India produces nearly two million tonnes of carps a year. The prevalent carp farming systems mainly use farm-mixed feeds containing 2-3 ingredients. Intensification of carp culture will require establishment of a feed industry to produce nutritionally balanced, floating feeds. Demonstrations conducted by ASA-IM show that such feeds are profitable to use in Indian carp farming. One demonstration in 2005 showed that rohu carps fed with floating feeds grew faster and produced greater fish yield at higher feed conversion efficiency than carps fed with the traditional farm-mixed feed. The Indian feed manufacturing industry is already warming to the possibility of producing aqua feeds for the carp farming sector.

Establishing Feed-based Carp Culture in India

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Background

India is the second-largest aquaculture producer in the world. Like the largest producer, China, India's aquaculture is dominated by carp production: about 80% of India's aquaculture production is composed of carps of Indian and Chinese origin. Most carp production occurs in extensive, polyculture systems throughout India. But, in the last 20 years, carp production has intensified in several parts of India. The traditional polyculture has given way to the dominance of one or two species: catla and rohu. These fishes fetch high market prices. Typical pond yields range from three to eight tonnes per hectare per year. The ponds are fertilized, but not aerated. Farm-mixed feed comprising of rice bran and a plant protein source such as peanut oil cake or cottonseed oil cake is given to the fish. As farming operations have intensified, the limitations of farm-mixed feeds have become more apparent. Procuring and storing larger lots of raw materials, and preparing and administering larger quantities of feeds, stretch the logistic capabilities of farmers. More importantly, much of farm-mixed feeds is not eaten by the fish and only fertilizes the pond. Excess organic loading pollutes pond bottom and causes a wide variety of production problems. The profitability and long-term sustainability of intensive carp farming are threatened by continuing the existing feed use practices.

Traditional fish feed prepared out of 2-3, low-nutrient agricultural byproducts

ASA-IM developed extruded floating fish feed containing 50% soybean meal

Several years ago, Chinese carp farmers fertilized and fed their culture systems the same way Indian carp farmers do now. Through field trials and demonstrations, the ASA-IM aquaculture program in China demonstrated that intensive carp farming can be sustained through the use of manufactured feeds. Soybean meal was used as the primary protein source in the feeds. The ASA-IM China aquaculture program worked closely by involving the stakeholders in carp farming, mainly government agencies (such as the Chinese extension service), feedmills, private farmers and farming groups to demonstrate the utility of sustainable, feed-based production systems and the positive uses of soy. Experts selected by ASA-IM provided technical support in the form of seminars and field visits to the farmers and feedmills to encourage sustainable aquaculture and the use of soy products in aquaculture.

Drawing inspiration and expertise from the Chinese experience, the ASA-IM through the Soy-In-Aquaculture (SIA) project has worked for the past four years in India to test the feasibility of using soy-optimized, extruded floating fish feeds for India's carp culture sector. This paper presents the lessons learned thus far.

Table 1: Farm management methods used in 2005 demonstration

	Traditional Practice Method	ASA-IM Method
Species & Stocking density (Number/Pond)	Rohu 311 Catla 125 Mrigal 187 Total 623	Rohu 1300
Feed	Mix of rice bran, ground corn and peanut oil cake at a Ratio of 2:1:1	Extruded floating feed, 32% crude protein, 6% crude fat
Feeding	In perforated bags; 1 time per day; as much as the fish would eat	Satiation feeding, 3 times per day
Target fish weight	Rohu 500 g Catla 800 g Mrigal 500 g	Rohu 500 g
Target fish yield (kg/ha)	3490	6500

Overview of ASA-IM approach

Based on the experience of ASA-IM in China, it was decided that promoting a feed-based system for intensive carp production in India would involve both education and actual demonstrations of the technology on a practical level. This required identification of farmers and feedmill cooperators. The feedmills were then provided with the technical expertise to produce extruded, soy-optimized feeds. The farmers were trained to practice feed-based production protocols and collect data. Profitability was used as the primary criterion for evaluating the economic feasibility of the new technology.

In 2003, we evaluated the feed acceptance and behavior of the two target species: rohu (*Labeo rohita*) and catla (*Catla catla*), and decided to conduct commercial demonstrations with rohu, as it appeared to be a better feed taking species and has a good market acceptance throughout India. In 2004 and 2005, we conducted full-fledged commercial demonstrations to show feedmills and farmers that soy-based extruded floating fish feeds perform well when used correctly. Results were disseminated by conducting frequent extension programs, seminars, on-farm consultations and by rendering services for business development activities for feed companies.

