

## TWO POLICY BRIEFS FROM DANIDA IMLAF PROJECT DFC NO 14-P01-TAN

### OPTIMIZING *DAGAA* HANDLING AND PROCESSING TECHNOLOGIES TO ADDRESS QUALITY, SAFETY AND POSTHARVEST LOSSES

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#### EXECUTIVE SUMMARY

The recorded catches of Lake Victoria sardines, popular as *dagaa* have increased steadily over the past three decades. Sardine fishery has developed partly as a reaction to decreased catch rates of Nile perch in Lake Victoria. Although stock assessments are not frequently carried out, sardine fishery has shown no signs of overfishing due to high turnover rate of the species. Due to little attention and poor perception by different actors in the value chain, sardines have been considered as of low economic and nutritional value. Sardines are known to be nutrient dense, thus play an important role in food and nutritional security of poor communities in low-income countries. Such fish have a unique combination of high-quality proteins and important micronutrients important for combating micronutrients deficiency and non-communicable diseases. Sardine fishery plays an important role as a source of health food, income, employment and brings in significant foreign exchange.



#### 1.0 INTRODUCTION

Fisheries management in Lake Victoria gives limited attention to small fish species including *dagaa* (*Rastrineobola argentea*). Recorded catches indicate that over the past three decades the fishing effort and thus landings of *dagaa* have increased steadily. *Dagaa* constitute 72% by weight of the total landings and there are no indications of the specie being overfished. The small silvery cyprinids, *dagaa* are characterized by rapid growth and short lifecycle to allow their exploitation of up to 70% annually. *Dagaa* is important in food and nutrition security, income generation, employment and livelihood of thousands of people. With regard to nutrition, *dagaa* have a unique combination of high-quality protein and micronutrients such as vitamins, Calcium, Iodine, Iron and Zinc, which play a critical role in

mental development, immune system support and general health. Its involvement in prevention of non-communicable diseases is associated with high content of essential omega-3 fatty acids in lipid fraction. Lack of recognition of these important health benefits due to limited attention and poor perception by actors in value chain of small fish species has prevented necessary investment in *dagaa* fishery for reduction of postharvest losses, improving product quality, shelf life and public awareness.

#### 2.0 BACKGROUND

Inadequate handling and processing technologies for safe and quality products hinders promotion of sardines' economic and nutritional value in domestic, regional and international markets. This has denied fishers, processors, traders and other actors in sardine value chain an opportunity to prevent losses, improve quality and diversify product type to satisfy market demand. Nearly all catch of sardines around Lake Victoria is traditionally sun dried by spreading freshly harvested sardines on beach sands, rocks or grasses to dry the product. The existing handling and processing practices expose the products to physical damages, contamination by sand, insects, microbes; and postharvest losses. The project objective was to assess the influence of existing handling and processing practices on safety, quality and nutritional value of sardines. Samples of existing *dagaa* products were

collected from different processors and processing technologies. Other samples were prepared during on-site controlled drying and deep frying experiments. Model greenhouse dryer was designed and tested on its performance under existing processing environmental conditions. Clove extracts were tested for use as natural antioxidants to retard lipid oxidation during drying and frying of *dagaa*. Greenhouse dryer improved the product quality by preventing access to product by insects, birds, animals and dust as opposed to open sun drying. Greenhouse dryer could protect the product from abrupt rains during rainy season thereby significantly reducing the postharvest losses. Clove extracts significantly improved the retention of omega-3 fatty acids during sun drying and deep frying of *dagaa*.

### **3.0 THE INFLUENCE OF HANDLING AND PROCESSING ON SAFETY AND QUALITY DAGAA PRODUCTS**

#### **3.1 Status of *dagaa* handling and processing technologies**

Due to high potential of the sardine, effort to optimize its value along the chain is vital starting with the handling and processing technologies. The findings revealed that there are a lot of technological challenges as far as handling and processing is concerned.

