Agrarian Potential of In-Situ Water Harvesting

A Case Study of Farm Ponds in Jharkhand

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Despite substantial government expenditure on major and medium irrigation systems, Indian agriculture continues being predominantly rain-fed. But increasing private interventions for water control, such as farm ponds, mark the emerging importance of in-situ irrigation systems for India's agrarian dynamism. A case study of farm ponds in Jharkhand finds the contribution of these in increasing the agrarian surplus through yield enhancement, crop diversification and crop intensification. However, the financial viability of such a system is scale dependent with farm ponds of only a certain size generating high benefit-cost ratio and internal rate of return.

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Since independence the Government of India has spent substantial amount on creating irrigation potential for defying the vagaries of monsoon and enhancing the food production. While the irrigation potential created has increased in the last six decades, majority of India's agriculture still continues to be rain-fed. High utilisation of the extant irrigation facilities and the improvement in irrigation service delivery, as found by Shah et al (2016) in Madhya Pradesh, are more an exception than rule. Groundwater has been the driver of the irrigation growth in South Asia. But depletion and quality deterioration raise questions about sustainability of such measures. In this context, promotion of small water harvesting structures that are privately owned and located on the user's farm, especially in areas that have hitherto remained outside the purview of irrigation, are expected to increase water control at the farm level and bring positive changes in the agrarian landscape of the area (Malik et al 2014). Based on this premise, this article looks into the impact of farm ponds on the lives and livelihoods of the agrarian population in three districts of Jharkhand.

Water Control and Agriculture in Jharkhand

Between 1951–56 and 2002–07, around ₹2,700 billion was spent in the country to create an irrigation potential of 77 million hectares. Much of this amount was spent on the major and medium irrigation systems—mostly dams and canals. These systems have contributed to around 50% of the total irrigation potential created but have consumed nearly 70% of the total expenditure. Actual irrigated area is, however, lower than the potential created—around one-fifth of the created irrigation potential has always remained unused (Planning Commission 2011). The ratio has not changed much in the recent years. In 2014–15, around 49% of the gross cropped area of 198 million hectares was irrigated (GoI undated 1). Between 2005–06 and 2014–15, gross irrigated area would remain around 46% of the gross cropped area (GoI undated 1). The growth in irrigated area has remained sluggish over the years. Between 1950–51 and 2013–14, irrigation coverage has recorded a compounded annual growth rate of 1.6%, and since the 1980s, decadal growth in irrigation coverage has shown a consistent decline (Indiastat.com).

Existing studies have found high correlation between irrigation and agriculture intensification (Shah 2009), and an important role of irrigation in reducing poverty (Hussain and Hanjra 2004). In a country like India where rural demography continues to remain overwhelmingly agrarian, with more than 70% of the workforce engaged in agriculture and allied activities as per the Census 2011, and where rainfall distribution pattern is unequal across the year, a sluggish growth in irrigation would have important implications for the agrarian livelihoods.

The configuration of low irrigation coverage, unequal distribution of rainfall, lack of agrarian dynamism in an otherwise agrarian state is perhaps nowhere starker than in Jharkhand. Around 76% of the state population resides in the rural area and around 63% of the population is engaged in agriculture. Between 2012–13 and 2016–17, however, agriculture's contribution in the state's economy, hovered around 15%, much lower than the national-level share of 20% (GoI 2018a; RBI 2017).

Jharkhand's agriculture is constrained by low net sown area,[1] high current fallows and low cropping intensity.[2] The above can be attributed to a low level of water management in the state. In 2010–11, only 12% of the net sown area in the state was under net irrigation, compared to 45% at the all-India level. The significance of irrigation (and the lack of it) in Jharkhand is further heightened by the temporal concentration of the rainfall pattern in the state, which surpasses the average skewness of the rainfall distribution at the national level. While the state gets around 1,300 millimetre (mm) of rainfall every year—much higher than the national average of 1,100 mm—around 84% of the mean annual rainfall is concentrated to the period June and September (data.gov.in).[3]

