



Strategies to Improve Trade in Dagua (*Rastrineobola argentea*) from Lake Victoria

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Abstract

The production of dagaa (*Rastrineobola argentea*), one of three major commercial fish species in Lake Victoria, has increased and it now contributes 55% of the catch, but only 16% of its value. Less than 30% of production is utilised for human consumption, with the rest being used for stock feed. This study assessed the dagaa trade to develop strategies to improve its contribution to nutrition, food security and incomes. It involved 298 respondents from landing sites, markets, feed production industries, supermarkets and border posts while institutions involved with policy and data collection and management were also consulted. Dagua offered livelihoods to women and youths as vulnerable groups. Uganda and Tanzania were exporters of dagaa while Kenya was an importer, while it was also exported to neighbouring countries. Prices and net revenues fluctuated seasonally and most of the catch was sun-dried on nets and on bare ground which resulted in high post-harvest losses. Most traders operated within their own countries and thus had little incentive to improve quality and meet food safety standards. Most dagaa were sold at the beaches but small quantities of were sold in supermarkets. It is recommended that institutions should strengthen policy, information, fisheries management, quality assurance, market regulation and data capture.

Keywords: Dagua; Post-harvest losses; Quality control, Trade; Utilisation; Value addition

Introduction

The endemic cyprinid fish *Rastrineobola argentea* (“dagaa”) is one of the three main commercial species on Lake Victoria, together with the Nile perch *Lates niloticus* and Nile tilapia *Oreochromis niloticus*. In the last ten years, the biomass of dagaa has increased from about 253,000 tonnes (20% of the total) in August 1999 to about 1,300,000 tonnes (44%) in August 2014. Dagua made up 55% (510,000 tonnes) of the total fish production from Lake Victoria in 2014 but this only accounted for 16% (USD 135 million) of its total value, compared to Nile perch which accounted for 65% of the value (LVFO, 2016).

Dagua is sun-dried and post-harvest losses can be as high as 40% during the rainy seasons when cloud

cover reduces the effectiveness of sun-drying (Masette *et al.*, 2014). This is consistent with small-scale fisheries elsewhere where quality losses can account for > 70% of total losses (FAO, 2014) but these can be reduced through improved handling, processing and use of appropriate packaging materials. There is also high incidence of tapeworms in dagaa, which adversely affect its value (Cox and Tumwebaze, 2008).

Dagua has high crude protein content (about 50%) and is rich in iron (10 mg/100g), zinc (5mg/100g) and calcium (1500 mg/100g) (Kabahenda *et al.*, 2011). Despite its high nutritive value, only up to 30% of the catch is used for human consumption with the rest being used as animal feed. It has been noted that 42%

of the 24 million children under the age of 5 years in the East African community (EAC) were stunted by malnutrition (Society for International Development, 2013) and dagaa from Lake Victoria could contribute significantly to the nutrition of these children. It could also be used to fortify other foods in order to provide consumers with choices of food varieties, subject to the tapeworm limitation.

Developing the trade in dagaa would stimulate improvements in its quality and make it more accessible to consumers. Improving efficiency in the trade would lower costs making dagaa more affordable while improving market access to the traders. However, despite the large quantities of dagaa taken from Lake Victoria the trade is poorly documented and its true value and contribution to the region's food security and economy has not been fully estimated. The paper draws from a study carried out through the Lake Victoria Fisheries Organisation (LVFO), in collaboration with WorldFish, which aimed to improve the data and information base on the dagaa trade.

This paper discusses the trade in dagaa from Lake Victoria, with special emphasis in its magnitude, processing methods and possible improvements, post-harvest losses and their impacts on the fishing community, and trade practices, trade routes and destinations. The trade regulations for dagaa and their compliance are identified, and potential value addition through industrial production and high-value marketing channels is assessed. Finally, the relevant institutions for dagaa marketing are identified and the suitability of existing data collection methods for planning dagaa trade is examined.

