

TBTI GLOBAL BOOK SERIES

OUR CONNECTION TO LIFE: MULTIPLE LENSES ON NIGERIA'S SMALL-SCALE FISHERIES



EDITED BY

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Multiple Lenses on Nigeria's
Small-Scale Fisheries**

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Shehu Latunji Akintola

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Too Big To Ignore Global (TBTI; <https://tbtinglobal.net/>) is a research network and knowledge mobilization partnership supported by over 800 members from around the world. The network aims at elevating the profile of small-scale fisheries, arguing against their marginalization in national and international policies, and developing research and governance capacity to address global fisheries challenges.

TBTI Global Book Series is a publication series that aims to highlight why we need to pay close attention to small-scale fisheries. The series will be of use to anyone interested in learning more about small-scale fisheries, especially about their important contribution to livelihoods, well-being, poverty alleviation and food security, as well as to those who are keen to help raise profile of small-scale fisheries in the policy realm.

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Lean Management Technique for Increased Culture Fisheries at Eriwe Cluster Cooperative Fish Farm Estate, Ijebu-Ode, Nigeria

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Abstract

There has been an increase in aquaculture production of catfish in Nigeria, making the country the highest catfish producer in Africa. The value chain of this fishery has been immensely impacted upon, and has served in sustainable livelihood for fish farmers. Cluster cooperative fish farm estate also improved production through economies of scale. The management techniques being used by the cluster cooperative fish farmers have been built through experience and resilience to the various challenges encountered on production system. The Lean Management Technique was used to identify various challenges encountered on Eriwe Cluster Cooperative Fish Farm through the training of Lean Subject Management Experts and by looking at how the effects of these challenges can be minimized to achieve profitable production from catfish culture. Lean Subject Management Experts were selected from cluster cooperative fish farms in Ogun State and Delta State and were trained at various stakeholders' meetings, either virtually, in class or during field trips with the assistance of WorldFish/Fish Innovation Lab/USAID and University of Ibadan.



Figure 1. African catfish harvesting from pond at Eriwe Cluster Cooperative Fish Farm Estate, Ijebu-Ode, Ogun State Nigeria, 2021. Photo by Shakiru Okanlawon Sule

Small-scale fisheries

The use of traditional fishing techniques by artisanal fisherfolk enables sustainable catch for local market, food security, livelihood and subsistence of the fisherfolk household through small-scale fisheries. Catch per unit effort and income generated from sale of catch is low and can only sustain the household for a limited period. Hence, the household must seek for another catch while consumption last. Small-scale fisheries operate in an uncontrolled and unpredictable environment. Cohen (2018) noted the marginalization of small-scale fisheries in face of dialogue on resources from the aquatic sector. Akintola & Fakoya (2017) noted that small-scale fisheries in Nigeria are exclusively artisanal, underdeveloped and heterogeneous. In Africa, small-scale fisheries are synonymous with crude fishing craft and practices in (ecosystem) marine, beach, coastal, lagoon, estuary, mangrove, lakes, marsh, floodplain, river, brackish and fresh water environments. They use vessels such as dugout canoes, fibre

