EFFORT OF MDI-NEPAL IN PROMOTING

THE CARP-SIS POLYCULTURE AT THE FOOT HILLS OF NEPAL

ACKNOWLEDGEMENT

This report is the product of a project entitled 'Conservation of Indigenous Fish Bio-diversity in East Rapti River Basin (ERB) through CARP-SIS Polyculture' supported by UNDP GEF Small Grants Programme of Nepal. However, the views expressed do not necessarily reflect organizations' official policy. We highly regard UNDP GEF Small Grants Programme/Satoyama Initiatives (SI)for this financial support provided to implement such a successful initiatives for the benefits of indigenous communities at the foot hills of Nepal in conserving fish biodiversity and for generating additional income and improve nutrition at household level.

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MDI is truly blessed to have you as esteemed developmental& expert partners in this process. We believe, you will continue to support such a local initiatives with the noblest of objective to keep the world free of hunger& malnutrition in the days ahead.

SATOYAMA INITIATIVE

Japan Biodiversity Fund

gef

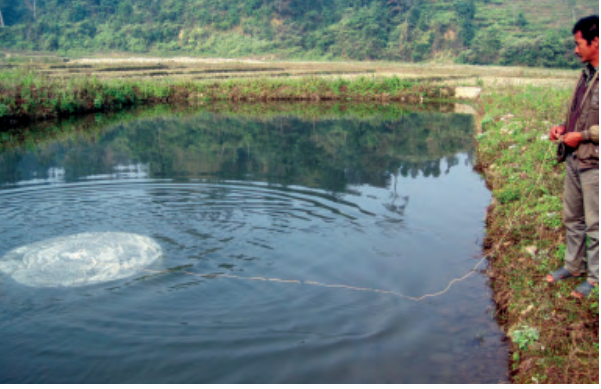
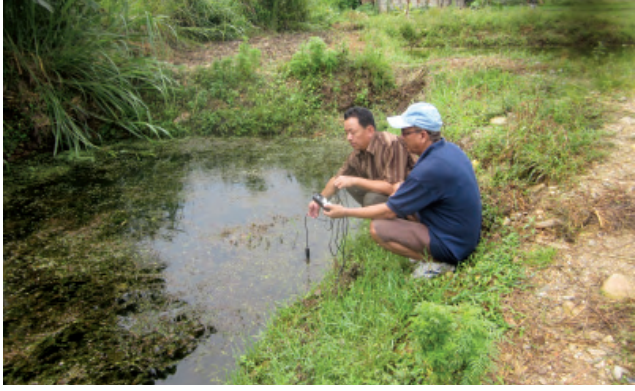
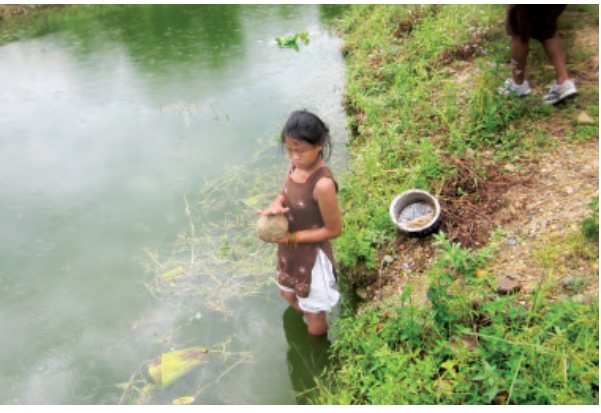
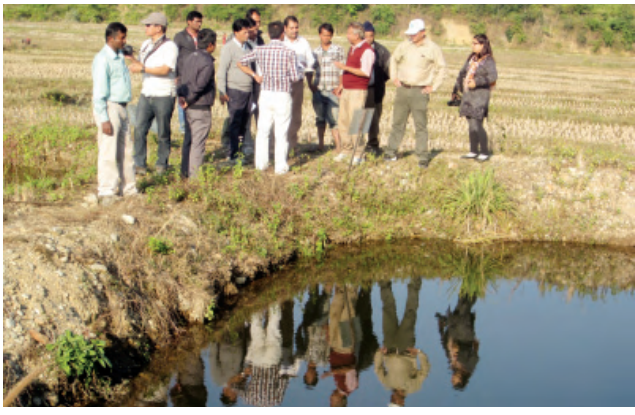
SGP The GEF Small Grants Programme

UNDP NEPAL

INTRODUCTION

Nepal is a landlocked country. It's borders are not in contact with any accessible waterways, such as a gulf or ocean or any coastline. But, Nepal is still rich in water resource because of abundant high Himalayas located on the northern part of the country. When snow melts in the Himalayas, the glacier and rivers are formed. The rivers flow through the mountain regions to the plain area (i.e. Terai). Thus, nature has been very kind to this country by providing with unlimited supply of water. Nepal deserves to be the second richest in the water resources in the world after Brazil.

