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Impact of Participatory Irrigation Management (PIM): A Case Study of Aunli Irrigation Project in Odisha, India

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Abstract:
Participation in irrigation Management by Water users can take a wide variety of forms. Farmers can be involved in various system management functions including Planning, design, operations, maintenance, rehabilitation, resource mobilization and conflict resolution. Moreover they can be involved in these functions at various system levels from the field channel to the entire system. The concept of participatory Irrigation Management (PIM) has been recognized, all over the world, as a tool to bring improvement in the management of irrigation. In the Indian context PIM has become very important in view of deterioration of Irrigation system, which has so far been managed by Government Agencies with little involvement of beneficiaries in the process. The purpose of this scheme is for optimum use and equitable distribution of Irrigation water through participation of farmers in operation and maintenance of canals as well as water management for these purpose water users associations (WUA) have been formed in the command areas.
The study discusses all the water users in Aunli Irrigation Project in Odisha, India. After discussing the Project profile and trends of growth of participation in irrigation management, agricultural and economic activities have been analysed. Participation also implies access to knowledge and information related to agricultural and irrigation management. The study reported that the Present impact related to the Participatory Irrigation Management (PIM) in Aunli medium irrigation Project is an ideal system of irrigation management in Asia because one of a water users association (WUA) managed by women only. The ability of women to participate meaningfully in this project is very remarkable and very unique in nature all over the country. The first project appears to have succeeded in raising crop revenues, in changing the pattern of irrigation, better irrigation management in the WUA level and in raising the confidence of the water users.

Keywords: *Participatory Irrigation Management, Ownership, Sustainable Agriculture development*

1. Introduction

Odisha is predominantly an agricultural state. Cultivators and agricultural labourers constitute 65 percent of the total workforce. Agriculture provides direct or indirect employment to 65 percent of the total workforce and contributes 26 percent of the net state domestic product. Kharif is the main cropping season and rice is the principal crop during Kharif season. The state has a cultivated area of 62 lakh hectares out of which 27 lakh hectares are high land, 19 lakh ha medium land and 16 lakh ha low land. The growth rate of agriculture in the state is very low, due to various constraints, which are climatological, institutional, technological, infrastructural and social-cultural. Agriculture is an integral part of the development system and irrigation holds the key to increasing agricultural productivity. Odisha is one of the few states in the country which is endowed with abundant water resources. But this resource is very unevenly distributed over time and space. The state has around 11% of the total water resources of the country with eleven rivers basins and also with a 4% geographical area. Rainfall is the main source of water and a long term average rainfall in the state is the order of 1452 m .m. which is equivalent to 230.76 billion cubic meters (BCM).About 78% of the above is received in the monsoon season (June to September).Irrigation is a crucial input and is a basic infrastructure required for agricultural production. Water Management is one of the key components for strengthening food security. This means sustaining irrigation service would lead to sustainable food production. Out of cultivable area of 65.99 lakh ha about 41 percent is under irrigated conditions (both Kharif 18.5 lakh ha and Rabi 8.5 lakh ha) and 59 percent is non-irrigated. The total irrigation potential created so far from all sources is about 39.31 lakh ha (Kharif 26.65 lakh ha and Rabi 12.66 lakh ha).The gross irrigated cropped area is 27 lakh ha which is about 68 percent of the potential created.

Irrigation is a pre-requisite for adoption of improved yield enhancing technology (Dhawan, 1987, 1988; Bharadwaj, 1974, 1990). Use of irrigation water enables the application of other yield stimulating inputs like HYV seeds, chemical fertilizer and farm yard manure. In Odisha huge investments have been made for creation of irrigation potential. The major and medium irrigation projects are basically fully state owned, state funded and is departmentally managed by a hierarchical bureaucracy in a centralized and top down approach. However, in such a bureaucratically managed irrigation system, the overall performance of the irrigation sector has been quite dismal. The agricultural productivity from irrigation commands has not increased appreciably. The yield increasing potential of irrigation is rarely achieved. Leaving aside the capital costs of irrigation projects, even revenue receipts from sale of

water hardly cover the recurring operation and maintenance costs. Irrigation service has been unduly subsidized because of political necessity i,e. to woo the rural electorate. Due to highly subsidized water rates, the irrigation sector has not been able to generate resources internally required for the operation and maintenance of created irrigation structure. Even government is not, in a position to allocate adequate resources for operation and maintenance of canal irrigation systems. Due to squeezing of budgetary allocation for irrigation development and paucity of finance, the conditions of irrigation infrastructures have deteriorated significantly causing system inefficiency and rendering the huge investments made in creation of irrigation potential virtually infructuous.

