Enhancing water, food and income security through Farm Ponds

Meghna Mukherjee and Nirmalya Choudhury*

Abstract

The performance of the agricultural sector in the economy continues to be low despite having a plethora of programs and initiatives directed towards its development. One of the main reasons for its underperformance can be attributed to its high dependency on monsoons. Variations in the monsoon can cause crop failure in the short run and even drought in the long run. Thus, vagaries of monsoon can cause serious concern for the development of the economy as well as for the well-being of the households engaged in the agricultural workforce. To ameliorate the condition, water conservation measures which harvest water within the farm should be promoted. Farm Ponds in this sense can be seen as a low cost and easy to adopt rainwater harvesting structures which would provide a supplemental water source to the farmers during the Rabi season.

In Jharkhand, farm ponds have been promoted through the MGNREGA program in various districts. Tata Steel Rural Development Society (TSRDS), a nongovernment organisation in Jharkhand, since 2010, has been promoting construction of farm ponds in the Kolhan region (West Singhbhum, East Singhbhum and Seraikela Kharsawan district). Till date, it has constructed approximately 800 ponds in the three districts of Kolhan region. These farm ponds not only act as water harvesting structures but simultaneously work to improve agriculture/horticulture and allied activities like fisheries and duckery by promoting optimal use of water, which then results in income enhancement and stabilisation. Reduction of the drudgery of women who are largely associated with carrying water from long distances and access to drinking water for livestock can also be seen as a positive externality created by farm ponds. Broadening the impact set, one can probe further into the implication on the ecology as a whole.

The purpose of this study is to evaluate the socio-economic impact of the farm ponds promoted by TSRDS on the life and livelihoods of the people in the Kolhan region using a sequential mixed method approach. It was seen that farmers reaped positive economic impacts through intensification, diversification and surplus generated from various farm-based livelihoods (agriculture, fisheries and livestock) which led to income enhancement. Further analysis was done on the essential quality of life indicators like access to health, drinking water and sanitation

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services. It was seen that income enhancement through farm ponds did not translate into an overall improvement in the quality of life. Further, a basic financial analysis was undertaken and the Internal Rate of Return and the Pay off Period were calculated to compare the net benefits across different farm pond size.

Introduction

The performance of agricultural sector in the economy continues to be low despite having a plethora of programs and initiatives directed towards its development. One of the main reasons for is underperformance can be attributed to its high dependency on monsoons. Rain fed agriculture contributes 40 per cent to the country's food grain production with 60 per cent area vulnerable for weather vagaries *(Kareemulla et al., 2009*). Variations in the monsoon can cause crop failure in the short run and even drought in the long run (*Kishore et al. 2015).* This is a serious concern for the development of the economy as well as for the well-being of the households engaged in agricultural workforce. They account for around 70% of the rural population in India and 59% of rural population in Jharkhand who are dependent on agriculture as their main source of livelihood. *(Agricultural Census, 2011*)

In 2016, the Mean Annual Rainfall in Jharkhand was 1264 mm, much higher that agriculturally prosperous states like Madhya Pradesh (1098 mm and 1223 mm in Western and Eastern MP respectively) and Gujarat (764 and 483 mm respectively in Gujarat and Kutch/Saurashtra respectively). As seen in the Figure 1, the rainfall distribution in Jharkhand is skewed with some 80% precipitation taking place in the months of July, August and September. But such skewness is a national phenomenon (more than 80% of the MAR in 2016 took place between July to September in Gujarat and Rajasthan). This leaves the agricultural sector of the state highly vulnerable to the vagaries of monsoon. Agriculture in the state suffers from poor surface water availability and poor water control despite adequate rainfall. The high dependency and low irrigation facility in the state (11.54% of net sown area is irrigated) has resulted in low cropping intensity (Cropping Intensity of Jharkhand is 125 as compared to 137 for an all India level) with around 70% of the area which is under Kharif cultivation remaining fallow during non-monsoon months (*Jharkhand economic survey 2013; Jharkhand State Agriculture Development Plan 2012).* Skewed rainfall distribution and low irrigation coverage, constrains the scope for agriculture intensification in the state. The strangle hold of limited water control on agriculture can only be unshackled through increase of irrigation coverage through various ex-situ and in-situ water conservation measures. A recent NITI Aayog (2018) document argues for measures like rain water harvesting by bunding of plots and construction of runoff management structures like minor irrigation tanks and ditches. These measures would then provide critical supplemental irrigation and contribute to growth of less water intensive crops like pulses and oilseeds (*NITI Aayog, 2018*). The 5th Census of Minor Irrigation schemes also suggests adoption of minor irrigation techniques like dugwells, tubewells, surface flow schemes and surface lift schemes by various state governments for the promotion of agriculture. Since micro irrigation projects do not involve much forest land and can be completed in shorter time, its benefit to the farmers is accrued in a shorter time period. (*Report on 5th Census of Minor Irrigation Schemes, 2017; State Agriculture Department, Government of Jharkhand).*

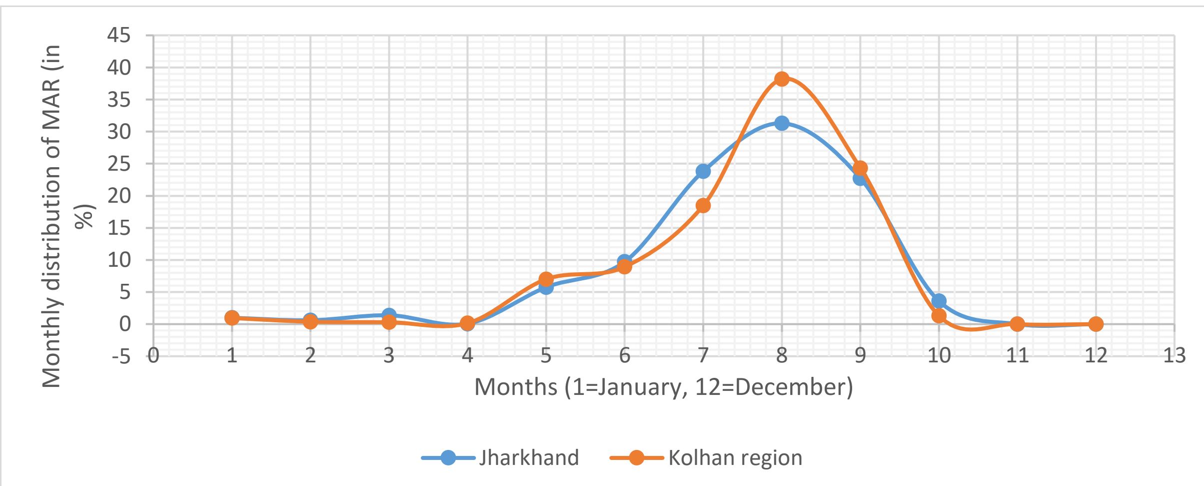

Figure 1: Rainfall distribution in Jharkhand and in Kolhan Commissionerate in 2016

