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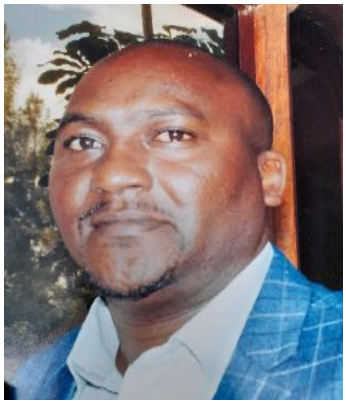
KEY LIMITATIONS OF FISH FEEDS, FEED MANAGEMENT PRACTICES, AND OPPORTUNITIES IN KENYA'S AQUACULTURE ENTERPRISE

Munguti J[1]*,Obiero K[2], Odame H[3], Kirimi J[4], Kyule D[1] Ani J[5] and D Liti[6]



Jonathan Munguti

*Corresponding author email: jmunguti2000@gmail.com

[1]Kenya Marine & Fisheries Research Institute, National Aquaculture Research Development & Training Center (NARDTC), P.O. Box 451-10230, Sagana, Kenya

[2]Kenya Marine & Fisheries Research Institute, Sangoro Aquaculture Research Station, P.O. Box 136-40111, Pap-Onditi, Kenya

[3]Agricultural Innovation Systems, Centre for African Bio-Entrepreneurship (CABE), P.O. Box 25535-00603, Lavington, Nairobi, Kenya

[4]Department of Animal Sciences, Chuka University, P.O. Box 109-60400, Chuka, Kenya

[5]University of Eldoret, Department Fisheries and Aquatic Sciences, P.O Box 1120-30100, Eldoret, Kenya

[6]University of Eldoret, Department Biological Sciences, P.O Box 1120-30100, Eldoret, Kenya

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ABSTRACT

Profitability is key in fish farming, just as it is to any other enterprise. For the farmers to actualize high-profit margins, it is imperative to have access to well-balanced nutritive and cost-effective feeds, backed by sound on-farm feed management practices. This paper audits Kenya's fish feed industry and the on-going on-farm feed management practices, and emerging opportunities for fish farmers. The development of fish feed quality standards has boosted the aquaculture sector in Kenya, providing them hope that farmers will access high quality fish feeds. Much of the fish feed currently being used in Kenya is produced on-farm or by small-scale fish feed manufacturers within the East African region, while a few are imported directly from overseas countries, notably Israel, Netherlands, Mauritius and Denmark. Fish feeds produced by small-scale manufacturers are not closely monitored by quality standard agencies and not surprising that a majority are of poor quality. The improvement in the quality of these feeds is likely to lead to increased productivity and profitability because they are cheaper and readily available to fish farmers, compared to imported fish feeds. Besides feed quality, feed management practices markedly impact both the growth and economic performance of fish production. Adopting appropriate feed management strategies, therefore, is instrumental in the maximization of fish production and economic returns. Research has demonstrated several strategies for best feed management practices, which have not hitherto, been adopted by fish farmers in Kenya. Farmers have mainly focused on the mode of delivery of feeds to the fish. Furthermore, promoting natural pond productivity and supplementary feeding is still a common practice in the East African region. Provision of species-specific feeds and targeting the nutritional requirements of the different life stages of fish is still a major issue, although some local companies like Unga Farm Care (EA) have come up with a size and species-specific feed for catfish such as Fugo catfish®. To improve access to such information, public-private partnerships should be developed and, programmes that utilize the local media platforms such as extension service outlets must also be encouraged. Feed quality checks can also be carried out amongst fish feed suppliers. Lastly, farmers should be trained in various fish feed aspects like formulation, transportation and storage to sustain a steady fish feed supply and save on associated feed costs.

Key words: Feeds, management practices, quality, aquaculture enterprises, tilapia, catfish

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INTRODUCTION

The United Nations's Food and Agriculture Organization [1] estimates that to feed the world population by 2050, agricultural output emanating from fisheries and aquaculture must somehow grow by over 60% [2]. However, it is a great challenge for the international community to achieve this, considering the fact that many people especially in the developing nations still suffer from hunger, malnutrition and poverty. To meet the high demand for food fish by an increasing global population by the year 2030, aquacultural production growth rate needs significant acceleration since it appears that the capture fisheries production has stagnated since the early 1990s (Figure1) [3].