In recent years the irrigation sector has been under tremendous pressure to improve its system performance. New trends demand more farmers' participation in all aspects of water resources management, which include planning, design, construction, operation, maintenance, on-farm development, rehabilitation, modernization, water distribution, collection of water rates, monitoring and evaluation. During 1990s most of the major states in India such as Andhra Pradesh, Orissa, Maharashtra, Karnataka, Madya Pradesh etc. have implemented PIM with the objective to improve water use efficiency, ensure equitable water distribution and sustainability of the system. Orissa is a pioneering state in implementing PIM. The impacts of PIM have been analysed by many social scientists (Jairath, 2001; Hooja et al, 2002 and others). Also, there is a good deal of literature on methodology of Impact Evaluation (Groenfeldt and Sun, 2004; Nelson, 2004; Servaas, 2004; Baker, 1999, ADB, 2002). However a systematic, scientific, quantitative in-depth evaluation of impact of PIM has not so far been undertaken specifically in context of Odisha. The proposed research aims to study the socio-economic, agricultural, technological and environmental impacts of PIM in Odisha.

2. Literature Review

It is now widely recognized that the farmers who are the end-users of irrigation water should participate in the planning, development and management of irrigation infrastructure (Wade, 1987; Chambers, 1988: Ostrom et al. 1993, Meinzen-Dick et al.1997, Balland and Platteau , 1996 ; Vaidyanathan,1999 and others). Many countries all over the world are in fact broad basing their PIM programme. Pioneers in PIM are The Philippines, Mexico, China, Japan, Egypt, Turkey, Sri Lanka, Chile, Columbia, Morocco (Meinzen-Dick et al.,1997; Johnson et al., 2002). In India the concept of PIM has evolved gradually through three distinct phases (Maloney and Raju; 1994:16). In 1980s the concept was in its nascent stage limiting to farmers' participation through their representatives. It was felt then that in the decision making process of irrigation development, the views of farmers should be taken into account and they should be consulted in planning, design, construction, operation and maintenance of the system. However, mere farmers' representation in scheme level committees could not yield much result. In the latter part of 1980s, it was realized that farmers cannot have much stake in irrigation management without a formal structure/forum to express their views. Therefore, the catchword became farmers' organization.

In various states like Andhra Pradesh, Tamil Nadu and Maharashtra thousands of outlet associations/chak committees had been formed only in pen and paper but actually most of them became dysfunctional after a short period. By 1990s it became apparent that the concept of farmers' organization is not sufficient. Therefore, a radical concept of farmers' organization and system turnover has evolved in which it is envisaged to entrust the WUAs with the responsibility of operation and maintenance of minor/ distributary, allocation of water among farmers and collection of water charges from water users.Of late, most of the state governments in India have taken policy decision to introduce Participatory Irrigation Management (PIM) and turning over the management of tertiary segment of the canals like minor/sub-minors/ distributaries to Water Users' Associations (Maloney and Raju, 1994; Jairath, 2001; Hooja et al.2002, Brewer et al.,1999). It is contemplated that WUAs will be entrusted with the responsibilities of operation and maintenance of the tertiary units, distribution of water among water users and collection of water rates. The irrigation agency will make bulk sale of water volumetrically to WUA at minor/sub-minor level and retailing of water to farmers will be the responsibility of WUA.

National Water Policy of India adopted in 1987 clearly envisages that `Farmers should be involved progressively in various aspects of management of irrigation system, particularly in water distribution and collection of water rates.' Recently, National Water Policy 2002 emphasizes that 'Management of water resources for diverse uses should incorporate a participatory approach by involving not only the various governmental agencies but also the users and other stake holders, in an effective and decisive manner, in various aspects of planning, design, development and management of the water resources schemes.Water Users Associations and the local bodies such as municipalities and gram panchayats should particularly be involved in the operation, maintenance and management of water infrastructures/facilities at appropriate levels progressively, with a view to eventually transfer the management of such facilities to the user groups/local bodies.