##### *On-board handling of fresh catch*

The current status revealed that in the fishing vessels fresh catch is heaped in one of the three vessel's compartments (*mgigi*). Heaping of around 90 buckets (equivalent 18-20kg \*90 buckets = 1800kg) in one *mgigi* is common when harvests are good. The fishing boats lack on-board cooling facilities during fishing and transportation from the fishing areas to the landing sites. Furthermore, microbial and enzymatic activity are accelerated all of which hasten the on-board spoilage of fish. Overall, it is estimated that over 90% of total catch is damaged due to mounting pressure, prolonged storage on board without cooling elements and poor hygienic handling and offloading practices. Physical damage of fish at the bottom of vessel due to mounting pressure renders over 12% of catch degraded and unfit for processing for human consumption upon arrival at landing sites. Fishermen at landing sites have experience on this and would charge premium prices for the top late fresh catch whereas the ones damaged are considered as low-value animal feed or discarded.

##### *Processing for value addition*

The study established out that *dagaa* processing for value addition mainly depend on low-cost/cheap technology (open sun drying). Processing is done on the landing beaches with unhygienic premises and little product protection from lipid oxidation, chemical, biological and physical contaminants as well as exposure to insects and other pathogen transmitting vectors. Inadequate processing facilities and technology are employed in other artisanal processing methods like smoking and deep-frying. Absence of quality control in the whole *dagaa* value chain results in high postharvest losses, poor quality products with low acceptability, nutritional and economic value. Given its huge potential, *dagaa* fishery could greatly be improved with proper policy attention as well as public and private investments in order to address issues of quality, safety and postharvest losses.

#### **3.2 Greenhouse processing and handling technologies**



In an exertion towards addressing post harvest loss, the greenhouse drying technique was tested and introduced in the *dagaa* sub-sector to reduce the losses and increase the dry-product quality compared to the traditional open sun drying. Trials have registered up to 10°C temperature difference between inside greenhouse and the surroundings which may reduce drying time if air flow is controlled. This technology improves the product quality by preventing access to product by insects, birds, animals and dust as opposed to open sun drying. Greenhouse dryer would protect the product from abrupt rains which normally cause up to 100% loss in open sun drying during rainy season. Furthermore, there are visually physical differences between the greenhouse and open sun dried product. Greenhouse dried product retain its silvery “*Shiny*” color, is clean, free from sand, soft and straight for good look in packages. These product characteristics and good packaging opens up an opportunity to penetrate

into market segments/outlets (e.g min-supermarkets, supermarkets) which the existing open sun dried products would not.

### 2.3 Use of antioxidants to impede oxidation of Omega-3 fatty acids



*Dagaa* were found to be a rich source of nutritionally valued long chain omega-3 polyunsaturated fatty acids (PUFAs). The three omega-3 PUFAs namely; docosahexaenoic (DHA), docosapentaenoic (DPA) and eicosapentaenoic (EPA) acids constituted 57 - 60 %, 63 and 38 % of total PUFAs in lipid fractions of sun dried, smoked and deep fried sardines, respectively. Chemical indicators of lipid oxidation showed that open sun-dried products are prone to lipid oxidation during processing and storage. Sun dried products were characterized by high levels of secondary lipid oxidation products namely; 1-penten-3-oltrans-4-heptenal, *cis*, *cis*-2,4-heptadienal known to be decomposition products of DHA and EPA. These

compounds have very low odour thresholds which impact on product sensory acceptability. Other compounds such as malondialdehyde, *trans* 4,2-hexenal were found in sun dried *dagaa* and are responsible for color changes that occur during storage and marketing.

Intervention to stabilize lipids in sun dried and deep fried sardines against oxidation by using clove extracts as natural antioxidants was taken to impede lipid oxidation during processing and storage of *dagaa* products. Results showed that dipping fresh sardines in 5, 10 and 20 g/L clove water extracts prior to sun drying reduced peroxidation in dry products by 38.7, 54.6 and 56 %, respectively. This resulted in improved retention of omega-3 fatty acids (DHA, EPA and DPA) during processing and subsequent storage. The extracts reduced concentrations of volatile secondary lipid oxidation products which are known to be responsible for off flavour development in *dagaa* products.