For a state like Jharkhand which receives 1100 mm to 1442 mm of rainfall, a good alternative would be to harvest rainwater through construction of farm ponds. Farm ponds were originally conceived to collect and store rainwater so as to provide protected irrigation to crops during periods of water scarcity. Realizing the advantages of the surface irrigation schemes like farm pond, in the recent years, the central government and various state governments have also promoted the use of farm ponds to address the problem of water scarcity (*Kale, 2017*). Having being portrayed by media as the miracle strategy that addresses the water scarcity problem, makes evaluation of farm ponds an important issue.

Adoption and promotion of farm ponds is generally best suited for rainfed areas. In those regions, construction of storages to hold the excess flow of monsoon months can help in irrigation during dry months. Construction of farm ponds has also been encouraged by the government of India as one of the climate change adaptation mechanisms for the rain-fed areas. In accordance with their recommendations, specific guidelines were mentioned in the Common Guidelines for Watershed Development Fund which provided for financial assistance for cost intensive farming in private lands. Farm pond network has been suggested as the appropriate technology for watershed development which can have significant impact on the livelihoods of farmers. NABARD also has implemented the provision of giving short term loans to farmers to encourage them through incentives like differential rate of interest to construct network of farm ponds in their lands *(DHAN Foundation, 2009)*.

Farm ponds can be seen as a low cost and easy to adopt rain water harvesting structures which would provide supplemental water source to the farmers during the Rabi season (*DHAN Foundation 2009, NITI Aayog 2017).* Investments undertaken for its construction can easily be recovered and hence its replication in other parts of the country should also be promoted (*Giordano et al 2014, Banerjee 2008, Malik Year of Publication).*

In Jharkhand, farm ponds have been promoted through the MGNREGA program in various districts. Tata Steel Rural Development Society (TSRDS), a nongovernment organization in Jharkhand, since 2010, has been promoting construction of farm ponds in the Kolhan region (West Singhbhum, East Singhbhum and Seraikela Kharsawan district). During 2010-2013, TSRDS used to directly hire contactors to construct farm ponds in villages. However from 2013, the implementation process was restructured in order to enhance community participation in the planning and execution process. TSRDS strengthened existing community based organizations like Trusts/samities, got them registered, in case they were still informal and empowered them to engage with the community to select prospective pond owners and to do an initial planning of the farm ponds. During 2013-2017, TSRDS have promoted some 800 odd farm ponds in the Kolhan region (Chart 1). The purpose of this study is to evaluate the effectiveness of these farm ponds using a concurrent mixed method approach.

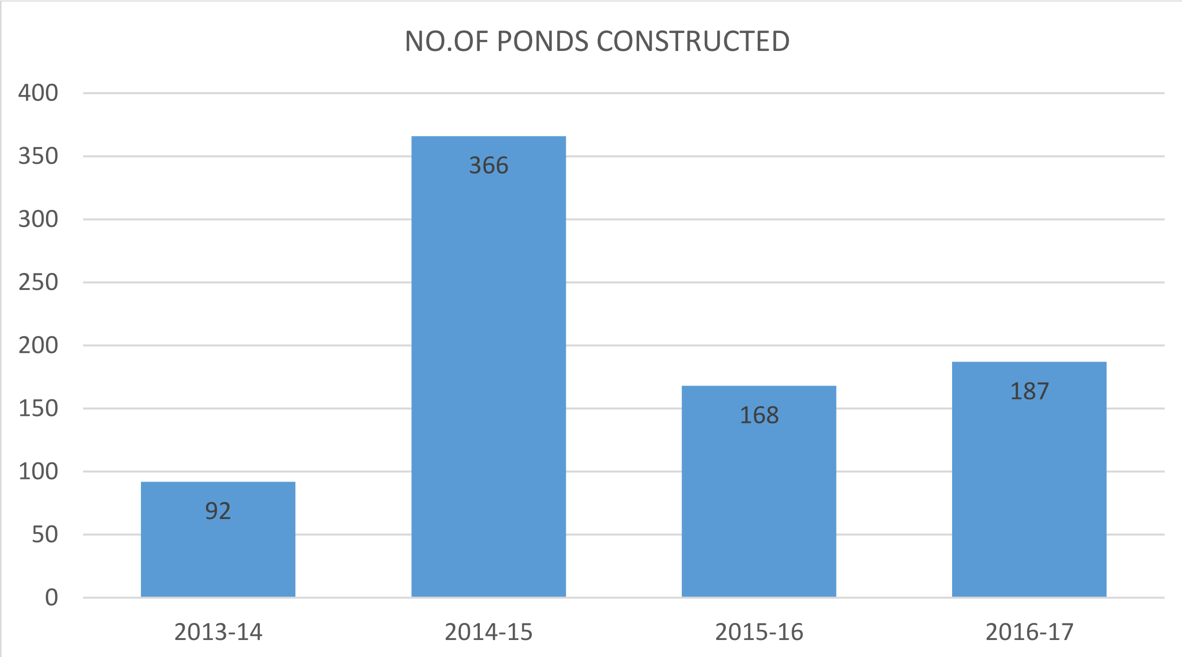

Chart 1: Farm Ponds promoted by TSRDS in Kolhan region

Methodology

The purpose of this study is to evaluate the socio-economic impact of the farm ponds promoted by TSRDS on the life and livelihoods of the people in the Kolhan region using a sequential mixed method approach (Creswell 2008). As on date there are 7 Samiti/Trusts which operate in the three districts of Kolhan region. The Samiti acts as an intermediary organisation performs multiple tasks ranging from community engagement, initial selection of the farm pond location (which are then technically appraised by the TSRDS team) and hiring of contractors for digging the pond. The size of the farm ponds vary as per farmers desire and feasibility on the site – from as small as 50 feet by 50 feet by 10 feet to as big as 150 feet by 150 feet by 10 feet. Accordingly the costs of the pond also vary. A small part of the pond cost is borne by the beneficiary.

