Research Bulletin

52

Impact Assessment of Technologies on the Farming and Livelihood of Farmers

Souvik Ghosh, Ashwani Kumar, B.K. James,
S. Roy Chowdhury, P.S. Brahmanand, R.K. Mohanty, G. Kar

Directorate of Water Management
(Indian Council of Agricultural Research)
Bhubaneswar- 751 023, India

2011

Research Bulletin - 52

Impact Assessment of Technologies on the Farming and Livelihood of Farmers

Souvik Ghosh
Ashwani Kumar
B.K. James
S. Roy Chowdhury
P.S. Brahmanand
R.K. Mohanty
G. Kar

Directorate of Water Management
(*Indian Council of Agricultural Research*)
Bhubaneswar – 751023

2011

Ghosh, Souvik., Kumar, Ashwani., James, B.K., Roy Chowdhury, S., Brahmanand, P.S., Mohanty, R.K. and Kar, G. (2011). Impact Assessment of Technologies on the Farming and Livelihood of Farmers, Research Bulletin No. 52, Directorate of Water Management (Indian Council of Agricultural Research), Chandrasekharpur, Bhubaneswar - 751023, India. p. 56.

Published by

Director, Directorate of Water Management
(Indian Council of Agricultural Research)
Bhubaneswar - 751 023, India

Printed at

Capital Business Service & Consultancy
B-51, Saheed Nagar, Bhubaneswar - 751 007
capital_a1press@yahoo.com

CONTENTS

1 INTRODUCTION 1

2 METHODOLOGY 3

3 FINDINGS 5

3.1 Impact of *in-situ* rainwater conservation for multiple use technology 5

3.2 Impact of crop diversification and residual soil moisture utilization and technologies 10

3.3 Impact of paper mill sludge application in acid uplands technology 32

3.4 Impact of integration of water chestnut cultivation and aquaculture technology 45

4. CONCLUSION 55

5. REFERENCES 55

1. INTRODUCTION

Agriculture is the mainstay for livelihood of two-third population in India. Eastern region of the country is blessed with plenty of rainfall, bulk (80%) of which occurs during monsoon period (July to October). However, because of erratic nature of the onset, distribution and withdrawal of rains, ranifed ecosystems (up, medium and low lands) have problem of uncertain moisture supply that results in mono-cropping of rice with lower production and productivity. Fallow after rice crop in about 12-16 million ha in eastern India due to lack of proper water resource management is another important issue. Addressing these issues, the institute has made research initiatives for generating technologies focusing on *in-situ* rainwater conservation for multiple uses in medium and lowlands, crop diversification in rainfed upland and medium land situations and residual soil moisture utilization in rainfed low lands. Large area (49 million ha) of the country under acid soils suffer from the lower crop productivity. Although wide ranges of liming materials are available, small and marginal farmers are unable to use those due to higher cost. Institute has standardized paper mill sludge application for soil amelioration and diversified cropping in acid uplands through on-farm applied research. The 8 million ha shallow low land ecosystem in the low lying areas of country, of which 5.8 million ha is in eastern India itself, face water stagnation above the ground more than six months in a year. For harnessing available water resources of waterlogged ecosystem institute has developed and tested technology for integration of aquatic crops like water chestnut and fish through on-farm research and trial. Adoptions of the aforesaid location-specific technologies by the farmers have potential to enhance farm production and income with improved livelihood.

A livelihood comprises of people, their capabilities and means of living including food, income and assets. Tangible assets are resources and stores and intangible assets are claims and access. A livelihood is sustainable when it maintains or enhances the assets on which the livelihood depends. Many of the definitions of livelihood security currently in use are derived from the work of Chambers & Conway (1992). A livelihood comprises of the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. A livelihood is sustainable which can cope up with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels in the long and short term. The idea of livelihood as defined above embodies three fundamental attributes: i) the possession of human capabilities (such as education, skills, health, and psychological orientation); ii) access to tangible and intangible assets; and iii) the existence of economic activities. The interaction between these attributes defines what

livelihood strategy a household pursues. Sustainable livelihoods are achieved through access to a range of livelihood resources (natural, economic, human, financial and social capitals) which are combined in the pursuit of different livelihood strategies viz. agricultural intensification, livelihood diversification, migration, etc. (Scoones, 1997).

People and their access to assets are at the heart of livelihoods approaches. In the Department for International Development (DFID) framework (1999), five categories of assets or capitals are identified, which are:

a) Human capital: skills, knowledge, health and ability to work

b) Social capital: social resources, including informal networks, membership of formalised groups and relationships of trust that facilitate co-operation

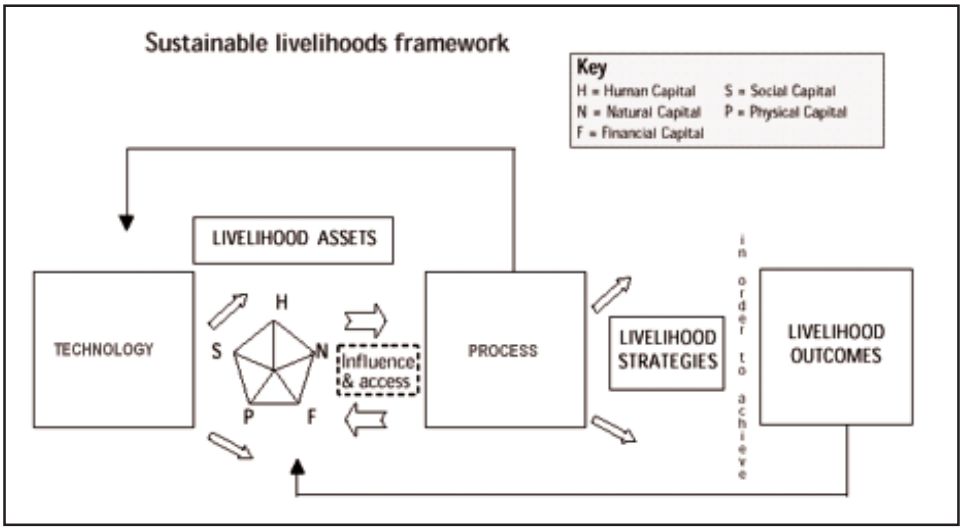
c) Natural capital: natural resources such as land, soil, water, forests and fisheries

d) Physical capital: basic infrastructure, such as roads, water & sanitation, schools, ICT; and producer goods, including tools and equipment

e) Financial capital: financial resources including savings, credit, and income from employment, trade and remittances

Policies, institutions and processes can have a great influence on access to assets - creating them, determining access, and influencing rates of asset accumulation. Those with more assets are more likely to have greater livelihood options with which to pursue their goals and reduce poverty.

Livelihood strategies are the range and combination of activities and choices that people undertake in order to achieve their livelihood goals (including productive activities,



investment strategies, etc.). This is a dynamic process in which people combine activities to meet their various needs at different times. Livelihood outcomes are the achievements or outputs of livelihood strategies. One should not assume that people are entirely dedicated to maximising their income. It is hard to weigh up the relative value of increased well-being as opposed to increased income, but this is the type of decision that people must make every day when deciding which strategies to adopt. There is a close relationship between livelihood outcomes and livelihood assets, the two being linked through livelihood strategies.

The topic of 'rural livelihoods' is complex and wide-ranging (Ashley *et al.*, 2003). What exactly is it that needs to be assessed, depends on the research purpose and policy question at hand. Policy Guidance Sheets produced by the Overseas Development Institute for the ODI Livelihood Options Study broadly identifies four key areas for assessment: household economics (who is doing what, drawing on which assets, earning what income?); changes in livelihoods: what are the sources and impacts of short-term and long-term livelihood change?); diversified livelihoods (why are households diversifying their economic activities? How does diversification differ for different groups and what success does it bring?); access and exclusion: how are some groups excluded from key economic opportunities, how does this affect their access to resources or their capacity to exercise their rights; how does this affect their livelihoods?)

Rural livelihood diversification is an adjunct to rural economic diversification. Crop diversification, farm sector diversification and livelihood diversification influence the rural economy. Despite low employment elasticity, rural employment continues to be predominantly agrarian. Therefore, coexistence of advanced agriculture with rural livelihood diversification holds the key for development of rural economy (Mehta, 2009).

The potentiality of any technology lies not only in efficient utilization of resources and enhanced production but also in improving the quality of life of the farmers on adoption of it. The livelihood of a farmer is influenced by many factors which are having temporal and spatial variability. Therefore, it is not apt to generalize the change in livelihood of farmer only because of the adoption of any particular technology. However, the increased farm production and income is expected to influence changes in livelihood of the farmers, the extent of which may vary. The measure of livelihood gives an idea of the changes on standard of living of the farm families that includes physical, social, financial, human and natural assets of the farm households.

2. METHODOLOGY

Impact on the farming situation of the farmers on adoption of a technology is realized through a comparison of farming pattern, acreage, production, cost of cultivation and

gross income before and after adoption of the technology. Measures of livelihoods have considered the comparative position of physical, social, financial, human and natural assets of the farmers before and after adoption of the intervention (WORLP, OWDM, 2001).

Physical assets include the type of housing condition, sanitation, conveyance, electric, cooking and communication facility. Social assets mainly refer to the recognition, social and political participation, active involvement in developmental works, common services used and group membership pattern. Financial assets are measured on the basis of sources of income, kinds of savings and investments, lending and borrowing. Human assets involve language competencies, education/literacy, management skill and mobility. Natural assets are the natural resources holdings of the farm family *viz.* farm size, irrigated land, livestock holding, poultry and fishpond. All the above-mentioned variables under five types of assets are measured on the basis of the responses of farmers on a 5-point continuum scale (minimum and maximum value is 1 and 5, respectively) during interview schedule survey and focus group discussion. Overall standard of living of farmers is assessed on the basis of their assets holding before and after adoption of a particular technology; the value of overall standard of living ranges from 5 to 25.

Brief detail of sampling of farmers adopting particular technology for the impact assessment is given below:

Name of the technology	No. of sampled farmers adopted the technology	Location
In-situ rainwater conservation for multiple use	9	Sadaiberini and Gajamara, Dhenkanal district
Crop diversification and residual soil moisture utilisation	20 19 20 26	Maturapur, Khntuni, Cuttack dist. Asarala, Begunia, Khurda district Delang, Puri district Arada, Khandayata, Cuttack dist.
Standardization of paper mill sludge application in acid uplands	24 18	Bhimda, Mayurbhanj district Rautrapur, Balasore district
Integration of water chestnut cultivation and aquaculture	35	Raisuan, Haldipada, Balasore district

The afore-said technologies were generated through on-farm research and trial under the projects carried out by the institute following participatory approach. The impact assessment is carried out through interview schedule survey and focus group discussion covering sample of farmers adopting the respective technology.

3. FINDINGS

3.1 Impact of *in-situ* rainwater conservation for multiple use technology:

The technology not only alleviated the fear of drought but also ensured water availability for three crops in succession through two-stage rainwater conservation. The technology generates additional farm employment and water availability (upto 1 m by end of February), which helps in short-duration fish culture, life saving irrigation during dry spells and growing of rabi crop. Kharif rice production level has been enhanced and cropping intensity increased by 31-100%. Mono-cropped rainfed system could be converted into double-cropped system. Assured water availability encouraged fish culture of Indian Major Carps (IMC) in ponds and vegetable crops on embankment that enhanced the overall income of the farmers and provided diversified livelihood options which otherwise depended earlier only on mono-cropping of rice.

Survey of nine farmers who adopted the technology reveals that even though there is not much change in acreage of kharif paddy but its production has been almost doubled, which is mainly due to timely sowing as well as providing irrigation during dry spells from the conserved rainwater. There is an increase in average area under vegetable crops from 1.35 to 1.75 acre with enhanced production from 1.50 to 3.10 tonne. Short-duration fish culture is adopted by six out of nine farmers which has given an additional average income of about Rs. 23900/- per acre to them. The maximum increase in income is from the vegetables (2.5 times) followed by paddy. The total average income of the farmers from the farming has been more than doubled after adoption of in-situ rain water conservation and multiple use technology (Table 1).

It is evident from the Figure 1 and Table 2 that there is an improvement in all the five types of assets of farm families during post-adoption period.

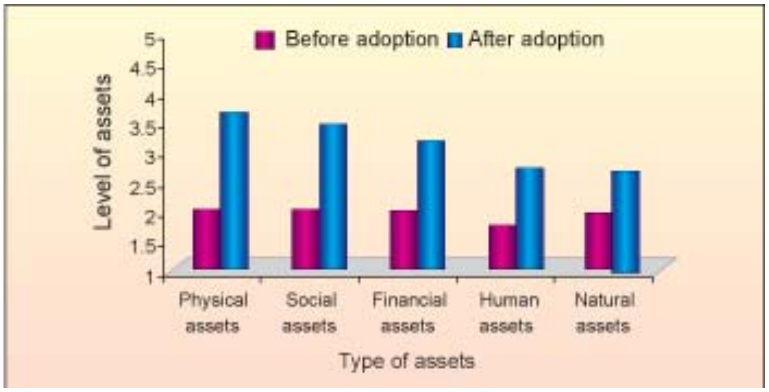


Fig. 1: Average level of different types of assets measuring livelihood of farmers

All the five assets holdings are found to be below average during pre-adoption stage; however, physical, social and financial assets are increased considerably to come at above average level. Maximum improvement is occurred in physical assets (increased by 82%) followed by social

(71%) and human assets (59%) that indicate the improvement in living condition and socio-personal profile of farm families. Financial assets gained by 58%, while natural assets gain is by 40%. Improvement in socio-economic condition and social recognition are also reflected which results in achievement motivation leading to inculcate the entrepreneurial abilities of the farmers. The increased income on adoption of technology has motivated the farmers to invest and intervene further leading to the growth in physical and financial assets.

The changes in overall standard of living of all the nine farmers are presented in Fig. 2.

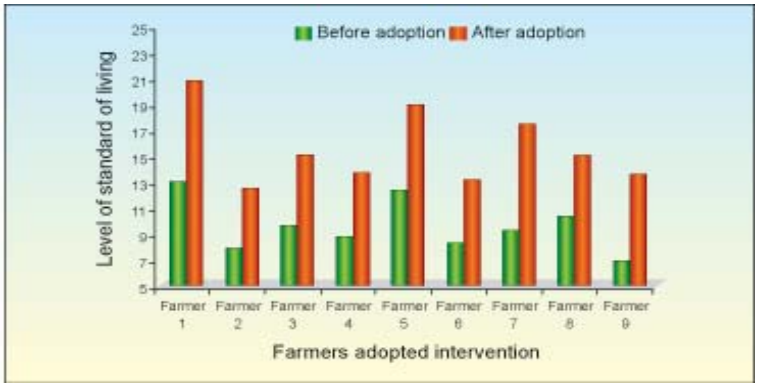


Fig. 2: Overall standard of living of selected farmers before and after adoption

It can be noted that living standard of all nine farmers was below average level prior to opting for in-situ rainwater conservation and it's multiple use. However, with the change of farming situation, adoption of this technology has already helped in bringing the living standard of five farm families at above average level and rest of the four farmers at close to average level. Six farmers (farmer 1, 2, 4, 5, 6 and 7 as indicated in the figure) have engaged in short-duration fish farming while four farmers have taken up dairy (farmer 2, 3, 5, and 8 as indicated in the figure) besides crop farming and their standard of living has relatively more improved. Mean value of overall standard of living of all the nine adopted farmers derived through addition of the mean values of five assets, which indicates that this has increased from 9.64 to 15.67 (minimum and maximum possible value is 5 and 25, respectively). The change in livelihood is a dynamic process and influenced by many factors having spatial and temporal variation. Therefore, the adoption of any technology is one of the factors influencing the changes in livelihood of farmers and the process of change varies from one farmer to another and over the space and time.