### 3.0 CONCLUSIONS

The current on-board handling of sardines and offloading practices results into physical damage of fish. Sardines from Lake Victoria are rich in health long-chain omega-3 fatty acids. Oxidation of omega-3 fatty acids occur during processing and storage of sardine products. Sun drying preservation method as it is currently practiced is associated with high postharvest losses. Sun dried products have relatively low oxidative stability and thus significant amount of omega-3 fatty acids are lost during processing and subsequent storage. Natural antioxidants from edible plants can be used to retard oxidation of omega-3 fatty acids in sun-dried and deep fried sardine products

### 4.0 IMPLICATIONS

Poor onboard handling of fresh catch degrade quality of raw materials, reduce economic value and divert products to low-value animal feeds denying nutritive advantages to the community. Unhygienic processing premises compromises safety of sun-dried products which in turn discourage consumption in local markets. Because of safety concerns penetration of sardine products in regional and international markets is limited. This affects the contribution of the sub-sector to the national income. Oxidation of omega-3 fatty acids is a sensory quality problem. Its effect follows production and accumulation of off flavor compounds, which discourage consumption and limit diversification of sardine products. Oxidation affects nutritional quality by losses a range of nutrients including health promoting in omega-3 fatty acids.

### 3.0 RECOMMENDATIONS

- i. Attitude change in recognition of important health and economic benefits of small fish species and promote necessary investment in *dagaa* fishery for reduction of postharvest losses, improving product quality, shelf life and public awareness.
- ii. Investment in sardine handling and processing technologies across the value chain from fishing, storage on board, offloading, processing and packaging is needed for development of the sub-sector. Investments required include renovation of boats to improve on-board handling of fresh catch. Provision of fish holds in boats need to be redesigned such that hard containers with known volume (weight) to be used to carry

fresh catch. Fish holds will prevent physical damage to dagaa, easy offloading and would be used as a unit of sales at the landing sites. Furthermore, these fish hold are likely to allow use of cooling elements such ice during handling and transportation of fresh dagaa.

- iii. Attitude change and use of improved drying racks with recommended drying nets and introduce closed drying facilities such as green houses to dry sardines. Use of closed drying processing facilities will improve hygiene, premises and protect product from lipid oxidation, chemical, biological and physical contaminants as well as exposure to insects and other pathogen transmitting vector to ensure product safety and quality.
- iv. Introduced, tested and piloted drying of sardines in green house could be introduced by construction of low cost model structures.
- v. The Fisheries sector in collaboration with technical institutions like VETA, SIDO, FETA, TEMDO, CAMATECH, TIRDO and other actors work together to design and pilot low cost technologies and or subsidized fish holds and closed drying facilities.
- vi. Fisheries regulations governing; (a) licensing of fishing vessels to include presence of fish hold containers as mandatory requirement, (b) processing premises for drying *dagaa* to be approved, (c) allow application of natural antioxidants during processing, transportation and storage of sardines and develop guidelines on process deep fried sardine. (d) Product differentiation based in shelf life, price based on process and quality.

# MAXIMIZING SARDINE MARKETING EFFICIENCY FOR DEVELOPMENT AND LIVELIHOOD IMPROVEMENT IN TANZANIA

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## Executive Summary

Lake Victoria is the second largest freshwater lake in the world after Lake Superior with surface and catchment areas of 68,000 km<sup>2</sup> and 184,000 km<sup>2</sup> respectively of which 51% is occupied by Tanzania. Despite the higher production and marketing potential, Tanzania's sardine business is facing two main challenges related to product quality and unpromising value chain. About 80% of processed sardine products in Lake Victoria Tanzania side has been treated as fit for animal feed. The main barriers are access to markets, business loans, low bargaining power and market information. About 80% of the market shares are controlled by 50% of traders and processors. Thus post-harvest value of sardine is manipulated by fewer regional traders who enjoy the income from sardine trade consequently the poverty levels of people living along the lake is high. The innovative collective efforts are recommended to address the marketing efficiency issues through improved bargaining power, processing and handling capacity, information sharing and access to finance.

