals per acre in the red soils and third class black cotton soils (these lands are suggested to be of the same category by the farmers in the resource mapping exercise). The same was taken as 0.73 qt per acre in the stony soils.

In a resource mapping exercise three soil patterns were identified a) red soils (200 acres) b) stony soils (200 acres) and c) black cotton soils. The black cotton soils were further divided into three categories. The third category with low soil depth and mixed with stones (about 200 acres) was equated with the red soils in term of productivity; the rest would be the black cotton soils of first and second quality.

Of the total area of 281 ha (695 acres) taken up for soil moisture conservation in the entire watershed, 200 acres of red soil, 200 acres of third quality black cotton soil and 200 acres of stony soils were only considered for analysis.

The incremental increase in yield arrived at earlier from the sample area of 151.5 acres was considered for analysis (derived from Table 19). The results of this analysis are given in Table 20, the value of incremental production being Rs. 14.62 lakhs.

Table 19. **Crop pattern changes and production changes in the sample area**

Crop →	Total cultivated area in the sample		Jowar		Red gram (mixed crop with Jowar)		Safflower	
	Before	After	Before	After	Before	After	Before	After
Area (acres)								
Red soil	33	49	30	48	20	47.5	1	1
Stony soil	46	46	46	44	40	40	0	2
Total			***76***	***92***	***60***	***87.5***	***1***	***3***
Production (Quintals)								
Red soil			63.5	158	18	98.5	5	5
Stony soil			48	78	7.5	20	0	5
Total			**111.5**	**236**	**25.5**	**118.5**	**5**	**10**
Yield (qt/ ac)								
Red soil			2.12	3.29	0.90	2.07	5.00	5.00
Stony soil			1.04	1.77	0.19	0.50		2.50
Fodder production (Qtls) @								
Red soils			30	60	9 #	49.25		
Stony soils			72	144	3.75	10		
Total			**102**	**204**	**12.75**	**59.25**		

** A small plot of 0.5 acres where other crops were grown was ignored.*
 # assuming (as per farmers) half quintal red gram chaff per quintal of red gram.

Table 20. **Value of increased production in the total area taken up under soil and moisture conservation by extrapolation**

S.No.	Soil types (Grain)	Source	Area (Acres)	Increase in yield (Qt / acre)	Rate (Rs.)	Amount (Rs.)
1	Red soil	Jowar –grain	400	1.17	400	187,200
		Redgram - grain	400	1.17	1500	702,000
2	Stony soil	Jowar –grain	200	0.73	400	58,400
		Redgram - grain	200	0.31	1500	93,000
		Total Grain				**1040,600**
	Fodder					
1	Red soil	Jowar - fodder	400	1	200	80,000
		Redgram-chaff	400	1.5	500	300,000
2	Stony soil	Jowar - fodder	200	1	200	40,000
		Redgram-chaff	200	0.02	500	2,000
		Total fodder				**5,22,000**
	Total value of grain & fodder					**14,62,600**

6.5 Complementary Investments

A total of 120 acres of assigned land was brought under cultivation in the entire watershed. With the investments on bunding, farmers have made further investments on clearing bushes, removing dead root stock and deep ploughing. Case studies reveal that this would approximately costs Rs.3000/ - per acre. At this rate the complementary private investments mobilized by farmers for the 120 acres was in the order of Rs.3.60 lakhs i.e. about 49% of the total public investments. This does not include recurring expenses in manures, fertilizers, seed etc.

7. Impacts on Livestock

A household survey was conducted with a structured questionnaire to assess the livestock impacts. In the impact mapping exercise people observed decreasing trend in the cattle, particularly bullocks. Table 21 presents the changes in livestock numbers.

Table 21. **Changes in livestock population**

Type	Buffaloes	Cows	Bullocks	Goats
Before*	102	184	110	281
Present#	140	114	63	439
Change	+ 38	-70	-47	+158

** the base line data available with the PIA*
 # from the household survey

The buffaloes population increased by 37%, whereas there is a decline in the population of cows by 38%. Bullock numbers declined drastically by 43%. The population of goats increased by 56%. These trends – particularly that of increasing buffalo population replacing cows and bullocks follow the general trends in the state. Non-availability of livestock grazers (jeeta gadu), increase in the education of children, tractorisation, rearing the cattle during the off-season etc., are the factors generally attributed for these trends during the PRA exercises.

No clear causal relation with watershed treatment could be established for the above trends and

Table 22. **Benefit cost ratio for the first year**

No.	Item	Investment from watershed program (Rs.In lakhs)	Value of benefits (Rs. in lakhs)		Benefit - cost ratio	Complementary investments mobilized (Rs. In lakhs)		Ratio of complimentary investments to public investment
			Increase in grain	Increase in fodder	Without fodder	With fodder		
1.	Soil and moisture conservation	7.31	10.41	5.58	1.42	2.18	3.6	0.49
2.	Water harvesting structures (for total five of the 6 structures)	3.5	5.56	-	1.59	-	5.80	1.65
	Total	**10.81**	**15.97**	**5.58**	**1.48**	**1.99**	**9.18**	**0.85**
	For the total watershed expenditure	**20.00**			**0.80**	**1.08**		**0.46**

hence, the team desisted from any generalizations. Also, the situation of livestock is more dynamic and owes to multiple reasons which could not be captured here.

6.3 Benefit - Cost Ratios

The cost benefit ratios of soil and moisture conservation works, water harvesting structures and watershed as a whole are presented in Table 22 and the assumed cost benefit ratios over the investment life cycle are given in Table 23.

- The watershed investments pay back during the first year itself.
- Even not accounting for any other benefits (of social capital etc.), the total investments (Rs.20 lakhs) would also be paid back within one year if imputed value of fodder is considered.
- Each rupee of investment in soil conservation work generates a benefit of Rs.1.42 without imputing the value of fodder and Rs.2.18 with imputing the value of fodder.
- Each rupee of public investment in watershed would trigger private investment of Rs. 0.85/ -. These complimentary investments are critical to get the right returns on the watershed investments.

The complementary investments generated per rupee of public investment was higher (1.65) in the case of water harvesting structures compared to soil moisture conservation (0.49). This is mainly because the non-poor are able to mobilize quick investments if water is available & also, because much of the soil conservation works were taken up in the lands of poor.

Over the life cycle of the investment (assuming 5 years) – each rupee investment in watershed would generate Rs.6.16 of benefit without imputing the value of fodder and Rs.8.31 with imputing value of fodder. By any reason, even not valuing several other benefits like social capital formation, equity, several by-products etc., the investments in Edulapally watershed have generated high rates of return.

Table 23. **Benefit – cost ratios over the investment life cycle**
Assuming five years of productive life span of the watershed investments :

S.No.	Particulars	Assumptions	*Future value (at the end of the 5th year) Rs. in lakhs
1	The value of the investment (Rs.10.81 lakhs) at the end of the life span	10 % rate of interest 5 years life span	15.82
2	The value of the benefits (without imputed value of fodder) of Rs. 15.97 lakhs) at the end of the life span	10 % rate of interest 5 years life span	97.50
3	The value of the benefits with imputed value of fodder (of Rs. 21.55 lakhs) at the end of the life span	10 % rate of interest 5 years life span	131.56
	Benefit cost – ratio over the investment cycle of 5 years without fodder		**6.16**
	Benefit cost – ratio over the investment cycle of 5 years with imputed value of fodder		**8.31**

*Future value is arrived at by the compounding formula : FV = S x (1+r)^n where FV: future value of investment; S = current value of the investment; r = rate of interest and n= number of years.

Individual impacts - some examples

Moulana

Before the watershed Moulana was a milk vendor and was also working with a contractor. During watershed he was nominated as watershed secretary. He also worked with the groups in the village. Because of his active participation and experience at village level he was appointed as district level resource person by DRDA and also as mahila bank manager.

Aruna

Aruna's father is mentally retarded. During W/ S she was a Self Help Group member. Based on her performance and also interest in work, she has been assigned the work of animator in the village.

Manjula

Initially Manjuala was a book keeper for the groups in the village. Seeing her qualification, experience and active participation, DDS has appointed her as a staff member.

Shankar Patel

Shankar Patel is a big farmer. His land is near He has no well or bore well in the field and also no structure was laid either in his field or nearby fields during the W/ S programme. Due to drought conditions, he could not cultivate land. After W/ S he purchased land near a check dam. In that field he has dug a well to a depth of 7.2 yards and could get water in it. Now he uses this water in the field where there is no water.

Khajamiya - progressive steps towards becoming a farmer

Khajamiya's family depends on labour for livelihood. He got 5 acres land as lavani patta from the government in 1994. This land is at the bottom of the hill, with large gullies due to soil erosion. Also it is covered with bushes, shrubs and trees and hence it could not be cultivated. As this is the only asset, he decided to bring this land into cultivation inspite of all the odds.

First he has cut the trees and then laid the bunds through W/ S in 1997. He invested 5,000/ - per acre to bring this into cultivation. The investments were mobilized from moneylender.

Khajamiya invested Rs.5 000/ - per acre to bring the wasteland into cultivation. But he didn't get any income for the first three years. This shows that it is difficult for a poor farmer to bring wasteland into cultivation. The lands do not come into cultivation just by laying bunds but lot more efforts are needed.

Table 24. **Investments of a farmer – Khajamiya**

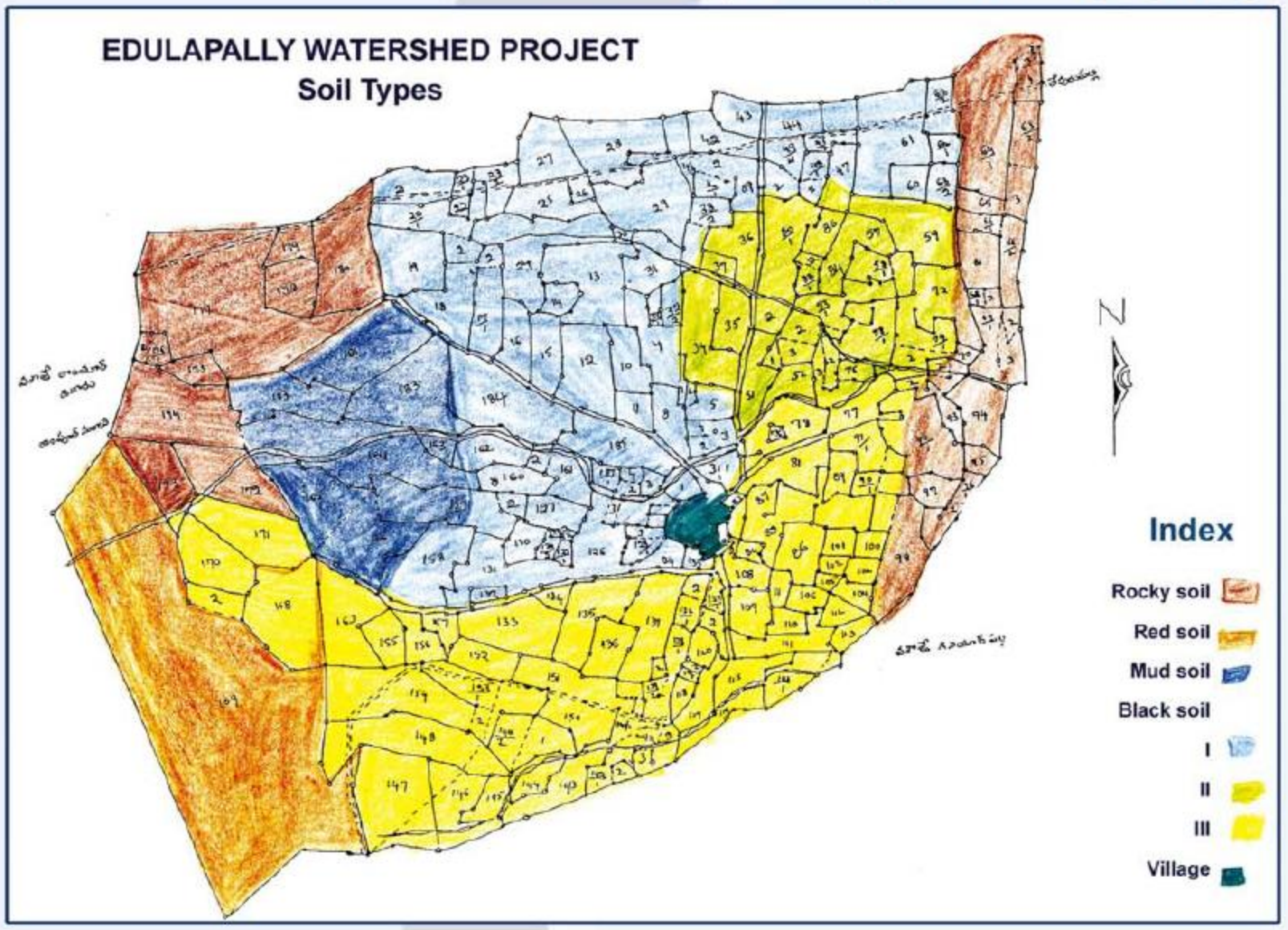
Sl.No	Activity	Year	Area	Expenditure	Income
1	Bush clearance	1996	5 acres	5 000	0
2	Bunding – WS Investment	1997	5 acres	6 000	0
3	Cultivating & sowing (Safflower 2 bags)	1998	3 acres	3 000	1500
4	Cultivating the land with own buffaloes and sowing Green Jowar & Red Gram & Purchasing the agricultural implements (2bags jowar, 0.5 bags red gram)	1999	3 acres	3 000	1500
	For three years			17 000	3 000
5	For growing the jowar and red gram a) FYM b) Repairs for bunds c) Cost of cultivation	2000 to 2002 2000 to 2002	3 acres 1 000	8 000 9000	Jowar- 15 000 Red Gram – 18 000
				18 000	**33 000**

Annexure : 1

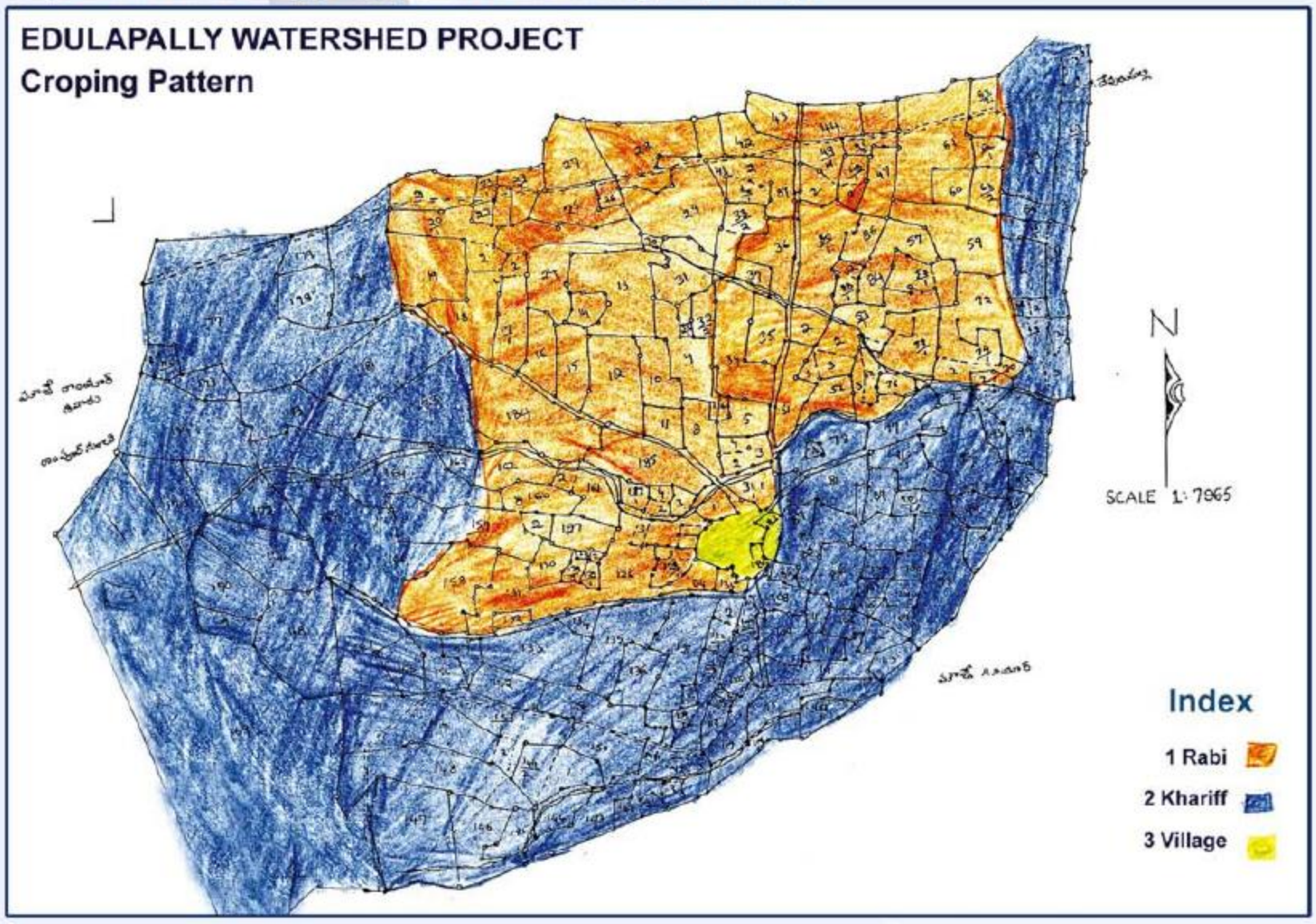
List of self help groups

Sl.no	Name of the group	Type	Date of formation	No. of members	Caste	Occupation	Status
1	Gulabi	Women	1-2-98	12	SC	Labour	Not Working
2	Deen Islam	Women	18-5-99	18	BC	Agril&labour	Not Working
3	Minority	Men	24-7-98	15	BC	Agril&labour	**Working**
4	Buddeswara	Men	17-3-98	13	BC	Agril&labour	**Working**
5	Ambedkar	Men	18-2-97	14	SC	Labour	**Working**
6	Jhansi	Women	3-3-97	15	SC	Labour	Not Working
7	Indira	Women	8-12-97	13	SC	Labour	Not Working
8	Marymatha	Women	13-5-99	15	SC	Labour	Not Working
9	Sadguru Sai	Women	16-5-00	15	OC	Agril.	Not Working
10	Sridatta Sai	Men	16-5-98	14	BC	Agril&labour	**Working**
11	Islam	Men	16-4-98	13	BC	Agril&labour	**Working**
12	Hussain	Women	16-4-98	12	BC	Agril&labour	Not Working
13	Mariamma	Women	28-2-97	13	SC	Labour	Not Working
14	Chaitanya	Men	28-2-00	12	BC	Agril&labour	Not Working
15	Balaji	Women	16-5-00	14	BC	Agril&labour	**Working**
16	Chettu	Women	3-3-97	15	SC	Labour	Not Working
17	Dhanalakshmi	Women	10-2-97	17	BC	Agril&labour	Not Working
18	Christu	Men	10-2-97	15	SC	Labour	Not Working
19	Bhavani	Women	29-4-97	13	BC	Agril&labour	Not Working
20	Lakshmi	Women	22-1-01	16	OC	Agril	**Working**
21	Bhavanimatha	Women	8-6-2000	13	BC	Agril&labour	**Working**

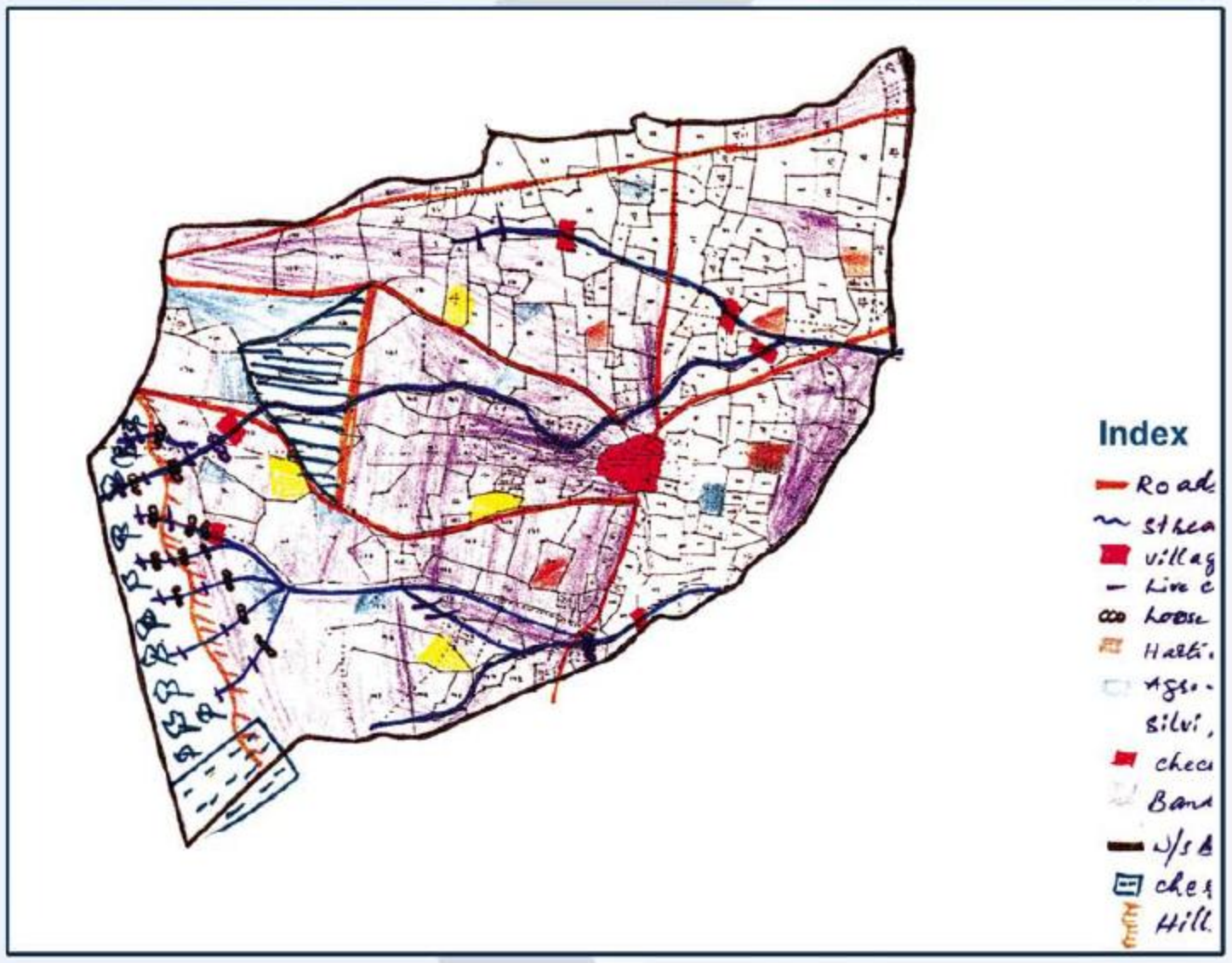
Map-1 **Soil types of Edulapally village**



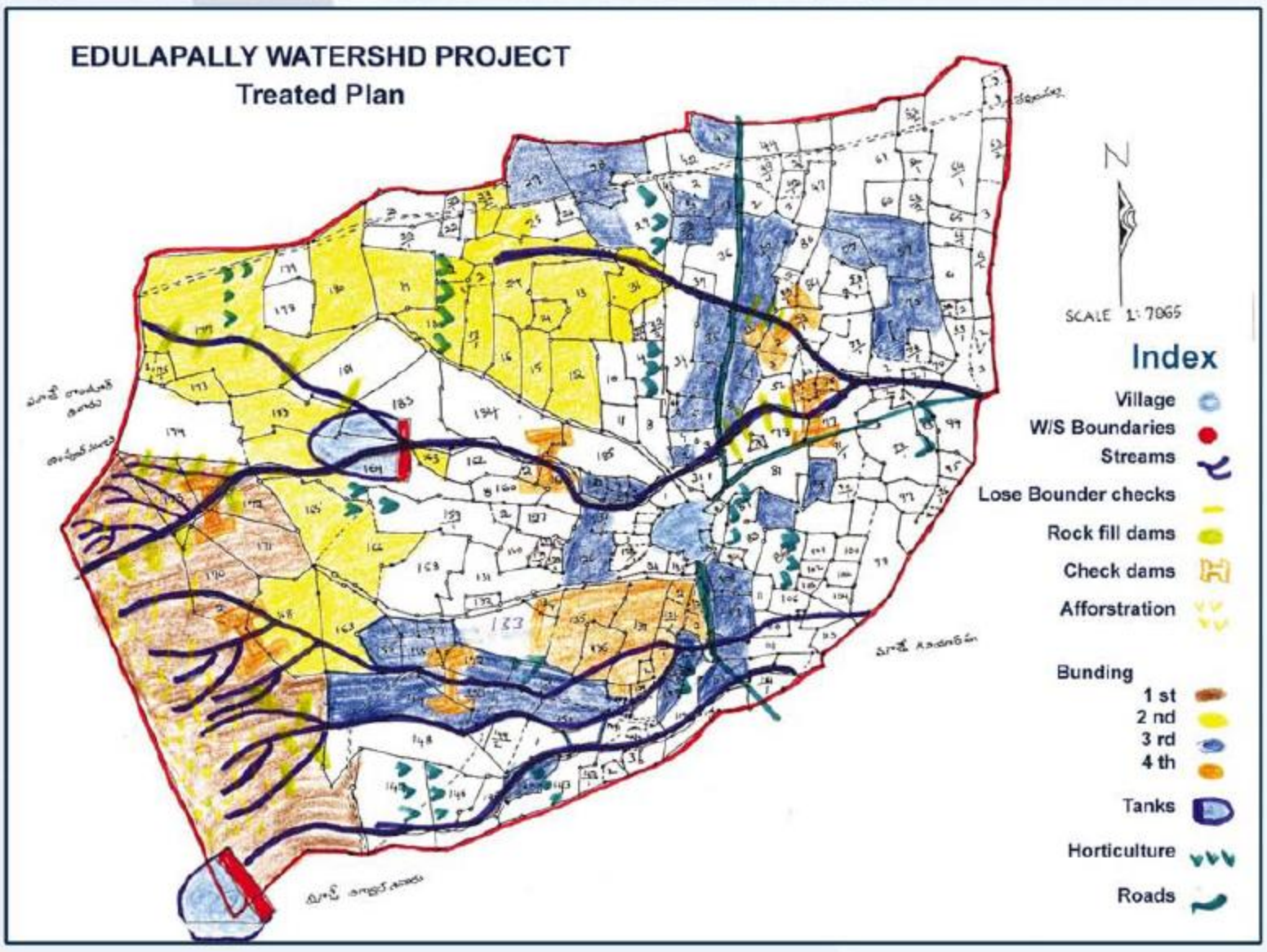
Map-2 **Present cropping pattern in Edulapally village**



Map-3 Four year treatment plan for Edulapally



Map-4 Actual treatment works carried out in Edulapally



2. Chityal Watershed

Village:***Chityal***

P.I.A:***SDDPA***

Mandal:***Wanaparthy***

Period:***1996-2000***

District:***Mahabubnagar***

Chityal is situated on Ghanpur and Wanaparthy road 3 km away from its mandal headquarter Wanaparthy in Mahabubnagar district. Watershed program was taken up in the village during 1996 - 2001. It is one of the first batch of watersheds and is implemented by SDDPA.

