# Growth Performance of Milkfish Fed Extruded, Floating, Soy-Optimized Feed in Marine Cages in Manjuyod Bay, Philippines

## Results of ASA/Soy-in-Aquaculture 2003 Feeding Trial

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**ABSTRACT**

A feeding demonstration was conducted at Manjuyod Bay, Negros Oriental, Philippines to compare the growth of milkfish (*Chanos chanos*) grown using two different extruded, soy-based feed formulations. Milkfish fingerings of size 11-14 g were stocked into six, 180-$m^3$ cages at 8,500 fish per cage. Fish in three cages were fed a 36% crude protein and 7% crude lipid (36/7) ASA formulated and extruded soybean-based feed. Fish in the other three cages were fed a 32% crude protein and 6% crude lipid (32/6) ASA formulated and extruded soybean-based feed. All extruded feeds were produced domestically in the Philippines. Milkfish on both diets grew to about 400 g in 168 days of culture. There was no difference in average milkfish growth, survival or feed conversion efficiency with the two diets after 168 days of culture.

## INTRODUCTION

The American Soybean Association (ASA), under the Soy-in-Aquaculture Program and in cooperation with Resources Producer Technology Corporation (REPROTECH) of Manjuyod Bay, Negros Oriental, Philippines, conducted a 168-day comparison demonstration with milkfish in marine cages using two different soybean-based feed formulations. The objectives of the project were to demonstrate the feasibility of culturing milkfish in High Volume, Low Density (HVLD) cages using elements of the ASA Low Volume, High Density (LVHD) cage technology and to compare performance of milkfish using two different ASA formulated soybean-based extruded feeds.

## MATERIALS AND METHODS

Six, 180-$m^3$ (5.5 m x 5.5 m x 6 m) HVLD cages at the REPROTECH cage farm site in Manjuyod Bay, Negros Oriental, Philippines, were used for the demonstration. The cages were constructed with a welded steel floating frame from which a rectangular nylon mesh (mesh size varied by size of fish), double bag cage net was suspended and weighted down to maintain the cage shape against water currents. Each cage was equipped with an internal feed enclosure and a light blocking cover as specified in the ASA LVHD Manual "Principles and Practices of High Density Fish Culture in Low Volume Cages". The six demonstration cages were placed at the

outside edge of the cage farm and spaced to provide at least one cage length of open water on all sides of each cage to facilitate water exchange. Cage nets were replaced on a 15-day cycle to combat bio-fouling.

Milkfish fingerlings of size 11-14 g were obtained from local land-based hatchery ponds and were stocked at a density of 8,500 fish per cage in the 180-$m^3$ HVLD cages. Fish in all six cages were of uniform size and age at stocking. Milkfish production targets were 400 g per fish and 3,400 kg per cage for the HVLD cages, or 18.9 kg/$m^3$ of cage volume.

Milkfish in all cages were fed twice daily, and as size increased, three times daily, with extruded, floating, pelleted feeds. Three cages were fed with a feed formulated to contain 36% crude protein and 7% crude lipid (36/7). The remaining three cages were fed a feed formulated to contain 32% crude protein and 6% crude lipid (32/6). These feeds were formulated by ASA to optimize soybean meal use, and contained 43% and 40% U.S. dehulled soybean meal by volume (respectively) as a percentage of total feed ingredients. These feeds were produced domestically in the Philippines by I.O. Basic Feedmill (Ace Feeds) in Angeles City, Philippines. The three cages using the same feed formulation were treated as replicates of a single feed treatment, with fish in all cages fed the same amount at the same time using the ASA satiation feeding technique.

Cage management was based on the ASA cage production model. Fish in all cages were sampled once per month on about the same date each month. At the conclusion of the trial, all cages were completely harvested and all fish weighed. All of the harvested fish were enumerated when weighed to obtain an average fish size and fish survival. Results were used to determine fish survival, average fish weight, gross fish production, feed conversion ratio (FCR) and to perform an economic analysis.

