Identify association of appropriate technological application with per capita income of small scale fishing household - a case of Jaffna small scale fishing community, Srilanka

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Abstract. Fishing is vital not only for nutrition supplementary but also livelihood of millions of people. Uninterrupted supply of sufficient and quality fish stocks without affecting marine eco system is ideal for sustainability fishing. However, balancing between sustainability of marine ecosystem, market equilibrium and livelihood of fishing and fishing dependent community is a challenge. Technological application is one of approach to overcome the sustainability of fishing activities. Technological applications are diversified as 1) technology in fishing vessels, fishing gears, equipment and so on. 2) Technology application in information sharing and digital applications such as Global Positioning System (GPS), mobile phone application under Global System of Mobile Communication and 3) Technological application in fishing infrastructure such as cold room, transport equipment and so on. Small scale fishing community depends on labour intensive whereas large scale commercial fishing industries attribute on capital deepening. Adaptation of technology depends on several factors such as financial capability and technology know how. The study examined which technological application is appropriate to small scale fishing activities in Sri Lanka since 90 percent of fishing were carried out by small scale fishers (Fisheries Year Book 2018/19). Primary sample data were collected by structured interview from household level fishing community in Jaffna, North of Sri Lanka. Data were analyzed using descriptive and correlation statistical techniques. The study revealed that information technology especially application of GPS, Internet and mobile coverage in order to obtain fish catch and market information followed by digital sensor application in fishing gear had positive impact on maintain sustainable fishing catches of small-scale fishing activities. In addition, strict law enforcement and monitoring of poaching vessels such as Indian trawlers using radar technology with coordination of fisheries cooperative societies was an essential requirement of small-scale fishing community as external support with regard to sustain fishing stock of the region and their livelihood.

1. Introduction: Sustainability and Protection of Fishing
“Sustainability” is a vital for every aspects of economic and social environment. The United Nations (UN) Brundtland Commission defined sustainability in 1987 that was “meeting the needs of the present without compromising the ability of future generations to meet their own needs. Subsequently the UN declared to implement 17 sustainability Development Goals (SDG) and to achieve targets within 2030 to sustain future of World. University of Queensland explained interdependent of the economy and society on natural environment creates “sustainability” as natural resources only be used at the same rate that they can be replenished. Protection of biosphere (Figure 1) is a fundamental of
societal development and thus economic prosperity and vice versa. Fish provides required nutrition at affordable price which is essential for healthy food to poor. Sustain marine resources including fishing is therefore essential. Thus protection of fishing resources is multiple benefits as achieving sustainability goals “life under water”, “no hunger”, “no poverty” and “good health”.

The question is how to protect fishing stock while sustaining livelihood of fishing community. Large scale fishing vessels used high tech equipment to find fishes within shorter period and minimize wastage as used capital deepening concept. Financial capability and technical know-how are required for large scale fishing activities[1] will be affecting income of households [2], helping poverty alleviation [3] and strengthen institutional [4]. Further, large scale fishing thread to fish stocks and marine natural habitats. In contrast, small scale fishing do not possess such financial capability and technical know-how to adopt high technological application. More than 80 percent of fishing activities are carried out by small scale fishing community as livelihood activities over the world and they feed fishes to the local market in a small scale but wider area. Improvement of living standard of small scale fishing is sustain not only their livelihood but also protection of marine resources, if they maintain rate of fish catches lower than rate of replenish of fish stocks.

Both rate of fish catches and fisher’s household income are mainly determined by demand for fish in the market. More supply/production of fish abet low income to the household. Therefore, market controls rate of fish catches and household income. Sustainability of fish stock is depended on market momentum. The challenge is the market demand is growing in line with population growth. In addition fishing community is also capital formation [5] for daily life.

