

Involving Women in Field-Testing of Periphyton Enhanced Aquaculture System for Nutrition Security

SUNILA RAI^{*}, MADHAV SHRESTHA¹, JAMES S. DIANA² and HILLARY EGNA³

¹Agriculture and Forestry University, Rampur, Chitwan, Nepal

²University of Michigan, Ann Arbor, MI 48109-1115, USA

³Oregon State University, Corvallis, OR 97331, USA

Abstract

An on-farm trial of carp polyculture was carried out with participation of women farmers from Sundardeep Women Fish Farmer's Cooperative (15 women farmers) in Chitwan District and Mishrit Fish Farmer's Cooperative (22 women farmers) in Nawalparasi District to field-test the enhancing effect of periphyton on use of feed and fish production. The trial was conducted for 8 months from April to December 2015. Women farmers stocked six carp species and two small indigenous species (SIS) to ponds. Women farmers were divided into two groups. One group fed their fish with dough of rice bran and mustard oil cake, while the other group installed bamboo substrates in their ponds and fed their fish with half the amount of the feed used by the first group. Women farmers netted and weighed fish monthly to check fish growth and calculate rations. Women farmers were provided with a book to record fish harvested for consumption or sale and fish mortality. Final harvest was done after 8 months of culture. The netted fish were counted, weighed, and returned to the pond as the farmers wanted to keep fish for their biggest festival "Maghi" in mid-January. In aggregate, 84 % of farmers consumed fish at home, and 41 % of farmers sold carps. The trial showed that culturing carps with SIS with 50 % feeding amount and with bamboo substrates in ponds resulted in a 22 % higher fish production as compared to the culture of carps with normal feeding. More interestingly, the gross margin of the half-fed periphyton enhanced carp polyculture was almost two times as much as that of the normal fed polyculture system. Women farmers also benefited socially as well as economically from the interactions within the cooperatives, which increased their self-confidence and developed leadership skills in some members.

*Corresponding author. Email address: sunilarai@yahoo.com

Introduction

The Government of Nepal has recognized the contribution of aquaculture to poverty alleviation, and food and nutritional security (MoAC 2009; NARC 2010). Fisheries and aquaculture development has been prioritized, with special attention paid to productivity and production enhancement (MoAC 2009; NARC 2010). Carp polyculture in ponds has developed as the most viable and popular aquaculture production system in Nepal accounting for over 90 % of total production (FAO 2016). Carp polyculture systems do not however promote household fish consumption because most farmers sell the carps rather than consume them (Rai et al. 2012). Realizing this problem, the Institute of Agriculture and Animal Science (now Agriculture and Forestry University AFU) has developed a production system that incorporates nutrient-rich small indigenous species (SIS) to increase household consumption and income over that of carp polyculture (Rai et al. 2012). Addition of SIS to the carp polyculture system raised fish production above the national average, doubled the consumption rate of household members, and provided Rs. 3,025 income per household in 270 days, which helped families become economically empowered (Rai et al. 2012).

In commercial fish farming, feed alone accounts for approximately 60 % of total input cost (Bhujel 2009), which is expensive for small-scale farmers, so it is essential to provide opportunities to reduce feed cost. Adding substrates such as bamboos to carp ponds can facilitate growth of periphyton, which serves as food for carp and increases production (Azim et al. 2002; Rai et al. 2008). Since the combination of species and type of feed would influence the yield and income in a semi-intensive system, it was necessary to test the combination of feed inputs, periphyton enhancement, and production to truly understand the best system to use for commercial production (Diana 2012a). Considering this need, an experiment was carried out at the Agriculture and Forestry University (AFU), Chitwan, Nepal to determine the best combination of carps, SIS, and periphyton enhancement to maximize net fish yield and profit in ponds. Two best treatments obtained from the trial were extended successfully to women farmers in 2 districts, Chitwan and Nawalparasi in Nepal.

Materials and Methods

The two best treatments; i) carp + 100 % feed and ii) carp + SIS + 50 % feed +bamboo substrate at 1 % of pond surface area were determined after on-station trials at AFU and were then tested in the community using household ponds of 15 women farmers from Sundardeep Women Fish Farmer's Cooperative in Chitwan and 22 women farmers from Mishrit Fish Farmer's Cooperative in Nawalparasi districts (Fig. 1). Selection of farmers for the training and the trial was done by an Executive Committee of the respective cooperatives on consensus through meetings. There were only women members in the Sundardeep Women's Cooperative while the Mishrit Cooperative had 16 women and 13 men members. From the Mishrit Cooperative, only women counterparts from selected households participated in the trial as per the need of the project. At the beginning, an inception meeting was conducted in each site to share protocols and objectives of the trial to the selected women farmers. The project provided financial supports for fingerlings, feed and fertilizers to the participating farmers.