Thus, it seems PIM is a win-win strategy for both the farmers as well as the irrigation agency. Many negative impacts of PIM on different stake holders have also been pointed out by several authors (Groenfeldt and Sun, 2004), which include devolution of corruption, increase in water rate, capture of power etc.

2.1. PIM in Odisha

Odisha is one of the pioneering states in India in implementing Participatory Irrigation Management (PIM) in a mission mode. Recognizing the need for systematic involvement and participation of farmers in irrigation management, the Government of Odisha in the state water policy, 1994 has incorporated the objective of `handing over of operation and maintenance of irrigation systems to the users in due course.' PIM was introduced in the state during 1995 on pilot basis in four projects with the assistance of World Bank under the banner Farmers Organization and Turnover component of Odisha Water Resources Consolidated Project (OWRCP). To motivate farmers in irrigation management, massive awareness campaigns, training programmes and workshops have been conducted at regular intervals.

In this study an attempt has been made to evaluate the impact of Participatory Irrigation Management in other words how Irrigation Management Transfer (IMT) from Government Irrigation Agency to Water Users Associations has affected the irrigation system performance, agricultural productivity and the socio-economic conditions of water users. The ultimate objective of the study is to highlight the factors or conditions that cause effective farmers' participation and improved irrigation performance. In the context of recent reform measures in irrigation sector in Odisha aiming at promoting farmer and local participation in irrigation management, this study will help the policy makers to chalk out an appropriate strategy and action plan for successful implementation of Participatory Irrigation Management and also strengthening the current reformed institutions of irrigation water management (Water Users Associations).

2.2. Objectives

The major objectives of the study are:

- To evaluate the impacts of PIM on efficiency in water use, equity in water distribution, Operation and maintenance of irrigation system.
- To analyse the socio-economic, agricultural and technological impacts of PIM by comparing pre and post as well as with and without PIM situation.
- To suggest measures necessary for enhancement of functional efficiency of Water Users' Associations and effective implementation of PIM.

2.3. Hypotheses

The following hypotheses will be tested:

- H(i) In the Post-PIM situation, the area irrigated increases and the gap between irrigation potential created and utilized is reduced.
- H(ii)Instances of canal cutting and breach of rules are reduced.
- H(iii)Due to PIM Situation Water disputes are reduced, Efficiency in water use improves and the water distribution gap between head reach and tail end farmers is reduced.
- H(vi)There is better operation & maintenance of irrigation system as well as the relationship between irrigation agency and Water Users Associations improves.
- H(viii) In the post PIM situation the cropping intensities, crop diversification, crop yield and farm income increase.
- H(ix)After adoption of PIM the use of yield enhancing inputs like Chemical fertilizer and H.Y.V. seeds increase.

2.4. The Project Study Area

It is proposed to undertake the study in Aunli medium irrigation project in Odisha. The Aunli Irrigation Project is a diversion weir scheme constructed across river Aunli near Village Kanaloi in Chhendipada block of Angul district. The Catchment area is 150 sq. km. at weir site. The major component of this system consists of diversion weir of 56 mtr. Length with automatic falling shutters of 0.9 mtr height. The main canal is 4.656 km. having 8 nos of minors and sub-minors. This project is having C.C.A. of 1746 ha. in Khariff and 523 ha. in Rabi.

Previously the canals were unlined earthen canals passing over sandy zone. So after constant use and due to lack of proper maintenance, it could not supply water to its full capacity. Hence in the year 1995-96, the project was included under Water Resources Consolidated Project (WRCP) to achieve its full capacity at an estimated cost of Rs.310.38 lakhs. Farmer's organization & turnover programme was introduced in Aunli Irrigation Project area during March 1998 as a pilot scheme. The purpose of the scheme is for optimum use and equitable distribution of irrigation water through participation of farmers in Operation and Maintenance of canals as well as water management.