Methods

This investigation was designed in accordance with standard operating procedures for socio-economics research developed by the Lake Victoria Fisheries Organisation (LVFO, 2005). The study was carried out from March to June, 2016 at 14 landing sites around Lake Victoria, namely Kiyindi, Kasenyi, Lambu and Kasekulo (Uganda), Kinda, Sare, Sori and Honge Sinyeye (Kenya), and Chakazibwe, Kibuyi, Kijiweni, Bwiru and Nyamikoma (Tanzania). It also covered five Customs Border Posts and markets, namely Katuna, Mpondwe and Elegu (Uganda), Busia (Kenya) and Sirari (Tanzania). Directorates and Departments of Fisheries, Country Revenue Authorities and Bureaus of Statistics were also included. Data were collected from a sample of 298 respondents, drawn randomly but proportionately from fishers, processors and traders of dagaa at the

landing sites, using the beach registers. The sites were chosen purposively to represent geographical regions and island situations.

Primary data were obtained from Key Informant Interviews with beach leaders to obtain beach-level information on production, processing, storage and trading in dagaa. The types and effects of post-harvest losses, the needs of women's groups and the main challenges to dagaa businesses were also recorded. Sample surveys were carried out using a semi-structured questionnaire, covering 298 respondents. The questionnaire sought information on the socio-economic characteristics of dagaa operators, the scale and returns from dagaa businesses, post-harvest management, compliance with trade requirements and challenges in dagaa businesses.

Secondary data were obtained by searching print and online sources such as the LVFO, Directorate and Departments of Fisheries, National Fisheries Research Institutes, Country Revenue Authorities, Trade Promotion Boards, Investment Authorities and Bureaus of Statistics, as well as the Food and Agriculture Organisation (FAO) to obtain macro-economic data on dagaa sub-sector in the region.

Fisheries and Customs Officers were interviewed and records reviewed at border posts and markets for information on export trade practices, its magnitude and the countries to which dagaa are exported. Information on policy, regulations and food safety standards for the dagaa trade, data recording mechanisms and dagaa statistics were obtained from the Directorates and Departments of Fisheries, country revenue authorities and Bureaus of Statistics. Selected industrial feed millers and supermarkets provided information on the dagaa products they dealt in, the issues of post-harvest losses, the economics of their operations and the challenges they met with in dealing in dagaa.

Results

Production, trade and utilisation of dagaa from Lake Victoria

The production of dagaa from Lake Victoria grew from 420,000 tonnes in 2010 to 674,600 tonnes in 2015 (Table 1). This was attributed to an increased biomass of dagaa (LVFO, 2016), which in turn led to an increase in fishing effort. It could also reflect decreases in the catch and of tilapia and Nile perch causing fishermen to switch to dagaa. Catches rose steadily throughout this period, with some fluctuation in Kenya and Tanzania, and by 2015 the total catch of dagaa was around 580,000 tonnes with a total value of around USD 227million. Tanzania was the largest

producer, with 65% of the catch and 67% of the value, followed by Uganda (25% and 14%) and Kenya (10% and 19%). This suggests that earnings for fishermen in Uganda were substantially less than those for fishermen in Kenya, partly because of the low average value of dagaa; US\$ 0.19 per kg in Uganda, compared to a US\$ 0.62 in Kenya and US\$ 0.35 in Tanzania (LVFO, 2016).

Uganda and Tanzania were exporters of dagaa while Kenya was an importer, which also explained

why Kenyan fishermen earned more because demand exceed supply. The volume of exports rose from around 12,000 tonnes in 2010 to 29,000 tonnes in 2011 before it began to fall to 19,000 tonnes in 2015 (Table 2). This decline was attributed to increasing domestic demand for dagaa, much of it being used for industrial production of stock feed. Uganda was the major exporter accounting for about 72% of exports, but only 48% of the value, again reflecting the low prices paid for dagaa in that country.

Table 1: Annual production of dagaa from Lake Victoria, in volume and value, by country for the period 2010 to 2015 (from LVFO, 2016).