glass vessels, row boat, raft, sail boat, outrigger craft. The type of venture of the small-scale fisheries can be in the form of commercial, artisanal, Indigenous, subsistence, recreational, and aquaculture. Typical gears the small-scale fisheries in Africa use include gill nets, entangling nets, hook and line, seine nets, trawl, falling gears/cast net, poisons/explosives, traps, surrounding nets, grappling and wounding (harpoons), gleaning (collection by hand), hoop net, acadja, spear/cutlass (Olaoye & Ojebiyi, 2018; Isaac et al., 2020). Akintola and Fakoya (2017) stated that small-scale fisheries are multi gear and multi species, specific for the fisherfolk as they employ the use of different gears to catch different species of fish. The importance of small-scale fisheries is noted for food security of over 200 million fishers and 2.3 million fishers employed in its value chain worldwide (Said et al., 2020). Olaoye & Ojebiyi (2018) report the main sources of small-scale fisheries in Nigeria are marine artisanal and inland artisanal fresh water capture fisheries. Small-scale fisheries are being relegated subtly as a result of politics, economics and conservation of the environment, despite its importance in food production, livelihood and poverty reduction (Cohen 2018). According to Edwards (2013a), traditional fishing is fundamentally linked to capture fisheries through the use of crafts developed from local or indigenous knowledge, operating within 5 nautical miles of the Exclusive Economic Zone (EEZ) (Olaoye & Ojebiyi, 2018). Small-scale fisheries are significantly affected by commercial industrial fishing and intensive large-scale aquaculture. The individuals involved in small-scale fisheries often lack representation in governance and policy initiatives, yet their presence continues to grow despite inadequate government support. Additionally, conflicts over rights and environmental destruction caused by oil pollution have emerged (Cohen, 2018). Unsustainable practices by fisherfolk are peculiar to small-scale fisheries, including overfishing and destructive fishing practices, which are some of the challenges in the sector (Sogbesan & Kwaji, 2018). Ogunsola (2014) reported that hazards aboard the vessels during fishing, such as stormy weather, water turbulence and capsizing of canoe, menace of aquatic weeds are some of the risks faced by fisherfolk.

The coastal rural riverine fisherfolk will continue to rely on small-scale fisheries for generations yet to come for their food and livelihood (Cohen, 2018). Meanwhile, Akintola & Fakoya (2017) reported that the inability of small-scale fisheries to reduce and preserve fish from postharvest loss is a major setback for the sector.

Small-scale fisheries have been able to address some of the major areas of the Sustainable Development Goals (SDG) of the United Nations by meeting the global present needs of man with a place for posterity in six areas (Table 1) of the seventeen goals. These have led to the improvement witnessed in the small-scale fisheries sectors.

Table 1. Success of small-scale fisheries based on Sustainable Development Goals (SDGs)

SDG	Examples of progress in Sub-Saharan Africa
SDG 1 No poverty	<i>Small-scale fisheries have created livelihoods, thus contributing to poverty alleviation:</i> Over 60 million fisherfolk worldwide (World Bank et al., 2012 in Cohen et al., 2018). Small-scale fisheries occurrence in coastal and inland riverine rural communities (Isaac et al., 2020). Small-scale fisheries have created jobs 37 million people in developing countries (Fakoya & Akintola, 2018).
SDG 2 Zero hunger	<i>Small-scale fisheries have impact on food and nutrition security:</i> Multi species catch (Akintola & Fakoya, 2017).
SDG 5 Gender Equality	<i>Small-scale fisheries are harvesting from the wild and are not an agricultural operation:</i> Women in small-scale fisheries (Akintola & Fakoya, 2017) Women involvement in in post-harvest/ marketing (Akintola & Fakoya, 2017)
SDG 8 Decent Work and Economic Growth	<i>Small-scale fisheries are an age-long practice of Indigenous fishing communities:</i> Employment of coastal rural citizens and migratory fishermen in gainful employment. Ancillary industries of net making/mending, gear and craft construction have developed and created employment.
SDG 13 Climate Action	<i>Climate impact on catch:</i> Reduced catch (Akanni, 2008) Reduced size (Aderinola et al., 2021) Continued research and development (Mapfumo, 2021)
SDG 14 Life Below Water	<i>Small-scale fisheries have witnessed increased fishing pressure (Kawarazuka & Bene, 2010):</i> Biodiversity/conservation loss (Sogbeasan & Kwaji, 2018) mitigated through closed season, fishing quota and co-management (Agbeja, 2012).

