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# **Common Carp Production in LVHD Cages in Three Gorges Reservoir, Chongqing, China**

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## **INTRODUCTION**

Two cage feeding trials were jointly conducted by the American Soybean Association International Marketing (ASA-IM) program and companies associated with the Wanzhou District Fishery Extension Center in Wanzhou, Chongqing, China, to assess the technical and economic feasibility of culturing common carp in LVHD cages in the new Three Gorges Reservoir. The Three Gorges Reservoir is currently under impoundment. Water depth during the 2006 cage feeding trial was approximately 135 meters. Maximum depth when full impoundment is attained in 2009 will be 175 meters.

ASA-IM participated in initial cage feeding trials with common carp in the Three Gorges Reservoir in 2005. The 2005 cage trials identified potential production constraints associated with periodic silt water turbidity and low water temperature in the Three Gorges Reservoir. The 2006 trials continued to evaluate these constraints, with the objective of identifying possible options to overcoming the constraints.

## **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> Common carp grown in several regions of China on this feed have exhibited rapid growth, good feed conversion efficiency, good health and body conformation, and high economic return. Preliminary ASA-IM cage trials conducted in 2005 in Three Gorges Reservoir demonstrated satisfactory production of 180-185 kg/m<sup>3</sup> in 4-m<sup>3</sup> LVHD cages, but common carp growth was slower than normal (346 g to 1,075 g in 139 days and 180 g to 1,092 g in 166 days, respectively, in two trials) and FCR with the 32/6 feed was higher

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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.

than normal (2.0:1 in comparison to the norm of  $\leq 1.4:1$ ). Three potential constraints to cage production of common carp in Three Gorges Reservoir were identified during the initial 2005 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.

## **2006 FEEDING TRIAL PROTOCOLS**

LVHD cage trials with common carp were conducted at two sites in the Three Gorges Reservoir in 2006, Dazhou Cove and Maoertou Cove. Both sites were located near Wanzhou in Chongqing Municipality. The Dazhou Cove trial was conducted in cooperation with Chongqing Yudong Fishery Development Company. The Maoertou Cove trial was conducted in cooperation with Wanzhou Xunfeng Agriculture Development Company.

### **Dazhou Cove Trial**

Three, 4-m<sup>3</sup> LVHD cages were used in the Dazhou Cove feeding trial. The cages were stocked with 180 local strain common carp per m<sup>3</sup> of cage volume (720 fish per cage). Average fish size at stocking was 336 g. Common carp were stocked in the cages on 19 April 2006. Fish were fed the 32/6 feed twice daily for 159 days, with fish in all cages being fed the same amount at each feeding for the duration of the trial. The 32/6 feed was least-cost formulated by ASA-IM and manufactured by Phoenix Feed Mill in Chengdu, Sichuan Province, in extruded, floating pellet form (Tables 1-3).

### **Maoertou Cove Trial**

Six, 4-m<sup>3</sup> LVHD cages were used in the Maoertou Cove feeding trial. The six cages were stocked with 180 common carp per m<sup>3</sup> of cage volume (720 fish per cage). Three of the Maoertou trial cages were stocked with an imported Jiang strain of common carp, while the other three cages were stocked with a local variety of common carp. Average fish sizes at stocking were 305 g for the local strain common carp and 243 g for the Jiang strain common carp. All cages were stocked with fish on 19 April 2006. Fish were fed the 32/6 feed twice daily for 172 days, with fish in all cages of the same fish strain being fed identically at each feeding. The 32/6 feed was least-cost formulated by ASA-IM and manufactured by Phoenix Feed Mill in Chengdu, Sichuan Province, in extruded, floating pellet form (Tables 1-3).

The target market size for common carp in both the Dazhou and Maoertou cage trials was 1,000 g per fish. Target biomass for the LVHD cages was 180 kg/m<sup>3</sup>, or 720 kg per cage.