The study took place in phases. The first phase undertook a qualitative exploratory research strategy with the broad objective of understanding the nature of the intervention (farm ponds). This phase included an exploratory visit to several farm ponds, semi-structured interview with the TSRDS officials and unstructured interview with beneficiaries and non-beneficiaries of the farm ponds and site visits to look into selected farm ponds. The selection was a mix of convenient and purposive sampling.

Based on the first phase, in the second phase a survey of selected farm ponds was undertaken. This time the farm ponds were chosen based on a multi-stage proportionate random sampling. In February 2018 a total of 90 farm pond (owners) were surveyed. The sample frame was collected from TSRDS which consists of the details of the farm ponds constructed during 2014-15 and 2015-16. These two years were purposefully chosen such that one the recall period was not too far, and second the farm ponds are not so new that a full agriculture year is yet to get completed post the farm pond construction. From the sample frame multistage proportionate random sampling was undertaken: districts formed the first stage and blocks within districts the second stage and the beneficiary households the final unit. The selected sample was spread across 15 villages across the three districts. Table 1 and 2 elaborates the sample selection process based on year of construction and ponds constructed in three districts. Further, to get an indepth understanding on if and how women in and around the selected household benefit from the farm pond intervention around four Focus Group Discussions were held with women.

Farm pond was constructed in	Total number	Number of pond selected for the study
2014-15	368 (69)	56 (62)
2015-16	167 (31)	34 (38)
Grand Total	535	90

Table 1: Sample selection according to year of construction (Figure in parenthesis are per cent of total)

Districts	Total number of Farm Ponds	Number of pond selected for the study
EAST SINGHBHUM	362 (68)	60 (66)
SARAIKELA KHARSAWAN	48 (9)	10 (11)
WEST SINGHBHUM	125 (23)	20 (22)
Total	535	90

Table 2: Sample selection from the three districts (Figure in parenthesis are per cent of total)

The economic impacts of the farm ponds were traced through metrics pertaining to intensification, diversification and surplus generated from various farm-based livelihoods (agriculture, fisheries and livestock). Further a basic financial analysis was undertaken and Internal Rate of Return and the Pay Off Period were calculated. Given the wide range of farm ponds promoted by TSRDS, the above metrics was compared across different farm pond size. Further data was also collected on essential quality of life indicators like access to health, drinking water and sanitation services, with an objective to trace out how the farm pond intervention has kind of affected the access to these services. The above analysis was also undertaken in an disaggregated manner where by the performance of different social categories of beneficiaries (Scheduled Caste, Other Backward castes, Scheduled Tribe and General Caste) on the above metrics were carried out.

Location and Ownership pattern

The beneficiaries of the farm pond intervention included households from different social groups – Scheduled Tribe (ST), Scheduled Caste (SC), Other Backward Caste (OBC) and General caste. Around 53% of the farm pond owners were ST, around 37% were OBC and 10% were SC farmers. The study focused on three districts – East Singhbhum, Saraikela-Kharsawan and West Singhbhum. Most of the beneficiaries in West Singhbhum were ST, while in East Singhbhum the OBC beneficiaries dominate(Table 4).

Districts	OBC	ST	SC	Gen	Grand Total
EAST SINGHBHUM	27	22	8		57
SARAIKELA KHARSAWAN	4	5		1	10
WEST SINGHBHUM	1	19			20
Grand Total	32	46	8	1	87

Table 4: Caste composition of Respondents

The landholding pattern in Jharkhand is undulating and can be broadly classified into upland, lowland and midland. The official/colloquial nomenclature varies, In the East Singhbhum district landholding classification is referred as: *taand-baad-kanali-baid*. Among these *taand* and *baad* corresponds to upland. The productivity of *taand* is usually low owing to thin soil cover and steep slope. The *kanali* and *baid* land have lower slope, higher soil cover and water retention capacity is usually high. As a result, the cropping pattern also varies across the different type of landholding – shorter duration crops (paddy) is cultivated in the midlands, while long duration paddy, with higher yield is cultivated in the lowland. In other parts of the landholding classification is locally nomenclature as *chetan ote-tala-latar ote* in West Singhbhum, and *gora-maalto-satia* in East Singhbhum district.[1]

Given the differential water retention capacity of different types of landholding, which intuitively indicate how good a particular location is for a storage/water harvesting structure like a farm pond, the authors looked into the location of the selected farm ponds with respect to the landholding classification. Around 45% of the farm ponds were found to be located in the midland and another 33% in the upland (Table 5).

Land on which Farm Pond is constructed	2014-15	2015-16	Grand Total
Upland	19	13	32
Midland	26	13	39
Lowland	11	8	19
Grand Total	56	32	90

Table 5: Location of farm ponds selected for the study

The location pattern analysis was followed-up with the water retention capacity of the farm ponds. The water retention capacity of the farm ponds was important for two reasons[2]: (a) It was reported that the existing water harvesting structure (farm ponds), due to wrong choice of location, resembled recharge ponds, where water supposed to be stored in the pond would percolate. As a result the pond would get dry quickly; (b) The productive and protective potential of the farm ponds get compromised – it fails to provide critical supplemental irrigation in the later half of the kharif (monsoon) season if a particular dry spell become unusually long, fails to intensify cropping if the pond cannot supply irrigation in the post-monsoon (rabi) season. The selected ponds showed high water retention rate. As per the respondents (farm pond owners) a pond would have water for around 10 months a year. While the retention period did not vary with respect to location of the

[1] Based on the interviews with multiple farmers in Patamda block of East Singhbhum district, in West Singhbhum and Seraikela Kharsawan in Jharkhand from 7th- 13th October 2017.
[2] Based on the interview with the TSRDS staff and farmers in Patamda Block of East Singhbhum.

farm pond, the level of water in the farm pond varied. While farm ponds located in upland would have around 4 feet of water in February, level of water would double in the ponds located in the lowland (Table 6).

