

*This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.*



**ISSN: 2150-3508**

## **Fisheries and Aquaculture Journal**

**The International Open Access  
Fisheries and Aquaculture Journal**

### **Executive Editors**

**Madison S Powell**

University of Idaho, USA

**Xu Hao**

China Fishery Machinery and Instrument Research Institution  
China

**Crawford W Revie**

University of Prince Edward Island, Canada

**Andrea C Alfaro**

AUT University, Auckland, Australia

**Brian Dixon**

University of Waterloo, Canada

**Available online at:** OMICS Publishing Group ([www.omicsonline.org](http://www.omicsonline.org))

**T**his article was originally published in a journal by OMICS Publishing Group, and the attached copy is provided by OMICS Publishing Group for the author's benefit and for the benefit of the author's institution, for commercial/research/educational use including without limitation use in instruction at your institution, sending it to specific colleagues that you know, and providing a copy to your institution's administrator.

All other uses, reproduction and distribution, including without limitation commercial reprints, selling or licensing copies or access, or posting on open internet sites, your personal or institution's website or repository, are requested to cite properly.

Digital Object Identifier: <http://dx.doi.org/10.4172/2150-3508.1000090>

## Participatory Evaluation and Verification of Improved Post Harvest Fishery Technologies on Selected Sites of Oromia water bodies

Tilahun Genet Abdi\*

Zeway Fisheries Resources Research Center, Zeway, Oromia Regional State, Ethiopia

### Abstract

The study was conducted in the year 2009 to 2013 in different major sites of Oromia water bodies. These sites include lakes and reservoirs found in Abaya, Finchawa, Gilgalgibe, Koka, Langano, Malkawakana and Zeway. This research study focuses on fish smoking technology, fish drying using simple tent dryer, fish meal technology and fish cage retaining. Participatory Rural Appraisal (PRA) was conducted to assess the capture and culture fisheries post-harvest technologies information and communication support for resource exploitation, demand for information, opportunities and constraints of fishermen's needs in the study area. The result indicated that simple drying using tent dryer at Abaya Lake, Langano, Finchawa and Gilgalgibe reservoirs are suitable and productive for the local fishermen. On the other hand, fish smoking at Gilgalgibe reservoir was not successful due to the unavailability of bricks made from mud in the area. At Koka reservoir fish meal technology was effective and well accepted by the locals. At Langano Lake fish smoking and fish meal technology were also suitable and successful. Moreover, fish smoking at Melkawakana reservoir and Zeway Lake, including fish drying using simple tent dryer were successful and in addition fish cage retaining were successful and recognized by the beneficiaries as possible source of income thus, ready for advance scaling at Melkawakana reservoir.

**Keywords:** Evaluation; Postharvest; Technologies; Verification

### Introduction

Technology is generated; beneficiaries are waiting for such innovation. To bring the fishing community and research activities together, technology evaluation and verification in collaboration with the end users is absolute to fill the gaps. Participation of target groups and other clients in this development has become a key concept in influencing the adoption and sustainability of improved technologies. Participation of key actors in particular, fishermen and researchers in the process of technology development and information dissemination contributes to the development of appropriate technologies for fishermen especially those operating in complex and diverse situations and having limited resources. The fishing industry provides a vital source of food, employment, recreation, trade and the economic well-being of people, for present and future generations. Still some nations have limited access and supply to fish and fishery products with little awareness in new technology. Cultural influences are hinders proper utilization of fish in various directions. First, fish has not been integrated into the nutritional diet of most populace. Second, religious sectors influence on the consumption patterns; the demand for fish becomes seasonal. Third, only few species of fish are consumed and others are discarded as fish meal by catch.

Conscious provision of information dissemination and support is crucial to prevent exploitation and sustain the available resources. Resource users and consumers demand varied types of information and support mostly on modern technologies for advance learning and proper management of resources.

Fish can be preserved using several techniques. These includes traditional fish processing and preservation techniques such as canning, freezing, cold storage, dehydration (salting, drying, smoking), and the use of chemical treatment [1]. These techniques vary primarily in terms of capital requirements, technological complexity [2] raw material requirement and the nutritional and organoleptic quality of the processed products. For fresh fish market, the use of specialized transportation methods such as refrigerated trucks is highly desirable. The technology of freezing and chilling is too expensive for the most

rural fishermen to adopt causing these local fishermen to rely heavily on a cheaper drying and smoking method of preserving fish.