Cooperatives, especially cluster groups are important part of small-scale fisheries. In Thailand, for example, the ICFO/ICA/TCLT (2008) reported 23 cooperatives in marine sector, 15 in brackish water sector and 34 in freshwater sector. These cooperatives collectively comprise 4,111, 2,915, and 5,541 members in each respective sector. This amounts to 72 fisheries cooperatives with over 12,000 members, which have supported the management of fisheries resources by reducing the over exploitation of resources. Globally, catch from artisanal small-scale fisheries has witnessed decrease in catch due to climate change, degradation of coastal environment, pollution of water bodies and increased number of fishers (Serge & Andrew, 2010). This development has opened up opportunities for small-scale aquaculture as an effective alternative for fish supply. By using culturally and ecologically relevant practices, a sustainable and reliable fish provision that not only enhances the economic stability of local communities is established but also fosters the preservation of aquatic ecosystems.



Figure 2. African catfish harvesting from pond at Eriwe Cluster Cooperative Fish Farm Estate, Ijebu-Ode, Ogun State Nigeria, 2022. Photo by S. O. Sule

Small-scale aquaculture

Aquaculture environment is controlled for optimal productivity of fish in order to meet human needs. Sarker et al. (2017) noted that aquaculture has gained recognition for reducing dependence on small-scale fisheries from the wild, which is an aspect of SDG 14. Mapfumo (2021) stated that aquaculture is the only way of increasing sustainably fish production in Africa with attendant improvement on economy, poverty alleviation and food security. Benefits derivable from small-scale aquaculture has improved nutrition, increased income and employment, while militating factors of expensive feed, low pricing system and financial credit sources have lowered an all-inclusive rural participation in small-scale aquaculture (Sarker et al., 2017). Belton (2013) opined small-scale aquaculture as a means of reducing poverty level (SDG 1); alleviating household food security (SDG 2) with economic generation for farmers irrespective of gender (SDG 5). Albers et al. (2021) stated that small-scale aquaculture is another livelihood alternative to local people in developing countries. He further noted that financial and technical aspect for developing small-scale aquaculture is the focus in Chile due to dwindling catch from the coastal resources. Geophore aquaculture is the production of fish from land-based holding facilities; this aquaculture production in inland water with integration can increase productivity, since the management of small-scale aquaculture goes through varied steps from clearing through to harvesting for consumption (Sarker et al., 2017). The production system of small-scale aquaculture has varied characteristics (Belton, 2013) with different culture methods. Edwards (2013a) reported that it is hinged on if the system comprises limited investment in assets; if it is the main source of income or the only livelihood of investment for the operator. Sarker et al. (2017) posit that small-scale aquaculture is a sustainable and cost-effective method of fish production that offers increased economic returns. As a result, many aspiring fish farmers have started to engage in small-scale aquaculture by leasing ponds specifically for income generation, rather than for subsistence and household consumption, as noted by Edwards

(2013a). Aquaculture in Nigeria is private-sector driven (Ayinla, 2007), with existing gaps in national small-scale aquaculture sector (Dizyee et al., 2020). These gaps are being addressed through successes recorded for SDG 8 that have led to economic growth in small-scale aquaculture.

Table 2. Success of small-scale aquaculture based on Sustainable Development Goals (SDG)

