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Improvement of feeding and feed management efficiency in aquaculture production in the Philippines

Bureau of Fisheries and Aquatic Resources

Output 1

Baseline information on feed ingredient supply and availability, nutritional requirements, feed formulation and type of feed used for Nile tilapia and milkfish farms in the Philippines are collected.

Output 1

Activity 1.1: Review of feed ingredient supply (imported/local): availability (seasonality), quality/composition, cost and distribution, current aquafeed production capacity, supply and demand, and policy dispensation (taxation, imports) in the Philippines

Activity 1.2: Prepare a database of locally available feed ingredients and their nutritional composition through literature search, field survey and/or laboratory analysis.

Activity 1.3: Review/survey of nutritional requirement and feed formulation for different life stages (fry, fingerlings and on-grower) for Nile tilapia and milkfish.

Activity 1.4: Review of existing formulations used in commercially available aquafeed and assess their suitability for tilapia and milkfish.

Activity 1.5: Collection of baseline information on the type of feed use of Nile tilapia and milkfish through liaison with farmers.

Activity 1.1: Review of feed ingredient supply

Issues

- Imported/local supplies
- Availability (seasonality)
- Quality and composition
- Costs along the value chain (e.g. importers, traders and distributors)
- Current aquafeed production capacity and technologies
    - Commercial aquafeed manufacturers
    - small-medium scale manufacturers
    - farm-made feeds

  Feed Manufacturing technologies
  - Simple mixtures / doughs
  - Compressed Pellets (sinking)
  - Extruded Pellets (sinking)
  - Extruded pellets (floating)

- Supply and demand issues
- Policy dispensation and regulatory framework (e.g. taxation, imports) in the Philippines

  (see Objective 4 - policy and regulatory frameworks for aquafeeds (including feed additives and quality standards)

Output: Survey Review

Activity 1.2: Prepare a database of locally available feed ingredients and their nutritional composition through literature search, field survey and/or laboratory analysis.

Possible to adapt existing database on the Aquafeed Formulator developed by FAO

Description	DM	Ash	GE	DE	CP	DCP	Lipid	Fibre
	%	%	MJ/kg	MJ/kg	%	%	%	%
Casein	91.5	3.7	21.7	20.5	86.5	81.7	0.2	1.0
Blood meal (batch)	89.0	4.0	22.0	14.2	76.7	57.5	1.0	1.0
Blood meal (ring/spray)	87.8	3.2	22.0	14.5	81.5	65.2	1.0	1.0
Crustacean meal (lango)	95.0	32.0	14.0	11.1	40.9	36.7	7.4	10.0
Fish meal (50% Tuna)	93.2	25.2	18.6	14.9	52.0	46.8	7.6	3.1
Fish meal (65% - anchovy)	90.4	15.7	21.2	18.7	68.0	61.9	9.0	1.0
Fish meal (70% - Danish)	90.3	12.4	20.2	14.5	72.9	63.9	13.3	2.2
Fish meal (62% - Vietnam)	93.2	21.8	20.5	18.1	62.1	55.9	5.7	1.5
Krill meal	92.9	13.0	23.0	17.4	58.0	52.2	18.0	6.0
Meat & bone meal (48%)	94.6	33.6	18.0	11.7	48.4	33.9	10.0	1.8
Meat & bone meal (52%)	95.0	30.8	18.3	11.9	53.2	38.3	8.4	1.5
Mussel (fresh)	19.4	1.6	3.6	3.2	11.9	11.3	2.2	0.0

Essential fatty acids
Essential amino acids
Cost

Add a section on dietary requirements

Laboratory analysis - who?
- cost?
- Diagnostics available ?

Tacon, A.G.J.; Metian, M.; Hasan, M.R. Feed ingredients and fertilizers for farmed aquatic animals: sources and composition. FAO Fisheries and Aquaculture Technical Paper. No. 540. Rome, FAO. 2009. 209p.

Activity 2.7 BMP feed manufacture and formulation

Activity 1.3: Review/survey of nutritional requirement and feed formulation for different life stages (fry, fingerlings and on-grower) for Nile tilapia and milkfish.

Activity 1.4: Review of existing formulations used in commercially available aquafeed and assess their suitability for tilapia and milkfish.

The nutritional requirements of Nile Tilapia

Good understanding of the nutritional requirements of the species.

