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# **Performance Comparison of Three Common Carp Strains in Three Gorges Reservoir, Chongqing, China**

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## **INTRODUCTION**

A cage feeding trial was conducted jointly by the American Soybean Association International Marketing (ASA-IM) program, the Wanzhou District Fishery Extension Center in Wanzhou, Chongqing Municipality, China, and the Wanzhou Xunfeng Agricultural Development Company to compare fingerling production of three strains of common carp in the new Three Gorges Reservoir. The Three Gorges Reservoir is currently under impoundment on the Yangtze River and has reached approximately 85% of its targeted full impoundment depth of 175 meters. Full impoundment is scheduled to be reached in 2009. Efforts are underway to establish sustainable cage aquaculture technologies for local farmers living adjacent to the reservoir by the time the reservoir reaches its maximum level.

ASA-IM participated in initial cage feeding trials with common carp in the Three Gorges Reservoir in 2005 and 2006. Three potential constraints to cage production of common carp in the reservoir were identified during these initial trials: 1) water temperature in Three Gorges Reservoir was consistently below the optimal level for common carp culture; 2) periodic silt water turbidity impacted fish health and growth; and 3) inbreeding of local strain common carp reduced fish growth and feed conversion efficiency.

The 2007 trial was the first phase of a two-year trial to compare production performance of three strains of common carp to see if one or more responded better than the local common carp strain to the high silt and low water temperature conditions in Three Gorges Reservoir. The local common carp strain was used in the 2005 and 2006 ASA-IM cage trials. The local common carp strain was also compared against the Jiang common carp strain in one of the two 2006 trials.

## **LVHD CAGE CULTURE OF COMMON CARP**

ASA-IM has had good success culturing common carp with an all-plant protein, 32/6 soy-based feed in which the majority of protein is provided by soybean meal.<sup>1</sup> Fingerling to market growout trials with common carp trials in several regions of China with this feed have demonstrated rapid fish growth, good feed conversion efficiency, good fish health and body conformation, and high economic return.

ASA-IM fingerling to market cage trials conducted in Three Gorges Reservoir in 2005 and 2006 demonstrated satisfactory common carp production of 180-185 kg/m<sup>3</sup> in 4-m<sup>3</sup> LVHD cages, but common carp growth and FCR was poorer than in trial results from other regions. In the 2005 Three Gorges trial, local strain common carp grew from 346 g to 1,075 g in 139 days and 180 g to 1,092 g in 166 days, respectively, in two trials with an FCR of 2.0:1. Normal FCR for common carp with the ASA-IM 32/6 feed is  $\leq$  1.4:1. In 2006, local strain common carp grew from 336 g to an average fish weight of 1,033 g in 159 days of feeding at the Dazhou Cove site, and from 305 g to an average fish weight of 1,042 g in 172 days of feeding at the Maoertou Cove site. Jiang strain common carp grew from 243 g to an average fish weight of 1,042 g in 172 days of feeding at the Maoertou Cove trial. FCR for the local strain common carp averaged 1.99:1 at the Dazhou Cove site and 2.04:1 at the Maoertou Cove site in the 2006 trials. FCR with the Jiang strain averaged 1.89:1. Both fish growth and FCR were marginally better for the Jiang strain than the local strain common carp in the 2006 study.

## **2007 FEEDING TRIAL PROTOCOLS**

The 2007 LVHD cage trial with three strains of common carp was conducted at the Maoertou Cove farm site. This site is located near Wanzhou City in Chongqing Municipality. The trial was conducted in cooperation with Wanzhou Xunfeng Agriculture Development Company. Three strains of common carp were evaluated in the trial: 1) the local Wanzhou strain; 2) the Jiang strain from Wuxi, Jiangsu Province; and the Songpu mirror carp strain from Harbin, Heilongjiang Province.