Studies, such as Phansalkar and Verma (2004), argue that improved water control strategies, which are in sync with the local resource condition and socio-ecology of the area would be able to redress the livelihood problems, improve the otherwise dismal human development indicators and boost the overall economy of the area. But, the undulating terrain in the state limits the scope of large dams-reservoir-canals kind of projects. Often such projects are also prone to time and cost overruns (Planning Commission 2011). In recent years, however, Jharkhand has witnessed multiple government and non-government initiatives for creating in-situ water harvesting structures like farm ponds. The farm ponds are much smaller in size, less expensive and have lower gestation period than dam-canals projects. These potentially enhance water control at the farm level and can prove to be an important intervention to kick-start agrarian dynamism in the state. A chain of farm ponds along a drainage line would be able to harvest the rainwater through surface run-off and base flows, provide critical supplemental irrigation in kharif, some irrigation in rabi and also aid in allied livelihood activities like fisheries and duck rearing (NITI Aayog 2018).

The goal of this study is to analyse the effects of the farm ponds on the lives and livelihoods of the pond owning rural households in the state. For this purpose, the study looks at the farm-pond initiatives of a Jamshedpur based non-governmental organisation, the Tata Steel Rural Development Society (TSRDS). Between 2013 and 2017, TSRDS has promoted some 800 odd farm ponds in the Kolhan region of Jharkhand, which comprise of the districts of East Singhbhum, West Singhbhum and Seraikela–Kharsawan.

Methodology and Data

The current paper uses a sequential mixed method approach (Creswell 2008) to evaluate the socio-economic impact of the farm ponds promoted by TSRDS in the Kolhan region in Jharkhand. The study took place in various phases. The first phase, conducted in October 2017, undertook a qualitative exploratory research strategy with the broad objective of understanding the nature of the intervention. This phase included visits to six farm pond sites, three semi-structured interviews with the TSRDS officials and eight unstructured interviews with beneficiaries and non-beneficiaries of the farm ponds. The sampling followed in this phase was a mix of convenience and purposive sampling.

Subsequently, based on the complete list of farm ponds promoted by TSRDS in 2014–15 and 2015–16, a sample survey of selected farm ponds was undertaken in January and February 2018. These two years were purposefully chosen for two main reasons. First, the recall period was not too distant, and second, each pond was old enough to complete at least one full crop year since its construction. The farm ponds were chosen through multi-stage proportionate random sampling. In February 2018, a total of 90 farm pond owners were surveyed. The selected sample was spread across 15 villages in the three districts. Further, to get an in-depth understanding of whether and how women in and around the selected households benefit from this intervention, four focus group discussions were held with women in March 2018.

Table 1: Farm Ponds by Year of Construction and District of Location

	Total Number of Ponds Constructed by TSRDS	Number of Farm Ponds in the Sample
Year of construction		
2014–15	368 (69)	56 (62)
2015–16	167 (31)	34 (38)
Total	535 (100)	90 (100)
District of location		
East Singhbhum	362 (68)	60 (66)
Seraikela–Kharsawan	48 (9)	10 (11)
West Singhbhum	125 (23)	20 (22)
Total Number	535 (100)	90 (100)

Figures in parenthesis are percentages of the total.
Source: Based on data maintained by Tata Steel Rural Development Society (TSRDS).

The farm ponds are livelihood improvement interventions. Through provision of superior water control these are expected to improve the livelihoods of the farming populace by enhancing the net sown area, and bringing agriculture intensification in an area where the cropping intensity is otherwise much lower than the national average. Additionally, superior water control is expected to result in yield enhancement, resulting in improvement of food security and increase in marketed surplus. The latter is expected to motivate the farmers towards introducing a change in the cropping pattern geared towards income maximisation, as compared to risk minimisation, which is typically done in areas where farmers have little water control.

This study looked into some of these aspects by tracing the economic impacts of the farm ponds through changes in agriculture intensification, agriculture diversification and surplus generated from the various farm-based activities. The financial viability analysis of the farm ponds was undertaken through the computation of benefit–cost analysis, payback period and the internal rate of return (IRR). The above metrics were compared not only across different farm pond sizes, but also across different social categories of beneficiaries. The analysis of these metrics was carried out.

