Inaugural Address

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Mr. Mohan Kumar, Dr. Wing-Keong Ng, ladies and gentlemen,

I have great pleasure in participating in this workshop on "Aquaculture Nutrition and Feed: Status of Knowledge, Research and Development Needs". Nutrition, feed and health of the stock are crucial for any successful aquaculture venture. In fact, cost-wise, feed is the major component in production cost, consuming anywhere from 40 to 60 percent depending on the species being cultured. We have 27 or so feed manufacturing units in the country catering to aquaculture feeds, producing about 220,000 mt per annum and the bulk of it as shrimp feed. The projected need is for another 50,000 mt within the next three years, in addition to imported feeds. There has been a significant change in the aquaculture feed industry and there is currently great need to produce feed of high quality with good shelf-life and appropriate for some of the phases of growth of the shrimp, *Penaeus monodon*. There is an effort at diversification for developing feeds for marine finfish and some of the cultivable invertebrates.

We have with us today Dr. Wing-Keong Ng, a renowned expert in fin-fish nutrition, to help and guide us in our deliberations. I join you all in extending to him our warm welcome. A concept paper for this Workshop was prepared by Dr. Albert Tacon, identifying five areas of concern ad eight species/groups of organisms for aquaculture which need our immediate attention. Perhaps we could use this frame-work to go on, besides the presentation of updates. We look forward for a considerable amount of participatory interaction on many of the issues the feed manufacturer, the aqua-farmer, the researchers and those who transfer technology face.

I am reminded of the seventies, when we started the mariculture programmes at CMFRI and wanted an update on the state of the art of nutrition and feed in aquaculture in the country. The most we could find was the arbitrary formulation of rice bran and oilcake with atta or cassava flour used as a binder, for the major carps, catla, rohu and mrigal, with hardly any information about the nutritional requirements for the different species for different stages of their life history, including brood fish. We have more information today on fortified diets in addition to the basal feeds for carps, but a considerable amount of research is needed on nutritional requirements.

The major turn around in nutrition and feed research and development was with the advent of shrimp culture starting in the seventies. It is amazing to see the wide spectrum of feeds, some highly specialized and very specific which are available today for the farming of the tiger shrimp *P. monodon* and other species. Attempts at regulated

enrichment of the biotic environment in which shrimp are cultured to produce high quality product with least impairment to the natural environment are in vogue. We are also now fully aware of the importance of nutritional biotechnology in aquaculture nutrition, feed and feeding to be successful should be closely linked to the health of the animal and its palatability.

This is all the more important as we have now to look at adopting a value chain approach in our aquaculture operations in order to also comply with product traceability in the light of HACCP and ISO 22000 standards. They are important both for the domestic and export markets and would involve innovative and intensive scientific and technological inputs for the different species/groups and the environment impact of such operations.

The magnitude of the problem is such that a multi-pronged approach is necessary. Who are the players in this? You, the participants in this workshop partly represent them – the aqua-farmer, the aqua-feed manufacturer, the feed ingredient supplier including plant by-products and materials, the aqua-feed developer, equipment manufactuerers, product developers, and those who manage quality of the products for HACCP and ISO standards to mention some. There is a need for strengthening inter-disciplinary and inter-organizational linkages so that our aquaculture could be safe – green – un-polluting, cost-effective and well controlled at all operational and logistic phases to yield quality products.

Two major concerns have been the scarcity of quality fish meal and the escalating energy cost, both having a synergistic effect on aqua-feed. One estimate is that in intensive shrimp farming 1.5 to 2 litres of fuel is needed for every kg of shrimp produced. As far as shrimp meal is concerned, the drive is for substitution with tested animal and plant derived products. This has also opened up new vistas in the application of biotechnology in aquaculture nutrition and feed. To be sustainable the quality of the manufactured feed should be in tune with the nutritional requirement of the candidate species for different growth phases including the broodstock.

The fact sheets sent to you indicates the great opportunities for diversification to develop suitable feeds for fin-fishes such as groupers, seabass, and cobia in open sea cage culture; culture of high value marine invertebrates such as crabs, lobsters, and holothurians; the culture of live feeds and the modalities of sustaining them and upgrading and refining feeds for freshwater fin-fish and freshwater prawn.

Culture of groupers has shown that different species need different feed formulations, let alone the need for specialized feeds for hatchery rearing and juveniles. The application of feed also needs critical evaluation. For instance, seabass responds to protein-lipid levels by faster growth, while the same feed for groupers would only result in deposition of fat. Such subtlety needs to be recognized. One study shows that groupers fed with dry pellets "loose their appetite", the feed quality being far from optimal for growth, texture and palatability. Such studies only highlight the need for more R&D in specific nutritional requirements and the quality of feed administered.

