5.0 AGRICULTURAL PRODUCTION SYSTEM DEVELOPMENT

5.1 Introduction

The primary objective of the Karnataka community–based tank management project, has been to increase agricultural production by restoring the storage capacity of tanks and the consequent improvement in cropping intensity and productivity of crops. Two-pronged approach is being envisaged to develop agricultural production` system in the tank command areas. One is **area-led** approach and the other is **productivity-pushed**. The area-led approach is to increase the irrigated area facilitated by the increased storage in the tanks and improved water distribution system in the command area. The productivity-pushed approach envisages promoting improved varieties of crops; land, water, nutrition and pest management, through a network of on-farm demonstrations of arable and horticultural crops and water management. The University of Agricultural Sciences at Bangalore and Dharwad have been entrusted the task of conducting demonstrations, dissemination and spread of new technologies, to improve productivity of crops and the consequent agricultural production.

Appropriate crop plans were prepared through TMIs and implemented to the extent possible depending on the availability of water in the tanks. Because of the increased storage capacity of the tanks due to the project interventions, the bore wells in and around the tank commands were also recharged during the project period. Thus the underground water resources became an additional source of water for the tank command farmers to raise their crops through conjunctive use of tank and bore well water. Many of the old open wells also got rejuvenated during the project period and served as supplementary source of irrigation water.

5.2 Impact indicators

Significant impact indicators considered in this study include:

1. Irrigated area under tank commands;
2. Functional wells and area irrigated in tank commands;
3. Land use intensity;
4. Cropping pattern;
5. Production and productivity of crops in tank commands;
6. Net income from agriculture and horticultural crops in tank commands;
7. Functional wells and area irrigated in catchments;
8. Production and productivity of crops in catchment areas;
9. Household crop production, productivity and net income;
10. Water Use Efficiency (WUE) and Productivity of Paddy crop;
11. Farmers education through demonstrations and FFS; and
12. Impact of silt on crop yields and income.

All the above had been identified and finalized based on discussions with JSYS and World Bank in the early stages of this assignment.

5.3 Methodology

The Community–based tank management project was implemented in the purposively selected nine districts of six agro- climatic zones of Karnataka State for the project period from 2003-04 to 2007-08. Agriculture was one of the important sectors included in the Project implementation strategy. Therefore all the nine districts formed the universe for the project impact study. From among the nine districts 187 sample tanks / commands were selected purposively; Similarly, 35 control tanks where the project was not implemented were also selected purposively.

5.3.1 The Project Profile

The details of the number of sample tanks and control tanks selected from each zone, for the study are presented in the following Table-5.1.

Table 5.1 : The project profile

Agro-climatic zones	*Project districts*	*No. of sample tank villages*		*Average designed command area (ha)*	
		Project area	*Control area*	*Project commands*	*Control commands*
1. Central Dry Zone (CDZ)	Chitradurga, Tumkur	40	8	49.08	58.99
2. Eastern Dry Zone (EDZ)	Kolar	89	20	21.46	12.05
3. Northern Dry Zone (NDZ)	Bagalkote, Bellary, Koppal	21	1	84.29	40.00
4. North Eastern Dry Zone (NEDZ)	Raichur	12	3	27.45	10.75
5. North Eastern Transitional Zone (NETZ)	Bidar	4	1	81.00	66.00
6. North Transitional Zone (NTZ)	Haveri	21	2	36.70	58.33

Among the six zones, the highest number of sample tanks included in the study were 89 from EDZ (Kolar dist.) followed by 40 sample tank from CDZ (Chitradurga and Tumkur dist.'s) while the least-four tanks were from NETZ. (Bidar dist.). The average designated command areas in each of the six agro-climatic zones are also delineated.

5.3.2 In this study Ex-post-facto research design was utilized. The primary data related to agriculture and horticultural crops with respect to, the area irrigated, functional bore wells and open wells, land use intensity, cropping pattern, crop production, productivity and net income derived, in both command and catchment areas were collected for the baseline as well as after the project intervention - the end of the project period, from 187 sample tank commands involving 182 Samples Villages, using a structured schedule through Focus Group Discussions with TMI office bearers and other stake holders supplementing by personal interviews of some TMI members and opinion leaders of the respective villages. The respondents were selected using purposive / random sampling technique. In order to eliminate the influence of extraneous variables like rainfall and other climatic conditions, similar data were also collected from 35 control tanks. Since the data from one of the project tank command was incomplete the data pertaining to 186 sample tank commands were finally utilized in the analysis. The impact of the project interventions was analyzed by deducting the figures of baseline (Pre-project implementation) from the end of the project (post- project implementation) figures and thus obtained the impact of the project on selected indicators related to tank commands. That is the **Before-After approach**. Before data was obtained on certain items from respondents through recall method. Similarly the natural impact on similar indicators in the commands of control villages was also measured. The differences in the percentage incremental change in the variables in sample commands and control commands were computed to obtain the real net project impact over the project period. The impact of project intervention in catchment areas was analyzed using the baseline data and the end of project data.

5.3.3 To study the nature of crops cultivated, yields obtained and income derived by the individual families in the command areas the data were also collected using personal interview schedule from 1030 individual households selected randomly from all the 182 sample villages. These numbers ranged from 4 – 8 farmers with an average of 6 farmers from each village. The secondary data provided by both

the universities on demonstrations and FFS plots were utilized in addition to the data collected from purposively selected demonstrator farmers, to understand the impact of demonstrations. The data were analyzed using percentages and averages.

5.3.4 Rainfall data : The season-wise rainfall data were obtained for the pre- project year: 2003-04 and the post- project implementation year: 2007-08 and the same is presented below in Table 5.2.

The Rainfall data presented in the Table 5.2 gives a clear picture about the rainfall distribution among three major seasons viz Pre-monsoon, South-west monsoon and North-east monsoon during 2003-04 and 2007-08, in the nine districts covered under the project. The rainfall was highest in South-west monsoon with 251.4 mm on an average in pre-project period while it was more than the double at the end of project period with 571.4 mm on an average in these selected nine districts.

Similarly in the pre-monsoon season the average rainfall in these districts was 35.7 mm in pre-project year which is almost 1/3 the average rainfall received (102.7 mm) during the post-project year. However, the rainfall during the north-west monsoon was much higher (135.8mm) in the base year than rainfall received (106.2 mm) in the post implementation period. This is so because of the poor rainfall received in northern districts of the project.

In general, the total average rainfall received (422.9 mm) in 2003-04 was lower than the total average rainfall received in the year 2007-08 in the project area as a whole. However, the impact of such differential rainfall before and after the project intervention on crop production and productivity has been minimized by comparing the rainfall data in project tank commands with that of control tank commands.

Table 5.2

5.4 Command Area

5.4.1 Irrigated Cropped Area under tank commands

Because of the desiltation work the water storage capacity of the tanks has increased substantially in many of the tanks, resulting in the recharging of ground water in bore wells and revival of the open wells. An effort was made to understand the incremental irrigated area from base line to the end of project years in both the command and control areas in order to identify the net project impact.

The data presented in Table 5.3 indicates the changes in the irrigated area in project and control tank commands between the base line and the end of the project periods. The incremental irrigated area from the base line in the project tank commands was on an average 31. 06 ha / command while the changes in the same period in the control tank commands was of the order of 13.25 ha per command.

Table 5.3 : Irrigated cropped area under tank commands in project & control areas

				Per tank command
Reference	**Project Area**		**Control Area**	
	Designed command area (ha)	**Irrigated cropped area (ha)**	**Designed command area (ha)**	**Irrigated cropped area (ha)**
Baseline	37.7	34.67	27.7	20.38
End of project	37.7	45.44	27.7	23.08
Incremental area from Baseline (%)	0.00	31.06	0.00	13.25
Net project impact (%)		17.82		

Thus the net impact of the project intervention was to the level of 17.82 percent in the command areas. This increased irrigated area is the reflection of increased cropped area both in rabi and kharif seasons put together.

5.4.2 Irrigated cropped area in tank commands across zones:

The data in Table 5.3A depicts the contribution of the project in each one of the zones for the incremental irrigated area from the baseline period; both in project tank commands as well as in the control tank commands. The net project impact per tank command was found to be the highest in the zone NTZ (Haveri dist.) with 61.84 Percent while it was found to be the negative (-1.18%) in NETZ (Bidar district). Bidar district continues to be a dry belt and so it failed to achieve positive results during the project period. Haveri district representing NTZ performed better because of the good increase in the irrigated area in the sample commands, while there was least increase in the irrigated area in control commands during the project period. It may be noted that almost all sample tanks in Raichur district had received full water storage during the year under reference. In order to increase the area under irrigation in project tank commands, live storage has to be increased considerably by appropriate desiltation works.

