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Building resilience through livestock and fisheries

in rainfed regions

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Rainfed regions, marked by erratic rainfall and frequent droughts, often see traditional agriculture struggle to provide reliable income and nutritional security. Livestock and fisheries-based farming systems enhances resilience, boosts resource efficiency, and diversifies livelihoods. Case studies from different states demonstrate the effectiveness of these models, with increase in household income, improved crop yields, and reduced input costs through natural nutrient cycling. Livestock and fisheries also contribute essential sources of protein and nutrition, strengthening nutritional security at household in rural areas. Moreover, these farming systems provide greater adaptability and resilience to climate challenges such as droughts and floods, enabling farmers to maintain production and income in adverse conditions. This approach supports the development of more sustainable, productive, and resilient food production systems, ensuring long-term livelihood security for rural communities.

Keywords: Fisheries, Livelihoods, Livestock, Nutritional security, Rainfed regions

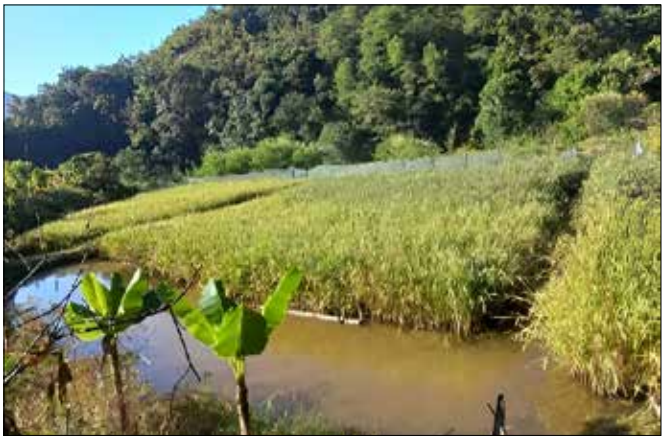
RAINFED regions occupy approximately 52% of India's net sown area and contributes nearly 40% of the country's total food production. These complex and highly diverse regions face significant challenges due to their dependency on erratic rainfall patterns and susceptibility to droughts. Vulnerability of rural livelihoods in these areas is compounded by climate variability and water scarcity. Traditional crop-based agriculture often fails to meet the livelihood needs of farmers in these regions, leading to income and nutritional insecurity. Livestock and fisheries-based farming systems in these regions provides a vital strategy for building resilience, diversifying income sources, and improving resource efficiency. Livestock contribute to rural economies through the sale of milk, meat, eggs, and manure, while fisheries provide income from fish production. By having multiple income sources, farmers are less vulnerable to the risks associated with crop failure or market fluctuations, creating a more stable livelihood base.

Significance of livestock and fisheries

India's dairy sector has grown significantly, making India the world's largest producer of milk, with an annual production of 209.96 million tonnes. The dairy sector alone contributes 4% to India's GDP, making it one of the most critical contributors to rural livelihoods. The meat sector also plays an essential role, contributing 1.7% to the national GDP, with an annual production of 8.2 million tonnes. This sector includes cattle, buffalo, poultry, sheep, and goats, which are key sources of income for rural. The egg sector contributes 0.77% to GDP, producing 122.05 billion eggs annually, and is growing at a rate of 8-10% per year, which further supports food security and rural income. The fisheries sector is another cornerstone of rural livelihoods, particularly in areas with access to water bodies. India is the second-largest producer of fish globally, with fisheries contributing 1.24% to the national GDP and 7.28% to agricultural GDP. Inland fisheries, especially in rainfed areas, provide substantial opportunities through several farming systems where fish farming is combined with livestock and crop production.

Livestock and or fisheries-based farming systems enhance resilience in rural rainfed areas by:

Diversification of income sources: Livestock and fisheries-based farming system provides multiple income streams for rural households in rainfed areas, where crop production is often unreliable. Livestock, such as cattle, goats, and poultry, contribute income through the sale of milk, meat, eggs, and manure, while fish farming generates revenue from fish sales. This diversified income base helps reduce the risks associated with crop failure and market fluctuations.



Rice + Banana + Fish farming

Cultivation of cucurbits on the pond dykes + Fish

Efficient resource use: In rainfed regions, where water and nutrient availability is limited, livestock and fisheries-based farming system maximizes resource efficiency. Livestock manure can be used to fertilize fish ponds, enhancing plankton growth, while nutrient-rich water from fish ponds can be used to irrigate crops, reducing the need for chemical fertilizers.

Enhanced water management: In rainfed regions, water scarcity is a critical challenge. Inclusion of fisheries with livestock enables efficient use of available water resources. Rainwater harvesting structures, ponds, and reservoirs can be used for both fish farming and providing water for livestock and crops, ensuring that water is used sustainably and efficiently.

Resilience to climate variability: In rainfed regions, where droughts and floods are common, livestock and fisheries enhances the resilience of farming systems. Livestock can survive on minimal feed during dry periods, and fish ponds can retain water, ensuring continuous production even when crops fail. During floods, fish farming systems can remain functional, while livestock can be relocated to higher ground.

