

Growth Performance of Rohu Carp in Ponds Using the ASA Feed-Based Technology with Soy-Maximized Feed Compared to the India National Package Methodology

Results of ASA/Soy-in-Aquaculture 2004 Feeding Trial

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ABSTRACT

A feeding demonstration was conducted at Thirumaniari, Tiruvaroor District, Tamil Nadu, India to compare the growth of rohu carp (*Labeo rohita*) grown using two different production and feeding methodologies in six 0.11-ha earthen ponds. Rohu carp of size 16 g were stocked in three ponds at 1,430 fish per pond and cultured using the ASA feed-based technology with soy-maximized, extruded feed. In the other three ponds, 12-g rohu (*Labeo rohita*), 12-g catla (*Catla catla*), and 24-g mrigal (*Cirrihinus mrigala*) carp were stocked at 330, 132 and 198 fish per pond, respectively, and cultured using the traditional India National Package (NP) methodology. The NP methodology uses low density culture with nutrient addition through animal manure and low quality supplemental feeds. Rohu carp cultured using the feed-based ASA technology grew from 16 g to 477 g in 221 days and yielded an average of 6,721 kg/ha. Rohu carp cultured using the NP methodology grew from 12 g to 404 g in 264 days. Total combined yield for rohu, catla and mrigal carps from the NP ponds averaged 2,160 kg/ha. Fish grown with the ASA technology and feed yielded significantly better weight gain, health, production, FCR and economic return than fish cultured using the NP methodology. Taste tests found no discernable difference in the taste of fish produced using either culture method.

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INTRODUCTION

The American Soybean Association (ASA), under the Soy-in-Aquaculture Program and in cooperation with Arvind Farm at Thirumaniari, Tiruvaroor District, Tamil Nadu, India, conducted a 264-day comparison feeding demonstration with Indian carps in earthen ponds. The objectives of the project were to demonstrate the feasibility of culturing rohu carp using the ASA feed-based production methodology with extruded, soy-maximized aquafeeds and to compare this culture methodology to the Government of India's manure and ingredient-based National Package (NP) method used in the area.

MATERIALS AND METHODS

Six, 0.11-ha earthen ponds at Arvind Farm at Thirumaniari, Tiruvaroor District, Tamil Nadu, India, were used for the demonstration. All ponds were dried prior to use and the bottom organic layers scraped away and removed prior to filling. Each pond was filled using borehole water. Preparation for the three ponds using the ASA methodology was conducted according to the ASA 80:20 Manual "Principles and Practices of 80:20 Pond Fish Farming". The other three ponds were prepared according to a mutually agreed protocol based on the NP methodology currently used in the area.

Rohu carp fingerlings of size 12-16 g were produced on site by Arvind Farm, which is primarily a hatchery and fingerling producer. Rohu carp were stocked in the three ASA methodology ponds at a density of 1,430 fish per pond. Three species of carp were stocked into the NP ponds. Rohu, catla and mrigal carp fingerlings were stocked in the three NP ponds at densities of 330, 132 and 198 fish per pond, respectively. Fish in all six ponds were obtained from the same production group and were of uniform age at stocking. Production targets were 500 g per fish, or 6,500 kg/ha, for rohu carp in the ASA methodology ponds, and 800 g for catla and 500 g for rohu and mrigal carp, for a combined yield of 3,400 kg/ha, for the NP methodology ponds.

Rohu carp in three ponds using the ASA methodology were fed 2-3 times daily with an extruded, floating, pelleted feed formulated to contain 36% crude protein and 7% crude lipid (36/7) for fish under 50 g average size (Tables 1 and 3). A second feed formulated to contain 32% crude protein and 6% crude lipid (32/6) was fed to fish \geq 50 g average size (Tables 2 and 3). These feeds were formulated by ASA to maximize soybean meal use, and contained either 46% (36/7) or 53% (32/6) dehulled soybean meal as a percentage of total feed ingredients. These feeds were produced domestically in India by Taiyo Feedmill in Chennai, India. These three ponds were treated as replicates of a single feed treatment, with fish in all ponds fed identically at each feeding using the ASA satiation feeding technique.

