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# Development of quality and affordable fish feed for small scale fish farmers in Malawi

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## Abstract

The project aims at contributing to increased fish production in rural communities of Mpamba in Nkhatabay district of Malawi. The aim is being achieved through developing quality affordable feed from locally available ingredients, evaluating production economics associated with the development of feed, and assessing and evaluating market chains of small scale aquaculture. The project is carried out through action research with farmers. The project is involving 2 MSc students for 2 years (2012 - 2014) costing US$60, 000.00 with support from the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

Key words: Action research, cost benefit, market chain, plant source

## Résumé

Le projet vise à contribuer à l'augmentation de la production de poisson dans les communautés rurales de Mpamba dans le district de Nkhatabay, au Malawi. Le but est atteint par le développement de l'alimentation de qualité et abordable à partir d'ingrédients disponibles localement, l'évaluation de l'économie de production associés au développement de l'alimentation, et l'évaluation des chaînes de marchés pour l'aquaculture à petite échelle. Le projet est réalisé grâce l'action de la recherche avec les fermiers. Le projet implique deux étudiants à la Maîtrise de Science (MSc) pour 2 ans (2012-2014), coûtant 60.000.00 $ US avec le soutien du Forum des Universités Régionales pour le Renforcement des Capacités en Agriculture (RUFORUM).

Mots clés: recherche-action, coûts-avantages, la chaîne de commercialisation, source végétale

## Background

The fishing sector is important to both Malawi's economy and its overall food security, providing 300,000 – 450,000 jobs and 4% of GDP (FAO, 2008). However, most natural fish stocks in Malawi are either fully or over exploited. On other hand, aquaculture which is growing exponentially in other parts of the world, as an answer to the frail fishery production against human population increase, is growing at a staggering low rate in Africa, only contributing 1.2 % to the global Aquaculture production. The aquaculture sector in Malawi contributes 2 percent to nation's fish production with an average productivity of 700 Kg/ year (Chirwa 2008). Availability of affordable quality feed is one of the most important challenges/problems that hamper Aquaculture growth for both small scale as well as large scale aquaculture operators in Malawi.

**Literature summary**

Access to nutritional inputs is identified as a key constraint by all fish farmers in Malawi (Andrew et al. 2003). Over 90% of all fish farmers use primarily maize bran as fish feed. This feed ingredient has been recommended by extension services since the 1940s, but it has low gross protein content (2-3%) and a poor food-conversion ratio (FCR) of 12-20:1 (Hecht, 1999).While the availability of maize bran is usually good, it can vary by region or season, and when there is a general shortage of maize (the Malawian food staple), maize bran faces competing uses as it is a major source of feed for livestock such as pigs and may be consumed directly by poorer families, hence not sustainable in production of fish feeds. Rather as observed by Hecht and Maluwa (2003) and Kang'ombe *et al.* (2009), available alternative ingredients would be sustainable.

One of the reasons for the low fish productivity in Malawi is the rising costs of inputs (feed and fertilizers) (Nagoli *et al.*, 2013). It is against this background that Kan'gombe *et al.* (2009), Hecht and Maluwa (2003) advocates that available alternative ingredients would be sustainable in Malawi. At present, evidence exists that farmers in Malawi are still not fully aware of the benefits of using alternative inputs such as ,cassava leaves, sweet potato leaves, buffalo bean grass,, napier grass, mulberry leaves,, banana leaves, pawpaw leaves, cabbage leaves, (Hecht and Maluwa, 2003). The use of non-conventional feedstuffs has been reported to register satisfactory good growth and better cost benefit values (Abowei and Ekubo, 2011).