Farm Ponds: Whose and Where

The beneficiaries of the farm pond intervention included households from different social groups. Around 53% of the farm pond owners belonged to Scheduled Tribes (ST), 37% were from Other Backward Classes (OBC) and 10% were Scheduled Castes (SC) farmers. Most of the beneficiaries in West Singhbhum were ST, while in East Singhbhum, the OBC beneficiaries dominated.

By their geographical distribution, landholdings in Jharkhand can be broadly classified into upland, lowland and midland. The productivity of upland is usually low owing to thin soil cover and steep slope. The midland and lowland have lower slope, thicker soil cover, and high water retention capacity. The cropping pattern also varies across the different type of landholding—shorter duration crops (mostly short duration paddy) is cultivated in the midlands, while long duration paddy, with higher yield is cultivated in the lowland. The upland could remain fallow or have sparse homestead cultivation. The differential water retention capacity of the farm ponds, which then defines the reliability of the water control structure, is contingent upon the site selected for the construction of the farm pond.[4]

Around 21% of the farm ponds are located on the lowland, 43% in the midlands and the remaining 36% in the upland (Table 2). The water retention rate is ubiquitous at around 10 months a year, irrespective of the location of the farm pond. However, the level of water in the farm pond during the dry months varies. While the farm ponds located in the upland would have around 4 feet of water in February on the average, level of water was reported to be double in the ponds located in the lowland (Table 2).

Table 2: Location-wise Water Retention Capacity of Farm Ponds

Location of Farm Pond	Number	Water Retention Period (in Months)	Water Level in February (in Feet)
Upland	32	10	4
Midland	39	10	5
Lowland	19	11	8
Total	90	10	5

Cropping Intensity and Yield

Water harvesting structures have two critical functions: protective and productive. Critical supplemental irrigation through water harvesting structures can partially cover up the soil moisture shortfall and ensure that the yield loss is minimised. Also, water harvesting structures like farm ponds can extend irrigation beyond the monsoon months, thus enhancing overall cropping intensity from 146% in the pre-intervention phase to 155% post intervention. This study finds that farm ponds have provided supplemental irrigation for the kharif crop.

Traditionally, landholding size is not a constraint in this area. Average landholding among the surveyed farmers is around 2.5 ha, much higher than the national average. However, the prevalence of intensive agriculture is low in the area. The usual agriculture pattern is monocrop—mainly rain-fed paddy—cultivated during kharif on a small patch of land (usually midland and lowland). Migration is high during other seasons. Open grazing and lack of water control have constrained agriculture intensification (Phansalkar and Verma 2004).

This scenario has changed with the advent of farm ponds. The gross cropped area among the beneficiaries has increased from 1.9 ha (pre-intervention) to 2.2 ha (post-intervention). As a result, the cropping intensity has also recorded a significant increase. The rate of growth is, however, different for different social groups. In the study area, the only group that traditionally bucked the general trend on monocrop followed by migration, was the SC Mahato farmers in parts of East Singhbhum. However, they have been practising intensive vegetable cultivation for nearby markets. Farm ponds have had marginal contribution in increasing the cropping intensity among this category, but among the ST and OBC farmers cropping intensity has caught up with the advent of farm ponds (Table 3).

This study looks at the yield of paddy in the intervention areas. Though paddy is the most important crop in the state in terms of its share in the gross cropped area (64% in 2014–15), irrigation coverage is low (5% in 2014–15), and so is the yield, hovering at 2.2 tonnes a hectare in 2016–17, compared to the national average of 2.5 tonnes a hectare (GoI undated 2; GoI 2018b). With the advent of the farm ponds, the average yield of paddy has shown a significant increase from 2.0 tonnes/hectare to 2.6 tonnes/hectare, at the household level. Given the importance of paddy in the overall food basket, farm ponds have potentially contributed to food security. Perhaps, the most important outcome of the yield increase is the significant enhancement in marketed surplus, increasing from 29% in the pre-intervention phase to 33% post intervention (Table 3).