Ponds using the NP methodology were fed using a supplemental feed mix used in the area. This was a combination mix of Rice Bran (RB), Maize Powder (MP) and Ground Nut Extract (GNE) at a ratio of 2:1:1. This was prepared by soaking the GNE in water for two hours and the other ingredients added to make a doughy paste. This paste was then added to perforated feed bags which were suspended in the pond from bamboo stakes (initially four but by the end of culture

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15 bags). Feed amount was determined from consumption (30-60 minutes, or until the feed bag floats). Feed levels were modified on a weekly basis. Feed was provided once per day.

Pond management was based on the ASA 80:20 pond production model or the NP methodology. The NP Methodology is used in many regions of India, varying slightly in the techniques applied and the species used. However, in all parts of India, this is a multiple species, manure based system, often using low quality supplemental feeds. Harvest size under this methodology is expected to be reached in about a six month period.

In order to have a valid comparison to the ASA feed-based system, the following modifications of the NP methodology were agreed to:

1. Mortalities in the first week would be replaced.
2. Monthly sampling of the ponds would be performed, preferably with a single seining event. Fish captured were counted and weighed by species.
3. Equal treatment was to be given to the ponds in terms of total feed and fertilizer provided to the ponds.
4. Once the target species, rohu, reached an average of 500g, all three NP ponds would be completely drained and harvested.
5. Complete records were to be kept of all inputs and outputs of the ponds.

The following protocols were agreed to as what an average farmer would be expected to do under the NP methodology:

- Increase water depth over the course of the demonstration with a final water depth of 1.5m maintained
- Exchange water as necessary to maintain proper water quality (i.e. water is exchanged when fish are showing signs of oxygen stress). Time and cost of water exchange to be recorded.
- Fertilization: based on using cow manure, an initial amount of 300kg was added to the ponds, with about 150kg added on a monthly basis. The amount of feed/manure provided to the fish by weight was recorded on the date of application.
- Chemicals:
 - Lime: An initial amount of 40kg of hydrated lime was added to each pond. In accordance to local practice, when fish are in distress, 5-10kg (per pond) could be added to help relieve the conditions if needed
 - Clinar and Butex: These pesticides are used to control fish lice and are normally applied by the fish farmer. The amount added was 25ml/pond at a one time application if fish lice are thought to be a problem.
- Harvest: Catla carp were harvested when the average size reached about 800g through selective seining.

Fish in all ponds were sampled once per month on about the same date each month. At the conclusion of the demonstration, all ponds were completely harvested and all fish enumerated

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and weighed. Results were used to determine fish survival, average fish weight, gross fish production and feed conversion ratio (FCR).

All expenses related to the pond and pond management were recorded by the farmer. At the conclusion of the project the ASA team and the farmer used this information to create a financial analysis of the pond project.

Description of Sensory (Taste) Tests

In order to test if there was a difference in taste between the rohu produced under the two methodologies, taste tests were carried out at Arvind farm under the supervision of experts in food science. Two live rohu carp were taken from each pond and were washed thoroughly with potable water and filleted. The external features of harvested fishes like eyes, gills, and appearance were recorded. The fillets were steam cooked for 15 minutes and subjected to sensory evaluation by team of eight panelists. The samples were appropriately coded to conceal the nature of sample. The origin of the carp was known to only the staff preparing the fish and identification for panelists was given by randomly assigned number/letter groups. Totally there were six batches of fish samples, three from ASA feed fed pond and three from conventional feed fed pond.

A taste test panel was formed of the owners of Arvind farm, their workers and other fish farmers. The panelists were regular fish eaters and were explained in detail regarding the tests to evaluate. Descriptive hedonic scaling method of 1-9, as described by Raju et al, (2003) was followed.

The descriptions of the Hedonic Scale scores are as follows:

9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

An overall acceptability score of 5 is defined as the limit of acceptance. The panelists were asked to assess the acceptability of the attributes like color, taste, odor, texture, flavor and overall acceptability of a given product under given set of conditions. The responses from the panelists were collected and subjected for statistical analysis. The raw data was subjected for Two-way analysis of variance to test whether any significant difference between two groups of fishes occurred. The two-way ANOVA was carried out as described by Snedecor and Cochran (1962).

