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Improvement of Women's Livelihoods, Income and Nutrition through Carp-SIS-Prawn Polyculture in Terai, Nepal

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Abstract

Many poor Nepalese women and children suffer malnutrition caused by vitamin and mineral deficiencies. In December 2008, the project "Improvement of women's livelihoods, income and nutrition through carp-SIS-prawn polyculture in Terai, Nepal" was launched in Chitwan, a district, to test the possible role of small indigenous fish species (SIS) in combating malnutrition. Fifty household ponds of 100 m^2 each were constructed and stocked with carp such as rohu (*Labeo rohita*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and mrigal (*Cirrihinus mrigala*), and SIS such as dedhwa (*Esomus danricus*), mara (*Amblypharyngodon mola*), pothi (*Puntius sophore*) and prawn (*Macrobrachium rosenbergii*). Average total production was 2.6 $t \cdot ha^{-1} \cdot year^{-1}$ but was affected by low stocking rates and mortality caused by poisoning from canal water. On average, the farmers' households consumed 54% of the production. Farmers, all of whom were women, and their families consumed all SIS and sold surplus carp and prawns. Their fish consumption was above that of the national average, which is still low by world standards. Farmers earned Nepalese rupee 1,523 $household^{-1}$ in 250 days. The study's results, although modest, are a promising start to introducing new farming practices to increase the income, food and nutritional standards of women and their households.

Introduction

Among poor women and children in Nepal, malnutrition caused by vitamin and mineral deficiencies has been well recognised as a serious health problem (Ministry of Health and Population (MOHP), 2006). Essential micronutrients such as iron, zinc, vitamin A and calcium are lacking in the Nepalese diet, and consequently large population groups are suffering from diseases and disorders associated with micronutrient deficiencies. The most common forms of malnutrition in the country are protein energy malnutrition (PEM), iodine deficiency disorders, vitamin A deficiency, and iron deficiency anaemia. Nearly 48% of children under five are anaemic and 49% are stunted (MOHP, 2006). Similarly, 36% of women aged 15-49 are anaemic (MOHP, 2006). The situation is dire, especially among rural, ethnic minority women and children because they are

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resource-poor and have very little education. Limited access to resources affects women's nutrient intake, underlining the importance of nutrient-rich food sources.

Small indigenous fish species (SIS) are of special interest because SIS are rich in essential micro-nutrients including vitamins and minerals (Roos et al. 2007a). Nutrient analyses of common Bangladesh SIS such as mola (*Amblypharyngodon mola*) and darkina (*Esomus danricus*) have shown that they contain much higher vitamin A, calcium and iron than do cultured fish (Roos et al. 2006). Studies in poor, rural households in Bangladesh and Cambodia showed that even small quantities of the vitamin A-rich fish, mola, produced in household ponds, can meet the annual vitamin A requirements for 2 million Bangladeshi children. A traditional, daily meal with the iron-rich small fish, trey changwa plieng (*Esomus longimanus*) can meet 45% of the daily median iron requirement of Cambodian women (Roos et al. 2007b).

Semi-intensive carp polyculture is the major established aquaculture system in Nepal. Existing carp polyculture systems do not however promote household fish consumption because carp are usually grown to a large size and sold in the market, rather than being consumed by the farmer. Developing a production system that increases household access to nutrient-rich fish consumption, in parallel with the carp production, also carries potential to increase household income.

Polyculture of SIS with carp and prawn appears to be one of the possible options. Incorporating SIS and prawn in carp ponds can benefit farmers in two ways: i) by improving the nutritional status of farming families through regular partial harvesting and consumption of nutrient-dense, self-recruiting SIS fish; and ii) by increasing household income from selling valuable carp and prawn to local markets. Realising the potential role of SIS to address the malnutrition problem, a project entitled "Improvement of women's livelihoods, income and nutrition through carp-SIS-prawn polyculture in Terai, Nepal" (carp-SIS-prawn project) was launched in Chitwan District in Terai, Nepal by the Institute of Agriculture and Animal Science (IAAS), Nepal in collaboration with the Bangladesh Agricultural University (BAU), Bangladesh and the University of Copenhagen (KVL), Denmark. The project, which is still in progress, aims to improve the health and nutrition of women and children through increased intake of nutrient-dense SIS, and to empower women by providing additional income to the family. The total duration of the project is 3 years, December 2008 to November 2011.