Table 3: Household-level Yield Enhancement, Agriculture Intensification and Diversification

	Pre-intervention	Post-intervention
Paddy production per household (tonnes)***	3.9	5.2
Paddy yield per household (tonne/hectare) ***	2.0	2.6
Self-consumption of paddy per household (tonnes)	2.9	3.1
Paddy sales per household (tonnes)***	1.5	2.2
Gross cropped area per household (hectare)**	1.9	2.2
Average cropping intensity per household (%) ***	146	155
Household-level cropping intensity by social categories:		
OBC (%) **	150	160
ST (%) ***	140	150
SC (%)	161	165

**p<.05; ***p<.01.

Source: Authors' own calculation based on survey data.

Crop Diversity

Herfindahl Index (HI) is used to study the effect of the farm ponds on crop diversity, with HI being defined as:

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

where $P_i = A_i \Big/ \sum_{1}^{n} A_i$

and A_i = Area under *ith* crop; $\sum_{1}^{n} A_i =$ Total (Gross) Cropped Area

The value of HI varies between zero to one: with zero in the case of perfect diversification and one in the case of perfect specialisation. The HI is calculated with respect to different farm pond sizes, across different social groups (SC/ST/OBC) and across the location of the farm ponds (upland, midland, and lowland). The HI is estimated to have gone down in the post-intervention period indicating that the crop diversity has increased with the advent of the farm ponds (Table 4).

The increase in crop diversity has taken place among different social groups, but at different rates. Prior to the advent of the farm ponds crop diversification was comparatively low among the ST and the OBC farmers as compared to the SC farmers. Mahato farmers were already into

Table 4: Crop Diversity by Social Groups, Location and Farm Pond Size

	Number of Observations	Herfindahl Index	
		Pre-intervention	Post-intervention
Overall (for all households in the sample) ***	86	0.67	0.54
Social groups			
OBC***	31	0.64	0.50
ST***	45	0.70	0.57
SC	9	0.58	0.53
Agricultural plot			
Upland**	63[5]	0.72	0.60
Midland***	73	0.98	0.92
Lowland	65	0.99	0.99
Farm-pond size (length*breadth*depth, all in feet)[6]			
80*80*10**	12	0.71	0.59
100*100*10***	19	0.65	0.54
120*120*10	8	0.60	0.56
100*120*10	5	0.60	0.59
150*150*10***	15	0.75	0.58
100*80*10***	8	0.64	0.44

**p<.05; ***p<.01.

Source: Authors' own calculation based on survey data.

vegetable cultivation, which they would supply to the nearby townships. With assured irrigation from the farm ponds Mahato farmers have further diversified their vegetable cultivation. The ST and OBC farmers have diversified their overall cropping pattern and moved towards vegetable cultivation.

The level of diversification differs between the upland, midland and lowland agricultural plots. Lowland, which has thick soil cover and high soil moisture, has been traditionally used to cultivate long duration paddy. Even with the advent of the farm ponds the tradition continues. The biophysical factors like high soil moisture holding capacity for a prolonged period of time and lack of drainage does not render the land fit for vegetable cultivation. Hence, the cropping pattern has remained unchanged in the lowland agricultural plots. However, with assured irrigation from the farm ponds, farmers in the midland agriculture plots have moved into second and third crops—vegetables—post the paddy season. In this region the soil cover is thick, and drainage of water is not a constraint. Even on some of the upland agriculture plots, where the soil cover is not too thin and the slope is not steep, farm pond owners have moved into vegetable cultivation. As a result, crop diversification has increased in the midland and upland agriculture plots (Table 4).

Crop diversification has increased across all the pond sizes. Currently diversification is highest for 100*80*10 pond size, followed by 100*100*10 pond size. The growth in agriculture diversification is also highest for the 100*80*10 pond size. Around 50% of the farm ponds of 100*80*10 are owned by the ST community and about 38% are owned by OBC community. With the advent of the farm ponds both these communities have been able to significantly diversify their agriculture. Hence, the pond of this size has shown maximum growth in crop diversification.