5.5 Functional wells and area irrigated in tank commands

In view of the intervention of the project, good number of bore wells got ground water recharged while many of the dried up open wells were revived due to increase in water table in and around the sample tanks.

5.5.1 Functional bore wells and open wells:

The data about the number of bore wells and open wells and the area irrigated per tank command both in project and control areas were collected directly from the owners of these wells as well as the office bearers of TMI's . AS per the data collected from TMI office bearers and the stakeholders presented in Table - 5.4

Table 5.3A

the percentage increase in the number of bore wells and open wells during the project period in the project commands over the control tank commands were highly positive as the number of bore wells and the open wells increased by 36.67 per cent and 28.0 per cent respectively in project command areas while the irrigated areas increased by 65.00 per cent and 27.64 per cent respectively in bore wells and open wells. Consequently, the net impact of the intervention of the project was 20.00 per cent and zero per cent in respect of number of bore wells and open wells and correspondingly the impact on the area irrigated was found to be 21.52 per cent under bore wells when it was 18.84 per cent in the open wells. The results indicate **a substantial increase in water recharge of bore wells** than the increase in the level of water in open wells. This is the positive impact of desiltation of the tanks.

Table 5.4 : Functional Bore wells and Open wells in tank commands

								Per tank command
Reference	**Project area**				**Control area**			
	Bore wells		**Open wells**		**Bore wells**		**Open wells**	
	Number	**Area (ha)**	**Number**	**Area (ha)**	**Number**	**Area (ha)**	**Number**	**Area (ha)**
Baseline	5	6.98	4	2.46	5	7.73	4	1.69
End of project	7	11.52	5	3.14	6	11.09	5	1.84
Incremental number/area from Baseline	2	4.54	1	0.68	1	3.36	1	0.15
Percentage from the Baseline	40.00	65.00	25.00	27.64	20.00	43.48	25.00	8.80
Net impact %	20.00	21.52	---	18.84				

5.5.1.1 Functional bore wells

The Table 5.4A provides the figures with regard to the functioning of bore wells in the tank commands across zones. With regard to functional bore wells the NETZ (Bidar district) exceeded other zones in terms of the percentage increase in the number of bore wells (100%), when the increase in irrigated area was highest with 154.26 percent per command in NDZ over the base line year. Also the net project impact on the irrigated area increase was highest in NDZ with 161.95 percent.

5.5.1.2 Functional open wells:

With regard to the functional open wells the data provided in Table 5.4B indicate that the percentage increase in the irrigated area was significantly higher (364.00%) in case of NDZ in view of the revival and opening of new wells in the project area. The negative impact was found in Haveri district (NTZ) because of the drying up of few open wells resulting in just one open well per command on an average in the project area. The net project impact with regard to irrigated area increase was highest in NDZ with 377.33 percent.

5.6 Land Use Intensity / Crop Intensity

In view of the rehabilitation of tanks the water availability for raising crops has also increased considerably in kharif / summer season, or in both the seasons during good rainy years. So it is appropriate at this juncture to know how far the land use intensity (crop intensity) has increased during the project period from 2003-04 to 2007-08. The data on the irrigated area / cropped area in both the project and the control tank commands were obtained. The data were analyzed and the details of land use intensity have been presented in the Table below

Table 5.4A

5.6.1 Land Use Intensity in tank commands

Table 5.5 indicates the average land use intensity in the project tank commands as well as in the control tank commands.

Table: 5.5 Land use intensity in tank commands

Reference	Land Use Intensity (%)	
	Project Area	Control Area
Baseline	89.16	83.53
End of project	120.99	93.53
Incremental land use intensity	31.83	10.00
Net Project Impact %	21.83	

Not only the increased water storage capacity in tanks but also the reduced conveyance losses because of canal lining facilitated to bring in more area under cultivation.

As per the data, the land use intensity per tank command in the project tank commands was 89.16 per cent on an average, while it was 83.53 per cent in the control tank commands during the base-line year. The land use intensity has increased to 120.99 per cent in Project tank commands while it was only 93.53 per cent in the control tank commands at the end of project year. So the incremental land use intensity was to the extent of 31.83 per cent in project tank commands while it was 10.00 per cent in control tank commands. Consequently the net project impact was 21.83 per cent which is quite encouraging. This rise in land use intensity /cropping intensity in the tank commands is apparently due to the increased water storage capacity of the tanks, better conveyance of water as well as the adoption of some of the integrated water management technologies.

5.6.2 Land Use Intensity across Zones:

The zone-wise details on land use intensity in project as well as in control tank commands across zones are presented in Table 5.5A and Figure-1

Table 5.5A : Land use intensity in Tank commands across zones

							Per tank command
Zone	**Project area**		**Control area**		**Percentage Incremental land use intensity over baseline in (project area)**	**Percentage Incremental land use intensity over baseline in (control area)**	**Net project impact (%)**
	Baseline	**End of project**	**Baseline**	**End of project**			
CDZ	95.43	123.53	72.20	84.45	29.44	16.97	12.47
EDZ	130.24	177.76	127.39	145.17	36.48	13.96	22.52
NDZ	65.20	97.74	66.75	86.40	49.91	29.44	20.47
NEDZ	115.13	140.78	131.83	153.33	22.29	16.31	5.98
NETZ	37.51	44.30	35.36	42.18	18.10	19.29	-1.19
NTZ	91.45	141.84	67.63	49.65	55.10	-26.58	81.69

The land use intensity in all the zones was higher at the end of the project period except in case of NETZ. The percentage increase in land use intensity was highest in NTZ with 55.10 percent when it was lowest in the zone NETZ (18.10%). The net impact of the project in terms of land use intensity in the zone NTZ accounted for 81.69 per cent while the negative impact was observed in the zone NETZ (-.19%). The positive impact in NTZ may be due to better live storage capacity created in tanks and better rains, while the negative impact in NETZ may be due to meagre rains in the- district and lack of live storage facilities created in the tank.

Figure – 1

5.7 Cropping pattern

The changes in the cropping pattern / diversification of crops were inevitable in view of the tank improvement activities. For the maximum utilization of scarce water resources of the tanks and bore wells, there is an absolute need to incorporate certain changes in the cropping pattern in command areas. Over the decades, farmers have been cultivating mostly paddy in tank commands whenever the tanks are filled fully with water. Because of this traditional practice the fertility of soils have been depleted. The area under paddy is gradually getting reduced, due to heavy consumption of water by it ; the requirement of water is almost double the requirement for ragi and other crops. According to the date available in the Bangalore University CBTMPCS water requirements for paddy is almost double (80 ha cm) the requirements of ragi, groundnut (40 ha cm) and Maize (50 ha cm). Therefore, an attempt was made to understand the extent of paddy grown in each one of the command area vis-à-vis non- paddy crops.

5.7.1 Extent of paddy and non- paddy areas

As per the data presented in Table 5.6, no significant changes were observed in cropping pattern in the command areas during the project intervention years.

Table 5.6 : Extent of paddy and Non paddy areas

Per tank command

Reference	Paddy		Non Paddy	
	Project	Control	Project	Control
Pre project	28.02	37.06	71.97	62.93
End of Project	27.66	35.40	72.34	64.57
Percentage incremental from the Project	-1.29		0.50	
Percentage incremental from the Control	-4.48		2.60	
Net project Impact(%)	3.19		-2.09	

The extent of non- paddy area and paddy areas remained almost same during the project intervention years. During the project period area under non-paddy crops increased marginally by 0.5 percent over the base year while paddy crop reduced by 1.29 percent on an average per tank command during the same period in the project command tanks. However, the net project impact was negative (-2.09 %) in respect of non –paddy crop while it was 3.19 percent in paddy crop. The farmers continue to grow paddy when ever the tanks get filled up to their capacity as it is a staple food crop and the provider of fodder to the animals. However, perceptible changes were observed among the non-paddy crops raised by farmers.

5.7.2 Paddy and non-paddy areas across zones:

The data presented in Table 5.6A gives the indication about the changes in the extent of paddy cultivation in command areas vis -a- vis the non-paddy crops. As per the data, the average paddy area in command areas has increased in all the zones except NETZ (Bidar) where no paddy crop was taken up in the selected four sample tanks.

However, the percentage increase in paddy area during the project period was highest in CDZ with 86.10 percent while it was least in NEDZ(11.68%) under project tanks. The net project impact is more evident in respect of paddy cultivation and it is true of non-paddy cultivation also in the command areas. This increase in the areas of crop cultivation both of paddy and other non-paddy crops across zones is due to the increase in the availability of water resources. While the net project impact of paddy cultivation is more pronounced in zone NTZ (Haveri) with 80.98 percent, the area under paddy cultivation considerably reduced in the zone NEDZ (Raichur) by 4.32 percent per command. On the other hand the net project impact in respect of non-paddy area per command was highest with 94.36 percent in NTZ when it was least (-1.18%) in NETZ. It is a good trend in view of the continuous paddy cultivation in those command areas

over the years. Paddy can be replaced by ragi / jowar to get food and fodder for the stakeholders even with limited water. Oil seed crops fetch better prices while pulses and vegetables may be good rotation crops.