Table 2: Formula of the ASA 32/6, soymeal-based feed used in the 2005 ASA-IM SIA Rohu Carp Comparative Demonstration Project at Arvind Farm, Thirumaniari, Tiruvaroor District, Tamil Nadu, India. The feed was fed in 3-mm and 4-mm pellet sizes.

Ingredient	% Inclusion Rate
Soybean meal, 47.5%[1]	50.00
Wheat, Feed flour, 11.7%	26.40
Corn gluten meal 60%	6.00
Rice bran, 15%	5.00
Wheat midds, 15%	4.00
Fish oil, Unspecified	3.50
Calcium phosphate, Mono	2.30
Blood meal, Ring-dried, 93%	1.00
Soy lecithin	1.00
Vitamin premix	0.50
Mineral premix	0.25
Stay C 35%	0.03
Ethoxyquin - 100%	0.02
Total	100.00

[1]The numbers in % following each ingredient, except Stay C and Ethoxyquin, indicate the crude protein specified for the given ingredient. Stay C is ascorbic acid polyphosphate manufactured by DSM and the % indicates the active level of ascorbic acid in the product. Ethoxyquin is an antioxidant and the % indicates purity of the antioxidant.

Details of demonstrations

Two commercial, demonstrations were conducted in 2004 and 2005 to evaluate the performance of carps fed with a soy-optimized fish feed. The demonstrations were conducted in Tamil Nadu, a south Indian State. The details of methods and results of one the trials in 2005 are as following:

Methods

Six, 0.1-ha earthen ponds were used for the demonstration. Three ponds were managed the way the farmer traditionally used to do. This method was designated as traditional practice (TP) method. The other three ponds were managed based on ASA-IM method. Table 1 shows the details of the two methods.

The farm mixed feed for TP method was prepared by soaking the peanut oil cake (locally called as groundnut extract) in water for two hours and adding rice bran and ground corn to it to make a doughy paste. This paste was then added to perforated feedbags, which were

Audience at an aquaculture technical seminar

Table 3: Vitamin and mineral premix formulas used in the ASA 32/6 soybean meal-based feeds for the 2005 ASA-IM SIA Rohu Carp Comparative Demonstration Project at Arvind Farm, Thirumaniari, Tiruvaroor District, Tamil Nadu, India. .

Vitamin Premix PMX-F2[1]

Nutrient	Unit	As fed
Vitamin A	IU/kg	1200000
Vitamin D3	IU/kg	200000
Vitamin E	IU/kg	20000
Biotin	mg/kg	40
Folic acid	mg/kg	1800
Niacin	mg/kg	40000
Pantothenate	mg/kg	20000
Pyridoxine (B6)	mg/kg	5000
Riboflavin (B2)	mg/kg	8000
Thiamin (B1)	mg/kg	8000
Vitamin B12	mcg/kg	2000
Ethoxyquin	mg/kg	500

Mineral Premix PMX-F1[1]

Nutrient	Unit	As fed
Iron	ppm	40000
Manganese	ppm	10000
Copper	ppm	4000
Zinc	ppm	40000
Iodine	ppm	1800
Cobalt	ppm	20
Selenium	ppm	200

[1] Premix ingredient quantities are per kg of premix.

Farm consultations and field support being rendered by ASA-IM staff

Figure 1: Growth of rohu carp grown in earthen ponds using feed-based (ASA-IM) and manure/ingredient-based (TP) production methods during a 179-day culture period in 2005

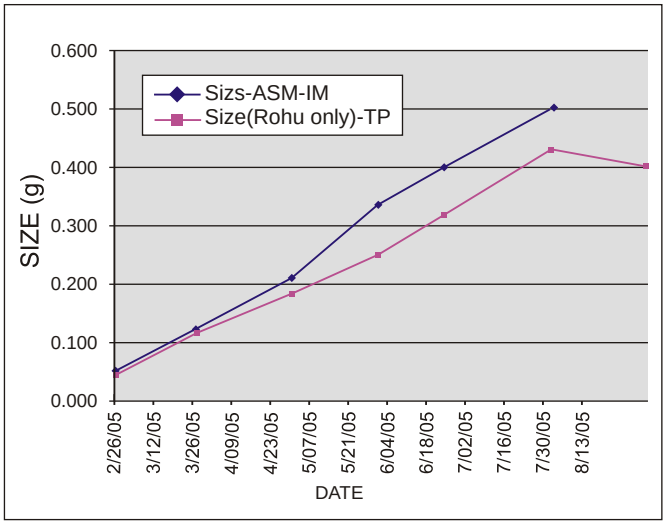


Figure 2: Biomass of rohu carp grown in earthen ponds using feed-based (ASA-IM) and manure/ingredient-based (TP) production methods during a 179-day culture period in 2005