SDG	Examples of progress in Sub-Saharan Africa
SDG 1 No poverty	<i>Aquaculture has improved people's livelihoods, contributing to poverty alleviation:</i> There are over 300,000 fish farmers in Sub-Saharan Africa in 2018. There is a large number of aquaculture farms in several countries (e.g., Nigeria, Kenya, Ghana, Rwanda, Zambia, etc.) Significant number of jobs created at several large commercial fish farms (e.g., Zimbabwe, Madagascar, Zambia, Ghana, Uganda and elsewhere).
SDG 2 Zero hunger	<i>Aquaculture has contributed to food and nutrition security:</i> Tilapia and catfish farms are producing affordable protein for the bulk of Sub-Saharan Africa's populations. The ongoing establishment of fish farms has created much-needed employment and improved livelihoods, which is essential to achieving food security.
SDG 5 Gender Equality	<i>Aquaculture has been identified as an agricultural practice in which women can participate:</i> Out of the 300,000 fish farmers accounted for in 2018, 12% are women. Women are actively involved in post-harvest and marketing as noted in Ghana, Zambia, Zimbabwe, Madagascar, Nigeria. Women are active in provision of aquaculture services (government, research, etc.).
SDG 8 Decent Work and Economic Growth	<i>The promotion of aquaculture, especially large-scale ventures, has meaningfully contributed to decent employment:</i> Significant employment created by the large farms in Nigeria, Zambia, Zimbabwe, Kenya, Madagascar, Ghana. Spin-off sectors (e.g., fish feed industries, fish marketing and distribution, government/civil service) have developed and created employment. Local economic growth is evident where fish farms are established.
SDG 13 Climate Action	<i>The ongoing promotion and increased adoption of 'climate smart' farming practices and innovations:</i> Adoption of the Ecosystem Approach to Aquaculture (EAA) in aquaculture planning. Climate-smart aquaculture practices such as water reuse systems (aquaponics, RAS, etc.) are evident in SADC region. Continued research and development.
SDG 14 Life Below Water	<i>Sustainable aquaculture is meant to reduce fishing pressure, thus conserving inland waters/ocean resources:</i> The adoption of EAA for aquaculture planning by Sub-Saharan Africa countries (sustainable practices that reduce negative impacts to environment). Aquaculture as an alternative livelihood option, especially for coastal communities
SDG 17 Partnerships to achieve the Goal	<i>There are several existing partnerships for the implementation of aquaculture programmes in Sub-Saharan Africa:</i> FAO-initiated Technical Cooperation Programmes (TCPs) and other Trust Funds in Sub-Saharan Africa. AU agencies work collaboratively with regional organizations in Africa such as FAO, AU-IBAR, RECs, WorldFish.

Source: Adapted from Mapfumo (2021)

Economically, aquaculture performance has been assessed in Nigeria (Van Tran et al., 2020) with benefit-cost ratio of 1.34, with profit maximization on small-scale aquaculture of catfish farming (Emaziye, 2020). However, Adelesi & Baruwa (2022), in a recent study on small-scale aquaculture of catfish in a fish farm estate in Lagos, reported that new fish farmers may not be able to make profit due to the huge investment cost. Meanwhile, existing farmers are only earning to cover production cost due to reduced total revenue (i.e., negative profit or net loss). However, Sarker et al., (2017) reported that small-scale aquaculture is economically important and that it maintains the physical environment with equity in social administration for effective wealth distribution.

According to Dasgupta & Durborow (2009), success in small-scale aquaculture is only achieved with effective marketing with commensurate profitable price. Marketing opportunities and strategies need to be devised along production line, with marketing channels for live haulers and processors. Some of the methods in which sales are conducted include live product sales (live haulers need no form of transport, payment made at the time of purchase for fish), farm sales (directly to consumers), complemented with wholesales sales (selling to market/fish mongers who now retail/add value).

Small-scale fisheries and small-scale aquaculture: the link

There are numerous links between small-scale fisheries and small-scale aquaculture. According to Jabbar (2008), the livestock revolution has given small-scale producers opportunity to latch on to the vast market to improve their livelihood. Kawarazuka & Bene (2010) noted that small-scale fisheries and small-scale aquaculture are interlinked, as both assist in meeting the nutritional needs of household food security and help improve household income for other family needs. Aquaculture fish are 'cash crop' rather than 'food crop' in small-scale fisheries, hence the revenue base cannot be compared, with the former having high profit than

the latter (Edwards, 2013a). The fish demand of the global population cannot be met by small-scale aquaculture alone as complementarity in animal food protein security by small-scale fisheries is inevitable (Cohen et al., 2018).

