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Microlevel Water Resource Development through Rainwater Management for Drought Mitigation in Sub-humid Plateau Areas of Eastern India

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Dedicated

to

Tribal Farmers

of

Dumuria

Keojhjar (Orissa)

PREFACE

The eastern region is endowed with adequate rainfall with rainfall varying from 1100 mm in eastern U.P. to more than 1500 mm in north Bengal. Unfortunately, even with this rainfall, the drought is a common occurrence. With undulating topography and poor ground water availability, the plateau areas are severely affected by drought. During 1961-2000 period, Orissa experienced 14 droughts out of which 5 were severe, although the state average rainfall was below 1000 mm only thrice with lowest being 950.7 mm. Thus, the occurrence of the drought in this region is not due to deficiency of the rainfall, but its erratic distribution. The drought not only affects the productivity, but also adversely hurts the investment sentiments, due to which there is very little investment in rainfed agriculture. As the rainfall is quite sufficient, its proper management can lead to drought mitigation. With this in view, a project on 'Rain water management strategies for drought alleviation' was undertaken at Raipur, Bhubaneswar, Ranchi, and Jabalpur under Rainfed Rice Production System of Rainfed Eco system with funding from National Agricultural Technology Project. At WTCER, Bhubaneswar, this project was undertaken at village Dumuria in Keonjhar district. The project has given a viable technology for micro level water resource development through rain water management. This bulletin is an effort to compile the results of this technology in hydrology, hydraulics, production, and economic terms as well as its social management. Chilka Development Authority, Bhubaneswar, is already replicating the technology in its watershed programme. We hope that this bulletin will be useful in replicating this technology at different places.

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Authors

CONTENTS

1.0 INTRODUCTION

The eastern (Chhotanagpur) plateau and eastern ghats, hot sub humid eco-region has been classified as Agro Ecological Region (AER) No. 12 by NBSS & LUP, Nagpur (Sehgal et al.1992). This agro ecological region comprises hilly parts of districts of Visakhapattanam , Vijayanagarm and Srikakulam of A.P. , Koraput, Bolangir, Sudergarh, Sambalpur, Dhenkanal, Kalahandi, Mayurbhanj, Phulbani, Keonjhar and Western highlands of Cuttack, Puri, Ganjam and Balasore of Orissa, whole Jharkhand and Chhatisgarh and Purulia, Bankura, Western Part of Midnapore, Birbhum and Burdwan district of West Bengal. The climatic water balance, humidity, aridity and moisture indices of the representative locations of this agro eco region show that water deficit is prevalent from November to May in almost all locations(WTCER,2001). Although the region receives annual rainfall between 1200 to 1700 mm, even Kharif crops face moisture stress due to prolonged dryspell. In Orissa, out of forty years(1961-2000) there has been 14 droughts out of which 5 have been severe, although only in 3 years , the rainfall has been below 1000 mm. This is also reflected in poor productivity level of this region. The foodgrain productivity of Orissa is 1250 kg ha^{-1} , Bihar & Jharkhand 1480 kg ha^{-1} , M.P. & Chattisgarh 1080 kg ha^{-1} , against national average of 1547 kg ha^{-1} . Even for rice which is main staple crop of the region , the yields are lower than national average , with difference ranging from 20% to 40% . As the irrigation development in this region is quite low with only 10.05% in Jharkhand , 22.46% in Chattisgarh , 35.13% in Orissa and 43.96% in north A.P. (the level is higher in last two states due to higher irrigated area in coastal zone i.e; AER 18 and AESR 18.4), the drought creates havoc with rural economy. Due to these factors this region has become habitat of maximum number of people below poverty line. In absence of gainful employment , a large scale migration of labourers takes place creating serious socio economic consequences. This is happening in spite of the region being rich in natural resources. The region is trapped in the vicious circle of low agricultural productivity and poverty, i.e., 'Low Level Equilibrium Trap', in view of which this region can aptly be called a 'Resource Rich Region Inhabited by Resource Poor People'.

Providing irrigation is a major tool for alleviating the poverty by increasing and stabilizing agricultural productivity. Since in this region, the traditional irrigation systems, viz. deep tube well or large storage based canal systems are not suitable and sustainable due to geological and hydrological constraints, it is necessary to innovate new water resource for creating irrigation potential in sub humid AER 12. Rainwater harvesting for fulfilling domestic and agricultural needs is as old as human civilization itself. However, its role varies as per the climatic conditions of the region. In arid and semi-arid regions, the role of rainwater management is to provide life saving irrigation to kharif crop to save it from vagaries of monsoon. This reduces the instability in yield and provides cushion to subsistence level agriculture against rainfall variations. However the situation is different in high rainfall areas where rain water management has a potential of being an irrigation water resource which can provide full irrigation in conjunction with rainfall to a transplanted rice based two crop rotation (Srivastava

and Panda, 1998; Srivastava, 2001). Figure 1 presents the cumulative rainfall, open pan evaporation and expected runoff from terraced cultivated land with group B hydrological cover complex at 50% exceedance probability for Bhubaneswar. It is evident from figure that if rainfall had spread over the year, there would have not been any moisture stress for a two crop rotation. Figure 2 presents a scenario with different levels of rainwater management. It has been assumed that during monsoon months, effective monthly rainfall will be equal to open pan evaporation (since on weekly basis, 50% probable rainfall is more than 50% probable open pan evaporation, the minimum value of effective rainfall will be equal to open pan evaporation). It is evident from the figure that with catchment command area ratio more than 3.0, a rainwater management system designed in conjunction with rainfall can easily ensure meeting full water requirement of a two crop rotation. This rainwater management system can be an irrigation source in this region unlike in arid and semi-arid regions where it is a drought alleviation measure.

Based on this, WTCER, Bhubaneswar (Srivastava, 2001) has developed design parameters of runoff recycling tank based irrigation systems for different seepage conditions of rice based cropping systems (Table 1). These design parameters have been developed at 80% exceedance probability and therefore quite reliable. These systems have been tested in research farm as well as in farmers' field and have been found quite successful (Srivastava et. al. 2001). However, these systems suffer from two shortcomings to become an assured irrigation source:

- The system will provide water for transplanting of rice in first week of July, but no provision has been made for meeting irrigation requirement of its nursery in June.
- The catchment area required for irrigating 1 ha of area is 3.0 ha for two conditions and 5 ha for one condition. Even in multi series tanks where command area of one tank will serve as catchment area of another, the total irrigated area in a watershed will not cross the figure of 30% which is minimum limit for declaring an area irrigated area.

As evident from Table 1, the simulation model has shown that the tanks, paddy fields and catchments area significantly contribute to ground water. This process has been schematically shown in Figure 3. The expected amount of total additional recharge varies from 3000 m^3 to 4800 m^3 per ha command area i.e., approximate 1000 m^3 per ha catchment area. While calculating the recharge due to seepage loss, the model assumes that the water table is always below pond depth, which is in normal case. If a part of this recharged water could be harvested back through open dug wells, this will remove both flaws mentioned above, i.e., it would provide water for rice nursery raising in June as well as increase the irrigated area. To assess the potential of this system, such systems were installed in field under National Agricultural Technology Project (NATP) sub project 'Rain water management strategies for drought alleviation'.

The evaluation of the system has given an insight in its hydrology, hydraulics, impact on crop productivity and socio-economic constraints. The results of the evaluation are of signifi-

Table 1. Summary of design parameters of runoff recycling based irrigation system

Sl. No	Item	Quantity		
		Seepage loss less than 6 mm per day	Seepage loss less than 10 mm per day	Seepage loss more than 10 mm per day
1	Tank Capacity per ha command area	1750 m^3	2500 m^3	1650 m^3
2	Catchment Command area ratio	>=3.0	>=5.0	>=3.0
3	Rice variety	Short duration 110-115 days or medium duration (130 days)		
4	Post monsoon crop	Low duty with irrigation requirement of 150 mm in whole command or high duty vegetable crop in part.		
5	Size of the system	Conveyance efficiency should not be less than 80%		
6	Allowable limit of seepage loss.	6mm/day	10 mm/day	Tank should be lined
7	Probable days of ponding	77 days for short duration and 93 days for medium duration		
8	Total runoff water captured for a system commanding one ha command area at 80% probability (runoff stored + seepage loss from tank and water stored in paddy fields)	6062 cu m	6753 cu m	4687 cu m
9	Recharge to ground water (approx) per ha command area	3000 cu m	4800 cu m	2500 cu m

Fig.1 Cumulative rainfall & open pan evaporation at 50% probability

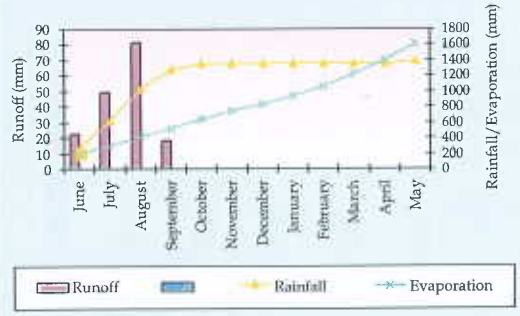
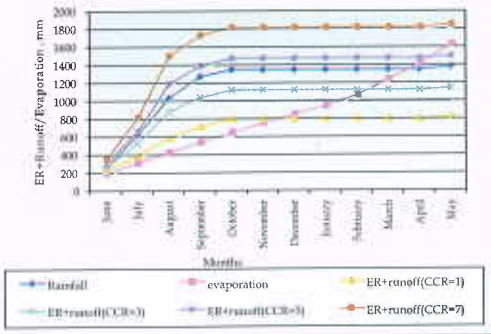