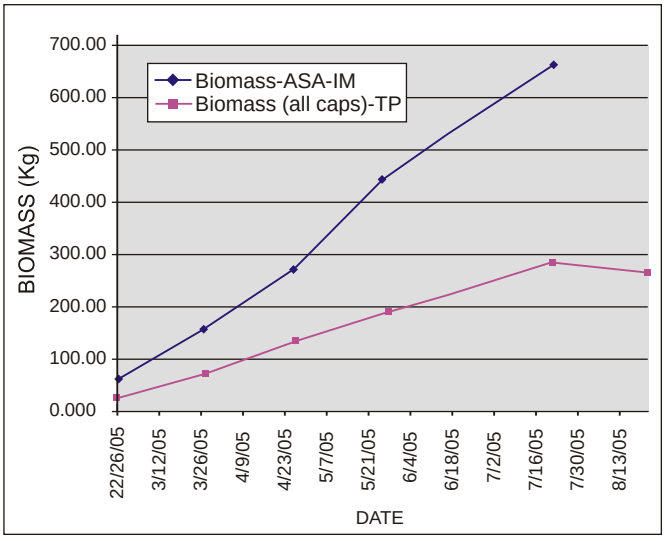
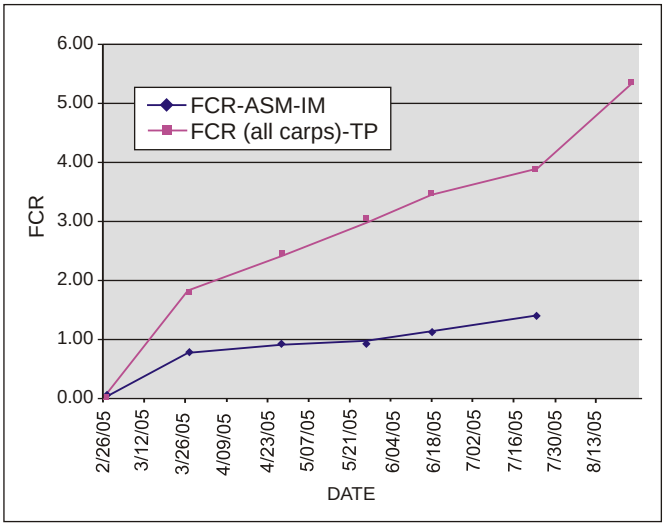


Figure 3: Feed conversion ratio of rohu carp grown in earthen ponds using feed-based (ASA-IM) and manure/ingredient-based (TP) production methods during a 179-day culture period in 2005



suspended in the pond from bamboo stakes. Feed amount was determined from consumption (30-60 minutes, or until the feed bag floated). Feed levels were modified on a weekly basis. Feed was provided once per day. At the time of stocking four bags were used per pond, and by the end of culture, the number of bags increased to 15.

The feeds for ASA-IM method were formulated to optimize soybean meal use, and contained 50% soybean meal as a percentage of total feed ingredients (See Tables 2-3 for formulas). The feed was produced by a feed mill in South India.

Feeding was recorded by the farmer on a daily basis and fish were sampled on a monthly basis under the supervision of the ASA-IM staff.

Table 4: Fish production achieved in 2005 demonstration

	Traditional Practice Method	ASA-IM Method
Date of stocking	26 February 2005	26 February 2005
Date of harvest	24 August 2005	24 July 2005
Number of days of culture	179	147
Initial weight of rohu (g)	43	47
Final weight of rohu (g)	401	494
Estimated survival of rohu (%)	95	100
Total harvest weight (kg/ha)	2634	6483
Feed conversion ratio	5.29	1.34
Average return on investment (%)	-28	13

ASA-IM staff disseminating results to feed manufacturers and government officials

SIA in SEA

In addition to the efforts in India, the ASA-IM has been working on demonstration projects in SEA, in the nations of Indonesia, the Philippines and Vietnam specifically. Aside from carp, the SIA project has been working with tilapia, milkfish and red drum in both pond and cage demonstration projects. Results and commentary can be found on the Soy-In-Aquaculture website www.soyaqua.org. As in India, the ASA-IM understands that the best way to promote better production systems and the benefits of soy in aquafeeds does not only involve education and seminars, but by actually going to the field to work on demonstrations with real feedmills and farmers. As in China, where the ASA-IM continues to work after more than 15 years, the aquaculture activities in SEA and the ASC are expected to continue long term.