As this technology requires initial investments for land shaping, most of the farmers', being resource poor, are unable to implement the technology without financial support from state machineries and financial institutions. In this connection the centre has already appraised different such functionaries through several national level trainings and meetings with concerned officials. It is also recommended as one of the bankable technologies to NABARD for providing financial assistance/loan to the farmers interested to adopt this technology.

Table 1. Assessment of impact of in-situ rainwater conservation for multiple use technology on farming practices of the farmers adopted in Gajamara and Sadeibareni, Dhenkanal district

Name of the farmer	Farm size (acre*)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)	Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Panchanan Behera	12.5	Paddy	7.5	4.5	15000	32000	Paddy	7.5	5.7	20000	45000
		Vegetable	0.5	0.5	2000	5000	Vegetable	2.5	4	12000	40000
							Fish	2.5	1.2	25000	65000
Dhaneswar Samal	7.5	Paddy	5	3	10000	22000	Paddy	5	6	25000	50000
		Vegetable	1.25	1	2000	6000	Cashew	1.5	0.2	2000	12000
		Fish	0.25	0.2	2000	7000	Fish	0.5	0.4	5000	17000
							Dairy	7 nos	700 lit	4000	16000
Srinibas Behera	5.0	Paddy	3.75	2	6000	11000	Paddy	3.75	8	30000	65000
		Vegetable	2.5	3	10000	28000	Vegetable	1.25	2	8000	23000
		Dairy	2nos	300 lit	1500	5500	Dairy	5 nos	500 lit	10000	30000
Gourang Swain	6.5	Paddy	5	3	10000	20000	Paddy	5	4	10000	40000
							Fish	0.065	0.04	500	2500
Brahmananda Swain	22.0	Paddy	20	8	25000	45000	Paddy	20	15	60000	140000
		Fish	1	0.5	5000	20000	Fish	2	1	10000	45000
							Dairy	3 nos	100 lit	1000	2000
Ishwar Ch. Samal	6.25	Paddy	3.75	3	10000	20000	Paddy	3.75	4	20000	40000
		Vegetable	1.25	1	5000	8000	Vegetable	2.5	4	10000	50000
							Fish	0.125	0.08	1000	5000
Souri Sahu	10.0	Paddy	5	3	10000	22000	Paddy	5	5	20000	45000
		Vegetable	1.25	2	8000	14000	Vegetable	1.25	2.5	10000	25000
							Fish	0.25	0.15	2000	9000
Krushna Ch. Swain	15.0	Paddy	15	6	20000	45000	Paddy	15	6	25000	55000
		Dairy	2 nos	100 lit	1000	2000	Dairy	6 nos	200 lit	2000	3800
							Small ruminants	10 nos		5000	20000
Prafulla Sahoo	5.0	Paddy	3.75	2.5	10000	20000	Paddy	3.75	5	20000	50000
							Vegetable	1.25	3	5000	15000
Mean Value	**9.75**	**Paddy (n=9)**	**7.64**	**3.89**	**12889**	**26334**	**Paddy (n=9)**	**7.08**	**6.52**	**25556**	**58889**
		Vegetable (n=5)	**1.35**	**1.50**	**4400**	**12200**	**Vegetable (n=5)**	**1.75**	**3.10**	**9000**	**30600**
		Fish (n=2)	**0.63**	**0.35**	**3500**	**13500**	**Fish (n=5)**	**1.03**	**0.55**	**7250**	**23917**

**1 ha = 2.5 acre*

Table 2. Assessment of impact of in-situ rainwater conservation for multiple use technology on livelihood of the farmers adopted in Gajamara and Sadeibareni, Dhenkanal district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Panchanan Behera	2.43	4	3	4.75	2.5	4.25	2.75	4.25	2.4	3.6
Dhaneswar Samal	1.70	2.4	1.5	2.5	1.5	2.5	1	2	2.2	3.2
Srinibas Behera	1.70	3.10	2.3	4	2	3	1.5	2.25	2.20	2.8
Gourang Swain	1.85	3.57	2	2.75	2.5	3	1.5	2.5	1	2
Brahmananda Swain	2.43	4.5	2.25	4.25	2.5	3.75	2.25	3	3	3.5
Ishwar Ch. Samal	1.7	3.14	1.5	2.5	1.75	2	1.75	2.75	1.6	2.8
Souri Sahu	2.43	4.5	1.75	4.25	2	3.75	1.5	2.25	1.6	2.8
Krushna Ch. Swain	2.43	4	2.25	2.75	1.75	3	1.75	3	2.2	2.4
Prafulla Sahoo	1.4	3.7	1.75	3.5	1.5	3.25	1.25	2.25	1	1
Mean Value	**2.01**	**3.66**	**2.03**	**3.47**	**2.00**	**3.17**	**1.69**	**2.69**	**1.91**	**2.68**
Standard deviation	0.42	0.69	0.48	0.87	0.41	0.68	0.53	0.68	0.66	0.81
% increase	**82.13**		**71.23**		**58.33**		**59.02**		**40.12**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

3.2 Impact of crop diversification and residual soil moisture utilization technologies:

The eastern region of India is endowed with adequate rainfall varying from 1100 mm to more than 1500 mm with nearly 80 percent of it being received during monsoon period (July to October); therefore, farmers do not have option to grow any crop other than rice in kharif season and no crop in rabi season keeping the land fallow due water scarcity. Rice-fallow cropping system not only hampers the agricultural productivity but also causes soil erosion and lowering of soil fertility; therefore, affects the sustainability. In this context, residual soil moisture utilization and crop diversification technology holds paramount importance to alter the non-remunerative farming pattern. The year round crop cover is ensured once farmers are adopting rice, pulse and oilseeds based cropping systems in rainfed upland and medium land situations and residual soil moisture utilization in rainfed low land situations.

The assessment of impact of the technology on farming situation and livelihood of farmers was carried out covering 20 farmers of Mathurapur, Cuttack district and 19 farmers of Asarala, Khurda district adopting crop diversification in rainfed upland and medium land condition, respectively and 20 farmers in Delang, Puri district and 26 farmers in Arada, Cuttack district adopting residual soil moisture utilization technology in rainfed low land condition. Thus, a total of 85 farmers adopting the technology are considered for the impact assessment.

The farmers of Mathurapur village in Cuttack district are having marginal land holding with average 0.61 acre only growing paddy with low yield and income before adoption of crop diversification. The average income is increased by nine fold after the farmers have started growing crops like pigeonpea, horsegram and potato. Pigeonpea as intercrop with paddy was grown by nine farmers while horsegram was grown by 10 farmers. Potato crop is also grown in 0.37 acre during rabi availing irrigation by lifting water from an adjacent dug-well by the group of 20 farmers (Table 3).

The sampled farmers of Asarala village in Khurda district have also adopted crop diversification. The average farm size is about 2.1 acre, where paddy was mainly grown during kharif with lower productivity (1.5 t/ha) prior to adoption of crop diversification technology. Groundnut is grown in an average of 0.9 acre land while blackgram and horsegram occupy about 0.7 and 0.5 acre area in rabi season grown mostly through utilization of residual soil moisture. Irrigation is given two to three times to groundnut crop by lifting water from a creek. Thus, the crop diversification results in higher production and on an average three fold increase in income (Table 4).

The impact on livelihood of the farmers is realized through average holdings of physical, social, financial, human and natural assets by the farmers during pre and

post-adoption period. The minimum and maximum possible mean value for each of the assets is 1 and 5, respectively. The Figures 3 and 4 depict the average level of five types of assets before and after adoption of crop diversification by the sampled farmers.

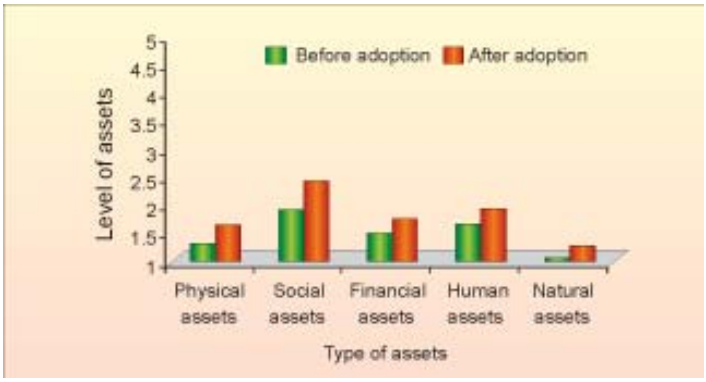


Fig. 3: Average level of different types of assets measuring

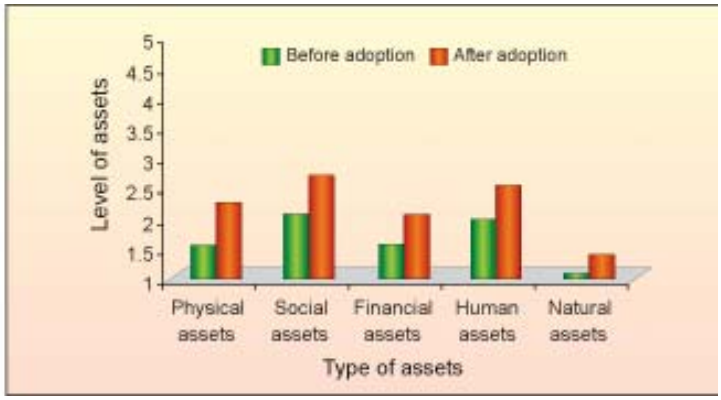


Fig. 4: Average level of different types of assets measuring

Even though there is a gain by 25-26% in physical, financial and natural assets holdings and 17% in financial and human assets of the farmers in Mathurapur village during post-adoption period, all the five types of assets holdings are still remained below average level. The farmers being very resource poor with marginal land holding and cultivating in rainfed upland would need a relatively longer period to have an above average living standard. Social recognition is reflected with higher mean values of social assets holdings of the farmers. Natural assets refer to land, water resource and livestock holding particulars, which is found to be meager for the sampled group of farmers (Fig. 3 and Table 5).

In contrast, the increase in average level of different types of assets of farmers of Asarala village is relatively higher. Physical assets gain is maximum (46%) while an increase

of 32% is found in case of financial, natural and social assets. Inspite of higher gains the average assets holdings are close to average level and needed little more time to come at above average level (Fig. 4 and Table 6).

Overall standard of living of farmers is assessed through addition of mean values of all five types of assets of sampled farmers before and after adoption of the technology. It is presented in the Figures 5 and 6, respectively.

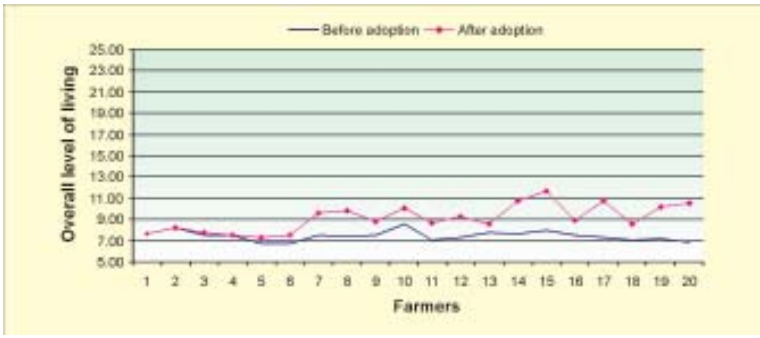


Fig. 5: Living standard of farmers of Mathurapur village in

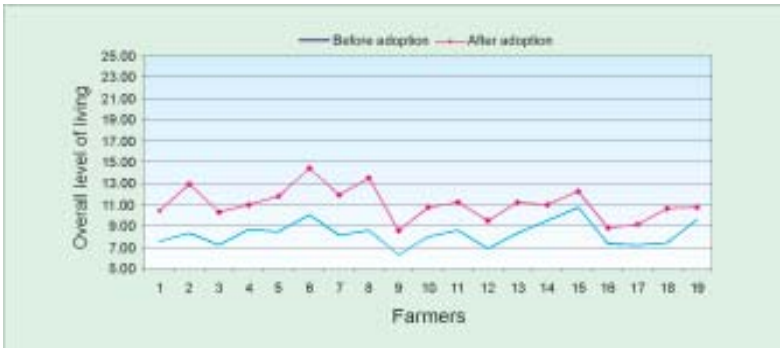


Fig. 6: Living standard of farmers of Asarala village in Khurda

It is noted that living standard of the farmers in both Mathurapur and Asarala remained below average level; however there is an increasing trend in case of all the sampled farmers. The extent of increase is relatively higher in case of the sampled farmers of Asarala. Mean value of overall standard of living of all the adopted farmers derived through addition of the mean values of five assets, which indicates that it is ranged from 6.73 to 8.58 during pre-adoption and from 7.32 to 11.65 during post-adoption period in Mathurapur and from 6.25 to 10.75 during pre-adoption and from 8.57 to 14.43 during post-adoption period in Asarala. It indicates that the process of change in livelihood varies from one farmer to another farmer and over the space and time. The adoption of any technology is not the only but one of the factors influencing the changes in livelihood of farmers.