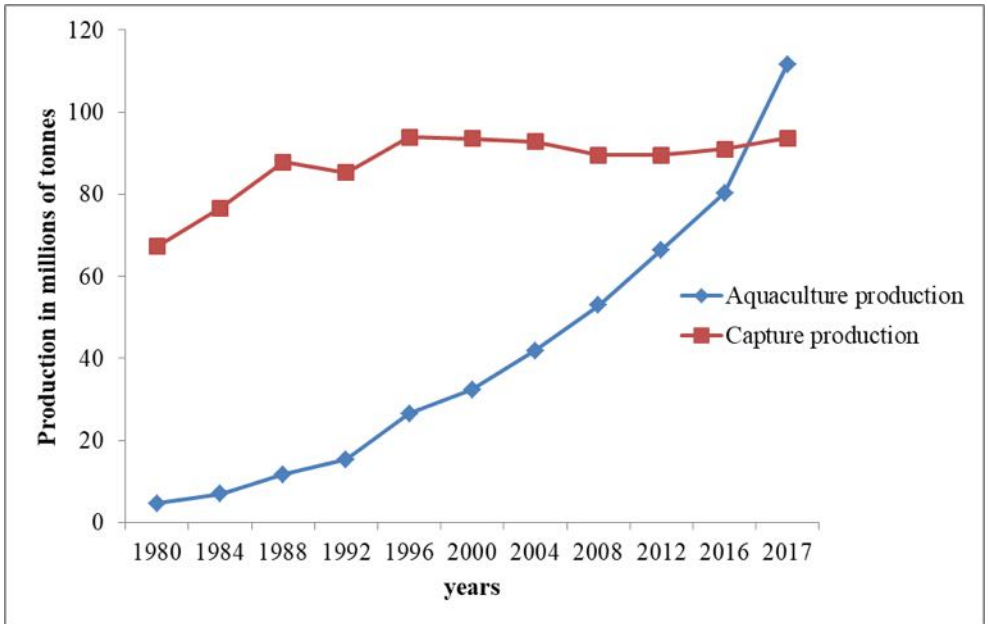

Figure 1: Global trends in the contribution of aquaculture to fisheries production, 1980–2017 Source: Adapted [4]

There has been continual development of aquaculture technologies in many nations around the world, with an aim of accelerating production, especially targeting feed and feed management practices [3]. Notwithstanding the significant inter-nation variances in production capacities, aquaculture has comprehensively attained the highest average growth and is currently the fastest-growing food production sector in the world. The global production figures have increased from 32.42 to 111.95 million tonnes between 2000 and 2017 [4]. Technological developments in fish feed processing equipment and feeding techniques have led to an increased contribution to the total aquaculture production, which is now at similar levels with capture fisheries [3, 5]. However, this increment is largely linked to Asia, which accounts for approximately 92% of the total global production, while the other continents (Americas, Africa and Europe) together contributed a paltry 8.3% [5]. The contribution of aquaculture to global fisheries production rose to almost threefold from 15% in 1988 to 47% by 2010 following significant contributions from the Asian countries [5].

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African aquaculture is currently undergoing an incremental phase of growth after numerous false starts, perhaps as a result to the high incidence of poverty, malnutrition, and unemployment [6]. The potential of African countries to practice aquaculture exists because 37% of its surface area is suitable for artisanal fish farming and 43% for commercial fish production [7]. Although there is still room to enhance aquaculture production in Africa, through improvements in the production system, genetics, general farm management practices and the desired growth levels, which are necessary to meet the ever-increasing demand for fish can only be achieved through the production of cost-effective and high quality fish feed, coupled with effectual feeding practices [8].

Despite such constraints, fish production in Kenya over the last decade has increased from 895 metric tonnes in 2009 to the current level of 18,542 metric tonnes in 2019 (Figure 2). This increase is attributed mainly to the Government of Kenya's stimulus programme to boost the fish farming programme and increased growth in cage fish farming [9]. The ripple effect of the programme led to increased pond construction, placing a great demand for both fish seed and feeds to over 100 million and 100,000 metric tonnes, respectively [9]. This demand could not be adequately and timely met by both public and private sectors dealing with fish seeds and feeds [10]. The deficieny in feeds led to importation of fish feeds.