3. Methodology

The study is undertaken with both secondary and primary data sources of material. For secondary materials more reliance is placed upon available standard literature and published officials documents and literature. However, the main focus of the study is on primary level data from water user level and expert level and ground level materials. In this study both qualitative and quantitative techniques applied for data collection and analysis. All the water userss under Aunli Irrigation Project has been taken into account for this study. Under the qualitative techniques participatory rural appraisal techniques such as focused group discussion, semi-structured interviews applied in collecting relevant information from water users. Under the quantitative techniques the data are to be collected through direct interview with structured questionnaire from heads of farm households. A stratified random sampling method used to select the water users for inclusion in study.

3.1. Sampling Design of the Study

Multistage simple random sampling method has been followed in the collection of primary data to study the impact of PIM in Aunli Irrigation Project region. The stages are as follows. For impact study data collected on various socio-economic, agricultural and environmental indicators for Pre and Post PIM situation. All the water userss coming under Aunli irrigation project selected. Stratified random sampling method applied for selection of households. The entire command area divided into Head Reach, Middle Reach and Tail End region.

- **The Socio-Economic Profile of the Study area and field level data analysis and discussion of the case study.** The case study illustrated the socio-economic profile of the study area with the forms of user participation. There were extensive discussions on this case study with emphasis on different aspects related to the participatory approach of water management and their impacts etc. A long term bottom up approach is visualized for the Aunli Irrigation project and the following sections describe the major findings of the survey in relevant categories.This paper synthesises the most significant evidences about the impacts of participatory irrigation management programme and the analysis based primarily on the findings of this case study.
- **Socio-Economic characteristics of farm households:** Agriculture is the mainstay of this village's economy and substance of life for the people. This study is based on a sample of 300 farm households randomly selected from 8 villages covering 4 WUAs under Aunli Irrigation Project in Angul district of Odisha. The Socio-Economic characteristics of farmers like their class, caste, education and others etc. greatly determine their orientation for formation of Pani Panchayat. Therefore this briefly outlines the demographic and land ownership pattern of surveyed households in this section.
- **Distribution of Operational Holding by Size Class (Area in acres)**: The number of marginal and small holdings put together accounted for a lion's share in the total no of household. All the water users were divided into four categories on the basis of their average size of operational holding. The farmer classes were marginal farmers (MF) those with less than 2.5 acres of operational area. The Small farmers (SF) operational area is 2.5 acres or more but less than 5 acres, medium farmers(MDF) those with 5 acres but less than 10 acres of operational area and the large farmers'(LF) operational area of 10 acres or more acres. Out of a total 300 households in our sample the marginal farmers constituted the highest 49.3 percent proportion of households followed by small farmers 31.3 percent medium farmers12.0 percent proportion of households followed by large farmers 7.3 percent .Thus there are more than 80 percent of households were marginal and small farmers operating less than 5 acres of land. The total average size of holding is only 1.25 ha. In the present agriculture scenario, the marginal farmers, constituting 50% of the farmers, either own or rent a piece of land for cultivation.

Farmer Class	No of HHs. Holdings.	% of Total HHs.	Total Irrigated Area owned (in acre)	% to Total area	Average owned Irrigated Area/HH
1	2	3	4	5	6
MF (<2.5 acres)	148	49.3	110.00	19.4	0.74
SF (2.5-5 acres)	94	31.3	167.50	29.6	1.78
MDF (5-10 acres)	36	12.0	114.50	20.2	3.18
LF (>10 acres)	22	7.3	174.00	30.7	7.91
Total	300	100.0	566.00	100.0	1.89

Table 1: Distribution of Operational Holding by Size Class(Area in Acres)
Source: Compiled from field data

3.2. Distribution of categorisation of water users by occupation

In the century that followed, new generations of entrepreneurs developed financial management and marketing skills geared to their own changing societies and cultures. Out of the surveyed population 52.7 percent were engaged as cultivators,7.3 percent engaged in agricultural wage labour,20.3 percent in non-agricultural wage, 3.0 percent economic active population engaged in service,7.7 percent engaged in business and 9.0 percent in others economic activities.