Table 3. Assessment of impact of crop diversification technology on farming practices of the farmers adopted in Maturapur, Khuntini, Cuttack district

Name of the farmer	Farm size (acre*)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)	Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Panchu Behera	0.4	Paddy	0.4	0.24	500	1300	Paddy	0.33	0.533	1500	4000
							Pigeonpea	0.08	0.03	400	1000
							Potato	0.33	2	2500	10000
Ashok Behera	0.4	Paddy	0.4	0.2	500	1300	Paddy	0.4	0.9	3000	8000
							Potato	0.33	2	2500	10000
							Horsegram	0.08	0.017	50	150
Kalandi Behera	0.5	Paddy	0.5	0.25	600	1800	Paddy	0.5	1.00	3500	8500
							Potato	0.25	1.84	1900	7500
							Horsegram	0.25	0.049	200	500
Mayadhar Behera	0.4	Paddy	0.4	0.2	600	1600	Paddy	0.4	0.8	2500	6500
							Potato	0.4	3	3000	12400
Prafulla Pradhan	0.4	Paddy	0.4	0.2	700	1700	Paddy	0.4	0.6	2000	5000
							Potato	0.4	3	3000	12500
Kanduri Dehuri	0.4	Paddy	0.4	0.3	800	2000	Paddy	0.4	0.5	1000	2800
							Potato	0.4	3	3100	12100
Jambeswar Dehuri	0.4	Paddy	0.4	0.3	700	1900	Paddy	0.33	0.5	1200	3200
							Pigeonpea	0.08	0.03	500	1000
							Potato	0.33	2	3000	10000
							Horsegram	0.08	0.017	65	165
Kanhu Nayak	1.5	Paddy	1.5	0.75	1200	3700	Paddy	1	1.2	4000	10000
							Pigeonpea	0.5	0.2	3000	7000
							Potato	0.4	3	3500	13500
Syama Dehuri	0.4	Paddy	0.4	0.2	600	1600	Paddy	0.33	0.4	1000	3000
							Pigeonpea	0.08	0.025	400	900
							Potato	0.4	2	3000	10000

Basanta Behera	0.4	Paddy	0.4	0.2	500	1400	Paddy	0.4	0.6	1500	4000
							Potato	0.33	2.4	2500	9500
							Horsegram	0.08	0.017	50	150
Narasa Dehuri	0.4	Paddy	0.4	0.3	800	2000	Paddy	0.4	0.6	2000	5000
							Potato	0.4	2	3000	10000
Madhaba Behera	0.4	Paddy	0.4	0.25	700	1700	Paddy	0.33	0.53	1500	4000
							Pigeonpea	0.08	0.03	400	1000
							Potato	0.4	2	2400	9400
Pravakar Pradhan	0.4	Paddy	0.4	0.15	400	1000	Paddy	0.33	0.3	1000	2500
							Pigeonpea	0.08	0.025	500	800
							Potato	0.33	2	2500	9700
							Horsegram	0.08	0.012	60	150
Hrudananda Sahu	1	Paddy	1	0.7	1500	4500	Paddy	0.5	1	3500	9000
							Pigeonpea	0.4	0.15	2000	5000
							Potato	0.4	1	2000	5500
Satrughna Pradhan	1	Paddy	1	0.5	1200	3700	Paddy	1	1	3000	9000
							Potato	0.4	2	3000	10000
							Horsegram	0.4	0.085	350	600
Gueubari Behera	0.4	Paddy	0.4	0.2	600	1600	Paddy	0.33	0.3	1000	2500
							Pigeonpea	0.08	0.025	450	1000
							Potato	0.33	1.5	2500	7500
							Horsegram	0.08	0.02	80	160
Basudev Behera	1	Paddy	1	0.5	1500	4000	Paddy	1	1.25	4000	10000
							Potato	0.4	2	3100	8600
							Horsegram	0.4	0.08	300	600
Ramesh Pradhan	0.4	Paddy	0.4	0.3	800	2000	Paddy	0.3	0.3	900	2400
							Pigeonpea	0.08	0.03	400	900
							Potato	0.4	3	3000	12500
Bijay Dehuri	1	Paddy	1	0.5	1200	3200	Paddy	1	1.5	5000	13000
							Potato	0.4	2	3100	8600
							Horsegram	0.4	0.085	300	600

Prafulla Sahu	1	Paddy	1	0.5	1200	3600	Paddy	1	1.2	4000	11000
							Potato	0.4	3	3000	12500
							Horsegram	0.4	0.08	300	500
Mean value	**0.61**	**Paddy (n=20)**	**0.61**	**0.34**	**830**	**2280**	**Paddy (n=20)**	**0.53**	**0.75**	**2355**	**6170**
							Pigeonpea (n=9)	**0.16**	**0.06**	**895**	**2067**
							Potato (n=20)	**0.37**	**2.24**	**2780**	**10090**
							Horsegram (n=10)	**0.23**	**0.05**	**176**	**358**
Standard deviation	0.34	Paddy (n=20)	0.34	0.18	342	1064	Paddy (n=20)	0.28	0.36	1294	3344
							Pigeonpea (n=9)	0.17	0.07	945	2286
							Potato (n=20)	0.04	0.58	406	2031
							Horsegram (n=10)	0.16	0.03	126	217

*1 ha = 2.5 acre

Table 4. Assessment of impact of crop diversification technology on farming practices of the farmers adopted in Asarala, Begunia, Khurda district

Name of the farmer	Farm size (acre)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)	Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Rabindra Swain	2	Paddy	1	0.9	4000	6000	Paddy	2	1.9	8000	18000
							Blackgram	1	0.25	2000	5000
							Horsegram	0.4	0.085	350	550
							Groundnut	0.6	0.3	1500	3500
Sarat Behera	2	Paddy	2	0.8	3500	5000	Paddy	2	1.9	8000	17000
							Blackgram	1	0.25	2000	5000
							Horsegram	0.4	0.1	350	700
							Groundnut	0.4	0.25	1500	3000
Ankura Pradhan	1	Paddy	1	0.8	3500	5500	Paddy	1	1	1900	9000
							Blackgram	0.4	0.12	1200	2500
							Horsegram	0.4	0.1	300	750
Sukanta Behera	1	Paddy	1	0.9	3400	6300	Paddy	1	0.9	4200	8550
							Blackgram	0.5	0.15	1500	3000
							Horsegram	0.5	0.058	350	750
Sasikanta Behera	1	Paddy	1	0.85	3500	5500	Paddy	1	0.9	4200	8800
							Blackgram	0.5	0.15	1500	3000
							Groundnut	0.5	0.25	1500	3000
							Dairy				2000
Balaram Sahoo	4	Paddy	4	1.5	8000	10000	Paddy	4	3	16000	30000
							Blackgram	0.5	0.15	1200	3000
							Groundnut	2	0.8	6000	12000
Narasingh Sahoo	4	Paddy	4	1.5	8000	14000	Paddy	4	4	12000	40000
							Blackgram	1	0.25	3000	7000
							Groundnut	1	0.5	3000	6000

Natabara Pandey	5	Paddy	5	3.5	15000	20000	Paddy	5	5	22000	45000
							Blackgram	0.5	0.15	1500	3500
							Horsegram	0.5	0.05	150	550
Laxmidhara Upadhaya	1.5	Paddy	1	0.8	3500	5400	Paddy	1	1	4500	9000
							Blackgram	1	0.3	3500	7000
							Horsegram	0.4	0.07	200	575
Prasana Ku Tripathy	1	Paddy	1	0.9	3600	6000	Paddy	1	1	4500	9000
							Blackgram	0.4	0.15	1200	3500
							Horsegram	0.4	0.1	350	600
Rabindra Ku Mohapatra	3	Paddy	3	1.9	9000	15000	Paddy	3	3	15000	27000
							Blackgram	1	0.3	3000	6500
							Groundnut	2	0.75	4000	9000
Umakanta Upadyaya	1	Paddy	1	0.8	3600	6000	Paddy	1	1	4500	9000
							Blackgram	0.4	0.12	1200	2500
							Horsegram	0.4	0.15	500	1000
Pathani Pradhan	4	Paddy	4	1.5	7000	12000	Paddy	4	3.5	15000	30000
							Blackgram	1	0.25	3500	7000
							Horsegram	1	0.3	1000	2000
							Groundnut	1	0.4	2500	5000
Krupasindhu Khatai	2.5	Paddy	2	1.6	7500	12000	Paddy	1	1.2	7000	15000
							Blackgram	1	0.3	3000	7000
							Horsegram	1	0.2	800	1600
Nabakishore Jena	0.67	Paddy	0.67	0.6	3000	5000	Paddy	0.67	0.8	3500	7000
							Blackgram	0.4	0.12	1000	1800
							Horsegram	0.25	0.07	150	500
							Business				30000
Kanhu Ch Sahoo	1	Paddy	1	0.8	3700	5700	Paddy	1	1	4500	9000
							Blackgram	0.4	0.15	1500	3500
							Horsegram	0.4	0.12	300	700
Prasant Sahoo	1	Paddy	1	0.8	3650	6000	Paddy	1	1	4500	9000
							Blackgram	0.4	0.15	1200	3000
							Horsegram	0.4	0.1	250	600

Ram Ch Sahoo	1	Paddy	1	0.9	3600	6400	Paddy	1	1	4500	9000
							Blackgram	1	0.250	2500	5000
Harekrushna Sahoo	3	Paddy	3	2.2	10000	15000	Paddy	2	2	9000	18000
							Blackgram	1	0.300	3000	6000
							Horsegram	0.4	0.15	350	700
							Groundnut	1	0.6	2500	7000
Mean Value	**2.09**	**Paddy (n=19)**	**1.98**	**1.24**	**5634**	**8779**	**Paddy (n=19)**	**1.93**	**1.85**	**8042**	**17229**
							Blackgram (n=19)	**0.71**	**0.20**	**2026**	**4463**
							Horsegram (n=14)	**0.49**	**0.12**	**386**	**827**
							Groundnut (n=9)	**0.94**	**0.43**	**2500**	**5389**
Standard deviation	1.36	Paddy (n=19)	1.39	0.71	3228	4512	Paddy (n=19)	1.37	1.25	5456	11649
							Blackgram (n=19)	0.29	0.07	880	1815
							Horsegram (n=14)	0.22	0.07	240	438
							Groundnut (n=9)	0.63	0.22	1557	3190

*1 ha = 2.5 acre

Table 5. Assessment of impact of crop diversification technology on livelihood of the farmers adopted in Maturapur, Khuntini, Cuttack district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Panchu Behera	1.7	1.7	2	2	1.5	1.5	1.5	1.5	1	1
Ashok Behera	1.7	1.7	2.25	2.25	1.5	1.5	1.75	1.75	1	1
Kalandi Behera	1.28	1.28	2	2.25	1.5	1.5	1.75	1.75	1	1
Mayadhar Behera	1.28	1.28	2	2	1.5	1.5	1.75	1.75	1	1
Prafulla Pradhan	1.28	1.57	1.5	1.75	1.5	1.5	1.5	1.5	1	1
Kanduri Dehuri	1.28	1.57	2	2.5	1.5	1.5	1.75	1.75	0.2	0.2
Jambeswar Dehuri	1.28	1.57	2	3	1.5	2	1.75	2	1	1
Kanhu Nayak	1.42	2	1.75	2.5	1.5	2	1.75	1.75	1	1.6
Syama Dehuri	1.28	1.57	2	2.25	1.5	1.75	1.75	2	1	1.2
Basanta Behera	1.28	1.71	2.25	2.5	1.5	1.5	1.75	2	1.8	2.4
Narasa Dehuri	1.28	1.71	1.75	2.5	1.5	1.75	1.5	1.75	1	1
Madhaba Behera	1.28	1.57	1.75	2.5	1.5	1.75	1.75	2	1	1.4
P. Pradhan	1.71	1.85	2	2.25	1.5	1.5	1.5	2	1	1
H. Sahu	1.42	2.42	2	2.5	1.5	1.75	1.75	2.25	1	1.8
S. Pradhan	1.14	1.85	2.25	3.25	1.5	2.25	1.75	2.5	1.4	1.8
Gueubari Behera	1.28	1.42	2	2.5	1.5	1.5	1.75	2.25	1	1.2
Basudev Behera	1.28	2	1.75	2.5	1.5	2.25	1.75	2.25	1	1.8
Ramesh Pradhan	1.28	1.57	1.75	2.25	1.5	1.5	1.5	2	1	1.2
Bijay Dehuri	1.14	1.57	1.75	2.5	1.5	2.25	1.75	2	1	1.8
Prafulla Sahu	1.14	1.57	1.75	2.75	1.5	2.25	1.5	2.5	1	1.4
Mean Value	**1.34**	**1.67**	**1.93**	**2.43**	**1.50**	**1.75**	**1.68**	**1.96**	**1.02**	**1.29**
SD	0.17	0.26	0.20	0.34	0.00	0.30	0.12	0.28	0.27	0.47
% increase	**25.25**		**25.97**		**16.67**		**17.16**		**26.47**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

Table 6. Assessment of impact of crop diversification technology on livelihood of the farmers adopted in Asarala, Begunia, Khurda district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Rabindra Swain	1.57	2.14	1.75	2.5	1.5	2.25	1.75	2.5	1	1
Sarat Behera	1.57	2.57	2.5	3.25	1.5	2.25	1.75	3.25	1	1.6
Ankura Pradhan	1.43	1.86	1.5	2.75	1.5	2	1.75	2.5	1	1.2
Sukanta Behera	1.14	1.86	2.25	2.75	1.5	2	2.75	3	1	1.4
Sasikanta Behera	1.71	2.43	2	3	1.5	2.25	2.25	2.75	1	1.4
Balaram Sahoo	2.57	3.43	2.5	3.25	2	2.75	1.75	3	1.2	2
Narasingh Sahoo	1.43	2.43	2.25	3	1.5	2	1.75	2.5	1.2	2
Natabara Pandey	1.57	3	2	3.25	1.5	2.25	2.25	3	1.2	2
Laxmidhara Upadhaya	1	1.57	1.25	2	1.5	2	1.5	2	1	1
P. Ku Tripathy	1.71	2.14	1.75	2.5	1.5	2	2	2.75	1	1.4
R. K. Mohapatra	1.57	2.29	2.5	3	1.5	2	1.75	2.5	1.2	1.4
Umakanta Upadyaya	1.14	1.57	1.5	2.5	1.5	1.75	1.75	2.5	1	1.2
Pathani Pradhan	1.9	2.71	2	2.75	1.5	2.25	1.75	2.25	1.2	1.2
K. Khatai	1.29	2	2.75	2.75	1.5	2	2.75	3	1.2	1.2
Nabakishore Jena	2	3	2.75	3	2.25	2.5	2.75	2.75	1	1
Kanhu Ch Sahoo	1.29	1.57	1.75	2.25	1.5	1.75	1.75	2.25	1	1
Prasant Sahoo	1.14	1.71	1.75	2.25	1.5	1.5	1.75	2.5	1	1.2
Ram Ch Sahoo	1.14	2	1.75	2.5	1.5	2	2	2.5	1	1.6
H.K. Sahoo	2.14	2.57	2.75	2.75	1.5	2	2.0	1.2	1.2	2.25
Mean Value	**1.54**	**2.26**	**2.07**	**2.74**	**1.57**	**2.08**	**1.99**	**2.56**	**1.07**	**1.42**
SD	0.40	0.53	0.46	0.36	0.20	0.28	0.39	0.46	0.10	0.39
% increase	**46.34**		**32.48**		**32.77**		**29.01**		**32.60**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

The residual soil moisture utilization technology in rainfed low land situation is being adopted by 20 sampled farmers of Delang in Puri district. The average land holding is about 1.7 acre and Paddy is the predominant crop during kharif season with productivity increased from 2.7 to 3.7 t/ha due to adoption of scientific practices. Blackgram and/or greengram crops are grown by the farmers in rabi season mostly through utilization of residual soil moisture sown in standing crop of paddy or after the harvest of paddy in the area which otherwise used to be kept fallow. The average productivity of greengram and blackgram achieved by the farmers is 0.83 and 0.71 t/ha, respectively providing an additional income of about Rs. 20000/-. Dairy is taken as secondary occupation by the farmers. Irrigation is given two to three times to groundnut crop by lifting water from a creek. Thus, the crop diversification results in higher production and on an average three fold increase in income (Table 7).

The farmers of Arada village in Cuttack district surveyed during present study used to keep few patches of their low land fallow after harvest of paddy prior to opt for residual soil moisture utilization to grow pulses like blackgram and horsegram. Average cultivable area is 4.5 acre which is predominantly occupied by paddy crop. Farmers used to grow vegetables in about 1.4 acre; however, they have started growing pulses in about 1.6 acre with available residual soil moisture that has given an additional income of Rs. 8500/-. Nine farmers grow paddy in their uplands with short duration and relatively lower yield (Table 8).