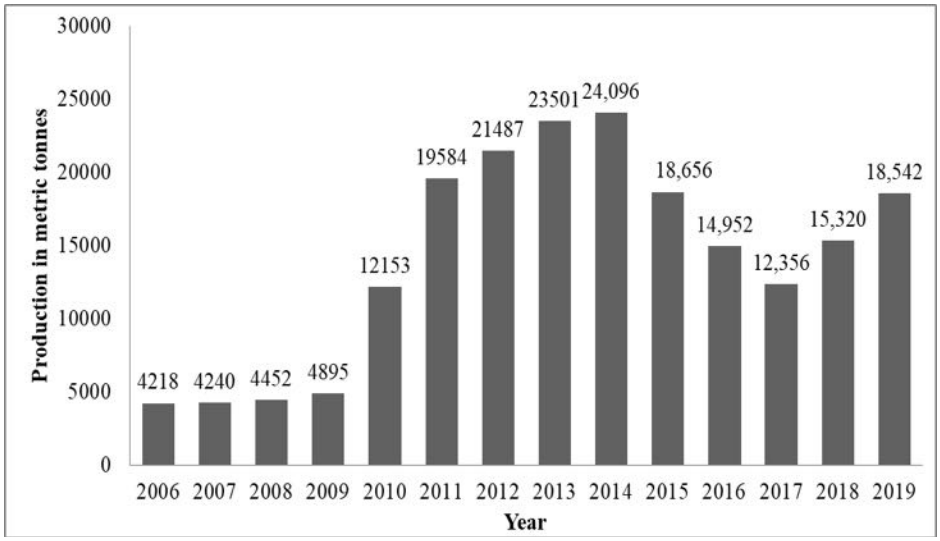

Figure 2: Trends in aquaculture production in Kenya 2006– 2019 [4, 11]

The growth of aquaculture in Kenya positively correlates with the gradual production of quality feeds, which meets the nutritional requirements of the cultured fish [12]. The increase in aquaculture production must, therefore, be supported by a corresponding increase in the production of fish feeds. Fish feed quality and feeding management practices are major challenges in aquaculture in Kenya [13].

Feed represents the largest expenditure among the operational items in aquaculture ventures and this is attributed to the high cost of protein sources in the feed [13]. In fertilized tilapia ponds, natural food organisms contribute a significant amount of nutrition necessary for fish growth. Supplemental feeds are used to augment natural

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food to maximize on fish yields [10]. For aquaculture to record considerable growth and meet its growth potential, development of Kenyan fish feed industry needs to be refocused. There is also a need to optimize feed production and employ best on-farm feeding management practices to sustain aquaculture growth in Kenya. Today, many smallholder fish farmers do not have enough skills to optimize feeding operations, leading to low returns in their aquaculture enterprises. This paper provides an audit of the current status of the fish feed industry and on-farm feeding management practices in Kenya. It also focuses on other aquaculture aspects including the opportunities and challenges linked to the farmers**.**

Status of the fish feed industry in Kenya

Fish feeds are among the most expensive animal feeds on Kenyan markets today, accounting for between 50 and 70% of the total production costs [14]. Access to quality and affordable fish feeds coupled with the optimisation of feed utilization by instituting suitable on-farm feed management practices is an important step towards ensuring profitability and viability of any fish farming enterprise. Most small-scale fish farmers usually fertilize their ponds and feed fish with locally available feeds derived mainly from agricultural by-products [15]. Before the availability of compounded feeds, many farmers used locally-grown rice and wheat bran, cassava meal and cornmeal to feed fish in their fertilized ponds. In traditional systems, fish were reared in ponds fertilized with organic manure with some or no inclusion of supplementary feeds [16]. Fish farmers mainly use plant-based single ingredients, which are low in both macro- and micro-nutrients and deficient in one or more amino acids, especially methionine and lysine [17] (Table 1). Such ingredients also have a high content of crude fibre, which reduces the digestibility and palatability of the feed, leading to low fish yields [16].

Studies done at Sagana fish farm in Kenya have indicated a variation in the performance of different cereal bran in promoting fish growth, with maize bran doing better than wheat and rice bran [16]. The limitation of using some brans as fish feeds is due to the low protein and high fibre content. The crude fibre in feed gives it the physical bulkiness, improves binding and moderates the passage of feed through the alimentary canal [18]. However, fish are generally unable to digest the fibre in feeds because they do not secrete cellulase which is an essential enzyme for digestion. The inclusion levels of these ingredients depend on the protein and energy contents of the feed, ingredients availability and their prices as well as the fish species and sizes.