Table 5.6A : Paddy and Non Paddy Areas Across zones

Per tank command

Zone	Crop	Project area (ha)		Control area (ha)		Percentage Incremental area from Baseline (Project)	Percentage incremental area from Baseline (Control)	Net project Impact (%)
		Baseline	End of Project	Baseline	End of Project			
CDZ	Paddy	8.82	16.41	10.56	12.90	86.10	22.16	63.94
	Non paddy	38.02	44.22	32.03	36.92	16.31	15.26	1.05
EDZ	Paddy	11.13	16.00	11.06	12.77	43.80	15.48	28.32
	Non paddy	16.82	22.14	4.29	4.72	31.65	10.05	21.59
NDZ	Paddy	6.13	7.74	4.58	5.40	26.20	17.90	8.30
	Non paddy	48.83	74.65	22.12	29.16	52.89	31.83	21.06
NEDZ	Paddy	10.48	11.70	7.50	8.70	11.68	16.00	-4.32
	Non paddy	21.12	26.94	6.67	6.78	27.55	1.67	25.88
NETZ	Paddy							
	Non paddy	30.38	35.88	23.34	27.84	18.10	19.28	-1.18
NTZ	Paddy	21.50	29.30	21.88	12.10	36.28	-44.70	80.98
	Non paddy	11.49	21.86	17.57	16.86	90.34	-4.02	94.36

5.7.3 Proportion of paddy and non-paddy areas across zones:

The data in Table 5.6B presents the proportion of paddy and non-paddy areas across zones in project and control commands. Necessarily, the net project impact with regard to proportion of paddy over non-paddy is higher in CDZ while it is the least (negative) in NEDZ. Though the farmers were advised to limit the area under paddy during the project period, large number of farmers grew paddy

during the end of the project year because of the persistent drought during the previous three years in which no paddy cultivation was possible. As paddy happens to be the staple food crop, the farmers were bound to grow paddy not only to have food security but also to have fodder security. Paddy is not a popular crop in Bidar district as they grow jowar for consumption.

Table 5.6B: Proportion of Paddy and Non paddy Areas Across zones

Per tank command

Zone	Crop	Project area		Control area		Percentage Incremental area from Baseline (Project)	Percentage incremental area from Baseline (Control)	Net project Impact (%)
		Baseline (%)	End of Project (%)	Baseline (%)	End of Project (%)			
CDZ	Paddy	18.83	27.07	24.79	25.89	43.77	4.44	39.33
	Non paddy	81.17	72.93	75.21	74.11	-10.15	-1.46	-8.69
EDZ	Paddy	39.81	41.95	72.05	73.01	5.36	1.33	4.03
	Non paddy	60.19	58.05	27.95	26.99	-3.55	-3.43	-0.12
NDZ	Paddy	11.15	9.39	17.15	15.63	-15.82	-8.91	-6.90
	Non paddy	88.85	90.61	82.85	84.38	1.99	1.85	0.14
NEDZ	Paddy	33.16	30.29	52.92	56.11	-8.67	6.03	-14.70
	Non paddy	66.84	69.71	47.08	43.73	4.30	-7.11	11.42
NETZ	Paddy							
	Non paddy	100.00	100.00	100.00	100.00	0.00	0.00	0.00
NTZ	Paddy	65.18	57.27	55.47	41.78	-12.14	-24.67	12.54
	Non paddy	34.82	42.73	44.53	58.22	22.72	30.73	-8.02

5.8 Production and Productivity of crops in tank commands

It is important to know the level of production and productivity of each of the crops grown in the tank commands in order to understand the impact of project intervention. This dimension is the most important one since it really reflects the direct impact of the tank rehabilitation works. The important crops grown in the command areas were only considered to measure the production and productivity. The measurement was made separately for kharif and rabi/ summer seasons as these are the major seasons in the command areas.

5.8.1 Production and Productivity of crops during kharif

The Table 5.7 and Figure-2 gives a clear picture of the present status of production and productivity of crops over the base year. The end of project year production of crops in control commands facilitates to eliminate the effect of rainfall and other climatic conditions from the total effect in the project commands. For better understanding of the production and productivity of the crops, paddy, maize and millets (which includes mostly ragi, jowar and bajra) were clubbed under cereals and millets, sunflower and groundnut under oil seeds, while all vegetables, except onion, under other vegetables. The productivity of paddy alone has increased from 39.93 quintals per hectare(q/ha) in the base year to 48.94 q/ha after the project intervention indicating an increase of 22.48 percent with a net project impact of 17.37 percent. However , the productivity of cereals and millets combined percent on an increase from 32.19 to 36.14 quintals per hectare during the project period, while the net impact of the project stood at 8.51% on an average in each command. Similarly the productivity of oil seed crops raised to 20.98 q / ha from 18.38 q/ha with a net project impact of 7.98%. In pulses the productivity increased from 14.53 to 17.30 q/ha with the increase in productivity by 19.00 percent and the project impact of 11.28 per cent. For vegetable crops including onion, the productivity

Table 5.7

Figure 2

figures at end of project was 178.45 against 131.90 q/ha during the base line period indicating an increase in productivity by 35.29 percent and the net project impact of 15.83 per cent.

In general, the production and productivity of all the crops had risen fairly well during the kharif season indicating the marginal impact of the tank rehabilitation. Thus the results clearly show case the limited impact of tanks rehabilitation works in terms of the enhanced production and productivity of all the crops grown in the command areas. This is so because of no substantial increase in the live storage of tanks; though dead storage increased. The planners need to take measures to desilt in the entire water storage spread area of the tank. Since farmers have resorted to conjunctive use of tank and bore well water, there is some improvement after the intervention.

5.8.2 Production and Productivity of crops across zones during kharif:

In order to understand the levels of production of each of the crops considered in the project impact study across the project area in real terms, eliminating the impact of extraneous variance, the zone-wise analysis was made and presented in Table 5.7A Except in the zones NETZ and NDZ, in all other zones the production of different crops was found to be better in the end of project period when compared to the base period. There is still scope for increasing the productivity and production of each of the crops through integrated water management practices.

Table 5.7A

5.8.3 Production and Productivity of crops during Rabi / Summer:

During this season, the production and productivity of cereals and millets were found to be better when compared to kharif season (Table 5.8 and Figure.3). The productivity of paddy rose from 42.27 q/ha to 48.07 q/ha while the productivity of cereals and millets combined was 39.68 q/ per hectare during the end of the project, while it was 31.07 q/ha during the base period. The net project impact was also higher and accounts for 10.48 per cent .The production and productivity of oil seeds were relatively higher than the figures of kharif season and the net project impact was 19.06 percent. Here, the productivity was higher in view of lower production in control command areas. With respect to pulses, production and productivity were lower when compared to kharif season, with the net project impact of only 4.48%. The productivity of tomato and other vegetable crops has increased to 227.75 q/ha from 199.51 q/ha in the base year. The net project impact was 13.80 per cent. The better performance of cereals and millets as well as oil seeds can be attributed to farmer's decision in some commands to store water in kharif and use the same in Rabi / summer season to derive the full benefit of the tank water. In this season the deed storage has also helped to recharge ground water and as such, the conjunctive use of tank water and bore well water has helped the farmers to harvest better food crops.

Table 5.8

Figure – 3

5.8.4 Production and Productivity of crops across zones during Rabi / summer:

The production of these crops across the zones shows similar trends, Table 5.8A but the millets production did not figure in NDZ and NEDZ while vegetable production was also found to be not impressive in most of the zones except CDZ and EDZ. There is ample scope to improve the production of millets and pulses across the zones. Ragi and jowar are the staple food crops and the pulses fetch better market prices and improve soil fertility and hence deserve attention.

5.9 Net income from agriculture and horticultural crops in tank commands

The data provided in Table 5.9 and Figures 4.1 & 4.2 indicates the total net income derived in agriculture and horticulture separately as well as in total for both project tank command area and control tank command areas. Agriculture registered a net income of Rs.32,68,712 during the end of the project, while it was Rs.13,77,934 in horticulture per tank command. Both agriculture and horticulture put together, the net income derived was to the extent of Rs.46,46,646 in a typical project tank command. The share of net income from agriculture and horticulture was 70:30 respectively in project tanks when it was 55:45 respectively in control tank areas. The percentage incremental income of project area was 28.86 in agriculture, 31.51 in horticulture and 29.64 with agriculture and horticulture combined. So the net project impact was 9.45 per cent in agriculture while it was 17.84 in horticulture and 12.85 per cent in total. The net income of horticulture seems to be better than agriculture. More emphasis on horticulture crops is essential. Because farmers get relatively better prices and income when compared to agricultural crops. This is a good trend even for improving the soil fertility, depleted due to the over-cultivation of agricultural crops over the decades.