Protein and essential amino acid requirements

Life stage	Weight (g)	Dietary Protein Requirement (%)
Larvae (first feeding)	<0.02	45 - 50
Fry	0.02 - 1.0	40
Fingerlings	1.0 - 10.0	35 - 40
Juveniles	10 - 25	30 -35
Adults	25 - 200	30 - 32
	>200	28 - 30
Broodstock		40 - 45

Essential amino acid requirements	(% dietary protein)
Arginine	4.2
Histidine	1.72
Isoleucine	3.11
leucine	3.39
Lysine	5.12
Methionine	2.68
Phenylalanine	3.75
Threonine	3.75
Tryptophan	1
Valine	2.8

Lipid requirements: 4 – 10 %

Essential fatty acids

Linoleic acid, 18:2 (n-6) : 0.5 – 1.0%

Or arachidonic (20:4n-6) : 1.0%

Carbohydrate requirement (Maximum 40)

Crude Fibre : 8-10% (max)

Protein - Energy Ratio: 110 mg protein/ kcal gross energy

- size effects

Typical formulations

Ingredient composition (%)		Pre-starter	Starter	Grower	Finisher
	Fish meal	15.0	12.0	10.0	5.0
	Fish oil	4.0	3.0	3.0	2.0
	Corn	0.0	0.0	3.1	14.9
	Rice bran	0.0	24.6	35.0	35.0
	Wheat bran	10.0	10.0	10.0	10.0
	Cassava	6.7	10.0	10.0	10.0
	Soybean meal	62.4	38.5	27.3	21.1
	Limestone	0.6	0.7	0.7	0.8
	Dicalcium phosphate	1.1	1.0	0.7	1.0
	Vitamin premix*	0.1	0.1	0.1	0.1
	Mineral premix*	0.1	0.1	0.1	0.1
Proximate composition (%)					
	Crude protein	40	30	25	20
	Crude lipid	6	5	4	4
	Crude fibre	3.5	4.7	5.2	5.2
	Cost (US$/tonne) in 2005	300	250	220	200

Some nutritional issues to consider when formulating feeds:

- Life stage / size and nutritional requirements
- Culture system and natural productivity e.g. extensive systems (natural feeds) vs semi-intensive / intensive systems.
- Ingredient source. Processing and anti-nutritional factors in ingredients
- Freshwater / brackishwater - Salinity and gross protein requirements (Nile tilapia)
  - e.g. fry (0.024g)

Salinity (ppt)	Protein requirement (%)
0	30.4
5	30.4
10	28.0

The nutritional requirements of Milkfish

- Nutritional requirements best understood for juveniles
- Significant work on alternative protein sources / different culture systems

Protein and essential amino acid requirements

Life stage	Weight (g)	Nutritional requirements Dietary Protein Requirement (%)
Fry	0.02 - 1.0	40
Juveniles	10 - 25	30
	reduces to 24-17 in fertilized ponds	

Essential amino acid requirements	% dietary protein)
Arginine	5.2
Histidine	2
Isoleucine	4
leucine	5.1
Lysine	4
Methionine	3.2
Phenylalanine	5.2
Threonine	4.5
Tryptophan	0.6
Valine	3.6

Crude lipid: 7 – 10%
Carbohydrate: 25% max
Digestible energy: 10.4-14.7 Kj/g

Outputs for Activities 1.3 and 1.4 :

- Complete review of nutritional requirements of the two species, current commercial aquafeed formulations in use and their applicability
- Particular reference to:
    - Ingredient sources identified from the survey (Activity 1.1)
        - Literature review on ingredient sources (proteins, lipids, carbohydrates, binders, additives), alternative protein sources, processing conditions, anti-nutritional factors, etc.
        - Cost / availability
    - Target culture systems systems (ponds, cages / tanks) and conditions (e.g. brackish water / fresh water, intensive vs extensive)
    - Manufacturing technologies / production capacities and formulations
    - Current aqauafeed formulations and performance e.g. Growth, FCRs, Cost analysis, availability issues

Activity 1.5: Collection of baseline information on the type of feed use of Nile tilapia and milkfish through liaison with farmers.

Link to:

Output 3 - Activity 3.1 Develop an understanding of on-farm feeding and feed management practices and constraints

- Rapid Farmer survey
  - 50 Tilapia farms
  - 50 Milkfish farms
- Case study area feed availability, distribution and cost (combine with Objective 1: Activity 1.1 – baseline survey)
- Laboratory proximate analysis and economic analysis
    - Are farmers getting a fair deal?

Output 2

High quality and cost-effective feed formulations for different life stages (fry, fingerlings and on-grower) of Nile tilapia and milkfish and improved capacities for small- to medium scale feed manufactures to produce safe and appropriate semi-commercial and commercial aquafeeds are developed.

Output 2

- *Activity 2.1:* Based on the information from the activities under Output 1, develop/prepare specific feed formulations (e.g., floating, sinking and extruded pellets) for different life stages (e.g., fry, fingerlings and on-grower) for tilapia and milkfish based on best available knowledge and locally available feed ingredients using linear programming or Excel-based available software. This activity will also include the selection and inclusion levels of appropriate binders to be used to increase the water stability of pellets.

- *Activity 2.2:* Test the new feed formulations against the available commercial feeds in the market for different life stages in laboratory and through farmers' participatory trial under field conditions for growth, feed conversion and economic efficiency.

- *Activity 2.3*: Identify the most appropriate binder at correct inclusion level to increase the pellet stability in water and include in the test formulation.