The project was launched in the Tharu community. Tharu are a marginalised ethnicity in Nepal. They make up 6.8% of the total population (Central Bureau of Statistics, 2006). They are traditional fishers, capturing fish from rivers, swamps, lakes, and ponds to feed their large families. The catch from such fisheries is low and inconsistent. Hence, producing fish in their own ponds can provide more consistent yields while also improving household income and nutritional status. In addition it may also decrease fishing pressure and improve fish stocks in natural water bodies.

Activities

Site and farmer selection

Since the project aims to empower women through fish farming, only women farmers were selected for the project. Women were involved in the income generating activity to help empower them economically and socially. In total, 50 women farmers were selected at Fulloria, Mudovar, Jeetpur and Simara in Chitwan District. Criteria used to select participants in the project included their access to resources, especially water sources, and their interest in fish farming.

Pond construction

Farmer selection was followed by pond construction. Altogether 50 ponds were constructed at the site. The average pond size was 98.5 m^2. Pond size varied between 35 m^2 and 236 m^2. Pond size depended on the land available to the farmer and the farmer's willingness to devote land area to pond construction. The surface area covered by all ponds in the project amounted to 0.5 ha. Pond construction began in February and continued to the end of March 2008.

Pond stocking and management

Ponds were stocked with fingerlings of four carp species (rohu (*Labeo rohita*), mrigal (*Cirrihinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*)), three SIS (dedhwa (*Esomus danricus*), mara (*Amblypharyngodon mola*), pothi (*Puntius sophore)*), and one prawn (*Macrobrachium rosenbergii*) in May 2008. Fingerlings of rohu, mrigal, silver carp, bighead carp and juvenile prawn were stocked at rates of 3,000, 1,000, 1,000, 2,500 and 10,000 ha^{-1}, respectively (Table 1). SIS were stocked at a rate of 25,000 ha^{-1}. Farmers adopted five different farming practices: i) carp farming, ii) carp + prawn farming, iii) carp + dedhwa + prawn farming, iv) carp + pothi + prawn farming and v) carp + dedhwa + mara + pothi + prawn farming. Ten farmers adopted each type of farming system as shown in Table 1. Prawn juveniles were brought from Bangladesh and nursed at IAAS ponds for 1 month prior to introduction into the ponds. Fish were fed a daily mixture of rice bran and soybean cake at 3% of total estimated biomass. Ponds were fertilised with urea, di-ammonium phosphate (DAP) and cow dung monthly at the rate of 0.4 g $N \cdot m^{-2} \cdot day^{-1}$ and 0.1 g $P \cdot m^{-2} day^{-1}$ (Shrestha and Pandit, 2007). Each farmer was provided with a record keeping book so that she could record the numbers and weights of fish consumed in the household, sold, harvested and that have died, as well as the amounts of feed and fertiliser applied to the pond. Records in the notebook were monitored by the Field Supervisor and a Research Student associated with the project. The record books were later used to estimate the fish production and income earned by the farmers.

Table 1. Stocking density (number of fingerling/juvenile per hectare) of carp, SIS and prawn in different farming systems. Ten farmers adopted each type of farming system.

Species	Types of farming systems				
	Carp	Carp-Prawn	Carp-Dedhwa-Prawn	Carp-Pothi-Prawn	Carp-Dedhwa- Mara-Pothi-Prawn
Rohu	3,000	3,000	3,000	3,000	3,000
Mrigal	1,000	1,000	1,000	1,000	1,000
Catla	1,000	1,000	1,000	1,000	1,000
Silver carp	2,500	2,500	2,500	2,500	2,500
Dedhwa	-	-	25,000	-	8,334
Pothi	-	-	-	25,000	8,333
Mara	-	-	-	-	8,333
Prawn	-	10,000	10,000	10,000	10,000

Training

Two training sessions were conducted: training for the trainers and training for farmers. Eighteen senior and experienced women farmers (13 from the Rural Integrated Development Society (RIDS) and five from the Rural Empowerment Society (REST)) were trained to be trainers by experts from IAAS and the Nepal Agriculture Research Council (NARC). Training focused on the fundamentals of carp-SIS-prawn farming and the role and importance of SIS in nutrition of women and children. The training was followed by a field trip to Madi, where participants observed successful integrated fish farming and were able to interact with farmers in Madi. Those 18 senior and experienced farmers, who had received training on carp-SIS-prawn polyculture, then served as Project Trainers. One month later, the Project Trainers trained the project farmers. Farmers were taken on a field trip to Pokhara to observe pond and cage fish culture, and interact with farmers. A written manual in Nepali on carp-SIS-prawn polyculture was prepared and provided to all farmers during the training