		2010	2011	2013	2014	2015
Volume (tonnes)	Uganda	59,000	88,000	127,000	165,000	171,000
	Kenya	70,000	72,000	52,000	66,000	69,000
	Tanzania	290,000	316,000	408,000	371,000	433,000
	Total	419,000	476,000	587,000	602,000	673,000
Value (US\$ x 1000)	Uganda	5,000	13,000	21,000	28,000	32,000
	Kenya	32,000	33,000	29,000	37,000	43,000
	Tanzania	30,000	61,000	74,000	69,000	152,000
	Total	67,000	107,000	124,000	134,000	227,000

Table 2: Annual export of dagaa by volume and value by country for the period 2010 to 2015. Data from FAO (2014), NBS (2014) and UBOS (2016).

		2010	2011	2012	2013	2014	2015
Volume (tonnes)	Uganda	500	19,000	18,000	14,000	10,000	15,000
	Tanzania	12,000	10,000	8,000	7,000	7,000	5,000
	Total	12,500	29,000	26,000	21,000	17,000	20,000
Value (US\$ x 1000)	Uganda	598	2,896	2,913	2,315	1,846	2,106
	Tanzania	3,379	4,039	3,530	3,020	2,040	1,885
	Total	3,977	6,935	6,443	5,335	3,886	3,991

The main destinations for Ugandan dagaa were the DRC (15,000 tonnes per annum), Kenya (4,400 tonnes) and South Sudan (4,100 tonnes), with some going to Rwanda, Tanzania and Burundi. Tanzanian exports went mainly to Kenya (3,600 tonnes) and the DRC and Rwanda (1,700 tonnes). Kenya imported 6,200 tonnes in 2010, rising to 7,900 tonnes in 2011 and then declining to 4,200 tonnes in 2015. The value of these imports rose from US\$ 2,15,000 in 2010 to US\$ 2,950,000 in 2011 then declined to US\$ 2,055,000 in 2015, following the trend in volumes because prices remained fairly stable during the period.

In Uganda, 7.5% of the dagaa catch was exported and only 20% was used for human consumption (FAO, 2010) with the rest being processed for livestock or fish, some of which was exported. More of the dagaa (50%) was used directly by humans in Tanzania where consumption rates ranged from 7 to

10 kg per capita (FAO, 2014). The fact that only 30% of the dagaa catch was used for human consumption in a region where *kwashiorkor* is prevalent in malnourished children is a matter of concern (MoH 2009).

Social characteristics of dagaa operators

Most of the 298 respondents were male (55%) although in Kenya 64% (N=73) of them were females, with the lowest proportion of females being in Tanzania (28%; N=140). These results indicated fairly equitable sharing by women, a vulnerable group, in the opportunities and benefits from dagaa trade in Kenya and Uganda but not in Tanzania, where it is less than 30%.

The average age of dagaa operators was 35.5 years with most fishers and traders being young (18-35 years) while processors were older men and women (35-60 years). Children (below 18 years) and the

elderly (above 60 years) were not reported. Younger people had the advantage of being energetic enough to do hard physical activities like fishing and moving between landing sites and markets to sell dagaa. They were also likely to be better educated and able to acquire knowledge and skills for quality control and business management. Mature people in the sub-sector, on the other hand, had the advantage of more capital, either having saved it over the years or having collateral against which to take loans.

Most of the operators (44.5%) had completed primary education but a significant number (30.1%) had only an incomplete primary education. Fewer respondents had obtained tertiary (3.0%) or university (2.6%) education, while a few (3.2%) had no education at all. The limited level of education amongst the respondents was attributed to parents insufficiently motivated to send children to school, limited and low quality educational facilities, and lack of money to pay for scholastic requirements with free primary education. With such limited education, operators cannot acquire essential skills in business management, quality assurance or value addition. However, the few respondents with tertiary and university education were a positive step for development of the trade.