Table 5.8A

Table 5.9 : Net income of agricultural and horticultural crops per tank command

References	Tank type	End of Project (Rs)	Baseline (Rs)	Percentage Incremental net income from baseline (project) (Rs)	Percentage Incremental net income from baseline (control) (Rs)	Net impact of project (%)
Agriculture	Project	3268712	2536600	28.86	19.41	9.45
	Control	1229492	1029628			
Horticulture	Project	1377934	1047798	31.51	13.66	17.84
	Control	983176	864987			
Total income	Project	4646646	3584399	29.64	16.79	12.85
	Control	2212668	1894614			

In order to understand the profitability of the crops raised in tank commands, the net income from agriculture and horticulture was derived and analyzed separately for the base and the end of the project period in both the project tank command and control tank commands in kharif and rabi seasons.

Figure 4.1 & 4.2

5.9.1 Net income from agriculture and horticulture across zones during kharif:

In respect of agriculture, Haveri district (NTZ) registered the highest net income of Rs.532,492 followed by the zone CDZ with Rs.430,998 per tank command on an average (Table 5.9A). In respect of horticulture the highest income was observed in CDZ (Chitradurga and Tumkur districts). The net project impact was found to be more in NTZ with 45.05 per cent followed by zone NDZ with 30.57 per cent.

Table 5.9A : Net income of Agril and horticultural crops per tank command across zones during kharif

Zone	References	Project area		Control area		Percentage incremental net income from Baseline (Project)	Percentage incremental net income from Baseline (Control)	Net impact of project (%)
		End of Project (Rs)	Baseline (Rs)	End of Project (Rs)	Baseline (Rs)			
CDZ	Agriculture	430998	355736	163431	147275	21.16	10.97	10.19
	Horticulture	515128	420242	11125	10375	22.58	7.23	15.35
	Total	**946126**	**775978**	**174556**	**157650**	**21.93**	**10.72**	**11.20**
EDZ	Agriculture	143773	270876	68851	75863	-46.92	-9.24	-37.68
	Horticulture	25547	23249	8250	7888	9.88	4.60	5.29
	Total	**169320**	**294125**	**77101**	**83751**	**-42.43**	**-7.94**	**-34.49**
NDZ	Agriculture	325033	218880	241240	206000	48.50	17.11	31.39
	Horticulture	155738	95455	109500	80600	63.15	35.86	27.30
	Total	**480771**	**314334**	**350740**	**286600**	**52.95**	**22.38**	**30.57**
NEDZ	Agriculture	424679	264660	149633	110000	60.46	36.03	24.43
	Horticulture	70042	62265	21867	17559	12.49	24.53	-12.04
	Total	**494721**	**326925**	**171500**	**127559**	**51.33**	**34.45**	**16.88**
NETZ	Agriculture	234500	269750	63000	55800	-13.07	12.90	-25.97
	Horticulture	252375	165500	310000	276000	52.49	12.32	40.17
	Total	**486875**	**435250**	**373000**	**331800**	**11.86**	**12.42**	**-0.56**
NTZ	Agriculture	532492	327551	118333	98000	62.57	20.75	41.82
	Horticulture	55666	47048	400025	365000	18.32	9.60	8.72
	Total	**588158**	**374599**	**518358**	**463000**	**57.01**	**11.96**	**45.05**

Both agriculture and horticulture suffered losses in net income in Kolar district in view of the continuous drought and the ban imposed by the government on the use of tank water for raising crops over the past four years. This Order was

issued to facilitate recharging of underground water to provide drinking water to the community. Such actions do nullify the objective for which the tank rehabilitation work was undertaken. The JSYS authorities may have to re examine such orders from the district authorities.

5.9.2 Net income of agriculture and horticulture across zones during rabi / summer season:

The agricultural income during the end of the project was highest in the tank commands of NETZ with Rs.434,358 followed by Rs.224,282 in the zone CDZ (Table 5.9B). In horticulture the zone NDZ performed better with an average net income of Rs.192,690 per tank command.

However the net impact of project was highest with 40.59 per cent in agriculture in NEDZ followed by the CDZ with 23.69 per cent. In horticulture the net impact of the project was highest with 57.35 per cent in EDZ. Agriculture failed to make a dent in Bidar while horticulture could perform better. In summer, Kolar district exceeded all other zones with regard to net project impact in Horticulture as many farmers grow cost-intensive and more profitable hybrid tomato, in addition to potato and onion, of course many farmers incurred loss in some years due to drastic fall in prices.

5.10 Catchment Area

5.10.1 Functional wells and area irrigated in catchments

In order to know the effect of tank rehabilitation on the bore wells and open wells **situated in the catchment area**, data on water table and area irrigated were analyzed. The data reveals a considerable increase in the ground water levels in bore wells and so also in open wells.

As per the data given in Table 5.10A, it is observed that the total area irrigated by bore wells and open wells was highest at the end of the project in NDZ with

Table 5.9B

26.27 ha, followed by CDZ with 21.06 ha for catchment area. However, the percentage change in the irrigated area by bore wells and open wells was highest in NDZ with 63.33 per cent followed by CDZ with a change of 47.14 per cent. The contribution for the total irrigated area was considerably high by bore wells than the open wells. This suggests that the **project intervention has certainly helped the farmers in the catchment area** also to harvest more water and raise better crops. The bore wells found to be more in NEDZ (18) followed by EDZ with (16) on an average per catchment. In Kolar Dist (EDZ) the bore wells have gone upto 1000 ft deep but suddenly go dry in some areas.

Table 5.10A : Functional bore wells and open wells and area irrigated per catchment across zones

Zone	Period	No. of Bore wells	No. of Open wells	Area irrigated by Bore wells (ha)	Area irrigated by Open wells (ha)	Total area irrigated (ha)
CDZ	Baseline	11	1	14.01	0.30	14.31
	End of Project	14	3	20.58	0.48	21.06
	Percent change					**47.14**
EDZ	Baseline	13	1	11.72	0.18	11.90
	End of Project	15	1	14.43	0.24	14.67
	Percent change					**23.27**
NDZ	Baseline	12	7	14.85	1.24	16.09
	End of Project	18	9	24.80	1.48	26.28
	Percent change					**63.33**
NEDZ	Baseline	11	5	9.60	0.96	10.56
	End of Project	12	6	10.80	1.16	11.96
	Percent change					**13.26**

Zone	Period	No. of Bore wells	No. of Open wells	Area irrigated by Bore wells (ha)	Area irrigated by Open wells (ha)	Total area irrigated (ha)
NETZ	Baseline	2	1	2.67	0.28	2.95
	End of Project	2	1	2.88	0.38	3.26
	Percent change					**10.63**
NTZ	Baseline	3	1	2.58	0.32	2.90
	End of Project	4	1	3.36	0.34	3.70
	Percent change					**27.59**

5.10.2 Production and productivity of crops during Kharif season

The crop wise area production and productivity of the major crops raised in catchment area have been analyzed and presented in Table 5.10 B and Figure.5. The area and production of crops has increased during the project period when compared to the base period. The productivity of paddy has increased to 50.51 quintals per hectare from 41.79 q /ha at the base year. It amount to 20.86 per cent, increase. In the case of cereals and millets, the productivity has increased to 37.92 q/ha from 32.46 q/ha of base period. In terms of percentage the increase in productivity due to the project works out to 5. 46 per cent.

Similarly the productivity of oil seeds has increased to 18.73 q/ha during the end of project year from 16.4 per cent during the base year; an increase of 2.37 percent. The increase in the productivity of oil seeds was insignificant The productivity of vegetable crops has been relatively better than the oil seeds, with the increase of 4.28 percent. The productivity of vegetables has increased to 188.73 q / ha from 184.5 q/ha at the base period. The increase in area and productivity of cereal and millets is due to the importance given by farmers for food crops than the oil seeds or pulses. Since vegetables are relatively more remunerative farmers have given importance to vegetable cultivation.

Table 5.10B

Figure 5

5.10.2.1 Production and Productivity of crops across zones during kharif:

The Table 5.10C provides information on the area, production and productivity of kharif crops across zones in catchment area. The paddy was grown in larger area in NEDZ than other zones while none in NETZ. Maize and millet crops were grown in all the zones in larger areas than the paddy area on an average. Among the oil seeds, groundnut was grown in all the zones, except in NETZ and NTZ and sunflower in NETZ. Pulses and vegetables were raised in all the zones except NTZ. The reason for not growing some crops in certain zones may be the non suitability of agro-climatic conditions to cultivate them.

5.10.3 Production and productivity of crops during Rabi/Summer season

In Rabi/summer seasons also many farmers in catchment area have raised all types of crops. There has been an increase in area under all crops during the project period as seen from the data presented in Table 5.10D and Figure.6.