Eight, 4-m<sup>3</sup> LVHD cages were used in the comparison feeding trial. The local and Jiang strain carp were each stocked in three cages at a density of 2,000 fish per cage (500/m<sup>3</sup>). Average sizes of the local and Jiang strain carp were 4.3 g and 3.7, respectively, at stocking. The local and Jiang strain carp were stocked in the trial cages on 23 May and 14 June 2007, respectively.

Due to delays in obtaining fish from Harbin, the Harbin strain was only stocked in two cages and at a density of 1,200 fish per cage (300/m<sup>3</sup>). The Harbin strain was stocked in cages on 11 August 2007 after culturing from an advanced fry stage to an average fish size of 27.4 g in ponds in the Wenzhou area.

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<sup>2</sup>The 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.

All fish were fed the ASA-IM 36/7 fingerling feed three times daily from stocking size to an average size of 50 g (Tables 1 and 2). At size 50 g, the fish were weaned to the ASA-IM 32/6 feed (Tables 3 and 4). Fish were fed the 32/6 feed twice daily, with fish in all cages of the same fish strain being fed identically at each feeding. The 36/7 and 32/6 feeds were least-cost formulated by ASA-IM and manufactured by Phoenix Feed Mill in Chengdu, Sichuan Province. The feeds were produced in extruded, floating pellet form.

## **FEEDING TRIAL RESULTS**

Local strain common carp grew from 4.3 g to an average fish weight of 305 g in 177 days of feeding between 24 May and 16 November 2007 (Table 5). Gross fish production averaged 290.8 kg per cage (72.7 kg/m<sup>3</sup>) in the three 4-m<sup>3</sup> LVHD cages. The average survival rate for the local strain carp was 47.8%. Common carp in each of the three local strain cages were fed 499.5 kg of feed, which yielded an average FCR of 1.77:1.

Wuxi strain Jiang common carp grew from 3.7 g to an average fish weight of 115 g in 155 days of feeding between 15 June and 16 November 2007 (Table 5). Gross fish production averaged 101.2 kg per cage (25.3 kg/m<sup>3</sup>) in the three 4-m<sup>3</sup> LVHD cages. The average survival rate for the Wuxi strain Jiang carp was 43.9%. Jiang strain carp in each of the three trial cages were fed 240.5 kg of feed, which yielded an average FCR of 2.65:1.

Harbin strain Songpu carp grew from 27.4 g to an average fish weight of 188 g in 98 days of feeding between 11 August and 16 November 2007 (Table 5). Gross fish production averaged 209.2 kg/cage (52.3 kg/m<sup>3</sup>) in the two 4-m<sup>3</sup> cages stocked at 60% of the density used in the local and Jiang strain cages. The average survival rate for the Harbin strain Songpu carp was 92.9%. Songpu carp in each of the two test cages were fed 349.6 kg of feed, which yielded an average FCR of 1.99:1.

## **SUMMARY AND CONCLUSIONS**

The 2007 trial was designed as the first phase in a systematic comparison of common carp strains to determine whether different strains from other locales in China will grow more efficiently under the environmental conditions of Three Gorges Reservoir. The 2007 trial was compromised by not being able to secure fish of the three targeted test strains that were of the same size and age, at the same time, and in sufficient quantities to conduct a performance comparison under the same conditions. Low survival of the local and Wuxi strain Jiang carp strains further compromised the results. Low fish survival appeared to be directly correlated with stocking small, 3-5 g fish. The 93% survival rate for the Harbin strain Songpu carp, which were stocked at 27 g after an interim period of pond culturing, was more than twice the survival rate for the other two strains. Results suggest that common carp should be pond cultured to a size of 25 g or larger before stocking in cages in the Three Gorges Reservoir. Small fish appear to have a more difficult time coping with the environmental conditions prevalent in the reservoir.

Feed conversion efficiency was poor for all of the test strains in this trial. Best FCR was obtained with the local strain common carp, but the low survival rate of these fish resulted in a low degree of confidence in the data.

ASA-IM recommends that the 2008 phase of the common carp strain comparison be conducted only if fish of similar size and age can be obtained at the same time for the three fish strains being compared. In addition, the fish from the three strains need to be stocked at the same density and cultured using identical protocols. The trial should only be conducted if these conditions can be adhered to.