RESULTS

Rohu carp in the ASA methodology ponds were fed an average of 219 days between 18 March and 25 October 2004. Rohu grew from an average of 16 g to 477 g in this period and yielded an average production of 6,721 kg/ha for the three ponds (Figure 1; Figure 2; Table 4). Rohu carp in the NP methodology ponds grew from an average 12 g to 404 g in 263-264 days (Figure 1; Table 4). Combined production of rohu, catla and mrigal carps in the three NP ponds averaged 2,160 kg/ha (Figure 2). Respective survival rates were 108% and 99% for rohu carp in the ASA and NP ponds. Average FCR for rohu carp in the ASA methodology ponds was 1.45:1, and 4.58:1 for the combined carp in the NP methodology ponds (Figure 3; Table 3).

No significant difference in taste were found between the fish produced in the two methodologies.

Average economic return for both treatments was negative, but was significantly poorer for the NP ponds. Average return on investment (ROI) for the NP ponds was -35.7%, while average ROI for the ASA ponds was -2.7% (Tables 5-8).

SUMMARY AND CONCLUSIONS

Results of this feeding demonstration indicate that there is significant opportunity for the India aquaculture industry to boost productivity and improve economic efficiency in existing aquaculture systems by adopting feed-based production strategies. Rohu carp production in this demonstration was more than three times the combined production of rohu, catla and mrigal carps using the NP technology. In addition, significantly less labor and time was required to culture rohu using the ASA technology, and rohu grew to a larger size in less time and at a significantly higher density without water quality or disease problems. These production advantages were obtained with an all-plant protein feed that utilizes renewable soy protein as the primary feed ingredient.

Further improvements to fish growth and economic return can be achieved by adopting feed-based production strategies for all life stages of rohu carp. Providing high quality feeds to broodstock will increase egg production, egg and fry quality and survival, and healthier fish. Use of high quality manufactured feeds for fry and fingerling stages will yield faster growing fish with better and more aggressive feed taking behavior. In support of this strategy, ASA will conduct follow-on studies to demonstrate the advantages of feed-based production at all life stages for rohu carp. ASA encourages both the Government of India and the private sector to evaluate and promote the adoption of feed-based technologies as a means to optimize productivity with scarce water resources and to provide high quality, healthy products for Indian consumers. Adoption of feed-based technologies will also allow diversification of production species that would provide consumers accessibility to a wider range of good-health aquaculture products for an increasingly health-conscious nation.

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CITATIONS

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ACKNOWLEDGEMENTS

The ASA Soy-in-Aquaculture Program gratefully acknowledges the local ASA India office for their help and support of this demonstration project.