Table 5.10C

Table 5.10D : Production and productivity of Rabi/summer crops per catchment

(q/ha)

Crops	Area (ha) / Production (q/ha)	Project		Percentage incremental yield from baseline in catchment area
Cereals and Millets		**End of project**	**Baseline**	
Paddy	**Area**	5.38	4.29	
	Production	262.98	190.43	10.14
Maize	**Area**	4.00	2.93	
	Production	176.32	116.63	
Millets	**Area**	2.67	1.52	
	Production	80.90	45.01	
Area		12.06	8.74	
Production		520.20	352.07	
Productivity		**43.15**	**40.27**	**2.88**
Oil seeds				
G.nut	**Area**	9.35	5.52	
	Production	170.19	83.90	
Sunflower	**Area**	5.76	3.96	
	Production	100.59	58.00	
Area		15.11	9.48	
Production		270.78	141.90	
Productivity		**17.92**	**14.97**	**2.95**
Vegetables				
Area		5.30	3.16	
Production		1103.60	635.05	
Productivity		**208.03**	**201.03**	**7.01**

Figure 6

The area-led production has increased per catchment area. The productivity of paddy during the project period has increased to 48.9 q/ha from 44.4 q/ha during the base year, with an incremental increase of 10.14 per cent.

The overall productivity of cereals and millets was found to be 43.15 q/ha at the end of the project while it was 40.27 q/ha during the base period. Thus there was an incremental yield of 2.88 per cent. The oil seeds productivity increased from 14.97 q/ha to 17.92 q/ha registering an increase of 2.95 per cent,while the vegetable productivity increased from 201 q/ha to 208 q/ha with an increase of 7.00 per cent during the project period. Except paddy crop, the increase in yields of all other crops was found to be marginal.

5.10.3.1 Production and productivity of crops during Rabi/Summer season across zones

The area, production and productivity of all the crops are delineated zone-wise in Table 5.10 E. Paddy was grown in all the zones except in NETZ while maize except in NEDZ and NETZ. Millets specially ragi (finger millet) was found to be popular in CDZ and EDZ and not in other zones. Oil seeds and vegetables did not show up in NETZ. Which remains a backward zone. Millets and vegetable crops are to be popularized under bore well and open well cultivation in catchment areas as they can provide better income when compared to other crops.

5.11 Agricultural Households

In order to understand the nature of crops raised, the technologies adopted, the production and productivity of the crops cultivated in the sample villages, the data were collected from the randomly selected 1030 agricultural households from 182 sample villages and 35 control villages across the project area. The data collected from these individual farmers were analyzed to draw certain inferences relevant to the project impact.

Table 5.10 E

5.11.1 Individual Household area under crops:

The data in Table 5.11A provide the information on the area cultivated by each family before and after the project implementation both in kharif and rabi/summer seasons under the major crops cultivated by them.

Table 5.11A : Individual household's area under crops during kharif and Rabi/summer

Crop	Season	End of project (ha)	Baseline (ha)	Percent change
Paddy	Kharif	0.68	1.18	-0.50
	Rabi/ Summer	1.07	0.67	0.40
Maize	Kharif	0.77	0.63	0.13
	Rabi/ Summer	0.79	0.90	-0.11
Millets	Kharif	0.83	0.75	0.08
	Rabi/ Summer	0.90	0.40	0.50
Oil seeds	Kharif	0.98	0.63	0.35
	Rabi/ Summer	1.35	1.07	0.28
Horticulture crops	Kharif	0.58	0.44	0.14
	Rabi/ Summer	0.78	1.43	-0.65
	Perennial	0.35	0.42	-0.08
Others	Kharif	1.26	1.19	0.06
	Rabi/ Summer	1.17	1.08	0.09

Most of the crops grown by each farmer were less than one hectare before and after the project implementation except in case of paddy and oil seeds which were grown in areas of more than one hectare. The change in the area cultivated during rabi and summer were more in respect of millets and paddy. The change in the area cultivated was positive in all the crops except in case of paddy during kharif and maize and horticulture crops in rabi/summer which registered a negative change. The area under paddy decreased considerably, with 0.50 per cent change from the base year. While there was an increase in

the area by 0.4 hectares under paddy cultivation during rabi / summer. This situation has arisen may be because of the decision taken by the farmers of many tank commands to store water during kharif for use in the rabi/summer seasons. Contrary to this, the area under maize and horticulture crops has come down during rabi and summer seasons, as the farmers gave more emphasis on growing paddy and millets which are used as staple food. The millets include mostly ragi, hybrid jowar, and bajra.

5.11.2 Farmers adoption of technologies

The number of farmers adopting various technologies in raising different crops in their fields during the pre-project period and the end of the project period were obtained in order to understand the changes brought about in the package of practices adoption, to achieve better production and productivity. The data in Table 5.11B reveals the changes in the levels of acceptance and adoption of different technologies by farmers over the project period. The percentage of farmers adopting high yielding varieties has increased during the project period substantially in respect of cereals, millets, oil seeds and vegetables during kharif season. While in rabi season, the percentage of farmers adopting high yielding varieties in cereals and vegetables have increased while that of oil seeds and pulses have decreased. Interestingly, in summer season there is a decrease in the percentage of farmers adopting high yielding varieties of pulses while there has been an increase in all other crops. The adoption of high yielding varieties during the end of the project was by more than 80 per cent of farmers in respect of cereals, oil seeds, millets and vegetables which fount to be fairly higher when compared to baseline year.

This is mainly due to the availability of high yielding varieties during the season and also because of the extension work done by the Universities and the District Project Unit staff. In respect of paddy, many farmers have opted for KRH-2 hybrid variety as it has the highest yield potential among all the paddy varieties. With regard to the adoption of organic manures including vermi compost, silt and bio-fertilizers, the adoption was by 81.22 per cent in respect of

Table 5.11B

millets, 71.91 per cent in respect of oil seeds and 70.87 per cent in respect of cereals during kharif season at the end of the project period, while all other crops registered adoption of less than 70 percent of farmers in different seasons. This may be mainly due to the ignorance of the farmers about the bio-fertilizers like rhizobium, azospirilum, PSB, and azatobactor. There is some awareness among the farmers about the use of vermi-compost in the recent years because of the educational activities taken up by the Universities and the District Project Units. Interestingly, the use of organic manure has reduced during the project period in respect of cereals, because of the non-availability of farm yard manure in the rural areas. Even the FYM has become a bit costly input due to the decreasing trend in cattle rearing.

The farmers ranging from 21.4 to 87.34 percent continue to adopt fertilizers (NPK) in various levels for different crops. The use of fertilizers was by more than 80 per cent of farmers in respect of millets and oil seeds in kharif with the hope of getting higher yields. In respect of cereals the use of fertilizers by farmers ranged from 53-74 percent. The usage in the base period was 23 percent of farmers. The high cost of fertilizers and less margin of profit in paddy, probably has forced them to use less fertilizers and more of organic manures.

In respect of organic pesticides, except in case of millets – ragi and bajra, (67%), the farmers usage is found to be very limited in other crops. NSKE, panchagavya and Bordeaux mixture have come in handy for the farmers as they can be prepared locally at the least cost. So ragi and jowar being the staple food crops, many of them have tried to control some of the pests and diseases by using these organic pesticides.

The farmers have reduced the usage of plant protection chemicals considerably, because of the high cost of pesticides. Except for millets, especially jowar and oil seeds, farmers are not using plant protection chemicals for other crops, not more than 30 per cent adopt them.

Only at the high incidence of pests and diseases farmers resort to the usage of plant protection chemicals.

In general, the farmers are using more of high yielding varieties and fertilizers to get higher yields and more production. There is a need for educating the farmers to go in for low cost bio-fertilizers and organic pesticides in order to achieve higher net income. The adoption levels of all technologies except P.P. chemicals were better during the end of the project period compared to baseline year due to the demonstrations, training and FFS organized by both the Universities.

5.11.3 Household gross output:

With regard to the gross output of individual households, the trend remains the same as that of the changes in the area during the project period (Table 5.11C). Among the cereals and millets the gross output ranged from 28.57 q. to 35.6 q/ household. Oilseeds attained a maximum yield of 31.0 q./household while horticultural crops reached 126.32 q./ household on an average at the end of the project year. The percentage of change in the gross output was relatively high in case of millets (ragi and jowar) to an extent of 143.36 during rabi/ summer, 94.30 per cent in oil seeds in kharif season while 76.06 per cent increase in case of paddy in rabi/summer.