On average 62.5% (N=298) of the respondents belonged to organisations such as trader's (29.6%), fisher's (28.9%) or women's groups (28.1%), with smaller numbers in a dagaa processor's group (11.0%), Savings and Credit Co-operative Organisations (SACCO) (8.1%) and welfare groups (11.0%). The benefits of belonging to such groups were that they could purchase inputs collectively, be provided with training and information more easily, and could engage in collective marketing and save or borrow from each other through a SACCO. An example of this was the Kiyindi Women Fish Processors Association, where members pooled resources and produced value-added products, such as deep fried and powdered dagaa which fetched higher prices than the ordinary sun-dried fish.

Dagaa operators on the lake were categorised into fishers only (33.7%), traders only (28.8%), processors (21.5%), trader/processors (38.4%), fisher/processors (8.2%) and fisher/processor/traders (1.4%). Other operators along the value chains included industrial feed producers, supermarkets and poultry, livestock and fish farmers.

Dagaa processing and application of improved processing methods

Dagaa processing was dominated by processors/traders, followed by fisher/processors and lastly, processors only. This structure revealed the nature of vertical integration in the industry, with processing integrated more forward with trading than backward with production. Most respondents processed dagaa by drying on nets (72%), followed by drying on bare ground (31%) or raised racks, salting before drying and frying.

In Uganda, most dagaa was dried on bare ground, followed by drying on raised racks. A wider variety of methods were used in Uganda than in the other countries, reflecting efforts to adopt improved methods and value addition. These also included salting before drying, deep frying and drying on nets. In Kenya, almost all processors dried dagaa on nets spread on the ground but efforts to adopt improved methods, such as raised drying racks, have not been significantly adopted. In Tanzania, most processors (94.0%) dried dagaa on nets but some (4.0%) used raised racks, deep frying and smoking the fish with the remainder still drying dagaa on bare ground (2.0%).

Many respondents (42.1%) knew about drying dagaa on nets to avoid sand contamination while 25.2% were aware of drying on raised racks, but relatively few (14.2%) knew about preserving dagaa by salting it before drying. A considerable proportion did not know about improved dagaa processing methods (11.0%), with the largest proportion of them being in Kenya (27.0%). In addition, negative attitudes and practices towards improved processing methods and value addition were observed where prices for improved products did not match the additional costs involved.

Most processors (95.4%) did not produce any value-added products because they knew little about them and lacked the skills to produce such products. The few who did so produced fried dagaa, dagaa powder and industrial feeds that combined dagaa with other ingredients. Challenges that limited the production of value-added products included the lack of capital and equipment, inadequate skills and the need to comply with stringent food safety standards. All respondents used their own savings for capital, reflecting the lack of financing sources for these operations. There was no evidence that any banks provided funding for dagaa activities (LVFO, 2011).

In Uganda, drying racks were established in batches in 1999, 2012 and in 2016; their average expected lifetime was 3.3 years and the cost per unit

was US\$ 45.00. Funding was initially provided by the Uganda government, through the World Bank-sponsored Lake Victoria Environmental Management Project (LVEMP), United Nations Development Programme (UNDP) and local governments, as well as from owners' savings. Frying pans, for deep-frying dagaa were expected to last for one year on average and were acquired through owners' savings or credit from informal financial services. Basins were a common dagaa trading item, used for measuring volumes of dagaa and for carrying it from boats to drying grounds. The average number was 2.0 per operator and their expected lifetime was only four months. In Kenya, troughs were used for sieving dagaa to remove sand and dust contaminants. These cost about US\$ 20 and were expected to last for six months. The dagaa fishing nets generally used for drying cost about US\$ 100, were purchased by the processors themselves, and were expected to last for four months. Most processors owned a single net.

Post-harvest losses

Most dagaa fishers (65.9%, N = 112) experienced losses resulting from rotting or spoilage caused by having to land the catch from distant fishing grounds or delays caused by bad weather on the lake. They attempted to prevent losses by ensuring that their boats did not leak (50.7%, N=116), followed by early landing of catch (27.6%) and its proper handling (20.6%).