Farmer Class	No. Of HH.	Cultivation	Agricultural wage	Major non-agricultural wage	Service	Business	Others
1	2	3	4	5	6	7	8
MF	148	82(55.4)	16(10.7)	30(20.3)	0	2(1.4)	18(12.2)
SF	94	48(51.1)	6(6.4)	31(32.9)	0	2(2.1)	7(7.4)
MDF	36	22(61.1)	0	0	3(8.3)	9(25.0)	2(5.5)
LF	22	6(27.3)	0	0	6(27.3)	10(45.4)	0
Total	300	158(52.7)	22(7.3)	61(20.3)	9(3.0)	23(7.7)	27(9.0)

Table 2: Distribution of categorisation of water users by occupation
Source: Compiled from field data

- **Delivery of Canal Water:** Farmers are said to have first rights to water based upon historical use. Irrigation systems are complex in nature. Adequate and timely maintenance of an irrigation system is imperative to proper irrigation management. Efficient water management cannot be achieved unless the infrastructure for water conveyance and delivery system are in a reasonably good condition to retain its operated efficiency. The worst-affected areas are the secondary and tertiary systems. Irrigation plays a significant role in increasing the yield from the land. Non-availability of timely is adequate water for irrigation is now becoming a serious constraint in achieving higher productivity and stability of farming. Therefore, assured irrigation is the need of the hour and the table-13 has given the detailed information regarding the water use and availability given below herewith. Assessment of economic impact was made on the basis of data related to area under irrigation, quality of irrigation etc. Increase availability of water due to saving of water and increased supply enabled larger number of farmers to avail the benefit of irrigation. As can be seen from Table-13 the increase in per respondent area under irrigation was quite modest in many cases. Much more significant was the improvement in the quality of irrigation in terms of both adequacy and timeliness of water supplies as can be seen from table-13 given below. Assured irrigation motivated farmers to adopt better agricultural practices including use of moderate inputs of fertilisers, chemicals etc. resulting in better cropping pattern and higher yields.

Sl. No.	Issue	Yes	No	Not reported	Total
1	Receiving any prior information regarding supply of canal water	300 (100.0)	0	0	300 (100.0)
2	Availability of Canal Water	212 (70.66)	40 (13.34)	48 (16.0)	300 (100.0)
	(i)In time	140 (46.66)	30 (10.00)	130 (43.34)	300 (100.0)
	(ii)Before	80 (26.66)	40 (13.34)	180 (60.0)	300 (100.0)
	(iii)After	40 (13.34)	55 (18.33)	205 (68.33)	300 (100.0)
3	Adequacy of available canal water				300 (100.0)
	(i)Deficit	112 (37.33)	140 (46.67)	48 (16.0)	300 (100.0)
	(ii)Adequate	102 (34.0)	40 (13.34)	158 (52.66)	300 (100.0)
	(iii)Surplus	4 (1.33)	217 (72.33)	79 (26.34)	300 (100.0)
4	Is irrigation service dependable	300 (100.0)	0	0	300 (100.0)

Table 3: Delivery of Canal Water
Source: Compiled from field data.
Note: Figures within parentheses indicate percentages of total.

3.3. Distribution of Canal Water

Water Supply and Waterworks provision of a supply of water for domestic, industrial and irrigation needs, and the engineering installations necessary to treat the water to the WUA. Maintenance by WUA resulted in improvement in the physical condition of

field channels. One reason for this was the keen interest in maintenance taken by the officials with WUA members. The supply of canal water increased due to their involvement in management. The office bearers and association helped in preventing water loss due to damage structure and unauthorised outlets. The conflicts among the farmers had solved in WUA level and also with the involvement in management he collection of water fees increased. The WUAs vested interest on with the responsibility of O and M, water distribution, conflict resolution and collection of water fees. The distribution of canal water and other details can be seen in table-14.

Sl. No.	Issue	Yes	No	Not reported	Total
1	Supply of canal water				
	(i)Head Reach	281 (93.66)	0 (0)	19 (6.34)	300 (100.0)
	(ii)Middle Reach	247 (82.33)	7 (2.33)	46 (15.34)	300 (100.0)
	(iii)Tail End	89 (29.66)	93 (31.0)	118 (39.34)	300 (100.0)
2	Conflict arising among farmers regarding water distribution	15 (5.0)	285 (95.0)	0 (0)	300 (100.0)
3	Conflicts are solved				
	(i)By WUA level	11 (3.66)	0 (0)	289 (96.34)	300 (100.0)
	(ii)By intervention of local leaders	4 (1.33)	0 (0)	296 (98.67)	300 (100.0)
	(iii)Satisfaction level of canal maintenance	201 (67.0)	37 (12.33)	62 (20.67)	300 (100.0)
4	Satisfaction on collection of water fees	228 (76.0)	8 (2.66)	64 (21.34)	300 (100.0)

