Gender in Aquaculture and Fisheries: Navigating Change
Asian Fisheries Science Special Issue **27S** (2014): 165-174

ISSN 0116-6514

Asian Fisheries Science
The Journal of the Asian Fisheries Society

Technical Paper

Carp-SIS Polyculture: A New Intervention to Improve Women's Livelihoods, Income and Nutrition in Terai, Nepal

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Abstract

Based on lessons learned from field trials, carp-small indigenous fish species (SIS)-prawn polyculture technology was improved to a "carp-SIS polyculture" technology suitable for small scale farmers in Terai, Nepal. In December 2008, the project was initiated to improve income and nutrition of Tharu women in Chitwan (100 farmers) and Kailali (26 farmers) districts. SIS dedhuwa, *Esomus danricus* (Hamilton, 1822) and pothi, *Puntius sophore* (Hamilton, 1822) were intended to improve household nutrition through increased consumption due to their high micro-nutrient content whereas large carps rohu, *Labeo rohita* (Hamilton, 1822); mrigal, *Cirrhinus mrigala* (Hamilton, 1822); silver carp, *Hypopthalmichthys molitrix* (Valenciennes, 1844); bighead carp, *Aristichthys nobilis* (Richardson, 1845); common carp, *Cyprinus carpio* (Linnaeus, 1758) and grass carp, *Ctenopharyngodon idella* (Valenciennes, 1844) were grown mainly for sale. The farmers consumed 48.7% of the production and raised their fish consumption to twice the national average of 1.85 kg.caput^{-1}.year^{-1}. Farmers earned NPR 3,025 **(**USD 34.23**)** per household in 270 days which helped them economically. A women fish farmers' co-operative was established. Altogether 156 women directly benefited from the project. The training and project experiences improved their self-confidence. Micro-nutrient analysis of common SIS showed that vitamin A was higher in mara, *Amblypharyngodon mola* (Hamilton, 1822) whereas iron and zinc were higher in dedhuwa. The approach was found to be a more economic and sustainable, and is being replicated in other districts.

Introduction

The Nepalese people have a plant-based diet. In addition to staple plant foods such as rice and roti (flat bread made of wheat flour) vegetables such as green beans, cauliflowers, cabbage, brinjal, mustard, spinach, lady's finger, potatoes, radish, squash, tomatoes etc. grown in home vegetable gardens play a vital role in the supply of nutrients to the resource poor. However, quality and bio-

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availability of essential amino acids are higher in animal protein compared to plant protein (Pulami and Poudel 2004). Therefore, there are advantages to include animal protein in the diet. Fish are an important source of nutrients and micro-nutrients because fish are rich in protein, fatty acids, essential vitamins and minerals which are important for the cognitive and physical development of humans (Roos et al. 2006). Realising this fact, a pilot project entitled "Improvement of women's livelihoods, income and nutrition through carp-small indigenous fish species (SIS) - prawn polyculture in Terai, Nepal" was initiated in Chitwan (central region) and Kailali (far western region) districts of Nepal to help directly address malnutrition among poor women and children. The project ran for three years, commencing in December 2008. The approach included farming by the women, of carp rohu, *Labeo rohita* (Hamilton, 1822); mrigal, *Cirrhinus mrigala* (Hamilton, 1822); silver carp *Hypopthalmichthys molitrix* (Valenciennes, 1844); bighead carp *Aristichthys nobilis* (Richardson, 1845); freshwater prawn, *Macrobrachium rosenbergii* (De Man 1879); and small indigenous fish species (SIS) such as dedhuwa, *Esomus danricus* (Hamilton 1822); mara, *Amblypharyngodon mola* (Hamilton 1822); and pothi, *Puntius sophore* (Hamilton 1822) in household ponds. Farmers sell carp and prawn for household income, whereas the SIS are consumed by the family, through regular partial harvesting, to improve the nutritional status of family members as these fish are rich in vitamins and minerals (Thompson et al. 2002; Roos et al. 2003; Akpaniteaku et al. 2005; Roos et al. 2006, 2007a, 2007b). Moreover, as SIS are eaten whole, there is no loss of nutrients from cleaning or as plate waste, and the contribution to micronutrient intake is higher.