## Introduction

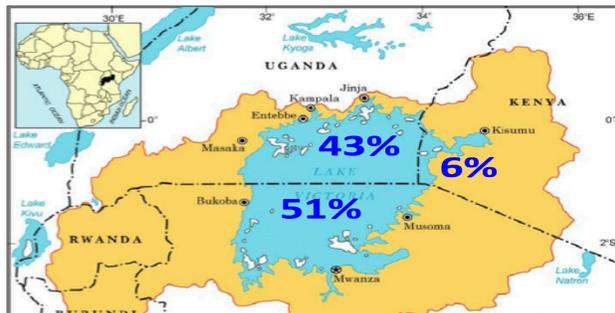


Fig.1: The Distribution of Lake Victoria in East Africa

The Lake Victoria basin provides livelihood to about 30 million people, with a rate of growth of 3.5% (Mukasa, 2011). Sardines are one of the major commercial species in Lake Victoria and leads with 71.2% in the catches. Despite the increased demand of sardine products, the livelihoods of actors along the value chain is not promising. Omwega *et al.* (2006) reported that fishers in Lake Victoria were regarded as poorest group of people in all sectors of the economy. Thus fish marketers are compelled to sell their product at a very low price to avoid huge wastage and in return their marketing margins and marketing efficiency are reduced. In addition, the distribution of wealth which

trickles down to the improvement of the livelihood of market participants was not known.

Effective and efficient business and institutional arrangements are essential for every industry to position the business ventures within the value chain, show how transactions are made among stakeholders and underlying economic logic for value creation. It was established that the business arrangements between the crew members and boat owners in Tanzania influenced revenue sharing among players. This has been connected to poor performance of crew members, theft of fishing equipment, boat engines and portion of fish products by crew members.

Furthermore, with regard to market share and efficiency, sardines traders have not been able to access the lucrative outlets due to weak institutional support and lack of economies of scale. Besides, lack of appropriate marketing strategies, skills and knowledge in marketing had further complicated the situation leaving many

sardine processors and traders struggling to grow market share. Moreover sardine capturing, processing and trading is like any other commercial businesses, require adequate finances that are always scarce.

## Background

The study aimed at developing an inclusive business model to improve the marketing efficiency of Lake Victoria processed sardine products. Efficient marketing system ensures fair distribution of benefits. In lieu of that, there was a need for characterizing market potentials and developing inclusive business models towards increasing marketing efficiency of processed sardine. Structure, conduct and performance framework were used to scrutinize the marketing efficiency. Consumers' buying decision factors were identified and tested before developing the business model in collaboration with the stakeholders. Primary data from Lake Victoria Tanzania side were collected using structured and tested questionnaires from 546 randomly selected respondents in Mwanza, Mara and Kagera regions. Key informants and focus group discussions complemented the information gathered through questionnaires. Data were tested for validity, reliability and model fit by using SPSS program version 24. Data were analyzed using multiple regression models and descriptive statistics. Market analysis used price efficiency, descriptive and organizational structure.

## Results

### Marketing Efficiency

Sardine losses were observed as most of the produced sardines dried on sand (80%) (Fig 2) was treated as fit for animal feeds whereby a bucket of 4 kg of dried sardines was sold for 3500 TZS (1.75 US\$) to 5 000 TZS (2.5 US\$) instead of 7000 TZS (3.5 US\$) to TZS 10 000 (5 US\$) for sardines died on raised racks and on rocks that had a better quality.



Fig 2: Sardines dried on sand

competitive and high inequality in the welfare distribution caused by the existence of dominant individuals affecting market price and others are price takers.

The main barriers to the market were capital in financing the fishing activities, poor access to market information, unreliable markets of processed sardines, lack of economies of scale, high government levies directed to processed sardines, high income inequality and poor distribution of the accrued benefits among beneficiaries and actors along the value chain.