Fresh fish when not properly handled and iced begins to spoil within 12-20 hours after being caught and brings unpleasant taste, smell and texture depending upon the size and type of the fish species. Hence, adulteration reduces consumer acceptability for any fish species. Moreover, fish when not eaten fresh harvest and caught needs to be processed for future use or be stored frozen to help prevent further adulteration and post-harvest losses [3].

This research study focuses on fish smoking and fish drying using simple tent dryer to evaluate and verify fish processing and preservation methods. Also to evaluate fish meal technology to and verify how fish offal is made (by catches) that can be used for poultry feeds and fertilizer. Furthermore, this research will assess the fish retaining cage and determines how fresh fish are retained until appropriate and sustainable market is available. All these technologies were also evaluated and verified for ant potential value in addition to the fishermen.

### Materials and Methods

The lakes and reservoirs of Oromia Regional State were selected for this study. The study was conducted in the year 2009 to 2013 in different major sites of Oromia water bodies. Selected sites for this study include Abaya, Finchawa, Gilgalgibe, Koka, Langano, Malkawakana and Zeway. Technologies selected for evaluation and verification were fish

\*Corresponding author: Tilahun Genet Abdi, Zeway Fisheries Resources Research Center, Ziway, Ethiopia, Tel: +251916844466; E-mail: [tilagenet2006@yahoo.com](mailto:tilagenet2006@yahoo.com)

Received December 30, 2013; Accepted January 30, 2014; Published February 10, 2013

Citation: Abdi TG (2014) Participatory Evaluation and Verification of Improved Post Harvest Fishery Technologies on Selected Sites of Oromia water bodies. Fish Aquac J 5: 090. doi: [10.4172/2150-3508.1000090](https://doi.org/10.4172/2150-3508.1000090)

Copyright: © 2014 Abdi TG. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

smoking, fish retaining cage, fish drying using simple tent drier and fish meal technologies. Participatory Rural Appraisal (PRA) was conducted to assess captured and cultured fisheries post-harvest technologies information and communication support for resource exploitation, demand for information, opportunities and constraints of fishermen's needs in the study area. Various technologies were also evaluated and verified in a participatory manner. Fishermen's participation as groups represented by Fishermen Research Extension Group (FREG) was crucial during verification and evaluation process. The groups were ready for further scaling up of fisheries post-harvest technologies. Qualitative analysis was used on this study and the data presented were analyzed by use of discussions and tables (Tables 1-5).

## Result and Discussion

This chapter deals with results and discussions of the study. The researcher has organized different FREGs (Fishermen Research Extension Groups) in different water bodies of Oromia Regional State

in order to evaluate and verify different technologies in a participatory manner. This research mainly focused on postharvest fish technologies. Each technology is analyzed and follows a category under different lakes based on their geographical areas.

### FREGs establishment and strengthening

The aim of establishing this group was to facilitate technology transfer by promoting the use of Fishermen Research Extension Group (FREG) as a mechanism for generating and disseminating improved and appropriate fisheries technologies. Each group is participated mostly by male fishermen and beneficiaries having 7 to 8 members per group except on Malka wakana with 12 members.

### Training given for beneficiaries

The training was focused on the following areas

- Fish production, handling, processing and marketing

	Lake/Reservoir	Place	No of established FRG			Year established (E.c)
			M	F	Total	
1	Zeway	Abosa	7	0	7	23/01/2001
2	Zeway	Korke Adi	7	0	7	02/06/1999
3	Langano	Daka Langano	7	0	7	30/05/1999
4	Langano	Ido Mandiya	8	0	8	19/02/2001
5	Koka	Koka town	8	0	8	20/02/2001
6	Gilgal Gibe	Inkure	5	3	8	11/02/2001
7	Gilgal Gibe	Hora Gibe	8	0	8	13/02/2001
8	Malka wakana	Malka Wakana	12	0	12	15/11/2000

Table 1: FREG established and strengthened during technology evaluation and verification.