Despite the high adoption of aquaculture in many regions of the country, formulated feed remains the highest challenge due to the high cost of feed [19]. The wide adoption of aquaculture in Kenya has led to high demand for fish feeds. This demand has seen the rise of unprincipled feed dealers who take advantage and compromise the feed quality, prompting the government to establish fish feed standards. The latter was a culmination of negotiations between different aquaculture stakeholders and the Kenya Bureau of Standards (KBS). The fish feed standards were, thus, created as part of the efforts to ensure high quality fish feeds on the market and address the challenges associated with aqua-feeds like low crude protein levels, short shelflife, aflatoxins, among others. The enforcement of these standards will ensure those feed manufacturers

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improve the quality of their products, hence assuring farmers of high quality feeds, which will automatically result in higher sales. Enforcement together with the maintenance of best feeding aquaculture practices will ensure that challenges associated with feeds in aquaculture are well addressed. The Kenya fish feed standards for tilapia, catfish and trout are shown in tables 2, 3 and 4.

Commercial fish feeds in Kenya, usually contain 24–30% and 30–40% crude protein for Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), respectively [10]. Due to the already highlighted challenges associated with their acquisition, farmers end up using different locally available ingredients such as a mixture of rice bran and fish meal, dried freshwater shrimp (*Caradina spp*.) and maize bran, and omena (*Rastrineobola argentea*) to formulate their feeds [8]. However, the practice of mixing does not prompt optimal feed requirement for fish, leading to poor growth and nutritional deficiencies [20]. To address the low-quality feeds in the country, the government in consultation with different aquaculture stakeholders carried out a vetting exercise for all fish feed manufacturers by analyzing their feeds.

Fish feed sources in Kenya

The category and value of feed inputs selected by farmers depend on whether they practice semi-intensive or intensive farming. They are also determined by both local and international market considerations, the value of the fish, availability of financial resources and the culture system used [21]. Mostly, the management practices for low-value species rely on natural food production in the ponds, the use of farm-made feeds or simply feeds bought from small-scale feed producers. Small-scale commercial feeds consist of one or more feed ingredients, while large-scale pelleted feeds which target high-value species that are cultured in intensive systems comprise of complete diets with nearly all the ingredients. The use of the latter is limited to few farms practicing intensive aquaculture because of the associated high costs.

In Kenya, most grow-out fish are hand-fed twice a day (morning and afternoon hours) with feeds containing 25 - 30% crude protein, while fingerlings are fed at least 3 times a day at 3% body weight with 30 - 40% CP diets. Majority of farmers use wheat, rice and maize bran, often supplemented with leaves and vegetables [22]. To get better growth results, formulated diets should be used. Compounded feeds give better fish growth than local brans. Economic comparisons have also favoured the utilization of formulated diets [23]. Thus, to be able to sustain the rising aquaculture development in the country, least-cost compounded feeds formulated from locally available ingredients should be used especially in semi-intensive systems.

As aquaculture production intensifies, there could be a shift towards the use of nutritionally complete feeds which will, in turn, increase the demand for commercially produced feeds [24]. However, farm-made feeds are generally more affordable than commercial ones and remain the main source of feed for most semi-intensive farmers in Kenya. Some production sectors in other countries like Vietnam who have improved their formulations and manufacturing techniques have already witnessed significant improvements in the quality of their farm-made feeds [25]. Most feed formulations currently contain up to six ingredients and are extruded to form semi-moist pellets with

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improved water stability [25]. Kenya could replicate such efforts to improve its fish production from aquaculture. The use of locally available least-cost feed ingredients like agro-industrial wastes has been fully embraced in Kenya. There exist several collaborative research initiatives geared towards expanding the list of ingredients and improving the feed conversion ratio (FCR), reducing toxins and anti-nutritional factors in order to improve quality and performance of both commercial and farm-made feeds. A survey conducted by KMFRI [26], tabulated a list of active feed producers, their location, production capacity, feed type and approximated farmers served from each producer as illustrated in Tables 6 and 7.