Though we have abundant source of water, our aquaculture is still holds fairly a new activity. Over the years, since beginning in 1940 with Indian Major Carps (IMCs), the carp polyculture in ponds has developed as the most viable and popular aquaculture production system in Nepal. An estimated 79,000 people are directly or indirectly involved in pond aquaculture activities nationally and the number is increasing. Fish production from commercial ponds increased by more than 23 percent over the past five years. A fresh statistics released by the Ministry of Agriculture Development (MoAD) shows fish production increased to around 30,000 tons in fiscal year 2011/12, up from 24,295 tons recorded in 2007/08. During the period, the number of commercial ponds surged to 29,970 from 23,884. The major part of the pond fish production takes place in the southern part of the country – the Terai plain – where 94 percent of the fish ponds are located. Fish farming contributes 2% to the Agriculture Gross Domestic Product (AGDP). Fish productivity in Nepal is 3.7MT/ha with per capita consumption of 1.8 kilogram. Low productivity is attributable to poor quality fish stock (seed), use of feed and poor pond management.

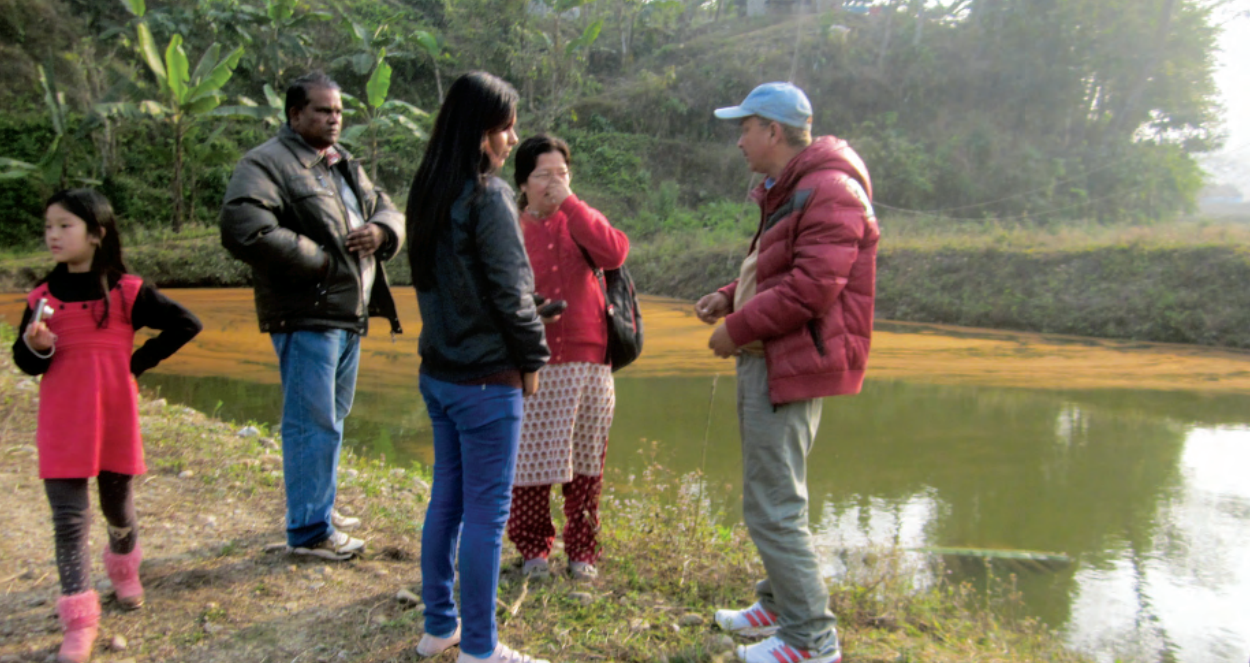
On the other hand, there are significant production of small indigenous fish species within the river system of Nepal which has been remained invisible in national statistics. Capture fishery is often the only source of livelihood for the fisher's communities living near water bodies. Rivers are one of the major sources of capture fishery, contributing almost 50% of total captured fish production.The fishers use different kinds of traditional fishing gear like nets, baskets, rod and line, spearing, fish traps and indigenous fish poison, as well as some destructive fishing methods such as insecticides, pesticides, dynamiting and electric fishing. Water resources of the country are the habitat of 232 species of fish from different climatic zones.Out of the 232, there are 217 native species and 15 exotic species (Jha, 2010).
The capture fishery sector including coldwater fishery has been given lesser priority by the government fisheries administration. This has contributed to a gradual decline in fish stocks in some areas.It's reported that 34 fish species constituting about 18 % of the total reported fish species are threatened (Nepal Biodiversity Profile).