Diversity of Agricultural Activities

Livestock potentially plays an important role in strengthening and sustaining rural livelihoods, reducing poverty through income enhancement and nutritional security. It can also enhance household resilience against natural and social risks. Studies have also found that livestock, usually managed by women, enhance the decision-making power among women within the household (Kumar et al 2012; Ramchandani and Karmarkar 2014; Patidar et al 2014; Bain et al 2018). Fisheries also contribute to employment security and nutritional intake, and diversification of livelihoods, particularly among smallholder farmers (Béné 2006; Mondal et al 2012; Thompson et al 2002; Edwards 2000; Martin et al 2013; Fisher et al 2017).

In the study areas fisheries were practised by the respondents even before the farm pond interventions. The intervening agency, however, promoted scientific aquaculture in the recent years. This intervention is at a nascent stage, yet the data shows that the number of households practising fisheries has increased with the interventions. Among livestock owning households, there is marginal increase in the ownership of cows, goats, and poultry after the farm pond interventions (Table 5). The respondents reported that the livestock contributed to both domestic consumption and income enhancement. Farm ponds are the major source of water for the livestock. During the course of focused group discussion with women, it was confirmed that since 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.

Agricultural Income

The farm ponds have contributed to yield enhancement of paddy, the most important food crop in the region, and has increased its marketed surplus. With assured irrigation from the farm ponds the pond owners could extend and diversify the cropping pattern. All these have contributed to income enhancement among the farm pond owners (Table 6). With the advent of the farm ponds, one an average, a pond owning household would get an incremental income of ₹54,906 per year.[7]

Table 5: Share of Households Owning Livestock and Fisheries

Livestock/Fisheries	% of Households Owning Livestock/ Fisheries (N=90)	
	Pre-intervention	Post-intervention
Cow	33	34
Buffalo	6	6
Goat	31	31
Sheep	5	5
Poultry	68	70
Duck	7	2
Bullock	13	13
Fisheries	13	85

Source: Authors' own calculation based on survey data.

Table 6: Change in Agricultural Income among Farm Pond Owners (₹)

	Pre-intervention	Post-intervention	Additional Income
Overall***	22,195	77,101	54,906
Social groups			
OBC***	9,027	80,834	71,807
ST***	28,058	68,494	40,436
SC	41,100	96,924	55,824
General	11,000	1,80,000	1,69,000

*** p<.01.

Source: Authors' own calculation based on survey data.

This study also analysed income enhancement across the different social groups to see how the benefit from farm pond gets distributed. The OBC farmers registered the maximum increase in the income. With the advent of farm ponds, not only their paddy yield stabilised but they got the opportunity to practise vegetable cultivation as well. Mahato farmers were already into vegetable cultivation and practised most advanced agriculture among the three groups. With the advent of farm ponds this group of farmers further diversified their production. As a result, this group also registered a fairly high growth in income. With the advent of the farm ponds, the ST farmers also increased their income, but not as much as the other two groups (Table 6).

Overall, the farm ponds have contributed to a significant income enhancement among the pond owners. The additional income from the farm ponds varied across different pond size groups. A comparative analysis across different farm pond sizes shows that the pond of size 100*80*10 feet provides the maximum additional income. As was seen earlier in this article, this pond size had recorded maximum crop diversification, and hence the lowest HI among the various pond size categories. Since the total income varies as the land owned by a pond owner varies, to bring the analysis to a common datum the additional income per unit of landholding (₹/ha) was also calculated. Here the pond size 80*80*10 shows the maximum income

Figure 1: Price Fluctuation of Crops (₹)