In April 2015, farmers stocked 1,500 carps, namely rohu (*Labeo rohita* (Hamilton 1822)), silver carp (*Hypophthalmichthys molitrix* (Valenciennes 1844)), bighead carp (*Aristichthys nobilis* (Richardson 1845)), mrigal (*Cirrhinus mrigala* (Hamilton 1822)), common carp (*Cyprinus carpio* (Linnaeus 1758)), and grass carp (*Ctenopharyngodon idella* (Valenciennes 1844)) and 25,000 SIS fish, namely, "dedhuwa", (*Esomus danricus* (Hamilton 1822)) and "pothi", (*Puntius sophore* (Hamilton 1822)) per hectare in their household ponds. The average pond size was 259 m² (range 145-500 m²) in Chitwan and 413 m² (range 163-552 m²) in Nawalparasi. Men fixed bamboo strips as substrate in the form of mats in the water column of ponds covering about 1 % of the pond surface to enhance periphyton growth. The purpose of installing bamboo strips was to provide space for periphyton growth that served as supplemental natural food to carp and reduced feed cost. The women also fed carp with dough of rice bran and mustard oil cake (1:1) and grass carp on banana leaves and grass every morning. In large ponds, both men and women fed fish. Each farmer was provided with a log book to record fish that were consumed, sold, or died so that fish production and profitability could be determined from the recorded data after harvesting. In December 2015, the final harvest was conducted by netting fish in shallow water following partial water

draining from ponds after 8 months of culture. Harvesting was performed by both men and women and also sometimes assisted by their children during school holidays. The total production was calculated by total weight of fish consumed, sold and finally harvested. Gross income was calculated from total production, assuming all carps were sold, whereas gross margin was calculated by deducting variable costs (fingerling, feed, fertilizer) from gross income. Fish production, gross margin and family fish consumption data were compared by using Student's t-test. Significant differences were considered at an alpha level of 0.05 ($P < 0.05$). All means are given with ± 1 standard error (S.E.). A one-day training on periphyton-enhanced carp-SIS technology was also provided to 35 (7 men and 28 women) non-adopters from Chitwan district on 30 November 2015, just before final harvest of the other ponds. In addition, women farmers were encouraged to share their stories and views on fish farming systems during project meetings to get feedback on the effectiveness of the intervention. Experiences were also shared from women farmers of other cooperatives.

Trial Sites

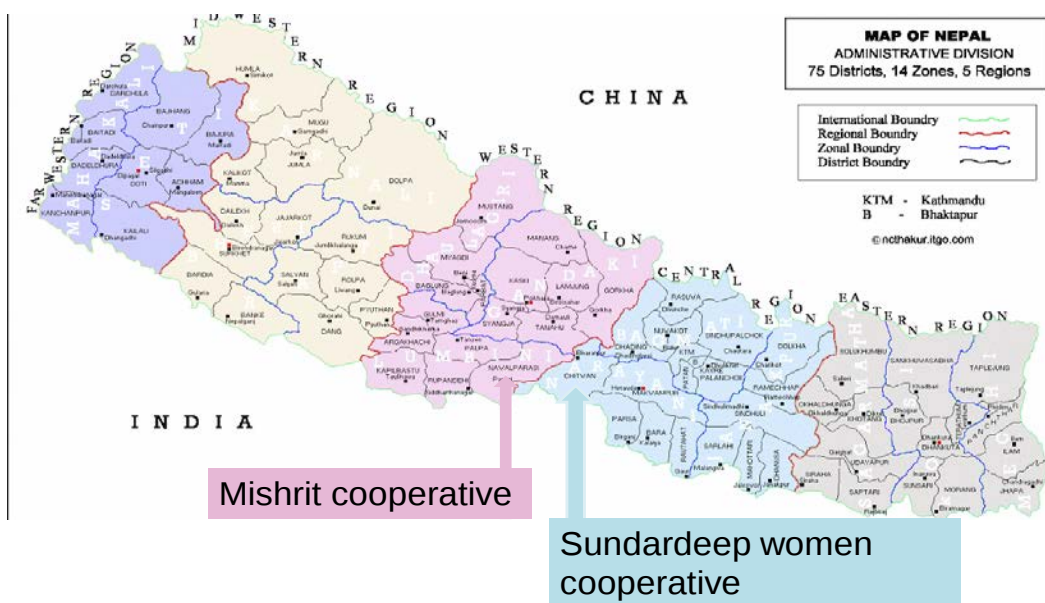


Fig. 1. Map of Nepal showing project sites



Fig. 2. Preparing dough of rice bran and mustard oil cake for fish feeding (a), Split bamboo substrate (b), SIS harvested from pond for household consumption (c) and Final harvesting of carp (d)

Results and Discussion

Both the cooperatives from where the beneficiaries were selected were dominated by Tharus, an ethnic group of Nepal. In aggregate, 92 % of participants were Tharus and the rest were Ghartis (5 %) and Ranas (3 %). The majority of farmers (54 %) were young (20-40 years) and the rest (46 %) were middle aged (41-60 years). Around 19 % women had higher education (intermediate to Bachelor's level), 32 % had studied up to secondary school level (Grades 6-10) and 49 % had primary level education (grades 1-5).

