



Enhancing Quality of Dried Fish Products through Effective Demonstration of Raised Rack Tent Dryer for Human Food in Tigray Region, Northern Ethiopia

Gebru Brhane ^{a*} and HaftomZebib ^b

^a *Abergelle Agricultural Research Center, Tigray, Ethiopia.*

^b *Tigray Agricultural Research Institute, Mekelle, Ethiopia.*

Authors' contributions

This work was carried out in collaboration between both authors. Author GB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author HZ managed the literature searches and managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://prh.globalpresshub.com/review-history/1698>

Original Research Article

Received: 30/07/2024

Accepted: 30/09/2024

Published: 18/10/2024

ABSTRACT

In the study area, the most economically important fish species are Nile tilapia, cat fish and barbus species, respectively. Among fish species, barbus fish species are underutilized, because the filets (meat) of labeobarbus fish has tiny bones that are difficult for consumption. The objective of this study was to demonstrate a raised rack tent dryer and assess farmers' perceptions on a raised rack tent dryer. In the first stage, Tanqua-Abergelle wereda were purposively selected based on

*Corresponding author: Email: gebru04@gmail.com;

Cite as: Brhane, Gebru, and HaftomZebib. 2024. "Enhancing Quality of Dried Fish Products through Effective Demonstration of Raised Rack Tent Dryer for Human Food in Tigray Region, Northern Ethiopia". *Asian Research Journal of Current Science* 6 (1):249-57. <https://jofscience.com/index.php/ARJOCS/article/view/120>.

their potential for white fish and availability of water for fish production. In the second stage, from 19 rural kebelles and one semi-urban kebele, four kebelles were selected in collaboration with researchers and extension experts. In the final stage, 95 participants of whom 31.58% women were purposively selected based on their interest in working with research, formal membership in fisheries organizations and their experience in drying fish through local methods. The results of this study revealed, that the majority of participants want the raised rack in general and modified raised rack in particular because the labor intensity is reduced (80%), construction materials are easily available (86.67%), construction complexity is limited (76.67%), and easy implementation procedures (93.33%). Regardless the additional cost incurred the raised rack tent dryer is very important in keeping the fish drying process hygiene and reduce post harvest loss. Therefore, Support in supplying durable raised rack dryer is very important, and market linkage with potential dried fish user is very crucial in the area.

Keywords: Demonstration; fish dryer; raised rack tent; and user's perception.

1. INTRODUCTION

Consumption of fish is one of the paramount importances in human diet in various aspects. Fish is a good source of nutrition, although it is perishable. Therefore, drying is a common method of preserving fish to compensate for its perishable nature. Drying fish is practiced in various cultures with different types of fish and different drying methods. Being particularly valuable and having specific, unique nutritive values, fish occupy a special position in a human diet [1]. People who live around the water bodies having fish potentials are the pioneers in the development of fish consumption in future, proper well-being of them undoubtedly beneficial to the future of country as well.

Fish is highly perishable because it provides a favorable medium for the growth of microorganisms after death [2,3,4]. A large percentage of the fish caught in the developing countries are lost through poor handling [5]. Similarly, around Tekeze reservoir, about 32–35% fish meat is used for consumption and market, but the remaining fish products and byproducts are not used properly, which leads to post catch loss, environmental pollution, human health impacts, and water body pollution. When the market is not available, quintals of fish meat are discarded from a refrigerator, which leads to economic loss. In addition, there is a lack of awareness about how to properly dry and utilization of the dried fish products.

Drying is used to describe any process involving the removal of water from fish or fish products by evaporation [6]. In the study area, fishermen use different drying types, namely, drying on trees, drying on stones, drying on the ground, and drying on bamboo grass. These all-drying types