TSRDS Pond	NO. OF MONTHS TILL WHICH POND HAS WATER?	WHAT WAS THE WATER LEVEL IN FEBRUARY? (IN FEET)
Upland	10	4
Midland	10	5
Lowland	11	8
Overall	10	5

Table 6: Water retention capacity of farm ponds

Crop intensification and yield stabilisation

As described earlier, any water harvesting structure might have two functions: protective and productive. In advent of a long dry spell, the actual evapotranspiration would fall short of the potential evapotranspiration and the shortfall if not overcome would result in decline of the yield. Critical supplemental irrigation, through water harvesting structures, can partially cover-up the shortfall and ensure that the crop loss is avoided. Superior water control, brought in through water harvesting structure, can provide irrigation beyond the monsoon months and ensure a second (and sometimes a third) crop, thus enhancing crop intensification.

Paddy is the most important crop of Jharkhand. Around 70% of the gross cropped area is under paddy cultivation (Glance, A. S. A. A. (2010) *Government of India*). Only 3% of the cultivated area is irrigated. (Glance, A. S. A. A. (2010) *Government of India*).Thus, the yield of paddy remains unstable and low. During 2001-02 and 2010-11, the yield of paddy hovered around 2.1T/Ha at the national level while in Jharkhand the yield was around 1.5T/ha (*Agricultural Statistics at a Glance 2009*). Hence a target was set to double the yield to 3T/Ha, as part of the 12th Five year Plan of the Jharkhand state (Planning Commission, Government of India.2002)

While during 2001-02 and 2010-11 the irrigation coverage at the national level hovered around 44%, the same was abysmally low (around 10%) for Jharkhand (*Agricultural Statistics at a Glance 2009*). Low irrigation coverage challenged agriculture intensification in the state. While between 2001-02 and 2010-11, cropping intensity in India was around 136%, in Jharkhand it was only 113% (*Agricultural Statistics at a Glance 2009*). Hence the target was to increase cropping intensity to 150% (*Agricultural Statistics at a Glance 2009*).). Hence in the 12th Five year Plan, the target was set to increase it to 150% (Planning Commission, Government of India.2002).

	Pre-Intervention	Post-Intervention	p-value
Paddy Yield (T/Ha)	2.1	2.8	***
Quantity used for self-consumption (T)	3.2	3.5	
Quantity sold in the market (T)	2.4	3.6	***

Table 7: Paddy yield and production with farm ponds

***p<.01

Paddy Cultivation

With the advent of farm pond, and hence assured irrigation, the yield of paddy has (statistically) significantly increased from 2.1T/Ha to 2.8T/Ha. Though the yield is yet to reach the state target of 3T/Ha, but farm ponds have certainly put the farmers (the farm pond owners) in touching close to the target. Given the importance of paddy in the overall food basket, the farm ponds have also contributed to food security as the quantity used for self-consumption has increased. Perhaps the most important outcome of the yield increase is the (statistically) significant enhancement in marketable surplus (Table 7). Thus, contributing to income enhancement for the farm pond owners.

Landholding among the farm pond owners (In Hectares)	
OBC	1.7
ST	2.8
SC	3.5
GEN	3.3
Overall	2.5

Table 8: Land Holding pattern

With the advent of farm ponds, and assured irrigation, Gross Cropped Area has significantly increased from 1.9 Ha (pre-intervention) to 2.2 Ha (post-intervention) among the beneficiaries of the farm pond intervention. As a result, the Cropping Intensity, a metrics for agriculture intensification, has also increased significantly. However, the overall level of intensification is still lower than the national (and state) average. Traditionally, landholding size is not a constraint in this area (Table 8), water control is, as a result the usual practice would be to cultivate rainfed paddy on a small patch of land (usually midland and lowland), followed by migration. Open grazing and lack of water control constrained agriculture intensification (Phansalkar and Verma 2005). The only exception, to a limited extent, would be the SC *mahato* farmers in parts of East Singhbhum, catering to the nearby urban markets. These group of farmers have marginally increased their cropping intensity with the advent of farm ponds. The ST and OBC farmers have shown a high growth in Cropping Intensity as they started with a pretty low baseline (Table 9).

	Pre-Intervention	Post-Intervention	p-value
GCA (Ha)	1.9	2.2	**
CI (%)	84	94	***
CI_ OBC (%)	91	96	
CI_ST (%)	76	88	
CI_ SC (%)	100	106	

Table 9: Gross Cropped Area (GCA) and Cropping Intensity (CI) **p<.05; ***p<.01

Crop diversification

Before the intervention paddy overwhelmingly dominated the cropping landscape and very few people took crops. Post-intervention the diversity of crops has increased and more number of people have been cultivating more type of crops. Farmers having farm ponds have confirmed that they are now able to diversify their crops and produce vegetables like cauliflower, brinjal, potato and even broccoli to meet the market demand (Table 10).

Pre-Intervention		Post-Intervention	
Crop type	Number of farm pond owners	Crop	Number of farm pond owners
Paddy	85	Paddy	88
Tomato	9	Tomato	51
Potato	7	Brinjal	24
Pigeon pea	5	Potato	21
Brinjal	4	Pigeon pea	19
Wheat	3	Wheat	11
Cauliflower	2	Mustard	10
Maize	2	Ladies Finger	7
Mustard	2	Bitter Gourd	6
		Pulses	6
		Cauliflower	5
		Cucumber	4
		Bottle Gourd	3

Table 10: Crop Diversity among the farm pond Owners

To analyze and compare the magnitude of crop diversification we have computed the Herfindahl Index (HI). The value of HI varies between zero to one. It is one in case of perfect specialization and approaches zero in case of perfect diversification (Velavan and Balaji, 2012). Given that the intervention agency has promoted farm ponds of different sizes (Table 11), the HI was calculated with respect to different farm pond sizes. HI is also calculated across different social categories (SC/ST/OBC) to look into the level of diversification that these groups have been able to achieve from a similar intervention (farm pond).