**Study description**

The research is conducted at Mpamba area in Nkhatabay district of Malawi. The area has more than 500 small scale fish farmers. The study has adopted an action research approach and engaged two Master of Science (MSc) students (1 male and 1 female). Student 1 is working with rural fish farmers and partner agencies in developing quality and affordable fish feed from locally available ingredients. Four procedures were carried out in the development of feed: 1) collection of plant based ingredients with farmers at Mpamba; 2) proximate composition analysis to determine nutrient content of each ingredient. The procedure was carried out at Bunda College Laboratory. Proximate analysis of plant ingredients were done for crude protein, crude fiber, crude fat, and energy, moisture and minerals (Phosphorus, Potassium and Calcium) following the A.O.A.C (2000). One way analysis of variance (ANOVA) was used to analyze data in SPSS for windows version 16.0. The significant differences were considered at 0.05 alpha level. Duncan's Multiple Range Test was employed to separate significantly different means. 3) Digestibility test of the formulated diets and 4) pond based fish growth experimentation using formulated diets.

Student 2 is working with farmers and partner agencies in analysing market chains based on small scale pond based aquaculture and evaluating production economic potential of feed developed using locally available ingredients. The market chain study was a survey that involved BSc students from Mzuzu University, farmers, consumers, traders and stakeholders in Nkhatabay. Data Analyses were done through calculation of static indicators which included the total costs, total revenue, gross profit and net profit. Income distribution of actors along the market chain was analysed using the Gini index.

## Research application

**Feed development.** Thirteen locally available plant based ingredients were collected on which proximate composition analysis was conducted. The ingredients included; Cassava leaves, Cassava peels, Sweet potato meal, Sweet potato peels, Cocoa yam, Banana leaves, Papaya leaf meal, Black jack leaves, Maize bran, Mexican fire plant, Akee, Jackfruit, Sweet potato meal.

Sweet Potato Peel, CYL: Cocoa yam, BL: Banana Leaf, PPL: Papaya Leaf Meal, BJ: Black Jack, MZB: Maize Bran, MFP: Mexican fireplant, AK: Akee, JF: Jackfruit.

**Table 1. Proximate composition of plant feedstuffs from Mpamba (Mean±SE) expressed as percent (%) dry matter.**

| Ingredient analysed | Moisture | Ash | Fiber | Protein | Fat | EnergyKj/g |
|---|---|---|---|---|---|---|
| CL | 11.97±0.75[a] | 13.6±0.65[b] | 16.35±0.75[a] | 21.17±0.56[a] | 3.16±0.00[b] | 20.59 |
| CP | 6.70±0.09[b] | 46.6±0.40[c] | 16.84±0.26[a] | 7.40±0.34[b] | 5. 92±0.1[b] | 8.78 |
| SPL | 10.89±0.31[a] | 85.75±0.0[a] | 9.16±0.70[c] | 8.40±0.10[c] | 2.98±0.25[b] | 29.7 |
| SPP | 25.95±4.29[c] | 6.04±0.45[b] | 3.26±0.20[b] | 8.40±0.80[c] | 5.01±1.64[b] | 15.21 |
| CYL | 7.08±1.56[a] | 14.84±0.45[b] | 3.95±0.15[b] | 24.28±0.11[d] | 7.23±1.52[c] | 19.54 |
| BL | 7.80±1.56[a] | 16.8±3.50[b] | 6.95±0.15[b] | 7.65±0.23[b] | 2.22±0.10[b] | 19.06 |
| PPL | 10.95±0.10[a] | 13.5±0.47[b] | 5.50±0.20[b] | 2.78±0.14[e] | 16.07±0.10[a] | 15.21 |
| BJ | 20.79±0.71[d] | 23.1±0.91[c] | 6.40±0.75[b] | 24. 35±0.7[d] | 5.65±0.93[b] | 12.4 |
| MZB | 8.87±0.90[a] | 3.72±0.32[b] | 3.40±0.15[b] | 11.81±0.11[c] | 7.28±1.90[c] | 15.72 |
| MFP | 10.05±1.00[a] | 11.9±0.21[b] | 6.35±0.25[b] | 11.40±0.11[c] | 4.64±1.49[b] | 12.22 |
| AK | 10.37±0.43[a] | 7.06±0.05[b] | 5.5±0.35[b] | 12.07±0.18[c] | 10.58±1.00[c] | 19.63 |
| JF | 8.44±0.20[a] | 9.05±0.15[b] | 7.0±0.20[b] | 4.77±0.45[b] | 7.83±0.25[c] | 19.27 |
| SPM | 9.67±0.11[a] | 85.7±0.15[a] | 3.19±0.30[b] | 11.97±0.45[c] | 3.2±0.45[b] | 15.32 |

Values (Mean±SE) in a column with different superscript letters are significantly different (P<0.05); Where; CL: Cassava Leaf, CP: Cassava Peels, SML: Sweet Potato Meal, SPP: Sweet Potato Peel, CYL: Cocoa yam, BL: Banana Leaf, PPL: Papaya Leaf Meal, BJ: Black Jack, MZB: Maize Bran, MFP: Mexican fireplant, AK: Akee, JF: Jackfruit.