are considered the traditional way of drying, which leads to contamination of dried fish and fish products [7]. To arrest these problems, many designs of sun dryers have been developed for the preservation of fish by different researchers. Of which [8] evaluated different fish drying technologies (raised rack, solar tent, family tent, and open air) and salting methods on moisture loss, moisture content and sensory acceptability. He reported fish meat dried in a raised rack dryer is more acceptable, and it showed good moisture loss (79.39%), moisture content (12.00% oven dried), and acceptable sensory quality than other driers [8]. In the study area in general, the area where fish drying is practiced is in the Tekeze valley, which is the hottest place. Fish drying by using the sun is considered the least expensive method to improve the shelf life of fish and fish products [9]. All drying types that use sun as a dryer method in areas with high temperatures are also environmentally friendly drying techniques [10]. Keeping in mind all the above-mentioned issues, this study was designed to demonstrate improved fish drying for human consumption in potential weredas of Tigray Region, Northern Ethiopia. Therefore, the specific objectives of the studies were to demonstrate the raised rack dryer and to assess farmers' perceptions about the improved fish preservation technology.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Description of the Study Areas: in the first stage Tanqua-Abergelle wereda was purposively selected based on its potential on white fish and availability of water for fish production. In the second stage from the 19 rural kebele and one semi urban kebele four participant kebelles namely Felegehiwot, Sye, Yechila and

Gurrewere selected in collaboration with researchers and extension experts. In the final stage 95 participant of which 31.58% of them female were selected purposively based on his/here interest to work with research, legal membership on fishing organizations and his/her experience in drying fish through local method. In the selection of participant farmers the role of DA's and extension experts were very critical. Additionally the participant farmers, health extension workers were practically and theoretically trained on how to prepare drying material and properly dry fish by improved dryer (raised rack tent).

2.2 Materials Used for Raised Rack Tent Construction

The materials used for the construction of modified raised rack tent dryer are rectangular wooden frame 4*5, flat wooden frame 25, stain less steel wire mesh with narrow aperture 3*4cm, thick plastic sheet, different sized finished nail, labor and cracking materials the crucial ones. Additionally the input used for drying fish meat and fish byproducts are modified raised rack solar tent dryer, sharp knife and Labeobarbus fish.

2.3 Procedures for the Construction of a Modified Raised Rack Tent Dryer

The construction of a four-layered modified raised rack tent is constructed with a size of 2 m height, 2 m length, and 1 m width frame wooden poles covered by strong transparent plastic sheet. Steps for the construction of a four-layered modified raised rack tent dryer are listed in eight steps as follows (Table 1).

2.4 The Drying Process for Fish Products and Byproducts

The drying process for fish products and byproducts was mainly the function we used to remove water from the fish product and byproduct through a modified raised rake tent. The drying procedure follows the following seven steps when preparing safely dried fish products and fish by products. And the critical steps are listed procedurally.

2.5 Training to Demonstration Participants on Improved way of Fish Drying Methods

The training participants on practical and theoretical training on construction of improved

modified raised rack tent dryer and drying procedure were clearly stated in the following Table 3.

2.6 Data Collected

Primary and secondary data were used in the investigation. A checklist was used in the study to collect primary data, and a disk inspection was used to obtain secondary data. The checklist comprises sections on the respondents' demographics, their knowledge and expertise in building an enhanced dryer, how important they believe the dryer is in relation to local practices, how well they understand proper drying procedures, and what opportunities and challenges they face. During the interview, the English version of the checklist was translated into the local language. Researchers conducted a peer assessment of the questionnaire. Enumerators gathered the information. Thirty volunteers, men and women, provided the necessary data from the demonstration.

2.7 Data Analysis

The study were used both descriptive (percentage) and narrative analysis by using Stata version 11

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Participants

Sex: The participant's sex was composed of female-headed households (31.58%) and male-headed households (68.42%). In practice, fish drying is assigned to men and youth. The main reason for having 68.42% of the respondent's male is associated with the real observation exercising at the household level. The participation of female-headed households strengthens the feedback collected during evaluation of the effectiveness of a demonstration when it is gender inclusive.

Age: The age of the respondents is one of the demographic characteristics that influence the technology adoption by users. The minimum and maximum ages of the respondents were 20 and 55 years, respectively. The mean age of the total respondents was 40.62 years with an SD of 11.02.

Education level of the respondents: It is obvious that education increases the knowledge

and skill of the people in a given society by diversifying sources of information. Therefore, the more educated a participant, the easier the effort of enhancing the quality of dried fish products. It also helps to use user knowledge and skill exchange for further technological adoption. Additional education level of participants is emphasized to use written

materials like leaflets and technical manuals on the procedure of fish dryer construction and drying procedures. The result of the study indicates that 75.21% and 24.21% of the sampled participants were literate and illiterate, respectively. The demographic characteristics of the participants are described in Table 2 in the following manner.