Inequality in income among traders was very high as indicated in Fig. 3, where about 80% of the monthly sales were accounted by 50% of the traders. The Gini coefficients for traders and processors were 0.59 and 0.64 respectively implying that the market was highly concentrated, less

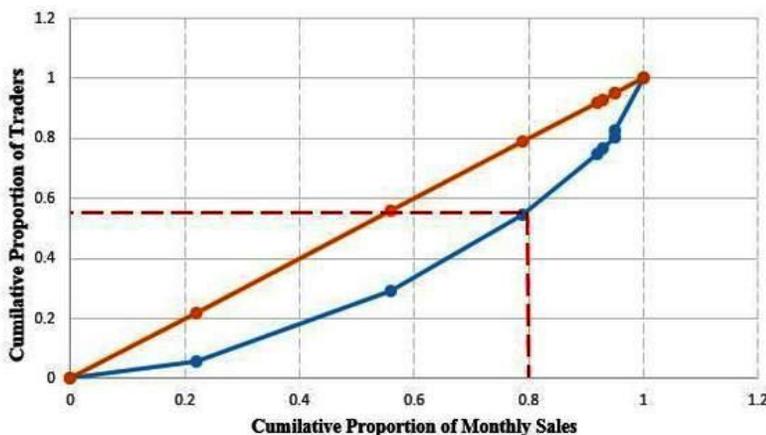


Figure 3: Lorenz Curve of Sardine Traders in the Study Area

The same applied to the processors whereby about 80% of the monthly income was accounted by 50% of the processors as indicated in Fig. 4. The policy issue here is that the gap between those who have it and those who don't have is very big. This is also connected to the poverty level of people living in the same area with access to the same resources but differs much in their living standards.

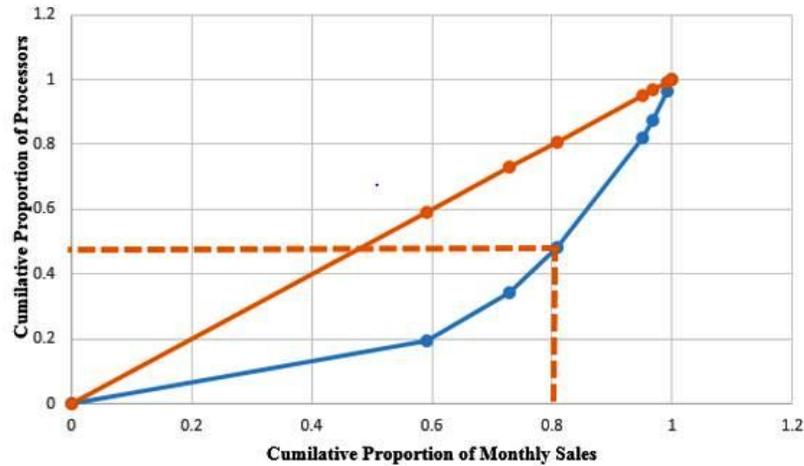


Figure 4: Lorenz Curve of Sardine Processors in the Study Area.

### ***Business and Institutional Arrangements***

With regard to business and institutional arrangements, it was established that most regional traders pre-financed the fishing activities to the camp owners and hence camp owner have to provide processed sardines for the funding received. Due to such business arrangement there was a predetermine quantity and quality of processed sardines. The camp owners were obliged to receive the finance in advance due to high cost of fishing equipment and daily operation costs which were about 8,400,000 (4,200 US\$) during the survey. The daily operation costs were on fuel for the boat and pressure lamps and food for fishermen, which was amounting at 200,000TZS (100US\$). The predetermined quantity and quality of the processed sardines was the reason as to why over 80% of the processed sardines were treated as good for animal feeds hence the product fetched very low prices. In addition the predetermined quantity of processed sardines were the reasons for use of illegal fishing nets which at the end might deplete the fish resources. **Fig. 5** depicts the existing regional business model. The policy issues here are based on the poor access of formal business loans, individual producers who are forced to produce based on the buyers requirements of which the value of processed sardined is manipulated by few regional traders.