The findings of proximate analysis in Figures 1 and 2 have directed the process of feed formulation for *Tilapia rendalli*.

**Economic analysis - Market chains.** The market chain at Mpamba is simple and short; it mainly consists of the fish farmers and consumers, to a lesser degree it links farmers, traders and consumers. The results have shown that after the farmers have produced the fish, it is sold directly to the ultimate consumer.

Production costs in Mpamba take the forms of variable and fixed costs (see Table 3). Variable costs include costs of labour, fingerlings, feed for the fish, manure and fertilizer. Labour constitutes the highest proportion (23%) of variable costs, seconded by costs of manure (organic and inorganic) 22%, followed by feed at 21% while cost of fingerlings is at 19% and lastly transport costs contribute 15% of variable costs. Fixed costs include the cost

**Table 2. Mineral composition of plant feedstuffs from (Mean±SE) Mpamba expressed as percentage (%) dry matter.**

| Ingredient analyzed | Calcium | Potassium | Phosphorus | Vitamin C |
|---|---|---|---|---|
| CL | $1.62\pm0.04^{c}$ | $1.11\pm0.01^{a}$ | $0.29\pm0.02^{a}$ | $5.55\pm0.75^{a}$ |
| CP | $0.57\pm0.02^{c}$ | $0.89\pm0.01^{a}$ | $0.12\pm0.01^{a}$ | $3.63\pm0.15^{a}$ |
| SPL | $21.1\pm0.29^{a}$ | $1.33\pm0.01^{a}$ | $0.88\pm0.03^{a}$ | $12.3\pm0.05^{b}$ |
| SPP | $14.8\pm0.12^{d}$ | $0.98\pm0.01^{a}$ | $14.8\pm0.12^{b}$ | $4.75\pm0.15^{c}$ |
| CYL | $0.23\pm0.10^{c}$ | $0.19\pm0.02^{c}$ | $0.55\pm0.00^{a}$ | $12.4\pm0.15^{b}$ |
| BL | $0.33\pm0.00^{c}$ | $0.26\pm0.23^{c}$ | $0.12\pm0.00^{a}$ | $3.00\pm0.20^{a}$ |
| PPL | $1.05\pm0.05^{d}$ | 0.89±0.01a | $2.23\pm0.04^{a}$ | $21.2\pm0.15^{d}$ |
| BJ | $4.66\pm0.00^{d}$ | 2.20±0.14b | $7.01\pm0.00^{c}$ | $5.07\pm0.75^{a}$ |
| MZB | $0.55\pm0.01^{c}$ | 0.33±0.00c | $0.56\pm0.02^{a}$ | $1.30\pm0.00^{a}$ |
| MFP | $2.80\pm0.00^{e}$ | 1.70±0.00a | $5.30\pm0.10^{a}$ | $13.7\pm5.15^{b}$ |
| MP | $2.30\pm0.06^{e}$ | $1.48\pm0.14^{a}$ | $4.02\pm0.01^{a}$ | $13.7\pm0.00^{b}$ |
| TPTP | $3.33\pm0.03^{e}$ | $2.60\pm0.25^{d}$ | $2.44\pm0.38^{a}$ | $12.6\pm0.20^{b}$ |
| SPM | $19.0\pm0.16^{b}$ | $1.64\pm0.00^{e}$ | $1.04\pm0.06^{a}$ | $2.80\pm0.00^{c}$ |

Values (Mean±SE) in a column with different superscript letters are significantly different ($P<0.05$); Where; CL: Cassava Leaf, CP: Cassava Peels, SML: Sweet Potato Meal, SPP: Sweet Potato Peel, CYL: Cocoa yam, BL: Banana Leaf, PPL: Papaya Leaf Meal, BJ: Black Jack, MZB: Maize Bran, MFP: Mexican fireplant, AK: Akee, JF: Jackfruit.