Payrat and Girard (2017) argued that application of new technology on monitoring and managing of fishery activities is a game changer to achieve sustainable of fish stock. Technological application can be in collaborative approach that means more than one stakeholders involved in technological application in the supply chain such as government facilitation on weather forecasting, market information, vessel monitoring system (VMS), protection from Illegal, unreported and unregulated (IUU) fishing and poaching and infrastructure facilities and non-collaborative approach such as smart mobile phone, Global Positioning System (GPS), digital weighing, drone application, electronic and digital technology and so on. Cost of these technologies and technical complexity are decisive factor for adoption of these technologies [6]. Selection Criteria of Technology presented in Table 1.
Table 1. Selection criteria of technology.

| Financial Capability | Technology Application in Operation | Technology Know How |
|----------------------|-----------------------------------|---------------------|
|                      | Low                               | User Friendly       |
|                      | Collaborative                     | High                |
|                      | Non-Collaborative                 | Medium              |
|                      | High                              |                     |
|                      | Collaborative                     |                     |
|                      | Non-Collaborative                 | Medium              |

The study therefore was to identify association of appropriate technological applications with per capita income of small scale fishing household using data collected from small scale community in Jaffna district, Sri Lanka. Sustainability in fishing activities consisted sustainability of fish catches and sufficient income earned by fishing household. Sustainability of fish stock can be achieved by limiting amount of fish catch and wastage of fishes and application of post fishing activities such as preservative technology of fish. Therefore sufficient earning from fishing can be stimulated by limiting supply of fish to market through application of technology into both fishing operation and post fishing activities. Technology application in fishing operation such as GPS application to locate suitable fishing spots and navigate shortest time duration, application of digital camera and digital technology application to find movement of fish schools and size, underwater and surface drone application to find fish stock and fishing vessels movements support to catch required amount of fish within limited time. It also helps to enhance fisher’s productivity.

Figure 2. Technology-fishing-household income.

Technology application (Figure 2) in post fishing such as preserve fish in the cold room and make dry fishes using smoking method or using salt to not only continuous supply of fish to market during the off season but also limiting supply to market during season to maintain income generation of fishers. Gathering market information via smart mobile phone and internet coverage at the sea are suitable technological application to decide amount of fish catch and usage of fishing gears to catch different variety of fishes, duration of fishing and importantly minimize wastage of fishes. Application of analyzed big data on fishing market trend supports fisher to decide fishing method to catch fish to get maximum income. At a given period, Household Income (I)= Amount of fish sales at market (Mf) X market price (Mp) + Amount of Fish Preserved (Pf) x Market Price of Preserved Fish (Mq). Total
Fish catch \( (F) = M_f + P_f \). At sustainable level of fish stock, total fish catch is constant, \( M_f \alpha P_f \); I = \( M_fM_p + (F - M_f)M_q \). It shows market price of fresh fish sales and price of preserved fish sales determined sufficient income to the household at sustainable rate of fish catch. Household income through market operation at the equilibrium level is ideal. Supply of fish catches is controlled as well as income generation of household by efficient market operation. Efficient application of technology to link market information and fishing operation boost limitation of fish catches and therefore minimizing wastage. The study examined which technological application is appropriate to small scale fishing activities in Sri Lanka since 90 percent of fishing were carried out by small scale fishers.

2. Method
The study examined which technological application is appropriate to small scale fishing activities in Sri Lanka since 90 percent of fishing were carried out by small scale fishers (Fisheries Year Book 2018/19 as Department of Fisheries and Aquatic Resources, Srilanka 2018 recorded) [7]. Primary sample data were collected by structured interview from 110 household level fishing community in Jaffna, North of Sri Lanka. Data were analyzed using descriptive and correlation statistical techniques.

3. Appropriate Technology and Sustainability of Small-scale Fishing
The results of analysis show that, the relationships at significant level of 95 percent were taken into consideration of analysis. The results of correlation analysis are Table 2. Fishers using GPS caught fish in shortest time period in the identified locations where fish school gathered returned to market earliest. Therefore, since they were able to supply fresh fishes to market, amount of damaged fish was declined. In addition, fishers having skill on dry fish techniques counted low amount of damaged fish. Fishers applied dry fish techniques used their smart phone application for marketing purposes. When they used smart phone application, they were tended to earn more income. The household having skills on GPS application in fishing activities and smart phone usage were comparatively wealthy in the community. Further cost and technical complexity using GPS and Smart phones were lower than other technological application in the survey. GPS technology is non-collaborative and low-cost technology. Internet coverage was crucial for application of smart phone. However, internet coverage was provided by their party organizations. The internet technology is a collaborative low-cost technology.

