KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
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SERVICE DELIVERY

BUSINESS PROCESS RE-ENGINEERING

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DISSEMINATION OF KMFRI's SUCCESSFUL SCIENTIFIC RESEARCH AND INNOVATIONS

1. Kenya Marine and Fisheries Research Institute (KMFRI) undertakes an expansive selective fish breeding programme that is being implemented at the Institute's Sagana Aquaculture Research Centre, aimed at enhancing the quality supply of fingerlings. The centre has ultra-modern hatchery equipment capable of accelerating the hatching of tilapia eggs. Lack of quality fingerlings has been identified as a major obstacle hindering fish farming in the country. The programme is critical in addressing this gap. The programme will also promote fish farming across the country to increase fish production from the current 18,000 to 71,500 metric tons, and consumption levels from 4.5 kg to 10 kg per capita per year by 2022.

2. KMFRI is undertaking research on how to utilize locally available ingredients such as Black Soldier Fly Larvae (BSFL) to produce affordable fish feeds. Fish farmers in the country are grappling with the high cost of fish feeds, which use fish meal commonly known as *omena* in local fish feed formulations. Fish feeds take over 50% of the total operational costs, and the high prices discourage farmers from practising fish farming. The larvae will therefore replace *omena*, which has been the main ingredient in fish diets. Experiments are also being carried out to incorporate BSFL as an alternative ingredient in a variety of feeds for poultry, pigs and dairy cows. Black Soldier Fly larvae grow well in a variety of substrates including cow dung, kitchen waste, brewers waste and chicken droppings, making it cheap to grow. The larvae's crude protein level is over 45%, making it a practical and viable replacement for *omena* in fish feed.

   The quality of fish meal commonly known as *omena* is also being questioned because businessmen are adulterating it with pebbles to disguise its weight rendering the ingredient unreliable in fish feed production. And with the declining capture fisheries, the idea of using insect feed such as BSFL is timely. Moreover, KMFRI produces commercial fish feeds in its ultramodern miller located in Sang'oro and does so by utilizing local ingredients like Ochonga (*Caridina nilotica*), *Omena*, wheat

or rice bran, sunflower or cotton seed cake and cassava for binding among other ingredients.The formulated diets include 40% crude protein for starter mash and 28% crude protein for growers pellets.

Special ornamental fish feed (with colour enhancing ingredients) such as green pepper, carrots and kales are also available. Fish feeds are formulated by feed experts (scientists) by mixing several ingredients to make a balanced diet. These ingredients are grounded separately and later mixed to ratios before pelletizing to produce floating pellets, which are dried and stored in gunny bags. The feeds are sold to farmers at affordable costs lower than of other brands found in Kenyan markets.

3. KMFRI has been developing a DNA barcoding reference library of commercially important fishery organisms, such as fish, crustaceans, and molluscs, since 2020. Kenya's marine waters are home to over 6,000 species, with 2,000 of commercial value. Creating DNA barcodes for these organisms will improve their identification and traceability along the fish market value chain, reduce species substitutions in fish markets (i.e. fishing fraud), and reduce cases of Illegal, Unregulated, and Unreported (IUU) fishing activities, which cost the country billions of shillings each year. Tissue samples and whole specimens (voucher) of the targeted species are collected from selected fish landing areas as part of the DNA barcoding process. Information about the species' biology and geographic locations is also gathered. Tissues are kept in 100% ethanol, while whole specimens are kept frozen at -80°C before being processed for long-term storage. Each species' genomic DNA is obtained for a maximum of five individuals. The mitochondrial DNA cytochrome c oxidase subunit I gene (COI) is amplified and sequenced using universal primers through polymerase chain reaction (PCR). Currently, 50 marine species have had their DNA barcoded, with the process for other species still ongoing.