District/Address	Sites	Year	No of trainees participated
Adami Tullu Jiddo Kombolcha	Batu	2001	60
	Kontola	2001	35
	Abbosa	2001	25
	Bochesa	2001	20
	Abayyi	2001	30
Arsi Negelle	Langano Hada Mandiya	2001	14
	Kararu Ido Mandiya	2001	18
From different fishers cooperatives	At the center	2001	54
Gedab Asasa, Dodola, Dugda, Arsi Negelle, Lume, Adami Tullu Jiddo Kombolcha	At the center	2001	30
<b>Total</b>			<b>286</b>

Table 2: Training given for different participants during technology evaluation and verification.

Days	Weight of fillet at morning (g)	Weight of fillet at evening (g)	Time when fillet exposed to sun	Time when fillet collected	Weight decreased (%)
1 <sup>st</sup> day	1140.2	850	6:00	12:30	25
2 <sup>nd</sup> day	850	50	3:00	12:30	94
3 <sup>rd</sup> day	50	43	2:00	8:00	14

Table 3: Solar drying of fish using simple tent dryer.

Days	Weight of fillet at morning (g)	Weight of fillet at evening (g)	Time when fillet exposed to sun	Time when fillet collected	Weight decreased (%)
1 <sup>st</sup> day	326.8	136.9	6:10	11:00	58
2 <sup>nd</sup> day	136.4	79.2	2:10	12:25	41.9
3 <sup>rd</sup> day	79.1	71.4	2:30	11:30	10.7

Table 4: Weight of filleted fish recorded during drying process.

Days	Weight of fillet at morning (g)	Weight of fillet at evening (g)	Time when fillet exposed to sun	Time when fillet collected	Weight decreased (%)
1 <sup>st</sup> day	1151.6	928.6	6:30	11:30	19.4
2 <sup>nd</sup> day	928.6	578.5	2:30	11:30	37.7
3 <sup>rd</sup> day	574.6	381.1	2:40	11:45	33.7
4 <sup>th</sup> day	381.6	300.7	2:35	12:00	21.2

Table 5: Solar drying of fish using simple tent dryer.

- Fishermen's cooperative right, obligations and financial management
- On the use of fish meal and smoking technologies for District fishery experts
- On gear making (net construction).

Generally, the training was given for fishermen beneficiaries and other stakeholders to facilitate fisheries post-harvest technologies evaluation and verification process. After the training, the trainees were encouraged to form groups (FREG) for this study and hence it was successful.

### Abaya lake

Lake Abaya is located in the main Ethiopian rift valley. Its shore is nourished shore by the Bilate on the northern part which rises on the southern slopes of Mount Gurage and the Gidado. Lake Abaya is 60 kilometers long and 20 kilometers wide with surface area of 1162 square kilometers. It has an elevation of 1285 meters. Numerous islands were known in this lake, the largest being Aruro; others include Gidicho, Welege, Galmaka and Alkali. Lake Abaya is fished by local people. Fish drying using simple tent dryer was verified and evaluated under Abaya Lake condition and analyzed as follows.

**Fish drying using simple tent dryer:** Solar drying of fish fillet using simple tent dryer was the only fish post-harvest technology evaluated and verified at Abaya site. Fourteen (14) members of Goro fishermen cooperative participated the survey evaluation and verification process of solar drying of fish fillet using simple tent dryer. Advanced method awareness was nurtured to the locals for fish drying using tent drier. Traditionally, fishermen used fish fillet drying by splitting fish fillet and exposing it directly to sunlight using rope for 4-5 days.

Table 3 above shows that weight of fillet was decreased by 25% at the time when the fillet was collected at night during the first day of evaluation and verification. On the second day of evaluation and verification the weight of fillet was decreased by 94%. During the final day of evaluation and verification the weight of the fillet was decreased by only 14%. This indicates that the maximum weight loss occurred during the second day of evaluation and verification process. Participatory evaluation and verification of solar drying of fish using simple tent dryer was commented as "better than drying locally in terms of time and quality".

According to Abera [4] the solar tent dryer produces a product of low moisture content that could have a long shelf life. Poulter et al. [5] reported that the product could have mold free with a shelf life of 50 days for fish dried to 15% moisture content. The present study also reported that the dried fillet can be stored for over one year without any spoilage.