Fig. 2 Cumulative effective rainfall (ER)+runoff at different CCR and open pan evaporation at 50% probability



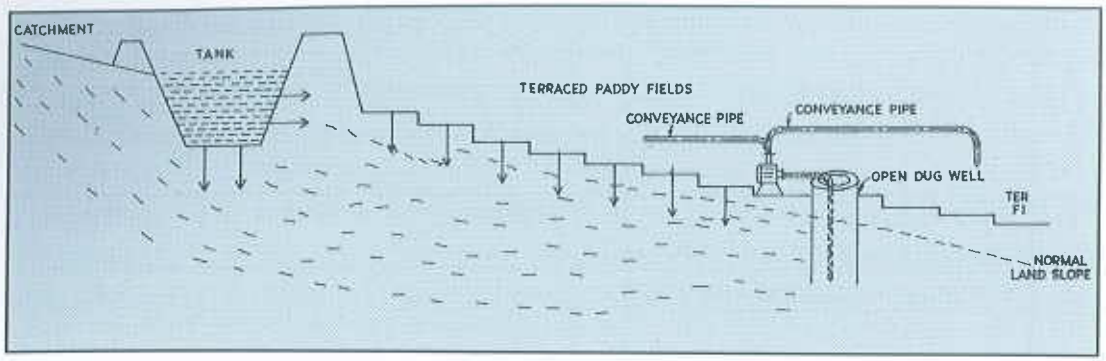


Fig. 3 : Schematic diagram of rain water harvesting based tank and well system

cance to the policy makers, field engineers, scientist and farmers who are interested in improving the agricultural scenario by drought mitigation and water resource development.

2.0 RESOURCE CHARACTERIZATION

Designing of any system is dependent upon resources of the area it has to serve. Thus before taking up the design, a resource characterization study was taken up for climatic parameters, soil resources and socio economic status. In addition a participatory resources appraisal was undertaken for assessing the problems of the people.

2.1Climatic Parameters

The monthwise climatic water balance of Keonjhar is presented in Table 2, It is evident from the table that there is water deficit from October to May. Even during water surplus season of June- September, the crop suffers due to erratic distribution. Fig. 4 and Fig. 5 show the rainfall of two years 2001 and 2002. Year 2001 was a flood year although total monsoon rainfall was just 20% above normal whereas year 2002 was a drought year although total monsoon rainfall was just 12% below normal because of the poor distribution. Thus the total rainfall might be in the range of ± 20 % of the normal rainfall but its erratic distribution create problem of flood and drought.

Fig. 4 Rainfall pattern of Dumuria Watershed,Keonjhar, Year-2001

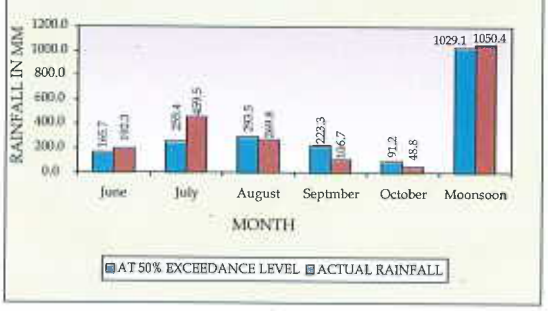


Fig. 5 Rainfall pattern of Dumuria watershed, Keonjhar Year 2002

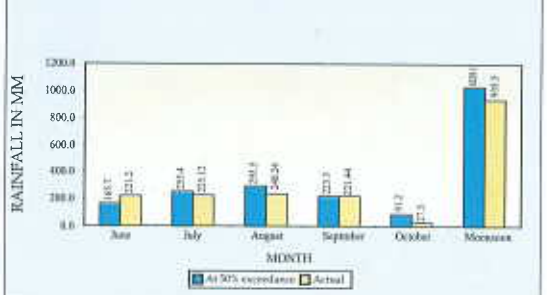
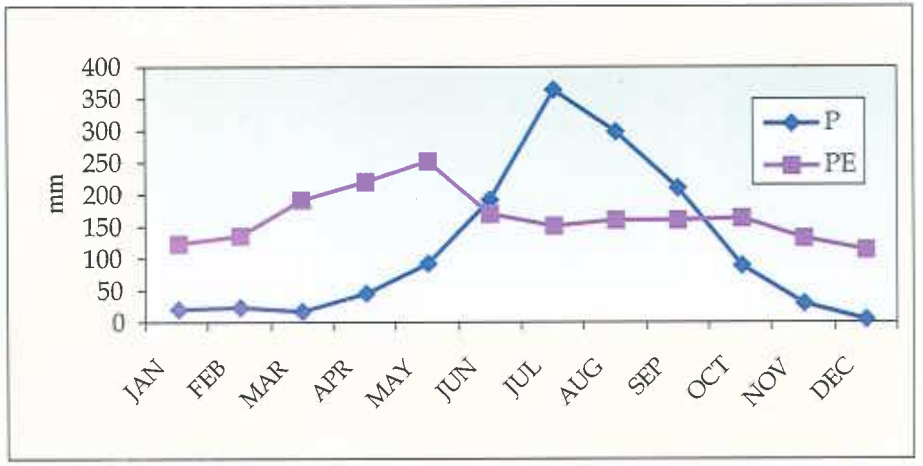


Table-2 Monthwise climatic water balance of Keonjhargarh(Orissa)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
P	23	26	19	48	95	195	367	300	213	91	30	5	1412
PE	124	139	194	222	252	171	154	161	164	167	134	116	1998
P-PE	-101	-113	-175	-174	-157	24	213	139	49	-76	-104	-111	-586
APWL	-392	-505	-680	-854	-1011	0	0	0	0	-76	-180	-291	-3989
STOR	10.99	5.18	1.61	0.51	0.18	24	150	150	150	90.38	45.18	21.56	649.6
S	-10.57	-5.81	-3.57	-1.10	-0.33	23.82	126	0	0	-59.62	-45.2	-23.62	0
AE	33.57	31.81	22.57	49.10	95.33	171	154	161	164	150.62	75.2	28.62	1136.8
WD	90.43	107.19	171.43	172.9	156.67	0	0	0	0	16.38	58.80	87.38	861.18
WS	0	0	0	0	0	0.18	87	139	49	0	0	0	275.18



Legend

P = Precipitation
PE = Potential evaporation
APWL = Accumulaltive potential water loss
STOR = Actual storage of soil moisture
S = Change in storage
AE = Actual evaporation
WD = Water deficit
WS = Water surplus
IH = Humidity index
IA = Aridity index
MI = Moisture index
AWC = Available water capacity

2.2 Soil Quality Appraisal

2.2.1 Physiography

Dumuria watershed is stretched between northern to south - eastern direction with 1 to 25% variations in slope, while it varies from 2 - 10% from west to eastern sides. Presence of pasture land at upper ridge (i.e. forest bottom) and cultivated land use system at middle and lower elevation are prevalent in the area. Depth of soil varied from 0.9 to 2.5 m, below which it was fractured rocks. The occasional presence of gravel, pebble and hard rock in between land uses intercepted its smooth spreading, which also created a strip of wasteland along the western border (10% slope) of the watershed.

2.2.2 Appraisal of soil

Based on pH, organic carbon, NPK content, bulk density and available water holding capacity, the soils of the transect were classified as good, marginally good, marginally poor, low and very low (Table 3). In general soil quality was good to marginally good in northern and western part of the transect and poor in western part of the transect (Fig. 6). This may be due to the deposit of humus coming from top forest area. The bulk density and SHC were moderate in the northern and central part of the transect, whereas it is low in the eastern part (location 14,22, 16) and certain pockets of the central and southern part (location 8, 13) and poor in water retention capacity and not suitable for heavy duty crop. This information was used while siting of the water harvesting structures so that the water is utilized effectively and efficiently.