Growth Curves for Rohu Carp in Earthen Ponds Using the ASA and NP Methodologies

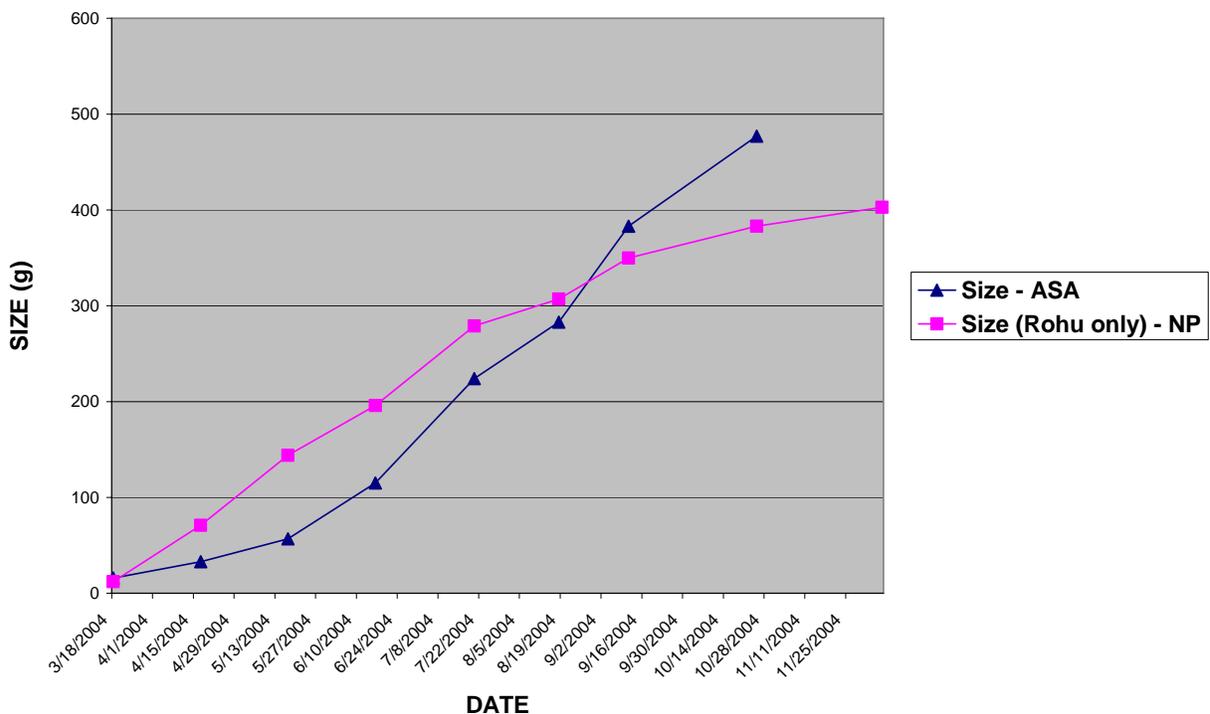


FIGURE 1. Growth curves for rohu carp grown in earthen ponds using feed-based (ASA) and manure/ingredient-based (NP) production methodologies during a 264-day culture period in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm at Thirumaniari, Tiruvaroor District, Tamil Nadu, India. Rohu carp grew from 16 g to 477 g in 221 days using the ASA methodology, and from 12 g to 403 g in 264 days using the NP methodology.