The impact on livelihood of the farmers is assessed through mean level of physical, social, financial, human and natural assets holdings by the farmers, which refer to living situation, social recognition, economic condition, socio-personal characteristics and land/water/livestock resources of the farm family during pre and post-adoption period. The minimum and maximum possible mean value for each of the assets is 1

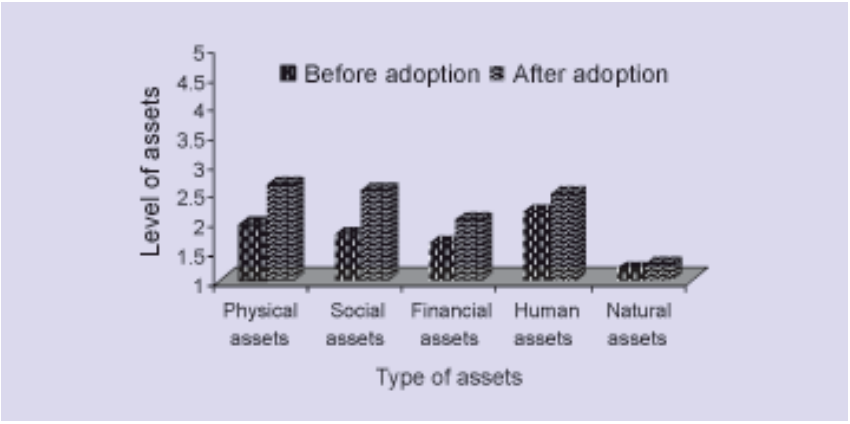


Fig. 7: Average level of different types of assets measuring livelihood of farmers of Delang in Puri district

and 5, respectively. The Figures 7 and 8 depict the average level of five types of assets before and after adoption of crop diversification by the sampled farmers.

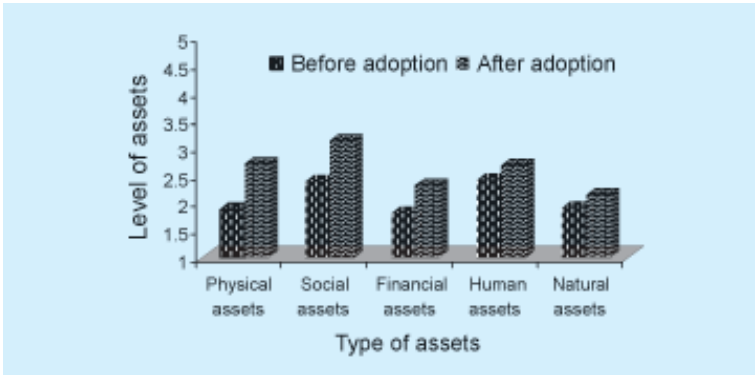


Fig. 8: Average level of different types of assets measuring livelihood of farmers of Arada village in Cuttack district

There is increase in all five types of assets holdings, maximum (43%) being the social asset and minimum (7.5%) in case of natural assets of the farmers in Delang. However, all the five types of assets holdings are still remained below average level and would need more time to come at an above average level. Betterment in living condition, social recognition and improved socio-personal profile is reflected with higher mean values of physical, social and human assets holdings of the farmers. Natural assets refer to land, water resource and livestock holding particulars, which is found to be at a low level for the sampled farmers in Delang. In case of the farmers in Arada village, physical assets gain is maximum (45%) followed by social (30%) and financial asset (28%). Both human and financial asset has increased by 11%. The social asset has crossed the average level while physical and human assets are closing to average level (Tables 9 and 10).

Overall standard of living of farmers is calculated both before and after adoption of the technology. It is presented in the Figures 9 and 10.

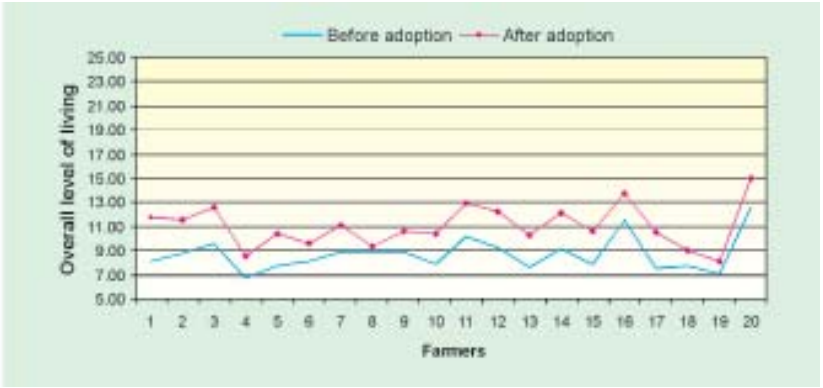


Fig. 9: Living standard of farmers of Delang in Puri district

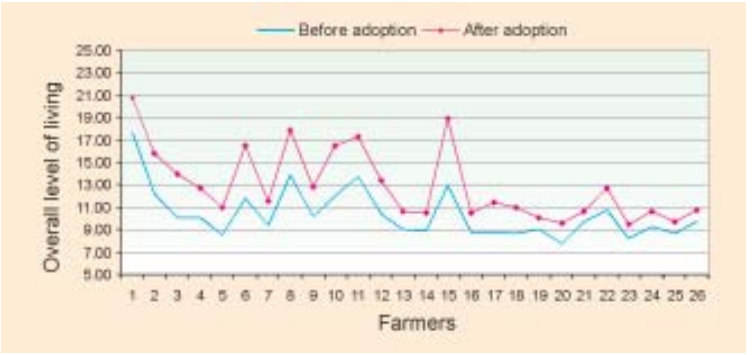


Fig. 10: Living standard of farmers of Arada village in Cuttack district

Mean value of overall living standard of all the selected farmers derived through addition of the mean values of five assets, which indicates that it is ranged from 6.75 to 12.60 during pre-adoption and from 8.14 to 15.02 during post-adoption period in Delang. It is observed that living standard of the selected farmers in Delang remained below average level barring one farmer crossing the average level. An increasing trend is evident in case of all the sampled farmers. Mean value of overall standard of living ranged from 7.74 to 17.60 during pre-adoption and from 9.45 to 20.75 during post-adoption period in case of sampled farmers of Arada village. It indicates that the extent of increase in level of living is relatively higher in Arada. Living standard of seven out of 26 farmers has reached above average level during post-adoption period. Inspite of having rich natural resources, rural eastern India is still poverty stricken with narrow livelihood options. The only way to alleviate poverty in this region is an improvement in agricultural productivity. But, major constraint to the improvement in agricultural productivity is poor water management scenario arising out of both scarcities as well excess of the water. On adoption of residual soil moisture utilisation and crop diversification technology, farming communities get benefit of increased production and income that led to their better living. The mono cropping practice with poor rice production has been transformed into multiple cropping with higher crop productivity which in term enhanced the net return of the farmers along with diversified livelihood options. By integrating pulse and oilseeds crops into the rice based cropping system, more insurance in terms of crop production and net returns has been achieved, which also significantly enhanced the livelihood security of poor farmers.

Livelihood of one farmer varies from another farmer even with similar farming situation and adoption behaviour. The adoption of any technology is not the only factor influencing the changes in livelihood of farmers as livelihood is function of many other direct and indirect factors like quality and quantity of land holding, resource endowment, family members' profile, etc having temporal and spatial variability.

Table 7. Assessment of impact of residual soil moisture utilization technology on farming practices of the farmers adopted in Delang, Puri district

Name of the farmer	Farm size (acre)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross Income (Rs.)	Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross Income (Rs.)
Braja Kishore Behera	1	Paddy	1	1	2500	7500	Paddy	1	1.25	7000	10500
		Dairy			2500	7500	Blackgram	1	0.35	4000	10000
							Dairy			9000	19000
Rabindra Samantaray	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	12500
							Blackgram	1	0.3	4000	9000
Naba Kishore Samantaray	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	6500	12500
							Blackgram	1	0.25	4000	8000
Bajia Pradhan	1	Paddy	1	1.12	3000	8500	Paddy	1	1.5	7000	13500
							Blackgram	1	0.3	4000	9000
Chhabindra Samantaray	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	12500
							Greengram	1	0.4	4000	12000
							Others		0.5	17000	35000
Reenamabi Nayak	1	Paddy	1	1.1	3000	8500	Paddy	1	1.5	6500	12000
							Greengram	1	0.4	4000	12000
Bidyadhar Behera	1.5	Paddy	1.5	1.6	4000	11500	Paddy	1.5	2.7	12000	22000
		Dairy			2000	6000	Blackgram	1	0.25	4000	8000
							Dairy			12000	24000
Satyabadi Behera	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	14000
							Blackgram	1	0.2	4000	7000
Anil Parida	1	Paddy	1	1.1	3000	8000	Paddy	1	1.6	7000	14000
							Blackgram	1	0.25	4000	8000
Kalandi Behera	1	Paddy	1	1.12	3000	8600	Paddy	1	1.6	7000	14000
							Greengram	1	0.35	5000	11000
Krushna Behera	2	Paddy	2	2.2	6000	16000	Paddy	2	3.2	14000	28000
		Dairy			3000	9000	Greengram	1	0.3	4000	9000
							Dairy			9000	18000
Narayan Behera	2.5	Paddy	2.5	2.5	7500	20000	Paddy	2.5	3.5	17000	33000
		Dairy			3000	9000	Greengram	1	0.25	4000	8000
							Dairy			3000	6000

Kailash Behera	2.5	Paddy	2	2.2	6000	17000	Paddy	2	3.6	14000	35000
							Blackgram	2	0.5	8000	15000
Ullasha Behera	2.5	Paddy	2.5	2.7	7500	21000	Paddy	2.5	3.6	18000	35000
							Blackgram	1	0.2	3000	6000
							Greengram	1	0.3	4000	9000
Santosh Behera	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	14000
							Blackgram	1	0.22	3000	6000
Dipak Kumar Parida	4	Paddy	4	4.4	12000	34000	Paddy	4	6	28000	53000
		Others			18000	78000	Blackgram	2	0.5	7000	12000
							Others				60000
Sundari Parida	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	14000
							Blackgram	1	0.25	4000	8000
Jagannath Behera	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	14000
							Blackgram	1	0.3	3000	5000
Dhuna Pradhan	1	Paddy	1	1.1	3000	8000	Paddy	1	1.5	7000	13000
							Blackgram	1	0.3	3000	5000
Syamsunder Samantray	6	Paddy	6	6.6	18000	48000	Paddy	6	8	42000	75000
							Blackgram	3	1.2	12000	22000
Mean Value	**1.7**	**Paddy (n=20)**	**1.68**	**1.82**	**4975**	**13630**	**Paddy(n=20)**	**1.68**	**2.50**	**11750**	**22575**
		Dairy (n=4)			**2625**	**7875**	**Blackgram (n=15)**	**1.27**	**0.36**	**4733**	**9200**
							Greengram (n=6)	**1.00**	**0.33**	**4167**	**10167**
							Dairy(n=3)			**11000**	**22333**
Standard deviation	1.3	Paddy (n=20)	1.29	1.41	4470	16237	Paddy(n=20)	1.29	1.77	9059	16700
		Dairy (n=4)			479	1436	B.gram (n=15)	0.59	0.25	2463	4411
							G.gram (n=6)	0.00	0.06	408	1722
							Dairy(n=3)			3775	7632

Table 8. Assessment of impact of residual soil moisture utilization technology on farming practices of the farmers adopted in Arada, Cuttack district

Name of the farmer	Farm size (acre)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross Income (Rs.)	Particular	Area (acre)	Production (t)	Cost of cultivation (Rs.)	Gross Income (Rs.)
Dibakar Jena	10	Paddy	5	3	10000	20000	Paddy	5	6	25000	50000
		Vegetable	2.5	2.5	15000	25000	Vegetable	2.5	4	25000	45000
							Pulses	2.5	0.75	5000	10000
							Upland Paddy	5	3	10000	20000
Gangadhar Khatua	5	Paddy	2.5	1.5	5500	10500	Paddy	5	3	12000	27000
		Vegetable	1.25	1.5	10000	12500	Vegetable	1.25	1.5	15000	30000
							Pulse	1.25	0.4	4000	8000
Pitabash Mohanty	2.5	Paddy	1.25	1	2500	7500	Paddy	2.5	3	10000	22000
		Vegetable	1.25	1	7000	10000	Vegetable	1.25		5000	10000
							Pulse	1.25	0.5	4000	9000
Ganesh Ch Mohanty	5	Paddy	2.5	1.5	4000	7500	Paddy	2.5	4	20000	35000
		Vegetable	1.25	1.25	5500	12500	Vegetable	1.25	2	12500	22500
							Pulse	1.25	0.5	4000	9000
							Upland Paddy	2.5	1.5	5000	9000
Bramhananda Ojha	2.5	Paddy	1.25	1	5000	7000	Paddy	2.5	3	10000	25000
		Vegetable	1.25	2	10000	18000	Vegetable	1.25	0.5	7000	15000
							Pulse	1.25	0.5	4000	9000
Sanatana Nanda	5	Paddy	2.5	1.5	2500	10000	Paddy	2.5	3	12500	24000
		Vegetable	1.25	1.25	7500	12500	Vegetable	1.25	1.8	12000	22500
							Pulse	1.25	0.35	3000	5000
							Upland Paddy	2.5	1.5	3500	6000
Suma Pradhan	2.5	Paddy	1.25	1	5000	7000	Paddy	2.5	3	12000	25000
		Vegetable	1.25	1.5	10000	20000	Vegetable	1.25	2.5	15000	30000
							Pulse	1.25	0.45	4000	7000
Bibuti Bhusan Jena	10	Paddy	5	2	7000	12000	Paddy	7.5	7	30000	60000
		Vegetable	2.5	1.5	12000	20000	Vegetable	2.5	3	25000	45000
							Pulses	2.5	0.7	5000	9000
							Upland Paddy	2.5	1.2	5000	8000

Durga Charan Jena	5	Paddy	2.5	3	10000	18000	Paddy	2.5	3	12000	25000
		Vegetable	1.25	1.5	5000	14000	Vegetable	1.25	1.5	15000	20000
							Pulse	2.5	0.8	5000	10000
Sankarshan Mohanty	5	Paddy	1.25	1	3500	7000	Paddy	2.5	3	15000	27000
		Vegetable	1.25	1	5500	10000	Vegetable	1.25	1	7000	12500
							Pulses	2.5	0.6	5000	10000
							Upland Paddy	2.5	1.5	4000	10000
Prasanta Ku Lenka	10	Paddy	5	3	10000	20000	Paddy	5	6	25000	50000
		Vegetable	2.5	2.5	15000	22000	Vegetable	2.5	3	25000	45000
							Pulses	2.5	0.6	5000	9000
							Upland Paddy	5	3	7000	12000
Purna Ch. Behera	3.75	Paddy	2.5	1.5	5000	10000	Paddy	2.5	3	7500	12500
		Vegetable	1.25	1.5	7500	12500	Vegetable	1.25	2	12500	22500
							Pulses	1.25	0.3	2000	5000
							Upland Paddy	1.25	0.5	2000	3000
Umesh Das	2.5	Paddy	1.25	1	4000	7000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1	5000	9000	Vegetable	1.25	1.8	5000	20000
							Pulses	1.25	0.3	2000	5000
Brahmananda Behera	2.5	Paddy	1.25	0.75	2500	5000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1	4000	8000	Vegetable	1.25	1	7000	20000
							Pulses	1.25	0.7	4000	10000
Rabindra Behera	7.5	Paddy	5	3	10000	16000	Paddy	5	6	25000	45000
		Vegetable	2.5	2.5	15000	22000	Vegetable	2.5	4	35000	55000
							Pulses	2.5	0.6	5000	9000
Sibaprasad Panda	5	Paddy	2.5	1.5	5000	9000	Paddy	2.5	3	7500	12500
		Vegetable	1.25	1.5	7500	12500	Vegetable	1.25	1.5	2500	22500
							Pulses	1.25	0.3	2000	5000
							Upland Paddy	2.5	1.5	3500	6000

