Volume 6 - Issue 01- January,2025

SABUJEEMA
An International Multidisciplinary e-Magazine

Article ID: SIMM0492 Popular Article

On-farm Water Management in Aquaculture-based Integrated Farming System: Boon for Tribal Farmers?

Rajeeb K. Mohanty, Roomesh K. Jena*, Prasanta Kumar Patra, Ranu Rani Sethi, Rabindra K. Panda, Arjamadutta Sarangi
ICAR-Indian Institute of Water Management, Bhubaneswar 751023, Odisha

Open Access

Abstract

This study examines the impact of water resource development and integrated farming systems (IFS) on the livelihoods of tribal farmers in Birjaberna village, Sundargarh district, Odisha. The interventions addressed critical challenges like inadequate irrigation, low productivity, and lack of technical knowledge by constructing flow-regulating devices, dug wells, and introducing sprinkler irrigation systems. These efforts enhanced water availability, enabling diversified cropping systems and integrated aquaculture. Introducing rice-mustard-groundnut cropping sequences replaced traditional mono-cropping, boosting yields and water productivity. Pisciculture in service reservoirs generated additional income, while training programs fostered community adoption of advanced agricultural practices. Results showed a significant rise in annual net returns (from ₹17,000/ha to ₹1,78,626/ha) and benefit-cost ratio (1.94 vs. 1.29). These interventions improved food security, household incomes, and resilience among tribal communities. The study highlights the potential for replicating agri-aquaculture-based IFS to enhance livelihoods and promote sustainable farming in similar agro-climatic regions.

Keywords: Integrated Farming System (IFS), Water Resource Management, Livelihood diversification, Tribal communities

Introduction

Ethnic minority (tribal) communities, commonly known as 'Adivasi', are among the most marginalised segments of the Indian population and play a key role in constructing the cultural heritage of India. They reside in approximately fifteen per cent of the country`s geographical area. For generations, the Adivasi have practised a diversified livelihood strategy combining agriculture and livestock farming, fishing, and hunting. Unlike the mainstream population, they originally inhabited sparsely populated areas with ready access to natural resources. Despite a robust community leadership system and high social coherence, their livelihoods are increasingly in jeopardy due to social, economic, and ecological factors. The land holding of this community is minimal and fragmented, while the majority are landless. With the increase in landlessness, working as agricultural wage labour or seasonal migration for unskilled jobs constitutes the few available livelihood diversification options. As traditional livelihoods are eroding, the majority are trapped in a vicious cycle of poverty, which is multidimensional. Thus, identifying and providing appropriate alternative livelihood options are essential to reducing vulnerability and increasing resilience in tribal communities. There is a growing appreciation for aquaculture in the diversification of rural livelihoods. Demonstration and research evidence shows that small-scale aquaculture or aquaculture-based integrated farming systems (IFS), promoted with due consideration for social, economic, and environmental contexts and framed within a shared understanding of livelihood assets and risk management, can substantially improve the livelihoods of poor, vulnerable and marginalised ethnic minorities. In addition, conventional approaches, emphasising the promotion of technology, infrastructure development, water resource creation, water management, and provision of targeted extension services, not only benefit impoverished tribal communities but also strengthen their capabilities, means of living, income, and assets. As a diversified livelihood strategy, when aquaculture becomes a component of an integrated farming system along with on-farm water management, it promotes ecological agriculture that exploits maximum benefit from the system, avoids harmful effects, and strives for maximum output using available energy and materials and thus provides added advantage in terms of yield, water productivity, and profit. In this backdrop, a case study was undertaken by the ICAR-IIWM through a tribal sub-plan (TSP) to study the impact of water resource creation and its multiple-use management on productivity, profitability, and socio-economic development of the tribal community at Birjaberna village of Sundargarh district, Odisha since 2016-17.

Study site

Birjaberna village in Sundargarh district of Odisha is a tribal-dominated village with 50 farm families and a population of 77% ST. It is a remote village (latitude 22° 01’ 51.27” N and longitude 84° 07’ 25.15” E) with a total geographical area of 1535 ha (**Fig. 1**). Despite 1200 mm annual rainfall (out of which 80% occurs during the monsoon period) and the existence of the Ghurlijore Minor Irrigation Project (MIP), the village was devoid of assured irrigation facilities during the post-monsoon and summer seasons. The total design command area of the MIP is 364 ha and 210 ha during monsoon and post-monsoon seasons, respectively, having five irregularly shaped canal-linked service reservoirs within a stretch of 3.5 km. The reason was primarily due to the non-existence of any proper water storage facility for assured irrigation and aquaculture. Hence, farmers depend only on *kharif* paddy throughout the year, and paddy yield was < 2.5 t ha^{-1} before intervention. The major problems identified were (1) lack of assured irrigation and water availability, (2) Timely availability of fingerlings for grow-out aquaculture, and (3) Lack of technical knowledge and awareness.