There are four hamlets in the main village. Two watersheds were allotted covering the entire village and its hamlets. Watershed boundaries within the village were not delineated. Applications for treatment were invited from the farmers and works carried out accordingly covering the entire village. This was showcased as one of the successful watersheds in the district.

1. Village Profile

Total population of the village is 5910 as per 2001 census. The area of the village is 1542 hectares (3809 acres). The area consists predominantly of dry lands (75%) and cultivable wastes (14%).

Soils are predominantly red soils (75%). Black saline soils constitute 13% and rest are mainly sandy loams. Black cotton soils are only 1% of the total area. Map 1 shows these details.

Fig 1

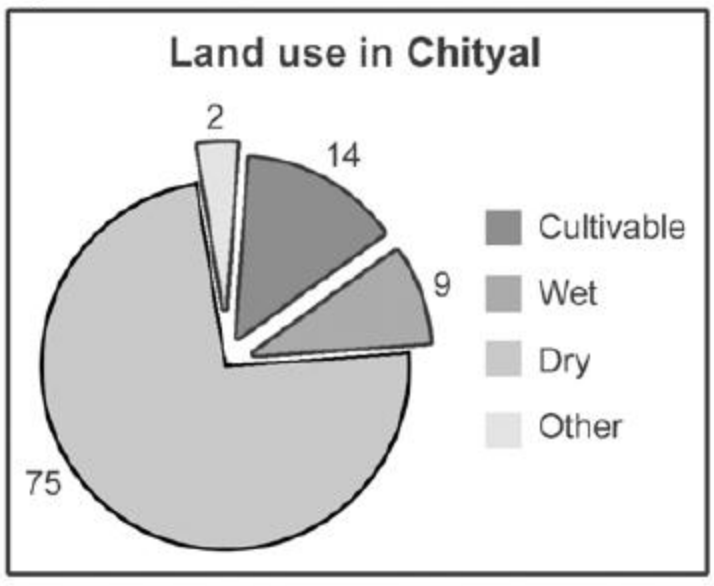
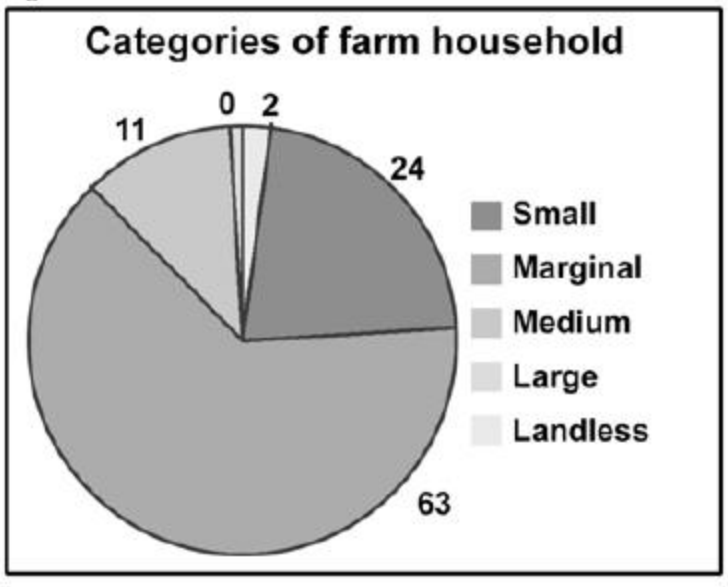


Fig 2



Dry lands (75%) and marginal farmers(63%) are predominant in farming (Fig. 1 & 2). Paddy and groundnut were the major irrigated crops. Jowar, castors were the major dryland crops constituting about 70% of the dry lands followed by maize (10%). Map 2 shows the land use pattern of Chityal village.

SDDPA - Society for Development of Drought Prone Area was registered under societies registration act 1860 on 6th oct. 1976. The management of SDDPA is by an Executive Committee with 9 members. The vision of the society is socially, politically, economically & environmentally healthy, harmonious and just society.

Mission of the society is to empower the powerless to build up such a society.

The society works in Mahabubnagar and Anantapur. It is involved in diversified areas like education, women development, agriculture, health care etc.

Table 1. **Water sources for irrigation**

Type	Open Wells	Bore Wells	Tanks & Kuntas
Total	213	25	
Functional	63	15	17

Source : Action Plan

Table 2. **Drinking water sources**

Bore wells	12
New	1
OH Tank	1

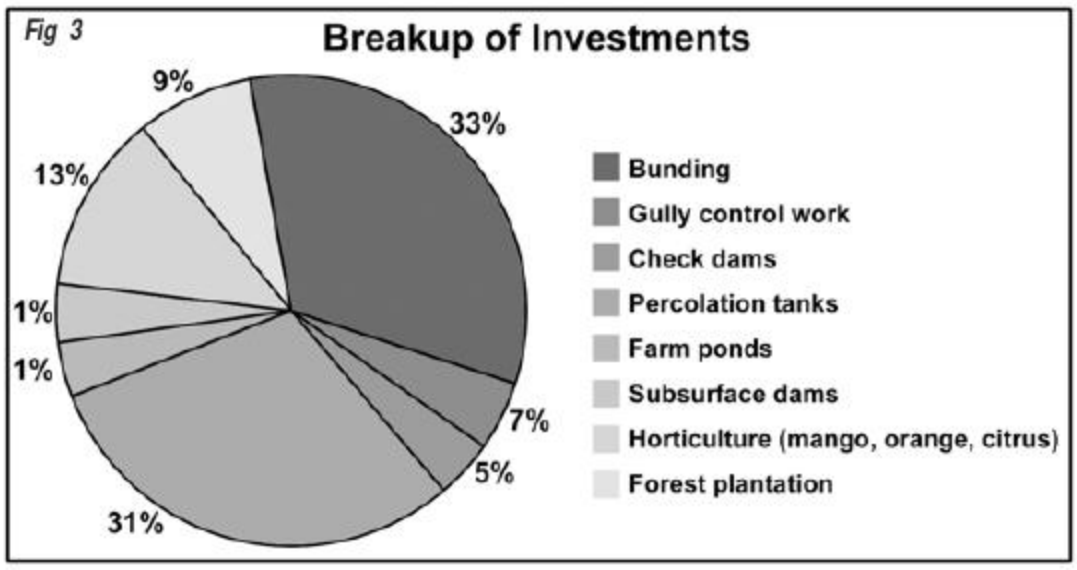
The village has 16 small tanks (kuntalu) and one big tank prior to watershed program. All these tanks have the traditional neerukatti i.e. the person responsible for water distribution. At the time of starting of the watershed program 63 of the total 213 open wells and 15 of the total 25 borewells were functioning. The village has protected drinking water facility but the hamlets depend on hand pumps and bore-wells for drinking water.

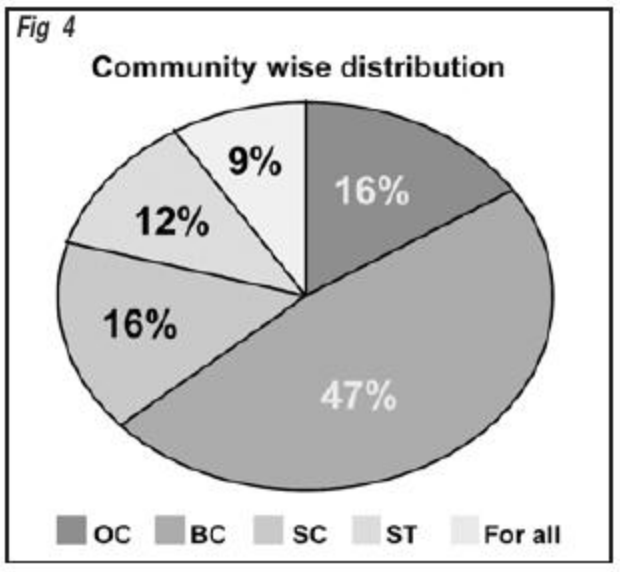
2. Watershed Works and Investments Profile

Map 3 gives the treatments carried out in the Chityal watershed. This was generated during the field study. Table 3 gives the financial and physical details of the watershed works and activities. Fig. 3 gives the activity wise break up of investments in percentage of total expenditure, whereas Fig. 4 gives the investments across various communities.

Table 3. **Watershed works and activities**

No	Activity	Total			OC		BC		SC		ST		Useful
		Area	Units (no)	Fin (Lakhs)	Qty	Amount (lakhs)	Quantity	Amount (lakhs)	Qty	Amount (lakhs)	Qty	Amount (lakhs)	for all
1	Bunding	250ha		4.54	46.4ha	0.8	129.84ha	2.36	32.96ha	0.6	40.8 ha	0.74	
2	Distributing stylo hamata			0.04									0.04
3	Gully control work	26ha	89	1.04	6no.	0.07	68no.	0.79	15no.	0.18	0	0	
4	Check dams	16ha	1	0.67	0	0	0	0	1no.	0.67	0	0	
5	Percolation tanks	142ha	6	4.44	1no.	0.74	3no.	2.22	1no.	0.74	1no.	0.74	
6	Farm ponds		4	0.2	0	0	4no.	0.2	0	0	0	0	
7	Subsurface dams		1	0.12			1	0.12					
8	Horticulture (mango, sweet lime, lime)	66ha		1.86	14ha	0.6	24ha	1.04	2ha	0.09	4ha	0.17	
9	Forest plantation	35		1.22									1.22
10	Sericulture		1	0.03	0	0	1no.	0.03	0	0	0	0	
	TOTAL			**14.16**		**2.21**		**6.76**		**2.28**		**1.65**	**1.26**
	Revolving Fund to SHGs			0.80									
	Entry point activity (for a temple)			0.80									





3. Impact Assessment

3.1 Analysis of Institutions

There are 39 Self Help Groups in the village consisting of 590 members. All are women groups. Caste wise break up of these members is as follows: 590 (SC-86; BC-381;OC-28; ST-95). Some salient features of SHGs are given in Table 4.

SDDPA was already involved in-group building in the village even prior to the watershed program. 11 groups were existing when the watershed started and 28 groups were formed during the watershed program (in two watersheds). Initially the watershed committee worked with the groups in information dissemination and planning. The groups did not have any other formal role in the watershed program other than providing manual labour individually.

Table 4. **Some salient features of SHGs**

Number of the groups	39 (total members 590 women)
Functioning groups	39
Year of formation	1995 –11 groups, 1996 – 2 groups, 1997 – 2 groups 1998 – 3 groups, 1999 – 14 groups, 2000 – 2 groups 2001 – 1 groups, 2002 – 3 groups, 2003 – 1 group
Amount of RF (Rs/-)	100,000(Watershed) 210,000 (from bank) 50,000 (SC Corporation) 120,000 (DRDA)
Deepam scheme	34 women received gas stoves
Utilization of loans	Loans given on the basis of purpose and necessity; used mainly for income generating activities. Loans are also taken for agriculture.
Role in watershed	Helped in information dissemination and planning.
Impacts	Decreased migration and indebtedness
Emergence of leadership	One woman was elected to Gram Panchayat
Present status of RF	Rotated once. At present no repayments and locked up

Detailed data sheets on the sample SHGs is presented in Annexure 1

All groups were functioning at the time of the survey and also some of the defunct groups were revived. Revolving fund was first given to 11 groups which was repaid. A **village development fund (*Grama Abhivrudhi Nidhi)*** was created to manage the Revolving Fund. Later in a gram Sabha, the organisation identified the artisans and the poorest (not in the groups) and facilitated advancing loans to them from this fund. This was an interest free loan to be repaid in 10 equal installments. The repayments stopped after 3 installments. The revolving fund thus, stopped from rotation, as there was no group pressure for repayments.

User Groups: They were formed nominally and are not functional.

Watershed Committee

In the Watershed Committee Of the total 11 members, one was woman-representing SHGs. Some details of the Watershed Committee are given in Table 5. The committee was active during the project period but not formally functioning at present. However, during the last drought period, the committee managed the drought relief works given to the village. The committee was not involved in any other development works in the village. The maintenance functions were also not followed up.

The total amount in Watershed Development Fund was Rs.1, 30,000. Though the committee passed a resolution to use WDF for income generation activities, it was not allowed, as there was no clarity at the Project Director's level on the use of WDF.

Table 5. **Details of functioning of Watershed Committee**

Date of formation	9-8-1996
Members	Total- 12; ST-1; SC-2; BC-7; OC-1; WDT-1
Watershed development fund	Rs.120, 000/-
Interest earned on WDF	Rs.5, 000/-
Utilization of WDF	Not yet used.
Functioning	Active and there were regular meetings during watershed program.
Emergence of leadership	One woman from watershed committee was elected to GP.
Individual development	Watershed secretary appointed as WDT for a Government PIA.
Post watershed – functioning/ not functioning	Not functioning.

Watershed Association

It is existing, but has nominal functional role. It is a registered entity. The watershed committee constructed a community hall from the funds available for SDDPA. The Watershed Association had not met formally since the completion of the program.

Gram Panchayat

There is a representative of Gram Panchayat in the watershed committee. There were good relations between the Panchayat and the committee. The Panchayat members were positive on the impacts of the program – particularly about reduced migration and increased wages during the program and

relief from indebtedness for some households. The Sarpanch in the earlier period used to preside over all the gram sabhas organized for watershed program. The present Panchayat did not have any formal role in the program and also did not take up any maintenance functions.

3.2 Impacts at the village level

The following general *social* impacts at the village level were identified during the initial exercises with the Panchayat and group leaders.

1. The primary school was upgraded to high school and presently there are 10 teachers working. Facilities such as health centre, protected drinking water, drainage, internal roads, transport and electricity were created. The role of leadership emerged from the watershed program like Satyanna, and the gram Panchayat.
2. People are actively participating in the government programs.
3. Some people have been employed in various other development programs.
4. Investments in productive activities such as leaf making, sheep rearing, dairy, petty business increased, which raised the income levels of many.

Building leadership

Satyanna Goud, a matriculate worked as an animator in SDDPA prior to the watershed program. Looking at his services he was taken as watershed secretary. He also got a state level prize in elocution competition on watersheds.

At the end of the program he was taken as a Watershed Development Team Member by DWMA.

Padma joined SHG when it first started and had become its leader. Once she assumed this position her in-laws stopped harassing her. She started earning after purchasing a sewing machine from group loan. She was appointed as an animator to maintain books of accounts and later had become Anganwadi teacher.

4. Impact Mapping

The impact mapping exercise was carried out at Pedda Bavi hamlet. The participation was limited due to sowings following the rains the previous day. About 18 (12 men+6 women) members participated in this exercise.

In the impact mapping exercise the following impacts were identified (Table 6).

Table 6. **Watershed works and activities**

No.	Structure	Impacts
1	Bunding	- Land leveled (after bunding). - Waste land brought into cultivation. - Increase in crop yield by about one quintal in Jowar. - Increase in soil moisture content. - Increase in soil moisture retention days
2	Farm ponds	Drinking water for livestock Stored water is being used for irrigation
3	Horticulture	Created income for labourers dependent on daily wages on a regular basis Extra income from wasteland.
4	Diversion drains	Water levels in wells increased. Recharging of bore wells.
5	Livestock	· Increase in number of buffaloes (due to increase in 'demand for milk') · Increase in sheep population · Decrease in bullock population · Rearing goats was banned even before the watershed program – but the regulation has become stringent as people are organized.
6	Overall	· Increased employment (from 3 to 8 months) during the implementation and reduced migration; but migration has increased again after completion of the watershed works – partly owing to drought. · Increase in daily wages from Rs.25/- to Rs. 50/-.

5. Impacts on Water

Water Availability

The sources of water for livestock purposes (drinking and washing) have increased because of the water harvesting structures. Public distribution system for drinking water was established recently, which also serves as a source of drinking water for livestock ; 12 hand pumps are also functional and are used for this purpose. There is no scarcity of drinking water for the village community.

Table 7. **Water harvesting structure - details and impacts**

Sl.No	Name of the water body	Water spread area (sq.m)	Approx. water storage capacity (cu.m)	Dries up in the month of	Silt depth (m)	Desiltation taken up	Water level increased in no. of wells	Uses	Remarks
1	Shanthanna kunta	2500	825	Jan	0	NA	5	Drinking water for live stock, washing livestock and irrigation (recharging)	No respon-sibility on kuntas
2	Savaraiah kunta	2900	957	Jan	0	NA	6	Drinking water for live stock, washing livestock and irrigation (recharging)	
3	Balanagaiah kunta	3500	1155	Feb	0	NA	5	Drinking water for live stock, washing livestock and irrigation (recharging)	
4	Kammari Dharmaiah kunta	3165	1045	Feb	0	NA	4	Drinking water for live stock, washing livestock and irrigation (recharging)	
5	Baleswaraiah kunta	3665	1209	Feb	0	NA	5	Irrigation (recharging)	
6	Vasudevamma kunta	2165	714	Feb	0	NA	4	Irrigation (recharging)	
7	Check Dam	630	126	Doesn't dry	0.6	Not done	4	Irrigation (recharging)	Silt to be removed under FFW
	Total	**18525**	**6031**				**33**		

Six percolation tanks and one check dam were constructed in the watershed program (see Table 7). A total of about 6000cu.m storage capacity was created. While the check dam is perennial, others dry between January and February. Siltation in the structures is negligible expect in the check dam. Systems for maintenance were not in place. There were no maintenance requirements at the time of survey. The structures are mainly used for livestock purposes and supporting well irrigation by recharging them. These details are given in Table 8.

Table 8. **Details of the influence zone of the water harvesting structures**

Sl.No	Name of the water body	Approx. water storage capacity (cu.m)	Cost of the structure (Rs. lakhs)	Total area of the influence zone (acres)	Area irrigated by wells	Total No. of farmers	SC & ST	BC	OC
1	Shanthanna kunta	825	0.8	24	20.5	8	0	8	0
2	Savaraiah kunta	957	0.95	37	25.5	6	1	5	
3	Balanagaiah kunta	1155	0.42	43	43	6	0	6	0
4	Kammari Dharmaiah kunta	1045	0.64	44	24	4	0	4	0
5	Baleswaraiah kunta	1209	0.81	24	19	6	0	6	0
6	Vasudevamma kunta	714	0.82	9.5	5	6	4	1	1
7	Check Dam	126	0.67	31	30	4	3	1	0
	Total	**6031**	**5.11**	**212.5**	**167**	**40**	**8**	**31**	**1**

Note: Except for Storage capacity, the other data was taken from secondary sources, Highlighted structures were taken for sample study

The above details were derived from the secondary data available with the Secretary of the watershed. The storage capacity was calculated with some assumptions. Of the total area of 212.5 acres under the influence zone (where 40 farmers were asked to contribute) 78% area was brought under irrigation.

Of the seven WHS, one check dam and two percolation tanks viz., Baleswaraiah kunta in the ridge and Savaraiah kunta in the middle were selected for detailed study. The team surveyed the individual plots under the influence zone of the structure. Plot-wise data on area, crops in different seasons, irrigation, production and farmers' particulars was generated by group exercises and individual survey with the farmers in the influence zone. These details are provided in Table 9.

Table 9. **Data on wells in the influence zone of the three sample WHS**

Caste	No. of farmers		Open wells					New borewells	
			Before		Present				
	No.	%	Fun-ctional	Defunct	Fun-ctional	Defunct	New	Fun-ctional	Failed
SC	3	30	3	0	3	0	0	0	0
BC	5	50	5	0	1	4	0	3	2
OC	2	20	2	0	1	1	0	3	7
Total	**10**	**100**	**10**	**0**	**5**	**5**	**0**	**6**	**9**

Horticulture, Bore wells and Debt Traps!!

Venkataiah one of the poor BC farmer has 6 acres land under the Savaraiah Kunta. He has an open well. After the percolation tank water level in the well increased. He used to cultivate paddy in 2 acres (followed by groundnut in Rabi) and Jowar in 3 acres. One acre was left fallow.

As part of the watershed program he converted 5 acres of his land into *lemon and mandarins (Battai/ mosambi)* plantations. He protected the orchard carefully for 2 years. His neighbour dug a borewell that resulted in drying up of his open well. All other open wells also dried up with this borewell.

Caught with the situation, Venkataiah did not have any option than to go for a bore-well to protect his 2 years orchard. He borrowed Rs.10, 000/- from neighbors. He dug 5 boreholes and only one succeeded in having water. Even this bore well does not have sufficient water to irrigate the plants. He incurred a total cost of Rs.1.05 lakhs-borrowing Rs.95,000/- at 36% annual rate of interest!!

Of the total 10 open wells that existed before the watershed program in the three sample structures, five had become defunct at the time of the survey (post-watershed). No new open wells have come up. Of the 15 new bore wells dug after the watershed program, 9 (60%) have become defunct quickly. There are 13 failed attempts to dig bore wells for these farmers.

It was observed by the farmers that initially water level in the open wells increased. But when farmers shifted to bore wells 50% of these open wells dried up.

Analysis of the data on the land use, crop and irrigation patterns generated from the field survey of the sample three water harvesting structures is presented below (see Table 10).

Table 10. **Land use in the influence zone of the sample structures – area in acres**

	Total Area	Fallow	Irrigated		Non-irrigated
			Crops	Orchard@	Crops#
Before	86.5	48	27.5	0	11
After	86.5	27	27	18	14.5
Change		21	-0.5	18	3.5
% Change		43%reduced	2%decrease	100%increase	32%increase

Source: Survey of land in three structures

#This increase was due to bunding activity @taken up under the horticulture program within watershed (irrigated)

Fallow lands decreased by 43% - much of these lands were brought into irrigated orchards and dry land crops. Some of the loss of irrigated crop area due to drying up of wells was also compensated.

The net cultivated area within the influence zone increased by about 24%. The gross cultivated area also increased. The cropping intensity in the irrigated area of the influence zone increased from 118 to 152 per cent (Table 11).

In the following the changes in crop-wise area, production and yield are discussed (Fig 4 & Table 12).

Fig 4 **Change in land use**

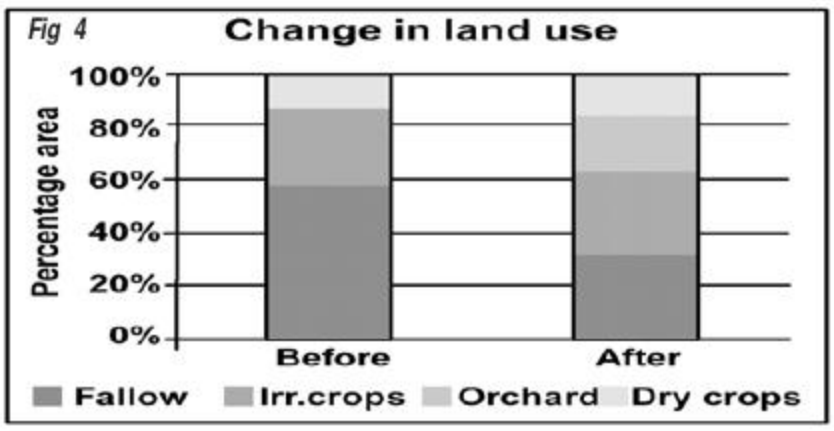


Table 11. **Cropping in the irrigated areas**

Area under crops (acres) in irrigated lands

	Kharif	Rabi
Before	17.5	15
After	26	15
Change in area	8.5	0

Net Cultivated Area (NCA):

	NCA	% of Total area in the influence zone
Before	38.5	45%
After	59.5	69%

Gross cultivated area (GCA) & cropping intensity in the irrigated lands

	GCA	Crop intensity (%)
Before	32.5	118.18
after	41	151.85

NCA: Total area – Fallow lands

GCA in irrigated lands (excluding orchards): (Area under Kharif + Area under Rabi) /net irrigated area x 100

Cropping intensity: GCA/Net irrigated area x 100

Table 12. **Changes in area, production and yield in the influence zone of the sample three water harvesting structures**

No	Crop	Area (Acres)			Production (Quintal)			Productivity (Quintal per acre)		
		Before	After	Change	Before	After	Change	Before	After	Change
1	Paddy									
	Kharif	15.5	24.5	9.0	322	616	294	20.77	25.14	4.37
	Rabi	0.5	2.5	2.0	10.5	56	45.5	21.00	22.40	1.40
2	*Groundnut*									
	Kharif	1	0.5	(- 0.5)	6.67	3.33	(-3.34)	6.67	6.67	0
	Rabi	13	11.5	(- 1.5)	88.33	91.67	3.34	6.79	7.97	1.18
3	*Ragi*									
	Kharif	1	1	0	20	20	0	20.00	20.00	0
	Rabi	1.5	1	(-0.5)	35	22	(-13)	23.33	22.00	-1.33
4	Orchards	0	18	18						

There was substantial increase in the kharif Paddy area and several lands were converted to orchards. The productivity increase was also substantial (21%) in kharif paddy – mainly due to a shift from open wells to bore wells.

Table 13. **Value of incremental production in the irrigated area under the sample water harvesting structures**				
Sl. No	**Crop**	**Change in production (Qt)**	**Rate (Rs./Qt)**	**Total value (Rs.)**
1	Paddy			
	Kharif	294		
	Rabi	45.5		
	Total	**339.5**	**450**	**152,775**
2	Ground nut			
	Kharif	-3.34		
	Rabi	3.34		
	Total	**0**	**1600**	**0**
3	Ragi			
	Kharif	0		
	Rabi	-13		
	Total	**-13**	**600**	**-7,800**
4.	Income from orchards (Rs)			
	A. Mango (4 acres)			13,000
	B. Lime (4 acres)			0
	C. Sweet lime (9 acres – there was no production from 1 acre – of Venkataiah)			30,000
	Total			**187,975**

Note: The income from orchards was the total amount paid by the fruit traders in the last season. For mango and sweet lime this was the second crop. Lime has not yet started producing yields. The farmers suggest that the income from orchards would improve with age of plants.

The total value of incremental production from the three sample structures was Rs.1,87,975/ -. Only the grain value of incremental production was considered and fodder values were not computed (Table 13).

Table 14. **Project investments in the area under the sample three structures:**				
S.No.	**Activity**	**Units**	**Quantity**	**Approximate amount (Rs.)**
1	Field bunding	Acres	29	21,000
2	Gully control structures	Numbers	3	4,500
3	Water Harvesting structures	Numbers	3	2,43,000
4	Horticulture	Acres	18	22,000
	Total			**290,500**

The investments were integrated i.e. on developing land, horticulture and water harvesting structures (Table 14). Table 15 details the investments in the influence zone of the water harvesting structures.