SIS such as Mara (Amblypharyngodonmola), Dedhwa (Esomusdanricus) and Pothi (Puntiussophore) are considered as highly valuable source of macro and micronutrients. Vitamins and minerals are found to be much more in small fish than in large fish such as Carps. In fact, farmers and extension workers are not aware of the nutritional value of SIS. Therefore, their culture potential is overlooked. SIS is self-recruiting and therefore can be harvested weekly and biweekly, favoring household consumption. The role of SIS in providing micronutrients is critical to take note of in a context where micronutrient deficiency is a big. Malnutrition caused by mineral and vitamin deficiencies among poor women and children has been a serious health problem in Nepal (MOHP 2006).

THE CARP-SIS POLYCULTURE

The CARP-SIS polyculture system is the technology recently developed by Bangladesh Agriculture University (BAU) and World Fish Center (WFC) in Bangladesh & later extended in Nepal by the experts of Institute of Agriculture and Animal Science (IAAS), Rampur, Nepal in 2010-2012 with financial support of the Embassy of Denmark. This project combines cultivation of Small Indigenous Species (SIS) mixed with some exotic carp species such as bighead carps, silver carps, rohu, naini and mrigal through polyculture system and has potential of producing additional 10% higher productivity.

Looking over this successful results of this CARP SIS project implemented by IAAS in Kathar VDC of Chitwan district in Nepal, MDI attempted to expand this successful initiatives in adjoining district Makawanpur targeting indigenous rural communities i.eTamang and Chepang. With little financial support from UNDP GEF Small Grants Programme of Nepal (US $ 28,000), the project was extended in three VDCs of northwest Makawanpurwithin the catchments of East Rapti river basin located at the foothills of Chure and Mahabharat hill range beginning from December 2012. Over the years, 71 ponds have been constructed and its beneficiaries have successfully harvested Carps and SIS as per targeted goals. Encouraging with this successful results, may communities particularly from ethnic origin (Tamang&Chepang) have been attracted &replicated the similar system throughout the project area and is expected to reach 129 ponds by the end of second year. The size of ponds they have expanded is 3 to 5 times bigger than those of earlier constructed (av. 264 m^2) and the number of ponds per families have also been increased with 2 ponds per families.



OBJECTIVE OF THE PROJECT

The overall goal of the project is to conserve and promote indigenous small fish species of East Rapti river basin with the aim of increasing cash incomes of indigenous communities, improving nutrition, protecting water resources and preserving fish biodiversity in the local water bodies.

A number of activities have been launched to enhance awareness level of participating households on SIS conservation and refining CARP-SIS technologies through training supports.

THE SMALL INDIGENOUS FISH SPECIES (SIS) IDENTIFIED IN THE EAST RAPTI RIVER BASIN

Mr. Dilip Kumar Jha, a renowned fish physiologist working as Associate Professor in Agriculture and Forestry University (AFU) of Rampur Nepal and his team conducted a field survey to assess fish bio-diversity of the East Rapti River Basin with its tributaries (Figure.1). Nine to tenfishing spots of upstream and downstream of the river in Makwanpur district were monitored from last week of August/1st week of September 2012 to August 2013.

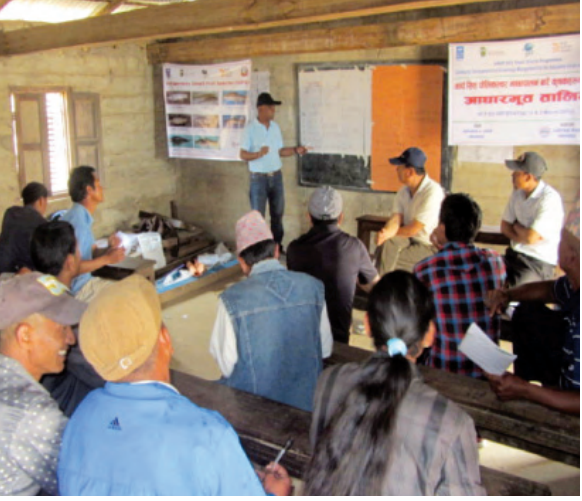
This survey identified 37 local fish species within East Rapti river basin and its tributaries, which is briefly summarized as follows;