Women fish farmer groups

Three women fish farmers' self help groups were formed and farmers were allocated to a group based on their location:

i. Farmers of Fulloria were allocated to the Namuna Bikash Mahila Machapalan Krishak Samuha
ii. Farmers of Mudovar were allocated to the Janmukhi Mahila Machapalan Krishak Samuha
iii. Farmers of Jeetpur and Simara were allocated to the Rai Mahila Machapalan Krishak Samuha

Each group had between 15 and 18 members. The women worked, developed plans and shared their problems in the groups. This enhanced their ability to work together and also developed social harmony in the community. Each group held monthly meetings and members deposited Nepalese rupee (NPR) 10 mth^{-1} each into their group's fund. This fund was then to extend loans of NPR 500 – 5,000 $person^{-1}$ to needy group members, at an interest rate of 1-2% mth^{-1}, and to repair equipment such as pump sets and fish nets.

Partial harvesting of SIS

SIS bred in the ponds within 2 months of the ponds being stocked. Farmers and their families began consuming SIS soon after the new juveniles were seen. They periodically harvested SIS by seine net until the end of the culture period.

Results

Fish and prawn production

After stocking in May, fish were grown for 250 days and prawns were grown for 150 days. Prawns were harvested by the end of November before temperatures dropped below the limits required for good growth and survival. Average total production was estimated at 16.5 $kg \cdot pond^{-1}$ which was equivalent to 2.6 $t \cdot ha^{-1} \cdot year^{-1}$. Total production represents the average of both fish (carp and SIS) and prawn consumed and sold in all 50 ponds. The total production per pond varied by pond size and farmer, and ranged from 3.4 to 40.3 $kg \cdot pond^{-1}$. Production of some ponds was affected by using poisoned canal water to top up the ponds; most of the fish died in those ponds. Canal water was poisoned due to application of pesticide to fish in Rapti River. Eight affected ponds were cleared and dried in the middle of the project.

Total production in SIS-stocked ponds was 27% to 33% higher compared to that in non-SIS ponds (Figure 1). Carp was the major contributor (88%) to the total production while SIS and prawn contributed 8% and 4%, respectively. Among SIS, dedhwa gave the highest average production of 2.4 $kg \cdot pond^{-1}$ whereas mixed SIS and Pothi gave 1.9 and 1.7 $kg \cdot pond^{-1}$, respectively. Average prawn production was 0.73 $kg \cdot pond^{-1}$ and was from 0.01-3.27 $kg \cdot pond^{-1}$. Total production did not vary significantly ($P<0.05$) among different farming systems. However, average total production was higher in SIS-stocked ponds than in carp ponds. Highest (18.7 $kg \cdot pond^{-1}$) total production came from carp + dedhwa + prawn farming and lowest (13.1 $kg \cdot pond^{-1}$) total production came from carp farming, both after 250 days.

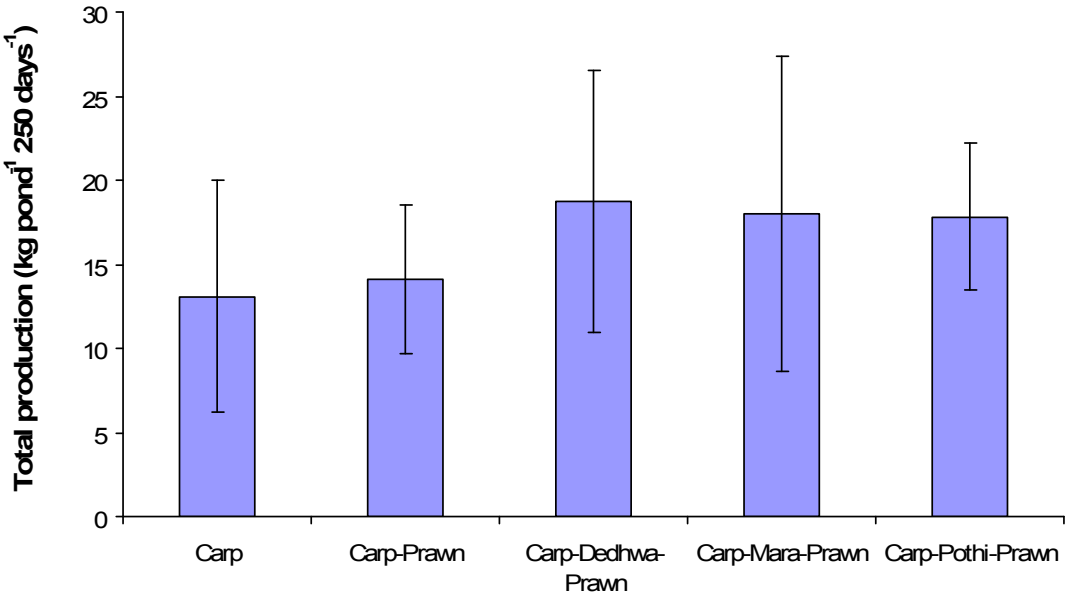

Fig 1. Total production (mean±SD) of fish and prawn (kg pond^{-1} 250 days^{-1}) under different farming practices. Bars represent average production of 10 households.