Issues of environmental concern from wastewater discharge, which ends up in artisanal communities, impact the catch and lead to eutrophication and growth of excessive aquatic weeds due to rich nutrient-laden wastewater. This has left small-scale fisheries at the receiving end of unethical practices from small-scale aquaculture, with the release of aquaculture effluent being laden with fish waste, water treatment chemicals and fertilizers. Meanwhile, fishing pressures has changed amongst artisanal fisherfolk due to diverse activities around natural water resources (Kawarazuka & Bene, 2010). The resultant effect of climate change, according to Agbayani et al. (2013), has led to a loss of livelihood opportunities for fisherfolk and farmers due to increased flooding of the area, both for small-scale fisheries and small-scale aquaculture.

Description of the small-scale aquaculture at Eriwe Fish Farm Estate

Seventy percent of fish production in Nigeria comes from culture catfish production on small-scale to commercial scale operation (Hecht, 2007) noting that the majority of fish farmers is in the catfish production sector in Nigeria. In his report on the success rate of farming African catfish in tanks in Nigeria Edwards (2013b) reported that 75% out of 140,000 metric tonnes of fish produced in Nigeria are from small-scale aquaculture, with an estimated value of USD 800 million through the value chain of seed, feed and sale of table sized catfish. The fish farmers in the Eriwe Fish Farm estate use a cooperative model: farms in the cooperative receive operational credit capital for one production cycle as production incentive. Edwards (2013b) described fully the farm estate in his case study on small-scale aquaculture. Although the ownership of the ponds is private and based on lease hold, it is similar to Companhia (2012) report of private

ownership of farms in Nampula province in Mozambique, which has 19 associations with 467 members with a total of 506 fish farms.

The inability to master the artisanal environment with its attendant hazards has seen prospective fish farmers opting for culture fisheries or aquaculture. Culture catfish fishery has been a major aquaculture production system due to the species ability to withstand adverse environmental condition. This culture fishery has helped in generating employment to fish farmers spread across cluster cooperatives in Eriwe fish farm estate, with ancillary services in feed milling, fish feed and fish ingredient sales, value chain addition processing, fish marketing through fish mummies/mongers, fish transportation, pond construction etc., All of this has been a source of revenue for the various stakeholders involved. In recent times production has shifted from the culture of catfish to the hybrid catfish production, due to inbreeding encountered with the catfish species. The waiting production period has been increased, nevertheless with justifiable profit as indicated by the fish farmers.



Figure 3. African catfish harvesting from pond at Eriwe Cluster Cooperative Fish Farm Estate, Ijebu-Ode, Ogun State Nigeria, 2021. Photo by S. O. Sule

Lean management

Management of fish farm follows a set of rules and standards. These are known as best management practices (BMP), which allow for optimal production at a reduced cost. Some of the BMPs have been overlooked in recent times by small-scale aquaculture farmers as methods are been sought due to various challenges encountered on the farm (high cost of feed, routine water change, etc.), which has led to marginal revenue.

Lean management technique is a management tool applied in various sectors of the economy worldwide. It lends credence to basic management practices that can help achieve increased production. Application to everyday small-scale aquaculture production practice will assist in optimization of resources such as feeding, water quality monitoring, energy usage, workplace arrangement, waste reduction, problem identification and proffering solution. The adoption has helped in waste reduction and elimination in areas where it has been applied.

According to Lawrence (2021) lean management is a method that minimizes waste while simultaneously maximizing productivity. This is achieved by improved production result with customers' satisfaction as the main goal of production. The improvement is achieved by managing system, people and processes for improved performance. In any production system satisfying end users is the ultimate goal and this requires low production costs to create high-quality products that are delivered on time while considering the environmental impact of the production system.

The BMP of small-scale aquaculture is similar to lean management, where goals need to be set (e.g., increased profit), with an objective (how to achieve the goals within a timeline) and the action plan which makes the objectives to be realized) (Lawrence, 2021). Like in all other ventures, problems do arise; some are noticeable while it takes the effort of a third party to note others. Lean management has to do with identification of a deficiency or an opportunity that is yet to be utilized. The problem identified is then focused upon through continuous improvement by

planning, doing, checking and acting on the problem identified (Borris, 2006; Agustiady & Cudrey, 2016; Lawrence, 2021). This is a waste elimination management tool (Agustiady & Cudrey, 2016) that have assisted varied production system in industries.

