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沿岸漁業開発戦略策定プロジェクト
ファイナルレポート
（別冊）

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独立行政法人
国際協力機構（JICA）

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3. Final Report of the Pilot Projects of Fishing Gear and Method for FSPAC
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5. Pilot Project Report of Examination of Coastal FAD by Artificial Seaweeds
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7. Coastal Fisheries Managements under climate changes with SDGs
8. Fisheries Management for Rural Community Development
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10. The Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea

1．ベースライン調査報告書

沿岸漁業開発戦略策定プロジェクト

ベースライン調査報告書

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エリトリア海洋資源省

独立行政法人 国際協力機構

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はじめに

独立戦争以降低迷していたエリトリア漁業は、1993 年の独立以来、沿岸水産資源の適切な利用に向けて徐々に再生しつつあり、漁村の生計を支援するいくつかのプロジェクトも実施されてきた。しかし、今日までコミュニティレベルにおける進展はほとんど見られず、明らかな成果も得られていない。このような状況に対処するため、エリトリア海洋資源省は JICA と共に水産資源の持続的利用と沿岸漁業者の生計向上を目的とした「沿岸漁業開発戦略策定プロジェクト（The Project for Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development: FSPAC）」を開始した。

プロジェクトの開始に当たり、北部紅海州の 3 つの沿岸漁村における漁業コミュニティの現状と代表的な３都市における水産物の流通・消費状況を把握するためのベースライン調査を実施した。調査対象はマッサワ郡ヒルギゴ／フォロ郡ズラ／ダハラク郡デヒル島の３沿岸漁村と、アスマラ市／マッサワ市／メンデフェラ市（地方高地都市）の 3 都市である。

ベースライン調査の目的は、潜在的な開発可能性を有する資源や、水産開発を阻害する制約要因等に関する情報を収集し、漁業開発の方向性を特定することである。さらには、広く全国の漁業・漁村を活性化するための沿岸漁業開発戦略策定の基礎資料とする。また、この調査結果は、プロジェクトの様々な活動実施のための基準指標として機能することが期待され、対象漁村や地域にどのような影響を与えたのかについて検証することにも利用するものである。

なお、ベースライン調査は次の 3 つの要素で構成されている。

1. 漁業コミュニティにおける生計と社会経済の現状調査
2. 水産物の流通・販売・消費等ポストハーベストに関する現状調査
3. 漁具・漁法・操業実態・操業コスト等に関する現状調査

第 1 部：漁業コミュニティと生存漁業

1. 調査方法

1 - 1 対象サイトと調査日

漁業コミュニティを対象としたベースライン調査の実施漁村は、JICA 専門家や MMR スタッフを含む FSPAC プロジェクトメンバー内で慎重に検討した結果、マッサワ地域周辺のヒルギゴ（マッサワ郡）、ズラ（フォロ郡）、デヒル島（ダラク郡）の 3 漁村とした。これらの選定に当たっては、代表的な漁村とすることに加え、村へのアクセスのしやすさと漁業活動のレベルに配慮して検討が行われた。また、これらの漁村をパイロットプロジェクトの候補地とすることもプロジェクトメンバーの間で合意されている。

調査は 2019 年 10 月 28 日から 11 月 8 日までの期間において各村 2 日間、地域のリーダー、行政官、漁業者への聞き取り調査で実施した。

表 1-1: 対象サイトと調査日

ベースライン調査サイト	調査日
ヒルギゴ村（マッサワ郡）	2019 年 10 月 29 日、11 月 5 日
ズラ村（フォロ郡）	2019 年 10 月 28 日、11 月 6 日
デヒル島（ダハラク郡）	2019 年 10 月 31 日、11 月 8 日

1 - 2 取材の方法と項目

ベースライン調査は、対象漁村を訪問し個別にインタビューする方法で実施し、各調査対象地を 2 日間に分けて実施した。1 回目の訪問では、調査対象地域の基礎情報となる漁村の状況（コミュニティ・漁業活動の概要）を中心に調査を行った。2 回目の訪問では、1）団体・協同組合の代表者にその活動内容や問題点などについて、2）個々の漁業者には営む漁業の詳細、世帯の状況、漁業活動やコミュニティ内での生計の問題点などについて、それぞれヒアリングを行った。インタビュー項目は表 1-2 （1）～（3）に示す通りである。