Table 1. Describes the summary of steps to construct four layered modified raised rack

| Steps | A list of the tasks completed at each stage |
|-------|---|
| Step1 | Cut each of the three wooden frame stand legs to a height of two meters. |
| Step2 | Build a two-meter-long flat wooden stand with legs that come together at the end at 46 centimeter intervals using finishing nails (6 inches), leaving a 20-centimeter stand above the floor. |
| Step3 | Repeat step 2 for the opposite side |
| Step4 | Upright (vertically) the constructed stand legs with attachment and assemble with flat wooden (1 m width at the front side), middle, and end sides using a finished nail (4 inch). |
| Step5 | Cut stainless steel mesh wire (1 m length*46 cm height) and make two window holes for natural air circulation at the top and bottom opposite sides of the dryer. |
| Step6 | Cut four stainless steel mesh wires (1 m in width * 2 m in length) and cover each drying rack. |
| Step7 | Cut thick plastic sheet (1 m length and 2 m height * 2-door sides, 1 m width and 2 m length bottom side, and 2 m width * 5 m length) and fully cover the dryer. There are two doors with two opposite sides of the dryer (movable plastic sheet to the top and bottom level). |
| Step8 | Fasten the plastic sheet with a thin wooden frame at each side except the doorside. |

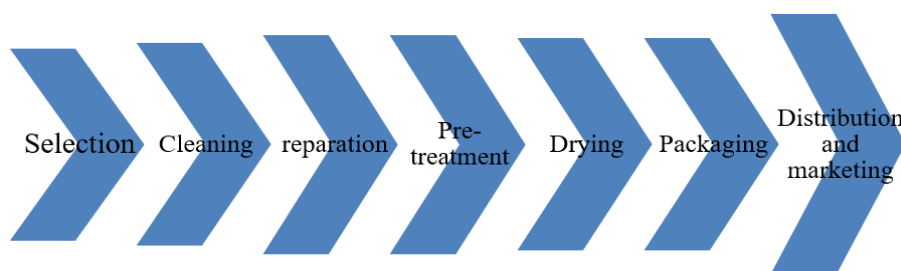


Fig. 1. Shows the critical steps in the drying process of fish and fish byproducts

Table2.Descriptive statics of the demonstration participants

| List of demographic characteristics | Response level | |
|-------------------------------------|----------------|-------|
| | No | %age |
| Sex | | |
| female | 30 | 31.58 |
| male | 65 | 68.42 |
| Age | | |
| mean | 40.62 | |
| Range | 35(20-55) | |
| Education level | | |
| illiterate | 23 | 24.21 |
| grade 1-4 | 40 | 42.10 |
| grade 5-8 | 22 | 23.16 |
| >= 9 | 10 | 10.53 |

Sources: Computed from own survey, 2023

Table 3. List of training participants on improved drying technology

| Type of participants | Sex | | |
|-----------------------------------|-----------|-----------|------------|
| | Female | Male | Total |
| Traditional fish dryer | 15 | 43 | 58 |
| Restaurant owner and fish traders | 15 | 22 | 37 |
| Researchers | 1 | 8 | 9 |
| Experts | 2 | 6 | 8 |
| Development agents | 9 | 9 | 18 |
| Head of Agriculture | | 2 | 2 |
| Total | 42 | 90 | 133 |

Sources: Computed from own survey, 2023

3.2 Participants' Opinions about how a Modified fish Meat Dryer was Built

The result of the study confirms that the majority of the participants want a modified raised rack because of its reduced labor intensity (80%), readily available construction material (86.67%), limited construction complexity (76.67%), and straightforward implementation procedure (93.33%). The traditional type of fish drying is exposed to quality reduction and post harvest loss due to dust, rodents and flies' infestations, the result is in agreement with finding of [11,12] while the improved raised rack dryer successfully protecting them. The drying duration of the improved technology takes from three to four days, while the conventional way of drying takes more than four days; the finding is similar with [13]. Additionally, the participant expresses disapproval of its greater construction cost (56.67%). They fiercely oppose current drying technology despite the flexibility of input utilized in its development, arguing that the dried fish products offer no financial advantage over conventional drying methods. The demonstration participants recommended a way to share costs in the form of subsidies by governments and non-governmental organizations in order to hasten the adoption of new technologies. The perception of the respondents on the construction of an improved dryer is described in percentage in Table 4.

