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Whiteleg shrimp
(*Litopenaeus vannamei*)

Shrimp farmers join with researchers to test best new diets

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The values of shrimp seafood products are declining, stable or in some cases increasing only slightly which is wonderful news for the consumer. At the same time feed, fuel and processing costs are rapidly increasing and causing some U.S. commercial aquaculture operations to cut production costs or go out of business. Given a fixed formulation, the cost of shrimp feeds has almost doubled in the last two years. This is in response to a wide number of factors but was first triggered by rising and unprecedented increase in the price of fish meal from 2006 to 2008. The rapid increase in world fish meal prices was followed by a moderate increase in the cost of other protein sources and a recent rapid rise in grain prices. All of these taken to-

gether caused feed costs to nearly double without corresponding increases in the value of the final product.

Although fish nutrition research cannot change world prices, it can provide alternative formulations to moderate feed price increases. Fortunately for the shrimp industry, researchers have been working towards the goal of quantifying nutrient requirements and providing information on the use of alternative feed ingredients for some time. Traditional shrimp feed formulations include 20 to 30% fish meal which is one of the most costly protein sources. Fish meal is an ingredient for which world supply cannot be expanded and is considered a limiting factor for the continued expansion of aquaculture. At this point, experts agree that one of the first steps to reduce shrimp feed prices is to provide alternatives to the use of marine ingredients and develop plant-based diets.

A number of research groups have been systematically identifying nutrient re-

quirements and working to improve feed formulation technologies. Using a variety of funding sources, researchers at Auburn University, Texas A&M, and the Wadell Mariculture Center took the challenge to develop a synergistic program to identify limiting nutrients in plant-based diets and demonstrate their findings to the industry. This included a systematic approach to identifying limiting nutrients in the laboratory, testing diet formulations in outdoor tanks and then in research ponds. Using balanced formulations based on alternative protein sources, primarily of plant origin, resulted in an improvement in the overall nutritional quality of practical diet formulations as well as considerable reductions in formulations costs. These formulations were made possible by systematically identifying limiting nutrients and balancing the formulations as fish meal was removed. For shrimp, identifying the total sulfur amino acid requirement was a key factor to removal of fish meal. Once the fish meal was removed, researchers also discovered essential fatty acids, cholesterol and phosphorus needed to be supplemented to plant-based feeds. Numerous studies have been conducted which have demonstrated the feasibility of reducing or completely replacing fish meal with no adverse effect on the productive performance of *L. vannamei*. These and current trials have demonstrated that practical diets can be formulated using soybean meal as the primary protein source. Other renewable protein sources such as distiller's grain solubles, pea meal and corn gluten meal have been utilized in combination with soybean meal to enhance the amino acid balance and to diversify the ingredient base of these formulations.

Based on these results, the next step was to gain commercial acceptance of reduced fish meal formulations. In order to promote the continued development of quality feed formulations, the American Soybean Association–International

Marketing provided funds to transfer feed formulation technologies to the shrimp industry. The project involved working directly with feed mill manufactures and producers in the United States, Latin America (Ecuador, Mexico, Colombia, Venezuela) and more recently Asia to provide technical assistance to both feed mills and shrimp farmers allowing them to improve production practices. With this purpose in mind, a series of regional seminars was conducted in each country to disseminate results obtained at various research centers and to provide sound technical advice on feed manufacturing and culture technologies. Producers and feed manufacturers who were willing to try new practices and improve their operations using plant-based feeds were identified. Shrimp farmers were asked to compare their conventional fish meal-based feed with feed containing less fish meal. The level of fish meal reduction was determined by the producers and feed manufacturer to make them feel comfortable with the experiment. Although controlling experimental conditions in the real world is difficult, farmers were asked to follow a protocol that included using similar sized ponds, using shrimp larvae of the same origin and stocking at similar densities. The production protocols, particularly feed inputs, were reviewed by experts to provide additional technical support to further encourage improved management practices. A similar approach was used with the feed mill manufacturers. Technical support was provided in terms of reviewing manufacturing practices, feed formulation and feed management recommendations. In most cases, improvements in feed manufacturing processes, formulation restrictions and feeding tables were made, resulting in significant reductions in manufacturing costs. Results to date have been encouraging with most farmers and feed mill manufactures adopting the suggested improvements in feed formulations technologies.