Fish consumption

On average, the farmers' households consumed 54% of the total production. Consumption varied from 0.8-22.4 kg·household^{-1}. By farming group, the highest (10.2 kg·household^{-1}) and lowest (7.3 kg·household^{-1}) amount of fish and prawn was found to be consumed by carp-dedhwa-prawn growing farmers and carp growing farmers, respectively (Figure 2), although the differences were not significant. Carp was the major commodity consumed by farmers (81%), compared to SIS (12%) and prawn (7%). All farmers growing SIS consumed but did not sell them. SIS consumption ranged from 0.03 to 5.3 kg·household^{-1}. SIS contributed 15% to the total fish consumption. Similarly all farmers growing prawn ate them, though in small amounts because the giant freshwater prawn was a new species to them. Prawn consumption was from 0.02-1.7 kg·household^{-1}.

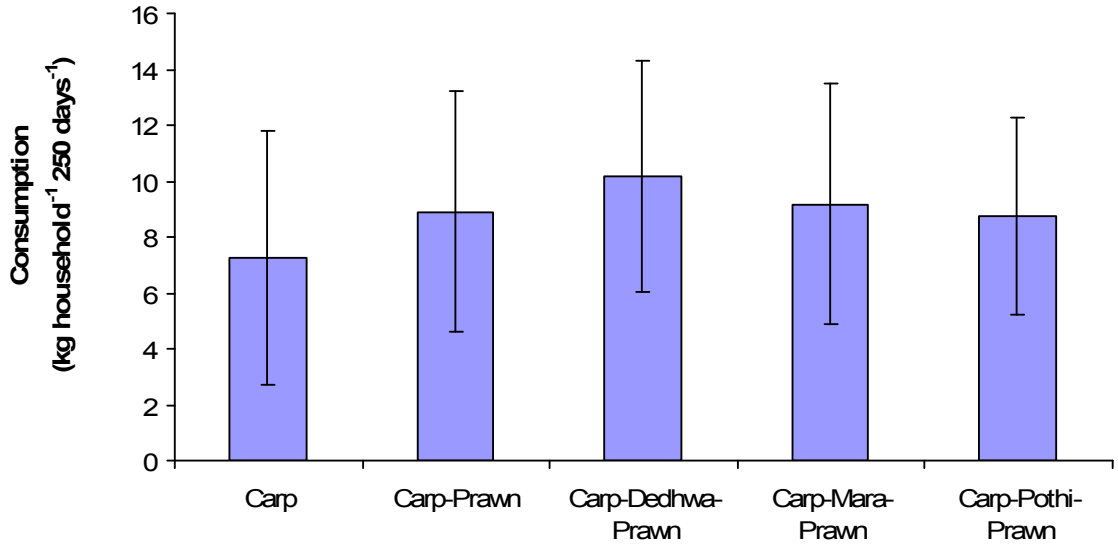

Fig 2. Total household consumption (mean±SD) of fish and prawn under different farming practices (kg household^{-1} 250 days^{-1}). Bars represent average consumption of 10 households.

Income generation

Farmers sold surplus carp and prawn. They sold carp and prawn at rates of NPR 200 kg^{-1} and NPR 600 kg^{-1}, respectively. The total amount of carp and prawn sold was from 0.7-24.2 kg·household^{-1}. Farmers earned NPR 135-4,846 for a growing season, which they used to cover household expenses. Farmers earned more than NPR 1,600 from carp-SIS-prawn ponds and less than NPR 1,200 from carp-only ponds (Figure 3), showing a substantial increase in income from these polyculture systems. However, the differences between average incomes by farming practice were not significant.