Dulav Behera	5	Paddy	2.5	1.5	3500	7000	Paddy	2.5	3	12500	25000
		Vegetable	1.25	1.5	7500	12500	Vegetable	1.25	2	12500	22500
		Animal				2000	Pulses	1.25	0.7	5000	10000
							Upland Paddy	2.5	1.25	3500	7000
							Animal				4000
Ganeswar Jena	2.5	Paddy	1.25	0.75	3500	7000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1.5	8000	15000	Vegetable	1.25	2	15000	25000
							Pulses	1.25	0.7	5000	10000
Mahendra Pradhan	2.5	Paddy	2.5	3	10000	20000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1.5	5000	10000	Vegetable	1.25	2	15000	20000
							Pulses	1.25	0.5	5000	10000
Gunanidhi Jena	2.5	Paddy	2.5	3	8000	15000	Paddy	2.5	2.7	7000	20000
		Vegetable	1.25	1.5	8000	15000	Vegetable	1.25	1.8	15000	20000
							Pulses	1.25	0.4	5000	10000
Krushna Ch Jena	2.5	Paddy	2.5	3	8000	16000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1.5	10000	15000	Vegetable	1.25	1.8	15000	20000
							Pulses	1.25	0.4	5000	10000
Laxmidhar Behera	5	Paddy	2.5	1.5	5000	10000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1.5	7000	12000	Vegetable	1.25	1	5000	10000
							Pulses	1.25	0.3	5000	7000
Dushasan Das	2.5	Paddy	1.25	1	3500	7000	Paddy	2.5	2.5	7000	20000
		Vegetable	1.25	1.25	7000	10000	Vegetable	1.25	1.5	5000	15000
							Pulses	1.25	0.4	4000	10000
Krushna Ch Behera	5	Paddy	2.5	1.5	5000	10000	Paddy	2.5	2	8000	18000
		Vegetable	1.25	1.5	7500	12500	Vegetable	1.25	2	12500	22500
							Pulses	1.25	0.3	3000	9000
							Upland Paddy	2.5	1.5	3500	6000

Patitapaban Pradhan	2.5	Paddy	1.25	1	3500	7000	Paddy	1.25	2	7000	20000
		Vegetable	1.25	1.5	5000	10000	Vegetable	1.25	2	15000	25000
							Pulses	2.5	0.6	5000	9000
Akhaya Lenka	2.5	Paddy	1.25	0.75	3500	7000	Paddy	2.5	3	7000	20000
		Vegetable	1.25	1.5	6000	12000	Vegetable	1.25		15000	30000
							Pulses	1.25	0.3	3000	9000
Mean Value	**4.47**	**Paddy (n=26)**	**2.40**	**1.70**	**5576.92**	**10750.00**	**Paddy (n=26)**	**3.03**	**3.32**	**12076.92**	**26269.23**
		Vegetable (n=26)	**1.44**	**1.53**	**8173.08**	**14019.23**	**Vegetable (n=26)**	**1.44**	**1.82**	**13480.77**	**24903.85**
							Pulses (n=26)	**1.59**	**0.50**	**4153.85**	**8576.92**
							Upland Paddy (n=9)	**3.06**	**1.77**	**5000.00**	**9333.33**
Standard deviation	0.98	Paddy (n=26)	1.27	0.86	2629	4775	Paddy (n=26)	1.33	1.35	6982	11938
		Vegetable (n=26)	0.46	0.42	3168	4494	Vegetable (n=26)	0.46	0.85	7542.52	11258
							Pulses (n=26)	0.57	0.16	1047	1770
							Upland Paddy (n=9)	1.10	0.71	2208	4500

*1 ha = 2.5 acre

Table 9. Assessment of impact of residual soil moisture utilization technology on livelihood of the farmers adopted in Delang, Puri district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Braja Kishore Behera	2.28	3.71	1.5	2.5	1.5	2	1.25	1.75	1.6	1.8
Rabindra Samantaray	1.85	2.57	1.5	2.5	1.75	2.5	2.75	3	1	1
Naba Kishore Samantaray	2.14	2.57	2.25	3	2	2.75	2.25	3.25	1	1
Bajia Pradhan	1	1.87	1.5	2.5	1.5	1.5	1.75	1.75	1	1
Chhabindra Samantaray	1.28	2.42	1.25	2.25	1.75	2.25	2.5	2.5	1	1
Reenamabi Nayak	1.57	2.14	1.5	1.5	1.75	2.25	2.25	2.75	1	1
Bidyadhar Behera	2.28	3	1.5	2.5	1.5	1.75	2	2	1.6	1.8
Satyabadi Behera	1.87	1.87	2.25	2.75	2	2	1.75	1.75	1	1
Anil Parida	1.71	2.42	2	2.5	1.5	1.5	2.75	3.25	1	1
Kalandi Behera	2.14	2.28	1.5	2.5	1.5	1.75	1.75	2.25	1	1.6
Krushna Behera	2.14	3.42	2.25	2.5	1.5	2	2.5	3	1.8	2
Narayan Behera	2.28	3.28	1.5	2.5	1.5	2	2	2.25	2	2.2
Kailash Behera	1.87	2.57	1.5	2.5	1.5	2	1.75	2.25	1	1
Ullasha Behera	2.71	3.42	1.5	2.5	1.5	2.25	2.25	2.5	1.2	1.4
Santosh Behera	1.42	2.14	2	2.5	1.5	2.25	2	2.75	1	1
Dipak Kumar Parida	3.14	3.28	2.25	3	1.75	2.5	3.25	3.5	1.2	1.4
Sundari Parida	1.57	2.28	1.5	2.75	1.5	2	2	2.5	1	1
Jagannath Behera	1.28	2	1.75	2.25	1.5	1.5	2.25	2.25	1	1
Dhuna Pradhan	1.28	2.14	1.75	2	1.5	1.5	1.5	1.5	1	1
S. Samantray	3	3.42	3	4	2.25	2.75	2.75	3.25	1.6	1.6
Mean Valu e	**1.94**	**2.64**	**1.79**	**2.55**	**1.64**	**2.05**	**2.16**	**2.50**	**1.20**	**1.29**
Standard Deviation	0.58	0.59	0.43	0.47	0.22	0.39	0.49	0.58	0.32	0.40
% increase	**36.05**		**42.66**		**25.19**		**15.61**		**7.50**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

Table 10. Assessment of impact of residual soil moisture utilization technology on livelihood of the farmers adopted in Arada, Cuttack district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Dibakar Jena	2.85	5	4.5	4.5	2.75	3.5	4	4	3.5	3.75
Gangadhar Khatua	2.71	3.57	3	4	2	2.75	2.5	3.25	2	2.2
Pitabash Mohanty	1.71	3	2	3	2.25	3	2.5	3	1.6	2
Ganesh Ch Mohanty	2.28	3	2	3	1.5	2.25	2.5	2.5	1.8	2
Bramhananda Ojha	1.42	2.14	1.75	2.75	1.75	2	2	2.25	1.6	1.8
Sanatana Nanda	2.28	3.28	3	4	2	3	2.5	3.25	2	3
Suma Pradhan	1.57	2.28	2	3	1.75	2	2.25	2.25	1.8	2
Bibuti Bhusan Jena	2.85	4.28	3	4	2	3	2.75	3.25	3.2	3.4
Durga Charan Jena	2.14	2.85	2	2.75	1.75	2	2.25	3	2	2.2
Sankarshan Mohanty	2.28	3.85	2.5	3.75	2.25	3	2.75	3.25	2.2	2.6
Prasanta Ku Lenka	3	4.14	2.75	4	2	2.75	2.75	3	3.2	3.4
Purna Chandra Behera	2	2.42	2.5	3	2	3	2.25	2.75	1.6	2.2
Umesh Das	1.42	2.28	2	2.5	1.5	1.75	2.25	2.25	1.8	1.8
Brahmananda Behera	1.57	1.85	2	2.5	1.5	1.75	2	2.25	1.8	2.2
Rabindra Behera	2.85	5	3.5	4.25	2.25	3.75	2.75	3.75	1.6	2.2
Sibaprasad Panda	1.28	1.71	2	2.75	1.5	1.75	2.25	2.25	1.8	2
Dulav Behera	1.28	2	2	2.5	1.5	2	2.25	2.5	1.8	2.4
Ganeswar Jena	1.28	2.14	2	2.75	1.5	2	2.25	2.5	1.6	1.6
Mahendra Pradhan	1.42	1.71	2	2.75	1.75	1.75	2.25	2.25	1.6	1.6
Gunanidhi Jena	1.14	2	1.75	2.25	1.5	1.5	1.75	2.25	1.6	1.6
Krushna Ch Jena	1.57	2.28	2.5	2.75	1.75	2	2.25	2.25	1.6	1.4
Laxmidhar Behera	1.85	1.85	2.25	3	2	2.75	2.5	2.75	2.2	2.4
Dushasan Das	1.28	2	2	2.5	1.5	1.5	2.25	2.25	1.2	1.2
Krushna Ch Behera	1.85	2.14	2.5	3	1.5	2	2.25	2.25	1.2	1.2
Patitapaban Pradhan	1.28	1.57	2	2.75	1.5	1.5	2.25	2.25	1.6	1.6
Akhaya Lenka	1.57	2.14	2.5	2.75	1.75	2	2.25	2.25	1.6	1.6
Mean Value	**1.87**	**2.71**	**2.38**	**3.11**	**1.81**	**2.32**	**2.40**	**2.68**	**1.90**	**2.13**
Standard Deviation	0.59	1.02	0.62	0.64	0.33	0.65	0.41	0.52	0.57	0.66
% increase	**44.63**		**30.24**		**28.19**		**11.60**		**11.82**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

3.3 Impact of paper mill sludge application in acid uplands technology:

Remarkable area of our country comes under acid soils (49 million ha). Out of this 25 million ha have pH below 5.5 which come under extremely acidic soils. Acidic soils are characterized by low pH, low cation exchange capacity, low active clay, high phosphorus fixing capacity and high exchangeable aluminum. Orissa occupies 4.5 million hectares of cultivable area of acid soils having the pH range 4.5-5.5. The origin of acidity in Orissa is attributed to acid parent material, excess precipitation and usase of acid forming fertilizers. They comprise mainly laterite soils, laterite red soils, ferruginous red soils and red yellow soils. They are low in bases, deficient in organic matter, nitrogen and phosphorous. Aluminum toxicity and low water retention capacity are also characterized with these soils. Hence one of the major reasons for the poor crop productivity of Orissa is due to this acidity problem.

The acid soils of Orissa are mostly concentrated in inland districts than in the coastal districts. Acid upland soils are predominantly found in Mayurbhanj and Balasore districts where the crop productivity has been very low. The soil textures of these districts come under sandy loam to sandy clay loam. Reclamation of these acid soils is the urgent need to boost the crop productivity of this state. The reclamation may be done with various liming materials. Any compound capable of increasing the soil pH and helping in neutralization of acid soil can be a liming material. In Mayurbhanj and Balasore districts the ideal lime requirement ranges from 1.75 t /ha (sandy loam) to 3.5 t/ha (silty loam).

Even though the wide ranges of liming materials are available in the market, the farmers of this region are unable to use them because of higher cost of these materials and poor socio-economic condition. Hence, there is a necessity of an alternate liming material which will be less costly and effective in reclamation process. In this context the use of Paper Mill Sludge (PMS) as reclamation material holds relevance.

Sludge is the solid by-product of Pulp & Paper mills containing mainly wood fiber and also rich in same chemical constituents as par the nature of manufacturing process. It is composed of input materials for making paper which are primarily wood fiber, lime, clays, as well as excess organisms produced as part of the wastewater treatment process. There has been tremendous potential to utilize the paper mill sludge as liming material in Orissa because of following reasons:

- There is a huge production of paper mill sludge by paper mills located in Orissa (>1.2 lakh tones)
- PMS is a by-product from paper mills and can be used for reclamation of acid soils as it contains $CaCO_3$.

- The farmers located nearer to paper mills will get the material easily.
- This practice not only helps in chemical reclamation of acid soils but also enhances the water holding capacity and organic matter content of these soils.

The assessment of impact of the technology on farming situation and livelihood of farmers was carried out covering a sample of 24 farmers of Bhimda village of Badsahi block in Mayurbhanj district and 18 farmers of Rautrapur village of Remuna block in Balasore district adopting the paper mill sludge application in acid uplands technology. Thus, a total of 42 farmers adopting the technology are considered for the impact assessment.

The farmers of Bhimda village in Mayurbhanj district are having marginal land holding with average 1.03 acre. The yield of paddy increased from 2.6 to 4.4 t/ha after application of paper mill sludge to reclaim the acid soils. The reclamation of acid soils also prompted the farmers to grow cash crops like groundnut during kharif and pulses, vegetables and oilseeds during rabi season. Vegetables and oilseeds are dominant crops after paddy. It is noticeable that farmers could diversify the cropping after amelioration of acidic condition through paper mill sludge application. The productivity of vegetables increased by 2 t/ha, while the productivity of oilseeds and pulses are found to be more than one ton per hectare. Many farmers have kept cattle and small ruminants which provide additional income. Few farmers also started to fetch income from poultry and fish. The average income is increased for all the farmers (Table 11).

The sampled farmers of Rautrapur village in Balasore district have also adopted the paper mill sludge application to reclaim the soils of acid uplands. The average farm size is about 1.55 acre. The yield of paddy has increased from 2.7 to 4.5 t/ha after paper mill sludge application. Farmers preferred to grow groundnut in kharif during post-adoption period as the average area under paddy decreased from 0.94 to 0.51 acre. Growing of oilseeds and vegetables by most of the farmers have diversified the cropping pattern and enhanced the production and income of the farmers. Keeping animals by many farmers provide additional income. The overall income of all the farmers increased during post-adoption period (able 12).

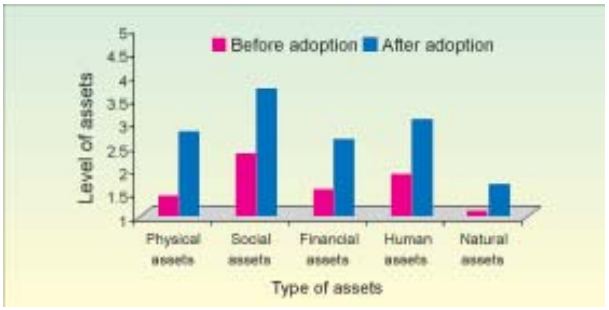


Fig. 11: Average level of different types of assets measuring livelihood of farmers in Mayurbhanj district

The impact on livelihood of the farmers is realized through average holdings of

physical, social, financial, human and natural assets by the farmers before and after adoption of the technology. The minimum and maximum possible mean value for each of the assets is 1 and 5, respectively. The Figures 11 and 12 present the average level of five types of assets during pre and post adoption period.

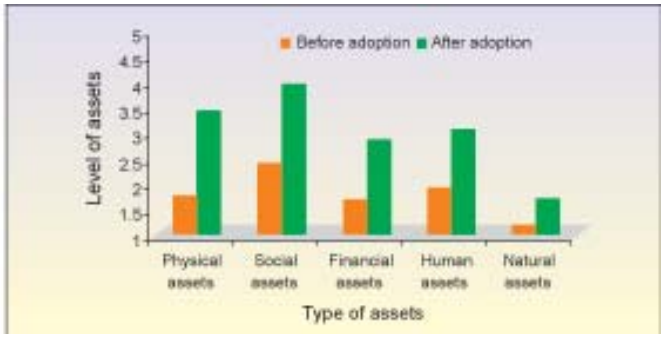


Fig. 12: Average level of different types of assets measuring livelihood of farmers in Balasore district

The increase in physical assets holding is maximum (increased more than 90%) in case of the sampled farm families of both Mayurbhanj and Balasore districts followed by the financial assets gain (67-68%). Maximum improvement in physical and financial assets indicates the betterment in living condition as well as economic condition. Increase in human assets of the farmers at both places is about 60%. However, social assts gain is 57% and 63% for the farmers of Mayurbhanj and Balasore, respectively. The increase in natural assets is 53% and 43% for the farmers of Mayurbhanj and Balasore, respectively. Assets holdings of all the sampled farmers increased (Tables 13 and 14). Physical, social and human assets of the farmers in Balasore have come above the average level. While social and human assets of the sampled farmers in Mayurbhanj district are more than the average level. It implies the fact of recognitions of the farmers in the society on adoption of paper mill sludge application to reclaim acid soils with better farming and increased production. The increased income on adoption of technology has motivated the farmers to invest and intervene further like keeping animals, poultry and fish farming leading to the betterment of income and living standard.