Table 15. **Benefit- Cost analysis**		
S.No.	**Particulars**	**Amount (Rs.)**
1	Total investments in the influence zone including WHS	290,500
2	Total gross value of incremental production (annual) from the influence zone including horticulture	187,975
	Pay-back period	2 years

As per the above data, the investments will be paid back within TWO years. Each rupee investment would result in a gross value of Rs.0.65 annually. This figure would improve when the mango and sweet lime plantations come to yield.

6. Land Development

Sample Selection

In the resource map four major soil types were identified – red soils, saline soils, sandy soils (*tuvva nelalu)* and black soils. Major investments were in red soils (about 494 acres) and to some extent in saline soils and others (about 125 acres). Sample was taken in the red and saline soils – as identified by the farmers in the impact mapping exercise. Two patches of red soils of about 15 acres and 6 acres were taken as sample for the assessment study. Another sample area in the saline soils was selected Availability of farmers was a constraint in this watershed as the study coincided with agriculture season.

Survey Methodology

Mapping of the sample patch of land. Identifying farmers, their caste, area of the plot and crops in the PRA exercise. The team moving from one plot to another surveyed the plots. The data was collected on plot-wise cards. About 22 villagers participated in this exercise.

Total 5.62 lakhs was invested on bunding (about 40% of the total investment) in about 617 acres-the average per acre cost was about Rs.910/ - including gully control and distribution of fodder seeds.

Table 16. **Project investments on land development**

S.No	Activity	Total		
		Area	Units (no)	Investment (Lakhs)
1	Bunding	250ha		4.54
2	Distributing Stylo hamata			0.04
3	Gully control work	26ha	89	1.04
	TOTAL			**5.62**

Table 17. **Quality assessment of bunding**

Sl.no	Characteristic	Quality	Red soil		Saline soil	
			Number	%	Number	%
1	Section	Good (>40 cm. Ht)	14	58	2	7
		Average (up to 40 cm.)	9	37	4	14
		Poor (30cm.)	1	5	22	79
2	Grass	Fully covered	3	12	0	0
		Partially covered	6	25	0	0
		Absent	15	63	28	100
3	Repairs	Not necessary	12	50	2	7
		Required-done	9	37	0	0
		-not done	3	13	26	93
4	Soil deposition	Upto 45cm.	3	12	0	0
		Upto30cm.	6	25	3	11
		Upto20cm.	15	63	25	89
5	Top level	Uniform	24	100	5	18
		Not uniform	0	0	23	82
6	Outlet	Yes	16	67	10	36
		No	8	33	18	64
7	Breached	Yes	2	8	25	89
		No	22	92	3	11
	Total no.of bunds	Red Soil -24				
		Saline Soil -28				

Quality Assesment of Bunds

Table 17 gives the quality assessment of the bunds in the selected area. The data clearly brings out the inappropriateness of bunding in saline soils. 95% of bunds have good cross section in red soils while 79% of bunds in saline soils have poor cross section. Grass did not establish in any of the bunds in saline soils. Farmers did not maintain the bunds in the saline soils as most of these lands were left fallow. 89% of bunds in the saline soils breached.

The red soil presents a contrasting picture with good cross section, uniform top level, grass establishment etc. Farmers attended to the maintenance requirement – repairing 75% of the bunds where repairs were required. 92% of bunds in the red soils were intact even after 5 years.

Table 18. **Land use pattern in the sample area (acre)**

Type of soil	Total area	Before		Present		Change	
		Fallow	Cultivated	Fallow	Cultivated	Fallow	Cultivated
Red soil	22.5	2	20.5	4*	18.5	2	-2
Red soil corrected fig@	20.5	2	18.5	2	18.5	0	0
Saline Soil	33	21.5	11.5	31.5	1.5	10	-10
Total	**55.5**	**23.5**	**32**	**35.5**	**20**	**12**	**-12**

*Some of the present cultivated land was under mango orchards –with mixed crop.
@ After removing the aberration due to one of the sample plots (of 2 acres size) that had become fallow after the bore well (dug after bunding) had failed.

Tables 18 & 19 gives land use patterns in the sample area and changes in area, production and yields of different crops. After removing the aberration, there was no change in the fallow and cultivated areas. However, the cultivated area fell drastically by 87% in the saline lands sample area after treating the land – the reason was attributed to excess moisture/ water retention due to Bunding.

Table 19. **Changes in area, production and yield in different crops in the red soils sample area**

Red soils		Area (Acres)			Production (Qtls)			Yield (Qtls/Acre)		
		Before	Present	Change	Before	Present	Change	Before	After	Change
1	Jowar	10.5	6.5	-4	23	26	3	2.19	4	1.81 (83%)
2	Castor	7	6.5	-0.5	16	22	6	2.29	3.38	1.10 (48%)
3	Total Groundnut	1	1	0	5	4	-1	5.0	4.0	-1.0*
a.	Groundnut	1	0	-1						
b.	Groundnut mixed with mango	0	1	1						
4	Total Maize	0	2.0	2	0	3	3		1.5	1.5
a.	Maize	0	1.5	1.5						
b.	Maize in Mango	0	0.5	0.5						
5.	Mango orchard	0	2.5	2.5						
	Total	**20.5**	**18.5**	**2.0**						

Note: Total mango plantation was 4 acres of which in 1.5 acres groundnut and maize were cultivated.
** as the effective crop area per acre has decreased as it was grown as an intercrop.*

Maize and groundnut crops were taken up in the lands brought under mango plantation in red soils. The land previously under Jowar and groundnut was brought into mango plantation. The shift from groundnut to maize was attributed to higher moisture availability in bunded area and also to low yields in groundnut.

The productivity in groundnut reduced as it was sown in the mango plantation as an inter-crop; the effective crop area reduced. The productivity increase in Jowar and Castor was substantial at 83% and 48% respectively.

Table 20. **Changes in area, production and yield in different crops in saline soils sample**										
In saline soils sample										
		Area (Acres)			**Production (Qtls.)**			**Yield (Qtls./ Acre)**		
		Before	**Present**	**Change**	**Before**	**Present**	**Change**	**Before**	**Present**	**Change**
1	Jowar	1	0	-1	1	0	-1	1	-	-
2	Castor	0	1.5	1.5	0	3	3	0	2	2
3	Arakalu	5	0	-5	5	0	-5	1	-	
4	Horse gram	5	0	-5	5	0	-5	1	-	-
	Total	**11**	**1.5**							

Bunding was an inappropriate intervention in saline soils. The cultivated area had fallen from 11 acres to 1.5 acres in this sample area. Castor was newly cultivated in these lands and gave a yield of 2 quintals per acre.

Table 21. **Crop yields and income - in red soils**									
S.No	**Crop**	**Area (Acres)**			**Production (Qtls.)**			**Rate (Rs.per qt.)**	**Gross value of change in production Amount (Rs.)**
		Before	**Present**	**Change**	**Before**	**Present**	**Change**		
1	Jowar	10.5	6.5	-4	23	26	3	500	1500
2	Castor	7	6.5	-0.5	16	22	6	800	4800
3	***Total Groundnut***	***1***	***1***	***0***	**5**	**4**	**-1**	**1600**	**-1,600**
a.	Groundnut	1	0	-1					
b.	Groundnut mixed with mango	0	1	1					
4	**Total Maize**	**0**	**2.0**	**2**	**0**	**3**	**3**	**800**	**2,400**
a.	Maize	0	1.5	1.5					
b.	Maize in Mango	0	0.5	0.5					
5.	Mango orchard	0	2.5	2.5					14,000*
	Total	**20.5**	**18.5**	**2.0**					**21,100**
	Total without value of Mango								**7,100**

* Gross income from the sale of mango – the first crop from the 4 acres.

The total value of incremental production in the sample area was Rs.21, 100/ -. If we exclude the value of mango (as it is an irrigated crop) the same would be Rs.7, 100/ -.

The shift to maize was also recent and the yields were lower than expected. The crop-patterns in the sample area are yet to stabilize. It was also a drought year. The yields and returns from mango plantations may go up during subsequent period.

Table 22. **Crop yields and income – in saline soils**

		In saline soils sample							
		Area (acres)			Production (Qtls)			Rate (Rs./qt)	Value of incremental production (Rs.)
		Before	Present	Change	Before	Present	Change		
1	Jowar	1	0	-1	1	0	-1	500	-500
2	Castor	0	1.5	1.5	0	3	3	800	2400
3	Arakalu	5	0	-5	5	0	-5	500	-2500
4	Horse gram	5	0	-5	5	0	-5	300	-150
	Total	**11**	**1.5**	**-9.5**					**-2,100**

The incremental value of production was negative in the saline soils, as the cultivated area had fallen by 86% (Table 22).

Benefit Cost Analysis

The total investment on the two sample areas of 51.5 acres was 0.43 lakhs (Rs. 0.38 for bunding and Rs.0.05 on horticulture). The total gross value of incremental production from was Rs. 21,100 and Rs. (-2100) respectively in red and saline soils in the year surveyed, which happens to be a drought year. The total gross value was Rs.21, 100 – 2100 = 19000/ -.

For every rupee of investment in bunding on the whole there is a benefit of Rs. 0.44 – this figure was Rs.1.11 for the red soils and there would be a loss of Rs. 0.087 in the saline soils. The following are some of the qualifications for the above analysis:

- Inappropriate technology in saline soils
- Horticulture plantations have a gestation period & yield would improve subsequently
- Drought year
- Crop patterns are not stabilized.

For projecting the benefit – cost ratios to the entire watershed – the ratio need to be arrived at only for dry lands. For this purpose a second estimate of benefit-cost ratio was arrived at after deducting the value of mango production (Rs.14,000) and Rs.7,100/ - was considered as the total benefit. The costs of land development was also deducted on the other side. The B-C ratio then works out at 0.58 in red soils. This figure is used for projections (Table 23).

Table 23. **Projection for the watershed**

In the watershed area	Area treated in the watershed (acres)	Investments on land development (Rs. lakhs)	Benefit – cost ratio	Total projected gross benefits (Rs. lakhs)
Red soils	494	3.63	0.58	2.10
Sandy loams soils	65	0.47	Similar to red soils i.e. 0.58	0.27
Saline soils	50	0.37	-0.08	-0.030
Black cotton soils	10	0.07	Not surveyed	-
Total	**544**	**4.54**		**2.34**
Total investments on gully control and seeds of *Stylo hamata*		**1.08**		
Total investment on land treatment		**5.62**		**2.34**

The total investment of Rs.5.62 lakhs on land development resulted in an incremental gross value of production of Rs.2.34 lakhs annually. The pay back period is three years – i.e. all the investment would be recovered by the third year.

The future value of the Benefits (in terms of value of incremental production) and investments were calculated at a compound rate of interest of 10% for five years i.e. at the end of 5th year from the year of survey at current prices. The future value of investments would be Rs.9.05 lakhs while that of the benefits would be Rs.16.53 lakhs. ***The Benefit – cost ratio for returns flow for five years would be 1.83 i.e. each rupee of investment on land development would result in a gross incremental value of production of Rs.1.83.*** The ratio is substantial considering that the benefits accrue to the dry lands where poverty and slow growth of agriculture are the predominant features. The ratio is also significant even though the cost of production was not considered in the analysis. Only the incremental production was considered with an assumption that the costs would not change much from the earlier situation. The cost of production in dry land agriculture would be low and would not change much with increase in production and much of these inputs would be in terms of labor. Some of the lands under bunding were leveled by farmers themselves; particularly near the water harvesting structures.

7. Horticulture and Plantations Development

The investment on horticulture was 1.86 lakhs (66 ha/ 163 acres) and on plantations was 1.22 lakhs (35ha / 86.5 acres) – together constituting about 7% area of the village. The horticulture investments were part of a package of land development and were analyzed in the land development and water harvesting sections above. The survival rate of the horticulture plantation was about 70%. Horticulture was taken up only in the private lands of farmers who have watering facility.

The plantations were taken up mostly in the common lands (80%). Some plants were distributed to the farmers for planting on bunds and in homesteads. The plantation investments also include 'protection' – employing a person paying Rs.400 monthly for a period of 6 months during the non-crop season. There was good growth in the plantation of mainly neem, cassia siamia, glyricidia and subabul. Social regulation was also in force. Goats were banned in the village 20 years back; which was also attributed as a reason for the success of the plantation. Also, the village already had good greenery.

While horticulture just started giving produce, the full benefits would flow after a year or two. The product flows from the plantations were not clear. The survival of the plantation was a question mark once the watch and ward is withdrawn.

8. Impact on Live Stock

A household survey of livestock holdings was conducted with the help from the village level workers. Data analyzed pertain to the entire village and shows the impact of two watershed development programs implemented in the village (Table 24).

Table 24. **Livestock - caste wise spread**

Sl.No	Livestock	OC		BC		SC		ST		TOTAL	
		B	A	B	A	B	A	B	A	B	A
1	Buffaloes	23	58	122	168	59	43	12	38	216	307
2	Cows	6	4	145	92	74	24	170	57	395	177
3	Bullocks	14	4	341	296	180	70	53	36	588	406
4	Goats	0	0	0	0	0	0	0	0	0	0
5	Sheep	0	10	1301	1461	21	20	42	60	1364	1551
6	Poultry	16	42	323	582	276	0	281	1281	896	2229

B: Before watershed A: At the time of the survey
OC: Other castes; BC: Backward castes; SC: Scheduled castes; ST: Scheduled Tribes
Source: Household survey

The buffaloes increased by 42%; they seem to be replacing cows, whose population drastically decreased by 55% (Table 25). People attributed this change to increased demand for milk and increased fodder availability with individual farmers. Bullock population decreased by 31%, which was attributed to increased use of tractors. The total bovine population decreased by 26%. Sheep population increased by 14%.

Table 25. **Change in livestock holding before and after the watershed program**

	OC	BC	SC	ST	Total	%Change
Buffaloes	35	46	-16	26	91	+42%
Cows	-2	-53	-50	-113	-218	(-) 55%
Bullocks	-10	-45	-110	-17	-182	(-) 31%
Total Bovine	23	-52	-176	-104	-309	(-) 26%
Goats	0	0	0	0	0	0
Sheep	10	160	-1	18	187	+14%

% Distribution of the total change in livestock – caste-wise

	OC	BC	SC	ST	Total	
Buffaloes	38	51	-18	29	100	
Cows	1	24	23	52	100	
Bullocks	5	25	60	9	100	
Sheep	5	86	-1	10	100	

More alarming was the decline in the livestock holdings of SCs. The bovine population of SCs decreased by 56%. The reasons need to be explored in depth. The possible reasons could be the following:

1. Decline in the area available for common grazing – approximately an area of 210 acres (Table 26).
2. Increase in horticulture, which might have reduced the area under share cropping with others where SCs provide inputs in terms of plough bullocks etc.
3. Shift to tractors for transport and Ploughing.

The above reasons however need to be ascertained.

Table 26.
Area lost for common grazing

Area brought under Protection	70 acres
Horticulture	100 acres
Irrigated area (2 crops)	50 acres
Total	**210 acres**

(in one watershed – the village also have a second watershed)

There was a social regulation on keeping goats (commonly agreed ban) in the village initiated about 20 years back, which is still being followed.

9. Impacts on Water Use

The study looked at the overall impacts on the water extraction in the village. A primary survey of all wells and bore wells was taken up to generate data. The following section presents an analysis of this data. Table 27 and Table 28 present the trends in the wells and bore wells in the village respectively.

Table 27. **Growth in wells**

Years	Non-functional #	Total investment + (Rs.)	Functional investment (Rs.)	Non-functional investment (Rs.)	Cumulative disinvestment @ (Rs.)
Up to 1975	15	560,000	146,000	414,000	414,000
1976 -80	13	542,000	204,000	338,000	752,000
1981-85	64	2511,000	880,000	1631,000	2383,000
1986-90	39	1235,300	226,300	1009,000	3392,000
1991-95	19	602,000	156,000	486,000	3878,000
1996-98	1	51,000	20,000	31,000	3909,000
1999	0	36,000	36,000	0	3909,000
2000	0	40,000	40,000	0	3909,000
2002	0	102,000	102,000	0	3909,000
	151	56,79,300	18,10,300	39,09,000	

Non-functional:dried up wells
+ Investment refers to the investment made by the farmer on a well was dug.
@ Cumulative Disinvestment refers to the cumulative (period-wise) investment (as) made by the farmers on the wells that were dried up during the period.

Table 28. **Growth in bore wells**

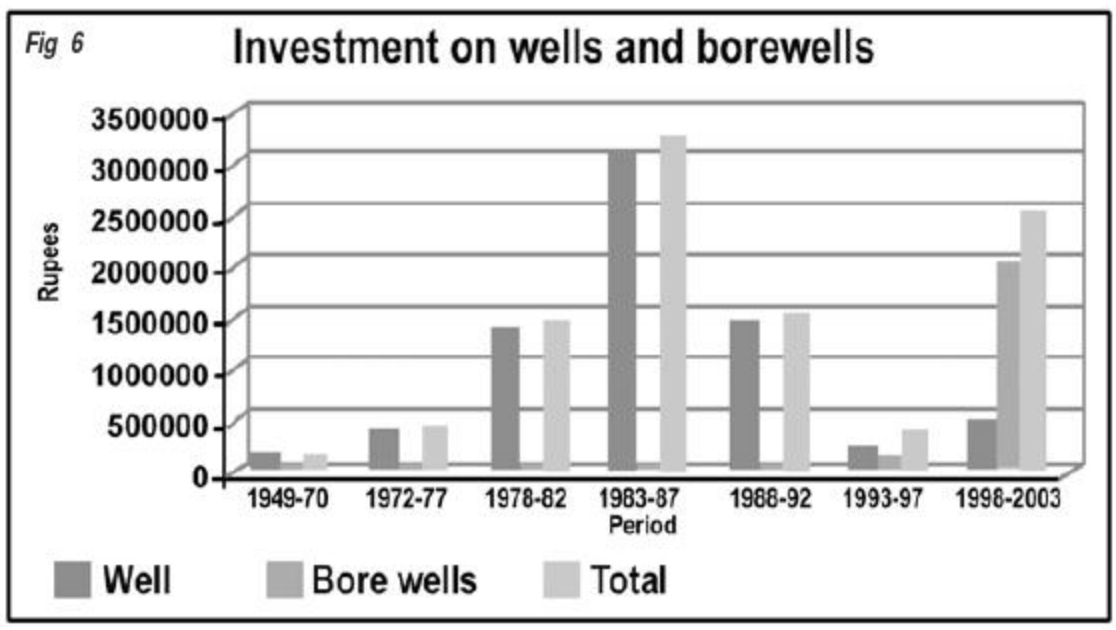
Year	Total bore wells	Functional	Non-functional	Total investment (Rs.)
1991-95	2	2	0	40000
1996	3	3	0	113200
1997	2	2	0	60000
1999	3	3	0	131000
2000	13	12	1	489000
2001	44	43	1	1364000
2002	14	14	0	405000

The focus was more on open wells until early nineties, the shift to bore wells started during the period 1993-97 and reached the peak after the ground water recharge benefits of watershed became visible from 1998 to 2002. (See Figure 6) and (Tables 27 and 28).

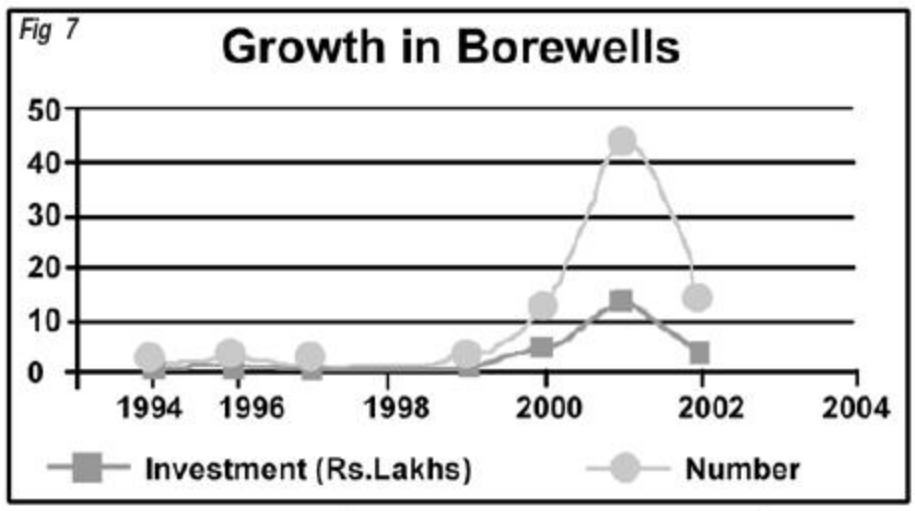
Bore wells grew at a much faster rate from the 2nd or 3rd year of the watershed program. In the year 2001 alone a total of Rs.13.64 lakhs was invested on bore wells. About Rs.24 lakhs was invested in total on bore wells by farmers since the second year of implementation of the program – an amount far exceeding the total investment on the watershed works (Rs.14 lakhs)! (Figure 7).

The open wells started drying up at a faster rate during the period 1990-95, just before the

Fig 6



watershed program. While there was a total investment of Rs.56.79 lakhs on the wells up to 2002, 68% of this was non-functional by 1995. The crisis reached its peak.

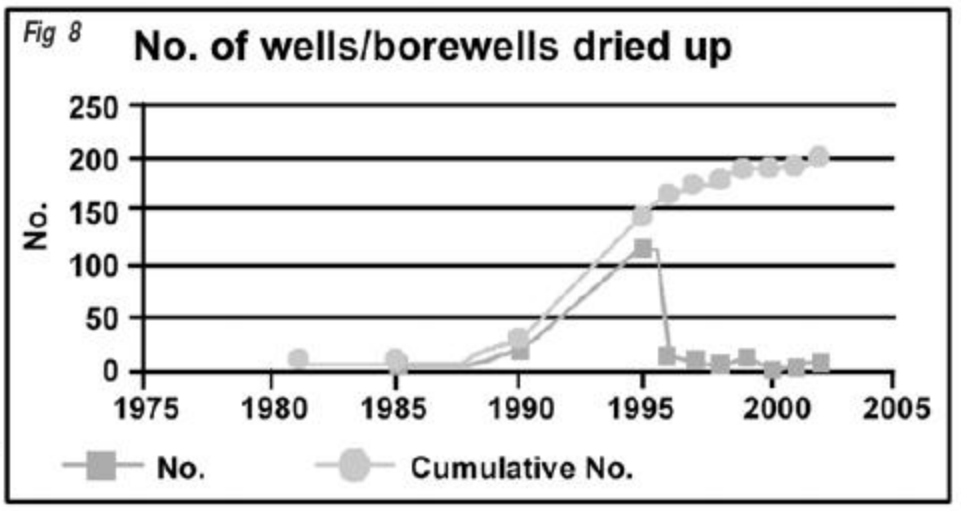


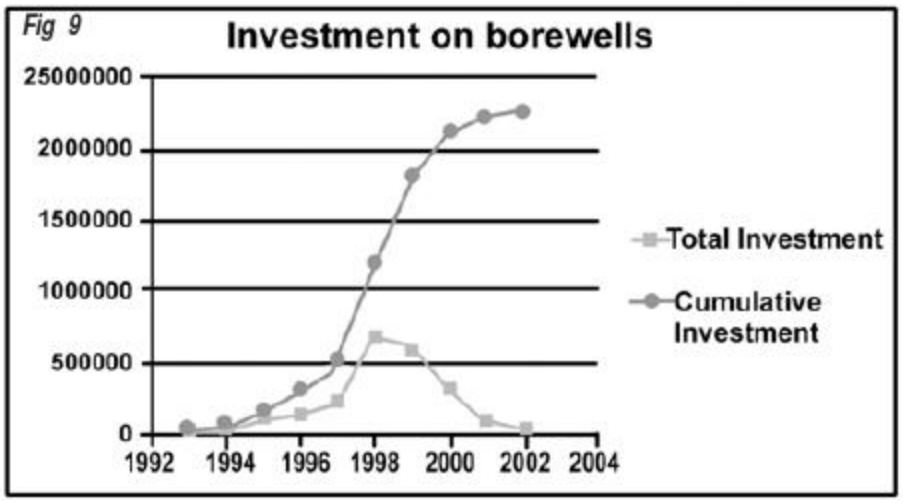
This process of drying up of wells/ bore wells almost stopped since the watershed program started. Also, several new bore wells came up as discussed earlier. The figure 7 shows the peaking of the number of bore wells, both in number and investment in the period 2000 to 2001. These happen to be years of low rainfall / drought.

Table 29 presents the summary picture of the total number of wells and bore wells at the time of the survey.

Table 29. **Summary of wells and Bore wells as in 2002-03**

	Total	Function	Dried up
Wells	284	95	189
Bore wells	81	75	6
Data not clear	43		
Total	**408**	**170**	**195**





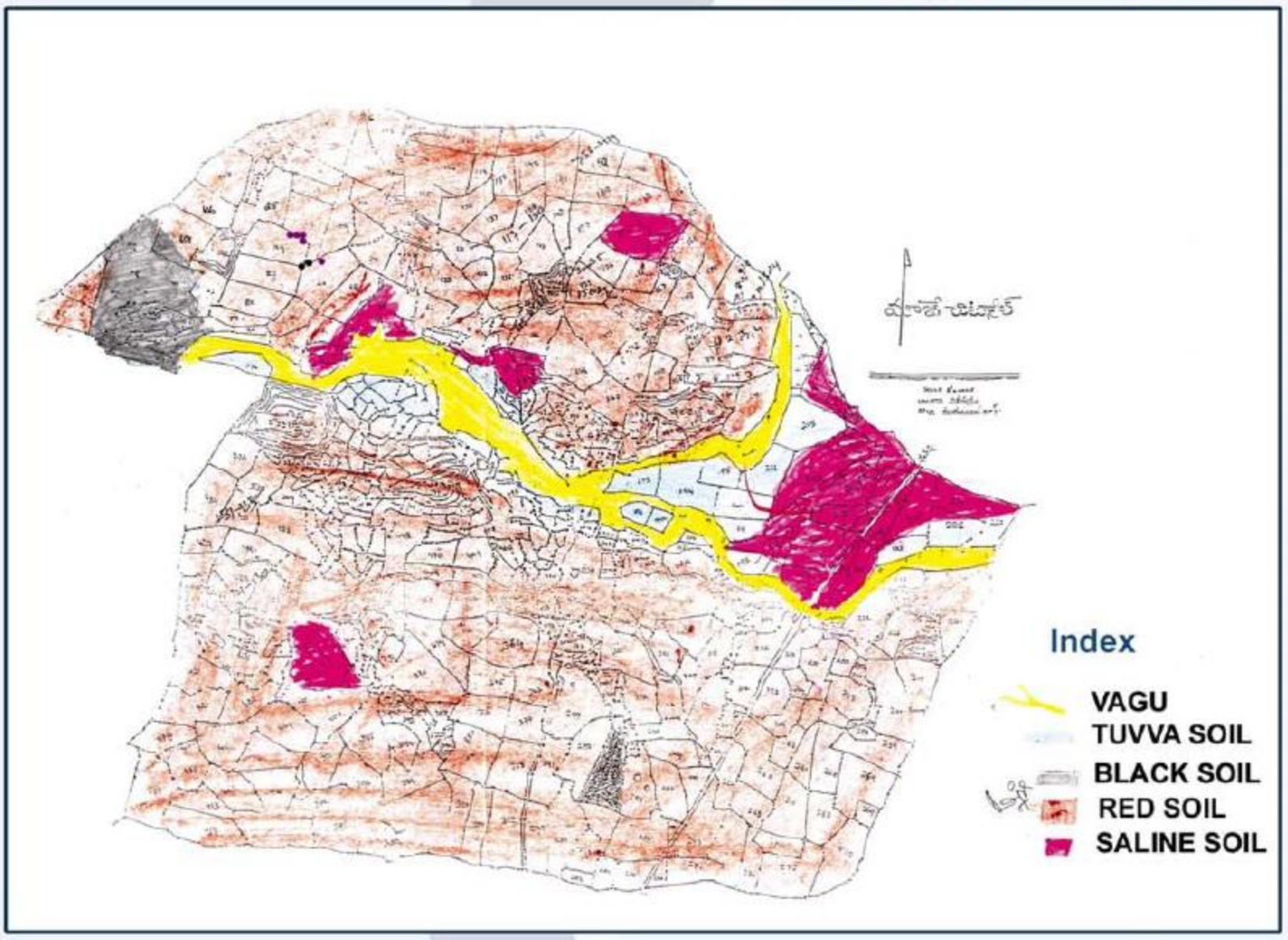
In summary, the watershed program gave a new lease of life to the ground water extraction infrastructure. But in the absence of proper regulation on the ground water infrastructure, it may be just a while away for the crisis to recur!