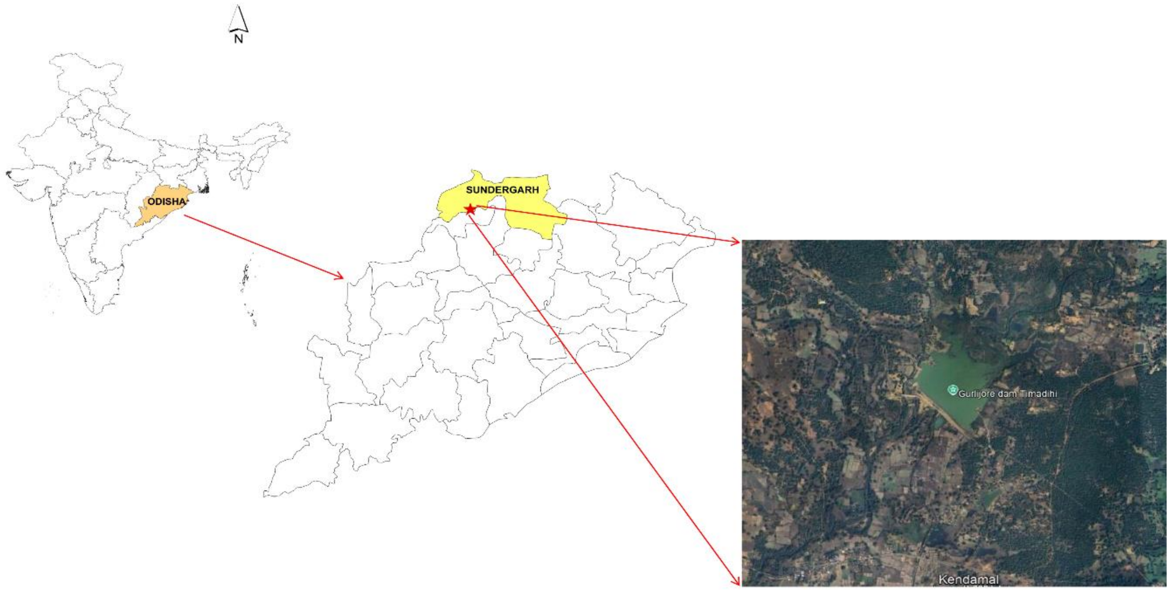

Fig. 1. Location of the study area

Scientific intervention

One of the basic premises of rural development is to utilise available resources in the local areas productively. The ponds and tanks in the villages often remain unutilised and underutilised for various reasons, such as lack of technical knowledge, investment and infrastructure, lack of support for inputs, a lack of a marketing system, etc. In most villages, available water resources are owned by the village communities, self-help groups or panchayat. Village communities control and manage these water resources, sharing the benefits with the community members. The technological demonstrations carried out in these resources are difficult to sustain without the perceived benefits to the members of the communities. Therefore, to attract the sustained attention of the village communities, it was essential to generate a higher level of benefits, which can be attained by utilising all available resources and opportunities in the agri-aquaculture system. Using the large and small water bodies for the grow-out fish culture and its multiple uses was thus a viable strategy in which all the available water bodies of the locality were utilised.

Various water conservation and management strategies were intervened and implemented. The flow regulating devices, like the provision of inlet, outlet and surplus escape structures, were designed and developed in the canal-command area. Further, the water supply from the dug well was linked with the underground pipeline with a sprinkler irrigation system.

Fig. 2. Various interventions implemented in the study area

linked service reservoir at the tail end to enhance its carrying capacity. The average water depth in the tank during the summer season was only 1.3m, whereas, after the control structures, it increased to a depth of 2.5m. Hence, water availability in the tank was enhanced by 120% (1.2 ha-m), substantially increasing the command area by 30% along with aquaculture. This also increased the water level in five nearby ponds and dug wells. Further, a dug well (4.8 m diameter and 9.0 m depth) was developed adjacent to the service reservoir along the drainage line. This intervention created 1.8 ha-m additional water availability, thus increasing an additional 2.1 ha

These interventions have brought confidence among the resource-poor tribal farmers in growing multiple crops since 2017-18. The impact of the regulating devices in terms of flow pattern, temporal water availability in the canal-linked service reservoir, and dug well hydraulics were studied, aiming to develop a sustained crop calendar and pisciculture in the tribal farmers' fields of the study area. Farmers have tried a sequence of paddy in kharif, mustard in rabi, and groundnut and green gram in the summer instead of rice mono-crop in the kharif season in the command area since 2017. Several other technologies, such as tank-cumwell systems, bring more area under crops due to assured irrigation facilities during *rabi* and *summer* seasons (Srivastava *et al.*, 2004; 2009), raised and sunken bed systems, multiple-use management (Mishra *et al.*, 2010), paired row (furrow irrigation) system (Mandal *et al.*, 2015), pressurised irrigation system for water saving options from source to agriculture field (Srivastava *et al.*, 2010) were also introduced along with pisciculture in the service reservoir (Mohanty, 2004) and adjacent small ponds.