**Figure 1. Market value chain of pond fish at Mpamba.**

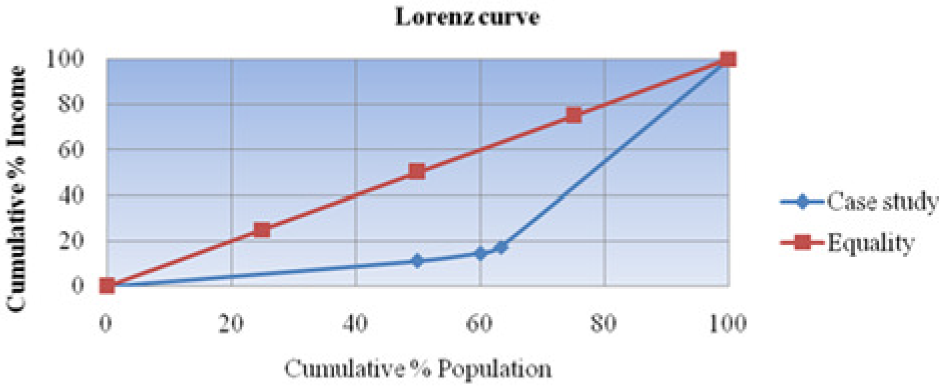


**Figure 2. Lorenz Curve showing distribution of income among farmers based on market type.**

**Table 3. Costs and income for Mpamba fish farmers (exchange rate: MK420 = 1US$).**

| Category | Amount (MK) | Percent (%) |
|---|---|---|
| **Fixed costs** | | |
| Farm equipment | 24,486.00 | 53 |
| Pond construction | 21,714.00 | 47 |
| Land (cost) | - | - |
| Total Fixed Costs | 46,200.00 | 100 |
| **Variable costs** | | |
| Feed | 9,320.36 | 21 |
| Fingerlings | 8,432.71 | 19 |
| Organic and inorganic manure | 9,764.19 | 22 |
| Labour | 10,208.01 | 23 |
| Transport | 6,657.40 | 15 |
| Total Variable Costs | 44,382.67 | 100 |
| Total costs | 90,583.00 | - |
| Gross income | 32,222.33 | - |
| Net income | -13,978.00 | - |
| Total income | 76,605.00 | - |

**Table 4. Income distribution of farmers at Mpamba based on market type.**

| Market type | Percent population | Percent income | Per capita income distribution |
|---|---|---|---|
| On farm | 50 | 11.1 | 0.222 |
| At market | 36.7 | 82.6 | 2.25 |
| World Vision | 3.3 | 2.9 | 0.879 |
| Customers' homestead | 10 | 3.4 | 0.34 |
| Total | 100 | 100 | |

of land, construction costs, cost of equipment and the costs of other structures on the farm. Farmers on average spend MK24, 486.00 on equipments and MK21, 714.00 on construction costs. On average each farmer spends MK44, 383.00 on variable inputs and MK46, 200.00 on fixed inputs, making a total of MK90, 583.00 in a single growing season which lasts for six months.

According to Table 4, a greater percentage (50%) of the farmers sells their fish right on the farm. These findings are in agreement with those of Banda *et al* (2012), who found out that farmers primarily sell fish at farm gate, this was attributed to low levels of production as is also the case with this study.

The shape of the Lorenz Curve is a good visual indicator of how much inequality there is in an income distribution (FAO, 2005). The closer the Lorenz curve is to the equi-distribution line, the more equal the distribution of income is in a population. Figure 1 shows that the Lorenz Curve lies in between the two extremes, meaning that income distribution of farmers in Mpamba is unequal.

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The study team is currently conducted digestibility trials, pond fish growth experimentation using diets and production economics study based on pond growth experimentatio*n*.

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