Table 3. Soil quality classification and distribution of soils under various classes

Soil quality class	Soil quality indicators and class values				
	pH	Organic carbon (%)	Bray's P2 - P (mg kg-1)	1N NH4OAc-K (mg kg-1)	Soil numbers (location wise)
I , Good	@ 6.00->6.50	0.50 - 0.75	5.30 - 10.00	3.50 - 5.00	1,2, 10, 11
IIa, Marginally good	6.00 - 6.50	0.40 - 0.61	3.00 - 6.50	2.00 - 6.00	3, 5, 6,12,15,23
IIb, Marginally poor	6.00 - 6.50	0.25 - 0.40	2.50 - 5.00	2.00 - 6.00	4, 7, 9, 17,20
III, Low	< 6.50	0.20 - 0.35	2.00 - 4.00	2.00 - 5.00	13, 19, 21
IV, Very low	6.00 - 6.50	0.10 - 0.40	0.30 - 2.00	1.50 - 5.00	8, 14, 16, 18, 22

2.3 Socio Economic Resources

A sample survey of 40 farmers was carried out to assess the base socio economic conditions of the village. The survey was done by questionnaire method (personal interviews). It was found that the village is a typical poor village of the drought prone area. The socio economic status in pre project phase can be summarized as below:

- 80% of population is engaged in agriculture
- 89% of the farmers are small or marginal

- The cropping intensity is just 108%
- 23% of able bodied adults migrate seasonally for livelihood
- Average productivity of Kharif paddy is 1.1 t/ha
- Net average crop income is Rs 3695/- per ha
- Only 3% of farmers owned a tank or well as source of irrigation
- Almost all the farmers cited lack of irrigation for not going for second crop in Rabi

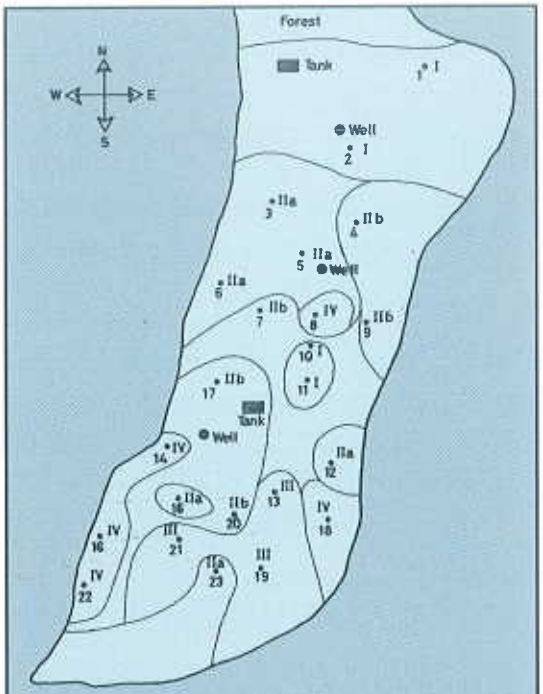


Fig. 6 : Soil quality appraisal and location of developed water resources in the watershed at Dumuria

2.4 Participatory Rural Appraisal (PRA)

Understanding the environment, present situation, mode of resource utilization and identification of existing farming systems forms the first step in the process of strategic planning. Various PRA techniques such as review of secondary data, resource mapping, transect mapping, venn diagram , agro-climatic mapping, ranking and scoring etc. have been used to elicit information on land, water, soil type, cropping pattern, water management, productivity. Analysis of the data was made with reference to secondary data for the block. Background information of the block such as socio-economic features, demography, land utilization, agro-climatic information, crop statistics, livestock information, input supply system and marketing infrastructure were analyzed.

Table 4. Land utilization pattern of Patna block

Land use	Area, hectare	Per cent of area
Net sown area	18422	43.85
Forest area	5125	12.20
Pastures and grazing lands	2081	4.95
Cultivable waste	872	2.10
Land put to non agricultural uses	3398	8.08
Barren and uncultivable land	1808	4.30
Current fallows	7314	17.41
Other fallows	2489	5.93
Miscellaneous tree crops and groves not included in the net sown area	498	1.18

Source: Keonjhar district profile, Govt. of Orissa

Table 5. Socio economic features of Patna block

Category	Percentage
Scheduled caste	7.13
Scheduled tribe	51.68
Male	49.54
Female	50.45
Total workers	479
Main workers	35.03
Percent of different occupation among workers	
Cultivators	60.15
Agricultural labourers	24.89
Live stock, forestry and fishery	0.11
Trade	2.43
Manufacturing, servicing and repair	3.76
Others	8.66

Source: Keonjhar district profile, Govt. of Orissa

The technological gaps were identified with reasons for such gaps through interview and matrix ranking. The problems of the village were assessed and prioritized by using Rank Based Quotient (RBQ). PRA tools like time trend analysis, seasonal calendar, and mobility map were used for setting the goals and objectives.

2.4.1 Basic information

The study area is located in Dumuria village of Patna block, which is situated in the eastern side of the rainfed district of Keonjhar, Orissa. It comes under the agro-climatic region No.12, i.e., Eastern plateau and hill region. The land use pattern and socio economic features at block level are given in Table 4 and 5.

2.4.2 Natural resources and cropping system of study area (Block basis)

Rice was the main crop grown in 84.1% of gross cropped area with the average yield of 1.12t/ha in Patna block. Maize, horse gram, black gram, mustard, groundnut, green gram, and sesamum are the other crops grown in 1.85%, 1.36%, 0.92%, 0.52%, 0.21%, 0.176%, and 0.093% of gross cropped area with the yield level of 5.71, 1.48, 1.66, 1.25, 5.37, 1.77, and 1.13 q/ha respectively. Vegetables were grown in limited pockets or as kitchen garden. The cropping intensity is around 100 per cent. Use of fertilizer was limited to few farmers and green manuring was not common. Cattle were indigenous types. There were no water resources available for irrigation except small ponds, which were mainly used for domestic purpose. Water table fluctuates between two to five meter, but due to the presence of hard rock, tube well is not feasible

Three types of land viz., up, medium and low lands were found and the soil type ranges from clay loam to sandy clay loam. *Terminalia arjuna, diospyros melanoxylon, sygygium cumini,*

Table 6. Matrix ranking for crop technologies

Criteria	K1	K2	K3	K4	Total score	Rank
Rice variety *Annapurna*	13	24	18	21	76	III
Lalat	**13**	**16**	**19**	**13**	**61**	**IV**
Swarna	**31**	**34**	**23**	**30**	**118**	**I**
Sprayer	14	19	4	16	53	VI
Fertilizer	20	30	27	24	101	II
Tractor	13	18	12	8	51	VII
Vegetable cultivation	8	24	10	14	56	V

dalbergia sissoo, shorea robusta and *butea monosperma* and grass species viz., *digitaria sp., choloris barbata, cynodan dactylon, bambusa sp.* and *dactyloptenium agep*ticum were the available vegetation in the watershed. Fruit crops viz., banana, papaya, guava, mango were grown around the residential areas. There was no orchard or plantation garden in the study area.

2.4.3 Technological behaviour

Technology map and matrix ranking analysis shows that improved paddy varieties viz., *annapurna, lalat* and *swarna* were the adopted technologies for their high yield and shorter duration (Table 6). But most of the farmers were growing local varieties due to fear of possible crop failure resulting from frequent drought, dry spell and early withdrawal of monsoon. Use of fertilizer and vegetable cultivation in limited area, use of tractor, sprayer(hiring basis) were other improved technologies adopted in the village for their easy operation and high yield.

Ploughing by wooden plough, leveling by *mai,* terracing, use of farm yard manure, *beushening,* cow dung spray against insect pest, use of *khothi*(made of wood, small bamboo pieces) for storage were some of the indigenous technologies found in the village.

2.4.4 Problems and action plan

Problems:

On the basis of RBQ value it was found that lack of irrigation facilities was the top most problem (Table 7). Marketing of paddy, unemployment during post monsoon period, non-availability of seeds, soil degradation, elephant menace, and pest attack followed it. It is evi-

Table 7. Agricultural problems

Problems	1	2	3	4	5	6	7	RBQ	Rank
Non availability of seed	-	-	3	5	2	-	-	58.56	IV
Soil degradation	-	-	1	2	4	-	2	38.55	V
Pest problem				1	1	6	2	27.10	VII
Lack of irrigation	8	2	-	-	-	-	-	81.70	I
Unemployment	1	2	5	1	1	-	-	68.60	III
Marketing	1	6	1	-	-	2	-	68.61	II
Elephant menace	-	-	-	1	2	2	6	28.56	VI

dent from the table that lack of irrigation has been cited first problem by 87% of the respondents, and therefore this was given top priority in the project.

Action plan: Based on the problems, the brief action plan prepared is as follows:

- Development of water harvesting structures(ponds, shallow open well, embankment)
- Multiple uses of ponds(vegetable, fruit trees on embankment and fish, duckery in the pond)
- Commercial cultivation of potato
- Extensive cultivation of vegetables
- Cross bred milch cows
- Arrangement for supply of inputs and marketing

The action plan if executed properly can solve some of the problems listed in table 7. As problems like unemployment is related to mono-cropping, creation of irrigation potential will solve this problem upto some extent.

2.4.5 Other related information

Seasonal analysis shows that animal diseases during May to July, labour migration between January to May, Pest and diseases of crops during August-September were the important seasonal problems. Mobility map shows farmers had to go Patna (8km) for purchasing agricultural inputs, marketing, and registration and to Keonjar (60km) or Karanjia (40 km) for the purchase of potato seeds or seeds of hybrid varieties. Time line shows that the use of high yielding rice varieties started during the year 1980 and tractor during 1990. Electricity, mould board plough, bank came during the year 1977, 1985 and 1984, respectively. Livelihood analysis shows that 75 per cent of income was coming from agriculture and allied activities, 20 per cent from labour and 5 per cent from other sources. Forty per cent of income was going to food and 20 per cent to agricultural investment.

3.0 WATER RESOURCE DEVELOPMENT

The study area drains in Baitarani river. The topography is rolling with overland slope of cultivated areas ranging from 2 to 5%. The crop lands are terraced. To assess the replicability of the technology, the system was evaluated in two transects. The locations of the tanks and wells were decided on the basis of the hydrological and social acceptability of the sites. The social acceptability was discussed with the farmers and panchayat members (Plate 1). The rain water management system was designed on the basis of the design parameters developed by Srivastava (2001), as presented in Table 1.