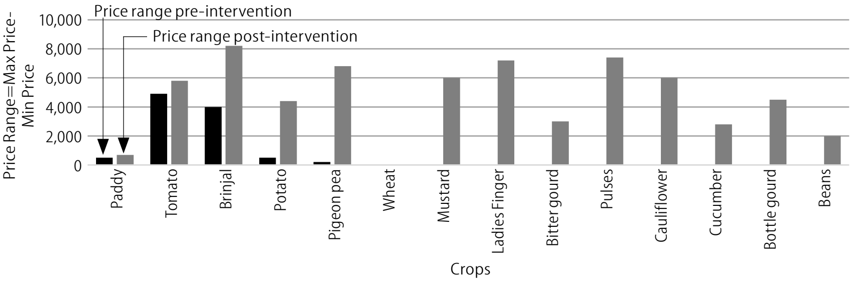

Table 7: Agriculture Income across Different Farm Pond Sizes

Size of Farm Pond	Number of Observations	Pre-interventions	Post-intervention income (₹)	Additional income (₹)	Additional Income per Unit of Landholding ₹/ha
80*80*10	12	7,025	1,08,713	1,01,688	89,265
100*100*10***	22	30,745	75,787	45,042	44,458
120*120*10	8	29,125	46,464	17,339	4,989
150*150*10 ***	15	12,064	51,479	39,415	19,703
100*80*10 **	8	49,300	1,65,263	1,15,963	41,051
Overall	90	22,195	77,101	54,906	35,894

***p<.01, **p<.05.
Source: Authors' own calculation based on survey data.

increase followed by 100*100*10 and 100*80*10 pond sizes (Table 7).

Risk Resilience

Crop diversification could either be a risk minimisation strategy or an income maximisation (through diversification to high value crops) strategy. The cropping pattern among the farm pond owners, dominated by various vegetable cultivation, does not resemble a risk minimisation strategy. On the contrary it seems that with crop diversification the risk within the agriculture system is increasing. The risk is manifested by the high price fluctuation experienced by the respondents with respect to the different crops, as shown in Figure 1. The fluctuations cannot be directly attributed to the farm ponds. But, the farm ponds have allowed the farmers to extend the cropping seasons, diversify their produce and increase the marketed surplus. Given this the farmers' engagement with the market has increased and they now have greater exposure to the vagaries of the market. The high price fluctuation indicates that increased irrigation has moved the farmers away from the vagaries of the monsoon and closer to those of the market.

Financially Viability of Farm Ponds

The scaling-up of the farm ponds is hinged on their financial viability. Due to the paucity of data on expenditure incurred for pond construction, the financial analysis was only restricted to farm ponds that were constructed in the 2015–16 financial year. The financial analysis is based on three metrics—the benefit–cost (B-C) ratio, the payback period, and the IRR.

The benefits in the B-C ratio include the sum of additional income from agriculture, livestock and fisheries, resulting from the farm pond intervention. The additional annual agricultural income is the difference between the annual income from agriculture post-farm ponds construction and pre-farm pond construction. The cost includes the average expenditure incurred to construct a farm pond of a particular size. The B–C ratio and the payback period varied across the size of the farm pond (Table 9). Overall the pond sizes of dimensions 80*80*10 and 100*80*10 have generated maximum returns.

Given the life of the farm pond goes beyond a year, the study also computed the IRR of the farm ponds. The IRR calculation is based on the following assumptions: First, the lifetime of the ponds is 15 years. Second, are three alternative scenarios.

– Scenario 1: Business as usual prevails, which means that the expenditure and the additional income calculated remain unchanged over time.

– 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 like droughts. Additionally, once in every five years, an amount equivalent to 40% of the capital cost is spent on pond maintenance.

Table 8: Benefit–Cost Ratio and Payback Period of Farm Ponds

Farm Pond Size	Annual Additional Agricultural Income (₹)	Expenditure Incurred on Farm Pond Construction (₹)	B-C Ratio	Payback Period (Months)
80*80*10	1,46,190	1,37,395	1.1	11
100*100*10	26,536	2,04,945	0.1	93
120*120*10	10,733	2,84,081	0.0	318
150*150*10	79,580	4,70,202	0.2	71
100*80*10	1,76,433	1,64,209	1.1	11
Overall	66,947	3,16,482	0.2	57

The IRR from the farm ponds is around 19% under scenario 1, but can go down to 13% to less than 1% under scenarios 2 and 3 respectively. The overall value of IRR is susceptible to assumptions, and the assumptions here are not very robust, but provide an indicative measure of financial viability. However, the IRR result seems to back up the B–C analysis. The farm pond of the dimension of 80*80*10 and 100*80*10 are estimated to be the optimum sizes in terms of financial viability (Table 9).