- *Activity 2.4:* Test water stability of the formulated pellets and compare against existing commercial pellets.

- *Activity 2.5:* Identify the type of pellet (floating, sinking and extruded) most suitable for tilapia aquaculture.

- *Activity 2.6:* Review of current aquafeed manufacturing processes used by small to medium-scale aquafeed manufacturers, and the development of Better Management Practice guidelines/ manuals for aquafeed manufacturing and feed formulation.
- *Activity 2.7:* Provide farmers and government extension worker training in better management practices (BMP) for aquafeed manufacturing and feed formulation.

Activity 2.1: Based on the information from the activities under Output 1, develop/prepare specific feed formulations (e.g., floating, sinking and extruded pellets) for different life stages (e.g., fry, fingerlings and on-grower) for tilapia and milkfish based on best available knowledge and locally available feed ingredients using linear programming or Excel-based available software. This activity will also include the selection and inclusion levels of appropriate binders to be used to increase the water stability of pellets.

- FAO feed formulator – Excel based

- Binders

Link to : *Activity 2.3*: Identify the most appropriate binder at correct inclusion level to increase the pellet stability in water and include in the test formulation.

Activity 2.2: Test the new feed formulations against the available commercial feeds in the market for different life stages in laboratory and through farmers' participatory trial under field conditions for growth, feed conversion and economic efficiency.

- Laboratory trials – who, where, what?
  - Location – Research Institutions / Universities
  - Available facilities : culture systems - tanks, ponds, cages, sizes etc.
  - Available fish / feeds (manufacture)
  - Design and replicate numbers : statistically meaningful results
  - Duration and growth rates (juveniles - 3 months, adults – 3-4 months +)
  - Who will run the trials / costs

Farmer participatory trials

Linked to farmers trials identified for feed management trials (Output 3)

Similar methodology to the laboratory trials

indicators: Growth / production parameters

Economic Feed conversion ratio (eFRC)

Activity 2.3: Identify the most appropriate binder at correct inclusion level to increase the pellet stability in water and include in the test formulation.

Activity 2.4: Test water stability of the formulated pellets and compare against existing commercial pellets.

Poor pellet binding results in:

- Economic Issues
  - Poor FCRs – high feed cost and reduced profits
- Environmental issues
  - Increased organic loading, levels of N and P
  - In extreme cases low DO and eutrophication

  Management issues e.g. low DO in early morning
- Management issues
  - High algal loading / Low DO in early morning
  - Carrying capacities

Pellet integrity / fines impacted by:

- Manufacturing technologies
  - Milling / sieving
  - Compressed Pellets
  - Extruded Pellets (cooking / gelatinization)
- Formulation / ingredients
  - some ingredients bind poorly at high inclusion levels
- Binders
  added to the formulations (2 – 30%)

Common binders / combinations used in aquafeeds:

- Wheat glutens
- Wheat flour
- Rice flour
- Maize flour
- Polymethyolcarbamide (Aquastab)
- Calcium lignosulfate (Lignobond)
- Ethylene/vinyl acetate polymer

abalone

Way forward

- Establish what manufacturing technologies are available and how this influences binding
- Establish what binders are available locally and develop a series of test diets based on the improved formulations and different binder inclusion rates
- Stability / Leaching trials to test the new formulations against currently available commercial feeds

Activity 2.5: Identify the type of pellet (floating, sinking and extruded) most suitable for tilapia aquaculture.

Floating feeds	**Sinking Feeds**
Advantages	**Advantages**
Directly observe feeding behaviour, easy feed management	Low cost
Uneaten feed can be removed from the ponds	Suitable for multiple feed ingredients
Increased digestibility of nutrients	Simple production technology
Good water stability	High density – storage
	Fish do not need to surface to feed / move through stratified water
Disadvantages	**Disadvantages**
More expensive to produce	Cannot directly observe feeding behaviour
Higher technology requirements to produce	Uneaten feed cannot be removed from production system – possible water quality issues
Fewer ingredients may be suitable for inclusion	
Fish spend more time at surface – bird predation	Lower digestibility of ingredients

To consider:

- Availability of suitable ingredients that can be incorporated into feeds
- Production technology (commercial vs small-scale)
- Feed cost and affordability / production cost
- Feed management issues
- Environmental management

Incorporate into Farmer Trials

Activity 2.6: Review of current aquafeed manufacturing processes used by small to medium-scale aquafeed manufacturers, and the development of Better Management Practice guidelines/ manuals for aquafeed manufacturing and feed formulation.

Activity 2.7: Provide farmers and government extension worker training in better management practices (BMP) for aquafeed manufacturing and feed formulation.

Develop BMP training materials to improve small-scale – medium scale feed manufacturing / formulation (excel based feed formulator)

Undertake small– medium- scale feed manufacturers and extension workers training to test training materials

Finalise BMP manuals and training materials