Overall standard of living of sampled farmers adopting the technology in Mayurbhanj and Balasore districts is assessed on the basis of all five types of assets of sampled farmers before and after adoption of the technology. It is presented in the Figures 13 and 14, respectively.

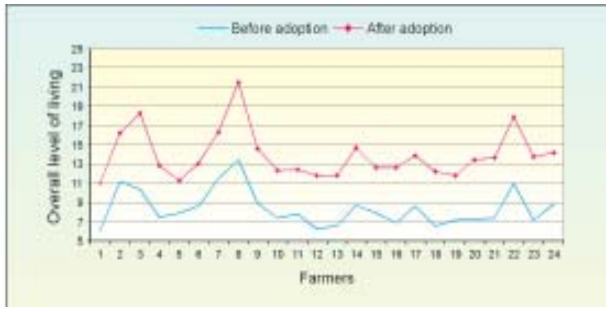


Fig. 13: Overall standard of living of selected farmers in Mayurbhanj district

It is noted that living standard of the farmers at both places was

below average level prior to adoption of the technology. However, five and nine of the sampled farmers in Mayurbhanj and Balasore districts are found to have above average level of living with the change of farming situation on adoption of paper mill sludge application technology. Mean value of overall standard of living of all the adopted farmers derived through addition of the mean values of five assets (minimum and maximum possible value is 5 and 25, respectively), which indicates that this is ranged from 6.05 to 13.42 during pre-adoption and from 10.97 to 21.45 during post-adoption period in Mayurbhanj and from 6.87 to 11.92 during pre-adoption and from 12.23 to 18.70 during post-adoption period in Balasore. Being a dynamic process, the change in livelihood varies from one farmer to another farmer and over the space and time. Therefore, the adoption of technology is one of the factors influencing the changes in livelihood of farmers.

Fig. 14: Overall standard of living of selected farmers in Balasore district

3.4 Impact of Integration of water chestnut cultivation and aquaculture technology:

Aquatic crop like water chestnut (*Trapa bispinosa*) has natural adaptability to grow under such environment especially in areas where water stagnation above the ground extends more than six months in a year. Water chestnut (*Trapa bispinosa* Roxb.) or 'singhara phal or 'pani phal' or 'pani singhara' is one of the few neglected but economically important aquatic crops grown in different parts of India. The 8 million ha shallow low land ecosystem in the low lying areas of country, of which 5.8 million ha is in eastern India itself, provides ideal environment for cultivation of this crop, mainly during kharif season. Orissa is having about 0.08 M ha waterlogged area predominantly occupied with rice as mono crop with very low yield (<0.9 t ha-1). Due to its aquatic habitat, crop has resurrection ability despite exposure to brief submergence or flash flood. The crop gradually adjusts itself with rise in water level to keep its leaf crown afloat. This provides relatively flood-proof property to the crop in comparison to other crops in low lying areas. Water chestnut fruits are generally consumed as raw or after boiling. Following sun drying, nut-flour is also used as source of non-cereal carbohydrate diet. A significant portion of the nut is processed for use as flour for food or for textile sizing.

As fish and aquatic crops integrate well under waterlogged ecology and for harnessing available water resources to enhance the water productivity of the waterlogged

Table 11. Assessment of impact of paper mill sludge application in acid uplands technology on farming practices of the farmers adopted in Bhimda, Badsahi block of Mayurbhanj district

Name of the farmer	Farm size (acre*)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross Income (Rs.)	Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Santosh Jena	0.3	Paddy	0.2	0.02	500	1300	Paddy	0.2	0.4	1200	4200
							Groundnut	0.3	0.09	1000	3200
Gour Mandal	1.25	Paddy	0.5	0.5	1250	1450	Paddy	0.5	1	3500	10800
		Goat			120	1720	Mustard	0.5	0.2	1650	6450
							Tomato	0.25	2	1600	5600
							Poultry			8500	24750
Hiran Jena	0.5	Paddy	0.25	0.25	625	1675	Paddy	0.25	0.5	1300	5000
							Tomato	0.25	2	1600	5950
							Goats			1500	3500
							Poultry			4300	12400
Ganeswar Maharana	0.3	Paddy	0.2	0.2	500	1300	Paddy	0.2	0.4	1200	4000
							Tomato	0.1	0.8	650	2370
							Goat			900	2400
Kanhu Mahallick	0.45	Paddy	0.25	0.275	625	1725	Paddy	0.25	0.425	1500	4500
							Cauliflower	0.2	0.9	1470	4870
							Bullock			1000	3200
Sarbesswar Singh	0.2	Paddy	0.2	0.2	500	1300	Paddy	0.2	0.41	1250	4250
		Cow			2500	8500	Cow			3200	11500
							Goat			1800	4800
Sundar Mohan Jena	1.9	Paddy	1	1.05	2500	6700	Paddy	0.5	0.8	3000	8200
		Cow			2800	8800	Groundnut	0.4	0.12	1300	4100
							Mustard	0.5	0.23	1650	6450
							Horsegram	0.5	0.21	1300	4800
							Cow			4000	19900

Sasidhar Mahallik	5.5	Paddy	4.5	4.5	11450	31700	Paddy	1.2	1.5	7000	15000
		Brinjal	0.2	0.8	1800	4300	Blackgram	0.5	0.15	2600	7100
		Bullock			1700	4550	Groundnut	2	0.9	9300	29100
							Vegetable	1.35	5	6300	23400
							Fish	0.45	0.45	3500	19500
							Bullock			5600	17900
							Goat			9000	29000
Jatia Singh	4.5	Paddy	4	4.2	10000	28900	Paddy	1	1.8	6000	18000
		Bullock			1600	4400	Groundnut	0.5	0.15	1500	5500
							Mustard	1	0.5	3500	13500
							Horsegram	2	0.9	5000	19400
							Goat			9000	29000
Prafulla Mahallik	0.65	Paddy	0.5	0.55	1250	3550	Paddy	0.25	0.45	1500	4650
							Groundnut	0.4	0.12	1128	4248
							Cow			3200	11400
Arun Jena	0.35	Paddy	0.25	0.275	640	1880	Paddy	0.25	0.4	1200	3700
							Cabbage	0.1	0.3	336	1136
							Goat			800	2300
Kati Jena	0.25	Paddy	0.25	0.25	625	1750	Paddy	0.25	0.5	1650	5350
							Cow			3400	11700
Banula Singh	0.5	Paddy	0.5	0.55	1300	3775	Paddy	0.5	1	3500	10500
							Cow			3300	11500
Mani Mandal	0.675	Paddy	0.5	0.55	1200	3400	Paddy	0.5	1	3000	10000
		Bullock			960	2360	Cucumber	0.05	0.175	425	1300
							Tomato	0.12	1	685	2550
							Goat			1560	4310
Kalia Rana	0.35	Paddy	0.25	0.25	620	1620	Paddy	0.25	0.4	1500	4000
							Tomato	0.1	0.8	650	2350
							Goat			850	2350

Sania Dalei	0.5	Paddy	0.5	0.5	1300	3300	Paddy	0.5	0.1	3500	10000
							Cow			3400	12500
Danardan Mandal	0.2	Paddy	0.16	0.4	1000	2600	Paddy	0.2	0.4	1600	4100
		Bullock			1100	2660	Bullock			3300	10500
Sarat Singh	0.2	Paddy	0.2	0.24	500	1580	Paddy	0.2	0.49	1270	4700
							Goat			2000	5000
Laxmidhar Mahallick	0.25	Paddy	0.2	0.2	480	1280	Paddy	0.25	0.5	1700	5200
							Bullock			1200	3500
Ananta Jena	0.35	Paddy	0.25	0.25	625	1525	Paddy	0.25	0.53	1300	5000
							Brinjal	0.1	0.4	335	1650
							Cow			3300	11600
Meram Singh	0.5	Paddy	0.5	0.5	1250	3250	Paddy	0.5	1.025	3500	10675
							Goat			1800	4800
Prafulla Mahapatra	2.5	Paddy	1	1.1	2550	6950	Paddy	1	2.15	7120	22120
							Mustard	1.5	0.75	4900	19750
							Goat			1500	4000
Rathia Singh	0.75	Paddy	0.25	0.25	600	1725	Paddy	0.25	0.5	1300	4900
							Cauliflower	0.5	2	3300	12300
							Goat			900	2400
Parshu Nayak	1.75	Paddy	0.25	0.25	630	1630	Paddy	0.25	0.5	1440	4940
							Horsegram	1.5	0.67	4000	14720
							Cow			3600	11800
Mean Value	**1.03**	**Paddy (n=24)**	**0.69**	**0.72**	**1772**	**4828**	**Paddy (n=24)**	**0.40**	**0.72**	**2543**	**7658**
		Animal (n=7)			**1540**	**4713**	**Oilseeds (n=9)**	**0.79**	**0.34**	**2881**	**10255**
							Pulses (n=4)	**1.13**	**0.48**	**3225**	**11505**
							Vegetables(n =10)	**0.30**	**1.50**	**1702**	**6183**
							Animal (n=21)			**3012**	**10002**
							Poultry (n=2)			**6400**	**18575**
Standard Deviation	1.37	Paddy (n=24)	1.12	1.15	2824	8008	Paddy (n=24)	0.28	0.50	1830	4913
		Animal (n=7)			921	2883	Oilseeds (n=9)	0.59	0.30	2732	8882
							Pulses (n=4)	0.75	0.36	1617	6758
							Vegetables(n =10)	0.39	1.41	1841	6894
							Animal (n=21)			2383	8234
							Poultry (n=2)			2970	8733

*1 ha = 2.5 acre

Table 12. Assessment of impact of paper mill sludge application in acid uplands technology on farming practices of the farmers adopted in Rautrapur, Remuna block of Balasore district

Name of the farmer	Farm size (acre*)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)	Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Nabin Ojha	0.6	Paddy	0.3	0.3	750	1950	Paddy	0.5	0.8	2500	8500
							Sesamum	0.5	0.13	700	3000
							Groundnut	0.6	0.2	2500	7900
		Goat			450	1150	Goat			880	2380
Arjuna Pradhan	0.7	Paddy	0.5	0.5	1250	3250	Paddy	0.5	1	3000	10000
							Tomato	0.2	1.6	1300	3950
							Poultry			4300	12450
Gopinath Biswal	2.1	Paddy	0.5	0.55	1250	3450	Paddy	0.5	0.9	3200	9500
							Mustard	1.5	0.6	5000	21800
							Knolkhol	0.1	0.38	1270	3400
Keshab Maharana	1.625	Paddy	0.5	0.5	1260	3260	Paddy	0.5	1	3000	10000
							Watermelon	0.1	2.15	2000	10000
							Cucumber	0.05	0.176	450	1350
		Goat			600	1400	Poultry	100	0.25	8600	24850
Baidhar Singh	0.75	Paddy	0.5	0.5	1250	3250	Paddy	0.5	0.8	3000	8300
		Goat			900	2100	Cabbage	0.25	1.05	1500	5350
							Goat			1800	4800
Prafulla Bindhani	1.1	Paddy	1	1.1	2700	7100	Paddy	0.25	0.45	1500	4650
							Groundnut	0.6	0.2	2500	7500
							Tomato	0.25	2.1	1650	6150
							Bullock			1000	3200
Tofan Singh	1.35	Paddy	1	1.9	2500	6500	Paddy	0.5	0.8	3000	7000
							Groundnut	0.6	0.2	2500	7500
							Cabbage	0.25	1.1	1550	5550
							Goat			1800	4800

Sukumar Singh	8	Paddy	5	5	15500	40500	Paddy	1	1.5	7000	15000
		Brinjal	0.5	2.5	4500	10750	Groundnut	4	2	16000	66000
		Bullock			850	2250	Mustard	2	1.1	6500	29600
							Sesamum	1	0.25	1300	6300
							Vegetable	0.25	1.5	1770	5820
							Fish	0.45	0.59	3800	23800
							Bullock			11300	31800
Banu Singh	0.6	Paddy	0.5	0.5	1300	3550	Paddy	0.5	0.9	3000	9000
		Cow			2800	8650	Knolkhol	0.1	0.38	1200	3400
							Goat			1800	4800
Mangala Singh	0.5	Paddy	0.4	0.44	960	2710	Paddy	0.25	0.79	1500	4930
		Goat			600	1400	Brinjal	0.25	1.2	1500	6000
							Cow			3400	11600
Lal Mohan Singh	1.6	Paddy	0.5	0.5	1200	3200	Paddy	0.5	1.075	3500	11000
		Bullock			980	2380	Groundnut	0.6	0.25	2500	8500
							Blackgram	0.5	0.16	2000	6000
							Cow			7000	23400
Chema Biswal	3.45	Paddy	3	3.15	7500	20100	Paddy	0.5	1	3300	10300
		Brinjal	0.2	0.8	1800	4300	Mustard	1	0.25	2500	9500
		Bullock			800	2000	Horsegram	0.5	0.22	1000	2000
							Groundnut	1.2	0.65	5200	19500
							Vegetable	0.25	1.45	1590	5390
							Cow			6480	17280
							Goat			9000	29000
Budu Singh	1	Paddy	1	1	2600	6600	Paddy	0.5	0.9	3000	9000
							Groundnut	0.5	0.3	2000	8100
							Cow			3500	11900
Bhaskar Ojha	0.5	Paddy	0.5	0.5	1250	3250	Paddy	0.5	1	3300	10400
		Cabbage	0.1	1	1200	4450	Goat			7200	19200
Banka Singh	0.7	Paddy	0.5	0.6	1250	2650	Paddy	0.6	0.85	4300	8800
		Bullock			1000	2600	Watermelon	0.1	1.415	1700	6700

Bania Singh	1.2	Paddy	0.25	0.25	630	1630	Paddy	0.5	0.8	3000	8000
							Groundnut	0.6	0.271	2500	8500
							Tomato	0.1	0.8	650	2350
							Poultry			4300	13050
Makuru Singh	1.1	Paddy	0.5	0.5	1250	3500	Paddy	0.5	1.05	3390	10740
		Goat			600	1400	Groundnut	0.6	0.333	2400	9400
							Poultry			4300	12400
Padia Singh	1.1	Paddy	0.5	0.55	1300	3500	Paddy	0.5	1.09	3600	11200
							Groundnut	0.6	0.2	2500	7500
							Poultry			8700	24950
Mean Value	**1.55**	**Paddy (n=18)**	**0.94**	**1.02**	**2539**	**6664**	**Paddy (n=18)**	**0.51**	**0.93**	**3227**	**9240**
		Vegetable (n=3)	**0.27**	**1.43**	**2500**	**6500**	**Oilseeds (n=12)**	**1.18**	**0.53**	**4242**	**16767**
		Animal (n=9)			**1014**	**2687**	**Pulses (n=2)**	**0.50**	**0.19**	**1500**	**4000**
							Vegetables (n=11)	**0.19**	**1.07**	**1312**	**4428**
							Animal (n=11)			**4935**	**14707**
							Poultry (n=4)			**6475**	**18825**
Standard deviation	1.76	Paddy (n=18)	1.18	1.22	3585	9404	Paddy (n=18)	0.15	0.21	1150	2351
		Vegetable (n=3)	0.21	0.93	1758	3681	Oilseeds (n=12)	1.00	0.54	4012	17160
		Animal (n=9)			688	2281	Pulses (n=2)	0.00	0.04	707	2828
							Vegetables (n=11)	0.08	0.59	416	1629
							Animal (n=11)			3438	10214
							Poultry (n=4)			2512	7019