## RESULTS

Milkfish were fed a total of 168 days between June 17 and December 2, 2003. Milkfish in the 36/7 feed cages grew from an average of 11 g to 406 g in this period while milkfish in the 32/6 feed cages grew from an average of 14 g to 427 g (Figure 1; Table 4). Gross production averaged 2,793 kg in the cages fed the 36/7 formulation (15.5 kg/$m^3$ of cage volume) and 2,868 kg in the cages fed the 32/6 formulation (15.9 kg/$m^3$ of cage volume). Fish growth, survival, production per unit of cage volume and FCR were not significantly different ($P>0.05$) for the two feed formulations (Figures 1 and 2; Table 4).

Economic return was greater with the 32/6 feed (Table 5; Table 6). Average return on investment (ROI) for the three cages in each feed treatment was 35% for the 32/6 feed treatment and 26% for the 36/7 feed treatment.

## SUMMARY AND CONCLUSIONS

The goals of this project were to quantify milkfish growth performance on diets varying in protein and lipid density and to demonstrate the use of extruded, soy-based feeds for culturing milkfish as an alternative to traditional sinking feeds. This feeding demonstration was also the first step in a process of demonstrating the technical and economic advantages of the ASA/IM LVHD cage and soy-based feed technology package.

The farmer cooperator in this demonstration had never previously used extruded, soy-based feeds. Sinking feeds used at the farm prior to this demonstration had yielded poor feed conversion and low profitability. Based on the results of this demonstration, the farmer changed almost entirely from sinking feeds to extruded, floating feeds within the first month of this demonstration. The extruded, soy-based feeds yielded a much lower FCR (2.0:1) than the previous sinking feeds (3.5:1), and resulted in significant feed cost savings and higher economic return for the farmer.

Data collected during the course of the feeding demonstration indicate the 36/7 diet yielded a better feed conversion in the early months of the trial. It may be practical to use the 36/7 diet during the early production stage, followed by the 32/6 diet, to optimize fish performance. This follows closely with the results seen in China with other omnivorous fishes where better growth is seen with a higher protein at the younger stages of growth when the growth is fastest and protein requirement highest.

The FCR obtained in this feeding demonstration is still high for an omnivorous fish such as milkfish. Milkfish growth may have been depressed as a result of insufficient available phosphorus in the feeds. Supplemental phosphate was inadvertently left out of the test diets. A follow-on demonstration, in which the feed formulations are adjusted, a two-stage feeding system (36/7 feed to 50g average fish size and 32/6 for fish 50g and over) is incorporated and a full LVHD system is used, is recommended to further investigate the production and economic advantages of the ASA LVHD technology and soy-maximized fish feed with milkfish.

## ACKNOWLEGEMENTS

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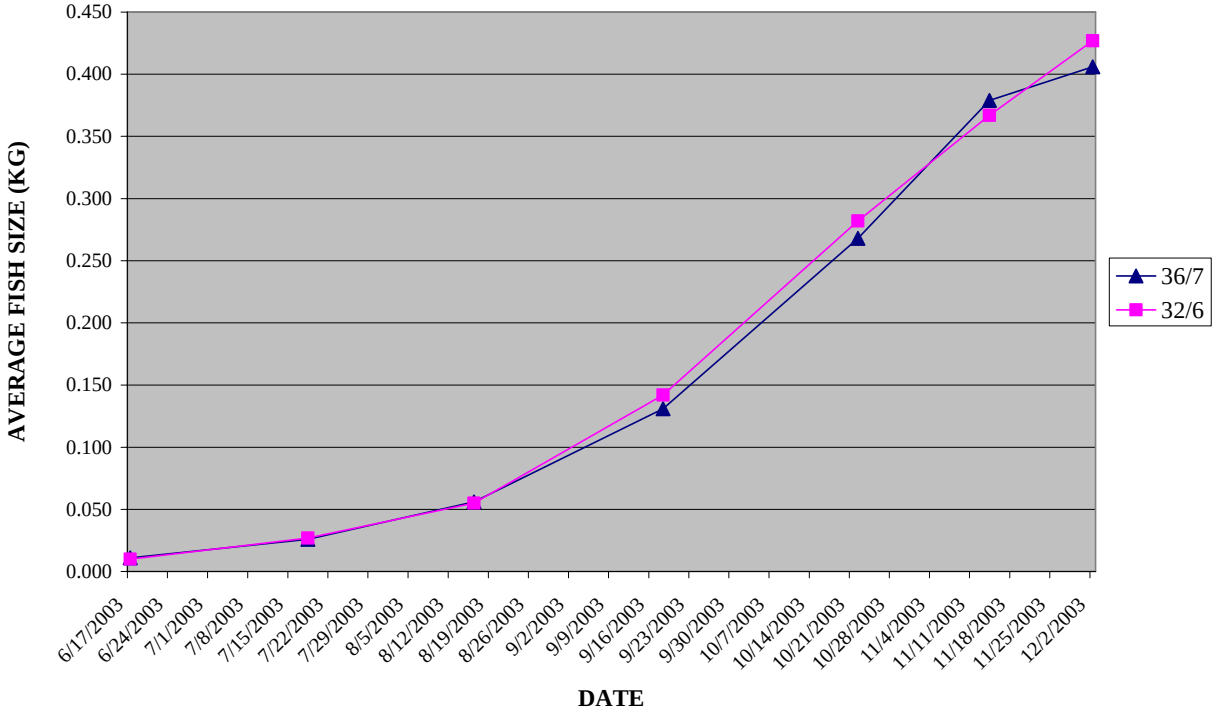