### Finchawa reservoir

Fincha reservoir is one of the reservoirs in Ethiopia used for hydroelectric power generation. The reservoir is found in the Western part of the country in Horro Guduru Wollega Zone, at about 286 km distance from the capital city, Addis Ababa. The reservoir, situated at 9°33'N/37°24'E is surrounded by four administrative Woredas, namely Jimmaa Genet in South-West, Horro in West, Guduru in East and Southeast and Abay Choman in North and Northeast. It has an area of about 350 km<sup>2</sup> at an elevation 2000 m.a.s.l. The reservoir has a mean depth of 7 m, maximum depth of 17 m with the temperature of 230C, dissolved oxygen 9.4 mg/l, pH 6.4, conductivity 78.3 µs/cm and

suchii Disk of 130 cm [6]. The reservoir has an out flow called river Fincha'a which generates the Electric power and also used for irrigation (Fincha'a sugar Factory) then join with river Abay.

Fish drying using simple tent dryer was verified and evaluated under Finchawa reservoir condition and analyzed as follows.

Solar drying of fish fillet using simple tent dryer was evaluated and verified at Finchawa site. Half day training was given for 24 members comprising of four different fisheries cooperative (Table 4) working on Finchawa reservoir regarding fish drying using solar tent dryer. Fish Weight was recorded early in the morning and at the evening to calculate water loss.

**Fish drying using simple tent dryer:** Solar tent dryer evaluation and verification was undertaken at Gudane dafino multipurpose services center in the presence of 19 members from the three cooperatives, livestock and fishery expert of Guduru districts and Development Agent worker at Gobbu. The cooperatives had no their own offices. After the training was completed, solar tent dryer was assembled. Ten Nile Tilapia fish was filleted and fresh (initial) weight was immediately taken and drying process was continued for three days.

Fish fillet was dried within three days during our stay at the field. The ambient temperature was high, dry and with low humidity. The amount of percentage weight decreased was minimum (11%) at the third day as compared to previous days and hence it was the last day of the drying process (Figure 1). After drying was completed the locals were called for feedback data and were recorded from the executive committee of Abdi boru fishermen cooperatives.

"The innovation is very impressive, the product dried using this technology is marketable, no spoilage, of best quality products. 1 kg is currently at 150 ETB. Collecting solar radiation with heat and light energy using this simple tent was remarkable. Under Finchawa environment condition meat drying takes 10 days, whereas fish drying using the new method of tent took only three days. This easily saves more time to dry the product. Using the new technique of meat drying is significant to fish. The technology helps the cooperative members to gain more profit as they are ready for further scaling".

Abera [4] reported that fish dried in solar tent dryer under fine and sunny condition would be expected to dry in about 3 days to achieve final lower moisture content. This study also indicated that fish dried using simple solar tent dryer was good in quality and marketable products and dried within 3 days.

### Gilgalgibe reservoir

Gilgalgibe reservoir is located 250 kms Southwest of Addis Ababa and 75 kms Northeast of Jimma City. It covers an area of 51 km<sup>2</sup> at an

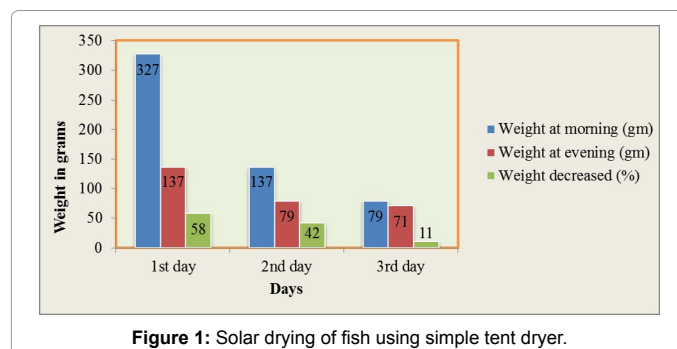


Figure 1: Solar drying of fish using simple tent dryer.

altitude of 1670 meters above sea level. The four districts bordering the reservoir are Omonada, Sekoru, Tiroafeta and Kersa with 6, 4, 5 and 2. Kebeles (smallest administrative unit) within ten kilometers from the shore line of the dam, respectively. Technologies such as fish drying using simple tent dryer and smoking technology were verified and evaluated under Gilgalgibe reservoir condition and hence analyzed as follows.