SIS SPECIES

1. Pothi(Puntius chola)
2. Pothi/Sidhara (Puntius chonchonius)
3. Sahar(Tor putitora)
4. Chepuwa (Aspidoparia morar)
5. Chiplefaketa/Bagh (Raiamas bola)
6. Khasre (Barilius bendelisis)
7. Pothi (Puntius sophore)
8. Gardi (Labeo dero)
9. Sahar (Tor tor)
10. Faketa(Barilius barna)
11. Bhoti/Hile (Channa orientalis)
12. Kapre (Glyptothorax pectinopterus)
13. Budhuna (Garra annandallie)
14. Kauwa/Thunge (Xenentodon cancila)
15. Galara,Patharchatti (Chagunius chagunio)
16. Gadela (Nemacheilus corica)
17. Tengra (Mystus bleekeri)
18. Bam (Macrognathus pancalus)
19. Singhi/Chilni/Aagomachha (Amblyceps mangois)
20. Bam/Gainchi (Macrognathus aral)
21. Thend (Labeo angra)
22. Goira/Pategadela (Acanthocobitis botia)
23. Naun/Lata (Lepidocephalus guntea)
24. Goira (Somileptes gongota)
25. Baghi (Botia geto)
26. Baghi (Botia lohachata)
27. Ratokapre (Pseudecheneis sulcatus)
28. Patekapre (Pseudolaguvia ribeiroi)
29. Tengar/Kanti (Aorichthys aor)
30. Pothi (Puntius ticto)
31. Mara/Dhawai (Amblypharyngodn mola)
32. Dedhawa (Esomus danricus)
33. Nakuro Budhuna (Garra gotyla)
34. Chuche Bam (Mastacembelus armatus)
35. Jhinge (River Prawn)
36. Katle (Neolissochilus hexagonolepis)
37. Jalkapoor (*Ompok bimaculatus*)

CARP SPECIES

1. Rahu (*Labeo rohita*)
2. Naini (*Cirrhina mrigala*)
3. Common carp/scale carp (*Cyprinus carpio var communis*)
4. Bighead carp(*Aristichthys nobilis*)
5. Common carp/mirror carp (*Cyprinus carpiovar specularis*)
6. Grass carp (*Ctenopharyngodon idella*)
7. Silver carp (*Hypophthalmichthys molitrix*)



A REVIEW OF THE CARP-SIS PROJECT LAUNCHED

During December 2014, after one year of its completion, some post graduate students studying in aquaculture in Agriculture& Forestry University (AFU) in Rampur, Nepal conducted a field survey as part of their assignments under their study and have interpreted, though not statistically, their observations which is briefly summarized as follows;

SUMMARY OF THE FINDINGS

Small Indigenous Fish Species (SIS) are important source of vitamins and minerals. Farmers and extension workers are not aware of the nutritional value of SIS. Experts say that the indigenous fish species of Nepal is gradually declining in the river systems of Nepal due to various unsustainable harvesting practices such aspoisoning, bombing, poaching etc. Developed in Bangladesh Agricultural University (BAU) and successfully tested in Kathar of Chitwan by the experts of IAAS Rampur in Nepal in 2010-2012, the CARP-SIS technology was further replicated in Makawanpur district of Nepal by MDI Nepal with funding from UNDP GEF Small Grants Programme of Nepal. Altogether, 71 fishery ponds with an average size of 263.6 m^2 have been constructed and stocked with carp such as (rohu (Labeorohita), Naini (Cirrihinusmrigala), common carp (Cyprinuscarpio), grass carp (Ctenopharyngodonidella)and SIS such as pothi (Puntiussophore), pothi/sidhara (Puntiuschonchonius), Dedhuwa (Esomusdanricus), Faketa (Raiamas bola), khasre (Bariliusbendelisis), gardi (Labeodero), Mara/Dhawai (Amblypharyngodnmola)etc. These local species were identified by Mr. Dilip Kumar Jha, Associate Professor of Agriculture & Forestry University (AFU) of Rampur, Nepal. The project started in December 2012 while the farmers stocked the fingerlings in pond during March/April 2013, which has attained an average of 138 days, till this survey period (December 2013). From the survey, it was observed that on average, the farmers' households consumed 23% of the production of which SIS shares 20%. Only farmers, especially from ethnic Tamang communities who represent 40% of the total respondents consumed SIS. Farmers earned Rs. 36,250 in 138 days with an average income of Rs. 7,250 per households against Rs. 2,700 from paddy, which is almost 2.7 times higher from the same piece of land area ((264 m^2). The current results are encouraging and is expected to be of promising start to introducing new farming practices to increase the income, food and nutritional standards of households members involved in CARP-SIS culture.