| Variable 1                        | Variable 2                        | Relationship | Value of Relationship | Strength of Relationship |
|-----------------------------------|-----------------------------------|--------------|-----------------------|--------------------------|
| GPS application in fishing activities | Amount of Damaged Fish             | Negative     | -0.728                | Significant at the 0.01 level |
| Smart phone application in Fishing activities | Household Income per Capita        | Positive     | 0.692                 | Significant at the 0.01 level |
| Smart phone application in marketing activities | Household Income per Capita        | Positive     | 0.654                 | Significant at the 0.01 level |
| Internet Coverage                | Smart phone Application in Marketing Activities | Positive     | 0.721                 | Significant at the 0.01 level |
| Application of                   | Household Income per              | Positive     | 0.688                 | Significant at the 0.01 level |
Application of digital camera technology and electronics in fishing activities especially those devices were attached with fishing boats and fishing gears for identifying vessels, underwater fish movements, finding location of drifting gears, remote sensing and operation of underwater drone. These devices needed certain technical know-how rather application of GPS. However, application of this technology had multiple advantages for fishers, especially no much physical strength was required for fishing activities. Further, this technology supports for sustainability of fish stock by preserving fishes without damages. The correlations shows that fishers’ ability on application of digital technology had positive correlation with their household income. Since the devices were comparatively similar cost of GPS technology, however, the technology required more technical know-how. It means complexity of this technology was more than application of GPS and smart phones. Wealthy household might had possibility to adopt the technology easier than low income households. The digital technology is a non-collaborative and middle expensive technology.

### 4. Conclusion

New technology application in the small-scale fisheries would be different depending on geographical environment, infrastructure facilities and socioeconomic characteristics of fishing community. Jaffna fishing community have not given facilities of collaborative technology such as integrated vessels monitoring system (VMS), radar technology support, weather forecast facilities, satellite guided technology, fish stock survey and market big data supporting services by either Government or other fisheries related organizations such as fisheries cooperative societies which has strong ethical support among fishing community in Jaffna. Non-collaborative and low-cost technology are more convenience to penetrate technology into small scale fishing activities followed by collaborative low-cost technology. However, maintain sustainability of fish stock collaborative information communication technology is more appropriate in a long-term perspective. Traditional knowledge and practices should be incorporated for sustaining fish stock. Fishers’ inbuilt traditional techniques to find fish stocks, sea current, changes of weather pattern and so on through their experiences gained throughout of fisheries operation. These traditional values are to be attributed to analysis on Information Communication Technology to achieve appropriate technological application into sustainability of fish stock.

### References

[1] Ainkaranathan S 2012 Impacts of socioeconomic characteristics on productivity and income per capita of fishing households; a case of Jaffna fishing community, Sri Lanka. 龍谷大学.

[2] Nurhapsa N Nuddin A Suherman S Sirajuddin S N Al-Tawaha A M and Al-Tawaha A R M 2020 Factors affecting coffee use income: A case study in the province of south Sulawesi, Indonesia Ecol. Environ. Conserv. 26 S263–S270.

[3] Arsyad M 2020 The role of public health services (PHS) in agricultural poverty alleviation Enfermería Clínica. 30 194–197.
[4] Nuddin A Arsyad M Putra I M Nuringsih N and Teshome T T 2019 Making the case for institutional support on designing agroforestry technology models for rehabilitating critical lands For. Soc. 3 49–63.

[5] Arsyad M Hasnah H and Lumoindong Y 2019 Farmer’s Motivation to Save Money in Bank Rakyat Indonesia: An Application of Logistic Regression Int. J. Innov. Technol. Explor. Eng. 8 375–381.

[6] Girard P and Du Payrat T 2017 An inventory of new technologies in fisheries in The Green Growth and Sustainable Development (GGSD) Forum.

[7] Resources D of F and A 2018 Fisheries Statistics Colombo: Ministry of Fisheries and Aquatic Resources Development, Government of Sri Lanka.