4. KMFRI has innovated and rolled out 13 fish value added products that include fish balls, fish samosas, fish sausages, fish burgers, fish kebabs, among others, and value added dried dagaa products. KMFRI uses catfish, Nile Perch, and big tilapia fish sourced from KMFRI Sagana fish ponds, aquaculture farms, Lake Victoria, East Africa Sea Food and fish outlets for processing and product development. The Institute through various aquaculture projects has trained thousands of fish farmers/traders and other stakeholders on manufacturing the products manually and preparation of different fish products. To safeguard against post-harvest losses, KMFRI has developed an improved smoking kiln that separates the fire place and the fish thus superior products are produced unlike previously where both firewood and fish were combined. Women no longer have to worry about burning their fingers while cooking since the kiln is user friendly. The kiln can also bake cakes and cook other types of food that require very low heat. The low-cost technology can be set up using

minimal investments and serves women who may need to leave some food simmering as they attend to other duties. It comes with a lock, hence safeguards against food theft. In 2020 research by FAO, the global fish consumption has increased at a rate of 1.5 per cent, outpacing the world population growth and the demand is expected through the introduction of value added products.

5. The artisanal fishery sector at the coast which accounts for 90% of the landings is also marred with post-harvest losses in both the cold and dry chain. KMFRI has come up with innovations to ameliorate some of the shortcomings.

Cold chain

In the cold chain, KMFRI has designed, fabricated and transferred as a pilot, a light-weight insulated cold chain box to selected fisherfolk in Kwale county to mitigate post-harvest losses. The fabricated box holds fish in ice next to homes or in the fish bandas. The local fisherman is thus able to keep his/her fish fresh for longer.

Dry chain

In the dry chain, KMFRI has introduced rack dryers with nylon mesh surfaces and UV stabilized polythene for the marine Dagaa fishery to ensure fish is dried in hygienic surfaces to avoid contamination. Fisher communities had been spreading Dagaa on the sandy ground to dry compromising its quality. Since Dagaa drying involves boiling, KMFRI has further introduced food safe food grade boiling cylinders to eliminate the risk of carcinogens from the plastic containers currently used in boiling. To reduce the cost of boiling, further KMFRI has introduced boiling vessels that can hold more boiling cylinders at a go, and introduced energy efficient and cost-effective boiling ovens/jikos that consume 50% less wood fuel. To eliminate any possibility of contamination, KMFRI has also introduced drainage racks to enable final sorting of fish without laying the fish back on fishing nets.

KMFRI has also introduced solar dryers, solar tunnel dryers and lately hybrid windmill solar tunnel dryers with capability of drying fish during wet weather conditions. The hybrid windmill solar tunnel dryer will be hooked to a solar based flake ice to support the cold chain. The end product from improved drying technologies is shorter drying time, better quality fish, enhanced shelf life, reduced losses during storage and use of green energy

The smoked fish chain

KMFRI has innovations on improved fish smoking technologies which has led to: (i) Improved fish quality (ii) Higher fish smoking capacity (iii) Less wood consumption by 60% therefore lowering carbon footprint (iv) Reduced smoke emission which does not injure the eyes of women smoking fish.

Fried fish chain

In the fried fish chain, KMFRI has introduced the improved fried fish display shelf "Mama Karanga box" in Kwale, Mombasa and Kilifi, though the number is still quite low. The 'Mama karanga" box is for the "Mama karanga" women who sell fried fish in the evenings from 5pm to 10pm, and who rely on the traditional paraffin tin lamps used as display lights.

Unfortunate spillage of paraffin from tin lamps spoil fish leading to food waste and loss. Smoke emissions from the paraffin tin lamps further cause air pollution, respiratory diseases, increased carbon footprint affecting climate due to burning of fossil fuels especially black carbon which causes intensive global warming in a short time.

Traditional fish display are also unhygienic because fish is placed on bare wood or on newspapers used as wrappers.

Improved "Mama karanga" box however replaces paraffin tin lamps with an ecofriendly rechargeable solar lamp which eliminates smoke and creates a conducive business environment. The box has food grade hygienic easy to clean aluminium lining on which to place fish. Women can do business for longer and fish quality is maintained.

The box also reduces food loss and wastage caused by paraffin spillage, cuts paraffin costs and reduces cases of respiratory diseases resulting in improved health. Burning of fossil fuels is reduced which has a positive effect on climate change. The demand for the boxes among the women is quite high. Kilifi County bought 160 boxes in 2017, KMFRI gave Kwale county 45 boxes and Mombasa received 30 of them. There are over 4,000 Mama Karanga women at the coast of Kenya.

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