**Fish drying using simple tent dryer:** One day training was given for 17 members of Gudatu gibe fishermen cooperatives regarding fish handling and solar tent drying using solar tent dryer. The training was focused on fish drying using solar tent dryer and done at Inkure landing sites of Gilgel gibe reservoir. Twelve (12) Nile Tilapia (*Oreochromis niloticus*) was filleted for the evaluation and verification of this technology. Length of time required to dry fish under Inkure condition was also recorded. Weight of fish fillet was recorded early in morning and at evening hence water loss was calculated by difference. Number of fish and amount (in g) of fish fillet used for the experiment was recorded. The fishermen who actively participated in the training also participated during evaluation and verification of this technology. Hence, they were pledged to use this drying method to provide for local market during bumper production.

This study shows that the fish fillet reached its final moisture content during the fourth day of drying process. However, Abera (2004) reported that fish dried in solar tent dryer under fine and sunny condition is expected to dry in about 3 days to achieve final lower moisture content [4]. This study also indicates that fish dried using simple solar tent dryer yield good in quality and marketable products whereas fish are dried only in 3 days that would save more time.

This may be because the relative humidity was in fact high, the ambient temperature was low and the fish was fatty so it took four days to dry the fillet.

**Smoking technology:** At Inkure site of Gilgalgibe reservoir, Altona Oven and Chorker smokers were constructed from trees (shown in Appendix). The technologies were demonstrated but after the ovens were burned out and unsuccessful, the team decided to construct another oven made of brick mud available in rift valley areas. The mud made bricks are more durable and have better heat retention properties, which further improves smoking process. It is not therefore recommend constructing oven from normal blocks since it entails more cost. Since the above system is not accessible, it is better to generate another cost effective post-harvest fish smoking technologies for the area.

### Koka reservoir

The Koka Reservoir is a reservoir in south central of Ethiopia. It was created by the construction of the Koka Dam across the Awash River. It is located in the East Shewa Zone of the Oromia Regional State at an altitude about 1600 m. Fish meal technology was evaluated and verified under Koka reservoir condition and analyzed as follows.

**Fish meal technology:** Fish meal preparation was verified successfully for 8 members of Awash River riparian and Koka reservoir fishermen cooperative. During the verification process, the locals were impressed and pledged to prepare fish meal during fasting season where bamber fish offal exists. The area is accessible and near to market. Hence, the fishermen can source out additional income and at the same time reducing pollution at the landing site.

Fishmeal is high in protein supplement, which can be mixed with other enhancements to produce a balanced diet for livestock.

It is also can be manufactured on a small scale basis in many tropical countries. Fish are simply air or sun dried on the beach, or concrete floors and then pulverized (Figure 2). Fishmeal development is very important to the success of other livestock activities. The contribution of fishmeal as animal feed compare to other by-products, such as oil seed cakes and flour mill is relatively high.

### Langano lake

Langano Lake is found in the Oromia Region of Ethiopia, about 200 kilometers by road south of the capital, Addis Ababa. It is bordered between the East Shewa and Arsi Zones of Oromia Regional State. It is located to the east of Lake Abijatta in the main Ethiopian rift valley at an elevation of 1585 meters. Technologies such as fish drying using simple tent dryer, fish smoking technology and fish meal technology were verified and evaluated under Langano Lake condition analyzed as follows.

**Fish smoking technology:** Altona Oven and Chorker Smoker were constructed at Dole site of Langano Lake to evaluate and verify fish smoking technology. The ovens were cost effective since they were made from simple mud bricks which were very cheap to construct. There was no market problem and the area was accessible for market. The study also indicated that the fish was smoked within 3 to 4 hours by using Chorker and Altona oven respectively. Abera [4] indicated that fish smoked using chorkor and Altona oven would be expected to smoke in 3 and 4 hours respectively to achieve the final lower moisture content. These technologies were effective in Dole areas. The supply of fish is sufficient for smoking. Fishermen also catch enough tilapia species for this purpose. Fishermen were very much willing to use these technologies because they need to add values on their products. The response of fishermen indicated that the technologies are best options to increase their income.

**Fish meal technology:** Fish meal preparation was verified successfully for 14 members of Daka Langano fishermen cooperative. The cooperative members were very happy during the evaluation and verification of this technology. The area was accessible and near to market. The participants were happy to work on fish meal when there is fish offal especially during fasting season. The product obtained during and at the end of the evaluation and verification was good and marketable.