**Biomass Curves for Rohu Carp In Earthen Ponds
Using the ASA and NP Methodologies**

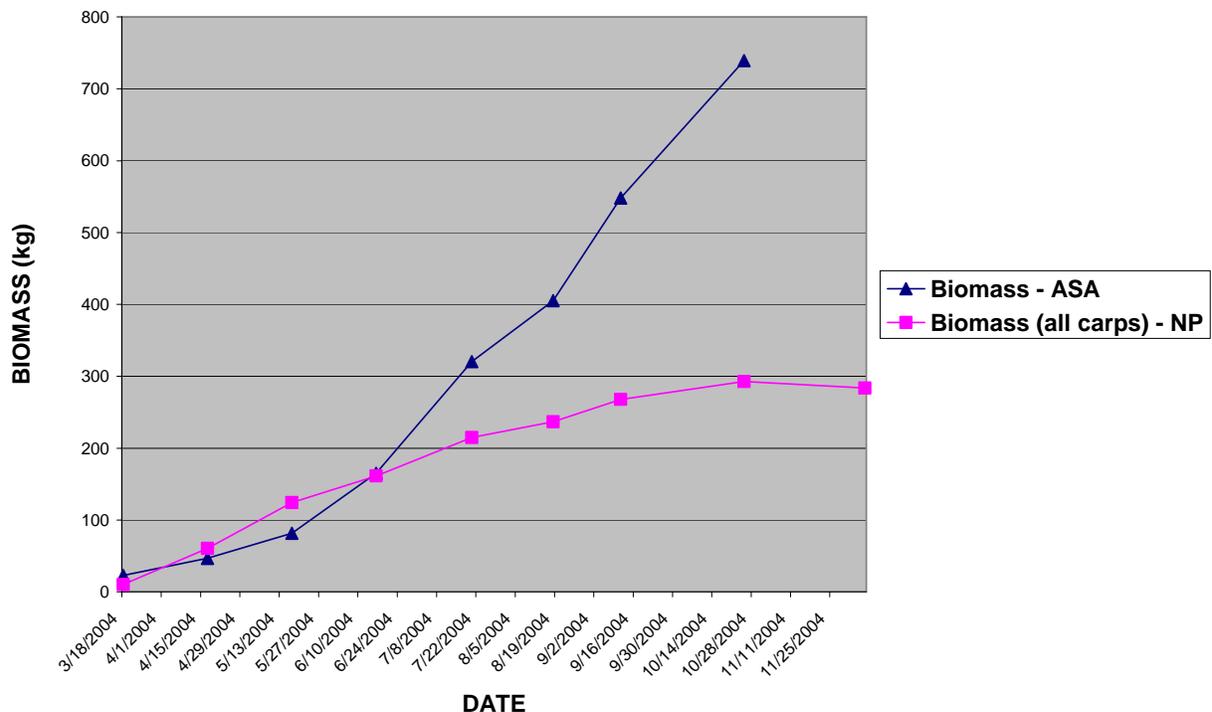


FIGURE 2. Fish biomass curves for rohu carp grown in earthen ponds using feed-based (ASA) and manure/ingredient-based (NP) methodologies during a 264-day culture period in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm at Thirumaniari, Tiruvaroor District, Tamil Nadu, India. Average fish biomass at harvest was 739 kg/pond (6,721 kg/ha) for rohu in the ASA ponds, and 238 kg/pond (2,160 kg/ha) for rohu, catla and mrigal carps combined in the NP ponds.

FCR Curves for Rohu Carp In Earthen Ponds Using the ASA and NP Methodologies

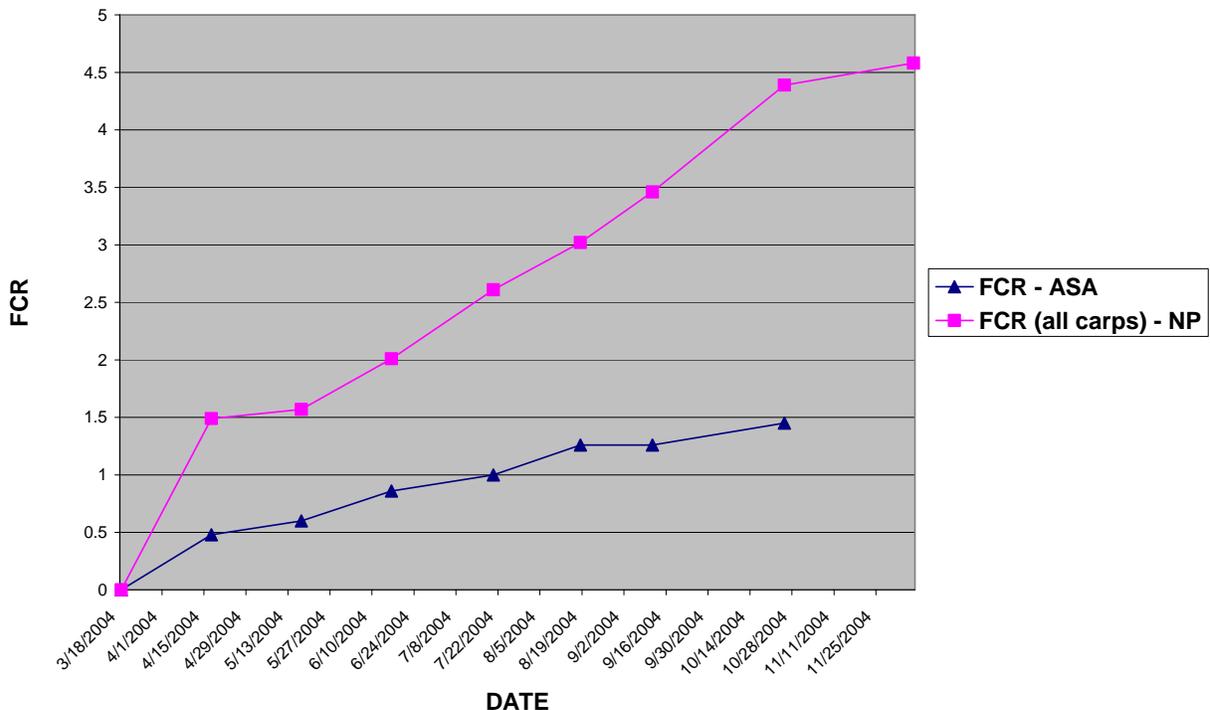


FIGURE 3. FCR curves for rohu carp grown in earthen ponds using feed-based (ASA) and manure/ingredient-based (NP) production methodologies during a 264-day culture period in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm at Thirumaniari, Tiruvaroor District, Tamil Nadu, India. Average FCR for rohu in the ASA ponds was 1.45:1. Average combined FCR for rohu, catla and mrigal carps in the NP ponds was 4.58:1.

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TABLE 1. Formula provided to Taiyo Feedmill for the ASA 36/7, soymeal-based feed used in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm, Thirumaniari, Tiruvaroor District, Tamil Nadu, India. The feed was fed in 2-mm size.