About 84 % of the farmers consumed carp fish at home. Over 40 % of farmers sold surplus carps whereas all the SIS fish were consumed at home without selling. Women began harvesting SIS partially from the month of July (maximum 3 times per month) and this increased the frequency of fish

consumption (Rai et al. 2014). Increased intake of SIS which is related to frequency of harvesting obviously improves women's and children's health and nutrition as the small fish are rich in vitamins and minerals (Roos et al. 2006; Rai et al. 2014). About 95 % of farmers sold carps on the pond site, while 5 % sold in the nearby local market directly to consumers without involvement of middleman. In the cases of on the pond site sales, both men and women were involved whereas selling at local market was solely done by women. By avoiding the middleman farmers sold fish at higher prices than when they sell to middleman at Rs. 220 kg⁻¹ (1 US \$ = 107 Rs) and received more profits. Mishrit cooperative farmers sold carps at Rs. 20 higher price (Rs. 270 kg⁻¹) than Sundardeep cooperative farmers (Rs. 250 kg⁻¹), which is reflected in both income and profit. Income earned by women from selling fish was used to pay children's education fees, buy stationery for the children, kitchen items and other domestic needs. Farmers did not empty their ponds on final harvesting because they kept some fish for "Maghi", their biggest festival that fell in mid-January. During Maghi, major sales of fish occur because fish is an important food item for this celebration. Some farmers also saved fish in ponds for year-round consumption and to fetch higher prices later when there were fewer fish in the village.

Carp + SIS + 50 % Feed + Substrate farmers obtained 22 % (10.2 kg.100 m⁻²) higher (P<0.05) fish production and 90 % (3237 Rs.100 m⁻²) higher (P<0.05) gross margins than carp + 100 % feed farmers due to better utilization of periphyton and supplementary feed by carp (Table 1).

Table 1. Fish production, consumption and profit earned by farmers in two treatments in 8 months

	Carp+100 % feed	Carp + SIS + 50 % Feed + Substrate
Production (kg.100 m ⁻²)	46.5±16.2 ^b	56.7±17.8 ^a
Gross margin (Rs.100 m ⁻²)	3586±2984 ^b	6823± 3045 ^a
Consumption of carps (kg.household ⁻¹)	14.7±13.4 ^a	15.3±12.7 ^a
Consumption of SIS (kg.household ⁻¹)	0.4 ±0.3 ^b	2.4±1.2 ^a

Table 2. Fish production, consumption, sale, and gross income per pond by farmers in 8 months for the two treatments in two cooperatives

Coopera- tive	Treat- ment		Carp sold (kg.pond ⁻¹)	Carp consu- med (kg.pond ⁻¹)	SIS consu- med (kg.pond ⁻¹)	Total produc- tion* (kg.pond ⁻¹)	Gross Income from fish sale (Rs.pond ⁻¹)
Sundardeep women cooperative (n=15)	Carp + 100 % Feed (n=7)	Avg.	10.0	15.0	0.3	75.0	18761
		Max.	60.0	35.0	2.0	150.0	37530
		Min.	0.0	6.0	0.0	24.0	5974
	Carp + SIS + 50 % Feed + Subst- rate (n=8)	Avg.	31.0	23.5	2.6	109.6	27411
		Max.	170.0	45.0	5.0	302.4	75598
		Min.	0.0	8.0	2.0	30.0	7510
Mishrit cooperative (n=22)	Carp + 100 % Feed (n=12)	Avg.	44.4	15.7	0.5	128.8	34766
		Max.	260.0	55.0	5.0	261.4	70575
		Min.	0.0	0.0	0.0	41.0	11062
	Carp + SIS + 50 % Feed + Subst- rate (n=10)	Avg.	25.8	8.7	2.2	164.0	44290
		Max.	155.0	20.0	10.0	275.8	74454
		Min.	0.0	0.0	0.0	107.5	23055

*Includes carp left in the pond and not consumed or sold at harvest.