Photo 1 : Farmers and panchayat members for deciding the sites of wells and tanks

3.1 Design of the system

In total, six tanks and five wells were constructed in two transects (Plate 2 & 3). The schematic diagrams of this system are shown in Figure 7. The details of the tanks are presented in Table 8. The irrigation potential has been estimated on the basis of the assumption that the rabi crop will be heavy duty crops like potato and other vegetables. If low duty crops like pulses and oilseeds are grown in rabi, the irrigation potential in rabi will be equal to that of irrigation potential in kharif, and the total irrigated area will be even more.

Photo 2 : Construction of tank in progress (No machines were used for earthwork to increase the employment generation)

Photo 3 : Construction of open dugwell in progress

Table 8: Details of tanks and wells constructed

Water harvesting structure	Capacity m^3	Cost of the System ha	Command area, ha	Kharif irrigation potential ha	Rabi irrigation potential ha	Summer irrigation potential ha	Total irrigation potential ha
Transect I							
Tank No.1 and well No. 1	3100	1.34	3.0	3.0	2.0	1.0	6.0
Tank No. 2 (embank-ment) and well no. 2	25000	1.63	8.0	8.0	6.0	1.0	15.0
Tank no.3 and well no. 3	4400	1.52	3.0	3.0	2.0	1.0	6.0
Transect II							
Tank No. 1	3100	0.57	1.5	1.5	1.0	-	2.5
Tank No. 2 and well no.2	4800	1.67	4.0	4.0	3.0	1.0	8.0
Tank No. 3 and well No. 3	4000	1.90	3.5	3.5	2.5	1.0	7.0
Total		8.63	23.0	23.0	16.5	5.0	44.5
Total cost of the system = Rs 8.63 lac, Cost per ha of irrigated area = Rs 19,393/-							

3.2 Hydrology of the system

The hydrology of the system was studied by monitoring the water levels of the tanks to estimate the water balance of the ponds and pumping from tanks. The effect of seepage from the tanks on downstream terraces was measured by monitoring the water level in the fields in

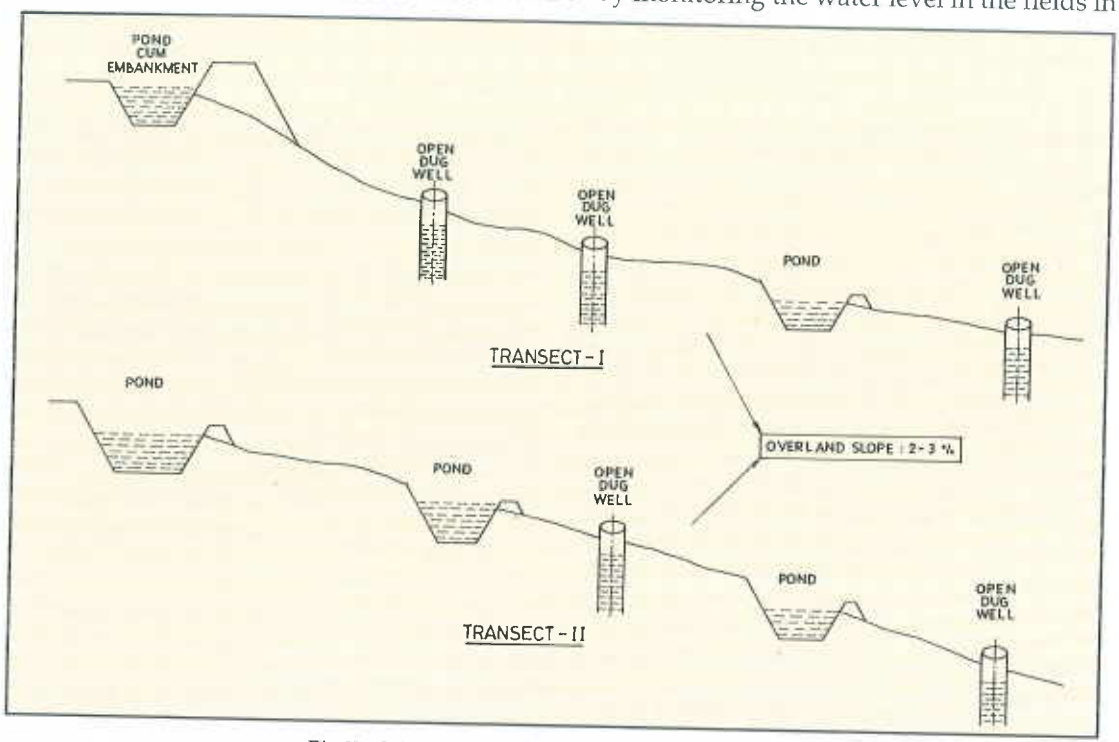


Fig 7 : Schematic diagram of tank cum well system

post monsoon season both along and across the slope. The water level data of one pond for both years 2001-02 and 2002-03 are presented in Figure 8. It is evident from the figure that in 2001-02, the tank got filled early in July itself due to high rainfall(about 95% above normal) in July (Plate 4) . The water level remained at almost full level for monsoon period and started declining after monsoon. In 2002-03(a drought year), the water was collected in the tanks from rains in early part of June. Later there was a 40 days dry spell from 17th June to 25th July which created havoc with the rainfed crops (Plate 5 a & b). However, with the water available in the tanks (Plate 6 a) as well as in the open dug wells (Plate 6 b), the farmers in the command area of these tanks could complete the transplanting as well as *beushening* of direct sown paddy

Photo 4 : Tanks full to the brink in July, 2002

Photo 5(a) : Dithering paddy crop in July, 2002

Photo 5(b) : Drought affected paddy crop in July, 2002 (The effect is vissible by the size of cracks in the field)

(Plate 7). Rains filled up the tanks again in August, which is evident from the figure. Thus, the system mitigated the effects of the drought which was also reflected on the yield levels.

Figure 9 presents the water level in the paddy fields. It is evident that the rice fields did not face any moisture stress in both the years even after cessation of monsoon, which was in the last week of September, while the crop outside the command area of the tanks suffered moisture stress in the reproductive phase. This was due to the seepage water from the tanks. Figure 10 presents the depth of water in the fields downstream the embankment on 18th October 2001. It is evident from the figure that the seepage water provided the water availability in the fields and it depended upon location of the field from valley line as well as the distance from the embankment. It was maximum near the valley line and reduced on both sides. Also as expected, the water levels reduced with the distance from the embankment. This trend continued upto January. This gave an indication that these areas were more suitable for long duration paddy (July-December) with single crop instead of trying another crop in post monsoon season after harvest of medium duration rice (July-October) in monsoon season as the fields were not ready for any tillage operation. Thus the system converted the uplands which earlier

Photo 6(a) : Water in the tank on 14th July, 2002 (Sufficient to save rice crop from drought)

Photo 6(b) : Water level in open dugwell in July, 2002 (Sufficient water to save rice crop from drought)

Photo 7 : Bushening of direct sown rice with pond water (waterflow from the tank is visible with pond embankment in background)

were not able to fully support even 100 days duration rice crop to become suitable for a paddy crop of 160-180 days duration giving yield of about 5 t/ha.

Table 9 gives the water balance of the tanks and wells for one transect in 2002-03. It is evident from the table that the system stored runoff equal to about 150% of the storage capacity. Out of stored runoff, about 37.1% is lost as seepage, about 14.6% lost as evaporation and 43.1% utilized for irrigation. Rest 8.2% remained in the tank for pisciculture, duckery and other domestic uses. Without open dug wells, the ratio of water yield and storage capacity is 0.65 which rises to 0.87 with open dugwells as the water lost as seepage is reharvested back through open dug wells. The ratio is lower as the farmers did not go for full utilization of the potential both in kharif as well as in rabi as evident from low amount of water utilized during kharif. Thus, in short, it can be said that the system mitigated the effect of the drought, changed the hydrology of downstream paddy terraces from uplands to suitable for long duration rice, recharged the ground water and provided sufficient water to the crops.

Fig. 8 Comparison of water levels in a pond in years 2001-02 and 2002-03

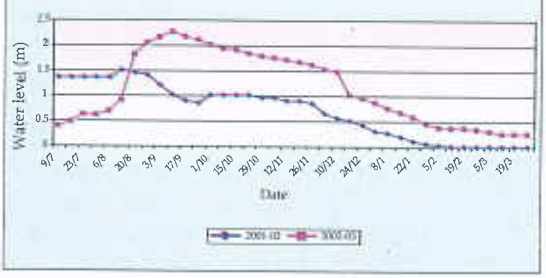
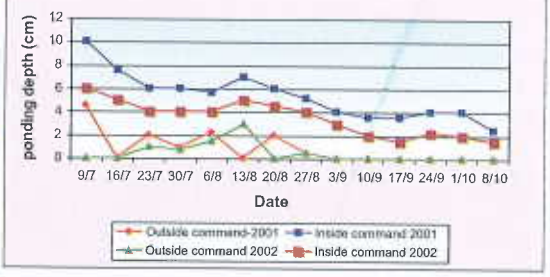


Fig.9 Comparison of water level in the fields of command area and outside command area



3.3 Hydraulics of open dug wells

In order to study the hydraulics of the open wells, the water levels in the wells were monitored. The farmers did not utilize the water fully in first year due to their inhibitions of growing post monsoon crop, but in second year it increased substantially but still lower than the potential. For evaluation of well yield, pumping tests were carried out in wells during different months to see the effect of the season on the well yield. As these wells are located in hard rock areas without any defined aquifer, the traditional well testing method could not be employed. Therefore the water was pumped from the well with pump being at ground till the

water level went below the suction limit. During this period, the water level and discharge were recorded. After cessation of pumping, periodic recording of water level in the well was