Average fish consumption rate and income of farmers increased after the interventions that brought new farming technology and provided training programmes (Rai et al. 2012). Despite this, farmers could not continue using the technology due to the unavailability of prawn seed as prawn seed production is not well developed in Nepal. These were sourced from Bangladesh and stocked in farmers' ponds during the first two years of the project. Transportation of prawn seed from Bangladesh was expensive and also suffered more than 50% mortality during transportation. Similarly, mara was unavailable in Chitwan and its transportation from other districts caused high mortality (Rai et al. 2012). Due to these bottlenecks, prawn and mara were excluded and only carp, dedhuwa and pothi were included in the stocking combination in third year. Based on this experience, the project introduced carp-SIS polyculture as an improved technology to the selected women farmers in Chitwan and Kailali in 2011. The findings from the first year of the project implementation (carp-SIS-prawn polyculture technology) were presented in Rai et al. (2012). The present paper presents the final results of the project. The paper describes findings of improved carp-SIS polyculture technology in relation to household fish production and consumption, the socio-economic conditions of women farmers and outcomes beyond the immediate project.

Materials and Methods

Farmers' selection

A total of 126 women farmers were selected, 100 from Chitwan (central region) and 26 from Kailali (far western region) based on their available resources, water source and enthusiasm for fish farming. The farmers were trained in pond fish farming. They were taken on an exposure trip

to a fish farming area, and assistance was provided to get them involved in income generating activities to improve their socio-economic status.

Training in pond polyculture

Female farmers received training on carp-SIS polyculture techniques for two days. Trainers from the Rural Integrated Development Society (RIDS) and the Rural Empowerment Society (REST) trained the farmers on carp-SIS farming (Rai et al. 2012). During the training, farmers were supplied a carp-SIS polyculture manual and a record book to record the numbers and weights of fish that were harvested, consumed and sold. The number and weight of dead fish and the amounts of feed and fertilizer applied to the ponds were also recorded. The record books were regularly monitored by the project staff. The farmers also visited Shankarnagar, one of the biggest fish producing area at Chitwan, to observe commercial carp farming.

Pond fish farming

Each farmer carried out farming in a small household pond of average size ~100 m^2 (sizes varied between 35 m^2 to 236 m^2). Ponds were dug in 2008 and the entire construction was supported by the project. All the ponds were fed with water channelised from nearby rivers and rivulets. Farmers stocked fingerlings of rohu, mrigal, silver carp, bighead carp, common carp *Cyprinus carpio* (Linnaeus, 1758), grass carp *Ctenopharyngodon idella* (Valenciennes, 1844), dedhuwa and pothi in March 2011. The stocking densities used by farmers were: carp 10,000 ha^{-1} and SIS (dedhuwa and pothi) 30,000 ha^{-1} (Table 1). Farmers fed fish and fertilised their ponds following Rai et al. (2010) and Knud-Hansen et al. (1993), respectively, except grass carp feeding. Farmers fed banana leaves, wastes of green vegetables and grasses grown on the dike to grass carp daily. Though feeding was done mostly by women, the transportation of feed and fingerlings and harvesting were done by both men and women.

Table 1. Stocking density (No. ha^{-1}) of carp and SIS.

Species	**Stocking density** (No. ha^{-1})
Rohu	2,000
Mrigal	500
Silver carp	3,000
Bighead carp	1,000
Common carp	2,000
Grass carp	1,500
SIS (Dedhuwa/Pothi)	30,000
Total	40,000

Record keeping and estimates

Fish production was estimated by deducting initial (stocking) total weight of fish from final total weight of fish. Final total weight was determined by summing total final harvest weight of fish, weight of fish consumed by family and weight of fish sold.