3.3 Participants' Opinions about how Fish Dryer Improves the Dried Fish Product

The result of the study show that the participants of the demonstration wants the improved dryer in its cleanness and hygiene (96.67%),flexible loading capacity and higher preservation capacity (63.33%) and higher drying efficiency (96.67%).The drying process needs strong fellow up in order to mitigate breaking problem when

over drying and removal of the important meat in the form of oil when the temperature is too warm.The properly dried fish paves room to increase the consumption trend of the rural community as it improves the shelf life and storage problem of fish products in the rural setting with the problem of transportation facilities and medium-sized cooling boxes. Additional the participant prefer the modified raised rack tent for its higher shelf life of the dried fish product (66.67%), higher post harvest lose reduction (80.00%) andcolor of the dried fish meat(50.00%). The fish dryer negatively criticize the improved way of drying in its lower price of the product (50.00%), the lower selling price of the properly dried fish product might be due to poor market linkage with final consumers of dried fish in different forms. The users' perception about the drying technology and properly dried fish product are summarized in Table 5.

3.4 Construction Cost of Raised Rack Dryers

The size, location, year of construction, and materials utilized in the construction of a raised rack tent dryer can all affect the building cost. Nevertheless, 5,644.18 Ethiopian birr is needed to build a four-layered modified raised rack tent with a loading capacity of 30-35 kg of fresh fish meat. On the other hand, as Fig. 2 illustrates, the local dryer requires no construction costs because it dries openly on the ground. The improved dryer reduces the problems that arise from a lack of hygiene during the drying process, perhaps improving dried fish products. Even though building a modified raised rack tent is more expensive, it creates space to properly dry about 65% of fish as byproducts for chicken feed, which can replace the enormous expense. The unrealized potential for generating extra revenue for local fishermen and poultry feed producers is still processing the fish byproduct. The detail cost for the construction of modified raised rack is stated in Table6.

Table 4. Explains the perception of respondent on constriction cost of modified raised rack dryer

| Characteristics | Farmers response level | | | | | |
|--|------------------------|-------|--------|-------|------|-------|
| | Low | | Medium | | High | |
| | No | % | No | % | No | % |
| Labor intensiveness | 9 | 30.00 | 15 | 50.00 | 6 | 20.00 |
| Availability of constriction materials | 14 | 46.67 | 12 | 40 | 4 | 13.33 |
| Constriction cost | 12 | 40.00 | 14 | 46.67 | 4 | 13.33 |
| Implementation process | 12 | 40.00 | 14 | 46.67 | 4 | 13.33 |
| Construction complexity | 14 | 46.67 | 9 | 30.00 | 7 | 23.33 |

Sources: Computed from own survey, 2023

Table 5. Explains the perception of respondent on the merit of modified raised rack dryer

| Characteristics | Farmers response level | | | | | |
|--|------------------------|-------|--------|-------|------|-------|
| | Low | | Medium | | High | |
| | No | % | No | % | No | % |
| Preservation capacity of quality fish meat | 4 | 13.33 | 7 | 23.33 | 19 | 63.33 |
| The expected use/profitability of the innovation | 1 | 3.33 | 10 | 33.33 | 19 | 63.33 |
| Compatible with a farmers' existing practices | 2 | 6.67 | 14 | 46.67 | 14 | 46.67 |
| Compatible with a farmers' existing resources | 6 | 20.00 | 14 | 46.67 | 10 | 33.33 |
| Hygienically | 0 | 0 | 1 | 3.33 | 29 | 96.67 |
| Drying efficiency | 0 | 0 | 13 | 43.33 | 17 | 56.67 |
| Taste of the dried fish meat | 3 | 10.00 | 18 | 60.00 | 9 | 30.00 |
| Odor of the dried fish meat | 0 | 0 | 15 | 50 | 15 | 50.00 |
| Color of the dried fish meat | 3 | 10.00 | 19 | 63.33 | 8 | 26.67 |
| Shelf life of the dried fish meat | 0 | 0.00 | 7 | 23.33 | 23 | 66.67 |
| Post harvest lose reduction | 0 | 00 | 6 | 20.00 | 24 | 80.00 |
| Price of the product | 15 | 50.00 | 15 | 50.00 | 0 | 0 |