Table 4: Distribution of Canal Water
Source: Compiled from field data
Note: Figures within parentheses indicate percentages of total

This paper begins with an overview of government policy on PIM and then it is followed by an analysis of the impact of the management reforms on the irrigation performance in terms of impact on governments expenditures for irrigation, quality of the irrigation service an agricultural productivity levels

4. Results

The study reported that the Present impact related to the Participatory Irrigation Management (PIM) in Aunli medium irrigation Project is an ideal system of irrigation management Firstly, the most important performance of the farmers Participation are adequacy, reliability, equity, timeliness, efficiency, employment in relation to water management, Secondly, financial performance is highly appreciable i.e, is reduced the cost of irrigation management for the government. Thirdly, it has been reported that the PIM improves the operation and maintenance of irrigation systems. Fourthly, the agricultural and economic productivity rises due to changes in the intensification of production and the use of higher-yielding crop varieties after PIM Situation. Fifthly, PIM improves the environmental sustainability. Another factor determines the scientific use of modern inputs such as fertilizer, pesticides, use of HYV seeds, modern agricultural implements and training for the proper use of available water for irrigation in right direction is complementary to it. To empower farmers in grassroots level there is need for institutional reforms through sensitization starting from the Pani Panchayat level to highest level. In departmental and Institutional provided crop planning, farm mechanization, agricultural development, financial transactions, competitiveness trade, capital mobility; investment and aid flows have become an important feature for most of the developing economies. The present study contributes to theory and practice by eliciting the PIM brings about many economic benefits to this Project region. It saves crop from irregular Water supply, increases yield and ensures more stability. It brings equity in water distribution, adequacy, timeliness and predictability. It also increases income, improves living standards and increased production over time. Considering the importance of women in terms of their numerical strength and the significant contribution they make to the agriculture. PIM is a test of rural intellect, resilience, equanimity and endurance to unearth the maximus of rural agricultural management. It is a platform for systematic community mobilization for enhancing the spirit of co-operation among the producers, creating value for stakeholders and finding new opportunities in irrigation management and agricultural development. This is the time to find new ways to turn constraints into competitive advantage by designing new processes, creating new ideas, markets with services, collaborating and partnering. PIM leads water user's higher productivity, greater acceptability, greater stability and greater sustainability. PIM brings irrigation sector more productive and efficient use of water more crop per drop. This brings transparency, equitable distribution, and improvement in irrigation efficiency, help bringing additional area under irrigation lead to diversification of crops, enable putting gap on operation and management expenditure, increased per unit of water etc.

5. Discusson

5.1. The visible impact

5.1.1. Sense of Ownership

WUA generally creates a stronger sense of ownership of the system on the part of users. Even though the actual ownership system facilities means the users now have a greater voice in selecting the governance in their system. People become closest and most reliable with government officials through water user association. The ownership of farmers in irrigation system reliable equitable in distribution of water and the tail end problem has been minimized. Through WUA farmers got freedom to adopt their own cropping patterns, better operation and maintenance, transparency, prompt action to problems and resolution of disputes. Disputes are resolved at monthly committee meetings. In participation, decision making, Operation and Maintenance functions, fund generation, group atmosphere, membership feeling, norms, empathy, interpersonal trust and social support is very interesting in Aunli irrigation project region.

- **Financial inclusion initiatives**
  The project involves extending necessary support services to the water users through training, exposure and proving agricultural implements in a mission mode. Appropriate agricultural interventions like crop planning, methods of cultivation, water management, pest management and fertilizer management leads more production. These innovations have been operationalised with the help of local experts and district level officers in a participatory mode.The agricultural production has been increased and bank has rolled out a financial inclusion plan in this project region. A special focus has been laid by the bank officials and helped the water users through its social commitment rural network cell.
- **Operation and Maintenance Performance**
  The impact of management transfer on the operational performance of irrigation systems is hypothesized that turnover leads to an efficient and more equitable water distribution and thus increased irrigation intensity. This section assesses the impact of management transfer on the maintenance of irrigation facilities by farmers. It is hypothesized that management transfer will bring about improvements in the maintenance of the irrigation facilities. The free labour contribution by water users with full length of all main and distributary canals were inspected during the irrigation season and it determine the functional condition of the infrastructure after turnover. This provides insight into the quality of maintenance after turnover and together with data on levels of spending on maintenance, provides an indication of the extent to which the WUAs are keeping up in maintenance.