Enhanced nutritional security: Livestock and fisheries provide essential sources of nutrition in rural diets, contributing milk, meat, eggs, and fish. Fish, in particular, is a rich source of protein and essential nutrients such as omega-3 fatty acids. This combination helps improve dietary diversity, particularly in regions where food security is compromised by unpredictable crop yields.

Livestock and fisheries-based farming systems

There are several livestock and fisheries-based farming systems across the country and some of the successful models are mentioned below.

Dairy-fish farming system: In rainfed areas of Madhya Pradesh, dairy farming has been successfully integrated with fish farming in small farm ponds. Farmers keep cows or buffalo for milk production, and fish are stocked in water bodies that also serve as sources of irrigation. National Dairy Development Board (NDDB) observed increased farm income by 50% with dairy-fish farming, with profits coming from both milk sales and fish harvests. The system also improved the nutritional status of rural households by providing a steady supply of protein through milk and fish.

Goat-fodder-fish farming system: In the Thar Desert region of Rajasthan, farmers have adopted an integrated system of goat rearing, fodder crop cultivation (such as Cenchrus and Napier grass), and fish farming in water storage tanks. Goat manure is used to fertilize both fodder crops and fish ponds. ICAR-Central Arid Zone Research Institute (CAZRI) reported a 40% higher income from goat farming in the system than stand-alone livestock rearing due to better feed availability. Fish farming in the water tanks boosted fish yields by 25% over traditional methods. Fodder cultivation increased goat health and milk yields by 20% during drought years.

Crop-livestock-fishery farming system: In rainfed areas of Telangana, farmers have combined rainfed agriculture with livestock (mainly cattle and goats) and fish farming. The system includes cultivating crops like sorghum, maize, and pulses, while fishes are raised in farm ponds, and manure from livestock is used to enhance soil fertility and pond productivity. National Institute of Agricultural Extension Management (MANAGE) reported increase in crop yields by 30% due to the use of livestock manure as organic fertilizer. Farmers reported a 50% increase in farm income, combining profits from crops, milk, and fish.

Fish-paddy-livestock farming system: In Jharkhand, a rainfed region, farmers have adopted a fish-paddy-livestock integration system. Fish are stocked in paddy fields during the monsoon, and cattle are raised for milk production. The rice fields benefit from natural pest control due to the fish, while livestock manure is used to fertilize both crops and fish ponds. ICAR-RCER reported increase in rice yields by 25%, while fish yields rose by 20% in the integrated system. The system provided farmers with multiple sources of income, and households were able to access both fish and milk for improved nutrition.

Fodder-livestock-fish farming system: In the semi-arid regions of Gujarat, farmers have successfully implemented integrated fodder-livestock-fish farming. Napier grass is grown as fodder for cattle, and fishes are cultivated in farm ponds irrigated by harvested rainwater. Fish farming contributed to a 40% increase in farm income by adding another income stream

alongside dairy farming. The integration of livestock and fish farming resulted in more efficient water use, reducing reliance on external feed and fertilizers by 30%.

Livestock-crop-aquaculture farming system: In the rainfed tribal regions of Chhattisgarh, farmers have integrated small-scale livestock (poultry, goats), crop farming (millets, maize), and aquaculture. Livestock manure is used as organic fertilizer for crops and fish ponds, and the fish provide an additional source of income. Indira Gandhi Krishi Vishwavidyalaya, Raipur reported increase household incomes by 50% as the system diversified revenue from fish, poultry, and crops. Fish farming boosted yields by 35% due to improved pond fertility from livestock manure.

Coconut-livestock-fish farming system: In Tamil Nadu's rainfed regions, farmers have adopted an integrated system combining coconut farming, dairy cattle, and fish farming. Fish ponds are established between coconut trees, and cows are kept for milk production. The manure from cows is used to fertilize both fish ponds and coconut trees. Tamil Nadu Agricultural University (TNAU) observed increase in coconut yields by 20% due to the nutrient-rich water from fish ponds and the manure applied to the soil. Fish farming contributed to a 35% increase in farm income, and the integration of dairy added an additional 25% in income from milk.

Aquaculture-paddy-poultry farming system: In the coastal rainfed areas of Andhra Pradesh, a new system integrating paddy cultivation, aquaculture, and poultry has been implemented. Poultry sheds are built near fish ponds, and poultry waste is used to fertilize fish ponds and paddy fields. The fish waste and nutrient-rich water are used to irrigate the paddy fields. National Fisheries Development Board (NFDB) reported increase in fish yields by 40%, with farmers reporting higher productivity due to the organic fertilizer from poultry. Paddy crop yields increased by 25% due to nutrient-rich water and reduced reliance on synthetic fertilizers, while poultry rearing boosted household income by 30% through steady sales of eggs and meat.

Silvopasture-livestock-fishery farming system: In the rainfed regions of Madhya Pradesh, farmers have adopted a silvopasture system (integrating trees with pastures), livestock rearing, and fish farming. Fast-growing trees like Leucaena are planted alongside fodder grasses, which provide food for livestock, while ponds are dug for fish farming.