Sources: Computed from own survey, 2023

Table 6. The comparison of constriction cost of modified raised rack tent dryer Vs local dryer

| List of costs and benefit analysis | Unit | Quantity | Unit Cost | Total Cost | |
|---|--------|----------|-----------|---------------------------------|----------------|
| | | | | Modified raised rack tent dryer | Local practice |
| Rectangular wooden frame 4*5 | Number | 3 | 420 | 1260 | - |
| Flat wooden frame 25 | Number | 2 | 970 | 1940 | - |
| stain less steel wire mesh with narrow aperture 3*4cm | meter | 8.5 | 115 | 977.5 | - |
| Thick plastic Sheet | meter | 8.5 | 115 | 977.5 | - |
| Finished nail 6 | kg | 0.341 | 185 | 63.085 | - |
| Finished nail 4 | kg | 0.1686 | 220 | 37.092 | - |
| Labor and cracking expense | Birr | 0.337 | 1154.35 | 389 | - |
| Total Expense | | | | 5,644.18 | |

Sources: Computed from the purchase list used for demonstration, 2023

3.5 The Inside and Outside Temperature of Raised Rack Tent Dryer

The Tekeze reservoir is located in the lowland areas of the Tangau-Abergelle area. Its mean

maximum internal temperature is 50 +/- 0.81°C [8], while its mean maximum outside temperature is 39.9°C, which is observed in April and June. According to the participant, the redesigned raised rack retains excess heat, which causes

the dried fish products to break. Fishermen recommend improving the timely collection of fish products as a means of managing the breaking problem, which is particularly noticeable during the hottest months of the year. Furthermore, Table 7 shows that in January, the research

area's mean minimum environmental temperature was recorded at 13.10 °C. The mean minimum internal temperature of the modified raised rack dryer is (0C): 32.5 +/- 0.57 [8]. Table 7 provides an environmental temperature description of the study area.



Local practices in the first stage



Evaluation of raised rack dryer by users



Evaluation of local practices by users



Raised rack constructed by users



Traditional way of drying fish for home consumption



Modified raised rack constructed from local materials



Locally fish drying practice on tree



Four layered modified raised rack tent dryer



Traditional way of dried fish product



Improved way of packing dried fish product

Fig. 2. Pictorial representation of convectional Vs improved fish dryertecnological development

Table 7. The environmental temperature of the study area at each month of the year

| List of parameters | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------|------|------|------|------|------|------|------|------|-------|------|------|------|
| Average Temperature | 26.7 | 25.7 | 26.9 | 29.6 | 30.6 | 29.2 | 22.5 | 22.8 | 24.1 | 25.5 | 26.2 | 25.2 |
| Maximum Temperature | 34.9 | 35.9 | 38.9 | 39.9 | 39.7 | 39.9 | 31 | 30.2 | 35.34 | 36.8 | 36.9 | 36.9 |
| Meanminimum Temp(°C) | 13.1 | 15 | 16.2 | 17.8 | 16.8 | 15.2 | 12.6 | 15.5 | 15.3 | 15.2 | 16 | 14 |
| Range | 21.8 | 20.9 | 22.7 | 22.1 | 22.9 | 24.7 | 18.4 | 14.7 | 20.04 | 21.6 | 20.9 | 22.9 |

Source: Computed from [14]

Table 8. The analysis of challenges and opportunities

| Opportunities | Challenges |
|--|---|
| ✓ Can construct from locally available material | ✓ Poor participation of fish based organizations |
| ✓ Reduce drying period (3-4 day) | ✓ Breaking problem |
| ✓ Can enhance the loading capacity (Ranging from 30-35 kg of fresh weight) | ✓ Limited loading capacity |
| ✓ Improvement in meeting consumer convenience | ✓ Deny their working bylaw |
| ✓ Increase fish based food diversity | ✓ not enough product recognition by buyers |
| ✓ Improves the ability of altering flavor and texture | ✓ Illegal fishermen and fish trader |
| ✓ Improvement in product safety hygiene | ✓ Shortage of capital |
| ✓ Effective to byproduct processing/ drying | ✓ poor market linkage and demand |
| ✓ Increase in product availability (fish powder) | ✓ Resource use base conflict among fishermen of Tigray and Amhara regions |
| ✓ Improves the ability to fortify and enrich new products (bread from fish flour) | ✓ Lack of control of illegal fisheries and gill nets |
| ✓ Creation of job opportunity for many youths | |
| ✓ Improves the income and food diversity of the fishermen, fish trader and fish consumer | |