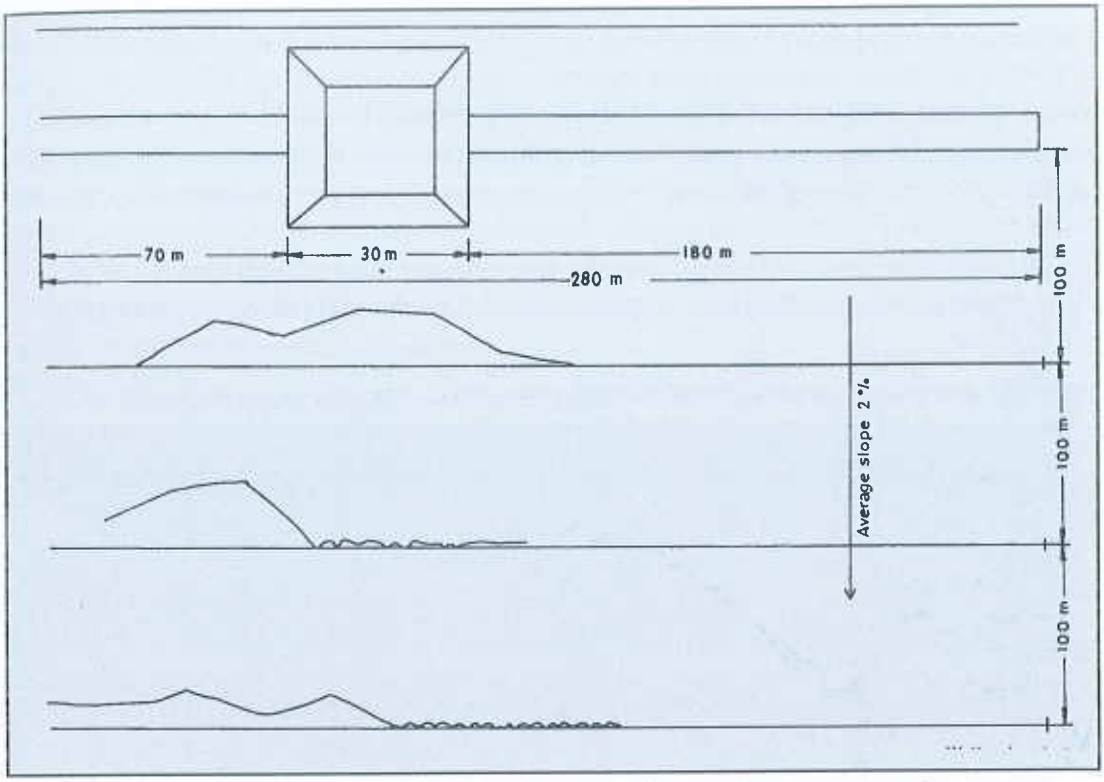


Fig. 10 : Depth of water in the fields below the embankment, Dumuria, Keonjhar on 18th October, 2001.

Table 9: Water balance of tank and well system in a transect II (2002-03)

Tank No.	Tank capacity	Catchm. area, ha	Runoff received,	Irrigation Water pumped, m^3		Seepage loss, m^3	Evapo-ration loss, m^3	Water pumped from well, m^3	
				Kharif	Rabi			Kharif	Rabi
1	3100	6	5079	340	1774	2316	677	No well	
2	4680	10	5722	675	1468	2257	1022	352	285
3	4000	10	6867	1026	2340	1987	874	504	1450
Total	11780		17668	2041	5582	6560	2573	856	1635
			17668	7623	(43.1%)*	6560	2573	2491	(14.1%)*
						(37.1%)*	(14.6%)*		
Total water utilized for irrigation = 10114 m^3 (57.24%); Water yield / tank capacity ratio=0.86									
* The percentage has been calculated from the amount of runoff harvested. The amount of runoff received is more than tank capacity as some amount was used for irrigation and rest lost as seepage and evaporation									

done till it recouped back to its original level. The well with a recharge structure at the up-stream side was compared with a well without any recharge structure.

The pumping data for the well located without a recharge structure (Well no. 1) and one with recharge structure (well no. 2) of transect II in the month of March are presented in Table 10 & 11. It is evident from the Tables that the well having no recharge structure is able to provide just about 20 cu m of water in one pumping session while the well with recharge structure provides about 96 cu m of water in 2.5 hours after which the water level went below suction limit. Thus the well without recharge structure cannot provide sufficient water required for irrigation. Out of 96 cu m water pumped, 79.97% of water came from stored water and 20.03 % came from recharge during the pumping period. This indicates the need of a larger diameter well, i.e., about 6 m diameter. A small diameter well will not serve the purpose of irrigation.

Table 10 : Pumping data of well with recharge structure (5.2m dia and 8 m depth)

Sl. No.	Cumulative pumping, minutes	Time between two readings, hours	Amount of water pumped, m^3	Amount of water pumped from stored water m^3	Amount of water pumped from recharged water, m^3	Recharge rate m^3/hour
1	0					
2	65	1.08	44.85	35.93	8.92	8.26
3	110	0.75	28.35	22.67	5.68	7.57
4	150	0.67	22.8	18.18	4.62	6.89
Total		2.50	96.00	76.78 (79.97%)	19.22 (20.03%)	7.68

Table 11 : Pumping data of well away from the drainage line with no recharge structure upstream (5.2m dia and 8 m depth)

Sl. No.	Cumulative pumping, minutes	Time between two readings, hours	Amount of water pumped, m^3	Amount of water pumped from stored water, m^3	Amount of water pumped from recharged water, m^3	Recharge rate m^3/hour
1	0					
2	11	0.183	6.258	6.1587	0.1	0.546
3	21	0.166	5.0796	4.8845	0.1951	0.1753
4	36	0.25	7.65	7.0088	0.642	2.568
Total		0.599	18.987	18.051(95.07%)	0.937(4.93%)	1.429

Figure 11 and 12 present the recuperation process of these two wells after the pumping ended. It is again evident from figures that the well in the recharge zone of pond recuperated 50% of the pumped water within 25 hours. The recharge rate was faster in initial period but declined with time and then stabilized. The condition was totally different in well without recharge structure. Here the recuperation was too slow and thus it can be said that once pumped,

it will be able to provide water only after a very long time. The time of 50% recoupment as well as the constant rate of recharge for recoupment varied in different months as evident from Figure 13. It is on expected lines as the time was least in monsoon months when the water table was highest and then increased. Similarly the recharge rate was highest during monsoon months and reduced with time. There was no permanent lowering of the water table after pumping and after recuperation it was at its normal level for that season. Table 12 presents the summary of the pumping tests of these two wells. It is evident from these figures and tables that an open dug well can function as irrigation source only if it is supported by a recharge structure up-stream.

It is evident from hydrological and hydraulic studies of the system that the tank cum well system is able to provide sufficient water with a quite fair degree of reliability for irrigating the monsoon, post monsoon and summer crops.

Table 12. Comparison of two wells with and without upstream recharge structure in March

Sl. No.	Item	Well without recharge structure	Well with recharge structure
1.	Water available in one pumping session	19 cu m	96 cu m
2.	Time of pumping	36 min.	150 min.
3.	50% recuperation period	109 hours	25 hours
4.	Average of recharge in recuperation	0.215 cu m/hour	1.15 cu m/hour
5.	Constant rate of recharge in recuperation	0.05 cu m/ hour	0.78 cum/hour

Fig. 11 Recharge recuperation curve of well with recharge structure

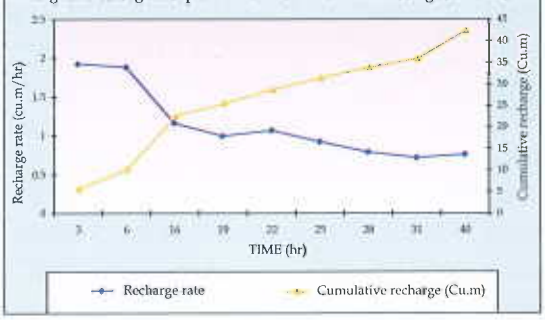


Fig. 12 Recharge recuperation curve of well without recharge structure

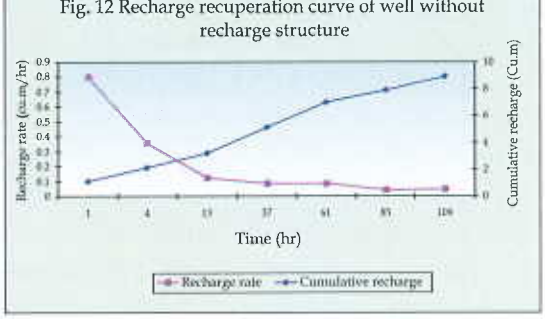
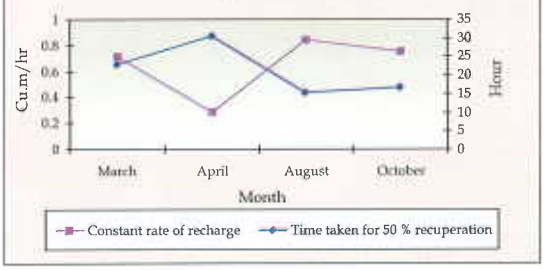


Fig.13 Time for 50% recoupment and the constant rate of recharge for recoupment



4.0 IMPACT OF WATER RESOURCES ON PRODUCTIVITY AND CROPPING INTENSITY

For evaluating the impact of the created water resources on productivity, production and employment generation, the farmers were persuaded to change to improved cropping pattern and package of practices in both kharif as well as rabi. The availability of water in the wells and support from the project in form of seed availability prompted farmers to go for vegetable cultivation in summer also. For multiple use of water, the farmers were persuaded to plant papaya on embankments. For effective utilization of the embankment, farmers planted vegetables as well as red gram, which gave them good returns.