Table 5.11C : Individual household's Gross output during kharif and Rabi/summer

Crop	Season	End of project (q)	Baseline (q)	Percent change
Paddy	Kharif	28.57	47.00	-39.21
	Rabi/ Summer	35.60	20.22	76.06
Maize	Kharif	31.82	24.32	30.83
	Rabi/ Summer	30.75	33.04	-6.94

Crop	Season	End of project (q)	Baseline (q)	Percent change
Millets	Kharif	33.81	29.86	13.23
	Rabi/ Summer	33.00	13.56	143.36
Oil seeds	Kharif	18.42	9.48	94.30
	Rabi/ Summer	31.50	24.48	28.68
Horticulture crops	Kharif	97.06	68.93	40.81
	Rabi/ Summer	126.32	172.77	-26.88

There was a considerable reduction in gross output of paddy by 39.21 per cent in kharif, while 26.88 per cent in horticultural crops and 6.94 per cent in case of maize during rabi / summer; in line with the reduction of area under these crops in their farms. The farmers in general have given more importance for stable food crops like paddy and millets, while oil seeds and horticulture crops as commercial ventures. Its is a good trend that the paddy cultivation has been reduced in kharif to save water, while ragi which consumes half of the paddy requirement of water has taken larger share in Rabi / Summer.

5.11.4 Individual households crop productivity:

The productivity of crops raised by the individual farmers are presented in Table 5.11D. Farmers obtained better productivity among all crops the highest being 42.00 q/ha of paddy, 41.47 q/ha of maize, 40.70 q/ha of millets during Kharif at the end of project year.

The productivity of paddy increased by10.5 percent during rabi and summer. Oil seeds and horticulture crops also registered increase in productivity to the tune of 25.35 and 34.33 per cent respectively. Oil seeds performed better in kharif season while paddy and horticulture crops achieved better increase in rabi / summer season over the base year.

Table 5.11D : Individual households crop productivity during kharif and Rabi/summer

(q/ha)				
Crop	**Season**	**End of project**	**Baseline**	**Percent change**
Paddy	Kharif	42.04	39.76	5.72
	Rabi/ Summer	33.35	30.18	10.51
Maize	Kharif	41.47	38.38	8.05
	Rabi/ Summer	38.69	36.71	5.38
Millets	Kharif	40.70	39.61	2.75
	Rabi/ Summer	36.54	33.90	7.78
Oil seeds	Kharif	18.80	14.99	25.35
	Rabi/ Summer	23.31	22.85	1.99
Horticulture crops	Kharif	167.99	155.74	7.87
	Rabi/ Summer	161.78	120.44	34.33

In general the productivity of all the crops increased during the end of the project period over the base period, though with differential magnitude. This indicates that the interventions of the project in terms of rejuvenation of tanks and extension activities undertaken by both the Universities Consultancy services to educate the farmers about the value of the latest technologies through demonstrations, training programmes, field days etc. have helped immensely for the substantial increase in the levels of crop production and productivity.

5.11.5 Individual households net income:

The net income derived by the farmers in respect of different crops raised during the end of the project period is presented in Table 5.11E. The net profit is influenced by the local market rates at the time of the harvest season. However, the figures give the quantum of benefits the farmers can derive under normal season and market. As seen from the data, the net income from horticulture crop was the highest with Rs.15768 /ha. during rabi / summer, while it was Rs.14,276/ha during kharif and this followed by paddy with Rs.14185 /ha during

kharif. The least net income was from millets like ragi during kharif and Rabi/summer seasons respectively, may be due to the seasonal glut in the market and fall in prices. Of course the perennial crops provided the highest income to the farmers to an extent of Rs.41836/ha but not all farmers will have the opportunity to raise perennial crops like coconut and aracanut. The percentage change in the household net income over the pre-project period was highest in case of oil seeds in kharif season (88.54%) during kharif while it was 72.0 per cent during rabi/summer season in case of paddy. Horticulture crops also registered an increase of 59.62 per cent during kharif season. So it is but natural that the farmers were going for paddy cultivation, oil seeds and horticulture crops to derive better profits under the normal market situation.

Table 5.11E : Individual households Net income during Kharif and Rabi/summer

				(per ha)
Crop	**Season**	**End of project (Rs)**	**Baseline (Rs)**	**Percent change**
Paddy	Kharif	14185	12864	10.28
	Rabi/ Summer	9705	5642	72.02
Maize	Kharif	8346	6663	25.27
	Rabi/ Summer	5804	7200	-19.38
Millets	Kharif	5675	4951	14.62
	Rabi/ Summer	6612	4841	36.58
Oil seeds	Kharif	6220	3299	88.54
	Rabi/ Summer	10222	8353	22.38
Horticulture crops	Kharif	14276	8944	59.62
	Rabi/ Summer	15768	19530	-19.26
	Perennial	41836	39489	5.94
Others	Kharif	8804	6698	31.45
	Rabi/ Summer	8968	5370	66.99

In general it can be said that the farmers have benefited largely with the general increase in the household income during the project period. The farmers may have to grow oil seeds and horticultural crops in addition to paddy crop to earn higher net income.

5.12 Farmers Education through Demonstrations and FFS

5.12.1 Water Use Efficiency (WUE) and productivity of Paddy crop

The University of Agricultural Sciences at Bangalore and Dharwad had undertaken the organization of result demonstrations on paddy in the project area in order to educate the farmers about the profitability of Jalasri (SRI) method of paddy cultivation. The most important advantage of SRI method (Aerobic method) of paddy cultivation is the saving of scarce irrigation water. In view of the shortage of water in the tanks, many a times resulting in the loss of crops of the farmers in the tail ends, there is an absolute need to adopt appropriate technologies to save water but still get comparatively good yields In this direction the data of the demonstrations conducted by the University consultancy services, Bangalore, is presented in Table 5.12A will be of immense value. The data presented in Table pertains to demonstrations on Jalasri / SRI method of paddy cultivation, two each from 12 taluks of Kolar Tumkur and Chitradurga districts of the Project area. These demonstrations were conducted during the project period 2003-04 to 2007-08, most of them during kharif season and some of them in summer season as a part of Farmers Field School (FFS) activity. The technologies adopted in most of the demonstrations include use of hybrid variety of paddy KRH-2, seed rate of 4 - 5 kg/ha, wider spacing of 30 x 30 cm / 30 X 25 cm, direct sowing of sprouted seeds, use of recommended doses of FYM and balanced fertilizers including some quantities of bio-fertilizers, soil application of zinc sulphate, check basin method / on and off method of irrigation (light irrigation) and use of bio-pesticides as per the need. All these demonstrations were organized as crop demonstration with the exception of four

Table 5.12A

demonstrations of water management. While the farmers followed the normal farm practices in the check plots by using high yielding varieties like Tella Hamsa and Hamsa paddy varieties and only in few places the hybrid variety. In check plots, they had used higher seed rate (20 kg/ha), resorted to irregular transplanting, imbalanced fertilizers use with no bio-fertilizers or bio-pesticides. Here farmers followed submergence of paddy / flooded irrigation which has consumed lot of water. In Jalasri method of paddy cultivation, profuse tillering was observed in all the plots which is a distinct characteristic of this method of paddy cultivation.

The yields obtained in the Jalasri method of paddy cultivation by CBTMPCS, Bangalore ranged from 50 q/ha to 95 q/ha with an average yield of 73.88 q/ha while in check plots the yield of paddy ranged from 30 to 62.5 q/ha with an average of 47.98 q/ha. So the percentage of increase in yield of paddy ranged from 30.48 to 150 with an average of 57.00 percent over the check. This is substantially a high percentage of increase over the check plots despite huge savings in water. The yield of fodder is also important to the farmers and the increase in yield of fodder over the check plot ranged from 23.46 to 87.5 per cent with an average of 48.36 q/ha.

The water use efficiency in demonstration plots ranged from 62.5 kg/ha.cm to 119.6 kgs/ha.cm with an average of 93.44 kgs/ha.cm. While in check plot the range was 25 to 62.92 kgs /ha.cm with an average of 45.82 kgs/ha.cm. However, it is interesting to note that the increase in water use efficiency in demonstration plots over the check plots was of the order of 40 per cent to 275 per cent with an average figure of 112.5 percent. Therefore, this method of paddy cultivation need to be propagated intensively among the farmers in command areas in order to derive better benefits out of the scarce tank water resources. Some farmers are of the opinion that the weeds infestation is more in SRI method, which can be curtailed by taking up intercultural operations.

On-farm Demonstrations:

Both the University consultancy services have organized three types of on-farm demonstrations viz water management demonstrations; arable crop demonstrations and horticultural crop demonstrations in all the nine districts in kharif and rabi / summer seasons, to show the value / influence of technologies on crop yields and income. These demonstrations were conducted mostly on paddy, ragi, hybrid maize, groundnut, sunflower, tomato, potato, brinjal, red gram etc.