表 1-2:（1）「漁村の状況」に関する質問項目

項目の分類	質問項目
（1-1）コミュニティの概要	コミュニティの名前、人口、世帯数、主な職業/収入源、魚市場の有無、学校の有無、保健施設の有無
（1-2）漁業の概要	漁業種類別漁業者数、漁法・漁船数、主な漁場・漁期、漁業関連インフラ、水揚げ場所・施設状況・衛生状況、加工施設の有無および品質 、伝統的な管理慣行の有無、違反者の数/違反の内容、漁業における権利と義務

表 1-2（2）「漁業団体・協同組合の状況」に関する質問項目

項目の分類	質問項目
（2-1）団体・協同組合の概要	協同組合の名前、インタビュー対象者の名前、代表者の名前、協同組合員数、種類別の漁船数と稼働中の漁船数、漁法別の漁船数、協同組合の役割と活動、協同組合の収支、事業のための借り入れ（物品を含む）の有無
（2-2）水産振興活動の実施状況	実施項目、政府・団体・コミュニティの実施体制、政府機関の支援や普及活動の有無および内容、ドナーによる技術・資金協力の有無、進捗状況と期待される成果
（2-3）問題とニーズ	潜在的リソースの有無、漁具漁法の問題・ニーズ、流通と販売（マーケティング）の問題・ニーズ、水産物加工の問題・ニーズ、その他の問題・ニーズ

表 1-2:（3）「漁村の個々の漁業者・世帯の状況」に関する質問項目

項目の分類	質問項目
（3-1）漁業の状態	漁業階層（零細漁業／カヌー漁業／生存漁業）、漁期別の操業形態、対象魚種、主な漁場、漁船の種類・乗組員数、年間漁業収入・支出
（3-2）漁業世帯の状況	世帯規模、収入源別世帯月収、毎月の世帯支出、家計の問題と課題、収入機会、魚食の頻度・魚種・調理法、世帯の女性の役割、若者の希望する職種、漁業と水産物食習慣に関する慣習・文化
（3-3）問題とニーズ	潜在的リソースの有無、漁具漁法の問題・ニーズ、流通と販売（マーケティング）の問題・ニーズ、水産物加工の問題・ニーズ、女性と若者の可能性

2. 調査結果

2 - 1 ヒルギゴ村

（1）コミュニティの概要

マッサワの南約 10 km、北部紅海州マッサワ郡行政区に位置するヒルギゴ村は伝統的な沿岸漁村である。世帯数は 466 世帯、約 2,000 人が村と周辺の集落に住んでいる。村内の学校はエチオピアからの独立戦争時代に一時期機能していなかったが、1991 年の独立後に再建され、現在は小学校から中学校までの 8 年制である。また、独立後に政府が建設した保健所があり、地域社会に則した医療・保健サービスを受けることができるようなっている。村の

主な収入源は、漁業・農業・畜産（牧畜）。村には魚市場は存在せず漁獲物の多くはマッサワの市場で販売されているが、一部は漁業者によって村内（戸別訪問）で販売されている。

表 1-3: コミュニティの概要

項目	現状
コミュニティの名前	村名：ヒルギゴ　　郡名：マッサワ
人口	約 2000 人
世帯数	466 世帯
主な職業・収入源	農業、漁業（マッサワを拠点とする漁船漁業の乗船員）
魚市場	無
学校	有（小・中学校）
保健・医療施設	有

（2）地域の漁業概要

漁業分野に積極的に参加しているヒルギゴ村民のほとんどは男性の若者であり、40 歳以上は少ない。また女性は漁獲活動には参加していないという結果であった。ヒルギゴ村の漁業コミュニティには零細漁業（漁船漁業）は存在せず、すべての漁業者は生存漁民である。漁業に従事する女性は一人も居ないものの、女性を対象とした組合は存在している（設立後間もなく活動を停止）。漁業に従事する若者の数は約 50 人で、多く年間を通して活発に操業しているが対象魚種は季節的に変化している。主な漁場は、ヒルギゴ発電所近くの桟橋からエリトリア海軍基地に隣接する難破船までのヒルギゴ湾内である。

漁法は、刺し網と手釣りの 2 種類が一般的であるが、殆どの漁業者が手釣りを行っているのに対し、刺し網を使用していた者は少なかった。ヒルギゴの生存漁業者はカヌーを所有していないが、その代わりに伝統的に利用されていた浮き具を使って浅海域において操業している。この浮き具は、板状の発泡スチロールを砂糖や小麦の空袋に詰めてロープで縛り補強したもので、これを 3 個から 4 個繋ぐと強い浮力と安定性が得られる。オールは用いずビーチサンダル等を使って手で漕いで進むが動きは遅く、特に風波の強い時は遠い漁場へ行くのは困難である。