Fish production (Kg. $pond^{-1}$) = Final total wt. (harvest wt. + wt. of fish consumed + wt. of fish sold) – Stocking total wt.

The amount of fish consumed and sold by the family was determined from the records of weight, number and type of fish consumed and sold by the farmer. Income generated by each farmer from fish sale during and at the end of the culture period after final harvest was summed up to calculate total income earned from pond fish sale.

Results

The project participants

A total of 126 women farmers adopted carp-SIS polyculture, 100 in Chitwan and 26 in Kailali districts. The average family size was 6.4. Most families (96%) were headed by men (husband, father or father-in-law). Both men and women in the family were involved in agriculture. However, only women were selected for the project to meet the objective of the project. The majority of the farmers (95%) were Tharu, the least privileged ethnic group of Nepal. Involvement of Tharu women in income generation activity through carp-SIS farming helped to empower them economically and socially. Moreover, their involvement in group activities provided them the opportunity to come out of their house and improve their self-confidence and play significant roles in the society. Some emerged as leaders while others increased their participation in social activities. Moreover, their roles in household decision making also improved while earlier their responses would be "I have to take permission from my husband or father-in-law", if they were asked to participate in training, field trips etc. Later they began to demand to go for training and on field trips.

Women fish farmers' groups

Six women fish farmers' groups have been formed, five in Chitwan and one in Kailali (Table 2). The number of members in each group ranged from 15 (Piple) to 26 (Hasuliya). 95% of the women were Tharu, and other castes included Sarki, Pariyar and Brahmin. Women's groups of Phulloria, Mudovar and Piple have mixed communities whereas those of Majhui, Phaphini and Hasulia have only women from the Tharu community. The majority of women (58%) were young (20-39 years) followed by middle aged (40-59 years, 39%) and old (60-70 years, 3%). Elder women members could read and write with difficulty but they were found to be very sincere in performing their duties such as pond management, feeding fish and keeping fish production records. In aggregate, 87% of the women members had a primary level of education (Grade 1-5), 9% had secondary education (Grade 6-10) and 2% had higher levels of education (Intermediate).

Each group held monthly meetings. During the meetings, problems such as fish diseases, poisoning of water sources, water supply, advocacy with the District Agriculture Development Office (DADO) and their solutions; as well as future activities such as "where" and "how" to procure fingerlings were discussed. A monthly deposit of NPR 10-25 per member was made in the groups' account. This corpus was used for providing loans of NPR 500–5000 per person (USD 5.32-53.2) to group members who were in need of financial support, at an interest rate of 1% per month as well as for repairs of equipment, e.g. purchase of pump set and fishing net. The number of members were found to have increased since the establishment of the women's groups of Piple (15 to 17 members), Majhui (21 to 25 member) and Phaphini (25 to 39 member). New members constructed fish ponds on their own in Piple and Majhui whereas in Phaphini ten members received support from the project (supported by Danida, Denmark) and DADO in 2011 and 14 members received support from Twinning project-phase I in 2012 for pond construction.

Table 2. Women fish farmers' groups formed in Chitwan and Kailali districts.

S. N.	Women fish farmers' groups	Village	No. of members per group	Ethnic composition	
1	Namuna Bikash Mahila Machapalan Krishak Samuha	Phulloria, Chitwan	23	19 Tharu	4 Sarki
2	Janmukhi Mahila Machapalan Krishak Samuha	Mudovar, Chitwan	16	15 Tharu	1 Pariyar
3	Rai Mahila Machapalan Krishak Samuha	Piple, Chitwan	15	14 Tharu	1 Brahmin
4	Laligurans Mahila Machapalan Samuha	Majhui, Chitwan	21	21 Tharu	-
5	Saypatri Mahila Machapalan Samuha	Phaphini, Chitwan	25	25 Tharu	-
6	Lalpur-Bhadari Mahila Machapalan Samuha	Hasulia, Kailali	26	26 Tharu	-
	Total		**126**	**120**	**6**

Capacity building

Altogether 156 women benefited directly through capacity building and empowerment through their roles as farmers (136), trainers (18), field supervisor (1) and coordinator (1). Eighteen women farmers from RIDS and REST were selected by their respective executive bodies based on their experience and literacy (Rai et al. 2012) and they in turn trained 136 project farmers on carp-SIS polyculture. In addition, eight women lead farmers and eight project staff (2 women and 6 men) visited Bangladesh to observe and study advanced aquaculture technologies. Visiting lead farmers included chairpersons from each of the six women's groups (6) and the two highest fish producing farmers, one each from the first and second project years.