Optimizing feed management strategies in fish farming

The profitability of commercial farming is paramount; therefore, adopting suitable feed management strategies contributes substantially to optimal use of the feeds thereby ensuring maximum returns. While maximum growth rates can be achieved when fish are fed to satiation, over- or under-feeding results in low fish growth due to poor feed management practices employed [27]. Under-feeding lowers growth rates because of lower protein intake and promotes size heterogeneity [28], which can lead to cannibalism and eventually low yields. Optimization of feeding strategies requires the calculation of suitable ration sizes and feeding rates, feeding frequencies and times, taking into consideration the natural feeding rhythms of the farmed species. Farmers using commercial feeds need technical support to help them determine rations and also feeding schedules. Fish feed companies should ensure that their feeds are utilized appropriately as well as try to develop long-term commercial relationships with their clients. Farmers using their farm-made feeds are less likely to have access to the information on the feeding schedules of their cultured fish species, hence, finding it difficult to determine suitable rations, and in many instances, likely to adopt inappropriate feeding strategies. Many farmers do not feed their fish according to the prescribed rates and fail to take into consideration ambient temperature, body mass and pond biomass when calculating the feed rations. Poor record-keeping makes it difficult for them to even adjust the daily rations. Most of them do not have the knowledge and skills of monitoring, recording feed utilization; this makes it difficult to use FCRs to determine feed efficiencies. Most fish farmers lack records on stocking rates, mortalities and water quality, making it difficult for them to assess and monitor the efficacy of their production systems and determine whether changes effected in their management strategies are effective in production efficiencies. There is, therefore, a clear need to train fish farmers in feed management practices, and use of feeding tables to ensure that they maintain enough feed and production records. Indeed, some farmers think that by over-feeding the fish, higher growth rates will be achieved.

In some examples, innovative farmers have detailed building up their feeding techniques to enhance feed use. For instance, a few farmers spread their farm-made feeds at different fixed points within ponds and feeding at the same time daily. However, placing powdered feeds in this manner could result in most of it being dispersed in the water column and thereby being wasted. More innovative techniques such as ‘bag feeding’ in which the feed mixtures are placed in bags that are located throughout the pond ought to be energized. This strategy advances feeding on demand

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and results in higher growth rates, improved feed ingestion rates, and higher retention rates [10].

Plate 1: Suspended feeding bags in a fish pond [29]

The possibility of restrictive feeding methods where the fish are left unfed for one day in every ten days diminishes feed costs and invigorates compensatory growth, needs some consideration [30]. While the potential for restrictive feeding regimes has been exhibited experimentally for the African catfish (*C. gariepinus*), it is yet to be embraced as a farming method [31]. Break feeding schedules which include parting feed proportions into a few portions, postponed by 20 minutes' span may have important application in Kenya. This methodology permits both large and smaller fish to be able to feed to satiation, thus, promoting negligible size variations at harvest. The role that such innovative farmers play in improving on-farm feed management practices is worth considering. Notwithstanding, these advancements need further development before disseminating the innovation to fish farmers and later imparted to fish farmers.

Promotion of natural productivity for effective feed management

Enhancing natural productivity gives food resource for low trophic fish feeders. The utilization of inorganic and organic fertilizers in both extensive and semi-intensive production systems is a settled practice in numerous nations [32]. However, impressive contrasts exist in the type of fertilizers utilized and accessibility, cost, and application rates. In Kenya, farmers fertilize ponds at sub-optimal levels resulting in lower levels of primary production. In such cases, training farmers on how to utilize simple indicators to gauge the levels of natural productivity in their ponds and giving data that aid in the management of plankton, benthos and periphyton production helps to boost their production efficiencies. This can be made possible by establishing subjective and quantitative relationships between natural productivity, and the effect of supplemental

feeds on nutrient cycling and their retention in the culture systems [33]. A superior comprehension of these dynamics helps to improve the nutrient use in the culture systems, diminishing feed costs and improving the efficacy of feed management systems and thus need further explanation.

Feed formulations

The provision of species-specific feeds that addresses the nutritional requirements of the different life stages of fish is still a challenge for most commercial and farm-made feed production sectors [34]. Most formulations of commercially manufactured feeds in Kenya are experimental and use high quality ingredients, thus, only a few feeds are tested under on-farm conditions. Commercial formulations in Kenya mostly lack scientific research backing or the formulations are based on proximate data tables which were analyzed in other countries and most formulators do not take in to account whether the data were given on dry weight or as fed basis. In this case, the formulation may not meet target nutritional requirement. Undoubtedly, the utilization of inappropriate formulations is a common problem in Kenya. In some cases, Kenyan farmers use commercial grow-out formulations that contain a more elevated level of dietary protein than is required, while others feed fish with grow-out feeds that are designed for other species. While a significant amount of research has been done to establish the nutritional requirements of many species, a lot of these data have not been gotten to by most farm-made feed producers or small-scale feed manufacturers (Tables 2, 3 & 4). Data on nutritional requirements of fish, mainly dietary protein and protein-energy ratios and how the dietary protein level changes over the production cycle, are as yet missing [35]. However, with continuous on-farm training done by several but relevant aquaculture players, this challenge is probably going to be addressed in the long-run.