Many of the problems associated with poor fish performance in the Three Gorges reservoir are related to environmental conditions in the reservoir. Chronic low water temperature and periodic high water turbidity caused by siltation will limit cage aquaculture opportunities. Water temperatures have consistently not reached 25°C until July. Average water temperatures have been in the range of 19.5°C in April, 22.0°C in May, and 24°C in June. Water temperatures increase to 26-27°C in July and 28-29°C in August, but decline again to 25-26°C in September. By early October the average water temperature drops to  $\pm 22^{\circ}\text{C}$ . Sub-optimal water temperatures during as much as 65% of the production season significantly impact fish growth and feed conversion efficiency. Low water temperatures and heavy silt loading appear that they will be chronic problems for cage fish producers in Three Gorges Reservoir.

## **ACKNOWLEDGEMENTS**

ASA-IM gratefully acknowledges the participation and cooperation of the Wanzhou District Fishery Extension Center and the Wanzhou Xunfeng Agriculture Development Company for their significant contributions of time, personnel and facilities to conduct the LVHD cage feeding trials detailed in this report.

Table 1. Formula for the least-cost formulated ASA-IM 36/7 feed used in the 2007 common carp comparison feeding trial in Three Gorges Reservoir, Chongqing Municipality, China. The 36/7 feed is a high protein feed typically used for growing fingerling fish from 3 g to 50 g in size.

Ingredient	Percent of total
Soybean Meal 46%	34.00
Wheat Flour 13.2%	19.80
Fish Meal 64/4	13.50
DDGS 28.5/12.8	10.00
Rice Bran 13%	8.00
Corn Gluten Meal 60.7/3.6	7.00
Fish Oil, Anchovy	2.70
Blood Meal 90/0.5	2.00
Ca Phosphate Mono 21%	1.30
Soy Oil	0.50
Vit PMX F-2	0.50
Min PMX F-1	0.25
Mold Inhibitor	0.30
Choline Chloride 60%	0.10
Stay C 35%	0.03
Ethoxyquin	0.02
TOTAL	100.00

Table 2. Calculated nutritional profile of the ASA-IM 36/7, soy-based feed used in the 2007 common carp comparison feeding trial in Three Gorges Reservoir, Chongqing Municipality, China.

Nutrient	Value, As Fed
DE Fish (extruded)	2828
NFE	34.14
Starch	18.14
Protein, crude	36.81
Protein, digestible	33.82
DE:DP ratio	8.4:1
Fish Protein	8.64
Soy Protein	15.64
Fat	7.05
W-3 (omega 3 fatty acid)	1.02
W-6 (omega 6 fatty acid)	1.71
Fiber	3.97
Ash	7.46
Calcium	1.12
Phosphorus, available	0.70
Choline	2452
Vitamin C	105.00
Ethoxyquin	139.90
Arginine	2.15
Lysine	2.04
Methionine	0.69
Methionine + Cystine	1.22
Threonine	1.43
Tryptophan	0.39

Table 3. Formula for the ASA-IM 32/6 feed used in the 2007 common carp comparison feeding trial in Three Gorges Reservoir, Chongqing Municipality, China. The feed was produced as a least-cost formulation by Phoenix Feed Mill, Chengdu, Sichuan Province, under supervision of ASA-IM. Individual batches of feed produced over the 6-month trial duration may have varied in ingredient composition due to differences in specific ingredient nutrient profiles and ingredient availability.

Ingredient	Percent of total
Soybean Meal 46%	50.00
Wheat Flour 13.2%	25.00
DDGS 28.5/12.8	14.00
Corn Gluten Meal 60.7/3.6	3.00
Ca Phosphate Mono 21%	2.20
Soy Oil	1.70
Fish Oil, Anchovy	1.50
Blood Meal 90/0.5	1.50
Vit PMX F-2	0.50
Min PMX F-1	0.25
Mold Inhibitor	0.30
Stay C – 35%	0.03
Ethoxyquin	0.02
TOTAL	100.00

Table 4. Calculated nutritional profile of the ASA-IM 32/6, soy-based feed used in the 2007 common carp comparison feeding trial in Three Gorges Reservoir, Chongqing Municipality, China.