36/7¹ Fingerling Feed*

2004 India Rohu Carp Feeding Demonstrations

Ingredient	% Inclusion Rate
U.S. Soybean Meal 47.5%	46.00
Wheat, SWW	19.00
Corn Gluten Meal 60%	10.00
Wheat midds 16.5%	8.00
Fishmeal 65/10	8.00
Fish oil	4.00
Calcium Phosphate mono	2.20
Lecithin	1.75
Vit PMX F-2	0.75
Min PMX F-1	0.25
Stay C 35%	0.03
Ethoxyquin 100%	0.02
TOTAL	100.00

*For fingerling fish weighing between 2 grams and 50 grams

¹The numerical component of the feed description refers to the percentage of protein and fat, respectively, in the ration, i.e. 36/7 indicates 36% crude protein and 7% crude fat.

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TABLE 2. Formula provided to Taiyo Feedmill for the ASA 32/6, soymeal-based feed used in the 2004 ASA 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.

32/6¹ Growout feed* **2004 India Rohu Carp Feeding Demonstrations**

Ingredient	% Inclusion Rate
SBM 47.5%	53.00
Wheat flour 10%	25.40
Rice bran 15%	8.00
CGM 60%	6.00
Soy oil	3.50
Ca-mono-P	2.30
Lecithin	1.00
Vit PMX F-2	0.50
Min PMX F-1	0.25
L-ascorbyl-polyphosphate 35%*	0.03
Ethoxyquin 100%	0.02

*For fish ≥ 50 g

¹The numerical component of the feed description refers to the percentage of protein and fat, respectively, in the ration, i.e. 32/6 indicates 32% crude protein and 6% crude fat.

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TABLE 3. Vitamin and mineral premix formulas provided to Taiyo Feedmill for the ASA 32/6 and 36/7 soymeal-based feeds used in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm, Thirumaniari, Tiruvaroor District, Tamil Nadu, India.

Vitamin Premix PMX-F2¹

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-F1¹

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

¹Premix ingredient quantities are per kg of premix.

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TABLE 4. Results of the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm Thirumaniari, Tiruvaroor District, Tamil Nadu, India that demonstrated growth performance of rohu carp using the ASA 80:20 production methodology with formulated feed with the NP methodology commonly used in the area.

Pond No.	Treatment	Stocking size (g) of rohu carp	Stocking rate (fish/pond)¹	No. days fed²	Harvest weight (g)³	Gross Production (kg/pond)⁴	Survival (%)⁵	FCR⁶
1	ASA	16	1430	218-220	463	746	113	1.43
2	ASA	16	1430	218-220	470	706	105	1.52
3	ASA	16	1430	218-220	497	766	108	1.40
	Mean	16	1430	218-220	477	739	108	1.45
1	NP	12	330/660	263-264	471	268	95/95	4.08
2	NP	12	330/660	263-264	328	234	100/94	5.32
3	NP	12	330/660	263-264	409	211	102/98	4.33
	Mean	12	330/660	263-264	403	238	99/96	4.58

¹ For NP methodology ponds, 330 rohu carp were stocked, but 660 fingerlings overall (rohu, catla, mrigal carps)

² Number of days fed varies due to harvest over several days, additionally for ASA ponds, feeding was stopped one day prior to harvest, while NP ponds still had substantial natural production until harvest

³ Harvest weight of target species only (rohu carp)

⁴ Gross production is total biomass in the ponds, including multiple stocked species (if present)

⁵ Survival for NP ponds includes two numbers, i.e. 100/94. This indicates the survival of the rohu only/all fish in the pond

⁶ FCR in the NP ponds is taking into account all harvested fish

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TABLE 5. List of Economic Factors Monitored in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm Thirumaniari, Tiruvaroor District, Tamil Nadu, India that compared growth performance of rohu carp using the ASA feed-based production methodology with the manure-ingredient-based NP methodology commonly used in the area.