AREA AND LOCATION OF THE STUDY SITE

The study site lies around the MasineKhola in Handikhola VDC-7 in Makawanpur district. It's located in 7 km south from the Sannanitar, a small marketing port along the highway-10 km west from Hetaunda. The area lies in around 400 m altitude within fragile Churiya range and is part of Parsa Wildlife Reserve.

In and around these river systems, the project has promoted 68 fishery ponds giving benefits to majority of tribal families, the Chepangs & Tamang.

The water in the ponds is served either through irrigation canal sourced from Masinekhola/Thadokholsa (60%) and from naturally occurring underground spring sources (40%).

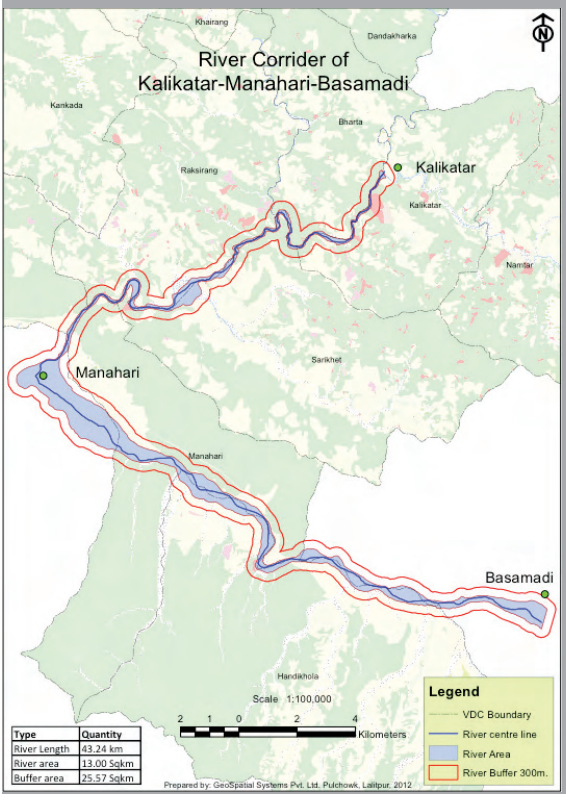


Figure 1 : Study Area

BENEFICIARY HOUSEHOLDS

There were 70 farmers participating in the first year while in the second year 49 farmers have been added digging new ponds which are under construction phase. Thus, there are altogether 119 beneficiary households in total. Out of them 82% represent from indigenous communities (Tamang, Chepang & Bankariya), 14 % from Bramhin & Kshettri and 4% from Dalits (Table.1).

UNDP/GEF SGP								
Conservation of Indigenous Fish Bio-diversity in East Rapti River Basin (ERRB) Through CARP SIS Polyculture								
S.N.	Types of Community	Year 1		Year 2		Total		%
		Benf. HHs.	pond	Benf. HHs.	pond	Benf. HHs.	pond	
1	Indigenous community	63	57	34	44	97	101	82
2	Other community	6	6	11	13	17	19	14
3	Dalit community	-	-	4	4	4	4	3
4	Research pond	1	5	-	-	1	5	1
	Total	70	68	49	61	119	129	100

Table.1: Participating Households in CARP-SIS Project

RESULT & DISCUSSIONS

POND TYPE AND SIZE

The pond size of the study areas varies from 200 m^2 to 300 m^2 with an average size of 264 m^2. All the ponds are earthen and are located near to the homestead and have perennial source of water. Most of the fish farmers of selected areas are marginal but having food sufficiency round the year from their own production.

The average area allocated for fishery ponds constitutes 5.68% including dyke and 4.11% for water area (Table.2). Local vegetable crops such as chilli, tomato, cucurbit vines, cowpea are grown around the dykes. The grasses are used for feeding grasscarps.

Descriptions	# of Respondents					Average
	1	2	3	4	5	
Total Area (in m^2)	10,168	20,336	15,252	4,067	3,559	10,676
Khet	10,168	10,168	2,034	1,017	2,034	5,084
Pakho	-	10,168	13,218	3,050	1,525	5,592
Land allocated for fishe farming						
Including dykes area	300	500	308	400	397	381
Water area	200	300	224	297	297	264
Percent of area allocated						
Including dykes area	2.95	2.46	2.02	9.84	11.15	5.68
Water area	1.97	1.48	1.47	7.30	8.35	4.11

Table.2: Area Allocated for Fishery Ponds

POND STOCKING AND MANAGEMENT

Ponds were stocked with fingerlings of four carp species rohu (Labeorohita), Naini (Cirrihinusmrigala), common carp (Cyprinuscarpio), grass carp (Ctenopharyngodonidella) with three major SIS Dedhwa (Esomusdanricus), Mara (Amblypharyngodonmola), Pothi (Puntiussophore) while many other local species are also added. The stocking was done in a series of time because of its availability in the hatchery. The first stocking was done during May 2013 with grasscarp, rohu&naini and continued until September first week 2013 for common carp.