*1 ha = 2.5 acre

Table 13. Assessment of impact of paper mill sludge application in acid uplands technology on livelihood of the farmers adopted in Bhimda, Badsahi block of Mayurbhanj district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Santosh Jena	1	2.42	2	3.5	1.25	2.25	1	2	0.8	0.8
Gour Mandal	2	3.71	3	4	2.5	3.25	2.5	3.5	1.2	1.8
Hiran Jena	1.85	3.42	3.25	4.75	1.75	3.75	2.5	3.75	1	2.6
Ganeswar Maharana	1	2.28	2.25	3.5	1.25	2.5	2	3	1	1.6
Kanhu Mahallick	1.14	1.85	2.25	3	1.5	2.5	2	2.75	1	1.2
Sarbesswar Singh	1.42	3.28	2.5	2.25	1.75	2.5	1.75	3.25	1.2	1.8
Sundar Mohan Jena	2.14	3.71	3	4	2.25	3.25	2.75	3.75	1.4	1.6
Sasidhar Mahallik	2.57	4.85	3.5	5	2.75	4.5	3	4.5	1.6	2.6
Jatia Singh	1.57	3.14	2.25	3.75	1.75	2.5	1.75	2.75	1.6	2.4
Prafulla Mahallik	1.14	2.42	1.75	3.25	1.5	2.25	2	3	1	1.4
Arun Jena	1.28	2.57	2.5	2.75	1.25	2.5	1.75	3	1	1.6
Kati Jena	1	2.14	1.75	3.5	1.25	2.25	1.25	2.5	1	1.4
Banula Singh	1	2.14	1.75	3.25	1.5	2.5	1.25	2.5	1	1.4
Mani Mandal	1.28	2.85	2	4	1.75	2.5	2.5	3.5	1.2	1.8
Kalia Rana	1.14	2.28	2.5	3.75	1.25	2	2	3	1	1.6
Sania Dalei	1.57	2.71	1.75	3.5	1.25	2.5	1.25	2.5	1	1.4
Danardan Mandal	1.14	2.71	2.25	4	1.5	2.25	2.5	3.5	1.2	1.4
Sarat Singh	1	2.14	2	3.5	1.25	2.25	1.25	2.5	1	1.8
Laxmidhar Mahallick	1.14	1.85	1.75	3.5	1.25	2.25	2	3	1	1.2
Ananta Jena	1.28	2.85	2.25	4	1.25	2.5	1.5	2.75	1	1.4
Meram Singh	1.42	2.85	2.25	4	1.5	2.5	1.25	2.5	1	1.8
Prafulla Mahapatra	2.28	4	3.25	4.75	2.25	3.25	2.25	3.5	1	2.4
Rathia Singh	1.14	2.71	2.25	4	1.25	2.5	1.5	3	1	1.6
Parshu Nayak	1.85	2.85	2.5	3.75	1.25	2.5	2.25	3.5	1	1.6
Mean Value	**1.43**	**2.82**	**2.35**	**3.72**	**1.58**	**2.65**	**1.91**	**3.06**	**1.09**	**1.68**
Standard deviation	0.45	0.72	0.52	0.61	0.44	0.57	0.55	0.55	0.20	0.44
% increase	**97.18**		**57.96**		**67.11**		**60.66**		**53.44**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

Table 14. Assessment of impact of paper mill sludge application in acid uplands technology on livelihood of the farmers adopted in Rautrapur, Remuna block of Balasore district

Name of the farmer	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Nabin Ojha	2	3.42	3	4	2.5	3.25	2	3	1.2	1.2
Arjuna Pradhan	2.42	4	3	4.75	1.5	3.25	2.75	3.5	0.8	1.6
Gopinath Biswal	2.57	4.71	3	4	1.75	3.5	2	3.75	1	1.4
Keshab Maharana	2.14	4.14	3.25	4.75	2	3.5	2.25	3.75	1.6	2
Baidhar Singh	1.14	2.71	2	3.75	1.75	2.75	1.75	3	1.8	1.8
Prafulla Bindhani	1.71	3.71	2.5	4.75	1.75	3	1	1.2		
Tofan Singh	2.71	4.28	2.75	4.5	1.75	3	1.75	3.25	1	1.8
Sukumar Singh	2.42	3.85	3	4	2.25	4	3.25	4.25	1	2.6
Banu Singh	1.42	2.85	1.5	3.25	1.5	2.5	1.25	2.5	1.2	1.8
Mangala Singh	1.42	2.85	2	3.25	1.75	2.25	1.5	2.75	1.6	1.6
Lal Mohan Singh	1.71	3.85	2.5	3.75	1.75	2.75	1.75	2.75	1.2	1.8
Sri Chema Biswal	1.71	3.42	3.5	4.75	2	2.75	2.75	3.75	1.4	2.2
Budu Singh	1.57	3	2	3.75	1.5	2.75	2	3.5	1	1.4
Bhaskar Ojha	1.57	3.14	2.25	4	1.5	2.5	2	3.25	1	1.8
Banka Singh	1.28	2.28	1.75	3.75	1.5	2.5	1.5	2.5	1.2	1.2
Bania Singh	1.28	3.14	2.25	3.75	1.25	2.5	1.5	2.75	1	1.8
Makuru Singh	1.28	3.14	1.75	3.5	1.5	2.5	2.25	3.5	1.6	1.8
Padia Singh	1.87	3.71	2	3.75	1.25	2.5	1.5	2.75	1	1.8
Mean Value	**1.79**	**3.46**	**2.44**	**4.00**	**1.71**	**2.88**	**1.93**	**3.09**	**1.21**	**1.74**
Standard deviation	0.49	0.62	0.59	0.50	0.32	0.46	0.57	0.68	0.29	0.34
% increase	**93.05**		**63.64**		**68.29**		**60.29**		**43.69**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

ecosystem, integrated aquaculture is imperative and economically lucrative. Farmers are always hesitant to grow fishes in isolated water bodies due to risk of theft and integration of water chestnut offers a surface cover protection in such cases besides diversifying livelihood options.

In fish-water chestnut integration, highest growth rate is obtained when cat fish like Magur (*Clarius batrachus*) is reared with water chestnut. Due to higher yield, production-size index and performance index, air-breathing fish culture along with water chestnut is advisable. Moreover, under this co-production system fish gets natural food even in presence of supplemental feed. Thus under controlled condition 25-30% feed can be reduced during each meal. It also results an increase in gross and net water productivity and net water productivity.

The assessment of impact of the technology on farming situation and livelihood of farmers was carried out covering a sample of 35 farmers adopting integration of water chestnut (WCN) cultivation and aquaculture. The integration of aquaculture with water chestnut could supplement fish feed requirement. The smothering effect given by water chestnut crop over water body could deter the pilferage of fish cultivated below. The potentiality of water chestnut – aquaculture integrated farming has been reflected through growth of overall farming system of the adopted farmers and provided a better earning and living to the small and marginal farmers of the waterlogged ecosystem.

Survey of 35 farmers adopted the technology reveals that average farm size is 3.30 acre out of which almost half of the area is each under paddy and water chestnut. However, area under fish farming (cat fish) has been increased by 0.44 acre. Even though there is not much change in acreage of paddy but its production has been increased. The average production of water chestnut increased by about 1.22 tonne with additional fish harvest of 0.36 tonne, which may be attributed to integrated cat fish culture with water chestnut. The integration of aquaculture with water chestnut has also increased the average income of farmers by Rs. 33,000 approximately. The total average income of the farmers from the farming has increased by more than 50% after adoption of integrated water chestnut cultivation with aquaculture technology (Table 15).

Variables under five types of assets measuring the changes in livelihood are assessed on the basis of the responses of farmers on a 5-point continuum scale (minimum and maximum value is 1 and 5, respectively) and mean values are derived for each type of asset. It is evident from the Figure 15 and Table 16 that there is an improvement in all the five types of assets measuring the changes in livelihood of farm families during post-adoption period.

Four out of five types of assets holdings are found to be below average barring the social asset before adoption of the integrated farming of water chestnut and cat fish culture technology. Financial assets gain is found maximum (by 41%) followed by physical (35%), social (31%) and human asset (29%). Natural asset gain is meager (7%) and except this one, all other asset holding of farm families increased considerably to come at above average level. Maximum improvement in financial and physical assets indicates the betterment in living condition as well as economic condition. The increased income on adoption of technology has motivated the farmers to invest and intervene further leading to the growth in physical and financial assets. Social recognition is also reflected with higher mean values of both social and human assets holdings of the farmers. Natural assets refer to land, water resource and livestock holding particulars, growth of which generally requires more time as compared to other types of assets.

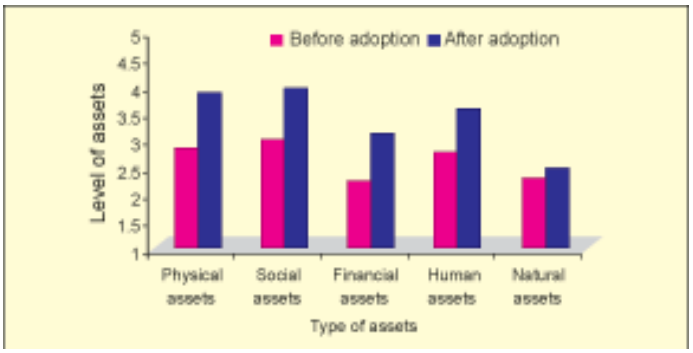


Fig. 15: Average level of different types of assets measuring livelihood of farmers during pre and post adoption period

Overall standard of living of farmers is assessed through summing up of mean values of all five types assets holdings of sampled farmers before and after adoption of a particular technology. It is presented in the Figure 16.

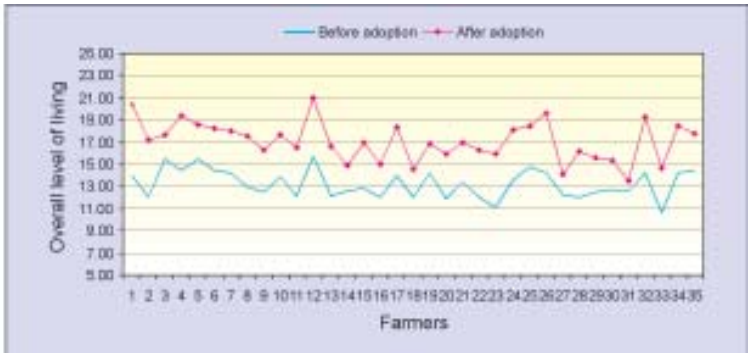


Fig. 16: Overall standard of living of selected farmers before and after adoption

It is noted that living standard of 3 out of 35 farmers was above average level prior to adoption of the technology. However, 30 out of 35 sampled farmers have been brought to above average level of living with the change of farming situation on adoption of water chestnut cultivation integrated with aquaculture. Mean value of overall standard of living of all the adopted farmers derived through addition of the

mean values of five assets, which indicates that this is ranged from 10.60 to 15.65 during pre-adoption and from 13.55 to 20.95 during post-adoption period (minimum and maximum possible value is 5 and 25, respectively). Being a dynamic process, the change in livelihood is dependent on many factors having spatial and temporal variation. The process of change also varies from one farmer to another farmer and over the space and time. Therefore, the adoption of any technology is not exclusive but one of the factors influencing the changes in livelihood of farmers.

There is market demand for both fish and water chestnut; therefore, growing water chestnut in combination with aquaculture fetches good income to the farmers of waterlogged area. Moreover options of post harvest processing of nut to flour could potentially avoid distress sale of excess harvest as well as provide better market price. Growing fishes in isolated water bodies is always vulnerable to theft/poaching and farmers are always hesitant to invest in fisheries away from their homestead. Integration of water chestnut offers a surface cover protection in such cases besides adding income from the crop. Shallow waterlogged areas of eastern India, where surface drainage is not possible, and water stagnates for a period of at least six months for a depth of more than 50 cm, this technology is a farmer friendly and cost effective option.

Under ICAR-CARE collaboration on "dissemination of inland water management technologies", the developed package of practices for water chestnut cultivation has been adopted by "The CARE India" under their dissemination program in three tribal districts (Bolangir, Phulbani and Gajapati) of Orissa. Successful implementation of the technology led to spread of water chestnut cultivation technology in tribal districts of Orissa. In the feed back report they intended extension of the technology through their on going schemes.

4. CONCLUSION

The adoption of selected technologies by the farmers has made positive impact on farming and livelihoods of the farmers. The technologies are being adopted in different agro-ecosystems as per the suitability; however, the differential impact is realized due to more of the cropping and/or farming options available to the farmers in the process of adoption of a specific technology. It is evident that inclusion of vegetables in cropping pattern and fish farming has made relative better impact on production and income of the farmers resulting betterment in their livelihood. The variability in the changes of assets which measure the livelihood of farmers is depended on initial assets holding of the farmers. The process of change varies from one farmer to another farmer and over the space and time. Therefore, the adoption of any technology may not be only but one of the factors influencing the livelihood of farmers.