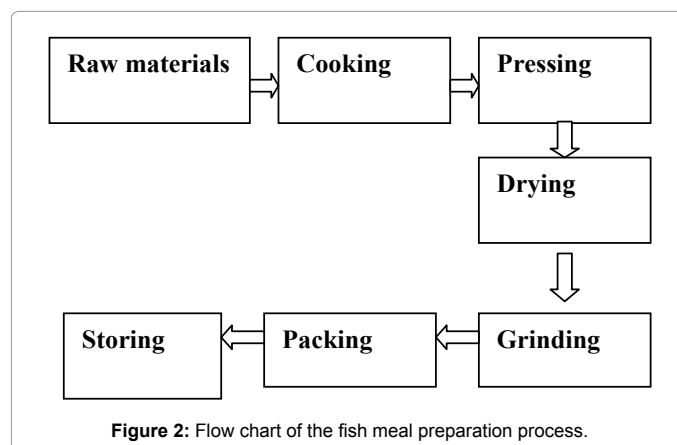


Figure 2: Flow chart of the fish meal preparation process.



After one year storage the product of fish meal was in good condition and free from insect and pest contamination. The study indicated that freshly processed fish offal, dried on rack under natural and sunny condition, was dried in about 5 days to achieve final lower moisture content.

Fishmeal is a high protein feed supplement which can be mixed with other supplements to produce a balanced diet for livestock.

**Fish drying using simple tent dryer:** The technology was effectively demonstrated to the local beneficiaries. The area is accessible for market. Fishermen are willing to use the drying technologies as an opportunity when there is high fish production and hence minimize the post-harvest loss. It was ready to be used within three days at the rift valley area.

### Melkawakana reservoir

Melka Wakena reservoir is one of the South-East high land dams which are established in 1987 G.C to generate hydro-electric power. The reservoir is bordered by three districts of West Arsi Zone namely Gedab Hasassa in North, Adaba in South and Dodola in West. Melka Wakena reservoir is located about 336 km south-east of Addis Abeba in the Oromia regional states. It has an area of 81.6 km<sup>2</sup> and shore line length of 126 km at an elevation of 2376 masl. It has maximum length of 37 km and maximum width of 18 km. It has a mean depth of 10 m, with present variation. There are major 6 in-flowing rivers namely: Burqa Hasassa at North Meribo, Nanesha, Leliso, Furona at south and Heraro River which flows to the reservoir in its western part. Technologies such as fish smoking technology, fish retaining cage and fish drying using simple tent dryer were verified and evaluated under Melkawakana reservoir condition and analyzed as follows.

**Fish smoking technology:** Fishery cooperatives of Gadab Asasa district were very active and ambitious to adopt this fish smoking technology. The cooperatives possess their own land in Asasa town. Fish smoking evaluation and verification was successfully done. Participants with a total of 50 persons from different stakeholders and cooperative members participated on the demonstration of the technology during the evaluation and verification process.

**Fish retaining cage:** This technology is effectively demonstrated to the locals. Fishes selected for the purpose of the evaluation and verification process were kept alive for 24 hours without any problem. The area was accessible for this technology wherein fishermen are interested and excited to use this technology.

**Fish drying using simple tent drier:** This technology was also demonstrated effectively for more than 3 days of drying due to the air condition of the area and the humidity. Though this technology was not priority during the study because fishermen had less harvest that leads them to dry and add values for their products. Fishermen prioritize fish smoking and fish cage retaining technology instead.

### Lake zeway

Lake Zeway is one of the freshwater Rift Valley lakes of Ethiopia. It is located about 160 kilometers south of Addis Ababa. The districts holding the lake's shoreline are Adami TulluJido Kombolcha, Dugda and Zeway Dugda. The town of Zeway lies on the lake's Western shore. The lake is primarily supplied by two rivers, the Meki from the west and the Katar from the east that is drained by the by Bulbula which empties into Lake Abijata. It has five islands which include Debre Sina, Galila, Tullu Gudo, Funduro and Tsedacha. Technologies such as fish

smoking technology, fish meal technology and fish drying using simple tent dryer were verified and evaluated under Lake Zeway condition and analyzed as follows.

**Fish smoking technology:** This technology was evaluated and verified at different sites around Zeway lake and analyzed as follows.