Lean management is a tool that was used in 1950s' by W. Edwards Deming of the Toyota Motor Company (Borris, 2006; Lawrence, 2021) to find solution to an identified problem/waste, seek solutions by finding the root cause and choosing the appropriate solution to eliminate/reduce the problem in the Toyota Production System (TPS). The problems can be in any of the waste DOWNTIME (defects, overproduction, waiting, not utilizing people, transportation, inventory, motion, extra processing) (Agustiady & Cudrey, 2016; Lawrence, 2021). According to Agbor (2008) LEAN is philosophical or management concept tool (not an acronym) that is a thought – through method, as well as culture, which allows employees to seek for continuous improvement in production process while eliminating all activities which have no direct value to the production process.

Tole (2019) stated that lean manufacturing involves the use of tools, which lowers cost by waste minimization, coupled with efficient operation and minimal resource usage in production. The lean management tools to be used in production may defer from one enterprise to the other in small-scale aquaculture. One of the tools that can be used to achieve efficient production management under lean system is the root cause tool. Under the root cause tool is (1) Fish bone diagram (studies the cause and effect of action in production, and also called Ishikawa diagram), (2) The '5 whys' which is sometimes less or morewhys/reasons (is a drill down methodology that drills down to the real cause by asking questions) (Borris, 2006; Agustiady & Cudrey, 2016; Lawrence, 2021), these are used to solve production problems of why things are not the way they should be and need to proffer solutions.

Different value streams exist in aquaculture production and these are ways/steps fish farmers get aquaculture product to the final consumers (broodstock-hatchery-fingerling/grow out-harvest-processing product

delivery). Each value stream has its own standard work/best practices (BMP) because in work environment with no standard, the results are not encouraging as there will be inconsistency, variation, quality deficiency and waste. Standards allows for less variation and the use of best practices (in the hatchery, feed mill, farms, processing and delivery) reduces errors, waste and risk, facilitates problem solving, and enables continuous improvement (Lawrence, 2021).

The Lean Management Technique was used to identify various challenges encountered on Eriwe Cluster Cooperative Fish Farm through the training of Lean Subject Management Experts and how the effects of these challenges can be minimized to achieve profitable production from catfish culture.

Waiting in production was noticeable as fish farmers were culturing hybrid clarias known as *Heteroclarias spp.*, which is a crossbreed of *Clarias spp.* and *Heterobranchus bidorsalis*. The production waiting time for the later species was an average of 10-12 months while for the former it was 4-6 months. The feasibility for the two enterprise was carried out based on the need to reduce waiting/production time; the findings showed that the two production cycles are feasible with less variable cost, while more variable cost are incurred in the production of the hybrid species. According to Agbor (2008), waiting in business affects productivity, increases production time and cost, with no value added to the price customers pays.

Extra processing was also noticed with on-farm feed produced from feed mill. Feed with fines were in ration meant for feeding, which leads to pollution of the water and necessitates frequent water change at extra cost. Farmers were informed of the need to rework the fines at the next feed production.

Defects were noticed in processed fish from the processing unit. This was attributable to burn and charring of smoked fish, which led to low patronage at the processing unit. The reason for the low patronage was addressed with the '5 whys'. Defects lead to loss of customer credibility for a product (Agbor, 2008).

Workplace organization in small-scale aquaculture farms is not well organized, which is attributable to the farmer/employee scattering tools/implements. Organization of workplace according to TPS is an effective way of restructuring production system (Dudek, 2013). Lean tools like 5S for workplace organization are powerful resources that can transform disorganized farms by systematically placing items in their proper locations. The 5S tool is an acronym for sorting (separating items), set-in-order (organizing it properly), shine (cleaning and repairing), standardize (by having a protocol to follow each time) and sustain (making sure that protocol is maintained) (Borris, 2006; Tole, 2019; Lawrence, 2021). By applying this strategy, you create a clean, organized, and efficient workstation, reducing waste and boosting productivity. The arrangement of feed ingredients at the feed mill and implements at farm store were not properly arranged. With the use of workplace organization different items were properly organized in different sections to the extent that finding materials and equipment is done easier, in less time.