Higher production was due to additional SIS fish and periphyton enhancement while higher gross margins were due to reduced feeding in the SIS ponds. Adding substrates to ponds provides both periphyton food and cover against predators like birds to prevent fish loss through predation. Reduced feeding rates have been found to provide comparable growth and better profit than full feeding for Nile tilapia (Diana 2012b). Similar result has been found for carps in the present study. Contribution of SIS to total production was small and ranged between 1.3-2.6 % by weight in carp + SIS + 50 % feed + substrate ponds. SIS production was very low in Nawalparasi because farmers used well water and had no source for SIS colonization. In Chitwan, farmers used canal water to top up the ponds, so, they sourced SIS easily from the canals. SIS was also harvested in carp-only ponds, as they could enter over time from canal water. Though collection of SIS from canals for pond stocking and harvesting of SIS from ponds for consumption was done by both men and women, water

management was done by men. In carp-only ponds, a maximum 2 kg of SIS were harvested per pond in Chitwan and 5 kg per pond in Nawalparasi, SIS consumption by households was 5 times higher in households which included SIS treatments ($2.4 \text{ kg.household}^{-1}$) than without SIS treatment ($0.4 \text{ kg.household}^{-1}$) (Table 2).

However, carp consumption by households did not differ between the two treatments which indicated farmers prefer carps over SIS. Present gross margin analysis did not take the cost of SIS and bamboo into account because SIS were collected from canal water free of cost while bamboo was freely available in the village. All farmers received a profit except one in Chitwan, who lost Rs. 1674 due to poaching of her fish.

Fish farming had become instrumental to women farmers to improve their group cohesion and socio-economic status. Since fish farming was carried out through cooperatives, the activity gave them the opportunity to meet each other in monthly meetings at the cooperative office and during collection of fish feed and fertilizers supplied by project staff at respective collection centres.

According to Lila Mahato, Vice President of the Mishrit Cooperative, prior to beginning carp farming she remained inside the house occupied in household chores and she had minimal communication with fellow farmers. Now she meets fellow farmers regularly in the cooperative meetings and project activities are taken up together. In meetings, they share their problems and seek solutions. Over a period, the activity has increased her self confidence and she is now leading her cooperative. The activity has also been economically empowering. Each member deposited Rs. 100 per month in a cooperative fund, which was loaned to the members for repair of pump sets, fish nets and to meet other requirements at a nominal interest rate of 1 %. So, farmers did not need to go to the bank and meet all the paper formalities for securing a small loan. In the Tharu community, having a fish pond is a matter of prestige in the society. Fish forms part of the menu at every important occasion and festival. Serving fish to guests is a matter of honour. Fish is now available in their own ponds.

“Growing Carp and SIS in the pond is much easier and better than paddy farming. For small scale women farmers like me, Carp-SIS farming is an easier

way to earn income by selling fish and to improve family nutrition by eating fresh fish and nutrient rich SIS from own pond”.

Bijaya Chaudhary from Sundardeep cooperative

She knows that fish is good for health and SIS is even more nutrient rich and eating them is more beneficial for health because these are eaten whole without dressing and losing nutrients. She adds:

“Fish in the market is already a day old and might be spoiled, so, it is not safe. Moreover, such fish is not tasty either. Eating fish from own pond is safer and tastier”.

SIS are self recruiting fish, so, farmers can harvest them regularly and fulfill the micro-nutrients needs of children and the women farmers who are among the most vulnerable groups in Nepal (MoHP 2006; UNICEF 2012). Unlike carp, SIS can grow well in shallow water and farmers can harvest them year round, even in the dry season. Those who had over production of SIS performed post harvest techniques such as solar drying in bamboo trays or smoking, and kept the fish in plastic bags and bamboo baskets for future use. Bhundi Chaudhary from Sundardeep echoed Bijaya and advocated that Carp-SIS-Substrate farming was the easiest and lower cost way of income generation because it required low inputs in terms of labour, time and money.

“Feeding is not laborious and is done only one time in the morning. Feeding does not take time, I can feed fish while cooking dishes at the kitchen. Feed ingredients like rice bran and mustard oil cakes are available from the farm and are less expensive. Adding bamboo substrates to the pond not only saved feed but also saved my fish from poaching”.

However, she found making split bamboo mats difficult, so, her husband made them and also fixed them in the pond.

Conclusions

The women-led field trial showed that culturing carps with SIS with 50 % reduced feed compensated by bamboo substrates resulted in a 22 % higher fish production as compared to the traditional culture of carps with complete

feeding. More interestingly, the gross margin was almost double that of the traditional system. Periphyton enhanced Carp-SIS polyculture is suitable and affordable to small-scale women farmers because it is a very simple and low-cost technology that gives higher fish productivity and profits, and it also has a potential of enhancing family nutrition and income as compared to the existing carp polyculture. The technology utilizes locally available bamboo and some farmers may access it free of cost in rural villages of developing countries like Nepal. Aquaculture is a male dominated practice in Nepal where only 33 % of farmers are female (Mishra 2014). In order to increase female participation in aquaculture and enhance empowerment, simple technology like that of periphyton-based green aquaculture is appropriate.

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