The main losses during processing were caused by rotting or spoilage (53.3%), followed by dagaa being swept back to the lake by rainfall (27.2%), sand contamination (13.6%) and a loss of colour (10.3%). A proportion of processors did not experience post-harvest losses, having developed measures to prevent them. These included washing dagaa before drying, spreading it on clean nets and turning it over, using clean brooms (57.5%, N=102) or using raised drying racks.

Most processors (43.6%) experienced heaviest post-harvest losses during the rainy seasons when there was insufficient sunshine to dry dagaa properly, resulting in spoilt or rotting fish. Others (23.4%) reported that it occurred every three months, indicating that episodes of post-harvest losses were spaced, hence the reason why some processors did not take adequate precautions. Dagaa that had been spoilt were sold at prices ranging from US\$ 1.05 to 1.48 per kg during low and high catch seasons, mainly to poultry, piggery and fish farmers (60.0%, N=112) or to industrial feed manufacturers (33.3%).

Trade practices, main trade routes and destinations

Some dagaa traders sold fish only within their own countries (62.5%, N=109) while the remainder sold it elsewhere. Traders who focused only on domestic markets could miss the opportunities offered by larger markets with higher prices and so have little incentive to improve quality or meet food safety standards requirements. Sun-dried dagaa was the least valuable product and the traders were therefore prone to quality lapses and post-harvest losses. Salted and sun-dried products were primarily sold by Ugandan traders (6.1%, N=71) while deep fried fish was traded mostly by Tanzanians (27.3%, N=56). This represented a step forward in product improvement, resulting in a better-quality product with a longer shelf life.

Essential equipment for trading operations included scales for weighing fish and most traders owned them. Means of transport, whether bicycles, motorcycles or trucks, were important for traders to deliver consignments. In most cases, traders used their own funds to as the source of capital, reflecting their lack of access to financial services.

There was little trading in value-added products for human consumption in each country, with estimates of 2.0% for Uganda (N=71), nil in Kenya (N=39) and 4.8% in Tanzania (N=56) and such products were an insignificant proportion of the total dagaa catch. In Kenya, not a single respondent was involved in value addition, saying "one could not add value when all other people in the market didn't, because one would be selling at a loss". This explained why solar driers introduced by Kenya Marine and Fisheries Research Institute (KMFRI) had not been successful in Kenya, although it should be noted that these driers were too small to handle the catch during high catch seasons. The main value-added dagaa products were animal feeds produced by industrial feed millers.

Most fishers (94.7%, N=116) sold their catch at their landing sites to save transport costs and allow time for fishing, their core business. However, these advantages were offset to some extent by the fact that beach prices were the lowest along the value chains. Most processors sold their dagaa at the beaches (71.7%, N=102) and only a few delivered it to buyers away from the beach but within the country (26.1%) or took it to another country (6.7%). The main buyers were traders who sold within the country (62.5%, N=109) while the rest sold it externally.

Thus, the dagaa trade is primarily a domestic activity, which is good for nutrition and food security but incomes were compromised because of the

limited demand and low prices. Traders who exported dagaa were better organised and were able to meet more stringent trade requirements of the export market.

Economic returns

Fishers experienced significant differences in the average catch per fishing trip during low and high seasons (March to August and September to February respectively), with the average catch per trip being 122 and 400 kg respectively. Selling prices were higher during low catch seasons (US\$ 0.19 kg⁻¹) than

during high catch seasons (US\$ 0.10 kg⁻¹) and the average gross revenue was US\$ 312 and 730 during low and high seasons respectively, thus making fishing more attractive during high seasons (Table3). Processors handled an average of 54 and 148 kg of dry dagaa per month during low and high catch seasons respectively, realising average net earnings of US\$ 158.76 and 413.66 respectively. On average, traders handled 630 kg and 1,669 kg per month during low and high catch seasons, with average net revenues of US\$ 3,124 and 7,878 respectively.