Table 9: IRR of Ponds of Varied Sizes

Farm Pond Size	Scenario-1	Scenario-2	Scenario-3
Overall	19	13	0.4
80*80*10	106	73	70
100*100*10	9	4	0
150*150*10	14	8.6	0
100*80*10	108	73	70

Conclusions

Kale (2017) has argued that farm ponds in Maharashtra have contributed to groundwater depletion, drinking water scarcity and increased evaporation loss as they cease to remain as water harvesting structures and become intermediary surface storage for groundwater. The farm ponds in Jharkhand are yet to manifest such ill fares. Rather, with the advent of the farm ponds there has been improvement in water control which has resulted in yield enhancement of paddy crop, and contributed to food security. With farm ponds at their disposal, farmers have simultaneously intensified and diversified their agricultural produce. Cumulatively the intensification, diversification and yield enhancement have contributed to income enhancement among the agrarian population. The economic impact has positively affected the different social categories of farmers, but the magnitude of the effect varies. While the OBC and the sc farmers have gained the most from the farm ponds, the st farmers have not been able to extract similar benefits.

In various parts of the country, diversification for income maximisation has resulted in new crops cultivated that are susceptible to high price fluctuation. The downward spiral of the fluctuation has hit the farmers hard. As a result, several states have witnessed large farmer protests demanding a higher price for their produce. The results from this study hint at increasing risk in the agrarian system resulting from crop diversification brought in by superior water control. Such an increase is conjoint with the gradual transition of the agrarian system to becoming more market dependent. While better water control has moved the farmers away from the vagaries of the monsoon, the high price fluctuation associated with the new crops has exposed the farmers to the vagaries of the market. Giordano and de Fraiture (2014) have argued that small irrigation systems such as farm ponds will be able to provide a sustained improvement in income and livelihoods if the farmers can be hedged from the volatility of the market. Thus, a plethora of "beyond the farm" intervention such as improved storage facility, strengthening of market linkages, packaging and value addition would be increasingly important if the positive outcome from farm ponds has to be sustained.

NOTES

1 Net sown area in Jharkhand is around 26% of the sum of cultivable, arable and culturable area. This share is around 78% at the national level (GoI undated 2).

2 Cropping intensity, measured as the ratio of the gross cropped area to the net sown area, was 115% for Jharkhand in 2010–11, compared to 141% at the national level (GoI undated 2).

3 https://data.gov.in/node/87154/download and https://data.gov.in/node/85824/download.

4 In interviews with the TSRDS staff and farmers in Patamda Block of East Singhbhum, the respondents informed that due to wrong site selection farm ponds would resemble recharge ponds and hence their water retention period would be limited. The productive and protective potential of the farm ponds gets compromised. These fail to provide critical supplemental irrigation in kharif (monsoon) season, and intensify cropping through assured irrigation in the post-monsoon (rabi) season.

5 With the advent of farm ponds, total number of farmers cultivating the upland has gone up from 19 to 63. For this variable a two-sample t-Test assuming equal variances was undertaken. For the other variables in the table, paired t-Test was undertaken.

6 The intervening agency has promoted farm ponds of other sizes, but they are too few in number.

7 During the survey, household level data on total cost of production, marketed surplus, farm produce used for self-consumption, and price at which the farmer sold the produce was collected for each of the cultivated crops. For calculating the income, the total production (sum of self-consumption and marketed surplus) was multiplied with the price from which the cost of production was subtracted, for each crop. Subsequently, the income from each crop was cumulated to calculate the income of the household. There were crops which were entirely used for self-consumption and not marketed and hence the price was not available. For those crops, we used the median price of the crop (based on our entire database) as a substitute of the price.

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