The Bangladesh visit had been a turning point for some farmers and project staff, providing the visitors from Nepal with the confidence that "we can also do". Having observed and learnt the integrated pond dike farming system utilising dikes for growing vegetables in Mymensingh, Bangladesh, some farmers adopted the same technology in the ponds back home with technical support from project staff. Two farmers also increased their pond size after the visit. One of the

farmers assisted her fellow farmers to establish a woman's fish farmers co-operative in the village a year ago. The co-operative will be a collaborating partner in a Twinning project–phase II (funded by Ministry of Foreign Affairs, Finland). Another farmer approached a donor (Danida Nepal) and DADO for financial support to construct ponds for her fellow farmers in the village. With support received from the donor and DADO, she succeeded in helping ten women in adopting fish farming and also increased the number of members in the group from 25 to 35.

Outcomes beyond the immediate project

Two significant impacts were observed as a result of the implementation of the project. These were the establishment of women fish farmers' co-operatives and the use of the project approach, materials and outputs as the basis of new projects. Women farmers from Majhui, Khaireni-3 and Chitwan established a women fish farmers' co-operative in December 2012. The co-operative consists of 25 members, with an elected executive board of 11 members for managing co-operative activities. The co-operative collects savings from members which they utilise to disburse loans to needy members at low interest. In Nepal, bank loans have a high interest rate and securing a loan is a cumbersome process. Therefore, the low interest loans from co-operative are attractive to farmers. The cooperative aims to improve the economic and social status of members through their participation in income generating activities such as fish farming, integrated fish farming and marketing.

Two new projects: "Twinning support for development of women fish farmers' organisations in Nepal," funded by the Government of Finland and "Agriculture and Nutrition Extension Project" funded by the European Union (EU) have been replicating carp-SIS polyculture in Chitwan, Nawalparasi and Rupendehi districts. In addition, the project's training materials, strategies; outputs and manpower have been used as the basis for these new projects. The Finnish project has appointed, Ms. Usha Chawdhary, a farmer of Majhui, as a Field Supervisor and also five lead farmers as Trainers. Similarly, the EU project has also recruited Mr. Bishwa Chandra Pokhrel, Field Supervisor of the project as an Aquaculture Officer.

Fish production

Fish were harvested after 270 days of stocking in December 2011. Farmers obtained an average production of carp (86%) and SIS (Dedhuwa/Pothi) (14%) of 4.4 tonnes.ha^{-1}.year^{-1} which was higher than the national average fish production of 3.5 tonnes.ha^{-1}.year^{-1} from carp polyculture (Ministry of Agriculture and Co-operatives 2009). The total production was higher in Chitwan (4.7 tonnes.ha^{-1}.year^{-1}) than in Kailali (3.0 tonnes.ha^{-1}.year^{-1}).

Fish consumption

48.7% of the total carp produced was consumed by the households. The average fish consumption rate increased to 3.7 kg.caput^{-1}.year^{-1}, whereas the average national fish consumption rate in Nepal is 1.85kg.caput^{-1}.year^{-1} (Directorate of Fisheries Development 2013). SIS consumption ranged from 0.5 to 6.4 kg.household^{-1} in 270 days. Fish consumption was higher in Chitwan compared to Kailali due to relatively higher fish production (Fig. 1).