Based on the current stocking record, the stocking density was found to be of 12.02/m^2 for Carps and 12.61m^2 for SIS (Table.3).

Ponds were fertilized with cattle manure at the rate of 10 doko/pond and with Urea @ 1 kg per pond in the beginning. No manures and fertilizers have been kept thereafter. However, the color of the ponds seems to be green in most of the ponds while few ponds looks with red coloration. The average size of pond is 264 m^2.

Stocking density/m^2	Respondents					Average
	1	2	3	4	5	
Carps	10.00	10.00	17.19	9.43	13.47	12.02
SIS	15.00	10.00	17.86	3.37	16.84	12.61

Table.3: Stocking density

SOURCES OF SEED

Fingerlings were brought from a private hatchery (Mr. HiraLalSahani) located in Tandi, Chitwan-50 km distance from the project site. Some of the fingerlings were also brought from Fishery Development Centers (FDCs) of the government farm from Bhandara, Chitwan&Hetaunda, Makawanpur.

WATER QUALITY ASSESSMENT

DO meter, PH meter, Thermometer, Sechi disk was used to measure the water quality parameters in each of the sampled ponds and found that the range for PH, DO, temperature and sechi disk transparency are in normal conditions i.e. 8.72, 7.76, 15.2 & 25 respectively in average (Table.4).

Parameters	Respondents					Avearge
	1	2	3	4	5	
Water quality						
PH	8.7	8.9	8	8.6	9.4	8.72
DO	7.6	7.6	7.2	8.2	8.2	7.76
Sechi disk transparency (cm)	20	25	22	36	22	25
Temperature (^{0}C)	14	15	16	15	16	15.2
Time hours	8-9 AM	9-11 am	2-4 pm	10-11 AM	2-4 pm	

Table.4: Water quality parameters

FEEDS, FEEDING & ASSOCIATED COST

Fish were fed with mustard oilcake mixed either with rice bran or maize flour at 3% of total estimated biomass once in a day. Record were taken from their registers which was properly maintained in their respective notebooks in close guidance of MDI Field Supervisors.

Through this analysis, it has been observed that the feed composition is properly mixed to meet 23% protein standard in the diet suited for carps. Feed Conversion Ratio (FCR) seems to be 1.57, which is also found to be at appropriate level. While feed cost goes to little high i.eRs. 40 per kilogram (Table.5), thus the farmers were found to have little worried for buying feedstuffs from the markets.

Descriptions	Respondents					Average
	1	2	3	4	5	
Quantity (kg)	250	150	170	300	150	
Oilcake	130	50	70	200	50	
Ricebran	120	-	-	-	-	
Maize flour	-	100	100	100	100	
Total Cost (Rs)	6,660	3,500	4,110	8,000	3,500	
Percent Parts	100	100	100	100	100	
Oilcake	52	33	41	67	33	
Ricebran	48	-	-	-	-	
Maize flour	-	67	59	33	67	
Protein Level (Existing)	25	20	22	29	20	23
Mustard cake	20	13	16	26	13	
Rice bran	5	-	-	-	-	
Maize flour	-	7	6	3	7	
Feed Conversion Ratio (FCR) = Feed fed (gm)/Wet weight of fish	2	1	1	2	1	1.57
Total feed (kg)	250	150	170	300	150	
Wet fish weight	102	166	129	139	147	
Feed Cost (Rs/kg) - Feed price x FCR	65	21	32	58	24	39.94

Note: Mustard cake 38.5% CP, Rice bran 10%, Maize flour 10% CP; Price Mustard cake Rs. 30, Rice bran Rs. 23 & Maize flour Rs. 20 per kilogram

Table.5: Feeds, feeding & associated cost

PRODUCTION

Till this period, farmers have been able to sell 174 kilograms of fish in an average of 138 days with a total value of Rs. 36,250 making an average income of Rs. 7,250 per household (Table.5). However, the project has yet to receive income from the remaining harvests to make balance over the current expenditures.