4.1 Monsoon season crop

In monsoon season, the farmers were advised to go for three types of paddy varieties; short duration, medium duration and long duration. The short duration varieties were planted in upland areas of the command, the medium duration on medium lands and long duration varieties in fields just below the tanks. While the first two type of fields were put under second crop, no second crop was taken in third type of fields as the water remained there up to January. To demonstrate the impact of the different improved package of practices, five treatments (four in the command area and one outside the command area) were imposed: (i) farmers' practice (direct sown, no fertilizer, local variety) outside command; (ii) farmer's practice (direct sown, no fertilizer, local variety) inside command; (iii) local variety, direct sown with recommended fertilizer; (iv) local variety, transplanted with recommended fertilizer; and (v) Improved package (high yielding varieties, transplanted with recommended dose of fertilizer). The effect of the water resource development was measured in comparison to the crop performance outside the command where it was local variety with no fertilizer (first treatment). A fertilizer dose of 60:30:30 NPK was applied in iii, iv, and v treatment. The inputs were arranged by the project on exchange basis for seed, i.e., the improved seed were given in exchange of same quantity of paddy grain, and partial payment basis for the fertilizer, i.e., the farmers paid about half of the price of the fertilizer. The farmers who could not afford to pay for fertilizer due to poverty were given free of cost. The data under different package of practices were recorded in the randomized block design manner with three replications for statistical analysis. Adjacent farmers' fields were selected as replications. Paddy was sown in 1st week of June in the case of direct sown treatments. Table 13 presents the rice yields under different package of practices for both years, i.e., 2001-02 and 2002-03. It is evident that in drought year 2002, mere direct sowing of local variety inside the command itself increased yield to the tune of 65% compared to the direct seeded local variety out side the command. This was due the continuous water availability due to seepage from water harvesting structures as shown earlier . Maximum grain yield was obtained by the adoption of complete improved package with 65.2% and 138% per cent increase in yield compared with the adoption of farmers' practices in the year 2001 and 2002, respectively. It revealed that assured water supply through water harvesting structures and other improved packages are necessary to exploit the full potential of high yielding variety in rainfed areas (Plate 8), which faces brief

drought during the critical period. The results are in line reported by Pandey et al.,(2000); Shiv Mangal Prasad et al.(2001) and Singh,(1995).

Photo 8 : Luxurious rice crop in the command area of pond in drought year 2002 (pond in background)

It is evident that different levels of adoption of package of practices are giving different returns. This can form a guide for persuading farmers to adopt different levels of technology compatible to their economic conditions. The results also show that the crop production programme should be initiated hand to hand along with water resource development in watershed management programme to utilize full potential of the water resources. For achieving the full potential of the water resources, total package of practices, viz., high yielding variety, transplanting and fertilizer application should be adopted, which gives an

Table 13 Impact of irrigation and other improved cultivation practices on rice yield

Farming practice	Grain yield, t/ha		Straw yield, t/ha		Additional yield, t/ha		Additional input cost Rs per ha*	Additional gross income per ha, Rs		Command area, ha	
	2001	2002	2001	2002	2001	2002	01&02	2001	2002	2001	2002
Local variety, direct sowing, no fertilizer outside command	2.13	1.52	2.92	1.58	-	-	—	-	-	NA	NA
Local variety, direct sowing, no fertilizer inside command	2.30	2.30	3.01	2.61	0.17	0.78	—	940	4930	5	5
Local variety, direct sown with recommended fertilizer inside command	2.68	2.80	3.43	2.90	0.55	1.28	675	3260	7720	3	3
Local variety, transplanted, fertilizer, inside command	3.05	2.82	3.64	3.25	0.92	1.30	675	5320	8170	3	5
High yielding variety, transplanting, fertilizer, inside command	3.52	3.62	4.27	4.20	1.39	2.10	925	8300	13120	7	10

* Additional cost includes cost of fertilizer and difference between cost of local variety and improved variety. It does not include cost of transplanting, which is family labour and has nil opportunity cost.

increase of 80 % in yield, more than 400% increase in net return and about 50 % increase in return per rupee invested. Where adoption of full potential is not possible, the farmers should be encouraged to go for adoption of high yielding variety, fertilization and transplanting in that order to get more benefits.

4.2 Post monsoon crops

In the post monsoon season, the farmers were persuaded to go for rabi crops viz., paddy, potato (Plate 9), tomato, field pea (Plate 10), gram (Plate 11) and wheat as second crop and summer vegetables viz., ladies finger, brinjal, ridge gourd, chillies and bitter gourd as third crop. Providing inputs from the project on cost sharing basis facilitated the effort. Area under second and third crops increased in the second year as farmers of command area were encouraged by the availability of water in pond and shallow open well and crop yields. The irrigation was done by pumping water from the tanks and wells (Plate 12) Vegetable cultivation like Pumpkin was taken up alongwith papaya on the embankment of ponds. One farmer even put pigeonpea (Plate 13) on embankment and got about 20 kg yield. Fish species viz., Catla catla(30%), Labeo rohita(30%) and Cirrhinus mrigala(40%) were stocked at the rate of 10,000/ ha in the ponds along with ducks. The yield of the crops and other multiple uses of water, i.e., fishery, ducks raising (Plate 14), horticulture on embankment of the tanks were monitored.

Table 14 presents the details of post monsoon crops undertaken by the farmers in both the years. It is evident from the table that the farmers increased the area in second year under the

Photo 9 : Potato crop in command area in rabi, 2002

Photo 10 : Pea crop in command area

Photo 11 : Gram crop in command area

Photo 12 : Irrigation of Potato by pumped water

Photo 13 : Pigeon pea on embankment of pond

Photo 14 : Duck rearing in the pond for multiple use of water

second and third crop. This happened after the farmers saw the water remaining in the tank and wells in the first year which removed their doubts regarding the dependability of the system in providing the water. Thus, a rainfed farmer will shift to irrigated agriculture only if he is convinced about the dependability of the resource. A properly designed tank cum well system provides that dependability which is evident from the increase in cropping intensity

Table 14- Area and productivity of different rabi and summer crops in the command

Crops	Area, ha		Productivity, t/ha
	2001-02	2002-03	
Kharif			
Rice	18	23	2.3-3.62*
Rabi			
Rice	0.8	0.1	3.2
Potato	0.33	2.5	20**
Tomato	0.03	0.75	15
Pea	0.5	-	0.6
Wheat	0.5	-	3.1
Brinjal	-	0.3	15
Cucurbits	-	0.2	10
Chillies	-	0.3	5.2
Summer			
Ladiesfinger	-	0.5	3.2
cucurbits	-	0.7	12.5
Other vegetables	-	0.5	
Maize	-	0.3	3.1
Cropping intensity	112 %	126 %	

* Rice yield obtained from different cultivation practices as per table 2

** In second year potato yields were between 10-12t/ha due to non-availability of certified seed.

from 100% in pre project period to 126% in second year. It is expected to increase further in future once the farmers are in position to invest more on seed and fertilizer in the post monsoon crops. Another factor, which is evident, is reduction in area of post monsoon rice, which reduced from 0.8 ha to just 0.1 ha. In the first year, the farmers being the rice eater, the first preference was summer rice, but next year, when they saw the benefits in other crops, they shifted to non rice crops with emphasis on vegetables. The farmers also went for multiple use of crops by raising ducks, pisciculture, and planting of horticultural crops like papaya, pumpkin and even pigeon pea. The pigeon pea although very small quantity provided an additional intake of protein for these tribal farmers.

5.0 ECONOMIC ANALYSIS

The economic analysis was done on the basis of incremental benefits achieved due to water resource development. For this the additional return for monsoon season crop, i.e., rice were estimated by calculating the additional gross return and additional expenditure for achieving higher yield and utilizing water. For post monsoon crops, the net return from the crop activities were taken as additional returns as there was no crop before development of water resources. Table 15 presents the abstract of economic analysis of the system in the first two years of its existence. It is evident from the table that the system performed quite well economically. Percent of investment recovered in two years was 50.80% by adoption of improved package of practices, taking up additional cropping and multiple use of tank. In second year, 43.5% farmers utilized full potential in monsoon season, 20% in post monsoon season and 40% in summer season.