Table 3. Average number of operations, volumes, prices and revenues of dagaa operators during low and high catch seasons. From Odongkara *et al.* (2014).

		Low season	High season
Fishers	Number of fishing trips per month	14.5	17.0
	Fresh dagaa landed per fishing trip (kg)	122	400
	Selling price of fresh dagaa (US\$/kg)	0.19	0.10
	Gross monthly revenue (US\$)	312	730
Processors	No. of days for one round of processing	1.0	2.5
	No. of processing rounds carried per month	4.0	6.5
	Quantity of wet dagaa processed per round (kg)	136	371
	Dry dagaa equivalent processed per round (kg)	54	148
	Buying price of fresh dagaa (US\$/kg)	1.11	0.84
	Selling price of processed dagaa (US\$/kg)	1.85	1.27
	Costs (US\$)	239	808
	Revenue (US\$)	398.	1221.
	Net earnings (US\$)	159	413
Traders	Number of days per trading round	3.5	2.0
	Rounds of trading carried out in a month	8.0	8.0
	Quantity of processed dagaa per round (kg)	630	1,669
	Buying price of processed dagaa (US\$/kg)	2.05	1.34
	Selling price of processed dagaa (US\$/kg)	2.67	1.93
	Costs (US\$)	10,332	17,891
	Revenue (US\$)	13,456	25,769
	Net earnings (US\$)	3,124	7,877

Trade regulations for dagaa and compliance among operators

Operators are required to comply with formal and informal regulations that relate to fisheries management, food safety standards and fish trade. The East African Community (EAC) has prepared draft East African Standards and individual countries also have standards set by their national standards bodies (SmartFish 2011; EAC, 2016). Regulations for fishers include fishing with licensed boats, using nets of 10-mm mesh size and fishing off-shore to minimise by-catches of juvenile Nile perch and tilapia.

The regulations most commonly applied to processors, and the level of compliance, include the possession of a trading licence (14.0%, N=109), prohibition of stepping on dagaa with shoes (39.0%), the use of plastic covers over dagaa (26.7%) and

cleaning the ground surface before drying (26.7%). Among traders, some complied with the acquisition of a trading licence (29.4%, N=109) and fish quality inspections. Variations in compliance were attributed to ignorance or indifference, weak law enforcement and an inability to meet the requirements. The highest levels of non-compliance were linked to important regulations concerning quality assurance and packaging of the dagaa products; some respondents did not comply with any of these requirements.

Value addition through industrial production and high-value marketing channels through supermarkets
Most value addition was carried out by industrial millers in products such as poultry, livestock and fish feeds, pharmaceuticals and food supplements. The

processes involve blending dagaa with other ingredients, including cotton cake, sunflower, animal feed premix, salt, soya cake and shells. The proportion of dagaa in these mixes varies from one feed miller to another and depends on the type of feed.

In Kenya, the main industries processing dagaa obtained their fish from Tanzania. Six industrial feed millers consulted In Uganda mainly bought processed dagaa from specified landing sites where they believed the fish was of good quality. The selling prices for feeds that included dagaa ranged from US\$ 1.27 during the low season to 0.91 per kg during the high season.

Key problems in industrial dagaa-processing included poorly-dried fish, damage from mites and insects in storage, sand and dust contamination, contamination with *Salmonella*, *Escherichia coli* and *Shigella*, high Value-added Tax on finished feeds, unclear quality control policy, tax and non-tax barriers to regional markets and border entry restrictions for foreign investors. Most feed millers complied with the need for trading licenses which cost about US\$ 90 per year and with the poultry breeder policy (breeder biosecurity) on raw materials to ensure that feeds met standards prescribed by the standards body.