Results

Table 4 presents a summary of the 2005 demonstration results. It is clear from the data that the feed-based ASA-IM method results in consistently faster fish growth (Figure 1), higher fish yield (Figure 2), better feed conversion (Figure 3) and better economic returns than the traditional practice of feeding fish with a farm-mixed feed. Though the desired target for rohu in the TP method was an average of 500 g, water quality deterioration and consequent risk of high mortality from low dissolved oxygen syndrome (LODOS) stress led to harvest at about 400g average size. Though stocking density in the ASA-IM ponds was slightly more than twice that of the traditionally managed ponds, the ASA-IM ponds were able to support the higher biomass and produced 6.5 tons of fish/ha in less than 150 days. The average economic return in the demonstration was based on a set average farm gate price of 45 INR/kg (~ US$ 1/kg). The negative return on investment in the TP method appears to be due to low production output

Rohu carp grown on soy-based extruded floating fish feed. Rohu is a popular species among the Indian major carps.

Bad pond bottom condition in TP ponds after harvest due to organic load build up.

A relatively clean, healthy pond bottom in ASA-IM ponds after harvest. This is due to minimal wastage of feed and non-usage of manures.

against significant input costs. Probably farmers in the area are farming many different animals and row crops concurrently that without keeping accurate records of input and output costs for each activity the farmers are not fully account for all costs associated with fish production.

What the ASA-IM demonstration did show to the farmers was the ability to predictably produce a high target biomass with no disease or water quality issues and to return a positive profit. Other advantages included healthy pond bottoms without significant organic load, ease of operation with reduced labor, reduction in grow-out period and marketing benefits owing to uniform sized fish.

Market response

Positive response by markets is an indication of technology acceptance. The first signs in the acceptance of the use of complete, extruded feeds in carp culture sector have appeared in India:

1) Two large commercial animal feed manufacturing companies and two smaller feed companies have started manufacturing and marketing extruded floating fish feeds.
2) A number of other feed mills and private entrepreneurs have indicated their interest in carp feed market and some are viewing the fish feed segment as an avenue of diversification within the animal feed industry. Some multi-national feed mills with operations in India have imported test consignments of fish feed from their parent manufacturing bases to test market it in India.
3) Farmers who have been taught feed based fish farming through demonstrations and seminars have accepted the new technology and have started using formulated fish feed. One farmer, after cooperating on a demonstration project, went on to become a feed distributor and promoter of feed-based aquaculture systems. The responses from the farmers highlight the profitability, with positive comments regarding the productivity of the system, the reduction in grow-out time, the ease of operation, the lack of diseases typically seen in traditional systems, the high water quality maintained and production of safe food.

The challenges ahead include feed cost management which needs to be achieved through optimization of feed ingredients, and increasing farm gate price of fish though efficient post-harvest preservation and marketing techniques. Also species diversification to include higher value fish in farming will pave way for widespread feed-based farming and bring better returns to the farmer. ■

ASA-IM consultants advising feed manufacturers on feed processing requirements

Dr P.E. Vijay Anand heads India's animal feed program for ASA-International Marketing/United States Soybean Export Council (USSEC) as Technical Director-Poultry, Livestock, and Aquaculture. He received his professional education in animal and fisheries sciences from the University of Agricultural Sciences, Bangalore, India. Over the past 14 years Vijay has held managerial positions with leading aquaculture and livestock feed companies in India. He has been associated with ASA-IM since 2000 as a resource person, then as Technical Manager-Aquaculture since 2003.

Mr Lukas Manomaitis is a consultant to the worldwide aquaculture and seafood industries through his company Seafood Consulting Associates, which is based out of Bangkok since 2001. He received his BS from Carnegie Mellon University (Pittsburgh, USA) and MS from Auburn University (Auburn, USA). Prior to working as a consultant in Asia he worked in the USA at Auburn University in Auburn and Gulf Shores. He also served as an Aquaculture Extension Agent with the U.S. Peace Corps and Ministry of Agriculture, Fisheries and Forestry in the Fijian Islands from 1995-1998. Since late 2002 one of his major clients has been the American Soybean Association International Marketing Program Soy-in-Aquaculture Project where he serves as their regional technical director for India, Indonesia, the Philippines and Vietnam.

Mr G. Ramesh is presently working as Technical Manager - Aquaculture in ASA-IM, India. He has completed his Masters degree in Coastal Aquaculture from Center of Advanced Study in Marine Biology, Annamalai University, Tamil Nadu, India. He has more than 11 years of experience in shrimp and fish farm management and disease management. His present responsibility in ASA-IM is to popularize soy-incorporated, floating feed based fish farming in India.