Nutrient	Value, As Fed
DE Fish (extruded)	2650
NFE	39.61
Starch	20.03
Protein, crude	33.46
Protein, digestible	30.43
Fish Protein	0.00
Soy Protein	23.00
Fat	6.03
W-3 (omega 3 fatty acid)	0.63
W-6 (omega 6 fatty acid)	1.96
Ash	4.01
Calcium	0.51
Phosphorus, available	0.60
Choline	2080
Vitamin C	105
Ethoxyquin	137.50
Arginine	2.03
Lysine	1.82
Methionine	0.49
Methionine + Cystine	1.01
Threonine	1.29
Tryptophan	0.38

Table 3. Vitamin and mineral premix formulations included in the ASA-IM 32/6 and 36/7 feeds used in the 2007 common carp cage feeding trial in Three Gorges Reservoir, Chongqing, China. Quantities of vitamins and minerals are per kilogram of premix. Premixes were produced by Phoenix Feed Mill, Chengdu, Sichuan Province.

Ingredient	Unit	Amount
<u>Vitamin Premix F-2</u>		
Vitamin A	IU/kg	1,200,000
Vitamin D3	IU/kg	200,000
Vitamin E	IU/kg	20,000
Vitamin K	mg/kg	0
Vitamin C	mg/kg	0
Biotin	mg/kg	40
Choline	mg/kg	0
Folic Acid	mg/kg	1,800
Inositol	mg/kg	0
Niacin	mg/kg	40,000
Pantothenate	mg/kg	20,000
Pyridoxine (B6)	mg/kg	5,000
Riboflavin (B2)	mg/kg	8,000
Thiamin (B1)	mg/kg	8,000
Vitamin B12	mcg/kg	2,000
Ethoxyquin	mg/kg	500
<u>Mineral Premix F-1</u>		
Iron	ppm	40,000
Manganese	ppm	10,000
Copper	ppm	4,000
Zinc	ppm	40,000
Iodine	ppm	1,800
Cobalt	ppm	20
Selenium	ppm	200

Table 4. Results of the 2007 ASA-IM aquaculture trial in Three Gorges Reservoir, Wanzhou, Chongqing, China that evaluated production of three strains of common carp from different regions of China.

Cage No.	CoC <sup>1</sup> strain	Stocking size (g)	Stocking rate (fish/m <sup>3</sup> )	No. days fed	Harvest wt (g/fish)	P <sub>G</sub> <sup>2</sup> (kg/m <sup>3</sup> )	Survival (%)	FCR
1	Local	4.3	500	177	294	71.1	48.4	1.81
2	Local	4.3	500	177	322	70.4	43.6	1.83
3	Local	<u>4.3</u>	<u>500</u>	<u>177</u>	<u>298</u>	<u>76.6</u>	<u>51.4</u>	<u>1.68</u>
Mean		4.3	500	177	305	72.7	47.8	1.77
4	Jiang	3.7	500	155	113	22.6	40.2	2.89
5	Jiang	3.7	500	155	136	31.4	46.0	2.04
6	Jiang	<u>3.7</u>	<u>500</u>	<u>155</u>	<u>98</u>	<u>21.8</u>	<u>45.4</u>	<u>3.02</u>
Mean		3.7	500	155	115	25.3	43.9	2.65
7	Songpu	27.4	300	98	180	50.1	93.0	2.09
8	Songpu	<u>27.4</u>	<u>300</u>	<u>98</u>	<u>196</u>	<u>54.5</u>	<u>92.7</u>	<u>1.89</u>
Mean		27.4	300	98	188	52.3	92.9	1.99

<sup>1</sup>CoC = Common carp

<sup>2</sup>P<sub>G</sub> = Gross Production