ICAR-Indian Grassland and Fodder Research Institute (IGFRI) reported improvement in livestock health, leading to a 30% increase in milk production, as animals had better access to nutritious fodder. Fish farming in the ponds increased overall farm income by 35%, with farmers selling both milk and fish.

Livestock, fisheries and millet farming system: In Odisha's rainfed tribal areas, farmers have adopted an integrated system combining millet cultivation, livestock rearing (goats, cows), and fish farming. This system has been introduced as part of a millet promotion initiative aimed at improving food security while integrating livestock and fisheries. Odisha Millet Mission observed improvement in millet yields by 30%, with better soil fertility due to the use of livestock manure. Goat rearing provided an additional income of 40% per household, along with milk from cows. Fish farming contributed to a 25% increase in household income, making the system more resilient to climate variability.

Agri-solar-livestock-fish farming system: In Rajasthan's arid zones, farmers have integrated agriculture (horticultural crops), livestock, fish farming, and solar energy. Solar panels are installed on the farm to generate electricity, which powers water pumps used for irrigating crops and fish ponds. Livestock manure is used to fertilize crops and fish ponds. Rajasthan State Agriculture Department reported reduction in farmers' energy costs by 40%, allowing for more efficient irrigation and water-use due to the solar energy. Crop yields increased by 20%, and fish farming contributed to a 30% rise in income.

Beel fishery-livestock farming system: In the floodplains of Assam, beel fisheries (seasonal floodplain wetlands) are integrated with livestock rearing (mainly cattle). Fish are stocked in the beel during the monsoon season, while cattle graze around the beel. Manure from the cattle enhances the growth of phytoplankton for fish feeding. This system has maintained fish production despite environmental challenges such as flooding. The integration of cattle has ensured that both fish and livestock continue to thrive even in difficult conditions. Research by the Assam Agricultural University has shown a 50% increase in fish yields, along with a stable income from cattle rearing.

Rice-fish-duck farming system: In the Sundarbans, farmers have developed a model that integrates rice farming, fish farming, and duck rearing in the same field. Ducks roam freely in the rice paddies, where they feed on insects and weeds, acting as natural pest control. Fish are cultivated in the water between rice plants, while their waste provides nutrients for the crops. This system has improved yields for rice and fish, increased protein availability, and diversified income streams for the farmers. Ducks also provide eggs and meat, adding to nutritional security. Studies conducted by the ICAR-Central Institute of Brackishwater Aquaculture (CIBA) have shown a 40% increase in rice yield and up to a 30% increase in fish production in such systems.

Livestock-poultry-crop farming system in rainfed areas: In the semi-arid regions of Maharashtra, farmers have adopted a farming system that combines livestock rearing (mainly goats and cattle), poultry (local breeds like Aseel), and rainfed crop cultivation (millets, sorghum, and pulses). Goats and poultry are reared alongside crops, and their manure is used to improve soil fertility. The inclusion of poultry provided an additional source of income through egg and meat sales, contributing to a 40% rise in household income.

Integrated watershed management with livestock and fish farming system: In the drought-prone regions of Karnataka, watershed management projects have integrated livestock (mainly cows and buffaloes),

fodder cultivation, and fish farming in community ponds. Rainwater harvesting structures are used to collect and store water, which is then used for fisheries and livestock drinking purposes. Watershed Development Department, Karnataka observed increase in fish production by 35% in 3 years through community fish farming in rainwater-harvesting ponds. Fodder availability for livestock improved due to water availability, leading to a 20% rise in milk production. Farmers practicing this system reduced their reliance on external inputs by 25% through efficient water-use and livestock manure recycling.

Challenges and opportunities

Despite the numerous benefits of livestock and fisheries-based farming systems in rainfed regions, several challenges remain. Water scarcity, land degradation, and limited access to markets and veterinary services are common obstacles faced by farmers. However, interventions such as the promotion of drought-resistant livestock breeds, adoption of rainwater harvesting technologies, and development of community-based fisheries management offer viable solutions. Government programmes like the National Livestock Mission (NLM), Rashtriya Gokul Mission (RGM), Dairy Processing & Infrastructure Development Fund, National Programme for Dairy Development (NPDD) scheme, National Animal Disease Control Programme (NADCP), Supporting Dairy Cooperatives and Farmer Producer Organizations (SDCFPO) scheme, *Pradhan Mantri Matsya Sampada Yojana* (PMMSY) have been instrumental in supporting the development of these sectors. These initiatives focus on improving infrastructure, providing access to animal healthcare, and promoting sustainable fish farming practices, all of which are crucial for enhancing the resilience of rural communities in rainfed regions.

SUMMARY

Livestock and fisheries-based farming systems in rainfed regions is a vital strategy for building resilience, enhancing nutritional security, and diversifying rural incomes. By optimizing resource-use and reducing dependency on unpredictable crop yields, these sectors provide rural households with sustainable means of livelihood. As climate variability and water scarcity continue to challenge rainfed regions, the role of livestock and fisheries in creating resilient farming systems will only become more critical. With appropriate government support, infrastructure, and community-based management, the potential of livestock and fisheries to transform rural economies and improve the well-being of farmers in rainfed regions is immense.

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