Annexure : 1

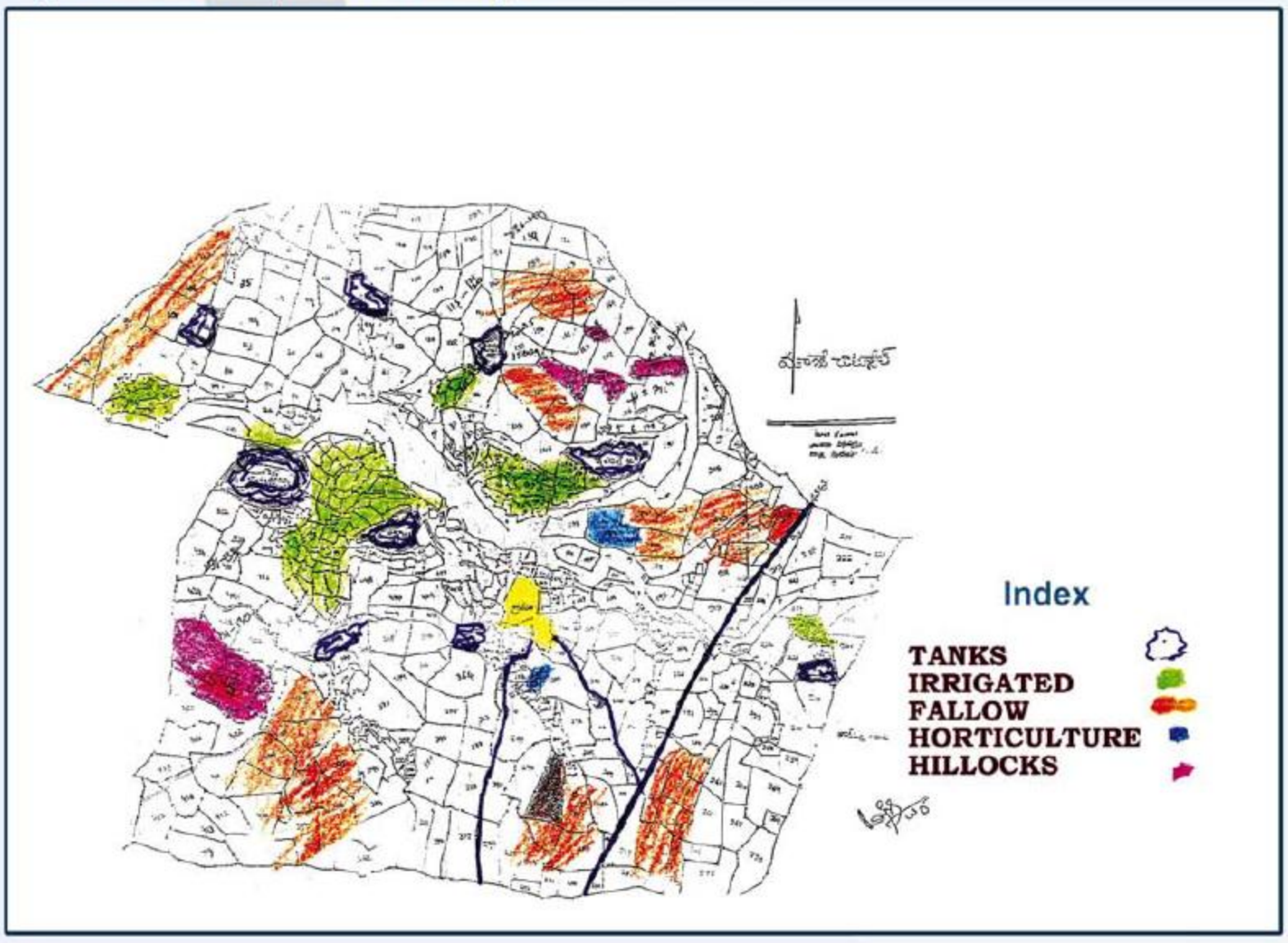
Analysis of sample SHGs							
Name of the SHG	**Shakthi Bhavani Mahila Sangam**	**Mothers Self Help Group**	**Anjana Mahalakshmi**	**Durga Bhavani**	**Bhavani Mahila**	**Shiva Jyothi Group**	**Aadarsh Group**
Date of formation	23-11-99	9-02-99	20-12-01	11-02-99	July, 1996	12-2-02	
No. of members	15	15	15	15	15	15	15
Caste	ST	SC	BC	ST	BC, OC	BC, OC	SC, BC, OC
Savings Rs/-.	30	30	30	30	30	30	30
Regular meeting	Yes, monthly	Yes, monthly twice	Yes, monthly	Yes	Yes, monthly	Yes, monthly	Yes(monthly)
Internal lending	Their own savings were lent to outsiders (individually) at the rate of 36%interest	Given to the individuals based on the need.	Based on the need.	Based on the need.	Based on need 24% interest	Based on need Min; 500/- Max; 1000/- (4months 36% interest)	Based on need (three months of 24% interest)
RF taken	-	10,000(from DRDA)	-	10,000/-(from watershed RF)	10,000(DRDA) 10,000 (watershed repayed)	-	-
Bank linkages	-	25,000(from SC Corporation)	-	-	-	-	-
Amount distributed	Equally distributed	Given based on the needs of members	Given based on need	Based on need	Based on need		Equally distributed
Usage	Purchase of clothes, lending to outsiders agriculture, health, food grains	Dairy, agriculture, children's education, house, bore well, health	Sewing machine, agriculture, daughter's marriage	Agriculture, health, food, basic needs	Fertilizers, seeds, sewing machine, leaf plate making, purchase of land	Health, basic needs, agriculture, kirana shop	Basic needs

Name of the SHG	Shakthi Bhavani Mahila Sangam	Mothers Self Help Group	Anjana Mahalakshmi	Durga Bhavani	Bhavani Mahila	Shiva Jyothi Group	Aadarsh Group
Repayment	Three months (24%interest)	Three months (24%interest)	Three months (24%interest)	Three months (24%interest)	Six months (24%interest)	Four months (36%interest)	Three months (24%interest)
Leadership rotation	Not there	Yes(Only for second leader)	No	No	Yes	No	No
Norms	Fine of Rs5/-if they fail to attend monthly meeting and also if they don't pay monthly savings.	Fine of Rs5/-if they fail to attend monthly meeting and also if they don't pay monthly savings.	Fine of Rs5/-if they fail to attend monthly meeting or if they come late.	Fine of Rs5/-if they fail to attend monthly meeting or if they come late.	No norms	No norms	Fine of Rs5/-if they fail to attend monthly meeting
Functionality	Working	Working	Working	Working	Working	Working	Working
Role in watershed	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings	Participating in Sharing and planning meetings
Participation in developmental activities	Participated in Janmabhoomi	-	-	-	-	-	-

Map-1 **Soil types of Chityal village**

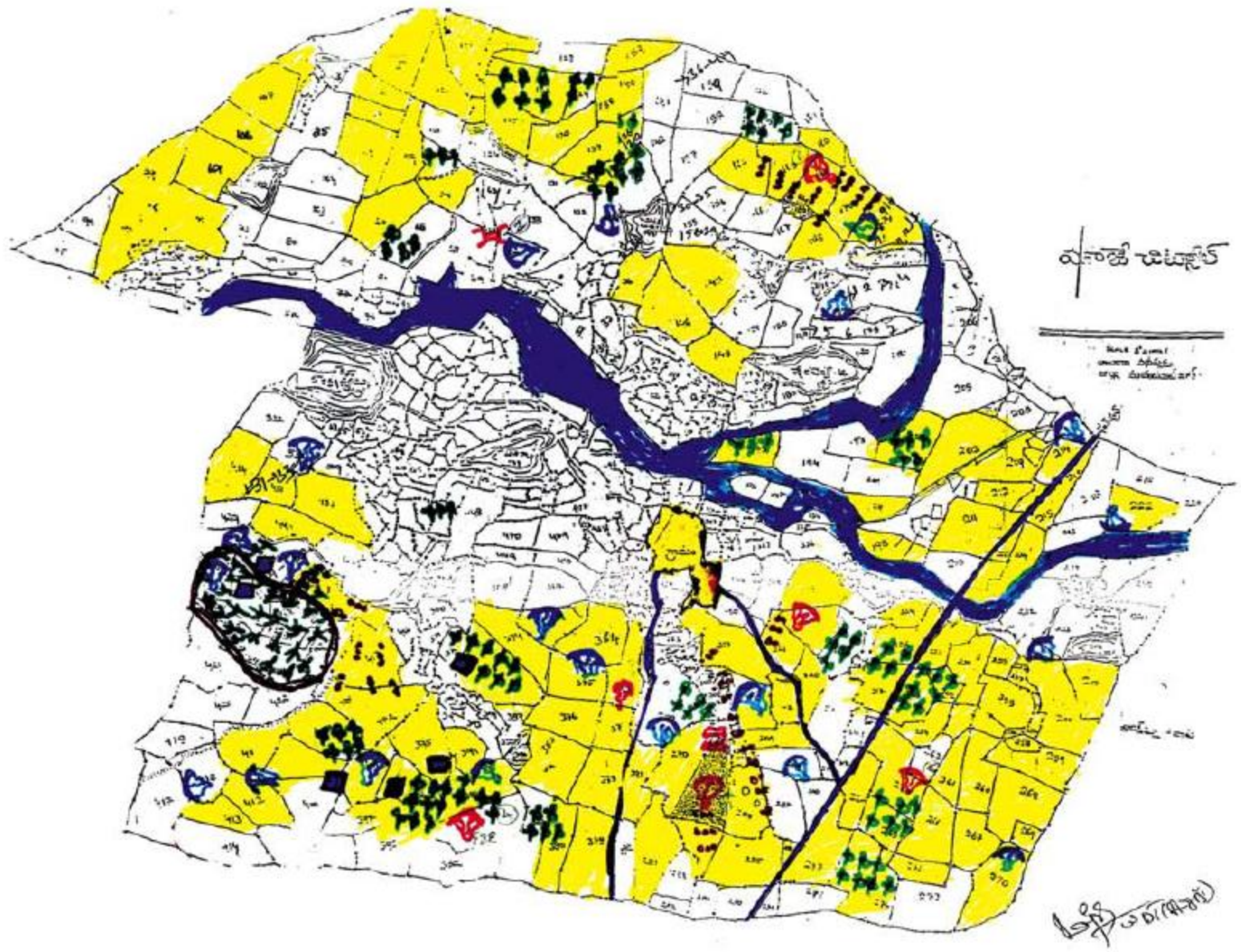


Map-2 **Land use pattern in Chityal**



Map-3 **Actual treatment works carried out in Chityal**

CHITYAL TREATMENT MAP



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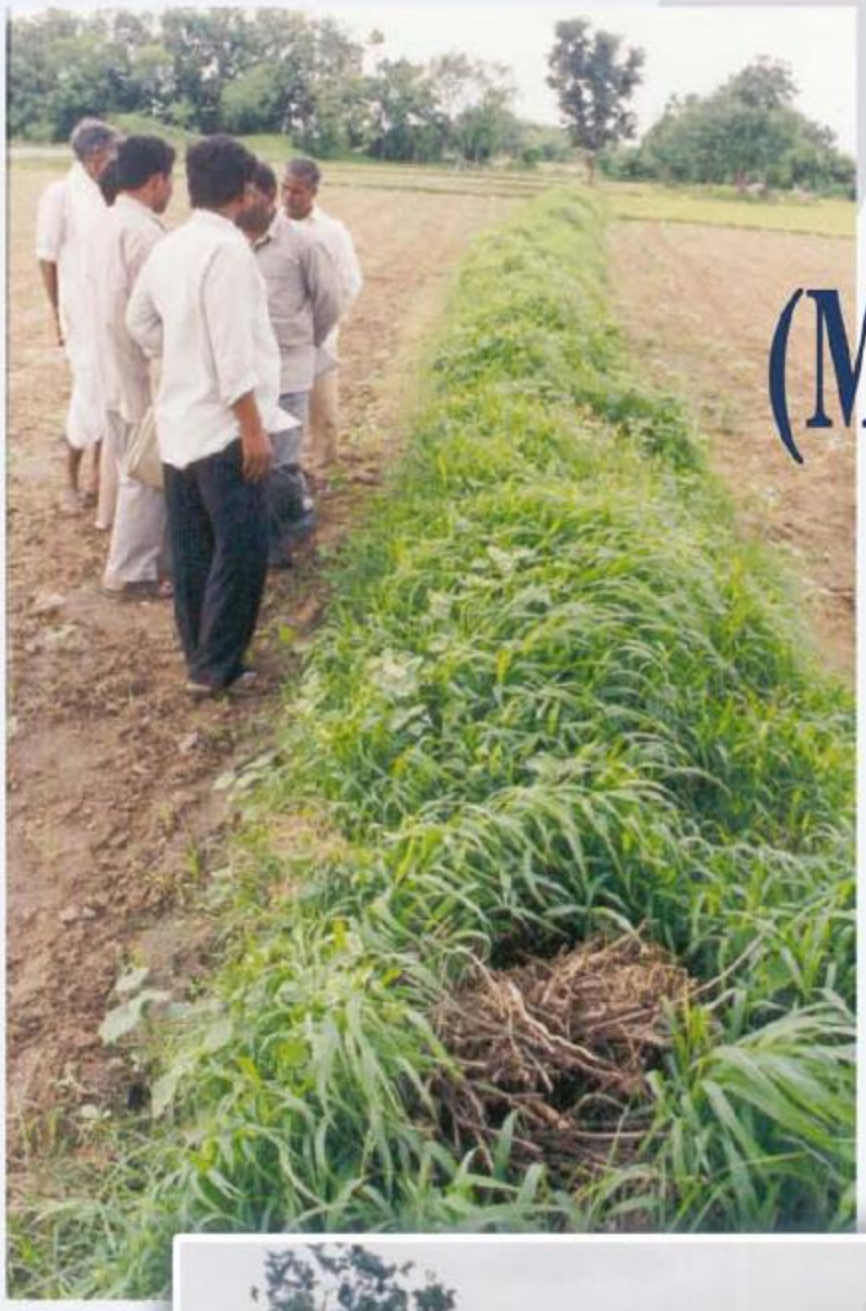


3. Mothkur (Mailaram) Watershed

Village:***Mailaram***

P.I.A:***MDT***

Mandal:***Doma***

Period:***1996-2000***

District:***Ranga Reddy***

The Multi Disciplinary Team of the District Water Management Agency implemented Mothkur watershed in Mailaram village, Ranga Reddy district. It belongs to the first batch of watersheds started in 1995-96. Due to the frequent changes of PIAs, the program could not be completed in the stipulated duration and lasted up to 2003.

1. Village Profile

The village has 161 households, majority of them (100 households) being STs belonging to the Lambada community. 30 households belong to SC community. The village has 3 hamlets. The village has total area of 1447 acres (585 ha). The entire village has been taken up under watershed development program.

Land Use

Of the total area about 660 acres are under hillocks, about 200 acres are under irrigated agriculture and about 400 acres are dry lands. About 200 acres were under fallow lands (Table 1). Red soils are predominant in the village. Map 1 gives the details of soils in the Mailaram village.

Crops

Jowar, ragi, red gram, sesamum, groundnut and cotton are the main crops in the village. Recently maize has replaced groundnut crop. Paddy and groundnut are the main crops under irrigation.

Table 1. **Soil types**

No.	Soil type	Area (acres)
1	Red soils	670
2	Black soils	200
3	Saline soils	30
4	Hillocks	660

Drainage & Water harvesting

The village has two main drainage lines. There is a big old irrigation tank, five percolation tanks *(kuntalu)* and a diversion weir before the program started. 10 percolation tanks and 8 checkdams (across higher order streams) were constructed during the program.

Drinking water

Drinking water was a major problem before the watershed program. About 10 borewells that were dug for the purpose failed earlier. A new borewell dug below the Narayana checkdam succeeded and is now providing drinking water for the village.

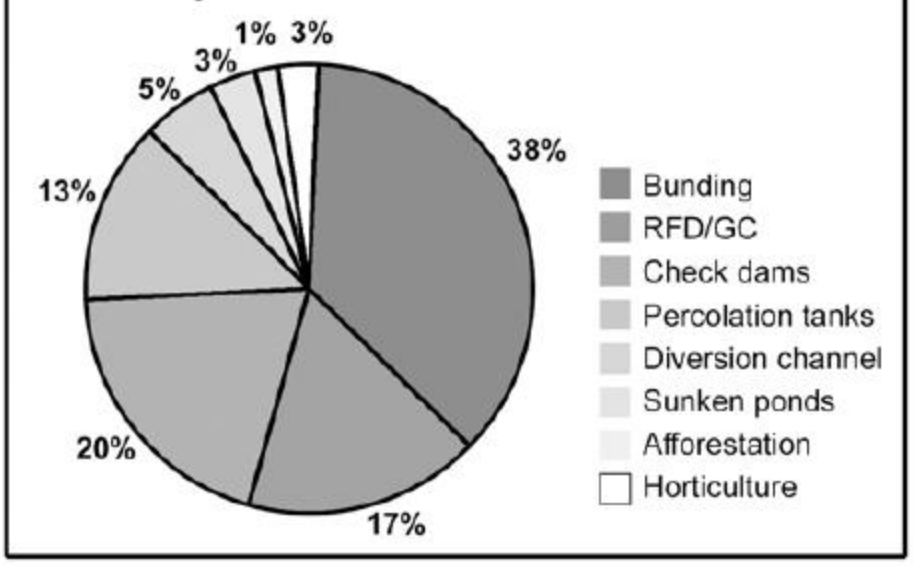
2. Watershed Works and Investments Profile

Table 2. **Work wise investments profile**

No	Activities		Works done		Number of beneficiaries					
		Area (ha)	Physical	Financial (Rs.lakhs)	Class-wise			Caste-wise		
					SF	MF	Others	SC	ST	Others
1	Bunding (cu m)	284	28464	5.50	50	70	10	40	30	60
2	Rock fill dams/GC (no.)	21	216	2.46	20	38	10	17	38	13
3	Check dams (no.)	40	8	2.90	15	6	4	2	12	11
4	Percolation tanks (no.)	40	10	1.97	15	5	10	4	10	16
5	Sunken ponds (no.)	12	6	0.50	3	8	2	2	5	6
6	Afforestation	10		0.18						
7	Horticulture	10		0.37	3	2	2		2	5
8	Diversion channel (cu. m)	15	3570	0.76	8	7	5	5	4	6
	Total			**14.64**	**114**	**136**	**43**	**70**	**201**	**117**

Table 2 and Figure 1 give the details of component wise expenditure under the watershed project. Out of a total expenditure of Rs. 14.64 lakhs, major investments went for land development (55%). Water harvesting structures have taken second place in the total investments (41%). Negligible investments were put on afforestation and horticulture (4%). Map 2 shows treatments carried out in Mailaram watershed.

Fig 1 **Component wise % of Investment**



3. Impact Mapping

3.1 Institutions

Groups

There were 8 women SHGs and 6 men SHGs were formed in the village. However, the men groups were nominal, which were floated for the purpose of receiving revolving fund (of Rs. 60, 000/ -). Though women groups were functional, they did not receive any revolving fund from the watershed program. The men groups became defunct immediately after receiving the revolving fund from the program. An NGO, which was earlier the PIA for the watershed facilitated the formation of the groups.

Three of the 8 women SHGs were studied as a sample. The details are in Table.2. At the time of the survey seven of the eight groups were functioning. However, some of them are partly dysfunctional, mainly for lack of external facilitation. The groups did not have any role in the watershed program.

Table 2. **SHG case studies**

Sl. No	1	2	3
Name of the group	Podupu Jyoti Mahila Sangam	Satyodaya Mahila Sangam	Sarojini Mahila Sangam
Date of formation	08.06.1996	31.12.1995	01.07.1995
No. Of members	15	15	15
Caste	SC	ST	BC
Savings	Rs.20/-per month, (20 000 total)	Rs.20/-per month (total 1 00 000)	Rs.25/-per month (Rs. 8609/- as on May 2003)
Regular meetings	Monthly, up to 2000	Monthly	Monthly
Records	Resolution book, bank passbooks, ledger, application for lending, credit sheet	Resolution book, bank passbooks, ledger, application for lending, credit sheet	Pass book, ledger
Lending	Within the group (agrl, marriages, bore wells, land development)	Within the group	Within the group
Revolving fund	Rs.10 000 from Mahalakshmi Mahila Sangam	Rs. 30 000 grant from DRDA	Rs. 15 000
Bank linkages	Rs. 20 000 matching loan	Rs. 60 000 –1,90 000-2	Nil
Loan utilisation	Need based loans, Equal distribution of RF for bore wells	Equal distribution	Equal distribution
Usage	Bore Wells	Agriculture, Marriage, education	Agriculture, Health, Urea, DAP
Repayment	Norms as per the case (3 months time flexible), interest 2% per month	Six months period with 2% interest; 100% repayment	Six months repayment period
Leadership	No	No	No
Norms	No specific norms	Monthly meeting questioning if savings/ loan is not paid properly	Surety while taking loans
Role in W/S	Structures were laid in their fields; one woman is member in WC	As labourers	Participated as labourers
Others	FFW – Road Laying	Nil	Nil
Functionality	Not functioning	Functioning	Not functioning
Reasons	Because of leaders involvement in politics	Because they get loans for less interest	Lack of facilitating agency
Remarks		No proper payment of savings	

Watershed Committee and Association

The watershed committee has good relation with the Gram Panchayat. It has received the "Best Watershed Association in the district" award. The Association and the Committee were active during the implementation of the watershed works, bud did not meet after the program is over and became


dormant. The last meeting was held on 30th August 2002. It had actively participated in getting roads in the village. There does not seem to be any agenda set for the committee to meet regularly. The emerging leadership however, is active as individuals.

A retired schoolteacher was nominated as the President of the Watershed Association. He mobilised youth in the village and together contributed to the planning process. This mobilisation has been helping the village in conflict resolution and several other important aspects of village life.

Watershed Development Fund was constituted during the program. It has an amount of Rs. 75,000/ -. This is in fixed deposit and was not used for any purpose so far. There is no clarity on the operational mechanism of the above fund.

Gram Panchayat

It actively participated in the watershed program and helped the Committee in organising gram sabhas, monitoring and quality assessment of works. The Panchayat leaders felt that the quality of organising Gram Sabha has improved with the experience in watershed program.

4. Impacts of Works

About 25 Farmers in the beneficiary area of the structures, 8 members from the SHGs, members of the Watershed Committee and Association, ex-sarpanch (who was the Sarpanch during the period of implementation) of the village and two members from the Youth Associations participated in the exercise to assess the impacts of the watershed works.

In the exercise the participants identified impact paths of each of the work / activity taken up in the watershed program.

4.1 Bunding

Bunding resulted in the control of soil erosion due to which soil fertility improved. In case of chemical fertilisers application it would suffice for two crops as the nutrients are retained in the field itself due to bunding. Both these factors resulted in reduced usage of fertilisers. Bunding also resulted in groundwater recharge and increased soil moisture retention – this provided soil moisture to the crops up to 15 days, even if there is no rainfall. Due to these favourable conditions as a result of bunding

about 25% increase was observed in crop yields. Grass was cultivated on bunds as part of the watershed program. Due to this fodder availability for cattle improved and bunds were also strengthened.

4.2 Gully Control

With the implementation of the gully control works erosion is under control and the land got levelled. These works also resulted in increased ground water recharge. In the upstream areas of the gully control structures regeneration of grass and trees is observed. The community got additional income from grass and trees on the bunds. The area with severe gullies, which was left uncultivated, is now reclaimed for agriculture with implementation of gully control works and the land getting levelled.

4.3 Percolation Tanks

The percolation tanks helped in increased ground water recharge. This and the seepage form the tanks helped in increasing the irrigated area. The community felt that the influence of the percolation tanks on the bore wells is more than that of the checkdams.

4.4 Check Dams

The check dams resulted in increased drinking water availability for cattle and goats. Water available in streams is useful for livestock. The water that is stored behind the checkdams is used for washing clothes and bathing. Drinking water availability in the village has increased.

The check dams resulted in increased groundwater recharge, which resulted in increased water availability in the bore wells. With the completion of soil and moisture works and water harvesting structures there is almost no runoff from the watershed this year. Some additional area is now irrigated by diverting water from 2 checkdams. Check dams provided critical irrigation for the survival of crops through lift irrigation.

4.5 Diversion Drains

As a result of constructing diversion drain the tank gets filled quickly. Farmers having fields near the diversion drains are now able to grow paddy. The tank used to dry up in the past, but at present there is water in all seasons. Fishery was taken up in this tank – the proceeds go to village development fund operated by the village development committee. This is a village common fund managed by the village development committee (formed with caste-wise membership). This fund is also rotated among the members.

5. Impacts of Plantation and Horticulture

About 90% of the plantations did not survive. Only eucalyptus, bamboo, teak and Kanuga species survived. Mango, coconut, tamarind plants were distributed in the watershed project. However, plants with two farmers only survived. These farmers each earned about 24,000 rupees income twice.