Size of Pond (length*breadth*depth, all in feet)	Number of Ponds constructed
80*80*10	12
100*100*10	19
120*120*10	8
100*120*10	5
150*150*10	15
100*80*10	5

Table 11: Farm Ponds of Different Sizes[3]

Herfindahl index is defined as:

$$\mathrm{HI} = \sum_{1}^{n} \mathrm{Pi}^2$$

$$\mathrm{P_i} = \frac{\mathrm{A_i}}{\sum_1^n \mathrm{A_i}}$$

$\mathrm{A_i} = \text{Area under ith crop}; \sum_1^n \mathrm{A_i} = \text{Total(Gross)Cropped Area}$

	Pre-Intervention	Post-Intervention	P-value
HI_Overall	0.67	0.54	***
HI_Upland	0.66	0.62	
HI_Midland	0.98	0.92	***
HI_Lowland	0.99	0.99	

Table12: Herfindahl Index – Overall and different part of the landholding ***p<.01

The HI has gone down over the years, which indicates that crop diversification has increased. The level of diversification is different across parcels of land depending on whether the parcel is in upland, midland or lowland. Lowland used to be under long duration paddy, it still continues to remain like that. Also, water retention and lack of drainage does not render the land fit for vegetable cultivation. Diversification has been maximum in the midland. Earlier the land would

[3] The intervention agency has promoted farm ponds of other sizes, but they are too few in number. Hence the table only shows those far pond sizes, for which at least 5 ponds have been constructed.

only be under paddy cultivation but now apart from paddy, cropping season has increased with vegetable cultivation post-monsoon. This change can be attributed to the farm pond intervention. Quite expectedly the HI for the midland has shown (statistically) significant reduction (Table 12).

Social Category	HI_preintervention	HI_postintervention
OBC	0.64	0.49
ST	0.70	0.57
SC	0.58	0.54
GEN	1.00	0.50

Table 13: Herfindahl Index before and after intervention according to social groups

Increase in crop diversification has pervaded different social categories, albeit at different rates. The SC *mahato* farmers were already cultivating vegetables. With the farm pond they have further diversified their cropping pattern. The OBC farmers were not as advanced as the *mahato* farmers, but they seem to have diversified their cropping pattern the most. The ST farmers have also increased crop diversification but not as much as the SC and OBC farmers (Table 13).

Size of Pond	HI_Preintervention	HI_Postintervention	Growth in Diversifciation
80*80*10	0.71	0.59	17
100*100*10	0.65	0.54	17
120*120*10	0.60	0.56	6
100*120*10	0.60	0.59	2
150*150*10	0.75	0.58	23
100*80*10	0.70	0.49	30

Table 14: Herfindahl Index across different farm pond size

Crop diversification has increased across different pond sizes. Currently diversification is highest for 100*80*10 pond size, followed by 100*100*10 pond size. The growth in diversification measured in terms of change in the HI is also highest for the 100*80*10 pond size (Table 14).

Building risk within the (agriculture) system?

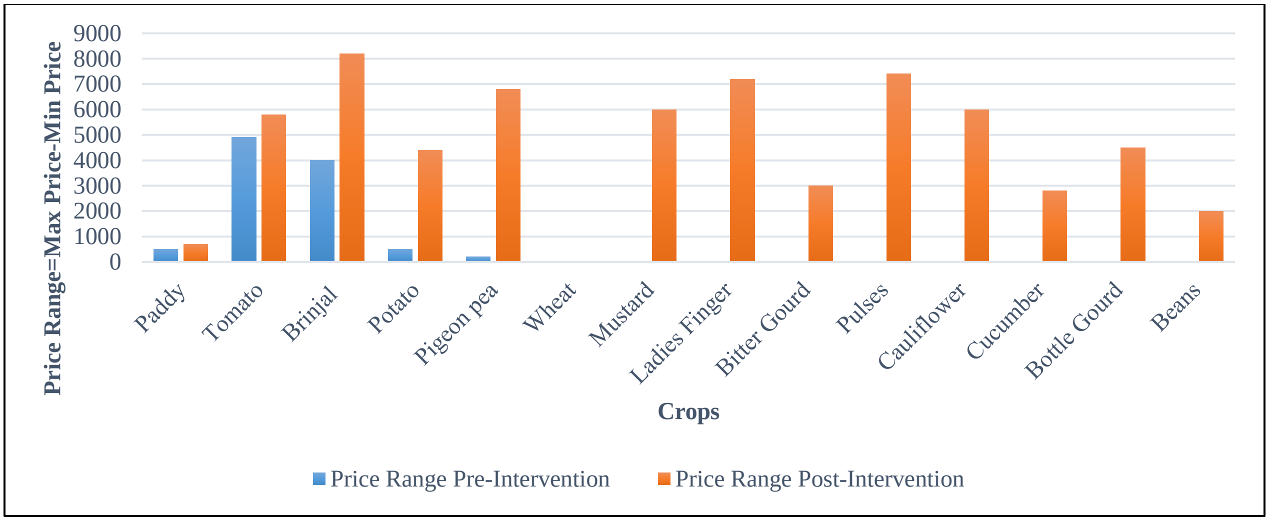

Chart 2: Price Fluctuation of Crops (in Rs)

With the advent of increase water control through farm ponds, there has been crop intensification and diversification. Crop diversification could be an income maximization strategy (in diversification is towards high value crops) or a risk minimization strategy. In this case the choice of crops – vegetables – does not resemble a risk minimization strategy. On the contrary it seems that with crop diversification the risk within the agriculture system is increasing. In order to maximize income the pond owners are cultivating a wide range of vegetables. But the price range among the respondents before and after the intervention shows an increase in the price fluctuation (measured by price range, which is maximum price minus the minimum price). In crops like tomato, brinjal, pigeon pea and potato, the price range post-intervention exceeds that of pre-intervention. For the others, which are cultivated only after the advent of farm ponds, the price fluctuation is high (Chart 2).