Feed processing technology

A significant part of the aquafeeds in Africa is either produced on-farm or by small-scale semi-commercial feed manufacturers [36]. Improvements to the quality and preparation of on-farm feed lead to improved productivity and cost savings. The quality of the feed ingredients utilized and the formulations applied, the manufacturing processes and type of feed produced can essentially influence the feed performance. Selection of sensibly priced, good quality ingredients and proper processing of those ingredients into complete diets is equally significant to the overall profitability of the aquaculture enterprise. Even though feed processing is often given less emphasis, it represents an important portion of feed costs that likely influence animal performance, beyond nutritional performance. Even though it is well perceived that high quality fish feed will directly impact growth and feed conversion, the importance of feed quality is not given enough priority. While farmers generally recognize the need to utilize quality feed ingredients, they often are unaware that feed processing technology has a significant effect on feed quality. In Kenya, many of the feed ingredients that are used in farm-made tilapia feeds are poorly milled and pelleted, hence fail to conform to the feed process standards. This leads to most of the feed being lost in the water column, resulting in low ingestion rates and high economic feed conversion ratios (eFCR). Farmers should, therefore, be encouraged to use simple extruders to compress their feed

ingredients into dry pellets. Likewise, improved milling and the binding characteristics reduce the number of breakages and fines, improves pellet hardness and water stability. This also improves the e-FCR which in turn, results in cost-related savings to the farmer [37]. Focusing on improving efficiencies in the farm-made and small-scale feed manufacturing sectors is likely to bring significant gains to on-farm feed efficiencies.

In conclusion, admittance to state-of-the-art market data for small to medium feed makers and ranchers creating ranch-made feeds is an issue that should be attended to. Contemporary market data including sources, providers, quality and cost is essential to the advancement of practical ranch made feeds. Moreover, the utilization of suitable neighbourhood and occasionally accessible feed fixings that can be consolidated into ranch made feed, ought to be energized.

Small to medium feed producers should be mindful of the accessibility of these fixing sources, and how they can best be joined into their plans. There is, therefore, a need to closely monitor the feed producers to ensure that there is a consistency of quality feeds produced and avoid the production of substandard feeds, a phenomenon common in the livestock industries.

Appropriate feed formulation techniques and processing technologies must also be imparted to the feed processors. Farmer clusters and associations should also be encouraged as an effective platform for information dissemination and promoting farmer-to-farmer training. Such training should focus on improving the existing feed formulations and formulate species- and life-stage specific diets. This can also aim at improving the understanding of ingredient quality, nutrient composition and selection; manufacturing processes; storage; and on-farm feed management practices. Access to up-to-date market data for firms and individuals producing farm-made feeds is an issue that needs to be looked into. Contemporary market information including sources, suppliers, quality and cost is a prerequisite to the development of cost-effective farm-made feeds. Furthermore, the use of suitable local and seasonally-available feed ingredients that can be incorporated into farm-made feed should be encouraged.

Farmers and small-scale feed manufacturers need to be informed of the availability of feed ingredient sources, and how they can best use them in their formulations. Currently, information networks are either inefficient or lacking and there is a need to promote programmes through the local media platforms to supply farmers with up-to-date feed ingredient accessibility, quality, and price and supplier contacts.