In Ugandan supermarkets, dagaa are packed and sold as whole dried and deep-fried fish, and as powder in quantities ranging from 200 g to one kilogram. Prices ranged from US\$ 3.03 to 5.52 per kg for sun-dried dagaa and supermarkets reported a high demand for dagaa, which is why they continued to stock it. In Tanzania, deep-fried dagaa packed in sealed polythene bags of different weights were sold in local markets, especially supermarkets in Dar-es-Salaam and Mwanza, while a small quantity was sold outside the country by foreign and domestic distributors. Challenges faced by supermarkets included (1) it was difficult to enforce quality control as dagaa products were delivered already packed; (2) weights on the labels often did not match the actual weights of the products; (3) poorly-dried dagaa spoiled in storage; (4) fish were contaminated with bacteria and posed a risk to customers.

Institutional set-up

A number of institutions concerned with dagaa trade were identified, and contribute to policy formulation and implementation, information and awareness, fisheries management, quality assurance, market regulation and levying customs duties on dagaa exports.

In Uganda, the Directorate for Fisheries Resources was the main institution regulating the dagaa trade (DiFR, 2015). It set the recommended net mesh-size (10 mm) and revised the law so that no fish, including dagaa, could be exported without first being processed. Other activities included interventions at selected landing sites in order to improve post-harvest handling. These resulted in high quality dagaa suitable for supermarkets and export markets.

In Tanzania, the dagaa fishery is regulated by the National Fisheries Policy (revised in 2015), Fisheries Regulations (amended in 2015) and Fisheries Laboratory (amendment) fees, 2015, which spelt out fish trading standards and procedures for trading in dagaa and other fish products from Lake Victoria. The National Fisheries Policy, 2015 addressed issues of fish and fish product utilization, processing and marketing. The fisheries laws and standards provided for appropriate mesh size, improved technologies and trading practices while the Fisheries (Laboratory) Fees Regulation of 2015 repealed export permit fees for dagaa and fish products traded at local and regional markets but increased the export royalty for dagaa from US\$ 0.042 to \$ 0.084 per kg.

In Kenya, the main regulatory intervention has been the institution of a closed season for dagaa.

Data collection

The research institutes in each country collect data on dagaa stocks, fishing effort, catch and marketing, while Fisheries Departments collect data on fish quality. Bureaus of Statistics collect macro-economic data on production, processing and trade and Revenue Authorities do the same for formal exports. Beach Management Units (BMU) collect data on number of dagaa boats and fishers, catch, number of processing units and movement of dagaa while traders record volumes and values of transactions, and the origins and destinations of the fish.

Difficulties with data collection include (1) the trade is highly informal, so standard business records are not kept; (2) data recording systems in the various institutions are not harmonised or co-ordinated, limiting comparison of data; (3) data collection is poorly staffed and funded in some institutions and so underperformed; (4) a lack of feedback from higher authorities discouraged data collectors, and (5) data were not used for any planning or decision making.

Discussion

The dagaa industry of Lake Victoria experienced steady growth in production, which greatly increased the availability of protein in the region, even if most

of it went for livestock feed. However, this saved the countries from having to spend foreign exchange on importing fishmeal. It also created employment in a where opportunities were limited. The challenge was to sustain this production, through implementation of appropriate management measures stipulated in the fisheries management plan for Lake Victoria.

The low value of dagaa, compared to that of other commercial fish species, and the high post-harvest losses need to be addressed through hygienic handling and improved processing and value addition methods, such as smoking, frying, sun-drying on raised racks and solar drying, and the products packed in polythene bags. Declining exports to Kenya, DRC, Rwanda, South Sudan and Burundi call for improved trade infrastructure, financing, business skills of traders, storage facilities and institutional support.

The emergence of new trade outlets involving supermarkets was important in extending consumption to the middle-income classes with high purchasing power. The issue of standards should be addressed in order to put more value-added products on the market. Further success in dagaa production, processing and trading depends largely on improved governance of the industry, including policies, institutions and regulations, both nationally and regionally.