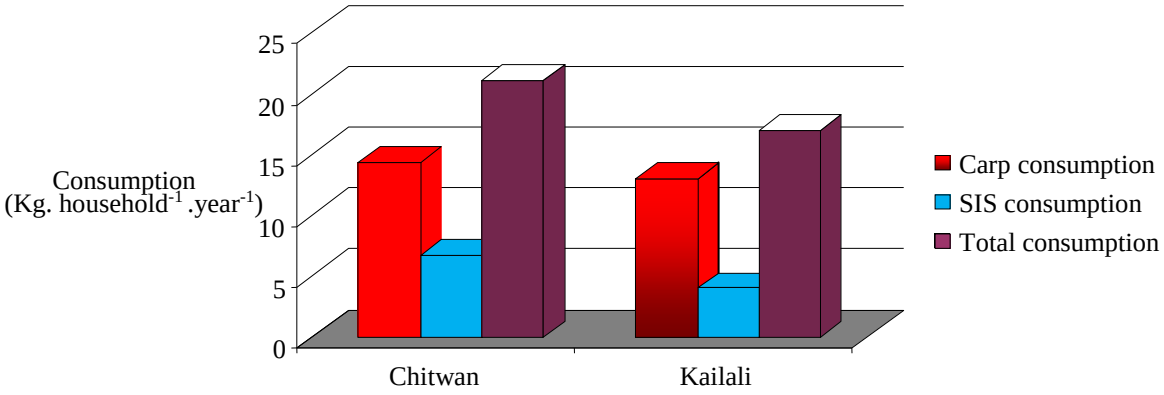

Fig. 1. Household fish consumption in Chitwan and Kailali.

Income

Farmers sold fish to locals in the neighbourhood and customers generally came to farmers' houses to buy the fish. Both men and women were involved in the fish sales. A few farmers sold fish to local vendors who in turn carried out their trade in the local markets. Carp was sold at the rate of NPR 200 (USD 2.1) per kg and the average income generated by the farmers per household in 270 days was NPR 3, 025 (USD 34.11).

Nutrient profile of SIS

Micro-nutrient profiling of SIS samples of dedhuwa, faketa (*Barilius* sp.), mara and pothi, collected through the project, was done at the University of Copenhagen, Denmark. Among the four SIS, vitamin A was found to be highest in mara whereas iron and zinc were found to be highest in dedhuwa followed by pothi (Table 3). In the table, the vitamin A and iron content of the four SIS is compared with that of mrigal and silver carp from Bangladesh (Roos et al. 2007b).

Table 3. Vitamin A, iron and zinc content in four common SIS of Terai, Nepal.

SIS	Vit. A (RAE.100g. rawclean parts^{-1})	Fe content (mg.100g. rawclean parts^{-1})	Zn content (mg.100g. rawclean parts^{-1})
Dedhuwa (*Esomus danricus*)	107.5	6.2	4.5
Faketa (*Barilius* sp.)	84.5	1.0	3.6
Mara (*Amblypharyngodon mola)*	685.5	2.4	4.3
Pothi (*Puntius sophore*)	56.0	3.1	4.2
Mrigal (*Cirrhinus mrigala*)	< 30	2.5	
Silver carp (*Hypopthamichyths molitrix*)	< 30	4.4	

RAE: Retinol activity equivalent

Discussion

The dietary habits of the Nepalese people is undergoing a change and fish consumption is gradually increasing. Indian and Chinese carp are the main fish cultured and eaten in Nepal but carps have lower vitamin and mineral content compared to SIS, particularly mara and dedhuwa. This fact indicates the benefit of increasing SIS production and consumption. In this regard, polyculture of carp and SIS in ponds can contribute to improved family nutrition as well as increased income in rural areas. In the past, SIS were not valued and their presence in ponds was considered undesirable (Rai et al. 2012). This project has contributed to changing the attitude towards SIS and has highlighted the nutritional value of SIS.