S.N	Descriptions	Respondents					Average
		1	2	3	4	5	
1	Fixed Cost	500	500	500	500	500	500
	Depreciation cost (10% of construction cost i.e. Rs. 5,000/pond)	500	500	500	500	500	500
2	Operational Cost	13,860	8,900	12,110	17,600	10,600	12,614
	Fingerlings	4,000	3,000	3,000	4,600	4,300	3,780
	Feed cost	6,660	3,500	4,110	8,000	3,500	5,154
	Oilcake	3,900	1,500	2,110	6,000	1,500	3,002
	Ricebran	2,760	-	-	-	-	552
	Maize flour		2,000	2,000	2,000	2,000	2,000
	Indirect labor cost	3,200	2,400	5,000	5,000	2,800	3,680
	Total Cost (1+2)	14,360	9,400	12,610	18,100	11,100	13,114
3	Total Sales	9,100	-	4,400	16,000	6,750	7,250
	Quantity (kg)	50	-	22	75	27	35
	Rate (Rs/kg)	182	-	200	213	250	169
4	Net Profit	(14,178)	(9,400)	(12,410)	(17,887)	(10,850)	(12,945)

Table.6: Statement of profit & loss

EXPECTED PRODUCTIVITY

The survey was further concentrated to measure the biomass currently holding by the pond and find out the expected productivity. For this, some sample of different species of fish were taken, weighed and calculated. This shows that the ponds can still produce fish at an expected rate of 3.75 ton/ha (Table.7).

Fish Species	Respondents					Average
	1	2	3	4	5	
1. Carps	44.80	109.00	52.10	119.70	51.20	75.36
Common	18.40	35.00	20.50	67.20	15.00	31.22
Silver	-	-	-	-	-	-
Rohu	13.70	56.00	14.40	52.50	18.00	30.92
Naini	5.10	8.00	15.00	-	-	5.62
Grasscarp	7.60	10.00	2.20	-	18.20	7.60
2. Local	24.00	24.00	32.00	-	40.00	24.00
3. Total Biomass (kg)	68.80	133.00	84.10	119.70	91.20	99.36
4. Pond Area (m2)	200.00	300.00	224.00	297.00	297.00	263.60
5. Projected productivity (t/ha)	3.44	4.43	3.75	4.03	3.07	3.75

Table.7: Current Biomass & Expected Productivity

MORTALITY RATE

The overall mortality rate of the fingerlings was found to be 7.09% with 6.5% (Table.8) after keeping in the pond and 0.59% during transportation. In some cases, there was unexpected mass killing after one month of stocking. The reason was not known properly.

Mortality	Respondents						Av. Mortality Rate
	1	2	3	4	5	Total	
Total # of fingerlings in the pond	2,000.00	3,000.00	3,850.00	2,800.00	4,000.00	15,650.00	
Total # of died fingerlings	60.00	-	18.00	21.00	1,010.00	1,109.00	7.09
On the way	60.00	-	2.00	20.00	10.00	92.00	0.59
After keeping in pond	-	-	16.00	1.00	1,000.00	1,017.00	6.50
Mortality rate	3.00	-	0.47	0.75	25.25	7.09	

Table.8: Mortality rate

MAJOR PROBLEMS OBSERVED BY RESPONDENTS

Different individuals show the responses over the problems in fish farming differently. From the Table.9 below indicates that over the many facets of problems they have ranked, lack of proper knowledge in fish farming leads as highest rank followed by high feed cost as priority-1 problem.

Major problems	Respondents				
	1	2	3	4	5
Mass mortality	1				
Different diseases appeared but not known	1				
Lack of proper knowledge in fish farming	2	1	1	1	2
High feed cost	3	1		1	
Pollution doubt from associated stream	3				
Losses of fish from ponds but reason unknown			1		
Not good growth observed			2		
Feed unavaialble locally			2		2
Frequant death of fish					1
Red water					1
Note: 1 = Major problems; 2= Second major problem & 3= Third major problem					

Table.9: Responses over the problems in fish farming

DECISION ON SELECTION OF FISHERY AS ENTERPRISE

From the Table.10 it's observed that almost 80% of the respondents have made decision in fish farming making consultation with their family members and similar level of respondents have committed for its future expansion. There is a good cooperation among family members in managing fishery enterprises and help in preparing feeds, feeding and marketing.

Responses	Respondents				
	1	2	3	4	5
Who made this decision ?					
I made this decision	-	-	-	yes	-
In consultation with family members	Yes	yes	yes	-	yes
Acceptance of family members	Yes	Yes	Yes	Yes	Yes
Future plan of expansion	I will expand it	I will expand it	I will expand it	I will expand it	I keep it constant

Table.10: Decision making matrix in selection of projects and commitment for future expansion

DISEASES OBSERVED

Farmers reported that there are some occurrences of diseases, exactly not known, but affected by some types of wounds observed in dorsal part of the body. No outbreak of this disease was observed and was confined only to Naini mainly.