5.12.2 Water management demonstrations:

The crops grown in these demonstrations include: paddy, ragi, hybrid maize, hybrid jowar, wheat, sunflower, groundnut, tomato, brinjal and onion etc., (Table 5.12B). The area covered by each demonstration varied with a maximum of 10.0 ha. The area under these demonstrations was reduced in many cases in view of the non filling of many tanks in the project area for nearly three years. Therefore, the sources of irrigation were not only tanks, but also bore wells in a majority of the commands. In many instances it is the conjunctive use of tank and bore well water and in some cases only bore well water. Though some of the open wells got rejuvenated; their utility was minimal.

Table 5.12 B : Performance of Water Management Demonstrations in the Project Area

Zone	Crop	No of Demo	Average yield		Increase in yield (%)
			Demo (q/ha)	Check (q/ha)	
CDZ	Paddy	2	42.00	36.00	16.67
	Ragi	2	32.10	24.51	30.97
	Sunflower	2	19.09	15.76	21.13
	Maize	2	56.00	45.25	23.76
EDZ	Paddy	8	65.75	43.50	51.15
	H.Jowar	1	24.05	18.40	30.71
	Maize	2	39.50	30.00	31.67
	Ragi	5	33.33	24.4	36.59
	Brinjal	3	327.20	261.33	25.20
	Tomato	2	334.50	265.00	26.22
NDZ	Paddy	2	51.30	42.63	20.34
	H.Jowar	3	36.44	27.07	34.63
	Ground nut	1	16.08	11.53	39.46
	Sunflower	3	15.93	12.67	25.79
	Onion	1	204.20	166.72	22.48
	Cucumber	1	352.00	315.00	11.75
	Maize	3	54.89	35.73	53.62
	Wheat	2	26.62	24.15	10.22
NEDZ	Paddy	1	55.54	49.26	12.75
	Groundnut	2	21.52	16.49	30.50
NTZ	Paddy	1	44.14	35.6	23.99
	Sunflower	1	18.60	15.75	18.10

The water management practices adopted in these demonstrations were: channel cleaning and repair for improved water conveyance, fixing outlet and V-notches, formation of ridges and furrows, check basins, broad beds and furrows, and corrugation; on and off method of irrigation specially in paddy, alternative furrow irrigation, ridges and furrow irrigation, border strip irrigation, paired row and skip furrow irrigation, depending on the crop raised; then irrigation at critical stages and at regular intervals.

Water management demonstration of maize (NAC-6004) organized at Koratagere by CBTMPCS Bangalore

The other important crop production practices adopted were: use of high yielding / hybrid varieties, seed treatment, closed spacing, line sowing, use of bio-fertilizers, complex fertilizers and bio-pesticides. The practices followed in check plots were; submergence in paddy and usual irrigation and other practices. Necessarily, the yields of demonstrations plots were higher than the check plots. The highest average yields attained in demonstration plots were: Paddy 65.75 q/ha and ragi 33.33 q/ha in EDZ, maize 56.00 q/ha and sunflower 19.09 in CDZ, Hy. Jowar 36.44 q/ha in NDZ, while groundnut 21.52 q/ha in NEDZ. Among

vegetables tomato registered highest average yield of 265.00 q/ha in EDZ. Thus the performance of crops differed in different zones may be due to varying agro-climatic conditions. The percentage increase in yield of these demonstrations over the check plots varied from crop to crop. The highest increase was in the case of maize (53.62%) in NDZ, paddy 51.15 percent in EDZ and groundnut 39.46 cent in NDZ, while the lowest was in case of wheat 10.22 percent also in NDZ. Both the universities have conducted large number of water management demonstrations but here, only a sample of demonstrations selected randomly from project sample villages are included for analysis. These were organized by both the University consultancy services in collaboration with the demonstrator farmers.

The enhanced yield levels can be attributed basically to the integrated water management practices adopted in the plots. Not all water management practices were adopted in each demonstration, a few of them were adopted in different combinations depending on the available water resources, type of layout, crops cultivated and the managerial ability of the concerned farmer. More the water management practices adopted better the crop yields were; while more the area better the impact. But in order to achieve better benefits out of the project intervention of tank rehabilitation activities, there is an absolute need to adopt integrated water management practices. The University and CFT Agril. specialists have a major role to play in organizing good demonstrations, and educating the farmers about the advantages of adopting integrated water management practices as a package.

5.12.3 Arable crop demonstrations:

As part of the University consultancy service activities, arable crop demonstrations were also organized across the project area during the project period. Here, again the major crops like paddy, ragi, hybrid maize, jowar, sunflower, groundnut, cotton, green gram were mostly covered in the demonstrations. The area covered under each demonstration varied based on

the quantum of irrigation water available and other situational factors. Though it was expected to cover 5.0 ha under each demonstration, in reality it was in some cases less than the prescribed area. The important production technologies covered in these demonstrations were: use of high yielding / hybrid varieties specially KRH-1 paddy, optimum spacing, line planting, appropriate irrigation layouts like check basins, ridges and furrows, broad beds and furrows; and irrigation methods like alternative furrow irrigation, border strip, ridges and furrow irrigation, optimum use of water; use of bio-fertilizers like azotobacter, azospirillium, rhizobium and PSB; vermi-compost, compost and NPK, micro-nutrients like zinc sulphate and ferrous sulphate, gypsum , use of bio-pesticides like 4% NSKE, Panchagavya, trichoderma and NPV. In some demonstrations jalasri /SRI method of paddy cultivation were adopted. Here, specially designed paddy drum seeders and weeders were utilized. The technologies adopted in each demonstration were based on the crop and the need. Because of the emphasis laid on the use of bio-fertilizers and vermi compost balanced fertilizers were not given in many demonstrations. In many instances farmers failed to provide inputs of their share and thus all the expected technologies were not adopted in demonstration plots. Most of the demonstration laid out in FFS were arable crop demonstrations per se. only the demonstrations laid out in sample villages were considered for analysis, highest number from EDZ (Kolar dist.) DPU's also organized arable crop demonstrations in some taluks to educate the farmers on latest technologies.

As seen from the Table 5.12C among the cereal crops, the yield of paddy was highest with 78.3 q/ha in NEDZ, ragi 32.15q/ha on an average in EDZ and maize with an yield of 58.20 q/ha in CDZ.

5.12C : Performance of Arable Crop Demonstrations in Project area.

Zone	Crop	No.of Demonstrations	Average yield (q/ha)		Percentage increase in yield over check
			Demonstration	Check	
CDZ	Paddy	3	47.00	36.50	28.76
	Maize	1	58.20	56.60	9.89
	Sunflower	1	20.10	13.40	50.00
EDZ	Paddy	9	43.47	31.92	36.02
	Ragi	11	32.15	24.54	31.01
	Maize	4	34.35	27.12	26.65
NDZ	Bajra	1	11.61	6.50	78.61
	Sunflower	1	16.08	7.92	103.03
NEDZ	Rabi jowar	1	56.94	26.50	114.86
	Groundnut	1	21.21	16.33	29.88
	Green gram	1	8.75	7.50	16.66
	Paddy	1	78.30	69.38	12.85
NTZ	Paddy	6	61.24	48.20	27.05
	Maize	1	39.38	35.25	11.71
	Cotton	1	13.90	8.80	57.95

The percentage increase in the demonstration plots over the check plots was highest with 114.86 percent in rabi jowar followed by 36 percent in paddy,31.0 percent in ragi and 26.65 percent in maize. The yields attained in demonstration plots were higher due to the adoption of many recommended technologies and extension guidance provided by Universities. The critical inputs used were shared by both the demonstrator farmer and the University consultancy services but at times the farmers failed to use their share of inputs. The results indicate that there is scope for further increase in yields of crops in the command areas with

the adoption of whole package of practices. Many stakeholders were exposed to new technologies through their participation in field days.

5.12.4 Horticultural crop demonstrations:

Though horticultural crops are not very popular in command areas, still farmers go for these crops as they are considered as cash crops specially the crops like hybrid tomato and potato which are cost-intensive, but high value crops. The target fixed for organizing such demonstration was 2.0 ha per demonstration, but the extent covered under demonstrations again varied due to lack of cooperating farmers to organize effective demonstrations and their hesitation to invest their part on critical inputs specially the plant protection chemicals. The crops included in the demonstrations were: tomato, potato, cauliflower, brinjal, chilli, beans, cucumber, bhendi with other vegetables. In many demonstrations 3-4 crops were combined in a plot.

The production technologies adopted here include: use of hybrid / high yield varieties, seed treatment, appropriate spacing, appropriate irrigation methods like ridges and furrow irrigation, broad bed and furrow irrigation, alternate furrow irrigation; combined use of organic manures, bio-fertilizers and inorganic fertilizers; use of bio-pesticides like trichoderma, 4% NSKE, panchagavya and pheromone traps.. However the use of pesticides were found inevitable in view of high incidence of pests and diseases in some plots. In these demonstrations emphasis was be given to the preventive measures for control of pests and diseases.