Among the farming families that took part in the project, total fish production was found to be higher than the national average production from carp polyculture and carp-SIS-prawn polyculture (Rai et al. 2012). Increased production can be attributed to extra production from SIS, improved management particularly in protecting fish from poisoned water, improved stocking combinations and increased stocking density. During the production period, farmers regularly harvested SIS (up to two times per month after breeding of the stocked brood SIS) for family consumption after three months of stocking, which maintained the optimum stocking density in the system and improved overall fish production. In carp-SIS-prawn polyculture, production was hindered by i) a fish kill from using a poisoned water source, ii) using low stocking density of 7,500 ha^{-1}, and iii) stocking four carp species which perhaps did not utilise all available niches (Rai et al. 2012). Fish production was comparatively lower in Kailali than Chitwan which was probably due to stocking of small size fingerlings and poor pond management.

Fish consumption among farmers was found to be double the national average per capita fish consumption and higher than from carp-SIS-prawn polyculture (Rai et al. 2012). The partial harvesting system of SIS obviously increased fish consumption. SIS contributed 28% to the total family consumption on average. A few of the farmers preserved their excess dedhuwa by drying them under sunlight for consumption later. However, fish consumption is far lower than the global average fish consumption, thus there is a potential and need to increase the fish production and consumption. Micro-nutrient analysis showed that mara and dedhuwa were more valuable in terms of nutrient content. Vitamin A was found to be comparatively lower in mara than reported by Roos et al. (2003, 2007a, 2007b) in Bangladesh. The reason might be the sample of mara contained juveniles having lower vitamin A content. Roos et al. (2002) reported that vitamin A accumulates with age in fish. Micro-nutrients in SIS were found to be much higher than in large carps in Bangladesh (Roos et al. 2003). Regular intake of such micro-nutrient dense small fish can mitigate malnutrition problems from which women and children often suffer.

Almost all farmers sold carps and increased the household income which empowered women economically. The income generated was higher than from carp-SIS-prawn polyculture (NPR 1,523 per household in 250 days) due to better production. Marketing was not difficult because production was small and demand was high. The farmers spent the income on household activities and micro-credit savings.

Realising the malnutrition problems, in 2012, Dr. Baburam Bhattarai, the former Prime Minister of Nepal gave a strong commitment to improve the nutritional status of children and women for future socio-economic growth and development of the country. To ratify the commitment, the Government of Nepal signed the Declaration of Commitment for Accelerated Improvement in Maternal and Child Nutrition, and launched the Multi-Sectoral Nutrition Plan (MSNP) on 17 September 2012 (UNICEF 2012). The new national nutrition programme may help the approach to expand to new areas and benefit larger number of women and children.

The project has been able to develop a sustainable fish culture package appropriate to small scale farmers which is now being replicated in five districts (Chitwan, Kailali, Kapilvastu, Makawanpur and Nawalparasi). Around 1,200 households have adopted this technology. The project has also played a significant role in leadership, skill and career development of women farmers involved in the project.

Conclusion

Though fish production was better in carp-SIS polyculture, it needs to be increased further by increasing production through improved technology such as using substrates for periphyton growth, integrating with vegetables and fruits and adopting multiple stocking and harvesting strategies. Upscaling of carp-SIS polyculture in other parts of Terai is essential to benefit more families. This upscaling may need collaborative efforts among rural communities, government line agencies, research institutions and donors. The approach might be a way to help implement the new Multi-Sectoral Nutrition Plan in the country (UNICEF, 2012).

Acknowledgement

The authors wish to thank Mr. Shankar Prasad Dahal, Fisheries Development Centre, Chitwan, Nepal; Mr. Jiyan Chowdhary, Rural Integrated Development Society, Chitwan, Nepal; Mr. Ramesh Chowdhary, Rural Empowerment Society, Kailali, Nepal and Dr. Mrityunjoy Kunda, Bangladesh Fisheries Department, and WorldFish Center, Bangladesh for their help in implementing the project and carrying out the research. DANIDA, through the Danish Ministry of Foreign Affairs, is gratefully acknowledged for providing financial support.

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