The internal rate of return (IRR) was estimated on this actual usage of potential. To study the effect of extent of utilization on IRR, five situations of potential utilization were studied. These five situations are on the basis of per cent potential utilization during different seasons. They are 43.5,20,40(present utilization), 50,25,40; 75,25,40; 75,50, 40; 100, 50, 80. The first figure represent per cent utilization in monsoon season, second represent per cent utilization in post monsoon season and third represents per cent utilization in summer season. For estimation of IRR, two conditions were envisaged. In first condition, it was assumed that the annual benefits from crop cultivation will increase at the rate of 5% and for the second condition, it would increase at the rate of 10%. Fig. 14 presents the internal rate of return for different percentage level of adoption of package of practices by the farmers. It is evident from the figure that at 5% increment rate, the IRR is 13.4% at the present level of adoption of technology. Thus even at minimum level, the IRR is at desired level. Thus for these small water resources,

Fig. 14: IRR & B-C ratio for different levels of adoption of package of practices

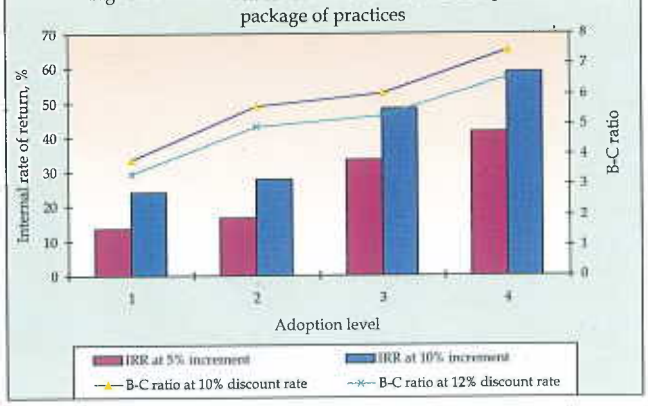


Table 15. Abstract of economic analysis of tank system for crop year 2001-02 and 2002-03

Sl. No.	Item	Amount in Rs.	
		2001-02	2002-03
1	Total gross additional return in kharif compared to out side command area which includes labour cost which is family labour	88,540	2,19,860
2	Total additional inputs used in command during kharif including pumping cost (seed cost Rs 1750/- and Rs 2500/- ; fertilizer cost Rs 8750 and Rs 12000/- ; pumping cost Rs 0 and Rs 5000/- in first and second year respectively)	10,500	19,500
3	Total net return in kharif including labour cost which is family labour	78,040	2,00,360
4	Gross return from different rabi crops	31,124	1,65,700
5	Cost of inputs in rabi crops including pumping cost (seed cost Rs 4405/- and Rs 25440/- ; fertilizer cost Rs 1540 and Rs 5120/- ; pumping cost Rs 1335 and Rs 6000/- in first and second year respectively)	7,208	36,550
6	Net return from rabi crops	23,916	1,29,150
7	Net return from multiple use(Fish, eggs and vegetable on the embankment of ponds)	3,500	3,500
8	Total net returns from kharif and rabi (3+6+7)	1,05,456	3,33,010
9	Total expenditure on tanks and wells	8,63,000	
10	Percent of investment recovered in two years		50.80%

even partial utilization gives a better return in comparison to major and medium irrigation systems where the large gap between potential and utilization makes the system uneconomical. Thus, the system is very much economical. To further assess the economics of the system, the benefit cost ratio of the system was estimated by discounted net worth method. At a discount rate of 10% which is the prevalent bank lending rate, the benefit cost ratio at present level of adoption of the package of practices has been found as 3.63 which increases with increase in the level of the adoption of the crop production technology as shown in Figure 14. It is therefore evident that the system is economically sound. Although this analysis do not include the cost of labour as there is only family labour involved and it has no opportunity cost at present, but the higher values of IRR and B-C ratio shows that the system will remain a viable financial proposition after accounting the family labour cost. However given the poor resource position of the farmers, the farmers cannot afford to build up these systems on their own and the state has to help in this regard.

6.0 INSTITUTIONAL MECHANISM FOR MANAGEMENT OF THE SYSTEM

The project is to end by December, 2003, and the system has to be handed over to the farmers for its management and maintenance. To achieve this, a water resource user association has been formed involving all the stakeholders (Plate 15). The association is in the process of getting it registered (Appendix I). Two 3.5 hp portable irrigation pumps have been given to the association which are given on hire to members as well as non members on different rates. While the rate for members is Rs 10 per hour, it is Rs 25 per hour for non members. A bank account has been opened by the association and it is depositing the money accrued from membership as well as from the hire charges of the pump provided under the project. This money will be used as corpus fund for future purchases of the pumps and maintenance of the system. The interaction with the farmers has revealed that the farmers' attitude towards the water resource development is very positive. However, the adoption of the practices is constrained by availability of inputs, poaching of produce, problems in guarding of the fields from grazing and wild animals. The elephant menace is a major constraint towards adoption of second crop.

Photo 15 : Meeting of water resource users association

7.0 EXTENSION ACTIVITIES AND VISITS

The farmers of the area had no knowledge of the production practices of the post monsoon crops. To bridge this gap, training programme was organized for cultivation practices of rabi crops. A Kisan Diwas was organized on 30th December, 2002 to demonstrate the system to the farmers (Plate 16). About 400 farmers as well as scientists of different ICAR institutes, state government officials and NGOs attended this.

Dr. J.S. Samra, DDG (NRM) visited the project area on 14th march, 2003 to have an on the spot assessment of the system. He was very happy to see the system and suggested its evaluation at other places (Plate 17 & 18).

Photo 16 : Kisan Divas being celebrated at project site

Photo 17 : Dr J.S. Samra, DDG (NRM), ICAR on visit to project site in March, 2003.

Photo 18 : Dr J.S. Samra, DDG (NRM), ICAR discussing with farmers (harvested potato crop in background)

8.0 EPILOGUE

The study indicates that the rain water management through tank and wells has potential of creating micro level water resources for providing reliable irrigation. This irrigation system can be created and managed by locally available skills. The investment on this irrigation system can be recovered back within few years. The internal rate of return of such systems is more than desired level of even at the present level of utilization of water by improved cropping practices. The system has potential of being another tier of water resource development in addition to major, medium and minor irrigation systems. Although it looks simple ,its design, layout, operation, and maintenance requires engineering skill, initial investment, participation of beneficiaries etc. Thus, its implementation will require dedication and special attention.

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APPENDIX

PROCEEDINGS OF THE MEETING (Page-1)

HELD ON Dt 7.8.2002. PLACE - DUMURIA.

[illegible]

1. [illegible] Tranject 1

2.

3. [illegible] Tranject 1

4. [illegible] Tranject 2.

5. [illegible] Tranject 2.

~~[illegible] Tranject 2~~

[illegible] Tranject - 2

6.

7. Hari har Mahanta. Tranject 2.

8. Bhagaban Naik Tranject 1

9. [illegible] Tranject 1

10. Kailash Chandra Naik Tranject 1

11. Binoda Naik

12. [illegible] Tranject 1

13. Ranjit Mahanta. Tranject 1

14. [illegible] Tranject 2

15. Kartik Chandra Mahanta. Tr - 2

16. [illegible] Tranject 1

17. Jayadish Naik Tr - II

[27]

୮।
୯। ସମିତିର ଉପ ନିୟମାବଳୀ (Bye Laws)
୧୦। ପ୍ରସ୍ତୁତ କରାଯାଇ [illegible]
୧୧। [illegible] କରାଗଲା । ସମିତିକୁ
୧୨। ରେଜିଷ୍ଟ୍ରି କରିବା ପାଇଁ ଜିଲ୍ଲା ସମବାୟ
[illegible]

PTO →

ଏହି ସମିତିର ପରିଚାଳନା କମିଟି ହେଲେ -

ନାମ ଦସ୍ତଖତ

୧- ଶ୍ରୀ ହରିହର ମହାନ୍ତ, ସଭାପତି - Horihar Mahanta
୨- ଶ୍ରୀ କୈଳାସ ଚନ୍ଦ୍ର [illegible] - ଉପ ସଭାପତି - Kailashchandra [illegible]
୩- ଶ୍ରୀ ବ୍ରଜକିଶୋର ମହାନ୍ତ - ସମ୍ପାଦକ - Brajakishore Mohanta
୪- ଶ୍ରୀ [illegible] - ସଦସ୍ୟ - [illegible]

ଶେଷରେ ସଭାପତିଙ୍କୁ ଧନ୍ୟବାଦ ଦେଇ ସଭା ଶେଷ ହୋଇଥିଲା ।

Horihar Mahanta
ସଭାପତି

FORM OF MEMORANDOM FOR REGISTRATION OF SOCIETY

1.memorandum of.....Dumuria Water Users Association

2.Location of Registered office of the Society at.....Dumuria

P.O...Dumuria.....Block...Patna.....District-Keonjhar

3.Aims and Objectives of the Society:

a)Uniform distribution of water among the farmers as per their Landholdings
b)To keep unity and co operation among the farmers.
c)To build the moral life and character of the members of the Association as well as the village and maintain discipline in the village.
d) To organize all the members of the village for various developmental activities and for other social services.
e) To take proper steps for all round development of Agriculture in the village.
f) To utilize properly Govt.Grants and other funds of the Association.

4.Name and Address of the Governing Body.

Sl.No	Name and Address	Designation	Occupation	Signature
1.	Hariahar Mahanta Dumuria.	Chairman	Cultivation	Hariahar Mahanta
2.	Kailash Chandra Naik Dumuria	vice-Chairman	Cultivation	Kailash chandra naik
3.	Bhagia Das Dumuria.	Secretary	Cultivation	ଭାଗିଆ ଦାସ
4.	Braja Kishore Mohanta Dumuria.	Treasurer	Cultivation	Braja kishore Mahanta

Above Sign attested
Srivastava

Dr.R.C SRIVASTAVA
CCP: RRPS-4
Water Technology Centre for Eastern Region
Bhubaneswar

BYE -LAWS OF WTER USERS' ASSOCIATION

1. **NAME**

The name of the society shall be the Dumaria Water Users Association. It is registered as a society under the Societies Registration Act, 1860, bearing registration No. _____ dt._____. For all purposes, the society referred to hereunder shall be identified as the 'Association'.