5.1.2. Improved Water Availability

The rehabilitation and Participatory management practices have resulted in increased drawal at the head and incremental supply for all the commands. As the distress of system resulted in shortage of at least 30% to 40% at the head which was causing extreme imbalance and in adequate supplementation from head to tail. This has now been rectified and with full restoration of the conveyance capacity and full irrigation coverage, the total economic benefit from farm produce has gone up by 40% to 50%.

5.1.3. Economical Water Use

Under the impact of SIFT and with functioning of WUAs the farmers of the command area are aware of reliable and regulated water supply in the canals even to the tail end areas. Agricultural extension system and farmers training activities under WUA have educated the farmers on water requirement of crops diversification, optimum use of water for different crops, water scheduling for better water use efficiency and increased crop output. Though on-farm development works have not yet been completed in the Pilot Projects but the SIFT and FOT activities have increased the water supply to tail end area assured water supply in the commends, release of according to the need of the farmers and scheduling of off and on method of water supply for judicious water use. These improvements have been manifested in terms of change in cropping pattern, increase in crop intensity, intensification of input use and increase in crop productivity. Timely and adequately water availability, equitable distribution of water, empowerment of farmers to manage irrigation systems, year round availability of water and choice in deciding irrigation timings becomes possible through formation of WUA.

- **Area coverage**
  Rehabilitation work in the command has created a confidence in the farming community about timely and assured irrigation up to the tail end areas. They are now happy with the arrangements made for supply of supplementary irrigation at the time of field moisture stress. This has encouraged the farmers to increase area under kharif crops and grow winter crops wherever feasible. Consequently there has been increase in the total crop coverage.

Year	Khariff	Rabi	Total
2001-02	1746	360	2106
2002-03	1746	345	2091
2003-04	1746	350	2091
2004-05	1746	335	2081
2005-06	1746	350	2096
2006-07	1746	500	2246
2007-08	1746	500	2246

2008-09	1746	523	2269
2009-10	1746	523	2269
2010-11	1746	523	2269

Table5: Details of Irrigated cropping area in ha. achieved in last 10 years from the year-2001-02 to 2007-08) in Aunli Irrigation Project of Angul district of Odisha, India
Source: Department of Water Resources, Government of Odisha, Bhubaneswar.

- **Agricultural Productivity**
  This section examines the impact of management transfer on agricultural production. The hypothesis advanced is that irrigation management transfer will result in an improvement in agricultural productivity levels. The hypothesis is tested by comparing crop yields between systems that have been turned over to farmer management and on the basis of farmer perceptions about changes in crop yield before and after turnover in the four PP case study.
- **Change in Cropping Pattern**
  Before rehabilitation of the canal systems with uncertain irrigation both in terms of time and volume the farmers of the command areas of the pilot projects use to grow paddy in the kharif season and lands remain virtually fallow or covered with scattered patches pulses like horse gram and oilseeds like sesamum in Rabi season. Summer paddy was cultivated in low land situation also in scattered patches. Change in cropping pattern in favour of high value crops, freedom to raise resources, diversification of cropping pattern, year round farm employment and diversified economic activities becomes possible through PP.After rehabilitation of canals and PP intervention there has been perceptible change in cropping pattern and crop sequence in all the projects as indicated. It is evident that farmers have adopted double and multiple patterns in the command areas with high value crops such as groundnut, mustard, sunflower and vegetables as second and third crops according to land situations and availability of canal water and also conjunctive water use.
- **Crop diversification**
  Diversification Agriculture essentially refers to a shift from one crop/variety/cropping system to another crop/variety/cropping system or from one enterprise to another enterprise. Crop diversification usually refers to the first category, which is governed mostly by price fluctuations in market, change in food habit, availability of high value and efficient crops and technology, weather aberrations, It is also observed that with the intervention of PP the farmers of this pilot project has change the practice of growing summer paddy during Rabi/Summer season and have gradually adopted low and medium duty crops such as groundnut, mustard, sunflower, sesamum and pulses after harvest of kharif paddy etc.
- **Cropping Intensity**
  Integrated approach of canal rehabilitation, Farmer's Organisation and Turn over and WUA activities has brought in positive change in the attitude of farmers and they have gradually switched over to grow short and medium duration paddy varieties during kharif season in place of long duration varieties to accommodate a second crop even a third crop of pulses/oilseeds/vegetables depending on the water availability, soil conditions and other socio-economic needs. As indicated the cropping intensity has increased from the base level of 117% to about 140% in Aunli projects.
- **Productivity**
  The productivity of different crops has registered an increasing trend in all the four WUAs in this project after WUA intervention. The yield of paddy has increased similar trend of rise in productivity of other crops like pulses, groundnut, sesamum, sunflower, vegetables and sugarcane has also been observed in the command area after intervention of WUA.
- **Agricultural productivity.**
  This section examines the impact of management transfer on agricultural production. The hypothesis advanced is that irrigation management transfer will result in an improvement in agricultural productivity levels. The hypothesis is tested by comparing crop yields between systems that have been turned over to farmer management and on the basis of farmer perceptions about changes in crop yield before and after turnover in the four PP case studies.