RESPONSES OVER THE SERVICES

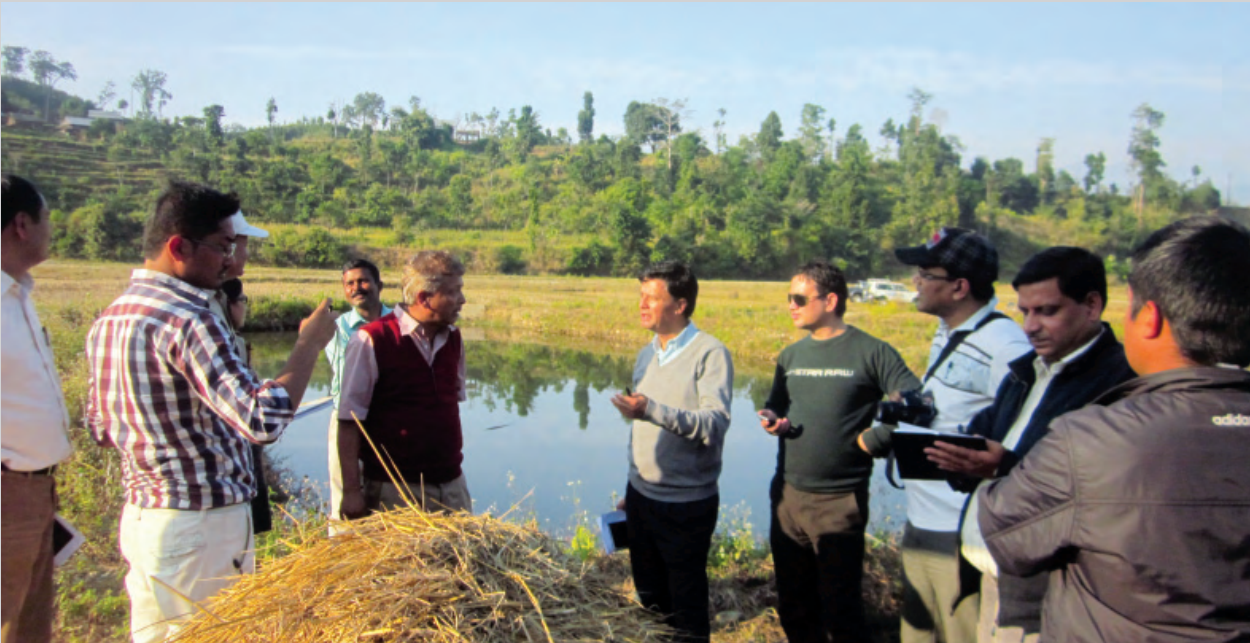
MDI had provided little support on construction of fishery ponds, training & other advisory services. In response to these services 40% respondents observed as 'Enough', 40% observed as 'Not enough' and 20% ranked as 'Fair'. While 60% respondents ranked the quality of services as 'Excellent' and 40% ranked as 'Satisfactory' (Table.11).

Responses	Respondents				
Support provided from MDI in pond construction, training & in other advisor services	1	2	3	4	5
Was that enough ?					
Enough (E)			E	E	
Not enough (NE)	NE				NE
Fair (F)		F			
How do you rank the services provided from MDI in fishery project					
Excellent service (E)	E		E	E	
Satisfactory (S)		S		S	
Not satisfatory (NS)					

Table.11: responses over the services

CONCLUSION & RECOMMENDATIONS

In overall the carp-SIS project is found to be able to address food and nutrition level of participating households through increased cash income by sales of carp and by increased intake of SIS in nutrition support to the family members. However, it requires adequate attention to provide technical know how on Carp-SIS further to meet the technical standards and improve productivity.



ABOUT MDI NEPAL

MDI-Nepal which stands for Manahari Development Institute-Nepal (MDI-Nepal) is a well established NGO in Nepal. The organization was established in September 19, 2001 with contemporary groups of professional staffs working in different NGO sectors.

Registered in district administration office of Makawanpur (Regd. No. 744/057/58) and affiliated with Social Welfare Council (SWC 13918), Kathmandu, MDI-Nepal has proven its strength to improve the livelihoods of rural poor primarily through interventions in agricultural and water sectors. The organization is steered by 9 Board Members of whom four are women.

GOAL

The main goal of the organization is to empower poor communities in rural areas to undertake development activities at their own initiatives, with the aim of enhancing their livelihoods on a sustained basis through food and income security.

VISION

MDI believes that poor, given some outside support can create capital and use it efficiently to improve their quality of life and achieve self-reliance. Land and labor being the primary asset of poor, sustainable agriculture development should be the core intervention for their improvement in food security and income.

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