**Zeway site:** The technology was demonstrated to fishermen using the ovens constructed at the center of Zeway fisheries resources research center due unavailability of area for demonstration. The researcher decided to evaluate and verify the technology at the center. Fishermen were very happy and planned to use the said technology. The area was very much accessible for the use of these technologies. Fish supply was also abundant in the area.

**Abossa site:** Altona Oven and Chorker smoker were constructed from locally available materials (mud bricks). The technologies were evaluated and verified effectively. Fishermen were very pleased to see these technologies and were willing to use it in the future. Fish supply is also abundant in the area. The fishermen showed great response to the use of technology as their best option to increase sale.

**Korke adi sites:** This area is under the Dugda district. Altona Oven and Chorker smoker were constructed from locally available materials (mud bricks).The technologies were effectively demonstrated and the fishermen were willing to use the technology. Unfortunately the site was not accessible for electrical supply to use refrigerators instead they plan to utilized this technology in Meki town.

**Fish meal technology:** Fish meal preparation was evaluated and verified successfully for 5 members of Ido Kontola fishermen cooperative and 60 members of Batu town fishermen. At the time of verification, the participants were impressed and pledged to prepare fish meal during fasting season when bomber fish offal exists.

**Fish drying using simple tent dryer:** The technology was evaluated and verified effectively. The area was also accessible and the fishermen were willing and happy to use the drying technology as an opportunity when there is a high production of fish to maximize post-harvest loss.

### Gender aspects

The importance of gender was considered during the participatory evaluation and verification of these technologies analyzed above. However, from the practical point of view, incorporating different participants of households such as women, children, spouses and males as head of the family were challenging in the fishery sector. A minimum number of female participants joined the evaluation and verification. Depending on where the research is being done, it may be necessary to form same-sex groups (i.e., groups of only men or only women), since in mixed groups women may not participate at all. Personal observation during this study indicated that it may be possible to organize a group of only women on fish smoking technologies and hence men can supply fishes for smoking. Household members have diverse responsibilities, perform different activities, and have varying workloads and access to resources which may have conflicting interests.

### Conclusion and Recommendation

Fish post-harvest technologies like fish smoking, fish meal, fish drying using simple tent dryer and fish retaining cage were evaluated and verified in different water bodies of Oromia regional state. Abaya Lake, Finchawa reservoir, Gilgalgibe reservoir, Koka reservoir,

Langano lake, Melkawakana reservoir and Zeway lake were selected for the purpose of this study. Fish smoking and fish drying using simple tent dryer were effective to add values for the fishermen and increase the shelf life of fish products. Fresh offal fish processed under local condition using locally only the available material and dried on raised rack are suitable and good as feeds for livestock. Fish retaining cage is appropriate to retain fish live for long time and minimizes fish post-harvest losses while increasing fish market value.

The researcher therefore concludes that the use of these technologies was effective for the local fishermen to increase their profit with good quality of fish and the products produced. Furthermore, the study recommends that the local fishermen needs scaling up for the use of advance technologies that will vary depending on the geographical location of these locals and to what it applicable and available in the areas surrounding Oromia water bodies.

#### **Acknowledgments**

Many individuals have contributed to the successful completion of this study. I would like to give my gratitude to all technical and support staffs of Zeway fisheries resources research center, particularly Mr Assefa Mitike, Alemu Lema, Mitiku Bonta, Badane Dalu, Kadir Sinba and Dawit Imiru. Finally, I would like to thank Oromia Agricultural Research Institute (OARI) for financing the research activity.

#### **References**

1. Oguntimehin GB (1985) Preservation through the application of energy (heat processing, Freezing, drying and radiation). *Proceedings of Nigerian Food Journal* 2:76-81.
2. Igene JO (1983) Notes on the traditional methods of fish preservation in Nigerian sector of Lake Chad. *Proceedings of Fish Society of Nigeria* 3:123-130.
3. Obodai EA, Muhammad BA, Obodai GA, Opoku E (2009) Effect of Fuel wood on the Quality of Smoked Freshwater Fish Species Sold in Tamale Central Market, Northern Region, Ghana. *Ethiopian journal of environmental studies and management*.
4. Abera Degebassa (2004) Solar drying of fish fillet using tent in zaway. *Proceedings of the 12th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.*