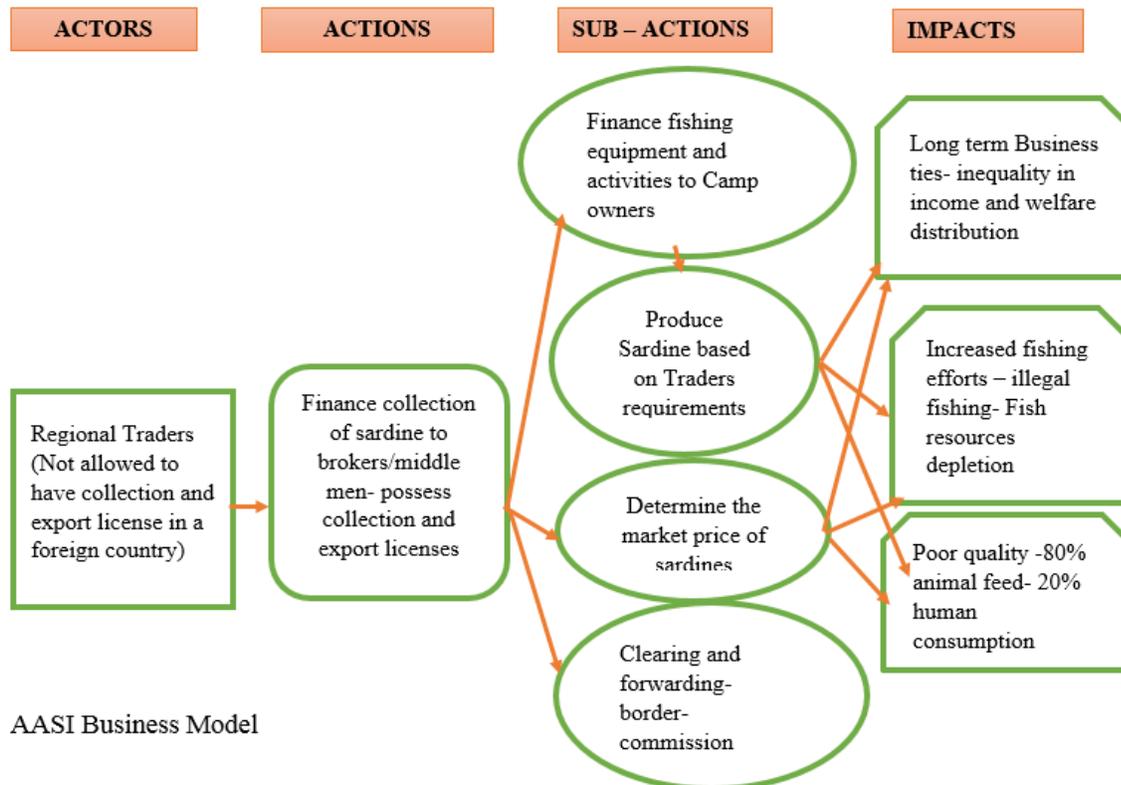


Figure 5: Lake Victoria Sardine Products Existing Regional Business model

**Recommended Business Model**

The recommended business model calls for the formation of producers associations for improving networking, innovations, product improvements and bargaining power, access to business loans, markets and market information. The recommended business model also encourages the government supporting institutions, specifically the Tanzania Bureau of Standards (TBS), Small Industries Development Organization (SIDO), National Fish Quality Control Laboratory (NFQCL) and Tanzania Fisheries Research Institute (TAFIRI) and the Local Government Authorities (LGAs) that have been supporting the sardine industry in value addition, provision of certification to processors and provision of training on value addition technologies (Fig.6) to keep the good work burning. The recommended business model also encourages more support to processors and traders in order to improve the quality of sardines as well as market efficiency and hence access the lucrative regional markets.