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Table 1: Crude protein (%) and amino acid composition (mg/100g protein) of some of the commonly used feed ingredients in Kenya [17]

	Fish meal	Soybean meal	Canola meal	Sunflower meal	Maize meal	Wheat bran
Crude protein (%)	54-55	47.4	344	24.8	10.7	16.0
Essential amino acids						
Lysine	7.81	3.01	4.01	3.14	1.42	1.75
Methionine	2.89	0.61	0.61	0.51	2.16	1.44
Cysteine	0.95	0.66	1.16	1.54	1.04	1.82
Histidine	2.43	1.26	1.57	5.44	2.12	1.81
Arginine	5.87	3.39	3.05	2.96	2.42	2.81
Threonine	4.28	1.96	2.10	3.87	2.60	3.16
Valine	5.40	2.24	2.34	6.27	4.09	4.93
Isoleucine	4.55	2.36	2.55	0.97	3.26	3.83
Leucine	7.55	3.69	3.78	10.06	7.15	6.85
Phenylalanine	4.20	2.71	3.84	5.83	4.24	3.79
Tryptophan	1.15	0.68	0.62	ND	ND	ND
Tyrosine	3.32	ND	ND	ND	3.25	2.32

Note. ND: Not detected

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Table 2: Specific nutritional requirements for compounded tilapia feeds

S/N	Parameter	Starter feed	Grower feed	Finisher feed	Brood stock feed	Test method
i.	Moisture content of pellets, %, max.	10	10	10	10	ISO 6496
ii.	Crude protein, %, min.	35	30	25	35	ISO 5983-1
iii.	Digestible Energy Kcal/Kg, min.	2500	2750	2900	2800	ISO 9831
iv.	Lysine, %, min.	2.1	1.7	1.7	1.7	
v.	Methionine, %, min.	0.9	0.8	0.8	0.8	ISO 13903
vi.	Methionine + cysteine, %, min.	1.4	1.1	1.1	1.1	
vii.	Crude fibre, %, max.	5	10	10	10	ISO 6865
viii	. Crude fat, %	5 -12	5 -15	5 -15	5 -15	ISO 6492
ix.	Calcium, %,	1.0 - 2.5	1.0 - 2.5	1.0 - 2.5	1.0 - 2.5	ISO 6490-1
x.	Phosphorus, %	0.6 - 2.0	0.6 - 2.0	0.6 - 2.0	0.6 - 2.0	ISO 6491
xi.	Sodium chloride, %	0.25 - 0.4	0.25 -0.4	0.25 - 0.4	0.25 - 0.4	ISO 6495

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Table 3: Specific nutritional requirements for compounded catfish feeds

S/N	Parameter	Starter feed	Grower feed	Finisher feed	Brood stock feed	Test method
i.	Moisture content of pellets, %, max.	10	10	10	10	ISO 6496
ii.	Crude protein, %, min.	45	35	30	35	ISO 5983-1
iii.	Energy (DE) Kcal/Kg, min.	3 000	3 000	3 000	3 000	ISO 9831
iv.	Lysine, %, min.	2.1	1.7	1.7	1.7	
v.	Methionine, %, min.	0.9	0.8	0.8	0.8	ISO 13903
vi.	Methionine+cysteine, %, min.	1.4	1.1	1.1	1.1	
vii.	Crude fibre, %, max.	5	10	10	10	ISO 6865
viii.	Crude fat, %	5 -12	5 - 15	5 -15	5 - 15	ISO 6492
ix.	Calcium, %	1.0 - 2.5	1.0 - 2.5	1.0 - 2.5	1.0 - 2.5	ISO 6490-1
x.	Phosphorus, %	0.6 - 2.0	0.6 - 2.0	0.6 - 2.0	0.6 - 2.0	ISO 6491

Table 4: Compositional requirements for compounded feeds for trout

S/N	Parameter	Starter diet	Grower diet	Brood-stock diet	Test method
i)	Energy (digestible energy), min, kJ/kg	15 500	15 500	15 500	KS ISO 9831
ii)	Crude protein, %, min.	45	40	35	KS ISO 5983-1
iii)	Amino acids:				
	a) Methionine	1	1	1	
	b) Lysine	1.4	1.4	1.4	KS ISO 13903
	c) Threonine	0.8	0.8	0.8	
iv)	Moisture, %, max.	10	10	10	KS ISO 6496
v)	Crude fibre, %, max	4	4	4	KS ISO 6865
vi)	Crude fat, %	15 –20	10 –15	10 – 15	KS ISO 6492
vii)	Acid insoluble ash, %, max.	4.	4	4	KS ISO 5985
viii)	Calcium, %, max.	1	1	1	ISO 6490-1
ix)	Phosphorus, %, min.	0.8	0.7	0.6	KS ISO 6491

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Table 5: Results on Crude protein content for commercial fish feeds analyzed at KARI laboratories in Kitale, Kenya [16]