<u>Item</u>	<u>ASA</u>	<u>NP</u>
Initial pond preparation	X	X
Meals for workers for pond preparation	X	X
Initial liming of ponds	X	X
Initial pumping to fill ponds	X	X
Initial labor for spreading manure		X
Initial manure (cow)		X
Fingerling cost (catla)		X
Fingerling cost (rohu)	X	X
Fingerling cost (mirgal)		X
Pumping during culture period	X	X
Labor during culture period (feed)	X	X
Labor during culture period (manure application)		X
Labor during culture period (other)		X
Chemicals (pesticides)		X
Feed (mix)		X
Feed (36/7)	X	
Feed (32/6)	X	
Manure (cow)		X
Draining at harvest	X	X
Labor during harvest	X	X

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TABLE 6. Economics of ASA Ponds in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm Thirumaniari, Tiruvaroor District, Tamil Nadu, India that compared growth performance of rohu carp using the ASA feed-based production methodology with the manure-ingredient-based NP methodology commonly used in the area.

Item	ASA POND 1	ASA POND 2	ASA POND 3
<i>Days of culture</i>	219	220	221
Initial pond preparation	1213.33	1213.33	1213.33
Meals for workers for pond preparation	208.00	208.00	208.00
Initial liming of ponds	60.00	60.00	60.00
Initial pumping to fill ponds	1113.60	1113.60	1113.60
Fingerling cost	2860.00	2860.00	2860.00
Pumping during culture period	7586.40	7586.40	7586.40
Labor during culture period	360.00	361.50	363.00
Feed (36/7)	688.40	688.40	688.40
Feed (32/6)	19001.90	19049.40	19087.40
Draining at harvest	525.00	525.00	525.00
Labor during harvest	350.00	350.00	350.00
<i>Total harvest (kg)</i>	<i>745.99</i>	<i>705.52</i>	<i>765.784</i>
<i>Price of fish/kg</i>	<i>45.00</i>	<i>45.00</i>	<i>45.00</i>
Total cost	34185.63	34235.63	34276.13
Gross Profit	33569.55	31748.40	34460.28
Net Profit	-616.08	-2487.23	184.15
ROI	-2%	-7%	1%

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TABLE 7. Economics of NP Ponds in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm Thirumaniari, Tiruvaroor District, Tamil Nadu, India that compared growth performance of rohu carp using the ASA feed-based production methodology with the manure-ingredient-based NP methodology commonly used in the area.

Item	NP Pond 1	NP Pond 2	NP Pond 3
<i>Days of culture</i>	264	264	263
Initial pond preparation	700.00	700.00	700.00
Meals for workers for pond preparation	120.00	120.00	120.00
Initial liming of ponds	60.00	60.00	60.00
Initial pumping to fill ponds	974.40	974.40	974.40
Initial labor for spreading manure	72.00	72.00	72.00
Initial Manure (cow)	90.00	90.00	90.00
Fingerling cost (catla)	660.00	660.00	660.00
Fingerling cost (rohu)	264.00	264.00	264.00
Fingerling cost (mirgal)	396.00	396.00	396.00
Pumping during culture period	6753.13	6753.13	6753.13
Labor during culture period (feed)	792.00	792.00	789.00
Labor during culture period (manure application)	12.00	12.00	12.00
Labor during culture period (other)	9.00	11.97	9.00
Pesticide	70.00	87.50	70.00
Feed (Mix)	8289.54	8289.54	8289.54
Manure (Cow)	105.00	105.00	105.00
Draining at harvest	175.00	175.00	175.00
Labor during harvest	350.00	350.00	350.00
<i>Total harvest (kg)</i>	<i>313.12</i>	<i>242.18</i>	<i>295.86</i>
<i>Price of fish/kg</i>	<i>45.00</i>	<i>45.00</i>	<i>45.00</i>
Total cost	19892.07	19912.54	19889.07
Gross Profit	14090.54	10897.88	13313.57
Net Profit	-5801.54	-9014.67	-6575.51
ROI	-29%	-45%	-33%

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TABLE 8. Economics of NP Ponds in the 2004 ASA SIA Rohu Carp Comparative Demonstration Project at Arvind Farm Thirumaniari, Tiruvaroor District, Tamil Nadu, India that compared growth performance of rohu carp using the ASA feed-based production methodology with the manure-ingredient-based NP methodology commonly used in the area.

<u>Item</u>	<u>ASA Ponds</u>	<u>NP Ponds</u>
Feed	58%	42%
Electricity (Pumping)	26%	39%
Labor	6%	10%
Other	11%	10%
Total	100%	100%
Average Net Profit	-973.06 INR	-7130.57 INR
Average ROI	-2.7%	-35.7%