2. **ADDRESS**

The registered office of the 'Association' is situated in the village Dumaria P.O. Dumaria Police Station Patna Tahasil Patna Block Patna District Keonjhar Orissa.

3. **AREA OF OPERATION**

The 'Association' will function having jurisdiction in the entire command of open shallow wells/ponds created by WTCER at Dumaria village.

4. **OBJECTS**

The main objects of the association shall be to:

i) Prepare O & M plans ~~for the supply of water and monitoring~~ of the same.

ii) Provide required talents, skills and management practices in the best interest of the farmers and undertake all reasonable steps to maintain the system transferred to the 'Association' efficiently and economically with active participation of the members of the 'Association' maintenance will include:

a) Silt clearance
b) Weed clearance
c) Repairs to structures
d) Environmental protection

iii) Educate the farmers/members and train them in preparing the fields suitably for receiving irrigation water, adoption of modern methods of irrigation to conserve water and attain high application efficiency.

iv) Educate farmers on irrigated agriculture, suitable crop varieties, growing times, crop combinations package of practices for optimal and efficient use of water for increasing agricultural production as well as productivity and profits of the farmers.

~~President~~ ~~Vice-President~~ Secretary Treasurer

Chairman Vice Chairman BHAGIA DAS (BRUKISHORE
(Mr. HARI MOHANTA) (MR. KAILASH NAYAK)

v) Prepare an annual report showing a) water utilized, b) area irrigated under different crops and c) a balance sheet of the amount of expenditure

vi) Make best use of natural precipitation and ground water.

vii) Resolve disputes in sharing of water by the individual farmers or group of farmers under the specific water resource

viii) Co-ordinate with all the concerned agencies/departments connected with water supply for improved irrigated agriculture.

ix) Raise funds for the Operation & Maintenance(O&M) fund by way of

a) Contribution from the members uniform rate per hectare of holding from all the users

b) Donations/Grants/Subsidies received from the Government or other welfare funds and Institutions.

c) Maintain accounts of the management cost and O&E costs separately.

5. MEMBERSHIP

i) All landowners, within the area of operation of the 'Association' will have the right to become members. All members will be the members of the General Body of the 'Association'. The membership fee maybe Rs.10 per member oras determined by the Association.

ii) Upon any land owner selling his land or absolutely conveying the same by way of gift under his will or otherwise the purchaser or donnie shall automatically become a member of the 'Association' A member of the 'Association' can authorize in writing any of his share coppers/holders to perform on his behalf for any of the functions of a member required.

6. SHARE

Every member owner, on whose land the water resources created, shall share the water with other members of association for their cultivation as per the requirement if any. However, the member owner can use the water resources(pond) for fish cultivation, Duckery. He/she also can cultivate the fruits, vegetables crops on the bunds of the pond. The fish, duckery, veg. Fruits will be the property of the owner, on whose land the resources was created. The embankment of water resources(check bund) created on the common land may be used for cultivating amount fruits crops by land less farmers, selected by he association.

President Vice-President Secretary Treasurer

Chairman Vice chairman

7. DISQUALIFICATION

A member who fails to pay his/her contribution to the association consecutively for a period of two seasons and defying association shall cease to be a member of the 'Association'. However, the membership may be restored on payment of all the arrears dues along with re-enrolment fee.

8. ORGANISATIONAL SET UP

(A) WATER USERS' ASSOCIATION

A Water Users Association is an 'Association' of all persons owing land within a hydrological delineated portion of the command area ranging water resources created.

(B) GENERAL BODY

All persons owing land and using water and who have been enrolled as members of the 'Association' shall constitute the 'General Body' of the 'Association'.

(C) EXECUTIVE BODY

The day to day affairs of the 'Association' shall be given by the executive body. The executive body will consists of following members a) Chairman, b) Vice-Chairman, c) Secretary & d) Treasurer.

9. FUNCTION OF GENERAL BODY

i) Maintain and operate the water resources created/ pumps. The expenditure will be meet from the contributory fund of the association.
ii)Demonstrate and practice improvement on farm water management, method for improving field application efficiency in the individual farmers' field.
iii)Make best use of natural precipitation and group water, in conjunction with the pond/well for increasing irrigation and cropping intensity in the command.
iv)Develop sense of economy in water use amongst the users
v)Ensure collective and community responsibility of the farmers to collect the fund for O&M.
vi)The 'Association' will resolve disputes amongst farmers in respect of water distribution and allies matters.

Chairman	Vice-Chairman	Secretary	Treasurer
Hari har Mohanta	Kailash Chandra Naik		Braja Kishore Mohanta

Except otherwise provided, resolution of the ' Association' shall require approval by majority members, casting votes in person.

10.FUNCTION & POWER OF EXECUTIVE BODY

i) The Executive Body shall have the powers and duties necessary for the administration of the affairs of the 'Association' in keeping with the provisions of the bye-law.

ii) Take care, upkeep and surveillance of water resources created in the area of operation of the 'Association' and the common areas and facilities.

iii) Levy charges for operation, maintenance and repairs of the created water resources.

iv) Collect contributions from members

v) See that cash book is written promptly and is signed by the Treasurer. Provide manner in which audit and accounts of the 'Association' should be carried out

vi) Hear and deal with complaints of land owner and resolve disputes.

vii) Correspond with concerned departments and agencies in concerned matters.

viii) Educate farmers in cropping pattern, water management, optimal and efficient use of water and inputs for increasing agricultural production, yields and their profits through trained Irrigation Community Organizers(ICO).

11 ELECTION AND TERM OF OFFICER BEARER

The Officer bearers and other members of the Executive Body shall be elected by members of the 'Association'. The tenure of the office of the executive body (office bearer) shall be three years. Upon an affirmative vote by a majority (more than 50% of the members present) of members of the General Body of the 'Association' any of the office bearers may be removed with cause and his successor elected as per procedure laid down.

12. MEETING

Meeting of the Executive Body of the 'Association' shall be held in the office of the 'Association' or at any other suitable place convenient to the members from time to time, but at least once in a month during the irrigation season. The first meeting of the newly constituted Executive Body shall be held within ten days of the election of office bearers. Two general seasonal meetings of the 'Association' shall be convened one month before every kharif and rabi season for preparing crop plan, water budget, maintenance and repair of water resources. It shall be the duty of the secretary to inform or send notice of each meetings to each member at the earliest.

Chairman Vice-Chairman Secretary Treasurer

13. AMENDMENTS OF BYE-LAWS

The Bye-Laws may be amended by the 'Association' in a duly constituted meeting for such purpose and non amendment shall take effect unless approved by absolute majority
i.e. two thirds of the members of the 'Association' and the modified bye-laws will be effective only after approval by the competent authority.

14. EQUIEDATION/DISSOLUTION

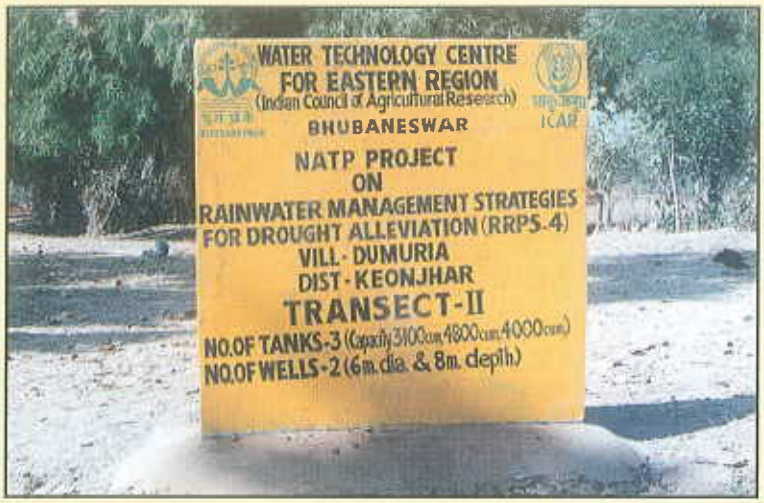
The 'Association' may be special resolution determine that it shall be dissolve and for that purpose two thirds of the members of the General Body shall confirm in writing. Upon such liquidation/dissolution the property of the 'Association' will be handed over to any other nearby Water Users' Association or to Government after satisfaction of all its debits and liabilities, or to the court and action taken as per direction of the court.

15. INTERPRETATION

In case of conflict arising out of the reading of the bye-laws of the 'Association' the interpretation as given by the competent authority.

Chairman Vice-Chairman Secretary Treasurer

Dr.R.C.SRIVASTAVA
CCPI RRPS-4
Water Technology Centre for Eastern Region
Bhubaneswar


WATER TECHNOLOGY CENTRE
FOR EASTERN REGION
(Indian Council of Agricultural Research)
BHUBANESWAR
ICAR
NATP PROJECT
ON
RAINWATER MANAGEMENT STRATEGIES
FOR DROUGHT ALLEVIATION (RRPS-4)
VILL - DUMURIA
DIST - KEONJHAR
TRANSECT-II
NO.OF TANKS-3 (Capacity 3100cum 4800cum 4000cum)
NO.OF WELLS-2 (6m.dia. & 8m. depth)