Source of fish feed	Crude protein content (%)	
LBDA Feeds (mash)	20.6**	26.2**
GOWINO Feed industry (mash)	18.1**	18.1 same
GOWINO Feed industry (Pellets)	21.3**	21.3 same
MELL-WIT-61 Mineral Enterprise Ltd	18.1**	
Tilapia pond growers (Pellets)	21.7**	21.7 same
UGA fish (pellets)	30.00	30.0 same
PAC-Kisumu (mash)	22.50**	22.5 same
SIGMA feeds (pellets)	31.9	32.0 same

** represent below optimum crude protein content for the cultured fish of 26% and above for growers

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Table 6: List of aquaculture fish feed manufacturers

Fish Feed Manufacturer	Location	Distribution Location	No. of Staff	Feed Production Level MT/Month	Production Capacity	Type of Feed	Fish Farmers Served
Jewlet (Feed) Enterprises Ltd	Kendu-Bay	Nationally	5	40	500	Floating and sinking pellets	1,000
Butula Fish Farmers Cooperative	Butula	Busia County	10	Nil		Sinking pellets	Operation Stalled
Dominion Fish Feed Limited	Siaya	Nationally	30	24,000		Sinking pellets	30
Tigoi Fish Feed Company	Kakamega	Vihiga County	4	1		Sinking pellets	200
Matayos Aquafeed SHG	Busia	Busia County	7	2		Sinking pellets	350
Nyawara Animal Feed Plant	Gem, Siaya	Nationally	2	10		Sinking pellets	>50
Deje Farm Products	Sega, Siaya	Siaya & Busia	4	1		Sinking pellets	>100
Awino Fish Feed Limited	Siaya	Siaya	4	1		Sinking pellets	15
Sare Millers	Kisumu	Vihiga County	6	15		Floating and sinking pellets	70
Kenya Marine and Fisheries Research Institute	Sangoro	Nationally	3	4	48	Sinking pellets	200
Nyanjiga Farm	Siaya	Nationally	2	10		Pelletizer, Mixer, Miller	200
Mabro Fish Feed Ent.	Bondo Siaya	Bondo, Siaya	11	6		Hammer, Mixer, pelletizer	70
Aqualife Solutions	Machakos	Nationally	5	20	500	Floating pellets	50
Sigma Feeds Limited	Rongai	Nationally		72	10,000	Floating pellets	>
Javarih Holdings	Nyamonye, Siaya	Nyanza Region	3	Nil		Sinking pellets,	20
Unga fish feeds- Nairobi	Industrial Area Nairobi	Nationally	12	300	5,000	Floating pellets	>200
Lenalia Feeds - Limuru	Limuru Kiambu	Nationally	4	40	1000	Floating and sinking pellets	>100
Bidii Fish Feeds Luanda (not producing)	Emuhaya, Vihiga	Western/Nyanza- Kenya		5	100	Floating and sinking pellets	>70

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Table 7: List of aquaculture fish feed importers

	Fish Feed Manufacturer	Local Dealer/ Representative	Distribution Location	Feed Imported In Mt/ pa (As at 2020)	Type Of Feed
1	**Aller Aquafeeds– Denmark**	Cage farms	Siaya, Usenge	250	Extruded feeds
		Mwea Aqua Fish Farm Kirinyaga			
		Sare Millers Limited, Kisumu			
2	**Rannan Fish feeds - Israel**	Samaki Express Limited, Nairobi	Nationally	156	Extruded feeds
3	**Novatech fish feeds- Zambia**	Victory farms	Homabay	400	
3	**Skirting fish feeds – the Netherlands**	(i) Victory farms	Homa Bay	4500	Extruded feeds
		(ii) Unga fish - (catfish)	Nationally	27	Extruded feeds
		(iii) Starter tilapia	Nationally	130	
		(iv) Starter catfish	Nationally	100	
		(v) Kamuthanga– Machakos	Machakos	156	Extruded feeds
		(vi) Fresh catch – Athi River	Athi River	102	
4	**LFL Riche Terre - Mauritius**	(i) Africa blue	Bondo	100	Extruded feeds
		(ii) Pindu Fish farm	Kiambu	26	
5	**Laguna brazil**	Jewlet enterprises	Homabay	600	Extruded feeds
6	**Prime feeds - Israel**	Africa blue	Bondo	100	Extruded feeds
	Biomar - France	(i) Starter diet– Makindi fish farm Thika	Thika		

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