It is also imperative that we have equipments and techniques for assessing the nutritional quality of the food ingredients in the processed feed. We have to also develop suitable indices to evaluate dietary efficiency linked with health of the stock.

Adjustment of specific nutrient levels in the diet, manipulations through feeding regimes and administering non-nutritional immunostimulants in the diet are essential nutritional strategies to be adopted. This is

an area where more work is needed.

The indiscriminate use of melamine in fish and animal feeds poses a new threat, with serious implications of systemic effects. The use of such additives in fish feeds for aquaculture needs to be addressed.

Probiotics and Prebiotics:

The aquaculture farmer today needs something more than the basic nutritional requirements of the organism being cultured. This is where the concept of functional feeds with functional nutrients comes in through the use of probiotics - live microbes as dietary supplement to improve the intestinal microbial balance. In contrast, prebiotics are non-digestible beneficial food ingredient which could selectively stimulate growth or activate the metabolism of health-promoting bacteria to improve the host's intestinal balance and help optimum nutrient uptake. Oppotunistic patogens could also affect productivity and create imbalances in the gut microflora resulting in reduced nutrient uptake and make the organism susceptible to disease. While increasing immune response, prebiotics could also reduce stress effects. Both, probiotics and prebiotics have important roles to play in the production of quality feeds for aquaculture. (Li and Gatlin, 2004, Aquaculture 231: 445-456).

More studies are needed on immuno stimulants such as chitin, lactoferrin, peptidoglycan, liposacchardes, sulphated polysaccharides and so on. Use of molecular methods such as microarray analysis, to precisely measure influence of immuno stimulants on expression of immunogenes and screen for effective dietary immuno stimulents are areas which need more work.

Mycotoxins:

Mycotoxins such as aflatoxin are serious threats when we use products such as grains, corn, and soy in aqua feeds. Aflatoxin B_1 contamination poses a major threat where moist feeds are involved. It could affect growth and the immune functioning through poor diet digestibility making the organism prone to diseases. When present in high values (1000 ppb) it could be transferred at low rates into the edible tissues of shrimp and affect the consumer. A lot needs to be done to monitor the feeds to be free of mycotoxins. Extracts of neem, turmeric, garlic, onion and some herbals are known to evince anti-fungal properties and there is need to know more about the active ingredients in these and their role. Yeast biotechnology and carbohydrate chemistry have opened new avenues for mitigating mycotoxin problems.

Nutritional Biotechnology:

A wide range of biotechnological inputs are becoming possible for adoption for aquaculture feeds, for dietary enrichment and as digestive and local absorption enhancers. A brief mention of some of these is called for:

Nucleotides have been described as "conditionally essential" nutrients. The nutritional value of nucleotides as a growth promoter in fish has been debated. According to one source, commercial nucleotide products have been shown to enhance early growth as well as immunity and disease resistance in cultured fish in comparison to fish fed on basal diet. However, the molecular mechanism(s) of physiological and immunological responses induced by dietary nucleotides is an unknown factor.

Nutrigenomics may be explained as the influence of feed on the organism at the molecular level. This will also involve the selection of a feed having the nutritional formula matched at least in part to the nutritional needs of the animal. In fact, this is a new approach to monitor gene regulation in nutrition. More work is called for in this area.

Amino Acids: In order to reduce requirements of protein, diets are formulated with digestible amino acid levels. This would help to minimize imbalances in the ingredients of essential amino acids used in feeds which need not necessarily meet the requirements of the species. This is an area for Research and Development.

Enzymes:

The use of exogenous digestive enzymes such as lipase, amylase, protease and phytase in fish nutrition are gaining importance. There are a number of areas in which enzymes can be used as dietary supplements and there is need for their wider application. How enzymes produce their beneficial effects needs to be researched in depth.

Enzymes can play an important role in the formulation of eco-friendly aqua fees. They can inactivate anti nutritional factors and enhance nutritional value of plant-based protein in feeds. This would also help the feed manufacturer to reduce the use of fish meal and reduce the cost of production. Phytae enzyme, which improves phosphorous utilization helps to reduce the discharge of nutrients into the environment.

Due to the beneficial effects enzymes are capable of, there will be wider applications in their use in fish nutrition, including development of models to predict response of enzyme treatment. Diversified prospective uses of enzymes in fish nutrition have been projected in some recent studies which needs our sustained attention both for research and development.

Conclusion:

There are many more new facets of recent developments which have application to fish nutrition, feeds and health of the stock. They are closely linked and should be taken as such. All these are exciting new areas for research. I hope it will be possible to develop a road map for cooperation, coordination, sharing of knowledge and Inter-organisational facilities at this Workshop. I have great pleasure in inaugurating this workshop and wish the deliberations all success.