Kharif	Area (ha)	Rabi	Area (ha)
Paddy	1466	Paddy	300
Mung	60	Maize	1
Biri	80	Pulses	5
G.nut	90	Sunflower	1
Vegetables	35	G.nut	113
Spices	15	Mustard	13
	-	Til	30
	-	Vegetables	30
	-	Spices	5
	-	Sugarcane	2
	-	Others	23
Total	1746		523

Table 6: Coverage of different crops in Aunli irrigation project region of Chhendipada Block of Angul district of Odisha (2010-11)

Source: Department of Agriculture, Government of Odisha, Bhubaneswar.

- **Crop production**
  Production of major crops in this pilot project has shown an increasing trend with use of quality seeds, fertilizers, plant protection measures, use of improved agricultural implements and water management after WUA intervention.
- **Change in Production**
  The production level of paddy, food grains including pulses, oilseeds and other crops like vegetables and sugarcane have recorded significant change over after implementation of PP. The percentage of change of production of different crops after WUA over pre-WUA year. The production of food grains has registered an increase of about 69% in Aunli project after WUA intervention. The production of oilseeds has recorded a significant change over in Aunli project. Similar change has also been observed in case of vegetables and sugarcane.
- **Cost Production**
  The cost of production of different crops has been computed taking into account the level of adoption of scientific technology of production by the farmers both before and after the WUA intervention. As revealed from the data the total cost of production has increased from Rs. 10.75 million to 17.33 million in Aunli. The percentage increase in cost of production has been about 63 % in Aunli.
- **Value of Produce, Net Profit and Crop Output/ha**
  The produce of crops of the project area has also been computed against the Govt. support price of commodities to arrive at the total cost of production. It is evident from that the change in total value of produce has also recorded a significant rise in all the WUAs in this project.Net profit to farmers on agricultural produce was computed for before and after PP intervention. Crop output per hectare of cropped area was calculated by transforming produce of all crops in terms of paddy. It observed that per ha. Production has registered an increase of about 35% in Aunli after WUA intervention. Based on the per ha. Output there is corresponding increase in farm income after WUA intervention in this project. Percentage increase in farm income rose from 15% to 35% in Aunli irrigation project.

6. Conclusion

The findings of the study suggest that the PIM contributes to agricultural development through changes in crop productivity, cropping intensity, cropping pattern, income and employment etc. The real participation of the farmers paying their own share for development has made the programme sustainable. It is clear from the findings that the Aunli Irrigation given special importance for more investment and priority should be made for its successful implementation and it act as demonstration centre in PIM. The PIM in this command area is better than many other Command Area Development Programmes in the country. It resulted in better utilization of irrigation potential created by water, bringing changes in better cropping pattern and increasing agricultural production and productivity in a participatory mode. It has made positive socio-economic impact in the command area of the project. The real participation of the farmers paying their own share for development has made the programme sustainable.

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