Intervention impact on yield performance and water productivity

The impact of the service reservoir along with the dug well (total command area is 2.1 ha; out of which 1.1 ha is for dug well command and 1.0 ha is for service reservoir command) was studied for the monsoon and post-monsoon season since 2016-17. Due to the creation of irrigation infrastructures, crops like paddy in the monsoon season and groundnut and green gram in the summer were grown in the command area against the paddy-fallow cropping system before the interventions. The yield of paddy (*var. Lalat*) under the study was 3.7 t ha^{-1} with water productivity of 0.35 kg m^{-3}. In contrast, the paddy yield of the same variety in non-intervened areas near the study site was 2.8 t ha^{-1} with water productivity of 0.26 kg m^{-3}. Rapeseed crop (*var. Parvati*) yielded 1.25 t ha^{-1} with water productivity of 0.42 kg m^{-3} during *rabi* season. Further, dug well and the introduction of pipe conveyance with sprinkler irrigation could produce a 27% higher yield with 31% less water use, resulting in 84% higher water productivity compared with check basin irrigation (1.31 t ha^{-1} and 0.32 kg m^{-3}, respectively) in groundnut. Similarly, the paired row furrow irrigation system helped in saving 15% irrigation water by producing a 15% higher yield, resulting in 36% higher water productivity compared with check basin irrigation in groundnut. In green gram, yield enhancement of 25% with 33% less water use was observed under sprinkler irrigation compared to check basin irrigation. The higher yield with less water application in groundnut and green gram under sprinkler irrigation was attributed to better uniformity of distribution and application efficiency of water under sprinkler compared to paired row and check basin irrigation. Composite fish culture of IMCs in the service reservoir resulted in a net income of ₹72,000 ha^{-1}. The interventions of water resource development and management in rice-rapeseed-groundnut cropping sequence with pisciculture enhanced the average annual net return from ₹17,000 ha^{-1} (pre-intervention period) with a B: C ratio of 1.29 in mono-cropped *kharif* rice to ₹1,78,626 ha^{-1} (post-intervention period) with B: C ratio of 1.94 at the study site. Moreover, the gross water productivity and net water productivity under the intervention were enhanced by 160 and 360%, respectively, over that under mono-cropped rice cultivation. After several training and awareness programmes and seeing the success in the field, farmers have already adopted/ started pipeline and sprinkler systems (24 farmers), vermicompost units (six farmers), mushroom cultivation (two woman farmers) and backyard poultry (four farmers).

Conclusions

Inlet and outlet flow regulating devices designed and constructed in canal-linked service reservoirs positively guided the unregulated flow of canal water. Due to the construction of flow-regulating devices, the water stored in the service reservoir facilitated pisciculture, which was a profitable option in farming. Further, the provision of a dug well and the use of water from the well in conjunction with water from the service reservoir through pressurised irrigation helped in growing crops around the year and improved the yield of Kharif rice through supplemental irrigations. Overall, the study demonstrates that the conservation of rainwater and its conjunctive use with groundwater through efficient means not only converted the mono-cropped rice areas to areas with productive cropping sequences throughout the year but facilitated higher income from farming through pisciculture in the upland plateau region of Odisha. Promoting agri-aquaculture/ IFS and related livelihood interventions via the project improved food and nutrition security, augmented household incomes, increased livelihood assets and built social capital, even among the poorest sections of tribal communities. This option may be replicated on a large scale within the area or in regions with a similar agro-climate to the study area for profitable farming.

References

Mishra, A., Adhikary, A.K., Mohanty, R. K., Brahmananda, P.S., Ghosh, S., Panda, S.N. & Kumar, A. (2010). Performance enhancement of minor irrigation system through secondary storage and multiple use management. *Research Bulletin No.* **49**, DWM, ICAR, Bhubaneswar, India, 32p.

Mandal, K. G., Kumar, A., Padhi, J., Ghosh, S., Mohanty, R. K., Majhi, P. & Raychaudhuri, M. (2015). Improving water productivity in a canal command through conservation of surface and ground water using tanks and wells. *IWRA (India) Journal (Half Yearly Technical Journal of Indian Geographical Committee of IWRA)*, **4**(1), 3-9.

Srivastava, R. C., Mohanty, S., Singandhuppe, R. B., Mohanty, R. K., Behera, M. S., Ray. L.I.P. & Sahoo, D. (2010). Feasibility Evaluation of Pressurized Irrigation in Canal Commands. Water Resource Management, **24**, 3017-3032.

Srivastava, R. C., Singandhuppe, R. B. & Mohanty, R. K. (2004). Integrated farming approach for runoff recycling system in humid plateau areas of eastern India. *Agricultural Water Management*, **64,** 197-212.

Srivastava, R.C., Kannan, K., Mohanty, S., Nanda, P., Sahoo, N., Mohanty, R.K. & Das, M. (2009). Rainwater management for smallholder irrigation and it's impact on crop yields in eastern India. *Water Resource Management*, **23**, 1237-1255

Mohanty, R.K. (2004). Density-dependant growth performance of Indian major carps in rainwater reservoirs. *Journal of Applied Ichthyology*, **20** (2), 123-127.