## **FEEDING TRIAL RESULTS**

### **Dazhou Cove Trial**

Common carp in the Dazhou Cove trial grew from 336 g to an average fish weight of 1,033 g in 159 days of feeding (Table 4). Two of the three cages had an average survival rate of 97.5%. An estimated 46% of the fish in the third trial cage were lost just before

harvest as a result of damage to the cage. Gross fish production in the two undamaged cages averaged 725.2 kg per cage (181.3 kg/m<sup>3</sup>). Common carp in each of the three cages were fed 953.9 kg of the 32/3 feed, which yielded an average FCR of 1.99:1 in the two undamaged cages. Net income for the two undamaged cages averaged RMB 146 (\$18.44) per cage, and yielded a return on investment (ROI) of 2.5% at an average market price for common carp of RMB 8.4/kg (\$1.06/kg).

### **Maoertou Cove Trial**

Local strain common carp in the Maoertou Cove trial grew from 305 g to an average fish weight of 1,042 g in 172 days of feeding (Table 4). Gross fish production averaged 736.5 kg per cage (184.2 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 98.1%. Common carp in each of the three local strain cages were fed 1,055.7 kg of the 32/3 feed, which yielded an average FCR of 2.04:1. Net income for the three local strain carp cages averaged RMB 72 (\$9.11) per cage, and yielded a return on investment (ROI) of 1.2% at an average market price for common carp of RMB 8.4/kg (\$1.06/kg).

Jiang strain common carp in the Maoertou Cove trial grew from 243 g to an average fish weight of 1,042 g in 172 days of feeding (Table 4). Gross fish production averaged 722.3 kg per cage (180.6 kg/m<sup>3</sup>) in the three 4-m<sup>3</sup> LVHD cages. The average survival rate for the Jiang strain carp was 96.3%. Common carp in each of the three Jiang strain cages were fed 1,030.3 kg of the 32/3 feed, which yielded an average FCR of 1.89:1. Net income for the three Jiang strain carp cages averaged RMB 420 (\$53.16) per cage, and yielded a return on investment (ROI) of 7.4% at an average market price for common carp of RMB 8.4/kg (\$1.06/kg).

## **SUMMARY AND CONCLUSIONS**

While common carp in both trials reached the target market size of  $\geq 1,000$  g, feed conversion efficiency was well below standard in both trials, and resulted in low economic return to producers. Results indicate significant improvements in overall fish performance will be needed for common carp production to be profitable in Three Gorges Reservoir.

Many of the problems associated with poor fish performance are related to the environmental constraints identified in 2005, i.e. chronic low water temperature and periodic high silt water turbidity. These same environmental constraints impacted the 2006 cage trials. While water temperature and visibility were both reported to be better in 2006 than in 2005, water temperature in the Three Gorges Reservoir in 2006 did not reach 25°C until July. Mean water temperatures at the Dazhou and Maoertou trial sites were 19.5°C in April, 22.0°C in May, and 24°C in June. Water temperature increased to 26-27°C in July and 28-29°C in August, but declined again to 25-26°C in September. By early October the average water temperature was down to 22°C. Sub-optimal water temperatures during 64% of the production season significantly impacted fish growth and feed conversion efficiency, and will likely be a chronic problem for cage fish producers in Three Gorges Reservoir. Projected water release through the Three Gorges Dam is

estimated to result in twelve or more complete reservoir volume turnovers per year, which will keep water temperature low. High silt turbidity levels during a portion of the production season further compound production efficiency difficulties.

The imported Jiang strain of common carp tested in the Maoertou Cove trial demonstrated some improvement in feed conversion efficiency, growth and economic return over the local carp strain. However, further improvements are needed to make common carp culture economically viable for local cage fish producers. It is recommended that the Wanzhou District Fishery Extension Center, in cooperation with cage fish producers in Three Gorges Reservoir, initiate a systematic comparison of common carp strains/varieties against the local strain(s) to determine whether other strains or varieties will grow more efficiently under the environmental conditions of Three Gorges Reservoir. As an example, the Songpu strain common carp has demonstrated very rapid growth (179 g to 1,100 g in 129 days) and good feed conversion efficiency (FCR 1.27:1) with the ASA-IM 32/6 feed in ASA-IM pond trials conducted in Heilongjiang Province in northeastern China, latitude 46° north, under a water temperature regime similar to that in the Three Gorges Reservoir.