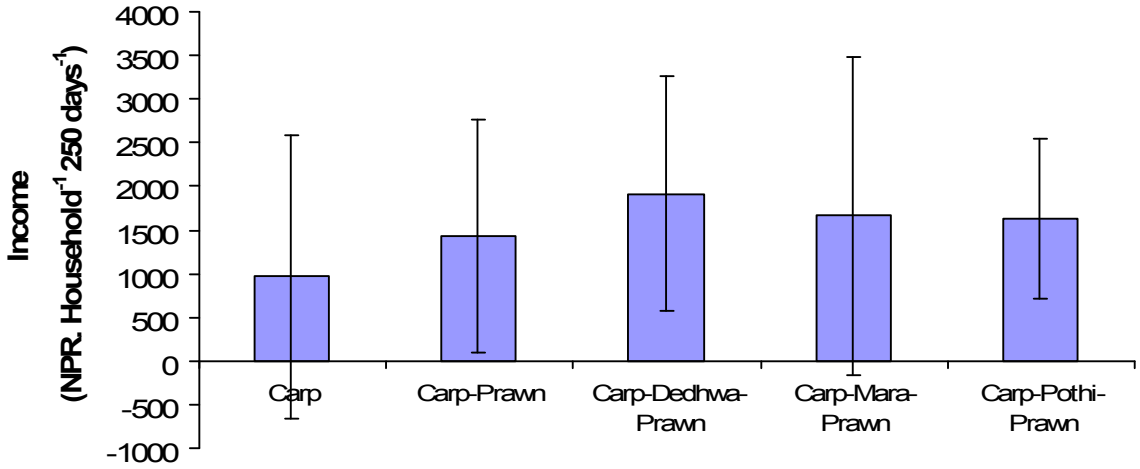

Fig 3. Total income (mean±SD) generated by farmer from fish and prawn sales (NPR ^{household} 250 $^{days-}$1) under different farming practices. Bars represent average income from 10 households.

Discussion

The project supported 50 women farmers. They actively participated in production and capacity building activities. Altogether, the carp-SIS-prawn project was able to help around 70 women, including all involved in training, research and supervision.

The carp-SIS-prawn growing farmers began consuming SIS regularly through partial harvesting of the ponds while carp and carp-prawn growing farmers had to wait until carp and prawns were large enough to eat. All farmers sold excess carp and prawn, and earned some income which helped them to be more empowered economically.

Total production was higher in carp-SIS-prawn ponds than in carp ponds. Average total production was lower than the national average production of 3.3 $t \cdot ha^{-1} \cdot year^{-1}$ (Ministry of Agriculture and Co-operatives, 2009), and it varied greatly among pond producers. This variation can be attributed to uncontrolled conditions including lower stocking density, fewer carp species stocked in ponds, poisoning from source water and water turbidity. In Nepal, stocking density of carp is typically 10,000 ha^{-1}, which is higher than the 7,500 ha^{-1} used in the present study. Similarly, farmers stock six to seven carp species in polyculture ponds to maximise the production by utilising all available niches, compared to the four carp species used in the present study. Some farmers used poisoned canal water from the Rapti River to top up the ponds. The chemicals were thought to be from fishermen who illegally used pesticides in the river to capture fish; the poisoned river water then reached the ponds through canals. This killed fish in the ponds and decreased production.

Among SIS, mara did not perform well. This may have been because it was stocked together with dedhwa and pothi. The latter two species may have been superior to mara under the pond conditions. Mara is not endemic to Chitwan, but dedhwa and pothi are widely available, found in almost all ponds in Chitwan, and enter ponds with canal water. However, their contribution to the total production is not counted in national statistics because these are considered weed fish. Although the Tharu community are not aware of the nutritional value of dedhwa and pothi, they do consume them.

Though prawn production was comparatively low, it made a significant contribution to total household income through its high economic value.

Fish are an integral part of the diet and income of Tharu people. Farmers and their household members consumed 8.9 kg of fish in 250 days with an average consumption rate of 2.3 $kg \cdot person^{-1} \cdot year^{-1}$, which was 31% higher than the Nepalese national average of 1.77 $kg \cdot person^{-1} \cdot year^{-1}$ (Ministry of Agriculture and Cooperatives, 2010). This is low by comparison with the global average consumption. The fish consumption rate among carp, SIS and prawn growing farmers was 65% higher than the national average. Household fish consumption was 20 to 40% higher in carp-SIS-prawn farmers compared to carp farmers. Increased intake of such nutrient rich SIS by farmers

is believed to improve their nutrition. Since SIS are eaten whole without loss of nutrients from cleaning or as plate waste, these contribute greatly to the micronutrient intake of farmers. Farmers growing carp, SIS and prawn together earned more income because production was better and prawn fetched a higher price. Income generation and pond ownership helped the women to be empowered financially.

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