FIGURE 1. Growth curves for milkfish fed two different diets over a 168-day culture period in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines. Milkfish grew from an average of 11 g to 406 g when fed the 36/7 formulation and from 14 g to 427 g when fed the 32/6 feed formulation.

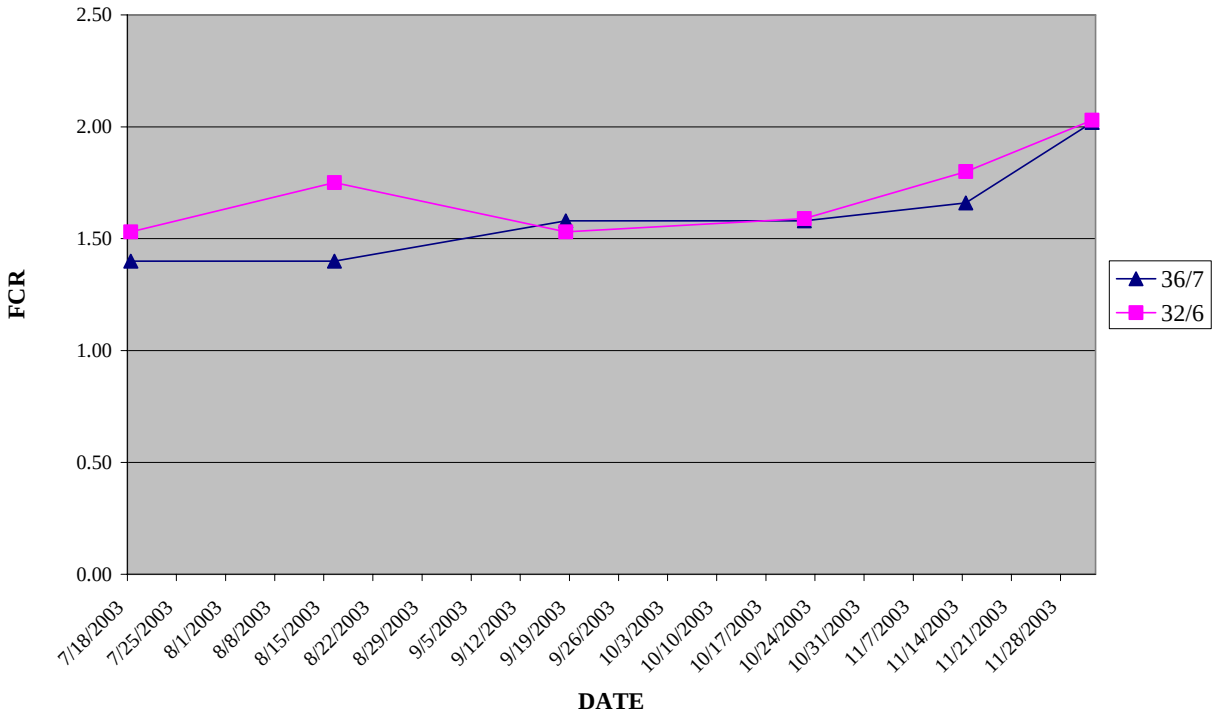


FIGURE 2. FCR curves for milkfish fed 36/7 and 32/6 soy-based feeds over a 168-day culture period in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines. Average FCR was 2.02:1 for the 36/7 diet and 2.03:1 for the 32/6 diet.