Livestock and fisheries with the advent of farm ponds

Livestock plays an important role in strengthening and sustaining rural livelihoods. It contributes in poverty reduction through income enhancement, achieving environmental sustainability through provision of organic manure and providing nutritional security. Livestock enhances household resilience and acts as an insurance against natural and social risks like droughts, famine, natural calamities, sickness and death. It ensures regular employment and a steady flow of income. Studies have found that livestock, usually managed by women, contributes to enhances the decisionmaking power among women within the household and enhances social welfare. (Kumar et al 2012, Ramchandani and Karmarkar 2014,Patidar et al 2014, Bain et al 2018).

Inland culture fisheries improve food security particularly among poorest of households and also contributes to income enhancement. Various studies have highlighted the importance of fisheries in improving the nutritional intake among the households engaged in culture fisheries. Fishing as an activity also diversifies the livelihood portfolio and contributes to employment security, particularly among households with poor quality landholding (FAO 2006. Mondal et al 2012, Thompson et al 2008; Edwards 2000, Martin et al 2013, Fisher et al 2017).

Given the importance of livestock and fisheries in the rural life and livelihoods, we looked into the effect of farm ponds on these two important assets. With the advent of farm ponds, fisheries have been promoted – initially by the farm pond owners on their own and recently by the intervening organization. The latter has promoted scientific aquaculture in the recent years. Given that the intervention is recent, impact of scientific aquaculture was too early to be capture in this study. However, the data shows that number of household practicing fisheries has increased from 13 to 85 (Table 15). Among livestock, cow, goat and poultry have shown a marginal increase among the pond owning households. The respondents reported that the livestock contributed to both income enhancement through sale of milk and meat and increased domestic consumption. Prior to the advent of the farm ponds, major source of water for the livestock was the stream. Post-intervention farm ponds have become the major source of drinking water for the livestock. During the course of FGDs with women, who are generally assigned the task of cattle rearing, it was confirmed that after the construction of ponds, it has become easier for them to fetch water for animals. The farm ponds not only cater to the needs of the animals of the farm pond owners but also water needs of animals from all over the village.

Livestock/Fish	Pre-Intervention	Post-Intervention	Major source of water post-intervention	Major source pre-intervention	Main Product
Cow	33	34	Farm Pond	Stream	Milk
Buffalo	6	6	Farm Pond	Stream	Milk
Goat	31	31	Farm Pond	Stream	Meat
Sheep	5	5	Farm Pond	Stream	Meat
Poultry	68	70	Handpump	Stream	Meat
Duck	7	2	Farm Pond	Stream	Eggs
Bullock	13	13	Farm Pond	Stream	
Fish	13	85			

Table 15: Livestock and Fisheries among the farm pond owners

Income from agriculture, livestock and fisheries

Watershed development facilitates like farm ponds helps in reducing the vulnerability of farm income to weather-induced shocks in rain-fed lands in India (Datta 2015). Through stabilization, intensification and diversification the farm ponds have contributed to income enhancement among the pond owners. While before the intervention the farmers would hardly generate marketable surplus, post-intervention the median[4] income from agriculture would hover around Rs 10,500. The farm ponds have made available more food grains for self-consumption to the pond owners. This has resulted in an opportunity benefit by reducing the expenditure that the farmers would otherwise incur to buy food for self-consumption. If that opportunity benefit is taken into consideration the median[5] agriculture income effect would be around Rs 24000 per household (from a pre-intervention income of Rs 16000 to a post-intervention income of Rs 40240).

(Mean) Income from Agriculture	Pre-Intervention	Post-Intervention	P-value
Excluding self-consumption (in Rs)	2900	44390	***

[4] The mean values show high fluctuation (as measured by high standard deviation). Hence median was chosen for a better aggregate representation for the income.
[5] Mean values show high fluctuation. Hence median was chosen.

Including opportunity value of self-consumption (in Rs)	29100	80450	***
Excluding self-consumption (in Rs/Ha[6])	17700	-1600	**
Including opportunity value of self-consumption (in Rs/Ha[7])	41100	11600	***

Table 16: Mean Income from Agriculture among the farm pond owners ***p<.01; **p<.05

Overall the farm ponds have contributed to significant income enhancement among the pond owners (Table 16). While the income from agriculture and fisheries have increased, a marginal decline is witnessed with respect to income from livestock (Table 17).

Income	Pre-Intervention	Post-Intervention
Livestock	9348	9165
Fisheries (inclusive of consumption)	6177	8780
Fisheries (exclusive of consumption)	3805	6175

Table 17: Income from livestock and fisheries

As was mentioned earlier, the implementing agency has promoted a plethora of sizes of farm ponds. The income enhancement potential of the farm ponds varied across the sizes. Among the various sizes, the ponds of size 80*80*10 feet provide the maximum benefit in terms of agriculture income (Tables 18 and 19). The same also holds true for income from fisheries (Table 20).

Farm Pond Size[8] (in feet)	Post-Intervention (exclusive of domestic consumption) Rs/Bigha	Pre-Intervention (exclusive of domestic consumption) Rs/Bigha	Post-Intervention (inclusive of domestic consumption) Rs/Bigha	Pre-Intervention (inclusive of domestic consumption) Rs/Bigha
80*80*10	14940	-1280	18100	670

[6] The data was obtained in Rs/Bigha. Pre-Intervention: -Rs200/Bigha; Post-Intervention: Rs 2360/Bigha.
[7] The data was obtained in Rs/Bigha. Pre-Intervention: Rs 1500/Bigha; Post-Intervention: Rs5480/Bigha.
[8] The implementing agency has promoted a plethora of farm pond with respect to their size. This table highlights only those sizes corresponding which a minimum of 5 ponds were implemented.

100*100*10	1680	250	4490	2180
120*120*10	-570	370	3020	2290
150*150*10	710	-500	3700	1680
100*80*10	2030	70	3480	740

Table 18: Income potential of different pond sizes per unit of landholding[9]

Farm Pond Size	Post-intervention (exclusive of domestic consumption)	Pre-Intervention (exclusive of domestic consumption)	Post-Intervention (Inclusive of domestic consumption)	Pre-Intervention (Inclusive of domestic consumption)
80*80*10	158790	-2360	158790	-2360
100*100*10	17910	1160	17910	1160
120*120*10	5760	7860	5760	7860
150*150*10	21470	-5330	21470	-5330
100*80*10	94920	48100	94920	48100

Table 19: Agriculture Income among the farm pond owners[10]

Farm Pond Size	Average Income (in Rs)
80*80*10	19870
100*100*10	7934
120*120*10	4296
150*150*10	7952
100*80*10	10480

Table 20: Additional Income from fisheries (including self-consumption)

[9] The figures have been rounded off.
[10] The figures have been rounded off.