6. General Impacts (mentioned by the community)

6.1 Impacts on Livestock

There is a decrease in the population of cows and buffaloes, as the availability of persons for rearing became difficult. It is more expensive to hire adults as children are not being employed because of Child labour Act.

There is fodder shortage this year due to drought in 2002-03. After the watershed project as the cultivable area increased there is an increase in number of bullocks. Farmers felt that goats are a big problem in the village. Goats eat away all the plants and could not be controlled. It was alleged that about 80% of the horticultural plants were eaten away by the goats.

6.2 Impacts on Livelihoods

Due to creation of wage employment in the watershed program the migration in the village is reduced. Before the watershed programme about 60% of the households used to migrate, which now reduced to 30% of the house hold. The wage employment available in a year increased from 2 months to 7months. Wages also increased significantly from Rs.20 and Rs.10 for men and women respectively to Rs.60 for men and Rs.25 for women. Working hours for women are lesser, which is the reason for difference in the wages earned. Increase in wage rates was also due to relatively even spread of irrigated areas to most of the households. With the improved soil and moisture conservation and availability of irrigation water labourers now prefer working in their own fields thus resulting in increased demand for labourers.

The drinking water problem for the village was solved with the watershed project. Before the watershed project women had to go upto 1 km for getting water from irrigation wells. Now there are taps within the village supplied from an over-head tank. A borewell was dug downstream of a check dam which was also fed by a diversion channel. This bore-well is supplying drinking water to the village. Solving drinking water problem saved women's time, this saved time is being used for other activities.

The food security of the village community increased. Before the watershed project they were dependent for some months for their basic needs but now they are self-sufficient in food for the entire year.

Watershed resulted in increased income and standard of living of the villagers. Impacts were more on the SC and STs who were also poor. The educational standards also improved - people going for higher education has increased. Number of children going to school increased from 50 to 150. Further, at present 15 members are going out for college education.

The community also observed that there is a decrease in family and village level conflicts.

6.3 Impacts related to farming

The watershed project resulted in increased ground water level. As a result 75 new bore wells were dug and 150 acres of uncultivated land was brought under irrigation. This means that there is an

increased investment on bore wells. Watershed project helped in bringing large chunks of uncultivated area into cultivation. Due to the increase in the area under agriculture the number of tractors in the village increased from 1 to 6.

There is a shift in the crops and varieties as a result of the watershed project. Earlier millets like ragi and sama were cultivated. With watershed works and assured soil moisture/ irrigation conditions crops like paddy, cotton and groundnut have taken over. Before the watershed programme the farmers used their own seed, but now they are using the seed from the local market.

7. Impacts on Water

Table 3 and Figure 2 provide the details of the water harvesting structures that were implemented in the watershed programme along with caste wise and class wise information of the beneficiaries. The changes in the water availability are given in Table 4.

Fig 2 **Beneficiaries of Water Conservation**

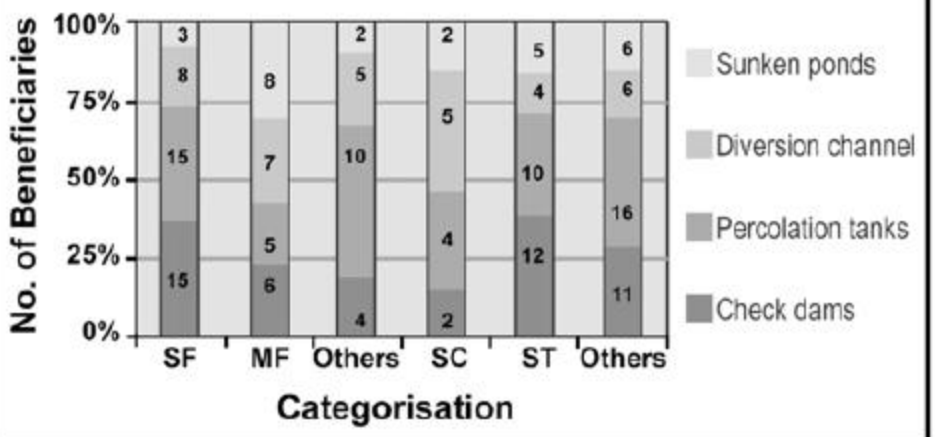
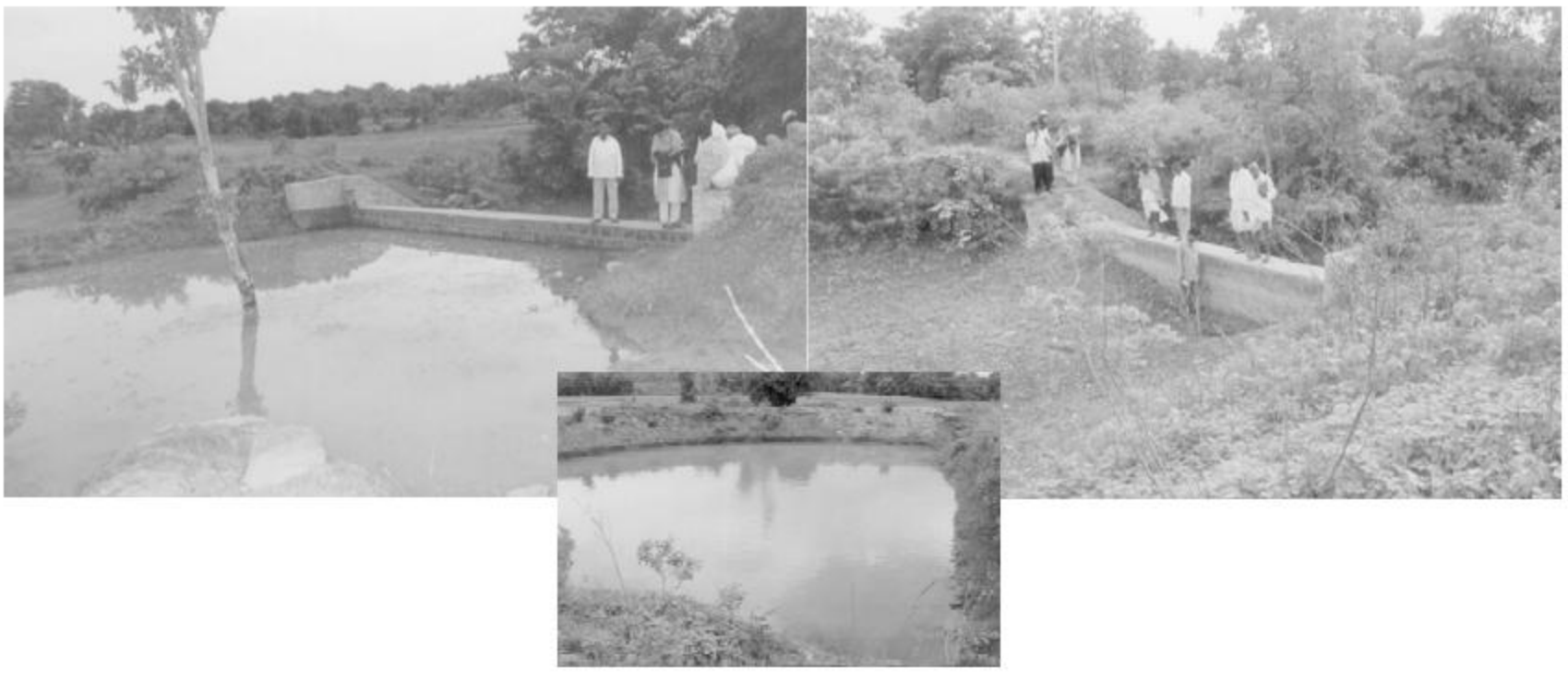


Table 3. **WHS – investments and beneficiaries**

No	Activities	Works done			Number of beneficiaries					
		Area (ha)	Physical	Financial (Rs.lakhs)	Class-wise			Caste-wise		
					SF	MF	Others	SC	ST	Others
1.	Check dams	40	8 no.	2.90	15	6	4	2	12	11
2.	Percolation Tanks	40	10 no.	1.97	15	5	10	4	10	16
3.	Diversion channel	15	3570 cu.m	0.76	8	7	5	5	4	6
4.	Sunken ponds	12	6 no.	0.50	3	8	2	2	5	6
	Total			**6.13**	**41**	**26**	**21**	**13**	**31**	**39**



There is a major change in the drinking water status. Rejuvenation of the old percolation tank, new percolation tanks and checkdams helped in solving the water problem of the village. The specific changes are as follows:

Table 4. **Change in water availability**

No.	Purpose	Source of water		Remarks
		Before	Present	
1	Drinking water for	Wells Livestock	CD, PT, Bore wells	Very few bore-wells in the village before watershed
2	Washing livestock	Wells	CD, PT	
3	Washing clothes	Wells, Bore wells	Taps, CD	
4	Cleaning utensils	Wells	Taps	
5	Irrigation water for agriculture	Wells, few bore wells	CD, PT	Direct irrigation through 2 checkdams and rest under indirect irrigation through wells and borewells.
6	Fishing	Nil	PT	
7	Drinking water for Villagers	Irrigation wells	Taps	Earlier used to go 1km for getting water

Note: CD: Check dam; PT: Percolation tank

Table 5. **Qualitative assessment of four-sample water harvesting structures surveyed**

Sl no	Name of the water body	Approx. volume of water (cu. m)	Dries up in the month of	Silt depth (m)	Desiltation	No. of wells influenced	Uses
1	Gandhi Checkdam	462	Jan/Feb	0.3	Not done	1well + 1 borewell = 2	◆ Drinking water for livestock ◆ Agriculture (Direct irrigation to 4acres- 1 crop)
2	Bheemaiah Checkdam	150	Dec	-	Not needed	2 bore wells	◆ Drinking water for livestock ◆ Agriculture
3	Thirumalaiah (percolation tank)	150	Jan/Feb	-	Not needed	1 well + 3 borewells = 4	◆ Drinking water for livestock ◆ Agriculture
4	Mangyanayak Checkdam	240	Jan/Feb	0.3	Not done	1 well + 1 borewell = 2	◆ Agriculture
	Total	**1002**				**3 wells + 7 borewells = 10**	
Total investment on these four structures: Rs. 1,80,000-							

Of the total 8 checkdams and two percolation tanks, a sample of three checkdams and one percolation tank were surveyed. The details of these are given in Table 5. The influence zone of the structures was demarcated and surveyed in total. The data surveyed pertain to only irrigated area under the demarcated influence zone of the structures. Table 6 presents the details. The following are the analytical observations:

- A total (one time) storage volume of 1002 cu.m. was created by investing Rs.1, 80,000/ - on these structures. Thus the cost of creating one cubic meter storage capacity works out to Rs.180/ -
- All the water-harvesting structures that were surveyed were found to retain water for 6 to 8 months. Normally these would dry up after December and before February.
- Out of the sample only two checkdams have siltation problems and the silt was not removed.
- These four structures supported 10 irrigation wells (3 wells and 7 bore wells).

Table 6. **Wells and bore wells, beneficiaries and area irrigated in the influence zone of the sample four structures**

Caste	No. of farmers		No. of wells		No . of bore wells		Area (acres)		Gross irrigated area			
	No.	%	No.	%	No.	%	No.	%	Before		Present	
ST	2	25	1	33	2	25	9	15	1	40	9	31
SC	2	25	0	0	2	25	8	13	0	0	6	21
BC	4	50	2	77	4	50	43	72	5	60	14	48
OC	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**8**	**100**	**3**	**100**	**8**	**100**	**60**	**100**	**6**	**100**	**29**	**100**

All the wells that are in the influence zone of the four water harvesting structures were old wells. As for the bore wells except for one dug in the year 1985 all the others (seven) were newly drilled after the watershed programme since 1998. The gross irrigated area increased about 5 times in these sample

Table 7. **Changes in area, total production, productivity and value of incremental production**

No.	Crop variety	Season	Total area irrigated		Total production		Yield		Value of incremental production (@Rs.450 per quintal)	
			(acres)		(quintals)		(Qtl/acre)		Change in production (Qtl)	Value (Rs.)
			Before	Present	Before	Present	Before	Present		
1	Paddy	Kharif	4	18.50	72	427	18.0	23.08	355	159750
		Rabi	2	10.25	47	255	23.5	24.88	208	93600
2	Vegetables	Rabi/ Summer	0	0.25	0	Rs.2000	0.0	Rs.2000	NA	2000
	TOTAL		**6**	**29**	**119**	**682**			**563**	**255,350**

water harvesting structures from 6 to 29 acres. The net sown area increased from 4 acres to 18.5 acres. There were no OC farmers in the influence zone. The benefits are spread across all the remaining castes in the village.

7.1 Impacts of water on agriculture

Table 7 gives the changes in the irrigated area, production and value of incremental production in the sample survey area, whereas Table 8 gives the details of the costs and benefits. The gross value of incremental production is Rs.2,55,350/ - while the cost of the structures was Rs.1,80,000/ -. Seven new bore wells came up after the construction of checkdams with private investments. At a gross level the public investments on checkdams generated sufficient value of incremental production to recover the entire costs of checkdams during the first year itself. The benefit cost ratio is at 1.42 even during the first year.

Table 8. **Benefit- costs**

No		Before	After
1	Area (ac)	6	28.75
2	Cost of cultivation (at Rs.3000 per ac)	18000	87,000
3	Production of paddy and vegetables	119	682
4	Value of production (at Rs.450 per qt)	53550	306900
5	Net benefits (Rs)	35550	219900
6	Net incremental benefit (Rs)		184350

Even after deducting an assumed cost of cultivation at Rs.3000 per acre the net incremental benefits were at about Rs.1,84,000. Even at this rate the total cost will be recouped within one year of implementation. In this case the benefit cost ratio would be 1 in the first year. The value of by-products was not taken into account in the above cases.

7.2 Complementary Investments

With the construction of the water harvesting structures, the farmers in the influence zone made complimentary investments on new borewells and land development. These investments amounted to Rs.3, 20,000/ - including drilling of borewells, electrification, cost of motor, its installation and land levelling. The ratio of private investments mobilised to public investment works out to 1.78 - an indicator that suggests high capital formation i.e. each rupee of public investment on checkdams catalysed 1.78 rupees of private investment.

Asserting an identity...

Ratnaiah and Ramulamma belong to SC family. They have 2 acres of degraded land. Ratnaiah used to hire out his bullocks for ploughing and carting. He also used to work as a painter for 2 months in summer. As a part of the watershed program two bunds and two rock fill dams were constructed in these 2 acres costing about 6,000 rupees. Ramulamma invested Rs.5000/- on removing stones from the field. She got this amount as a loan from her group.

Looking at the success of his fellow farmers, Ratnaiah invested Rs.12,000 on digging a borewell (135 ft). He also invested Rs.15,000 on getting electricity and a motor. The equipment costs (about Rs.20,000) were taken on 'uddera' (the shop owner sells for deferred payment). The family mobilised loans from the SHG and also used all the savings available in the family, including that of their children for digging the borewell. They struck water. They then invested Rs.10,000 in the first year on levelling the land.

Paddy crop was taken up in the first year during both kharif and rabi seasons. They could harvest about 35 quintals of grain. Next year, another acre land was levelled and they invested Rs.1500 on organic manure. The family already has bullocks.

Once the family used to be frequently in a vulnerable situation. Now they have put their hard efforts on their land. And these efforts are giving them an identity of becoming full-fledged farmers.

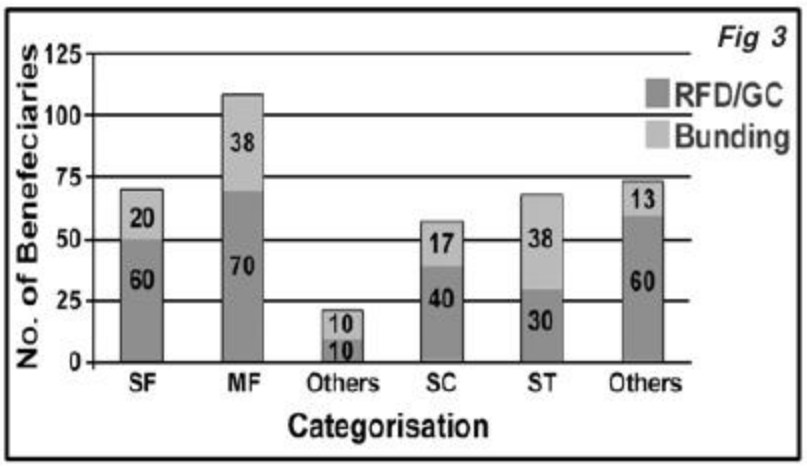
8. Impact of Land Development

Field bunding and gully control structures were the main activities on which a total of Rs.7.96 lakhs were spent. The per acre investment on area development works out to about Rs.1234/ -. These and other details are given in Table 9 and Figure 3.

Table 9. **Investments on area development**

No	Activities	Area (ha)	Works done	
			Physical	Financial
				(Rs.lakhs)
1	Bunding	284 (702 acres)	28464 cu m	5.50
2	Rock Fill Dams/GC		216 no.	2.46
	Total			**7.96**

Fig 3



8.1 Quality Assessment

The quality of bunds constructed in the watershed programme (Table 10), the impact of the bunds on the land use (Table 11), changes in crop production and value of increased production (Table 12 and 13 respectively) were studied by the research team along with the village community.

The study observed that the quality of the bunds implemented in the watershed project is good in terms of cross section, grass coverage, spillways and uniform top-level. For example none of the bunds were in the poor quality in terms of the cross section (i.e. < 30 cm ht). However, the cause for concern was that about 46% of the bunds were breached. Including this a total of 52.30% needed repairs. Out of this only 18% were attended to. This suggests the need for institutional mechanisms to ensure maintenance of bunds, which are mostly in private lands.

8.2 Bunding Impacts

The study team along with the community members physically surveyed a sample area of 60 acres and data was generated for every survey number in this area. Three patches

Table 10. **Bunding quality assessment**

No	Characteristic	Quality	Quantity (No.of Bunds)	%
1	Section	Good (> 40cm ht)	47	72.30
		Average (Upto 40cm ht)	18	27.70
		Poor (< 30cm ht)	-	
2	Grass	Fully Covered	35	53.85
		Partially Covered	29	44.61
		Absent	1	1.54
3	Repairs	Not Necessary	31	47.70
		Necessary	34	52.30
		Done	6	17.65
		Not Done	28	82.35
4	Soil deposition	Upto 45cm	19	29.23
		Upto 30cm	24	36.92
		Upto 20cm	22	33.85
5	Top level	Uniform	48	73.85
		Non Uniform	17	26.15
6	Spill way	Yes	57	87.70
		No	8	12.30
7	Breached	Yes	30	46.15
		No	35	53.85

dispersed in area were taken as samples. The area consists of mainly red soils. In the sample patches, 10% of the area is under saline soils.

The percentage of fallow lands decreased substantially from 48% to 13% (Table 11). Part of this land was brought under cultivation. The rainfed area did not vary much whereas substantial area (33%) was brought under irrigation with borewells.

Table 11. **Changes in land use**

Land use	Before		Present	
	Area (ac)	%	Area (ac)	%
Fallow	28.50	47.70	8.00	13.39
Rainfed	31.25	52.30	32.25	53.97
Irrigated	0.00	0.00	19.50	32.64
	59.75	100.00	59.75	100.00

After the bunds were constructed under the watershed program several farmers levelled their lands. Earlier there were several failed efforts in digging borewells. A drinking water borewell dug after the bunding succeeded. Looking at this success, Hafiz Mian dug a borewell and succeeded in getting water. The trend caught up and there was a spurt in digging borewells for agriculture purpose. In the surveyed area of 60 acres 8 borewells came up and in the village about 75 borewells were dug – all in the same season (1998 summer). With the success in borewells, farmers invested on levelling their lands- bunds made the task simpler.

8.3 Changes in crop patterns

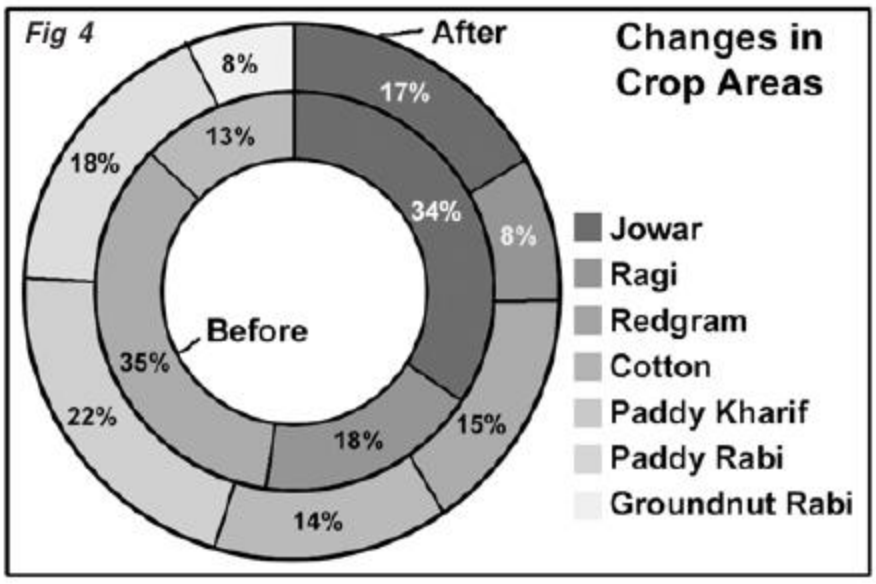
During the mapping exercise farmers reflected that dry land farming was neglected and the investments (labour and inputs) shifted to paddy (Table 12). Increase in wage rate up to 3 times also contributed to this neglect of dryland agriculture.

Table 12. **Changes in crops (area, production and yield) in the surveyed area**

NO.	Crop	Area (ac)		Production (qtl)		Yield (qt/ac)		
		Before	After	Before	After	Before	After	Change
A	**Rainfed**							
1	Jowar	15.50	12.00	39.50	27.50	2.55	2.29	-10%
2	Ragi	8.00	6.00	42.00	25.50	5.25	4.25	-19%
3	Redgram	16.00	10.50	14.75	8.00	0.92	0.76	-17%
4	Cotton	5.75	10.25	23.00	50.00	4.00	4.88	22%
B	**Irrigated**							
a.	**Paddy**							
1	Kharif	0.00	15.00	0.00	320.00	0.00	21.33	
2	Rabi	0.00	12.50	0.00	270.00	0.00	21.60	
b.	**Groundnut**							
1.	Rabi	0.00	4.50	0.00	32.00	0.00	7.11	

Acreage under dryland crops like Jowar, ragi and red gram decreased. As already indicated, due to the decreased attention and inputs from the farmers the yields of these crops also decreased. Yield decrease ranged from 10 to 19% in Jowar, ragi and red gram. Substantial improvement in the acreage and yield of cotton was observed.

Shift towards irrigated crops like paddy (27.5 acres gross area) and groundnut (4.5 acres in Rabi) was substantial as can be seen in Table 12 and Figure 4.



The total incremental value of production in the sample area at the rates mentioned by the farmers at harvesting time was Rs.3,60,775 for 60 acres. With per acre investment of Rs.1134/ - the total investment on watershed works in the sample area works out to Rs.68,040/ . *The ratio of incremental production to the total program investments in area development is 5.30 i.e. every rupee invested on land development results in an incremental value of Rs.5.30.*

This figure is higher because new area was brought under high value crops like paddy, cotton and groundnut. The cost of cultivation of these crops would also be substantial. An attempt was made in Table 13 to deduct the total cost of cultivation. The net value of incremental production after deducting the cost of its cultivation amounts to Rs.2.57 lakhs. The ratio of net value of incremental production

Table 13. **Changes in the value of production**

Crops	Area before	Area after	Change in Area	Rate	Value of change	Approx cost of cultivation	Costs of cultivation of changed area *
	ac	ac	ac	Rs./ qt	Rs.	Rs./ acre	Rs.
Jowar	39.5	27.5	-12	500	-6000	1500	-5250
Ragi	42	25.5	-16.5	400	-6600	2000	-4000
Redgram	14.75	8	-6.75	1500	-10125	1000	-5500
Cotton	23	50	27	2000	54000	5000	22500
Paddy Kharif	0	320	320	450	144000	3000	45000
Paddy Rabi	0	270	270	450	121500	3000	37500
Groundnut rabi	0	32	32	2000	64000	3000	13500
Total value of incremental production					**360775**		**103750**
Net value of incremental production (after costs)							**257025**

** difference in area after and before watershed minus the cost of cultivation of respective crops in the sample area*

(after deducting the cost of cultivation) to the total investment on area development works out to 3.78 **i.e. every rupee investment on area development (mainly bunding) will bring about Rs. 3.78 net returns (after deducting cost of cultivation) to the farmers.**

As already noted earlier, the benefits of irrigation are spread widely across the village with most of the households having some irrigated area.

9. Impacts on livestock

The data on livestock was collected through household survey of the entire village. Substantial decline in the population of cows (60%) and buffaloes (46%) was observed. Bullock population increased by 16%; STs have large numbers (42) of bullocks. Overall goat population remained relatively stable but the population shifted from BC households to STs. Sheep population also shifted from the traditional rearers to SCs and STs; their holdings increasing to about 75 to 85%. Tables 14 and 15 present the changes in the livestock. The data pertains to the entire village. The relation of these changes with respect to watershed interventions was not clear. Reduction in buffaloes along with cows is a trend contrary to the normal.

Table 14. **Livestock numbers before and after the watershed programme**

Caste	Cows		Buffaloes		Oxen		Goats		Sheep		Total (Main)	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
BC	40	14	62	24	59	35	51	19	150	122	362	214
OC	8	4	4	1	2	4	17	5	0	0	31	14
SC	63	25	13	14	48	45	73	50	8	82	205	216
ST	27	12	0	4	0	42	10	74	0	85	37	217
All	**138**	**55**	**79**	**43**	**109**	**126**	**151**	**148**	**158**	**289**	**635**	**661**

Table 15. **Change in caste wise holdings of livestock population**

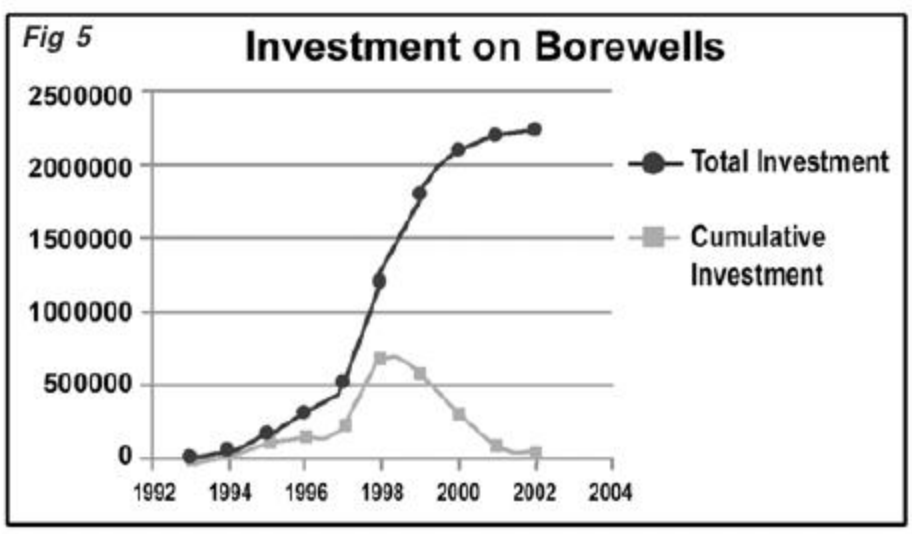
Caste	Cow	Buffaloes	Bullocks	Goats	Sheep	Total
BC	-26	-38	-24	-32	-28	-148
OC	-4	-3	2	-12	0	-17
SC	-38	1	-3	-23	74	11
ST	-15	4	42	64	85	180
All HH	-83	-36	17	-3	131	26
% Change	-60	-46	16	-2	83	4

There was significant decline in cows (60%) and buffaloes (46%) and substantial increase in the sheep population. Though decrease in cows is observed in several other villages, alarming rates of decrease in buffaloes mainly with BC community is a cause for concern. The reasons are not clear. Bullocks increased by 16%, which could be attributed to the increased agriculture. Overall livestock population increased by about 4%.