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Table 1. Formula for the ASA-IM 32/6 soy-based feed used in the 2006 common carp LVHD cage feeding trials in Three Gorges Reservoir, Chongqing, 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 46.5%	50.00
Wheat Middlings	25.00
Wheat, HRW	10.00
Corn Gluten Meal 60%	5.00
Fish Oil, Unspec.	4.30
Ca Phosphate Mono 21%	2.80
Blood Meal, 85/1	2.00
Vit PMX F-2	0.50
Min PMX F-1	0.25
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 32/6 soy-based feed used in the 2006 common carp cage feeding trials in Three Gorges Reservoir, Chongqing, China. The feed was produced in extruded, floating pellet form.

Nutrient	Value, As Fed
DE Fish (extruded)	2750.86
NFE	41.46
Starch	25.10
Protein, crude	32.83
Protein, digestible	30.36
Fish Protein	0.00
Soy Protein	23.25
Fat	5.97
W-3 (omega 3 fatty acid)	1.20
W-6 (omega 6 fatty acid)	0.70
Ash	6.21
Calcium	0.59
Phosphorus, available	0.68
Choline	2199.70
Vitamin C	105.00
Ethoxyquin	134.50
Arginine	2.02
Isoleucine	1.57
Lysine	1.81
Methionine	0.48
Methionine + Cystine	1.02

Table 3. Vitamin and mineral premix formulations included in the ASA-IM 32/6 soy-based feed used in the 2006 common carp cage feeding trials 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 two 2006 ASA-IM aquaculture trials in Three Gorges Reservoir, Wanzhou, Chongqing, China that evaluated common carp production in LVHD cages with the ASA-IM 32/6 soy-based feed.

Cage No.	Fish strain <sup>1</sup>	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	Net income (RMB/cage)	ROI (%)
<u>Dazhou Cove</u>										
1	CoC local	343	180	159	1,030	180.0	97.2	2.02	87	1.5
2	CoC local	338	180	159	1,037	182.5	97.8	1.96	204	3.4
3	CoC local	<u>337</u>	<u>180</u>	<u>159</u>	-----	-----	<u>52.5</u>	-----	-----	-----
Mean		336	180	159	1,033 <sup>3</sup>	181.3 <sup>4</sup>	97.5 <sup>5</sup>	1.99	146	2.5
<u>Maoertou Cove</u>										
1	CoC local	301	180	172	1,038	183.9	98.3	2.04	85	1.4
2	CoC local	304	180	172	1,056	184.9	97.2	2.03	100	1.6
3	CoC local	<u>309</u>	<u>180</u>	<u>172</u>	<u>1,032</u>	<u>183.7</u>	<u>98.9</u>	<u>2.06</u>	<u>30</u>	<u>0.5</u>
Mean		305	180	172	1,042	184.2	98.1	2.04	72	1.2
4	CoC Jiang	244	180	172	1,014	176.4	96.7	1.95	273	4.8
5	CoC Jiang	248	180	172	1,070	182.9	95.0	1.86	472	8.3
6	CoC Jiang	<u>237</u>	<u>180</u>	<u>172</u>	<u>1,042</u>	<u>182.4</u>	<u>97.2</u>	<u>1.84</u>	<u>518</u>	<u>9.2</u>
Mean		243	180	172	1,042	180.6	96.3	1.89	421	7.4

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

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

<sup>3</sup>Average fish harvest weight is for cages 1 and 2 only. A large portion of the fish in cage 3 were lost when the cage was damaged.

<sup>4</sup>Average production is for cages 1 and 2 only. Almost half of the fish in cage 3 were lost just before harvest due to cage damage.

<sup>5</sup>Average fish survival is for cages 1 and 2 only. Almost half of the fish in cage 3 were lost due to damage to the cage.