TABLE 1. Formula provided to I.O. Basic Feedmill for the ASA 36/7, soymeal-based feed used in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines. The feed was fed in 2, 3 and 4-mm, extruded pellet form.

## 36/7 ASA Feed
## 2003 Philippine Milkfish Feeding Demonstrations

| Ingredient | % Inclusion Rate |
|---|---|
| U.S. SBM 47.5% | 42.50 |
| Wheat, SWW | 21.00 |
| Fish meal, tuna, 54/8 | 18.25 |
| Wheat Bran 15% | 6.00 |
| Fish oil, unspec. | 5.41 |
| CGM 60% | 5.00 |
| Soy Lecithin | 1.00 |
| Vit PMX F-2 | 0.50 |
| Min PMX F-1 | 0.25 |
| Choline Chloride 60% | 0.04 |
| Stay C 35% | 0.03 |
| Ethoxyquin 100% | 0.02 |
| TOTAL | 100.00 |

[1]The 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.

TABLE 2. Formula provided to I.O.Basic Feedmill for the ASA 32/6, soymeal-based feed used in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines. The feed was fed in 2, 3 and 4-mm, extruded pellet form.

## 32/6 ASA Feed
## 2003 Philippine Milkfish Feeding Demonstrations

| Ingredient | % Inclusion Rate |
|---|---|
| U.S. SBM 47.5% | 40.00 |
| Wheat, SWW | 20.00 |
| Wheat Bran 15% | 16.26 |
| Fish meal, tuna, 54/8 | 12.00 |
| Rice Bran 15% | 4.00 |
| CGM 60% | 3.50 |
| Fish oil, unspec. | 2.40 |
| Soy Lecithin | 1.00 |
| Vit PMX F-2 | 0.50 |
| Min PMX F-1 | 0.25 |
| Choline Chloride 60% | 0.06 |
| Stay C 35% | 0.02 |
| Ethoxyquin 100% | 0.01 |
| TOTAL | 100.00 |

[1]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.

TABLE 3. Vitamin and mineral premix formulas provided to I.O.Basic Feedmill for the ASA 36/7 and 32/6 soybean meal-based feeds used in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines.

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.

TABLE 4. Results of the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines that demonstrated growth performance of milkfish using two different feed formulations.

| Cage No. | Treatment | Stocking size (g) | Stocking rate (fish/cage) | No. days fed | Harvest weight (g) | Gross Production (kg/cage) | Gross Production ($kg/m^3$) | Survival (%) |
|---|---|---|---|---|---|---|---|---|
| 2 | 36/7 | 11 | 8500 | 166 | 391 | 2811 | 15.6 | 85 |
| 4 | 36/7 | 11 | 8500 | 164 | 407 | 2758 | 15.3 | 80 |
| 6 | 36/7 | 12 | 8500 | 165 | 420 | 2809 | 15.6 | 79 |
| | **Mean** | **11** | **8500** | **165** | **406** | **2793** | **15.5** | **81** |
| 1 | 32/6 | 14 | 8500 | 168 | 426 | 2900 | 16.1 | 80 |
| 5 | 32/6 | 14 | 8500 | 163 | 437 | 2803 | 15.6 | 75 |
| 7 | 32/6 | 14 | 8500 | 167 | 418 | 2900 | 16.1 | 82 |
| | **Mean** | **14** | **8500** | **166** | **427** | **2868** | **15.9** | **79** |

TABLE 5. Financial analysis of milkfish production in ocean cages using a 36/7 ASA Formulated Soy-Based, Extruded Feed in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines.