Equity and farm ponds

Equity is defined as the ability of a system to distribute the benefits across different parts of the system in a just and fair manner (Lele 1993). Often in natural resource management interventions, argued, collective action, efficiency and sustainability trumps equity (Sangameswaran 2006). Hence the enhancement of the resource potential, the quantum of benefit generated from the resource, and the ability to maintain the resource-benefit potential of a system in foreseeable future, gets a higher priority over how the benefits gets distributed across different sections of the society – across class, caste and gender. In the context of watershed interventions, (Joy and Paranjape, 2004) argued that structure the interventions “accentuates inequity” as the interventions tends to favor the landed and people living in the lower reaches, compared to the landless. A recent research undertaken by the students from the Tata Institute of Social Sciences on Participatory Groundwater Management in Vikarabad district in Telangana, highlighted that within the bore-well pooling groups, the benefit sharing was structurally skewed towards the borewell owners compared to the non-borewell owners (**WPG 2017).** In this context the study aimed to look into the differential impact of farm ponds across the caste-tribe trajectory. Subsequently, the social impact of farm ponds also looks into the impact on ponds across gender.

In order to look into the impact of farm ponds across the caste-tribe trajectory, a comparative analysis of benefits from farm ponds among the farm pond owners was undertaken. The comparison was done across different social categories – SC, ST and OBC farmers. In order to look into the income effect of the farm ponds across various social categories, additional income in agriculture, livestock and fisheries was computed. The addition income was defined as:

$$Additional\ Income_i = (PostIntervention\ Income - PreIntervention\ IncomeIncome)_i$$

$$i = Agriculture, Livestock, fisheries$$

The income effect of farm pond varies across different social categories. With respect to agriculture while all have benefitted, the OBC and SC farmers have benefitted the most. In general income from livestock shows a marginal decline. The decline is sharp among the SC and ST farmers. While the OBC and SC farmers have experienced a high and positive income effect with respect to fisheries, the same is low (yet positive) for the ST farmers. It can be inferred that while all have benefitted from the farm pond, it is the SC and OBC farmers who have benefitted the most (Table 21).

Row Labels	Agriculture (Inclusive of self-consumption)	Livestock	Fisheries (Inclusive of self-consumption)
OBC	71683	1509	12326
ST	39698	-1645	2940
SC	66515	-1720	7405
Overall	55882	-193	6808

Table 21: Income effect from the farm pond intervention (in Rupees)

Towards better quality of life?

The stabilization, intensification and diversification of livelihoods needs to translate into superior quality of life. Access to safe and hygienic sanitation facility is a basic minimum requirement for having a reasonable quality of life – something that's still a challenge in large part of the country. Coffey et al (2017) reports that a majority of India's population still defecate in the open *(Coffey et al. 2017)*. As per the 72nd round of NSSO data which was undertaken in May-July 2015, just 45.3 per cent rural households reported having a sanitary toilet. Out of all the states the lowest percentage of households having sanitary toilets was reported in Jharkhand (18.8 per cent) (*NSSO 2016)*. Given this context the study tried to go beyond the livelihoods dimension of farm ponds and look into if increased income is actually translating into a better quality of life. Of the 90 farm ponding owning households surveyed in the study, around 40% of the households reported having toilets at home. Of the remaining 60%, nearly 90% continued to practice open defecation.

Access to clean fuel is still low among the respondents. Though indoor air pollution is identified as a major health risk factor in India (Smith 2000; Behera and Malamugesh 2004; Chengappa et al 2007); more than 80% of the respondents continue to depend on fuelwood as a source of cooking fuel. On an average one of four members in the household would fall sick. In such cases often people have to travel somewhere around 18 kilometers to access the nearest health facility. The sickness would impose a direct financial burden and would result in loss of labor days. Around

45% respondents reported that health problems would result in loss of labor days, around 15-23 days in last one year. Both these affected the income potential of the household.

More than 80% of the respondents reported handpump as the primary source for drinking and cooking, while the farm ponds were used more for washing and bathing. During the FGDs, it was observed that though women still take bath in the open but there has been a significant reduction in drudgery as compared to their situation before. Women confirmed that before construction of farm ponds, they had to walk miles to fetch water from the stream. However, there has been significant improvement in the situation now and they are able to meet all their water needs from the farm ponds. A woman of Sargu village in Ghurabanda block said, *"Earlier we used to go to the stream which is at least 2kms away from my house. Because of this I used to take bath on alternate days. But now the farm ponds is near to my house. I am able to take bath daily now."* The respondents reported that the farm ponds have contributed to increased recharge – while hand pumps used to dry up early, post-farm ponds they remain functional round the year. Though hydrogeological analysis of the claim is beyond the scope of the study, going by what the respondents have reported, the recharge benefits were akin to ecosystem services provided by the farm ponds to the nearby areas. The remaining depended on wells.

The study also looked into health and nutrition changes among the farm pond owning households. According to the ICMR guidelines, the minimum calories intake needed by a rural person is 2400kcal and by an urban person is 2100 kcal. However, due to poor income source, improper health care services and inadequate water and sanitation facilities, rural people are unable to fulfill their basic calorie requirement. As per ICMR norms, 77% of rural Indians are under nourished. Thus, to increase the level of nutritional level of intake, focus should be made to expand avenues of income. In a report by ICMR it suggests that nutritional outcomes of income improvement are much stronger for poor and rural households. The respondents have reported an increased consumption of eggs, fish and milk (Table 22). Intake of eggs, milk and fishes is a major source of protein and has a direct impact on the health and well-being of the households. Earlier farmers were not able to purchase these items from market due to limited disposable income. Now, as income and diversity in production portfolio has increased, the households are not only producing diverse edible items in-house but their ability to purchase from the market has also increased. According to a farmer in Bhula village of Boram block in East Singhbhum district, *"Every Sunday* *we have Fish and rice. Earlier we had to get it from the weekly market, but now we just go to our pond and catch a fish for our meal***.***"* Thus, a positive association can be established between rise in income opportunity with nutrition intake.