The highest yields obtained in demonstration plots were : 350 q/ha in potato, 474 q/ha in hybrid tomato and 120 q/ha in beans and 394 q/ha in cauliflower which indicates significant increase over the yields of check plots in general. The horticultural crops were grown predominantly in zone EDZ (Kolar).

The yields obtained in demonstration plots were higher than the yields obtained in farmers fields specially in tomato, beans and chilli crops. In some of the crops,

the differences are not significant since the farmers have been adopting many of the recommended technologies on their own because of the high value of the crop produce. Here also, a part of the critical inputs are provided by the University consultancy services. Drip irrigation was adopted in few cases. In some plots the check was the paddy crop to showcase the profitability of horticultural crops over paddy crop.

5.12.5 Farmers Field Schools: (FFS)

This is another activity organized by the University consultancy services in the project area. Farmers field schools were organized around crop demonstrations. The crops covered in FFS were mostly cereal crops like paddy, ragi, hybrid maize, hybrid jowar and wheat, oil seed crops like groundnut and sunflower, vegetables like potato, tomato, onion, brinjal, beans and others. Hy. Cotton was also included in some plots. These demonstrations were organized incorporating some components of arable crop demonstrations, horticulture crop demonstrations or water management demonstrations laid out mostly in an area of 0.8 ha each. In Haveri district mixed cropping of cotton + soya bean, maize +sunflower were also tried. In Bangalore University project area the treatments included in demonstration plots were: partially integrated approaches like integrated crop management / integrated nutrient management / integrated water management / integrated pest management, with farmers practices in the check plots. In Dharwad region variety, spacing, seed treatment and irrigations methods were also given emphasis in addition to integrated nutrients and pest management approaches. One of the significant treatment has been Jalasri / SRI method of paddy cultivation in both the Universities with emphasis on integrated crop management practices specially the use of low seed rate of 5 kgs /ha of hybrid paddy seed (KRH2) and use of on and off method of irrigation .

The technologies taught to them were about the seed germination, tillering, agro-eco-system analysis (AESA), nutrient management, pest and diseases identification and their control as well yield analysis. Both the knowledge and

skills are imparted in these sessions. In majority of the FFS, four to five sessions have been organized, though in some cases 8 sessions were held. In each school 30 farmers are enrolled in general, but in a majority of the sessions the participation was to the extent of only 20 to 22 on an average. The reasons provided by farmers for absence to some sessions were: some of the subjects taught in those sessions like, agro-eco-system analysis, percentage of seed germination and tillering were only of academic interest and not of any practical utility to the farmers; it is difficult to attend the sessions as per schedule, due their own on going field operations. The participation in the 'field days' organized in FFS plots were found to be more than 50 in a majority of the instances in which both the local and other TMI members participated.

The yields obtained in these plots seem to be higher than the control plots except in few plots where the crops failed due to lack of irrigation. There is variation in the percentage of increase in yield among different crops. Sunflower yield increased by 79.84 percent, , paddy by 52.0 percent, ragi by 25.71 percent, and tomato by 50.oo percent. The increase in yield ranged from 9.23 per cent to 79.84 per cent. The farmer's involvement in the schools was encouraging as it is a new method of learning. The records of FFS have been kept in the respective TMIs for the benefit of the community.

5.12.6 S.T.V Training programmes:

Both the Universities have organized training programmes to Samudaya Tantrika Vedika (STV) members from many of the TMI's at the rate of 2-4 on an average. These are specialized trainings with emphasis on entrepreneurship development and skill development. The subjects covered in SDP were : Integrated water management (IWM), integrated pest management (IPM) and Integrated nutrient management (INM), post harvest technology, animal health care, poultry, sericulture etc. Some of these were employment generation oriented courses. One important training which was found to be very valuable in respect of water management in command areas was the training given to Neeragantis (Water

distributors). These are the recognized families over the decades who takes care of water distribution among all farmers in the command area as per the community / stake holders decision.

5.12.7 Soil Testing and Interpretation of results

The University extension services, having acquired and established mobile testing labs, have analyzed large number of soil samples and made recommendations on fertilizers application (NPK) to crops based on soil test results. Even the Universities have prepared soil maps for a number of villages and displayed them in the respective TMI. But, the benefits of this activity have not reached many stakeholders, in view of the failure of the system to provide guidance to a majority of farmers during the start of the season, when they virtually require guidance in the interpretation of results and in the application of required doses of locally available fertilizers to the crops. The soil test results have helped to take up reclamation of large areas of saline soils in Tumkur district. Except in Tumkur district, in all other districts the ph values were found to be normal. With regard to NPK, the soils of the project area found to be rich in P_2O_5 and K_2O. The farmers who had taken advantage of the results have appreciated the efforts of the Universities in providing soil test results at their doors. This has facilitated many farmers to apply only the required quantities of fertilizers and attain good yields and high profits. Some agency need to take responsibility to provide guidelines to farmers at sowing seasons.

5.12.8 Other educational activities of the Universities

The Universities have also undertaken many educational activities in addition to demonstrations and FFS. These include; field days around demonstrations, field visits to successful farms, group meetings, method demonstrations specially with regard to preparation of 4% NSKE spray, panchagavya, and bordaux mixture, paddy sowing in SRI method, soil sampling technique and seed treatment, conducted tours, video presentations and cluster level interaction sessions in selected taluks of all zones ; these helped the farmers to gain new knowledge

and skills. STU's have provided cash and worms to many individuals and provided guidance in the preparation of vermin compost. Universities have ensured Participation of many farmers in field days organized at Bangalore and Dharwad University campuses. However, the Universities have failed to organize conducted tours/exposure visits to the expected level, may be due to some organizational problems.

5.13 Impact of silt on crop yields and income:

The farmers have been provided with silt, free of cost in most of the TMI's for use in their fields. Silt has been considered by many farmers as a valuable organic manure and so have used in raising crops like maize, ragi, paddy, groundnut, brinjal and tomato. Most of the farmers have applied the silt before the sowing of the crop. In some sample villages farmers have used silt indiscriminately ranging from 35 tons/ha to 225 tons/ha with an average of 140 tons/ha. The increases in yields obtained in these plots were not uniform, and ranged from 10 to 66 per cent over the yields in check plots. But, where silt was used to the extent of 185 tons/ha supplemented with fertilizer application, the increase in yield of paddy went up to 200 per cent compared to the yields obtained in check plots with no fertilizers.

From the study of few farmers who had used silt for various crops, the impact of silt application was found to be very encouraging and performed well when supplemented with FYM and fertilizers.

The trials conducted by the CBTMPCS, UAS, Bangalore has revealed that the application of silt alone to the extent of 150 t/ha is good enough to get better crop yields in paddy, ragi, sunflower and groundnut as seen from the Table 5.13.

Table 5.13

However, paddy registered highest yield of 71.11q/ha and an income of Rs.42,227/ha, with the use of silt at 150 t/ha supplemented with FYM at 5t/ha and recommended dose of fertilizers (NPK@100:50:50/kgs/ha). Therefore, paddy farmers may have to use all these three inputs to get the highest dividends. But in case of ragi, sunflower and groundnut better yields and incomes were derived when silt at 150t/ha and recommended doses of NPK were used in each crop.

Where the farmers cannot afford to use FYM or fertilizers application with only silt application at 150 t/ha can get good results from 2nd year and onwards. In the project area the stake holders can take advantage of the silt of their own tank and get sustainable agriculture production.

5.14 Recommendations:

- The stake holders of tank command areas will not derive any benefit unless a policy decision is taken to increase substantially the live storage capacity of tanks, for making water available for raising better crops in the entire command area of each rehabilitated tank.

- Project may have to give more emphasis for proper stone slab lining of canals, to facilitate free flow of water for the tail Enders to get access to water.

- University staff should guide each TMI in the preparation of feasible and most profitable crop plan, based on the quantum of water available in the tanks and the needs of the farmers before each season.

- In order to show the full potential of the available agricultural technologies to the farmers, the recommended package of practices need to be adopted in the demonstration plots by providing all the critical inputs by the University consultancy services itself, with out forcing the poor demonstrators to contribute their share.

- The crop production technologies to be adopted in each of the arable crop demonstration, water management demonstration and horticultural crop demonstration need to be decided in the joint workshop of the staff of JSYS and the implementing agencies to ensure transparency.

- The area to be covered under each category of demonstration and the contribution of the demonstrator farmer with respect to critical inputs if any need to be specified to avoid ambiguity.

- Water Management Demonstration will be more effective when it is organized in the entire tank command area by adopting all the integrated water management practices and the best cropping pattern with the involvement of TMI and all stake holders in that command. At least one such block demonstration in each taluk in a typical tank command area followed by organized field visits to farmers of other tank commands to such demonstration, will have a better spread effect.