Overproduction is the root cause of other waste (Agbor, 2008) encountered in production systems. There was a need to reduce the use of energy (cost of fuel), number of workforce and the amount of machinery. The cost implication on daily, monthly and cycle basis were analyzed and waste in overproduction cost noticed. This variable cost reduced the revenue accrued at the end of production cycle. Farmers were better informed, especially on the need to reduce daily energy usage either to once or twice a week.

Workers in Eriwe are well-trained in various aspects of cultural catfish production, ensuring there is no evidence of underutilization. However, farmers were advised that visual system can be used to communicate the 5S systems either through the use of signage, labeling, colour coding, logical placement and posted information of schedules/roles for effective staff operations. Use of shadow board (right placement of tools), daily checklist (identify whether things are done yes/no), schedule and status (who does what and when) and audit schedule and status (for supervisors) (Lawrence, 2021) were the new information passed on to fish farmers.

Labels are used to make the identification of materials and processes easy even to people unfamiliar with the organization (Creative Safety Supply, 2017) and this was the case on some of the farms visited.

Lack of record keeping is a significant challenge of small-scale aquaculture, as farmers are only concerned with the end profit and are not taking cognizance of each event that goes into production. Inventory management, another lean tool, takes note of inventory efficiency where surplus/scarcity are using visual ordering system that identifies low inventory and how replenishment is made. Visuals are also used to communicate with employees through (1) visual system in 5S workplace organization and (2) pull system which identifies minimum and maximum of stocks and when replenishment is needed (Lawrence, 2021). According to Ozer (2008) replenishment of inventory is a major task of the management who needs to be informed about the demand, as well as the lead time needed to replenish stock. Killian et al. (1998) stated that inventory of aquaculture stock can be achieved with estimated number of fish, estimated weight, use of Fishy 98 software, inventory from fish feeding response and the depletion method.

In small-scale aquaculture equipment are used in daily routine production process. The equipment may be that of electrical or mechanical, which will need maintenance. Equipment breakdown can significantly impact the production system, either by hindering operations or causing other issues, and fixing may be inevitable where replacement is not feasible in a short run. Total productive maintenance (TPM) is the medical science of machines (Venkatesh, 2005) that deals with management of equipment use and it involves all stakeholders so that equipment stoppage is avoided (Lawrence, 2021). In some organization a great success has been achieved by shifting from an old attitude of a single employee being involved in maintenance to a TPM where all employees are responsible for equipment maintenance. In TPM every worker is a maintenance team member.

Layout is the orderly arrangement of equipment in space so that efficiency is improved along with cost reduction. Layout optimization is how the workplace is organized through the creation of flow, with needs

at point of use to avoid excessive motion/travel. This can be achieved by using Sphagetti map/diagram (Agustiady & Cudrey, 2016; Lawrence, 2021), with the removal of unnecessary processes drastically reducing cost that leads to better use of organizational space, and reduced motion with effective supervision with low cost of operation (Chemim et al., 2021). According to Ojaghi et al. (2015) cost reduction and loss reduction in factory can be used to decrease price of goods sold through proper layout of the production environment, especially in the feed mill where increased competitors are been witnessed. A proper layout will reduce motion, save time, and increase efficiency along with productivity with a safer work environment for staff (Lawrence, 2021). As movement is reduced to only important activities, leading to available time for other productive activities that would have been scheduled for another time.

Conclusion

Small-scale aquaculture fish farmers in various culture enterprises at Eriwe are now reliably aware, informed and have adopted lean management technique in addressing different forms of production problems ('downtime') encountered in their business for effective management and optimal profitability.

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