Formulation and Pelleting of Low-Cost Feeds

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Summary

Aquaculture production in Sub-Saharan Africa is constrained by the high price of suitable fish feeds. Between 60% and 70% of operating expenses by fish farmers go to feed input because their ingredients are either imported or blended overseas. For this reason, formulation, and manufacturing of affordable fish feed in Africa is an integral part of creating more profitable fish farming business. Feed producers need to understand which ingredients and processes provide expected results to fish producers. Supply of low-cost fish feed can be promoted by the combination of locally grown crop and animal products and through the application of available extrusion and pelleting technologies. Compared to simple ingredients such as unprocessed grains, pelleted fish feed is more stable in water, improving nutrient transfer and reducing pollution. Pellets are also easier to store, package and transport, and their buoyancy can be crafted to suit the feeding requirements of different species. Pelleting has a modest investment requirement that provides quick returns, making it an attractive business venture.

Technical Description

A nutritionally balanced and adequate diet are important factors that maximize fish production and profitability, particularly as fish production systems intensify. The main objectives of formulations for aquaculture are to meet dietary requirements, particularly the relatively high need for crude protein, to minimize production and delivery costs, and reduce waste and pollution in ponds. Judicious selection of feed ingredients based on availability, price, and the quality of the nutrients is key in the process. Pelleted feeds can be manufactured through two processing technologies: dry-type extrusion which operates on friction to generate heat, and wet-type extrusion which utilizes drying as a binding process. State-of the-art extrusion combines raw materials under conditions of high temperature, moisture and pressure that results in partial gelatinization and deactivation of anti-nutritional elements. It also sterilizes pathogens, increases digestibility, and shapes pellets into different sizes. The buoyancy and stability of pellets in water allows producers to better monitor and regulate feeding behaviors.

Uses

Pelleted feeds are suitable for all types of farmed fish and are customized to match different species and their growth stages. Specific formulations are recommended for omnivorous species like tilapia, carp and trout, and carnivorous species like catfish and

perch. Feeding habits are matched to feed properties: floating pellets are used for surface feeders like tilapia and carp and sinking pellets for bottom feeders like catfish and perch. Temperatures, moisture, and pressure in the extrusion process further adjust feed properties.

Composition

Feed formulations are composed of ground ingredients in varying proportions to meet nutritional requirements of a particular fish. The common raw materials for omnivorous tilapia include wheat bran, soybean cake, fish meal and maize. For carnivorous catfish, the main ingredients are soybean meal, fish meal, rice, wheat bran and bone meal. When feedstuffs for the desired nutrient composition have been selected, they can be prepared through a process of milling, mixing, and pelleting. Oil may be added to improve buoyancy for floating feed.

Means of application

The most important consideration in manufacturing pelleted fish feeds is the use of quality feed ingredients that are locally sourced and competitively priced. In feed formulation, the upper limits of toxins and lower limits of substances that influence palatability and water stability must be considered. The first step in the production process is grinding raw materials with a hammer mill into a fine powder. Smaller particle sizes have greater digestibility, cohesiveness, and water stability. Materials should be sun or oven dried before grinding. Different ingredients must have a uniform size. The second step in the process is mixing the ingredients and can be homogenized by hand to form a mash before wet extrusion. A mechanical mixer can be used for large-scale feed production. If cereals in the formula are not adequate to bind the particles of the feed mixture, cassava starch or a similar product can be added as a binder. Just before extrusion, the raw materials are moistened so that they adhere. Wet-type steam pelletizers gelatinize starch which further improves nutritional value. For most adult fish, the diameter of pellets should be at least 4 millimeters.

Agroecologies	All Agroecologies.
Regions	Africa South of Sahara.
Developed in Countries	Zimbabwe, Zambia, Uganda, Tanzania, Sudan, South Sudan, Sierra Leone, Senegal, Rwanda, Nigeria, Mozambique, Malawi, Madagascar, Liberia, Kenya, Ivory Coast, Ethiopia, Equatorial Guinea, Djibouti, Democratic Republic of the Congo, Cameroon, Botswana, Benin.

Available in	Zimbabwe, Zambia, Uganda, Tanzania, Sudan, South Sudan, Sierra Leone, Senegal, Rwanda, Nigeria, Mozambique, Malawi, Madagascar, Liberia, Kenya, Ivory Coast, Ethiopia, Equatorial Guinea, Djibouti, Democratic Republic of the Congo, Cameroon, Botswana, Benin.
Solution Forms	Input Supply.
Solution Applications	Fish Farming, Feed/Fodder Production.
Agricultural Commodities	Fish.
Target Beneficiaries	Small-scale farmers, Commercial farmers.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

Localized manufacturing of pelleted fish feed represents a viable enterprise opportunity in support of fish production. Steps to enter feed manufacturing include: 1) Organize continuous supply of low-cost raw ingredients, 2) Locate production site conveniently close to fish farms and transportation corridors, 3) Procure and install appropriate, serviceable equipment, 4) Provide sanitary packaging and storage of feed, 5) Market feed products to fish farmers, agro-dealers, extension agents, and when possible, and 6) Pre-arrange contracts with fish farms at a profitable and competitive price.

Production Costs

Raw ingredients account for 60% to 70% of the total cost. Other costs for manufacturing fish feed are the purchase and maintenance of equipment, training and payment of skilled labor, and supply of utilities. Manufacturing fish feed with a motorized pelletizer is slightly more expensive than the use of a manual pelletizer because it requires more advanced equipment and a power supply. A fully automated line consisting of a vertical mixer, double screw extruder, dryer, and flavoring machine with conveyors and hoisters with a capacity of 120-150 kg per hour costs about US $18,000 excluding shipment and taxes. The equipment setup for a production capacity of 4 to 5 ton per hour costs about US $85,000.

Customer Segmentation

The manufacturing of fish feed pellets with locally sourced ingredients and automated equipment is relevant for privately owned or community-based enterprises. Companies that supply, engineer, and build feed production lines need to maintain close contacts with local producers, distributors, and government agencies for delivering services that match market conditions.

Potential Profitability

Generally, the total cost of producing and marketing pelleted fish feed is around US $1,200 per ton which can then be sold for up to US $1,500, suggesting low profit margins but high sales volumes. Fish feeds can be profitably retailed by agro-dealers and at local markets servicing fish producers. The use of pelleted diets for catfish culturing in Kenya has demonstrated to achieve a better feed conversion and growth rate, and higher net return compared to the same formulation of non-pelletized feeds. High-quality pellets can fatten stocks quickly for sales on local fresh markets for whole fish or processed products.

Licensing Requirements

Food safety audits and certifications are required to manufacture and sell fish feeds in many African countries that are required for regular testing of nutritional value and the presence of pollutants.

Innovation as Public Good

Knowhow for feed production is readily available as a Regional Public Good provided by WorldFish across Africa.

Solution Images

Fish feed production line (left to right): hammer mill, vertical mixer, extruder, and dryer

Feed formulation before (left) and after dry extrusion (right)

Institutions