| | Cage | | | |
|---|---|---|---|---|
| | **2** | **4** | **6** | Mean |
| **Average harvest size (g)** | 391 | 407 | 420 | *406* |
| **Feed Type** | 36/7 | 36/7 | 36/7 | |
| **Total feed (kg)** | 5522.7 | 5654.0 | 5434.7 | *5537.1* |
| **Feed price (Php/kg)** | 20.30 | 20.30 | 20.30 | *20.30* |
| **Total feed cost (Php)** | 112110.00 | 114775.19 | 110323.40 | *112402.86* |
| **Total fingerling (pc)**[1] | 8512 | 8575 | 8568 | *8552* |
| **Fingerling price (Php/pc)** | 0.96 | 0.96 | 0.96 | *0.96* |
| **Fingerling cost (Php)** | 8171.52 | 8232.00 | 8225.28 | *8209.60* |
| **Labor cost (Php)** | 3670.72 | 3670.72 | 3670.72 | *3670.72* |
| **Total harvest weight (kg)** | 2810.5 | 2899.5 | 2899.7 | *2869.9* |
| **Selling total weight (kg)**[2] | 2698.1 | 2783.5 | 2783.7 | *2755.1* |
| **Selling price (Php)**[3] | 56.69 | 57.00 | 57.58 | *57.09* |
| **Other costs (Php)**[4] | 1184.22 | 1190.27 | 1189.60 | *1188.03* |
| **Gross profit (Php)** | 152954.16 | 158660.64 | 160286.14 | *157300.31* |
| **Total costs** | 125136.46 | 126677.91 | 122219.40 | *124677.92* |
| **Net profit** | 27817.69 | 31982.74 | 38066.74 | *32622.39* |
| **ROI** | 22% | 25% | 31% | *26%* |

[1]Total number of fingerlings varied as fingerling mortality in the first week were replaced as specified in the protocol

[2]Harvest weight and selling weight differed in the financial analysis because buyers in this area demand about a 4% subsidy for perceived water weight.

[3]Selling price of the fish is according to market price on the day of harvest

[4]Other costs were calculated by taking 10% of fry and labor costs

TABLE 6. Financial analysis of milkfish production in ocean cages using a 32/6 ASA Formulated Soy-Based, Extruded Feed in the 2003 ASA SIA Milkfish Comparative Demonstration Project at Manjuyod Bay, Negros Oriental, Philippines.

| | Cage | | | |
|---|---|---|---|---|
| | **1** | **3** | **5** | Mean |
| **Average harvest size (g)** | 426 | 437 | 418 | *427* |
| **Feed Type** | 32/6 | 32/6 | 32/6 | |
| **Total feed (kg)** | 5699.25 | 5386.67 | 5653.95 | *5580.0* |
| **Feed price (Php/kg)** | 18.8 | 18.8 | 18.8 | *18.80* |
| **Total feed cost (Php)** | 107145.90 | 101269.40 | 106294.26 | *104903.19* |
| **Total fingerling (pc)**[1] | 8510 | 8525 | 8510 | *8515* |
| **Fingerling price (Php/pc)** | 0.96 | 0.96 | 0.96 | *0.96* |
| **Fingerling cost (Php)** | 8169.60 | 8184.00 | 8169.60 | *8174.40* |
| **Labor cost (Php)** | 3670.72 | 3670.72 | 3670.72 | *3670.72* |
| **Total harvest weight (kg)** | 2803.8 | 2758.0 | 2808.5 | *2790.1* |
| **Selling total weight (kg)**[2] | 2691.6 | 2647.7 | 2696.2 | *2678.5* |
| **Selling price (Php)**[3] | 58.49 | 59.91 | 58.10 | *58.83* |
| **Other costs (Php)**[4] | 1184.03 | 1185.47 | 1184.03 | *1184.51* |
| **Gross profit (Php)** | 157431.68 | 158622.51 | 156646.90 | *157567.03* |
| **Total costs** | 120170.25 | 113124.12 | 118134.58 | *117142.98* |
| **Net profit** | 37261.43 | 45498.39 | 38512.32 | *40424.05* |
| **ROI** | 31% | 40% | 33% | *35%* |

[1]Total number of fingerlings varied as fingerling mortality in the first week were replaced as specified in the protocol

[2]Harvest weight and selling weight differed in the financial analysis because buyers in this area demand about a 4% subsidy for perceived water weight.

[3]Selling price of the fish is according to market price on the day of harvest

[4]Other costs were calculated by taking 10% of fry and labor costs