10. A Crisis In the Offing - Water Extraction

Watershed works catalysed spurt in investments on borewells. These investments include digging bore wells, cost of motor & its fitting and land levelling. Figure 5 reveals this trend. Watershed works were started in 1996-7 and borewell investments (including land development) started heavily from 1997-98. Within three years these investments reached a peak. The private investments

Fig 5



during this period amounted to Rs.17.30 lakhs (Table 16) while the total investments from the Government on watershed works were at Rs.14 lakhs!

About 76% of the investments on borewells were made during the 5 years since the beginning of watershed program. About 71% of the investments came from own and deferred payments for the equipment (Uddera). Banks provided only 12% of the investments made by people.

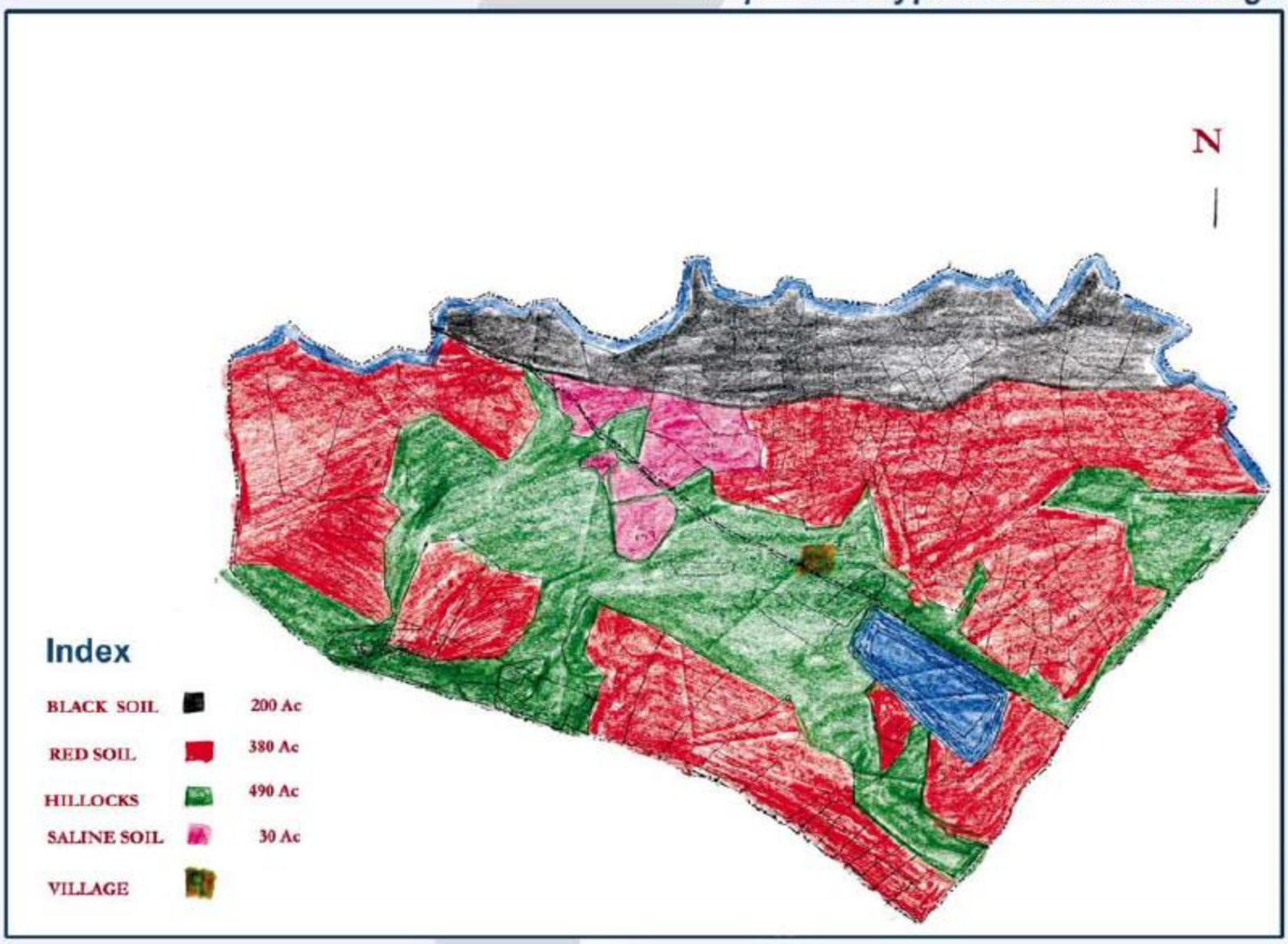
Table 16. **Year wise investment by farmers on bore wells and related aspects**

Year	Total investment	Cumulative investment	Own + *uddera**	Bank loan	Private loan
1993	10000	10000	10000	0	0
1994	46000	56000	36000	10000	0
1995	116000	172000	116000	0	0
1996	136000	308000	131000	5000	0
1997	215000	523000	170000	30000	15000
Pre-WS	***523000***		***463000***	***45000***	***15000***
1998	685000	1208000	495000	115000	75000
1999	590000	1798000	415000	45000	130000
2000	320000	2118000	235000	40000	45000
2001	95000	2213000	60000	10000	25000
2002	40000	2253000	30000	0	10000
Post-WS	***1730000***		***1235000***	***210000***	***285000***
%	100		71.38	12.14	16.47

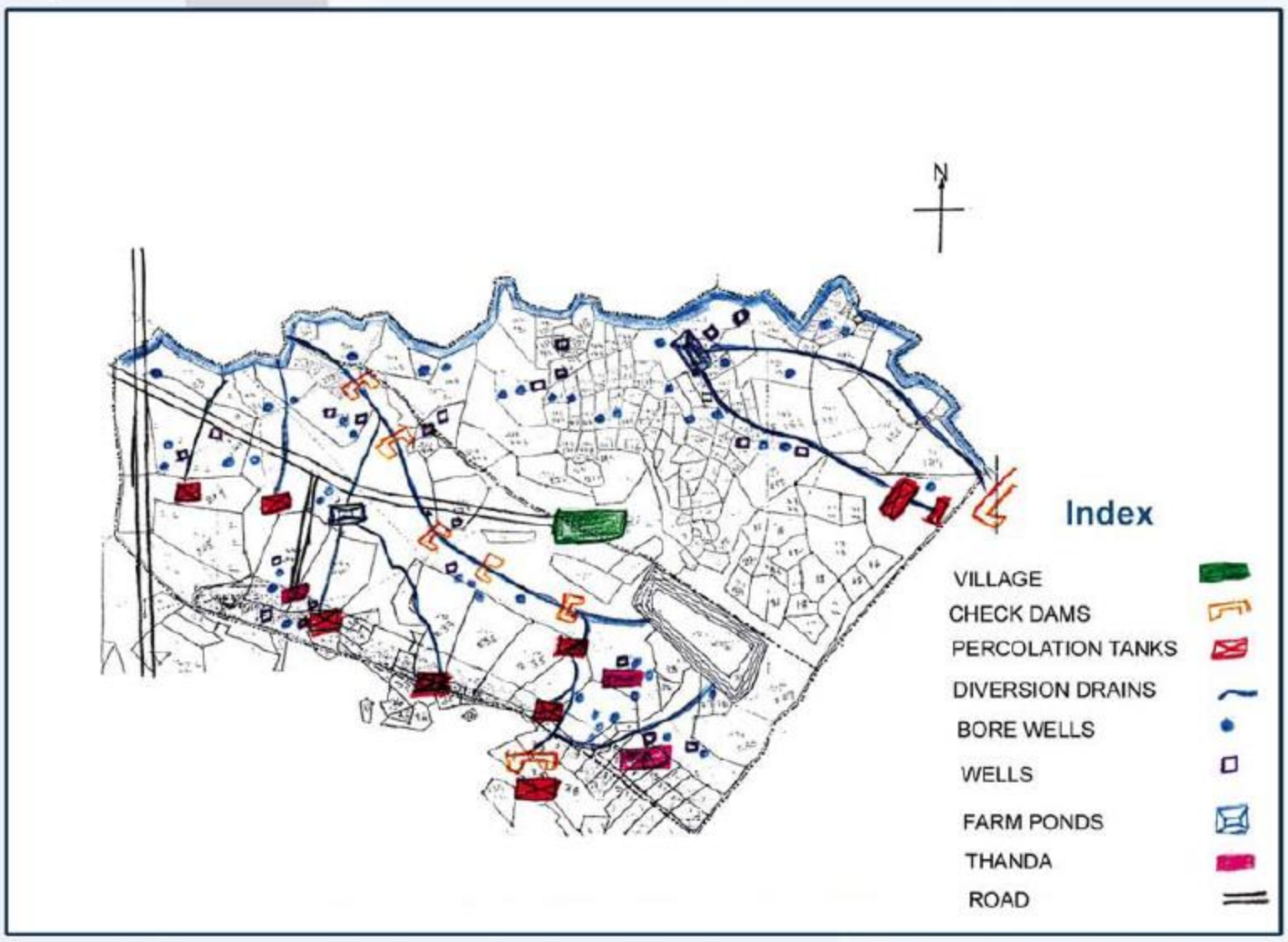
** Uddera: the traders and electrical shop owners invest on all the initial material requirements and repayments are made from the crop harvests. If the payments are delayed interest is charged*

In summary, the watershed investments have resulted in shift towards irrigated crops like paddy and groundnut. Whereas the institutional finances for farmers investments on borewells is very less, the spurt in borewell digging might lead to groundwater crisis in near future.

Map-1 **Soil types of Mailaram village**



Map-2 **Actual treatment works carried out in Mailaram**



4. Ellamma Vanka Watershed

Village:***Kunkanur***

P.I.A:***RAIDS***

Mandal:***Devanakonda***

Period:***1996 - 2000***

District:***Kurnool***

Kunkanur, a small town has a total geographical area of 4907 acres with 467 households. It is 6 kms away from mandal headquarters, Devanakonda, Kurnool district. Three watersheds were sanctioned to this village in 1995-96 (first batch of watersheds) with the Multi Disciplinary Team as the PIA. This agency implemented the watershed for about one year but could not move forward due to 'factions' within the village. This was later given to RAIDS, a local NGO in 1998. Watershed Association was registered in February 2000. The action plan was prepared in 1999-2000 and the project was completed in 2003.

1. Village Profile

The village has 467 households and about 3000 population of which 18% belong to SC & ST communities (Table 1). Families living mainly on labour constitute 59% of the total households. About 210 households migrate every year to nearby towns in search of labour. Artisans and other occupations constitute about 12% of the households (Table 2). There are 8 hand pumps and 26 stand posts supplying drinking water from an overhead tank. Drinking water scarcity is felt during the summer season.

Table 1. **Population details of the village**

Caste	*Male*	*Female*	*Total*
SC	*258*	*244*	*502* **(16 %)**
ST	24	24	48 **(2 %)**
Others	1292	1263	2555 **(82 %)**
Total	1574 **(51 %)**	1531 **(49 %)**	3105 **(100 %)**

Source: Action Plan, 2000

Table 2. **Occupations in the village**

No	Category	No. of Households	%
1	Landless labor	100	21.41
2	Agriculture labor (labour + land)	175	37.47
3	Farmers	136	29.11
4	Artisans	20	4.28
5	Others	36	7.71
	Total	***467***	***100***

Source: Participatory situation analysis, APRLP, 2003

The details of the landholdings are given in Table 3. The small and marginal landholdings constitute 72% of the total land holdings. Landless labour constitutes 21% of the total households.

Table 3. **Land holdings in the village**

Category	Numbers	%
Marginal	200	32
Small	250	40
Medium	100	16
Large	75	12
Total	***625***	***100***

Source: Action plan, 2000 (from revenue records)

The village has an area of 4907 acres. It was divided into 4 watersheds based on drainage lines. Of these, Yellamma Vanka watershed was selected for the purpose of the impact study.

Table 4. **Land use details in the Yellamma watershed**

Land use type	Area		
	Hectares	Acres	%
Cultivated	480	1185.6	92
Cultivable waste	8	19.76	2
Waste	32	79.04	6
Total Area	520	1284.4	100

Source: Action Plan, 2000

The Yellamma vanka watershed has 520 hectares (1284.3 acres) area. Of this about 92% area is cultivated. Cultivable waste and waste lands occupy about 8% of the area. These details are provided in Table 4. The slope varies from 1 to 2%.

Table 5 and Map 1 give information about the soil types: about 95% of the land in the watershed has saline soils and only 5% is under red soils. There are three classes of the saline soils viz., black(loamy), red and white saline soils. The yield levels also differ with these soil types- white saline soils *(pala choudu)* has relatively higher yield levels.

Table 5. **Soil types**

Soil Type	Area		%
	Hectares	Acres	
Red soil	28.3	70	5%
Saline soil	492	1215	95%

Source: Resource map exercise

Sunflower, Jowar, Red gram, Bajra, Korra, Tomato and Paddy are the main crops. Acreage under Paddy is limited, mainly cultivated under the seepage of the farm ponds. Irrigation is very meager, mainly under the functioning wells. Groundnut is the main crop under these wells.

Highly problematic soils, very low irrigation, high percentage of cultivated areas, higher incidence of landlessness and high levels of migration are the characteristics of the watershed.

2. Watershed Works and Investments Profile

Of the total expenditure on works, 64% was spent on water harvesting structures (32% on checkdams and 25% on farm ponds). 26% of the expenditure was on soil and moisture conservation. The total investments went almost in proportion to the household percentages by caste – investments accruing to SC households is 19% and for BCs it is 80%. About 73 ha were brought under horticulture and fuel & fodder trees (Table 6; Figure 1; Map 2).

Table 6. **Works and expenditure profile**

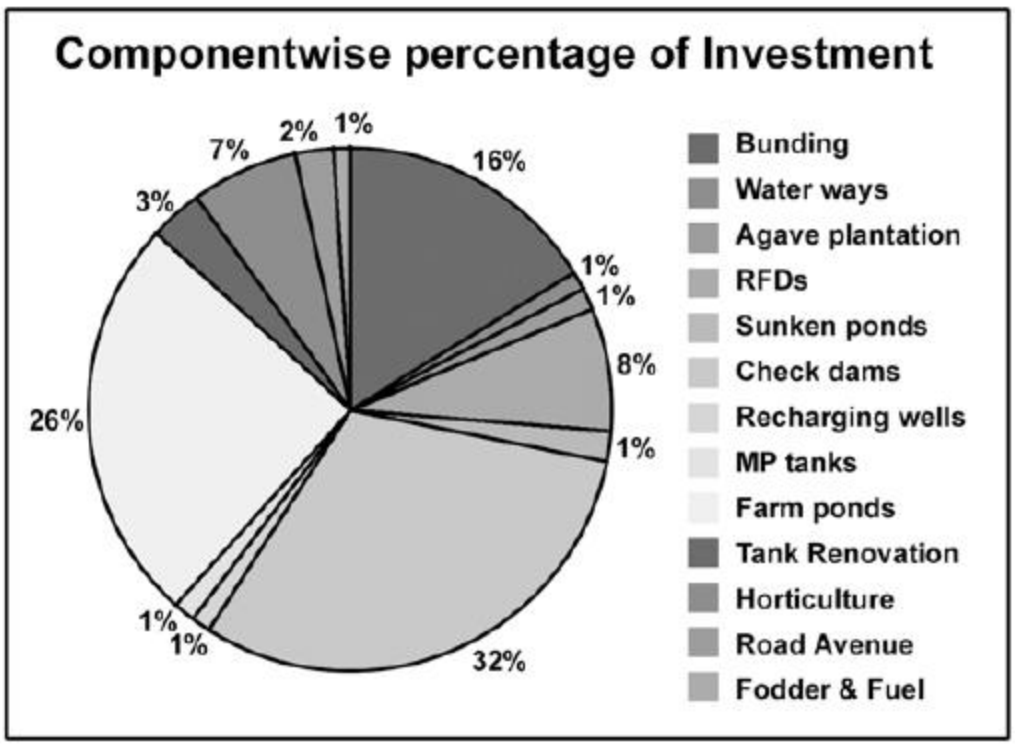
No	Activity	Unit	Total expenditure		SC		BC		OC	
			Physical	Fin (Lakh)	Physical	Fin (Lakh)	Physical	Fin (Lakh)	Physical	Fin (Lakh)
1	**Soil & moisture conservation**									
A	Bunding	Ha	164	2.33	61	0.64	103	1.69	0	0
B	Water ways	Ha	15	0.15	0	0	15	0.15	0	0
C	Agave plantation	Ha	12	0.16	0	0	0	0	12	0.16
D	RFDs	Nos	32	1.1	5	0.15	27	0.95	0	0
	Sub total			**3.74**		**0.79**		**2.79**		**0.16**
				(26%)						
2	**Water harvesting structures**									
A	Sunken ponds	Nos	45	0.19	25	0.1	20	0.09	0	0
B	Check dams	Nos	7	4.6	2	1.15	5	3.45	0	0
C	Recharging wells	Nos	16	0.1	1	0.01	15	0.09	0	0
D	Percolation tank	Nos	1	0.13	0	0	1	0.13	0	0
E	Farm ponds	Nos	17	3.69	2	0.25	14	3.44	0	0
F	Tank renovation	Nos	2	0.42	0	0	2	0.42	0	0
	Sub total			**9.13**		**1.51**		**7.62**		**0**
				(64%)						
3	**Plantation**									
A	Horticulture	Ha	71	0.94	9	0.25	59	0.65	3	0.04
B	Road avenue	Km	2.5	0.35			2.5	0.35		
C	Fodder & fuel	Ha	2	0.14	2	0.14	0	0	0	0
	Sub total			**1.43**		**0.39**		**1.00**		**0.04**
				(10%)						
	Grand total			**14.3**		**2.69**		**11.41**		**0.2**
				(100%)		**(19%)**		**(80%)**		**(1%)**

3. Impact Mapping

3.1 Process

Initially impact mapping was done separately with the Panchyat, watershed development committee, user groups and village organisations (federation of SHGs). About 70 members in all participated in these exercises. Three members were selected locally for detailed surveys like livestock analysis. During the field survey three villagers accompanied the study team along with two WDTs; farmers available in the sample fields were consulted.

Fig 1



Two transect paths were decided in the watershed area based on the resource map. The water harvesting structures, soil conservation measures and plantation activities were surveyed along these transect paths.

4. Analysis of Institutions

Self-help groups, user groups, watershed association and watershed committee are the new institutions envisaged in the program to effectively liaison with the gram panchayat and take issues relating to natural resource management. A Village Organisation (federation of SHGs) was established under AP Rural Livelihoods Project.

A meeting was organized with the Gram Panchayat to discuss issues like the linkages of GP with the watershed institutions, impact of the program, awareness of the GP members about the program. A focused group discussion was organized with the watershed association executive body and watershed committee members in which about 15 persons attended. The functioning and roles of the committee during and after the project period were discussed in addition to the impacts. Their relation with GP and groups were also discussed.

The study focused on the institutions created in Yellamma Vanka watershed only, but not of the entire village. In focused group discussions with the self-help group leaders the groups were listed and their basic data (functioning, caste composition etc.) collected. Four representative groups were selected for a sample study. The team then organized meetings with these four groups separately and generated the data.

4.1 Self-Help Groups

The groups received substantial inputs for revival from the AP Rural Livelihoods Project.

List of self help groups in Yellamma Vanka watershed		
1	No. of groups	10 (Total 144 members of which SC-25, BC-93, OC-26)
2	Functioning groups	10
3	Year of formation and number of groups	1995 - 2, 1999 - 1, 2001 - 3, 2002 - 4.
4	Amount of revolving fund	Rs. 38000/- to 3 Groups
5	Bank linkages	Rs. 73000/- to 5 Groups
6	Purpose of loans availed from the revolving fund	Petty shop, Flour mill, livestock
7	Perceived role in watershed program	No role
8	Emergence of leadership from out of the groups	Nil

The groups though dynamic, did not perceive any significant role in the watershed program both during the implementation phase and the post project period; except working as wage labourers. The changes in livestock were significant and there would be specific impacts on the livelihoods, but this was not studied. An amount of Rs.38,000/ - was received by 3 groups as revolving fund.

Watershed Committee and Association

Watershed committee	
Members in the committee	11, SC - 2, BC - 9. (women –2)
Year of formation	2000
WDF (watershed development fund)	Rs. 98,000
Interest earned on WDF	Data not available
Utilization of WDF	Not used till now, Planned to use for repairs
Role of WC beyond W/S	Nothing
Functioning of WC	Not functioning
Emergence of Leadership	None
Present status of WC	Not meeting since March 2003 (Project completion)
Received best secretary award at district level in 2001	

It is a village ridden with factions. Some of the members in the watershed committee played an important role in the last Panchayat elections, where the established leadership was defeated.

WDF has an amount of Rs.98,000/ - i.e. 6.85% of the total works budget. The account was frozen, as there was no instruction from the Project Director's office (a joint account holder). The committee stopped functioning formally since the completion of the project.

Watershed Association was also not functioning formally since the completion of the program. APRLP efforts were mostly centered around the Village Organisation and the watershed secretary was playing an important role in these efforts.

5. Impacts of Water Harvesting Structures

In the impact mapping exercise the following impacts were observed by the participants (Table 7).

Table 7. **WHS – impacts**

No	Purpose	Source of the water body		Remarks
		Before	Present	
1	Drinking water for livestock	Wells	Check dam, farm ponds, percolation tanks	Water availability increased in terms of multiple locations.
2	Washing livestock	Wells	Check dam, farm ponds	The time spent was greatly reduced.
3	Washing clothes & cleaning utensils	Wells	Check dam, farm ponds, taps, handpumps	There is a lot of saving on the for Washermen (Dhobi), women and for livestock rearers.
4	Irrigation	Wells	Check dam, farm ponds, Wells	The farm ponds and checkdams were greatly useful for raising the tomato nurseries. At three place paddy is grown near the farm ponds.

Because of the dispersed water harvesting structures – mainly farm ponds and checkdams water is now available at multiple locations (at 24 locations), thus reducing the long-distances traveled by women, washer-folk and livestock rearers.

Rejuvenating drinking water!

A bore-well drilled by the Panchayat for drinking water was abandoned earlier as there was no water. This bore well rejuvenated after the construction of Yellamma Vanka checkdam. Panchayat is now supplying drinking water to the village by pumping water from this bore-well. This has boosted the confidence of the villagers.

Investments on water harvesting are presented in Table 8. Of the total works budget 64% i.e. 9.13 lakh rupees were invested on water harvesting. Of the total investments on water harvesting about 17% and 83% went to scheduled and backward caste communities respectively.

Table 8. **Investments on water harvesting structures**

No	Activity	Total expenditure			SC		BC		OC	
	Water harvesting structures	Unit	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)
A	Sunken ponds	Nos	45	0.19	25	0.1	20	0.09	0	0
B	Check dams	Nos	7	4.6	2	1.15	5	3.45	0	0
C	Recharging wells	Nos	16	0.1	1	0.01	15	0.09	0	0
D	Percolation tank	Nos	1	0.13	0	0	1	0.13	0	0
E	Farm ponds	Nos	17	3.69	2	0.25	14	3.44	0	0
F	Tank renovation	Nos	2	0.42	0	0	2	0.42	0	0
	Total			**9.13**		**1.51**		**7.62**		**0**
				100		**16.5%**		**83.4%**		

Fig 2

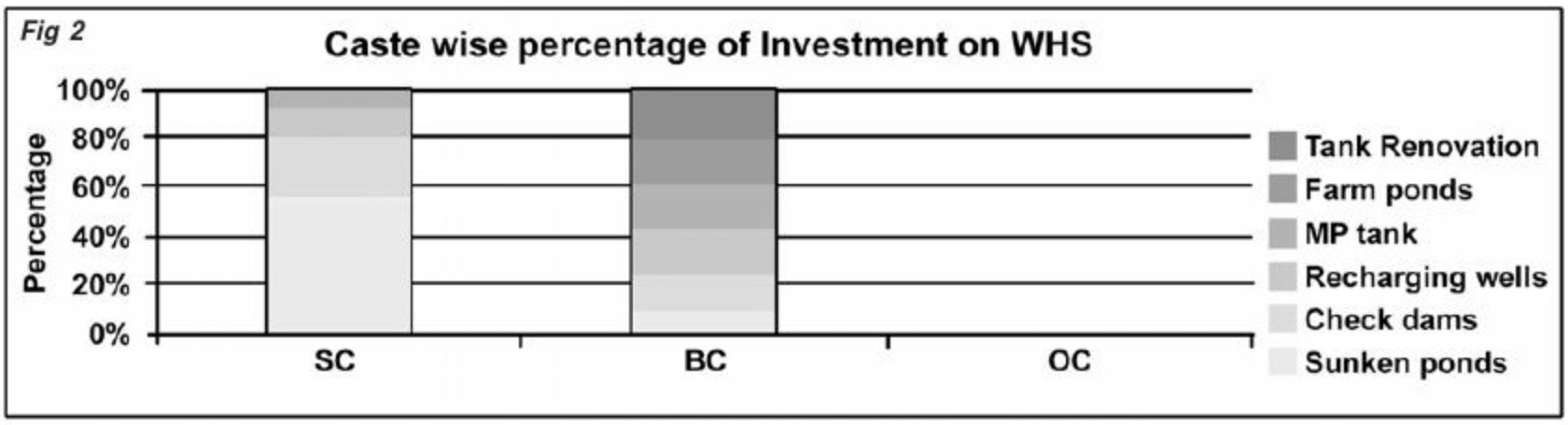


Table 9. **Qualitative assessment of checkdams**

No	Name of the waterbody	Volume of water spread (cu.m)	Dries up in the month of	Silt depth (m)	Desiltation	Recharged Wells/ Borewells	Uses	Remarks
1	Veerabadraiah CD	3000	April	No	Silt removed& applied in fields	0	Livestock: Drinking Water For pot-irrigation in tomato nursery	No repairs needed till now
2	Thammappa CD	15000	Water through out the year	No	No	0	Livestock: Drinking Water Human: Washing Clothes For pot-irrigation in tomato nursery	No repairs needed till now
3	Chakali Yellaiah CD	3000	April, May	No	No	0	Livestock: Drinking Water For pot-irrigation in tomato nursery	No repairs needed till now
4	Hanumanthu CD	560	April	No	No	0	Livestock: Drinking Water Used for pot-irrigation for nursery	No repairs needed till now
5	Yernala Vanka CD	60	Sep Oct	0.2	No	0	Livestock: Drinking Raising Tomato Nursery	No repairs needed till now
6	Yellamma CD	3040	March	0.2		2	Livestock: Drinking and washing Human: Drinking and Washing clothes Irrigation through wells	Drinking water bore well rejuvenated Vertical Cracksdue to salt soil, Repairs not done
7	Upponka CD	1020	Jan/Feb	0.3		0	Livestock: Drinking Water	Repairs not required
	Total	**25680**				**2**		

5.1 Quality Assessment of WHS

In all seven checkdams were constructed with a total expenditure of Rs.4.6 lakhs (50% of investments on water harvesting structures). Approximately 25680 cu.m storage area had been created. The cost per cu.m of storage volume created was about Rs.17.91 per cu.m; this cost is lower as the area is relatively flatter. One checkdam is perennial. In 4 checkdams water is retained till March-April and in other two checkdams water is there till October-January. In one checkdam silt has been removed and applied in the farmer's field by themselves. In three checkdams silt accumulated to a depth of 0.2 to 0.3 meters. In all these the silt is sandy and is not useful for applying in the field. All the checkdams were intact at the time of the survey and do not need any repairs except Yellamma checkdam which had a settlement crack developed immediately after construction and water is leaking through the crack. Repairs were not done.