3.6 Analysis of Challenges and Opportunities Improved Drying Technology

The analysis of setback and enabling conditions were analyzed in Table 8 as follows.

4. CONCLUSION AND RECOMMENDATION

Regardless of the additional cost incur in constricting the raised rack even without any difference in selling price the technology is very important in keeping the fish drying process hygiene and reduce post harvest loss. Therefore the study recommends

- Research on pre-extension popularization is needed
- Support in supplying durable raised rack dryer is very important

- Market linkage with potential dried fish consumer and traders is very crucial

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENT

The authors greatly thank Tigray Agricultural Research Institute (TARI), Operational Research to Technology Dissemination project (ORTDP-2), Agricultural Growth Project (AGP-2) and food system and resilience program (FSRP) for granting the financial support and facilities for this work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lebiedzińska A, Kostrzewa A, Ryoekiewicz J, Zbikowski R, Szefer P. Preferences, consumption and choice factors of fish and sea food among university students. Polish Journal of food and nutrition sciences. 2006;15(56):91- 96.
2. Ojutiku RO, Kolo RJ, Mhammed ML. Comparative study of sun drying and solar tent drying of *Hyperopisusbebeocci-dentalis*. Pak. J. Nutr. 2009;8(7):955-957.
3. Aliya G, Humaid K, Nasser A, Sami G, Aziz K, Nashwa M, Ponnerassery SS. Effect of the freshness of starting material on the final product quality of dried salted shark. Advance Journal of Food Science and Technology. 2012;4(2):60-63.2012.
4. Oparaku NF, Mgbenka BO. Effects of electric oven and solar dryer on a proximate and water ctivity of *Clariasgariepinus*Fish. European J. Sci. Res. 2012;81(1):139 -144.
5. Oladele AK,Odedeji JO. Osmotic Dehydration of Catfish (*Hemisynodontismembranaceus*): Effect of Temperature and Time. Pakistan J. Nutrition. 2008;7(1):57-61.
6. Eyo A. Fish processing technology in the tropics. 1st Ed. New Bussa, Nigeria: National Institute for Freshwater Fisheries Research (NIFFR); 2001.
7. BOSTID (Board of Science and Technology for International Development) /Office of International Affairs, National Research Council: Fisheries Technologies for Developing countries. National Academy Press Washington DC. 1988;215 – 237.
8. Zebib H, Teame T, Meresa T. Evaluation of solar dryers on drying and sensory properties of salted Tilapia filets, Tigray, Northern Ethiopia. ISABB Journal of Food and Agricultural Sciences. 2017;7(2):10-18.
9. Balachandran KK. Post-harvest technology of fish and fish products. Daya Books; 2001.
10. Akinola OA, Akinyemi AA, Bolaji BO. Evaluation of traditional and solar fish drying systems towards enhancing fish storage and preservation in nigeria: Abeokuta local governments as case study. Journal of fisheries international. 2006;1(2-4):44-49.
11. Udeinya BC, Ojike O, Okonkwo WI, Abada UC. Performance evaluation of mixed mode passive solar stock fish dryer. Nigerian Journal of Technology. 2021;40(6):1104-1109.
12. Randrianantoandro A, DieiOuadi Y. How simple raised racks have curbed fish losses and changed the landscape along lake Tanganyika in Burundi. Rome, FAO; 2015
13. Abdi TG. Participatory Evaluation and Verification of Improved Post Harvest Fishery Technologies on Selected Sites of Oromia water bodies. Fish Aquac J. 2014;5:090. DOI: 10.4172/2150-3508.1000090
14. Ethiopian National Meteorology Agency (ENMA). Meteorological Data. Addis Ababa, Ethiopia; 2020.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://prh.globalpresshub.com/review-history/1698>