	% of respondents
Change in consumption, Yes	60
Change in Consumption, No	40
Increase in meat fish milk and egg consumption	79
Increase in Vegetable and pulses consumption	21

Table 22: Change in Consumption pattern of households

Many of the respondents reported that earlier labor requirement would be restricted to monsoon season and the lean season would usually witness high outmigration. With superior water control, brought in by the ponds, the cropping season has increased and as a result demand for labor has increased. Hence people do not need to go out to the nearby city in search for job. They can work as a laborer in some others farm or cultivate his own land. FGDs with the women confirm that people now hire laborers from within the village.

Financial Analysis of farm ponds

Due to paucity of the pond expenditure data, the financial analysis was only restricted to farm ponds that were constructed in 2015-16. For calculation of the Benefit-Cost (B-C) ratio, the benefits emanating was calculated as the sum of additional income from agriculture, livestock and fisheries, resulting from the intervention (pond). Since a part of the produce is used for domestic consumption, which not only reduces purchase from the market but also contributes to nutritional diversity. In order to include this opportunity value that results from the intervention, the additional income is inclusive of the self-consumption. Given the plethora of farm ponds with respect to the size, the objective of the financial analysis was to zero down on that size which provides maximum benefit vis a vis the cost. The B-C ratio and the pay back period across different farm pond sizes showed that 80*80*10 and 100*80*10 were financially the two nost optimum sizes (Table 22).

Pond Size	Number of ponds	Total additional income (inclusive of	Expenditure in Rs	Payback period (months)	B-C ratio

		self-consumption) in Rs			
80*80*10	12	157156.6	137395.4	10	1.14
100*100*10	21	31256.29	204945	79	0.15
120*120*10	8	7736.667	284081.3	441	0.03
150*150*10	14	70673.4	470202	80	0.15
100*80*10	5	216150	164209.2	9	1.32
100*80*10	3	96800	164209.2	20	0.59

Table 23: Benefit Cost ration and payback period of farm ponds

Given the long-term nature of the intervention, Internal Rate of Return (IRR) is seen as a superior measure than the BC ratio. The IRR calculation was done based on certain assumptions:

- The lifetime of ponds to be of 15 years.
- Scenario 1: Business as Usual – expenditure is in the form on farm pond expenditure, the additional income calculated remains unchanged over the years.
- Scenario 2: Every second year the income reduces by 50% on account of price fluctuation or due to extreme events (like drought)
- Scenario 3: Every second year the income reduces by 50% on account of price fluctuation or due to extreme events and once in every five years an amount equivalent to 40% of the capital cost is spent for pond maintenance.

Overall the IRR from the farm ponds is around 21% under BAU situation, but can go down to 15% and 11% under scenario 2 and scenario 3. The overall value of IRR is susceptible to assumptions, and the assumptions here are not very robust. The data collected was not amenable to robust assumptions. hence the IRR values have to be seen more as an indicative rather than as a perfect measure of financial viability. Still, the IRR result seems to back-up the BC analysis: the farm pond of 80*80*10 is the most optimum size in terms of financial viability (Table 23).

Pond Size	Scenario-1	Senario-2	Scenario-3
Overall	21	15	11
80*80*10	114	95	88
100*100*10	12	7	2

100*120*!0	17	11	7
150*150*10	12	7	5
130*130*10	25	18	17
100*80*10	59	47	41

Table 24: IRR of ponds of varied sizes

Conclusion

In Maharashtra, a state with high inclination towards commercial agriculture, Kale (2017) argued, the farm ponds are less a rainwater harvesting structures but more often act as intermediate storage where groundwater extracted from bore-wells are stored before applying the same to the crops. As a result farm ponds have actively contributed in increased evaporation loss, limited recharge, groundwater depletion and drinking water scarcity. In Jharkhand, while farm ponds are gradually getting popular, the above problems are yet to crop up. Here the farm ponds have brought a plethora of changes in the life and livelihoods of the farmers in the Kolhan region. With better water control, the intervention has resulted in yield enhancement of paddy crop, the most important crop in the region. This has contributed to food security. The increased marketable surplus of paddy has also contributed to income enhancement.

With farm ponds at their disposal the farmers have simultaneously intensified and diversified their agriculture. But with diversification the risk within the agrarian system has increased. While better water control has moved the farmers away from the vagaries of the monsoon, the high price fluctuation has exposed the farmers to the vagaries of the market. In various parts of the country, diversification for income maximization has resulted in high risk, as the new crops are susceptible to high price fluctuation. The downward spiral of the fluctuation has hit the farmers hard and several states has witnessed large farmer protests demanding a higher price for their produce. As Damodar argues, Indian agriculture has moved to a new problem – a problem of “permanent surplus” (Damodaran, 2018). The command area of the farm ponds has just started witnessing diversification and high price fluctuation. In order to bring a sustained agriculture development in these areas, there is a need to work “beyond the farm”. Thus, interventions pertaining to improve storage facility, strengthening market linkages, packaging and value addition would be increasingly important in future.

While the economic impact has positively affected different social categories of farmers, but the effect is of varying magnitude. While the OBC and the SC farmers could take maximum use from the intervention, the ST farmers have not been able to extract similar benefits. The social impact of the farm ponds is more cheered. The higher income on its own has not translated into a better quality of life. Issues like safe sanitation, clean energy and access of quick health care seems to elude the otherwise income rich farmers. The women bear the brunt disproportionately. But the farm ponds through improved recharge has contributed to improved access to drinking water, water for domestic use (and hence an effect on the life of the women engaged in these activities) and have contributed to dietary improvement. Increased water control has also increased the labor demand in the area. Overall one can reiterate that the case of farm pond intervention in Jharkhand shows that though resource creation can lead to immediate income enhancement, the same might not translate into an overall improvement in the quality of life. Perhaps the case also provides a rationale for moving beyond individual interventions (like farm ponds, in this case) to a plethora of interventions which are geared towards improvement of the quality of life of the rural populace.

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