Construction of most of these checkdams was completed in 2002 (January - December). Only one complete year had elapsed before the survey time. Year 2002-03 happen to be a drought year. Only one checkdam has a well and a bore well and none other had any wells under their influence zone. The one bore well which was defunct had been rejuvenated and is now supplying drinking water for the village. In all there are only 6 open wells and two borewells in the watershed.

The impacts could not be computed for two reasons:

1) There was no usage of ground water under the influence zone of the checkdams.
2) Direct manual pot irrigation for raising tomato nurseries was practiced in almost all the checkdams. Farmers acknowledge this to be a critical impact as this irrigation helps in survival of the tomato nurseries – particularly when there is a prolonged gap in the rainfall. These benefits could not be computed owing to the complexity in such a situation.

Of the total 17 farm ponds a sample of 9 were surveyed on the two transect paths. Table 10 presents the details of the surveyed farm ponds and one renovated percolation tank. Of the total 17 farm ponds, six were dugout farm ponds and 11 surface farm ponds (a larger bund across the slope approximately 6 to 7 feet high at the lowest point and with a spillway). The cost per cubic meter storage volume in the sample farm ponds (excepting percolation tanks) was about Rs.11.63, lower compared to the masonry checkdams.

Almost all these farm ponds were done in the saline soils which were not under cultivation before construction. This might also be due to the submergence area required for such structures and the related ease in mobilizing farmers. The submergence area ranged from 0.5 to 1.0 acres per structure. Though the project looked at water harvesting, farmers looked at these structure more for conservation of these lands and to bring them to cultivation with the accumulation of silt.

There were no wells or borewells under these structures. In all the ponds water dries up by September-December, except in the percolation tank.

These farm ponds were completed between 2002 (April) and 2003 (February). All the land under these structures was fallow before the program (except for 1 acre). After the structures were constructed, 5 farmers out of the 9 started cultivating the land. Three farmers cultivated paddy from

Table 10. **Qualitative assessment of farm ponds**

No	Name of the water body	Type of structure	Cost of the structure (Rs.)	Volume of water spread (cu.m)	Dries up in the month of	Silt depth (m)	Desiltation	Recharged wells	Uses	Remarks
1	Dharmanna	Surface farm pond	22,540	300	August	No	Yes		Drinking water for livestock	Fallow till last year, this year Sun Flower
2	Boya Veeranna	Surface farm pond	21,080	250	August	No	No		To stop erosion of soil along the slope	Fallow till last year, this year Sun Flower
3	Bellam Anjaneyulu	Surface farm pond	20,770	450	Sept	No	No		Silt deposition and its usage in fields	3 acres brought into cultivation this year
4	Vadde Thimmappa	Surface farm pond	23,690	2000					Livestock: Drinking and washing	
5	Vadde china thimmappa	Surface farm pond	19,850	1125	Dec	0.1			Livestock: Drinking water	
6	Vadde pedda thimmappa	Surface farm pond	19,700	320	Sept	0.1			Livestock: Drinking and washing	
7	Vadde Maddileti	Surface farm pond	20,050	10500	Dec	0	0		Irrigation through seepage	Paddy in 0.5 acres
8	Harijana Dastagiri	Surface farm pond	20,480	600	Sept	0.1	0	0	Irrigation through seepage	Growing paddy in 0.25 acres since last year (but there were no returns)
9	Hanumanthu	Dugout farm pond	13,880	90	August	No	No			Planned for growing Paddy, but not doing
10	Renovation of Percolation Tank	Percolation tank renovation	18,530	2933	April				Livestock Drinking and washing, Washing Clothes	
	Total		**200,570**	**18568**						

the seepage water, but for lack of sufficient water the crop dried up. In addition, about 10 acres were also brought under cultivation in the current year (sunflower was taken up but not harvested at the time of survey). This completed year also happened to be a severe drought year.

The impacts of the farm ponds are yet to be visible. They might need longer gestation period for farmers to visualize benefits, to make complementary investments and to start cultivating the land. The impacts would be visible only after few years and hence no benefits were computed.

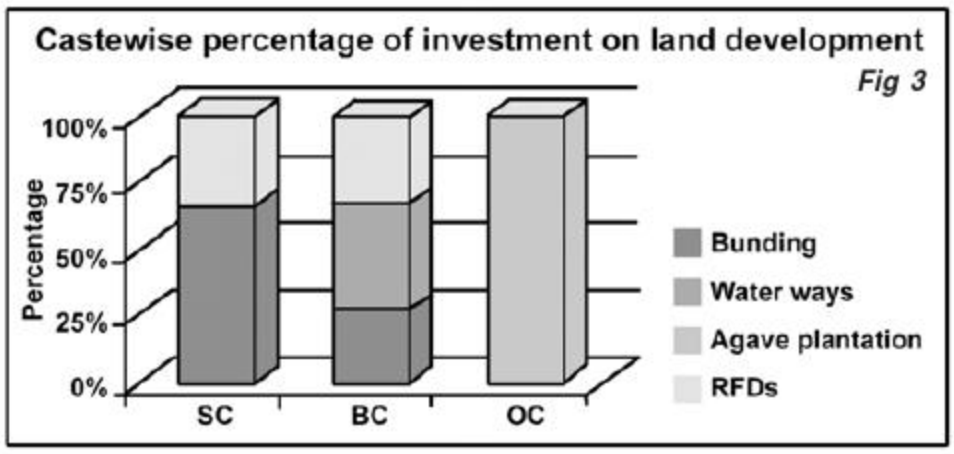
This experience also shows the criticality of complimentary investments for the watershed program to yield concrete results; therefore, the need for planning the complimentary investments if they are not forthcoming from the farmers.

6. Impacts of Land Development

Table 11. **Investments on land development**

Activity	Total expenditure			SC		BC		OC	
Soil & moisture conservation	Unit	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)	Physical	Fin (Lakhs)
Bunding	Ha	164	2.33	61	0.64	103	1.69	0	0
Water ways	Ha	15	0.15	0	0	15	0.15	0	0
Agave plantation	Ha	12	0.16	0	0	0	0	12	0.16
RFDs	Nos	32	1.1	5	0.15	27	0.95	0	0
Sub Total			**3.74**		**0.79**		**2.79**		**0.16**

In all 26% of the total works investments went for land development (Table 11). About 62% of the total land development investment was on field bunding and 29% on rock fill dams. About 21% and 75% of land development investments went to SCs and BCs; the later have bulk of the land ownership.



Quality Assessment of Bunding in sample area (73.5 acres)

In a transect explained earlier, 14 farmers and 73.5 acres (non contiguous) were surveyed. Bunding was taken up only in the saline soil areas (none in red soil areas). The sample was also entirely in the saline soil areas. The details of the survey are given in Table 12.

The quality of construction of bunds was good as 87% of the surveyed bunds had uniform top level, spillways were provided in almost all the bunds and the cross section was maintained in about 97% of the bunds. However, grass cover did not establish in many of the bunds. 29% of the bunds had breaches. Half of the surveyed bunds require maintenance of which only 21% were attended to i.e. in 79% cases maintenance was not done. Most of the breaches and maintenance requirements (not attended to) were in non-cultivated lands. In some cases there were large holes underneath the bunds, repair of which is difficult.

Table 12. **Quality assessment of bunding**

No	Bund characteristic	Quality	Number	%	Remarks
1	Cross section	Good (> 40cm ht)	13	34	
		Average (Up to 40cm ht)	24	63	
		Poor (< 30cm ht)	1	3	
2	Grass cover	Fully Covered	1	3	
		Partially Covered	12	31	
		Absent	25	66	
3	Maintenance	Not Required	19	50	
		Required	19	50	
		Done	4	21	
		Not Done	15	79	
4	Soil deposition behind the bund	Up to 45cm	14	37	
		Up to 30cm	1	2	
		Up to 20cm	23	61	
5	Top level	Uniform	33	87	
		Not Uniform	5	13	
6	Spill way provided	Yes	37	97	
		No	1	3	
7	Bund breached	Yes	11	29	
		No	27	71	
	Total no. of Bunds = 38.				

Table 13. **Land use in sample area (73.5 acres)**

	Total area (acres)	Land use (acres)				Moisture retention (days)	
		Before		Present			
		Fallow	Cultivated	Fallow	Cultivated	Before	Present
Area	73.5	43.5	30	24.5	49 *	11	19
Percentage	100%	59%	41%	33%	67%		

** of this area 4 acres were brought to cultivation in the current year (crop yet to be harvested)*

After treatment of the watershed area under fallows decreased by 19 acres i.e. by 44% and moisture retention capacity increased by about 8 days as expressed by farmers.

Table 14. **Area and production of various crops in sample area (73.5 acres)**

No	Crop	Area (acres)		Production (q)		Average yield (q)	
		Before	Present	Before	Present	Before	Present
1	Cotton	2	15	6	22	3.00	1.47
2	Sunflower	2	12*	6	48	3.00	4.00
3	Korra	12	11	44	45	3.67	4.09
4	Sajja	9	6.5	10	7	1.11	1.07
5	Paddy	0	0.5	0	8	-	16.00
6	Tomato	5	0	0	0	-	-
	Total	**30**	**49**				

** another 4 acres were sown during the current year which is yet to be harvested & not included in the calculations.*

As can be observed from Table 14 the yield levels have marginally improved compared to the 'before' situation. The yield improvements were in the range of about 11 to 30%. A shift was observed from tomato to sunflower and the area under cotton also increased. The productivity of cotton reduced by about 51% mainly due to drought situation (cotton is longer duration crop and is more vulnerable to drought).

Table 15. **Gross value of increased production**

No.	Crop	Changes		Rate /q	Amount
		Area	Production		in Rs.
1	Cotton	13	16	1800	28800
2	Sunflower	8	42	1000	42000
3	Korra	-1	1	500	500
4	Sajja	-2.5	-3	600	-1800
5	Paddy	0.5	8	500	4000
6	Tomato	-5	0	0	0
	Total	**19**			**73500**

The approximate total investment on 73.5 acres of survey area was Rs.68,000/ -. The value of gross increment in production as per current prices is Rs.73,500/ - (Table 15). The investment at the above rates pays back within a year. A Benefit cost ratio for even one year (which is a drought year) was 1.08.

7. Impacts of Plantations

About 10% of the total works budget was invested on plantations including horticulture. Table 16 and Fig. 4 give these details. About 66% of the plantations' investment was on horticulture & 24% was on avenue plantations.

The horticulture plantations were mainly of sapota (Chickoo), mango and guava. These were planted in 2002 July and are not yet in bearing at the time of the survey. Fodder and fuel plantation was a demonstration farm in a farmers' holding. The survival rates of the horticulture, fuel and fodder plantations were reported t o be good.

Fig 4

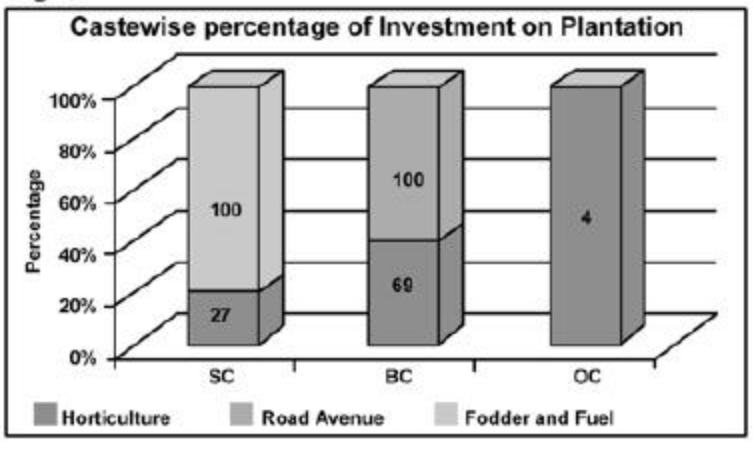


Table 16. **Investments on plantations**

No	Activity		Total Expenditure	
		Unit	*Physical*	*Fin(Lakhs)*
1	**Plantation**			
A	Horticulture	Ha	71	0.94
B	Road Avenue	Km	2.5	0.35
C	Fodder & Fuel	Ha	2	0.14
	Sub Total			**1.43 (10%)**

No impacts were observed as of now as the gestation period was not complete.

8. Impacts on Livestock

A format based household survey on livestock situation provided the data for the following analysis (Table 17 (a) & (b)).

Table 17(a). **Caste-wise ownership of livestock population before (1997) and after (2003) watershed program**

Type	ST		SC		BC		OC		TOTAL	
	B	P	B	P	B	P	B	P	B	P
Cows	0	0	39	34	110	250	1	0	**150**	**284**
Buffaloes	0	0	11	18	70	164	8	7	**89**	**189**
Bullocks	2	0	34	47	160	310	8	4	**204**	**361**
Goats	0	0	27	20	230	471	0	0	**257**	**491**
Sheep	0	14	11	25	809	894	0	0	**820**	**933**
Poultry	10	19	108	72	109	112	6	35	**233**	**238**
Pigs	40	5							**40**	**5**
Total	**52**	**38**	**230**	**216**	**1488**	**2201**	**23**	**46**	**1793**	**2501**

B: before ; P : present

Table 17(b). **% Changes in livestock population**

No	Type	Total (Nos.)		Change	% Change
		Before	Present		
1	Cows	150	284	134	89
2	Buffaloes	89	189	100	112
3	Bullocks	204	361	157	77
4	Goats	257	491	234	91
5	Sheep	820	933	113	14
6	Poultry	233	238	5	2
7	Pigs	40	5	-35	-88
	Total	1793	2501	708	39

The changes in livestock population were significant. But it might be a cumulative impact of the four watershed programs implemented in the village; it is not possible to isolate the impacts within Yellamma Vanka watershed. The changes in the livestock population are also a result of activities of the revolving fund made available through self-help groups. 50 cows, 45 buffaloes, 95 sheep were part financed through the revolving fund.

Availability of drinking water for livestock increased. It was also observed during the impact mapping exercises that fodder availability also increased. Mechanisation in the village was very low and increase in crop area might be a reason for increase in bullocks; more so for reasons of dependency on bullocks for transport. The results are too complex to be included in the benefit cost analysis.

9. Overall Benefit - Cost Analysis

There are three main areas of project physical investment viz., water harvesting, land development and plantations. Of these water harvesting did not yield any physical, measurable direct production related benefits, as the recharged ground water could not be used for lack of wells or bore-wells. It was not possible to quantify the benefits in this case. As the plantations were still at an earlier stage and had not crossed their minimum gestation period, it was difficult to compute the benefits from this activity also.

The returns to land development were analysed earlier. The average investment was Rs.925 per acre. Total area taken up for land development was 405 acres (164 ha). The value of incremental annual production observed from the sample was Rs.73,500 for a sample area of 73.5 acres i.e. Rs.1000 per acre in the first year itself. This also happened to be a drought year.

If the life of the land development infrastructure created was assumed to be five years, and at a compound rate of interest of 10% then the benefit – cost ratios would be as given in Table 18.

Table 18. **Benefit - cost ratios**

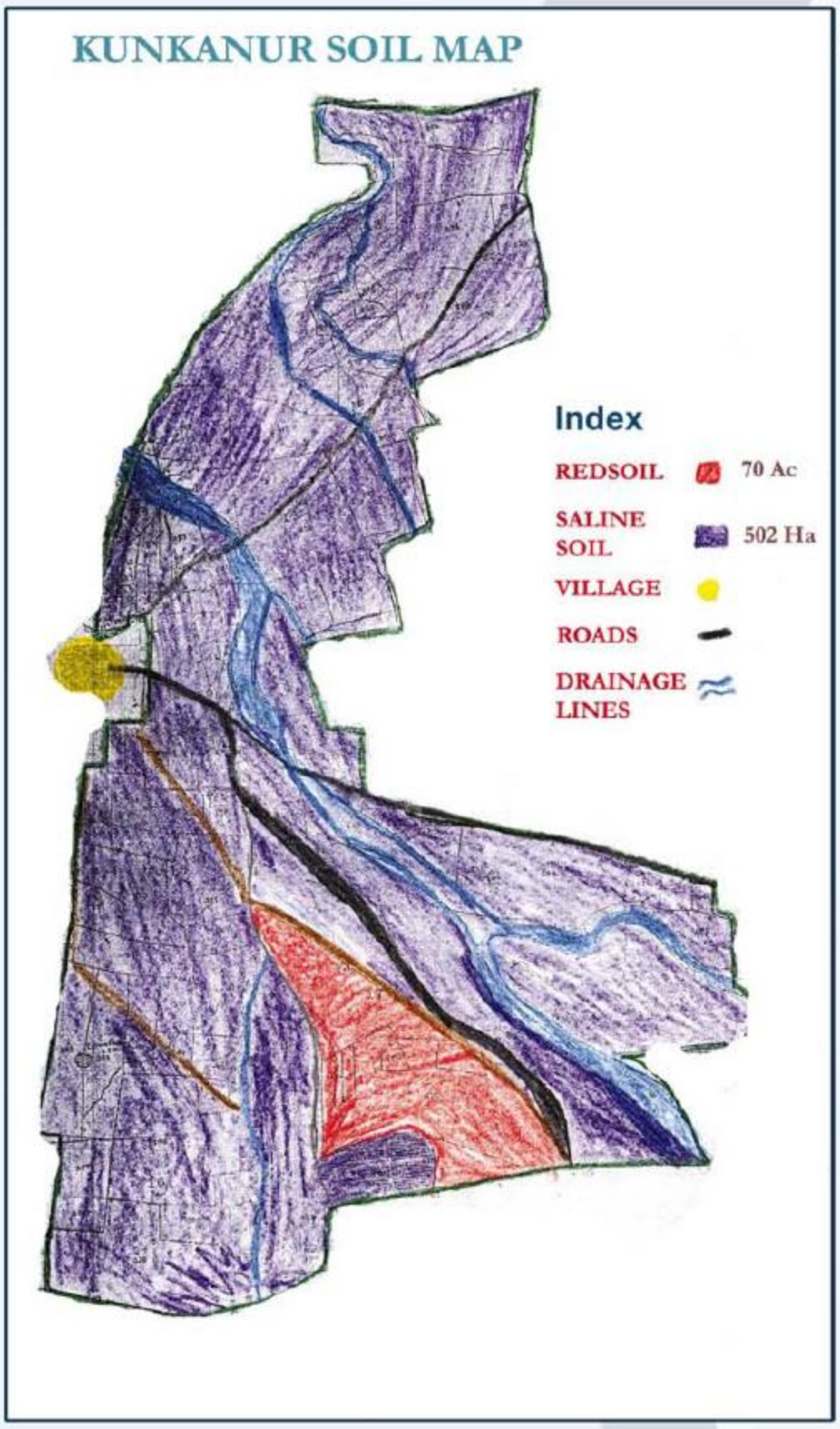
No	Particulars	Amount (Rs)
1	Compounded future value of the investment at the end of 5 years at current prices	548,488
2	Compounded future value of the **incremental** annual production for five years at the end of 5th year at current prices	2472,566
3	Benefit to Cost ratio for land development	4.50

The benefit-cost ratio is high at 4.5. Even considering benefits from land development alone over the total investment on watershed program (Rs.20 lakhs) the B-C ratio was about 0.8 with a pay back period of 8 years. The value of incremental benefits was taken with an assumption that there would not be substantial changes in the cost of production.

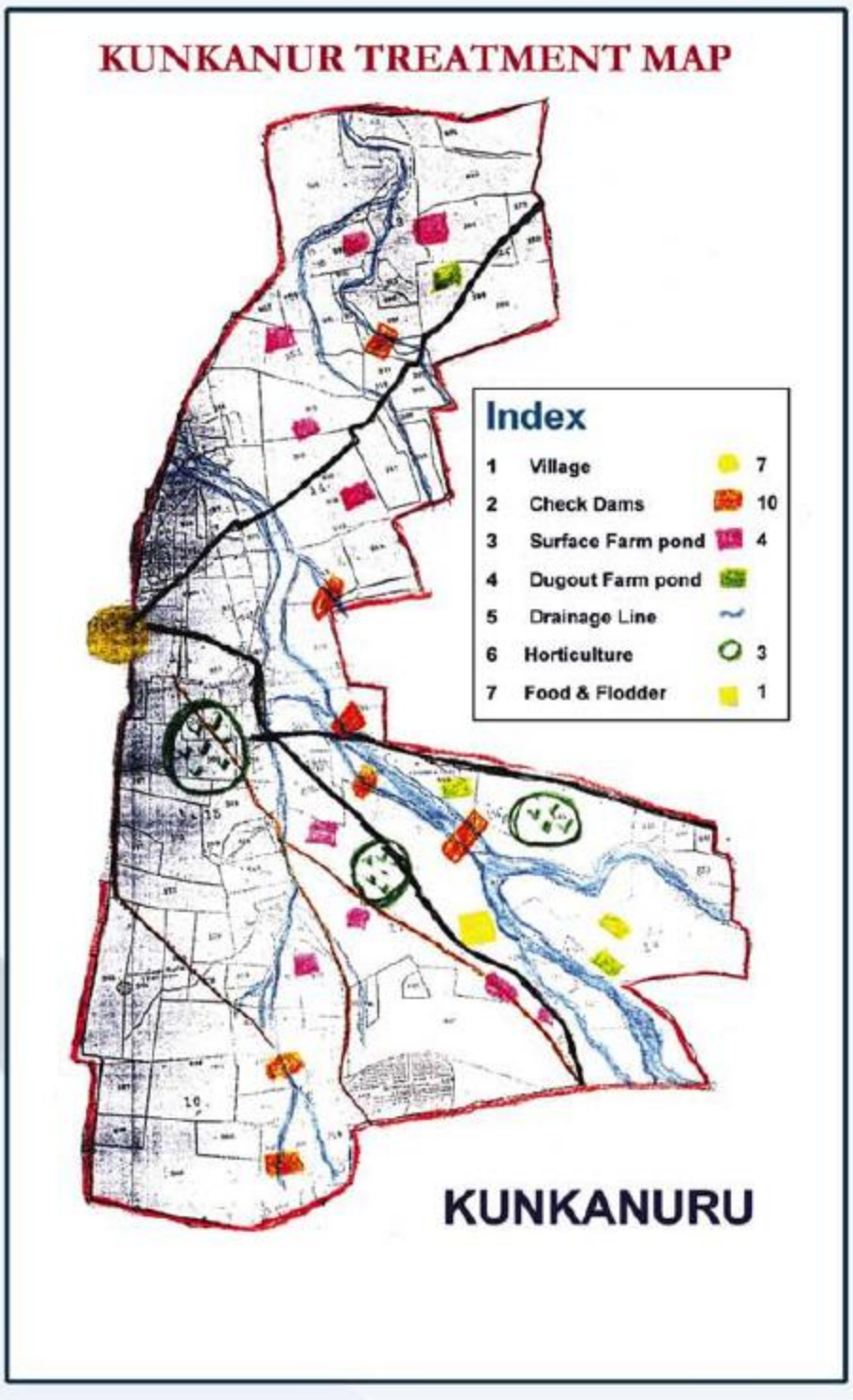
The environmental services and critical inputs into the village life from the watershed program are several – like increased availability of drinking water for both human and livestock, fodder, recharged ground water, the impacts of community Organisation (on the faction ridden village), etc.

More importantly there were very meager complimentary investments in this watershed from the farmers. The village was poised for a rapid growth with some gestation period as the horticulture plantations starts economic yields and also with some investments on ground water use.

Map-1 **Soil types of Ellamma Vanka village**



Map-2 **Actual treatment works carried out in Ellamma Vanka**



5. Dadapur Watershed

Village:***Dadapur***

P.I.A:***MDT***

Mandal:***Doma***

Period:***1996-2000***

District:***Ranga Reddy***

Dadapur, located in Doma mandal of Ranga Reddy district, is 28 kms from the nearest town Parigi. The village has an area of 1125 ha with hillocks sprawling from the west to east. The rain water drains into two streams flowing from North to South. Two watershed development programs were implemented in the village by the MDT (a government PIA) from 1995 to 2002. The study focused on Watershed-I.

1. Village Profile

Dadapur has about 453 households with a total population of about 3500. Backward castes (57%) are in majority followed by SCs & STs (31%) (Tables 1 & 2).

The village has two hamlets; the present study covered the main village and one of the hamlets - Kothapalli. A road to the village which almost approximates to the ridge line of one of the streams was considered as the boundary of the watershed. A overhead tank supplies drinking water to the main village while two hand-pumps supply water to the hamlet (Table 3).

The village has a total land of 1125 ha (2779 acres), 50% of which is under rainfed agriculture. About 10% of the land is irrigated. About 22% of land is under hillocks- a common pool resource. (Table 4). Tank beds and cultivable waste are to the tune of about 18% of the geographical area (Tables 4 & 5).

Of the 750 land holdings in the village 8 holding have >10 acres of land. Much of the land (67%) has sandy soils with some clay. Stony soils the next predominant soil type is particularly found in the commons.

Jowar, Redgram and Ragi are the main dryland crops while Rice, Groundnut and Maize are the main irrigated crops (Table 6).