This survey identified a number of actions that could be taken to deal with challenges in promoting human consumption and increasing the value of dagaa through trade. Management of the dagaa stocks should be improved in accordance with the fishing regulations for dagaa and business associations among dagaa operators should be strengthened to improve compliance with standards and record keeping. Taxes on the import of processing equipment and export of products should be reduced and the cross-border movement of goods and traders eased. Efforts should be made to improve the quality of dagaa to make it more attractive to human consumers.

This process must include improvement of processing methods to reduce post-harvest losses and promote value-added products. Suitable storage facilities for the products along the value chains will be required to avoid problems when it rains and to eliminate pests. Strategies to avert post-harvest losses should be adopted through early landing, dealing with bad weather, the proper handling of fish as well improved processing, storage and rapid turnover of stocks in shops.

Trade networks will have to be developed to improve information and support among stakeholders

in the industry while government and NGOs should strengthen their support for the industry through training, market identification, supervision, inspection and improved technology. Finally, no industry can operate effectively without adequate information and data capture systems need to be improved.

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References

- Cowx, I.G., Rollins, D. and Tumwebaze, R. (2008). Effect of *Ligula intestinalis* on the reproductive capacity of *Rastrineobola argentea* in Lake Victoria. *Journal of Fish Biology* **73**:2249-2260.
- DiFR. (2015). Annual Report for 2014. Directorate of Fisheries Resources, Entebbe, Uganda.
- EAC. (2016). Final draft East African Standard. Dried fish - silver cyprinid (*Rastrineobola argentea*) Specification. FDEAS 826: 2015. East African Community, Arusha, Tanzania.
- FAO. (2010). Fisheries and Aquaculture dataset. Food and Agriculture Organisation, Rome.
- FAO. (2011). Post-harvest fish loss assessment in small-scale fisheries. *FAO Fisheries and Aquaculture Technical Paper* No. 559: 93 pp.
- FAO. (2014). *State of World Fisheries and Aquaculture*. FAO, Rome.
- Kabahenda, M.K., Amega, R., Okalany, E., Husken, S. M.C. and Heck, S. (2011). Protein and micronutrient composition of low-value fish products commonly marketed in the Lake Victoria region. *World Journal of Agricultural Sciences* **7**:521-526.
- LVFO. (2005). Harmonized standard operating procedures (SOPs) for socio-economic research and monitoring on Lake Victoria. Lake Victoria Fisheries Organisation, Jinja, Uganda: 90 pp.
- LVFO. (2016). Regional catch assessment survey synthesis report, June 2005 to November/December 2015. Lake Victoria Fisheries Organisation, Jinja, Uganda: 35 pp.
- LVFO. (2011). Financial analysis of existing micro-finance institution on dagaa fishery in Lake

- Victoria, Tanzania. Lake Victoria Fisheries Organization, Jinja, Uganda; 36 pp.
- Masette, M., Walozi, R., Bamwirire, D. and Nakawoza, L. (2014). Physical loss assessment in the small pelagic fishery of lakes Victoria, Kyoga and Albert. NARO CGS Project ID/No: CGS/4/38/14.
- MoH. (2009). National Health Policy, reducing poverty through promoting people's health. Ministry of Health, Republic of Uganda, Kampala.
- NBS. (2015). Tanzania in figures, 2014. National Bureau of Statistics, Dar-es-Salaam.
- Odongkara K., Akumu, J., Mbilingi, B., Namatovu, S., Okwong, C., Naula, E., Olokotum, M. and Nasuuna, A. (2014). Strategies to improve profitability and market access for fisheries enterprises on Lakes Albert, Kyoga and Victoria, Uganda. National Fisheries Resources Research Institute, Jinja, Uganda: 41 pp.
- Society for International Development. (2013). Annual report 2013. Society for International Development, Washington DC.
- SmartFish. (2011). Dagua value chain study workshop, 26 August 2011, Mwanza, Tanzania. SmartFish Meeting Report No. 002: 31 pp. SmartFish Secretariat, Ebène, Mauritius.
- UBOS. (2015). Statistical Abstract, 2015. Uganda Bureau of Statistics, Kampala.