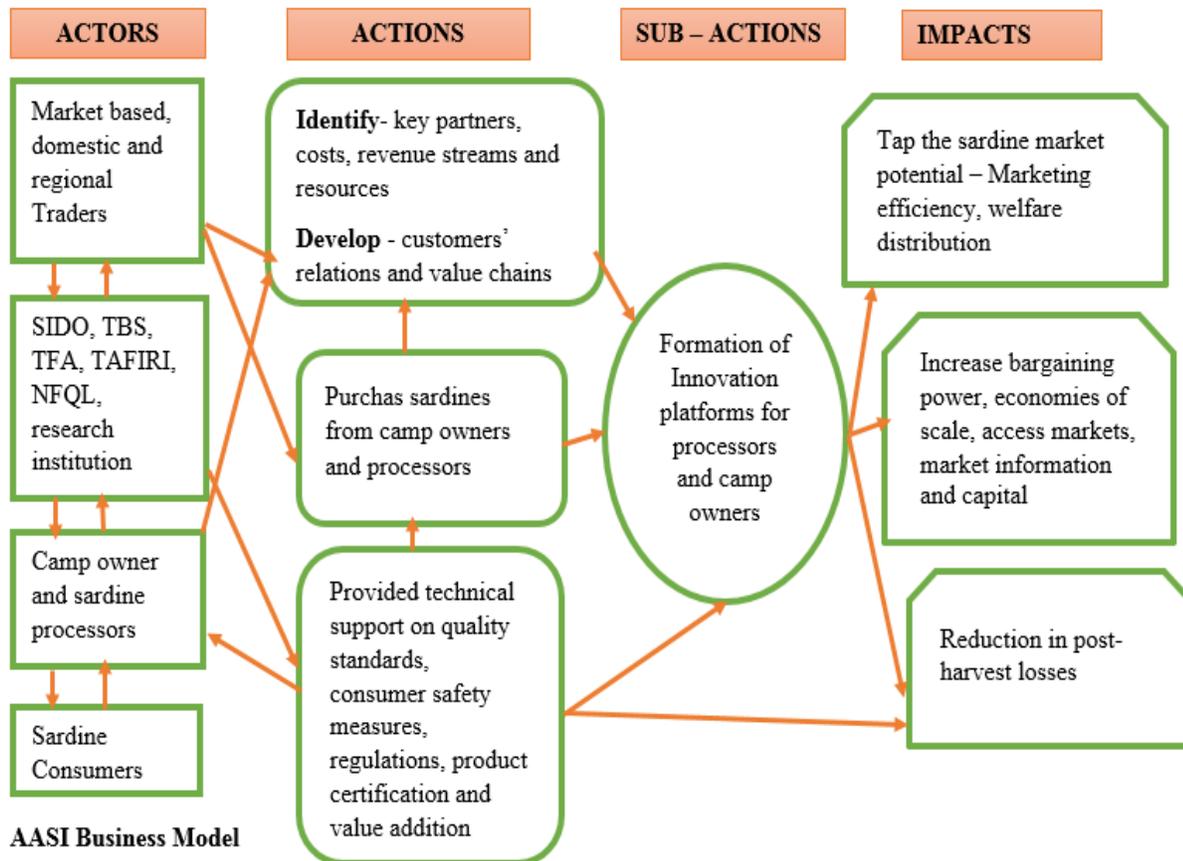


Figure 6: Recommended Business Model for Lake Victoria Processed Sardine Products

### Implications

The existing Lake Victoria sardine products business model depicts inefficiencies in value propositions which have implication on customer value, economic and structural dimension as shown in the distributions of market shares and incomes. More emphasis should be directed to increase the economies of scale through collective marketing and strengthening business and institutional arrangement that would improve access to markets, marketing information, and business loans hence, increase the volume traded and reducing the cost of doing business.

### Conclusion

The findings revealed inequality in income and market shares, lack of economies of scale, poor access to business loans, market information and markets for processed sardine products, the cost of doing business was high leading to inefficient marketing system with greater likelihood of domination as economic and game theories suggests.

### Recommendations

Since the marketing system for Lake Victoria processed sardine products is inefficient and imperfectly competitive due to high levels of barriers to entry and high cost of doing business, the following are recommended to the Government towards fostering competition; improving distribution of sales and income there-by enhancing the marketing efficiency:

1. To promote use of collective marketing approach which improve the marketing efficiency by increasing the bargaining power; access to trainings related to processing technologies, good handling practices and business; access to formal business loans, markets and market information as well as increase the volume

of traded products. Thus the actors along the sardine value chain should be supported to form associations and innovation platforms to engage in lucrative markets.

2. The regulatory, research and training institutions should support the producers in new processing technologies, quality improvement, trainings on good fishing and processing practices and provision of incentives for value additions.
3. To promote and regulate financial institutions, microfinance institutions and banks to innovatively develop facilities and financial products which accommodate small-scale fishers, traders and processors accessing financing for short-term and long-term investments.

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