Table 15. Assessment of impact of integration of WCN cultivation and aquaculture technology on farming practices of the farmers adopted in Balasore district

Name of the farmer and location	Farm size (acre*)	Farming situation before adoption					Farming situation after adoption				
		Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)	Particular	Area (acre*)	Production (t)	Cost of cultivation (Rs.)	Gross income (Rs.)
Chandan Ku Mahota, Raisuan	4.5	Paddy	3	1.8	7000	14000	Paddy	3	2.5	12000	22000
		WCN	1	5	16000	50000	WCN	1.5	7	24000	75000
		Fish	1.5	0.1	1000	3000	Fish	1.5	0.5	3000	16000
Ratnakar Jena, Raisuan	4.5	Paddy	1	0.6	2500	4500	Paddy	1	0.8	4000	8000
		WCN	3	7	35000	70000	WCN	3	8.5	3700	85000
		Fish	1.2	0.25	3000	8000	Fish	1.2	0.4	5000	13000
Gopal Jena, Raisuan	3	Paddy	1	0.6	2200	4000	Paddy	1	0.9	3000	8000
		WCN	2	8	29000	80000	WCN	2	8	33000	89000
		Fish	0.5	0.2	3000	9000	Fish	2	0.9	5000	36000
Ramakanta Barik, Raisuan	6.5	Paddy	2	1.2	5000	8000	Paddy	2	1.5	8000	14000
		WCN	4.5	15	52000	150000	WCN	4.5	17	68000	170000
		Fish	2	0.4	3000	8000	Fish	4.5	1.3	6000	47000
Purna Chandra Das, Raisuan	4.5	Paddy	3	1.8	6000	13000	Paddy	3	2.6	13000	24000
		WCN	1.5	5.5	23000	55000	WCN	1.5	7.5	28000	75000
		Fish	1.5	0.1	1000	3000	Fish	1.5	0.5	3000	16000
Sankar Behera, Raisuan	5	Paddy	3	1.8	7000	14000	Paddy	3	2.5	12000	22000
		WCN	2	8	32000	80000	WCN	2	8	32000	80000
		Fish	2	0.4	3000	12000	Fish	2	0.7	5000	26000
Prasant Jena, Khandahar	3.5	Paddy	2	1.2	5000	10000	Paddy	2	1.5	8000	14000
		WCN	1	5	17000	50000	WCN	1.5	6.5	23000	65000
		Fish	1.5	0.15	1000	3000	Fish	1.5	0.5	4000	21000
Gopal Patra, Lokhanath	2.5	Paddy	1	0.6	3000	5000	Paddy	1	1.1	4000	12000
		WCN	1.5	4	18000	45000	WCN	1.5	6.5	23000	68000
		Fish	1.5	0.3	3000	6000	Fish	1.5	0.9	5000	36000

Babuli Jena, Samanathpur	4.5	Paddy	3	1.8	7000	11000	Paddy	3	2.5	12000	23000
		WCN	1	5	16000	50000	WCN	1.5	7	24000	76000
		Fish	1.5	0.3	3000	6500	Fish	1.5	0.6	4000	18000
Paca Das, Padabadagon	4.5	Paddy	3	1.8	6000	15000	Paddy	3	2.7	13000	24000
		WCN	1.5	5.5	23000	55000	WCN	1.5	6.6	26000	76000
		Fish	1.5	0.25	3000	6000	Fish	1.5	0.6	5000	20000
Haribala Mahalik, Raisuan	5	Paddy	3	1.8	7000	14000	Paddy	3	2.7	13000	26000
		WCN	2	8	32000	80000	WCN	2	8	29000	80000
		Fish	2	0.4	4000	8000	Fish	2	0.6	4000	27000
Sukant Das, Raisuan	5	Paddy	2	1.2	7000	11000	Paddy	2	1.6	9000	15000
		WCN	3	7	27000	70000	WCN	3	9	35000	90000
		Fish	3	0.5	5000	18000	Fish	3	1	8000	32000
Raju Das, Raisuan	3.5	Paddy	2	2	5000	12000	Paddy	2	2.4	14000	24000
		WCN	1.5	5.2	9000	48000	WCN	1.5	7.4	25000	80000
		Fish	1.5	0.1	1000	3000	Fish	1.5	0.4	4000	13500
Sasi Mahata, Raisuan	2.5	Paddy	1	0.7	2000	4000	Paddy	1	0.9	2600	7000
		WCN	1	4.5	16000	45000	WCN	1.5	6.8	22000	68000
		Fish	1.5	0.2	1000	4000	Fish	1.5	0.6	5000	23000
Ranjan Mahata, Raisuan	1.5	Paddy	0.5	0.3	1800	2500	Paddy	0.5	0.9	5000	8000
		WCN	1	4.5	13000	45000	WCN	1	5.5	18000	55000
		Fish	1	0.2	3000	7000	Fish	1	0.5	3000	18000
Jata Jena, Nuapada	2	Paddy	1	0.6	2000	4000	Paddy	1	0.85	4000	7000
		WCN	1	4.2	15000	42000	WCN	1	4.6	17000	46000
		Fish	1	0.2	2000	4000	Fish	1	0.45	4000	15000
Babula Geri, Palasea Sadar	3	Paddy	1.5	0.9	3500	7000	Paddy	1.5	1.2	6000	13000
		WCN	1	4.5	18000	45000	WCN	1.5	6.5	27000	70000
		Fish	1.5	0.05	1000	2000	Fish	1.5	0.6	3000	27000
Gopinath Das, Pada badagan	1.5	Paddy	1	0.7	2100	4000	Paddy	1	0.9	4000	7500
		WCN					WCN	0.5	2.5	7000	25000
		Fish					Fish	0.5	0.1	1000	4000

Mayadhar Mahalik, Raisuan	1.5	Paddy	1.5	2.7	12000	20000	Paddy	1	1.5	5000	15000
		WCN					WCN	0.5	2.5	10000	25000
		Fish	1	0.5	8000	15000	Fish	0.5	0.2	2000	6000
Jendu Das, Raisuan	3.5	Paddy	2	2	5000	11000	Paddy	2	2.4	14000	24000
		WCN	1.5	3	9000	28000	WCN	1.5	4.5	25000	47000
		Fish	1.5	0.1	1000	3000	Fish	1.5	0.4	5000	25000
Amar Das, Nuapada	2	Paddy	1	0.7	2100	4000	Paddy	1	0.9	3000	7000
		WCN	1	4.8	18000	48000	WCN	1	5.8	21000	58000
		Fish	1	0.15	2000	4500	Fish	1	0.3	3000	11000
Chema Das, Amrda	2.5	Paddy					Paddy	1.5	1.2	7000	12000
		WCN					WCN	1	5	19000	50000
		Fish					Fish	1	0.3	4000	11000
Dinabandhu Jena, Padabadagan	3	Paddy	1	0.6	3000	7000	Paddy	1	1.1	4000	12000
		WCN	2	5.5	23000	60000	WCN	2	6	26000	65000
		Fish	2	0.4	3000	7000	Fish	2	0.7	8000	28000
Chaibala Mahalik, Raisuan	2.5	Paddy	1	1.2	5000	10000	Paddy	1	1.5	4000	15000
		WCN	1	4.5	17000	45000	WCN	1.5	6	23000	60000
		Fish	1	0.05	1000	3000	Fish	1.5	0.6	5000	19000
Sankar Das, Raisuan	2.5	Paddy	1	0.6	2000	3500	Paddy	1	0.7	3000	7000
		WCN	1.5	5	16000	50000	WCN	1.5	5	24000	50000
		Fish	0.05	0.05	1000	3000	Fish	1.5	0.5	4000	16000
Dibakar Sahoo, Bhandeswar	4.5	Paddy	2	1.2	5000	9000	Paddy	2	1.3	7000	12000
		WCN	2	7.1	27000	7000	WCN	2.5	7.8	33000	80000
		Fish	1	0.3	2000	6000	Fish	2.5	0.7	8000	27000
Kuna Parida, Padabadagan	2.5	Paddy	2	1.2	5000	9000	Paddy	2	1.5	8000	14000
		WCN					WCN	0.5	2.7	9000	30000
		Fish					Fish	0.5	0.2	2000	7000
Chalak Mahalik, Parmandapur	1.5	Paddy	0.5	0.3	1500	2000	Paddy	0.5	1.9	5000	17000
		WCN	1	4.5	13000	45000	WCN	1	5.5	18000	55000
		Fish	0.25	0.2	3000	7000	Fish	1	0.5	6000	32000

Ata Mahalik, Parmandapur	2.5	Paddy	1	0.6	1700	3500	Paddy	1	0.8	2000	10000
		WCN	1.5	5.4	28000	54000	WCN	1.5	5.4	28000	54000
		Fish	0.05	0.05	1000	3000	Fish	1.5	0.5	4000	20000
Mayadhar Jena, Raisuan	5	Paddy	3	1.7	7000	14000	Paddy	3	2.3	10000	20000
		WCN	2	8	35000	80000	WCN	2	8.5	36000	80000
		Fish	0.5	0.2	2000	6000	Fish	2	0.7	7000	27000
Kalia Mahalik, Nuapada	0.05	Paddy					Paddy				
		WCN	0.05	2.5	11000	27000	WCN	0.05	3.6	17000	40000
		Fish	0.05	0.1	1000	2000	Fish	0.05	0.3	4000	12000
Akadas Behera, Raisuan	5	Paddy	1	0.6	2100	4000	Paddy	1	1	3000	8500
		WCN	4	7.5	25000	75000	WCN	4	8.5	3300	85000
		Fish	2	0.5	5000	15000	Fish	4	1.1	13000	34000
Bhagabat Mahalik , Raisuan	3.5	Paddy	3	2	5000	11000	Paddy	3	2.4	14000	24000
		WCN	0.5	2.5	9000	28000	WCN	0.5	7.4	25000	80000
		Fish	0.05	0.1	1000	2000	Fish	0.05	0.3	5000	12000
Sania Jena, Raisuan	3	Paddy	1	0.6	2100	7000	Paddy	1	0.7	2700	9000
		WCN	2	5.5	24000	58000	WCN	2	0.6	27000	73000
		Fish	1	0.3	2000	4000	Fish	2	0.7	5000	30000
Babu Sahu, Raisuan	3.5	Paddy	1	0.6	2000	4000	Paddy	1	0.8	2900	7000
		WCN	2.5	6	27000	60000	WCN	2.5	8	31000	80000
		Fish	1.5	0.5	5000	15000	Fish	2.5	1	10000	36000
Mean Value	**3.30**	**Paddy (n=35)**	**1.65**	**1.12**	**4165**	**8118**	**Paddy (n=35)**	**1.63**	**1.49**	**6891**	**14057**
		WCN (n=35)	**1.53**	**5.23**	**19794**	**50735**	**WCN (n=35)**	**1.66**	**6.45**	**24000**	**68143**
		Fish (n=35)	**1.15**	**0.22**	**2324**	**6235**	**Fish (n=35)**	**1.59**	**0.58**	**4914**	**21757**
Standard deviation	1.39	Paddy (n=35)	0.87	0.63	2409	4551	Paddy (n=35)	0.86	0.70	4106	6460
		WCN (n=35)	0.95	2.31	9473	24451	WCN (n=35)	0.93	2.70	11277	25079
		Fish (n=35)	0.69	0.15	1626	4308	Fish (n=35)	0.93	0.27	2331	9983

*1 ha = 2.5 acre

Table 16. Assessment of impact of integration of WCN cultivation and aquaculture technology on livelihood of the farmers adopted in Balasore district

Name of the farmer and location	Measure of livelihoods									
	Physical assets		Social assets		Financial assets		Human assets		Natural assets	
	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption	Before adoption	After adoption
Chandan Ku Mahota, Raisuan	3.14	4.71	3	4.5	1.75	3.5	3.5	4.5	2.6	3.2
Ratnakar Jena, Raisuan	3	4	3	4.5	2	3	2.25	3.25	1.8	2.4
Gopal Jena, Raisuan	3.71	4.14	3	3.25	2.5	3.5	3.25	3.75	3	3
Ramakanta Barik, Raisuan	3.4	4.4	3	4.7	2.5	3.75	2.75	3.75	2.8	2.8
Purna Chandra Das, Raisuan	3.14	4	4	4.5	2.25	3.5	3.5	4	2.6	2.6
Sankar Behera, Raisuan	3.14	3.42	3	4.25	2.5	3.75	2.75	3.75	3	3
Prasant Jena, Khandahar	2.85	4	3	3.5	2.5	3.25	3.25	4	2.6	3.2
Gopal Patra, Lokhanath	2.85	4.28	3	4.5	2.5	3.5	2.75	3.5	1.8	1.8
Babuli Jena, Samanathpur	3.14	4.42	2.25	3.25	2	2.75	2.25	3	2.8	2.8
Paca Das, Padabadagon	3	3.71	3	4.25	2.75	3.75	2.75	3.5	2.4	2.4
Haribala Mahalik, Raisuan	2.71	4	3	4.25	2.25	3	3	4	1.2	1.2
Sukant Das, Raisuan	3.5	4.5	3	4.25	2.25	3.5	3.5	4.5	3.4	4.2
Raju Das, Raisuan	2.71	3.71	2.75	3.5	2.25	3.5	2.25	3.5	2.2	2.4
Sasi Mahata, Raisuan	2.71	3.28	3	3.25	2	3	2.25	2.75	2.6	2.6
Ranjan Mahata, Raisuan	2.85	4	3.25	4.25	2.25	3.25	2.25	3.25	2.2	2.2
Jata Jena, Nuapada	2.71	3.51	3	3.25	2	3	2.25	3.25	2	2
Babula Geri, Palasea Sadar	2.85	3.85	3	4.25	2.25	3.25	3.5	4	2.4	3
Gopinath Das, Pada badagan	2.42	3.28	3	3.25	2.25	3	2.5	3.25	1.8	1.8

Mayadhar Mahalik, Raisuan	2.14	3.85	4	4	2.25	2.75	2.75	3.25	3	3
Jendu Das, Raisuan	2.42	3.42	3	4.25	2.25	3.25	2.25	3	2	2
Amar Das, Nuapada	3.14	3.85	3	4.25	2.25	3.25	3.25	3.75	1.8	1.8
Chema Das, Amrda	3	4	2.75	3.75	2	3	2.25	3.5	2	2
Dinabandhu Jena, Padabadagan	2.42	4	2.25	3.5	2	2.75	2.25	3.5	2.2	2.2
Chaibala Mahalik, Raisuan	3.42	4.57	3	3.75	2.25	3.25	2.5	3.75	2.4	2.8
Sankar Das, Raisuan	2.85	4	3	4.5	2	2	3.5	4.5	3.4	3.4
Dibakar Sahoo, Bhandeswar	3	4.71	3	4.25	2.5	3.25	3.25	4.75	2.4	2.6
Kuna Parida, Padabadagan	2.71	3.28	3	3.25	2	2	2.5	3.5	2	2
Chalak Mahalik, Parmandapur	2.42	3.85	2.25	4	2.5	3	3	3.25	1.8	2
Ata Mahalik, Parmandapur	2.71	3.85	3.5	4.25	2	2.75	2.25	2.75	2	2
Mayadhar Jena, Raisuan	2.71	3.85	3.5	3.5	2.25	3.25	3	3.5	1.2	1.2
Kalia Mahalik, Nuapada	2.57	3	3.5	3.5	2	2.25	2.75	3	1.8	1.8
Akadas Behera, Raisuan	3	3.85	3	4.5	2.25	3.25	2.75	4	3.2	3.6
Bhagabat Mahalik , Raisuan	1.85	2.71	2.5	3.5	2	3	2.25	3.5	2	2
Sania Jena, Raisuan	2.85	3.85	3	4.5	2.25	4	3.5	3.5	2.6	2.6
Babu Sahu, Raisuan	3.42	3.71	3	4	3	3.75	2.75	3.25	2.2	3
Mean Value	**2.87**	**3.87**	**3.01**	**3.96**	**2.24**	**3.16**	**2.78**	**3.59**	**2.32**	**2.47**
Standard deviation	0.39	0.45	0.38	0.48	0.25	0.46	0.47	0.49	0.55	0.66
% increase	**34.94**		**31.47**		**40.76**		**29.31**		**6.65**	

Minimum and maximum possible value of each asset measured is 1 and 5, respectively

REFERENCES

Ashley C., Start D., Slater R. and Deshingkar P. (2003). Understanding Livelihoods in Rural India: Diversity, Change and Exclusion. Policy Guidance Sheets produced by the Overseas Development Institute for the ODI Livelihood Options Study, funded by the UK Department for International Development (DFID).

Chambers R. and Conway G.R. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper 296. Institute of Development Studies, Brighton, UK.

Department for International Development. (1999). Sustainable livelihoods guidance sheets. Eldis Document Store (http://www.eldis.org)

Mehta R. (2009). Rural Livelihood Diversification and its Measurement Issues: Focus India. Wye City Group on Rural Statistics and Agricultural Household Income, Second Annual Meeting, 11-12 June 2009, FAO, Rome

Scones Ian. (1997). Sustainable rural livelihoods: a framework for analysis, IDS Working Paper 72, Institute of Development Studies, Brighton, UK.

Western Orissa Rural Livelihoods Project (WORLP). (2001). Orissa Watershed Development Mission, Government of Orissa and DFID - the UK Department for International Development (http://www.worlp.com)