Table 1. **Population**

	Numbers	%
Men	*1763*	*50.41*
Women	*1734*	*49.59*
Total	***3497***	***100***

Source: Census 2000 from Village Secretary

Table 2. **Caste-wise households**

Caste	No of HH	%
ST	45	10
Sc	95	21
BC	260	57
OC	53	12
Total	***453***	***100***

Source: PRA- field survey

Table 3. **Drinking water facilities**

Overhead Tanks	2 (1 New & 1 Old)
Tap Connections	100
Well	1
Bore well	1
Hand Pumps	2 (Thanda)

Source: PRA- field survey

Table 4. **Geographical area**

Land use pattern	Area		
	Acres	Hectares	%
Cultivable waste	411	166	15
Dry cultivation	1400	567	50
Irrigated	270	109	10
Tank submergence (Sikkam)	89	36	3
Hillocks	609	247	22
Total Land	***2779***	***1125***	***100***

Source: Approximated during the field study

Table 5. **Soil types**

	Area		
Soil types	Acres	Ha	%
Red soil	210	85	8
Black soil	90	36	3
Sandy –clay soil	1870	757	67
Stoney soil	609	247	22
Total	***2779***	***1125***	***100***

Source: PRA

Table 6. **Main crops in the village**

Dry crops	Irrigation crops
Jowar	Rice
Raagi	Groundnut
Red gram	Maize

2. Watershed Works and Investments Profile

Table 7. **Details of expenditure on various watershed works**

No	Activity	Physical (no)	Area (ha)	Financial (lakhs)	% Expenditure	Beneficiaries Classification			Beneficiaries Classification		
						SF	MF	Others	SC	ST	Others
1	***Soil & moisture conservation***										
A	Bunding	34348	343	6.79	47.14	50	50	20	15	10	95
B	Rock fill dams/loose boulder structures for gully control	116	11	1.35	9.37	20	40	13	32	13	28
	Sub total			**8.14**	**56.51**						
2	***Water conservation***				0.00						
A	Percolation tanks	26	104	5.27	36.59	3	3	20	2	2	22
B	Dugout ponds	2	2	0.08	0.56	0	0	2	1	1	0
C	Sunken ponds	2	1	0.044	0.31	0	2	0	2	0	0
	Sub total			**5.394**	**37.45**						
3	***Plantation***										
A	Afforestation	0	20	0.6	4.17	Na	Na	Na	Na	Na	na
B	Horticulture	0	6	0.27	1.87	2	1	3	1	0	5
	Sub total			**0.87**	**6.04**						
	Grand total			**14.404**	**100.00**	**75**	**96**	**58**	**53**	**26**	**150**

Field bunding and percolation tanks constituted 84% of the total investment (Table7 and Fig1). Bunding and gully control was mostly carried out in small and marginal farmers' lands, while percolation tanks were almost entirely dug in the lands of the large farmers. More than 50% of horticulture was also taken up in the large farmers' lands (Fig 2). This data shows the equity orientation of these works. The treatment works carried out in Dadapur watershed are depicted in Map 1.

Fig 1

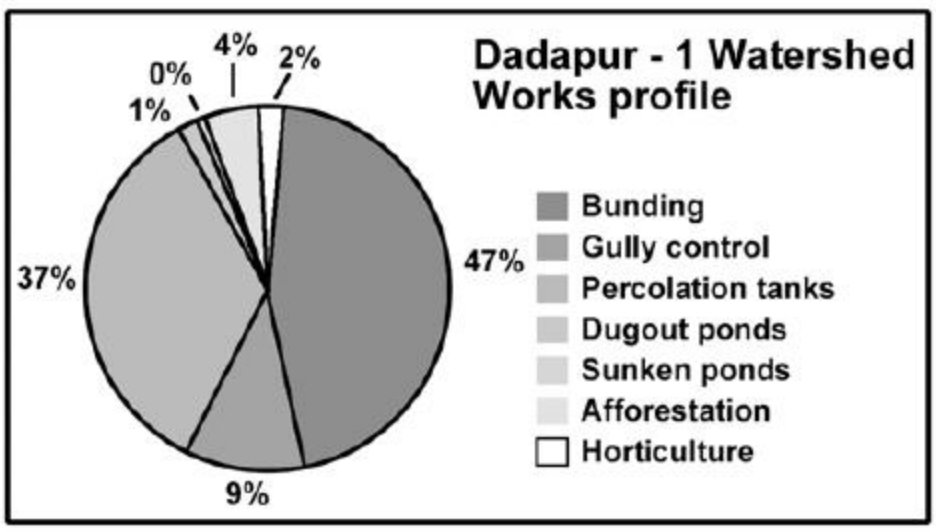
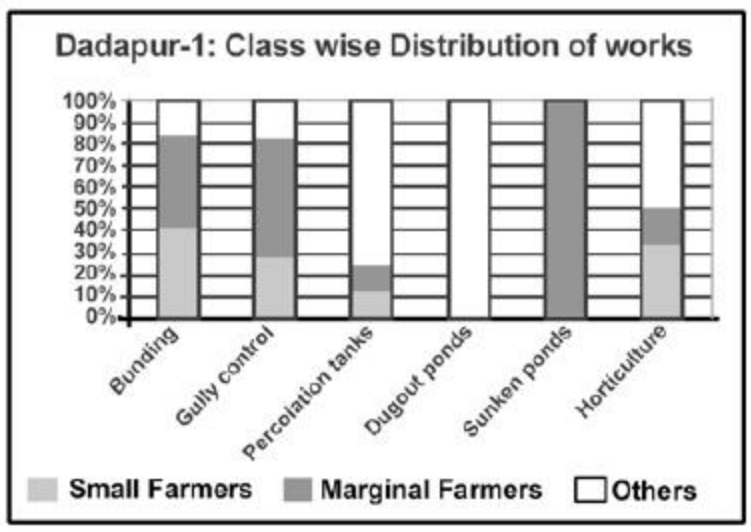


Fig 2



3. Impact Mapping

Process :

Through resource mapping exercise soil types, land use patterns, crops, wells/ borewells, works taken up were identified. About 35 persons from the watershed committee, Panchayat and group leaders

participated in the exercise. Later focused group discussion with SHG leaders was organized to asses the status and to decide on the sample. These sample groups were visited in the night and detailed study was made.

The second day, impact mapping exercise was taken up. About 30-40 persons participated in the exercise. Activities were listed and data on impacts against each activity was generated. The field samples were identified based on this data. Water harvesting structures were studied first, followed by the field survey in two patches of land for analysing impacts of bunding. Focused group discussion was also taken up with about 10 labors. Household survey of livestock and wells/ borewells was also taken up.

The people observed the following impacts during the impact mapping exercise.

1. There is increase in well water levels. About 18 wells were recharged.
2. About 45 acres of land was brought under cultivation.
3. Migration reduced to an extent of 90% during the works implementation of watershed.
4. Crop production increased by about 15%.
5. Milk production increased due to increased buffalo population, greater access to loans and increase in paddy straw.
6. Due to drought conditions, some have sold away their cattle.
7. Because of the percolation tanks water availability for cattle increased.
8. Good wage income during the program and increased wage rates (from about Rs.20 per day for women and about Rs. 40 for men to Rs.30 and Rs.60 respectively). Some people have purchased houses and some invested in agriculture
9. There is an overall increase in the area cultivated. The area under paddy also increased substantially.
10. Most of the borewells were dug immediately after field bunding. Percolation tanks were constructed later.
11. Sources of water for different domestic uses have increased as detailed in Table 8.

Table 8. **Changes in sources of water for different purposes**				
No.	**Purpose**	**Source of the water body**		**Problems faced if any**
		Before	**Present**	
1	Drinking water for livestock	Wells, tank	Bore wells, tank, mini PTs, taps	Before it was difficult. now sufficient.
2	Washing livestock	Wells, tank	Bore wells, tank, mini PTs, taps	
3	Washing clothes	Bore wells, wells, tank	Bore wells, tank, kuntas	
4	Cleaning utensils	Wells, tank	Wells, tank	
5	Direct irrigation	Wells	Bore wells	

4. Analysis of Institutions

The following tables (Nos. 9 & 10) present the status of various institutions in the watershed. Self-help groups were formed as part of the watershed program. There were no user groups. The program was concentrated in the watershed committee – led by a dominant family in the village.

Table 9. ***Self - help groups***	
No. of groups	16 (mainly initiated by DRDA) – about 9 groups formed during the watershed program
Functioning groups	14 (mainly followed up by DRDA)
Reasons to be defunct	No proper leadership
Date of formation	1995-7, 1996-2, 1999-4, 2000-1, 2002-2
Amount of RF taken	Rs.120,000/- (not rotated)
Bank linkage	Rs.190,000/-
Utilization of loans	Agriculture, marriages, purchase of land, health, children's education, dairy, and to fulfill the basic needs.
Role in watershed	No specific role
Impacts/income indicators	Increase in daily wages
Emergence of leadership	One member elected to Gram Panchayat. Before watershed program, election for Panchayat Sarpanch used to be unanimous – dominated by one family ; but now there are elections.

Analysis of the sample groups is presented in the annexure 1

Table 10. ***Watershed committee***	
Members	12; ST-1; SC-1; BC-9; WDT-1.
Watershed development fund	Rs.40,000/-
Interest earned on WDF	Not known
Utilization of WDF	Not yet used
Role of WC beyond watershed	No specific role
Functioning of watershed committee	Non functional at present
Emergence of leadership	Two members elected to Panchayat
Present status of watershed committee	Defunct

Men and women are not equally represented in the Watershed Committee. During the program the Watershed Committee used to meet every three months during which decision-making regarding various issues was made with the acceptance of the Association.

WDF (Rs.40000/ -) exists but is not in use. Contributions were collected from the farmers (OC & BC-10%and SC-5%) during the first six months – later deducted from wages of the labourers who executed the work. Gram sabha was conducted only three times during the entire watershed program. There is no role for WC in village development activities other than watershed. At present the committee is not functioning.

Table 11. **Gram panchayat**	
Members	10; OC-1; BC-6; SC-2; ST-1
Role in watershed program	Sarpanch and WC president were from the same family- the program was concentrated in this family
Village development activities	Construction of temple
Opinion on watershed	Could help to some extent in improving the livelihoods of labour
Opinion on present role	Limited only to giving suggestions
Role in promoting /revival of groups	Not at all interested and no role
Gender dynamics	No equal representation
Perceived impacts	Helped in decreasing migration Could earn Rs.100 to 150 per day Increase in ground water up to 20%

Institutional processes in the watershed program were very weak. The self-help groups are still functional but mostly facilitated by the DRDA. The watershed groups are nominal. The committee which took control of the program was dominated by the leaders who were also active in the Panchayat. Contribution was mostly deducted from the wages of labor. Even such nominal institutional processes were defunct at the time of the survey. Table 11 gives the analysis of the Gram Panchayat at the time of survey.

5. Impacts of Water Harvesting

A total of 5.4 lakhs (37%) of total expenditure on works was invested on water harvesting structures consisting of 26 percolation tanks, two each of dugout and sunken ponds. The percolation tanks were in the range of Rs.10000 to 60000 each. As observed earlier, most of these tanks (77%) were in the lands of medium and large farmers' lands. These details are given in Table 12.

Table 12. **Investment on water harvesting structures**

No	Activity	Total expenditure		Area (Ha)	Beneficiaries (class wise)			Beneficiaries (caste wise)		
		Physical (No)	Financial (Lakh Rs)		SF	MF	Others	SC	ST	Others
	Water harvesting structures									
A	PTs	26	5.27	104	3	3	20	2	2	22
B	Dugout ponds	2	0.08	2	0	0	2	1	1	0
C	Sunken ponds	2	0.044	1	0	2	0	2	0	0
	Sub total		**5.394**	**107**						

The study team selected 8 percolation tanks spread across entire watershed for detailed study. In each of these structures influence zone was marked and the changes in the crop areas and yields of the crops irrigated by sources within the influence zone (as identified by the farmers) were studied. Four persons from the village were part of the team and several farmers were contacted for data generation in the field.

Table 13. **Assessment of water harvesting structures**

No.	Name of the waterbody	Approx vol. of water storage (cu.m.)	Dries up in the month of	Silt depth (mts.)	De-siltation	Recharged		Uses	Remarks
						Wells	Bore-wells		
1	B.Bheemaiah kunta	780	Jan / Feb	0	Not needed	0	4	Livestock* Irrigation and Washing Clothes	
2	Ch.Ramaiah kunta	132	Nov / Dec	0		0	1	Livestock Irrigation	
3	K.Venkataiah kunta	64	Nov / Dec	0		0	2	Livestock Irrigation	
4	Md.Babu kunta	4176	Mar / April	0		2	3	Livestock Irrigation and Washing Clothes	Breached (spill way inadequate & settling of the dam)
5	G.Chandraiah kunta	756	Dec / Jan	0		0	1	Livestock, Irrigation and Washing Clothes	Breached (spillway inadequate & settling of the dam)
6	G.Anjaiah kunta	1296	Dec / Jan	0		1	1	Livestock, Irrigation	Same influence zone
7	G.Anjalaiah kunta	1050	Dec / Jan	0				Livestock, Irrigation, Washing Clothes	
8	R.Chandraiah kunta	300	Dec	0		1	1	Livestock, Irrigation	
	Total	**8554**				**4**	**13**	*** livestock drinking and washing purposes**	

Of all the 26 percolation tanks constructed two structures had breached (8%) ; both these structures were on the same stream. Md Babu kunta has the largest catchment and storage volume. It served the entire village (livestock drinking water) during the drought year 2002-3 before it breached. This is also located near the grazing lands. The approximate total volume of storage capacity created was

8,554 cu.m. The cost per cu.m of storage volume created is about 24 Rs. per cu.m.

Table 14. **Total area and production in the irrigated areas**

Crop	Area	Production Qt	Rate Rs./ Qt	Tot Value
Paddy	50.5	707	450	318,150
Ground nut	50.5	340	1600	544,000
Total	**101**			**862,150**

Buchhanna, a stone worker has 5 acres in the influence zone. His family has completely shifted to agriculture after they leveled their land using the bunding investment and digging of a bore-well. They are now cultivating two crops in a year.

Construction of these percolation tanks was completed in 2003. Only 5 of the total 8 tanks surveyed crossed two rainy seasons. First field bunding was taken up in these lands. After seeing the recharge, farmers dug 13 borewells. Later percolation tanks were taken up, which further contributed to the recharge of the borewells. There is no increase in the area irrigated from the borewells after the construction of the percolation tanks. Prior to watershed program this area was under dryland crops of Jowar, redgram and ragi. After the borewells two crops were taken - paddy in Kharif followed by groundnut.

Of the total 94 acres under the influence zone 50.5 acres became irrigated land (54%). Difficulty in separating the influence of bunding and percolation tanks complicated the study methodology. Therefore, no 'before and after' comparison is attempted here.

These 50.5 acres of irrigated land now produces a total of 707 quintals of paddy and 340 quintals of groundnut annually. The gross value of production at the prevailing rates was Rs. 8.62 lakhs (Table 14). However, the data is not available to compute the incremental value of production and to make cost-benefit analysis.

Table 15. **Complementary investments by farmers near water harvesting structures**

Sl.No	Activity	Unit cost Rs/-	Number of bore wells	Number of trials	Total expenditure Rs/-
1	Drilling & Casing	15000	13	26	364000/-
2	Electrical connection	14000	13		325000/-
3	Motor (7.5 HP)	25000	13		195000/-
	Total	**54000**	**13**	**26**	**884000/-**

Table 15 gives complementary investments made by farmers on borewell digging. Total 13 borewells struck water. For these 13 borewells a total of 26 attempts were made and farmers' had invested Rs.8.84 lakhs. Thus the borewells dug first with the momentum given by bunding were later stabilized by the construction of percolation tanks. Even assuming that the value of production before watershed as 1/ 2 of the total current value of production (of paddy + Groundnut) of Rs.8.62 lakhs the returns would be substantial to repay all the watershed investments in one or two years! The propensity to stimulate private investment is about 3.10 times (assuming about Rs.85,000 investment on bunding and about Rs.2,00,000 investment on percolation tanks)!

In all there were substantial net incremental benefits (which were not quantified) with bunding and percolation tanks.

6. Impact of Land Development/Field Bunding

As mentioned earlier, much of the benefits of land development investments – field bunding in particular went to small and marginal farmers. Field bunding and gully control structures are the main works taken up (Table 16).

Table 16. **Investments on land development**

Sl.No	Activity	Physical (no)	Area (ha)	Financial (lakh Rs.)	Beneficiaries (class wise)		
					SF	MF	Others
1	***Soil & moisture conservation***						
A	Bunding	34348 cum	343	6.79	50	50	20
B	RFD's/GC's	116	11	1.35	20	40	13
	Total			**8.14**			

SF: Small farmers, MF: Marginal farmers

A representative sample area of about 25.5 acres was selected for the field study. This area has the representation of all the soil types in the watershed and falls outside the influence zone of water harvesting structures. The details are given in Table 17.

Table 17. **Quality assessment of bunding in sample area of 25.5 acres**

No	Bund characteristic	Quality	Number	%	Remarks
1	Cross section	Good (>40cm)	51	68	Because of soil depth and texture
		Average (up to 40cm)	18	24	
		Poor (30cm.ht)	6	8	
2	Grass cover	Fully covered	52	69	Local grass grown on bunds naturally
		Partially covered	23	31	
		Absent	0	0	
3	Maintenance	Not required	50	67	In cultivated lands bunds are repaired
		Required	25	33	and in fallow lands no repairs done.
		Done	11	44	
		Not Done	14	56	
4	Soil deposition	Up to 45cm	14	19	Less deposition as the clay content is
	behind	Up to 30cm	19	25	less
	the Bund	Up to 20cm	42	56	
5	Top level	Uniform	66	88	Clay content is less
		Not uniform	9	12	
6	Spill way	Yes	24	32	As the clay content is less and
	provided	No	51	68	percolation is easier, no inter relation seen between spillway and breaching
7	Bund	Yes	23	31	
	breached	No	52	69	

Of the total 75 bunds constructed in the sample area 69% were intact after about 4 years. About 92% of the bunds have good cross section and grass cover is well established in about 70% of the bunds. About 33% of the bunds required maintenance at the time of the survey of which 56% were not attended to- mainly in the fallow lands. About 68% of the bunds do not have a spill way – a structural weakness.

In summary, the bunds in the surveyed area present a positive picture on the date of the survey except for the 31% of the breached ones.

Impacts:

The fallow lands reduced by 38% after the bunding. Of the remaining 9 acres 5 acres were fallow because of a family dispute (Table 18).

Table 18. **Changes in land use patterns**

Land use pattern (acres)			
Before		Present	
Fallow	Cultivated	Fallow	Cultivated
14.5	11	9	16.5

Table 19. **Change in area and production of various crops near bunding in the sample area**

no	Crop	Area (acres)				Production(qt)		Yield (qt)		Production difference (qt)
		Before		Present		Before	Present	Before	Present	
		Area	%	Area	%					
1	Jowar	4.5	23.7	4.5	21.7	7.7	8.4	1.7	1.9	0.7
2	Ragi	6.5	34.2	6.75	32.5	22	25	3.4	3.7	0.3
3	Sesame	0.5	2.6	1	4.8	0.2	0.4	0.4	0.4	0.2
4	Babbarlu	1.5	7.9	1.5	7.2	0.25	1.25	0.16	0.41	1
5	Paddy	3.5	18.4	3.5	16.9	22.5	32.5	6.4	9.2	10
6	Red gram	2.5	13.2	2.5	12.0	1	1.5	0.4	0.4	0.5
7	Horse gram	0	0.0	1	4.8	0	1	0	1	1
	TOTAL	**19**	**100**	**20.75**	**100**					

There was not much change in the crop pattern but for a marginal decrease in the area of Jowar and Ragi. The yield increase was also marginal. The value of total incremental production was about Rs.9000/ - (about Rs.550 per acre) – a marginal difference (Table 19).

The low impact of bunding is also corroborated by the farmers' observations. The problem is mainly in some of the soils where the vertical infiltration is low. In case of relatively high rainfall there is continuous lateral seepage in these soils resulting in crop losses. Bunding also created similar problem in these soils by withholding water for longer period. Farmers observed, bunding is not an appropriate intervention in some of these soils. Farmers' preference was for land leveling. The weak participatory processes- (no farmers' contribution) further aggravated the problem, as the farmer's consent was not involved.

7. Plantations

About Rs.87, 000 were invested on plantations and horticulture. All these plants were brought from outside, which were centrally distributed by the administration. Plantation was in the hillocks which did not survive for lack of protection. Farmers' reported almost zero survival rates.

8. Impacts on Livestock

The total livestock population increased by about 13% after the watershed program. The causal factors however, are not clear (Tables 20 & 21).

Table 20. **Livestock population**

Caste	Cows		Buffaloes		Bullocks		Goats		Sheep		total	
	Before	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
BC	52	115	84	128	230	256	224	150	33	40	590	649
OC	9	15	3	10	22	24	0	0	0	0	34	49
SC	16	24	5	9	54	60	17	10	2	4	92	103
ST	14	18	1	2	12	12	27	39	14	14	54	71
Total	**91**	**172**	**93**	**149**	**318**	**352**	**268**	**199**	**49**	**58**	**770**	**872**

Table 21. **Livestock – caste wise changes**

No.	Caste	Cows	Buffaloes	Bullocks	Goats	Sheep	Total
	Change in Nos.						
1	BC	63	44	26	-74	7	59
2	OC	6	7	2	0	0	15
3	SC	8	4	6	-7	2	11
4	ST	4	1	0	12	0	17
	Total	**81**	**56**	**34**	**-69**	**9**	**102**
	%Change						
1	BC	121	52.4	11.3	-33.0	21.2	10.0
2	OC	67	233.3	9.1	0.0	0.0	44.1
3	SC	50	80.0	11.1	-41.2	100.0	12.0
4	ST	29	100.0	0.0	44.4	0.0	31.5
	Total	**89**	**60.2**	**10.7**	**-25.7**	**18.4**	**13.2**

Buffaloes increased in a significant number mainly due to loans from the SHGs. Goat population reduced by about 26%. The livestock sector seem to be less influenced by the watershed project – as it has not made any significant impact on the land use. The plantations also did not come up.

9. Impacts on Water

There has been a pointed shift from open wells to borewells in the early eighties. Investment on open wells reached a peak around mid-seventies and declined drastically there after. There was a steep increase in the investment on borewells after 1996 (Table 22). This had reached its peak around 1998-99 much before the investments were made on the percolation tanks. It seems field bunding had

contributed to this visible recharge in ground water which gave a fillip to investments on borewells. The following figure illustrates this point.

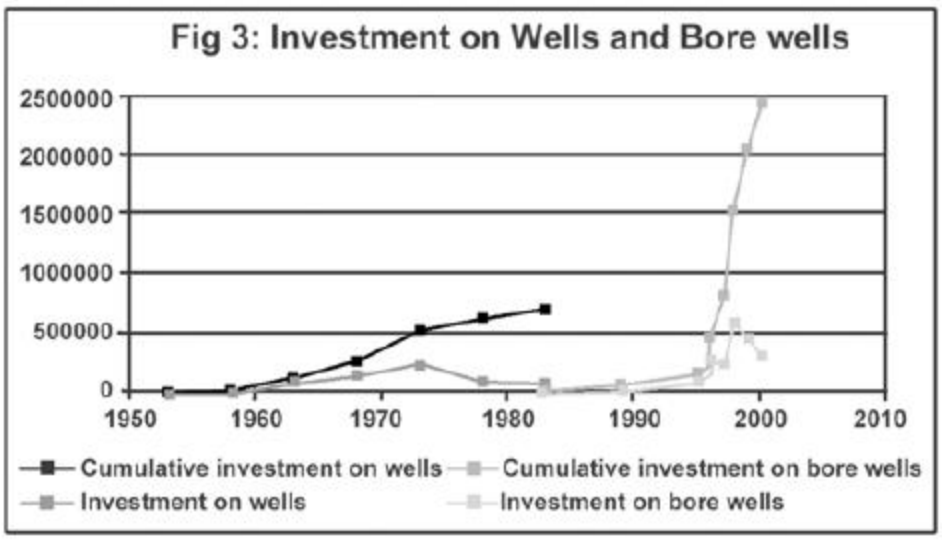


Table 22. **Investment on borewells**

Year	Annual investment	Cumulative investment
1983	10000	10000
1989	20000	38000
1995	95000	153000
1996	275000	463000
1997	245000	803000
1998	595000	1533000
1999	471000	2054000

There were 81 open wells and 91 borewells in the watershed. Of the total wells, 79 open wells became non-functional at the time of the survey. The cumulative disinvestment was of the order of about Rs. 6 lakhs (actual investment figures without compounding).

As can be seen in the table 22 annual investment more than doubled during 1997 and 1998 – when most of the field bunding works were completed. During the period 1997 to 2000 there was 16.31 lakh rupees investment on borewells i.e. 113% of the total investment on watershed works.

Thus, though the facilitation processes are weak, the watershed treatment has a substantial impact on the water use in the watershed.

Annexure 1 :

Analysis of sample SHGs:					
Sl.no	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Name of the group	Gnanodaya sangham	Jyothi sangham	DhanaLaxmi	MahaLaxmi	Durga Bhavani
Date of formation	14/11/95	28/11/95	27/2/96	27/2/96	8/11/1996
Members	15	14	11	15	16
Caste	OC-1:BC-14	OC-1:BC-13	BC-10:SC-1	BC	ST
Savings	Rs.30/-per month	Rs.30/-per month	Rs.30/-per month	Rs.30/-per month	
Regular meetings	Yes	No	No	No	No
Internal lending	Based on the need of the member	Based on the need of the member	Based on the need of the member	Based on the need of the member	Lending to outsiders
RF taken	Rs.27000/-	Rs.15000/-	Rs.11000/-	Not yet taken	Rs.16000/-
Bank linkages	0	Rs.135000/-(IRDP)	Rs.22000/-	RSs.600000/-	Rs.25000/-
Amount distribution	Equally distributed	Equally distributed	Equally distributed	Equally distributed	Equally distributed
Usage	Business, children's education, agriculture, marriages, health	Dairy, agriculture, marriage, health, purchase of land	Health, agriculture, purchase of food grains	Health, agrilculture, purchase of food grains	Lending, purchase of food grains, health and other basic needs
Repayment	At the rate of 3% interest (for every 6 month)	At the rate of 3% interest (for every 6 month)	At the rate of 3% interest (for every 6 month)	At the rate of 3% interest (for every 6 month)	At the rate of 3% interest (for every 6 month)
Leadership rotation	No	No	No	No	No
Norms	No	No	No	No	No
Role in watershed	No specific role	No specific role	No specific role	No specific role	Some of them were labourers in the bunding works
Other activities	Participated in janmabhoomi				
Functionality	Functioning	Functioning	Functioning	Functioning	Functioning

Watershed map of Dadapu village

Natural resource map