他の漁具と比較して手釣り漁具は安価で、生存漁民にとっては入手しやすい。一般的には 0.40、0.80、0.90mm 径のモノフィラメント釣糸を使用している。0.40mm 糸は、盛漁期（冬季）にグルクマ、小型のアジ類、フエフキダイ、小型のイケガツオなどの小型魚を釣るのに使う。他方、0.80 と 0.90mm の釣り糸は、主に酷暑期（夏季）に大型のヒラアジ類、ハタ、オニカマスおよびイケガツオのような大型魚を捕獲するのに利用されている。

刺し網による操業は年間を通じて行われ、小型のボラ、サバヒー、イケガツオなどが漁獲対象となる。夏季（6 月～9 月）は主に目合の小さな網を用いて新月前後の月明かりの無い

夜間に操業され、冬季（10 月～5 月）は目合の大きなものが主に使用される。

ヒルギゴ村の歴史は古く、長く漁業が営まれてきたものの、水揚げ場、衛生施設、加工施設などのインフラが整備されておらず、また実情に則した漁業権や漁業制度が明文化されずにいる。しかし、調査結果によると村の若者たちは漁場の保全に意欲を示しており、また漁業を営む権利と義務の明確化の必要性について問題意識を持ち、政府当局と協議してきた経緯があるとのことであった。

表 1-4: ヒルギゴの漁業の概要

項目	現状
漁業階層別漁業者数	零細漁業：不明（マッサワを拠点とする漁船員は登録済み） 生存漁業：約 50 名
漁法	・刺し網（ボラ等小型浮魚を対象） ・手釣り（アジ類・フエダイ類等小型の浮魚・底魚を対象）
主な漁場と時期	・村の前浜（背の立つ範囲）：10 月～5 月 ・村の前浜（浮き具を使用する水深帯）：12 月～5 月

（3）漁業関連団体

ヒルギゴには、生存漁民を対象とした「ヒルギゴ漁業協同組合（Hirgigo fishing cooperative）」と、女性による「ヒルギゴ漁網修繕・製作組合（Hirgigo net mending and making cooperative）」の 2 つの漁業関連団体がある。

表 1-5: ヒルギゴの漁業関連団体

	団体の名前	目的	会員数
1	ヒルギゴ漁業協同組合	生存漁民のための漁業協同組合	16 名
2	ヒルギゴ漁網修繕・製作組合	女性の収入創出のための組合	18 名

「ヒルギゴ漁網修繕・製作組合」は、海洋資源省の人材開発部（HRD）による漁網修繕と製作に関するトレーニング・コースを修了した 40 人の女性の内、18 人の女性により 4 年前にヒルギゴ漁民トレーニング・センターにて結成された協同組合であるが、現在では活動は殆ど行われていない。

生存漁民を対象として組織された漁業協同組合の主な目的は、漁業者の収入向上と生計改善に向けて、政府からの漁具等の支援の受け皿となることである。現在「ヒルギゴ漁業協同組合」の組合員数は男性のみ 16 名である。彼らは釣り漁具のみを所有している場合が殆どで、漁船やカヌーは所有しておらず、また刺し網を持っている者もわずかである。また、組合では運営・活動計画の策定が進んでいないことから、海洋資源省からの支援はまだ実施

されていない。

問題とニーズに関するヒアリングでは、適切な漁具・漁船の不足が指摘された。刺し網など効率的な漁具は絶対的に不足し、資源の豊富な沖に出漁するための漁船・カヌーも無い。また、酷暑期の漁業環境は非常に厳しく、漁業者の生活を維持することも困難となる場合がある。これに加え、市場へのアクセスの問題、氷の供給や輸送サービスの欠如が指摘された。

ヒルギゴ漁網修繕・製作組合の代表によると、メンバーは村内で収入向上を目指す意欲はあり、また技術トレーニングを修了済みではあるものの、漁網の材料であるロープ、撚り糸、浮子、沈子の板鉛などは手入できず、実際には網を製作することが困難であるとのこと。加えて、漁獲物を処理する衛生的な作業場や市場へのアクセス容易でない事がヒルギゴ村の水産開発を制約する要因であると強調した。

（4）漁業者・世帯の状況

ヒルギゴ村では、生存漁民 7 名に漁業活動について聞き取り調査を行った。実態として生存漁民は漁業のみで十分な収入を得ておらず、家計を維持するために多くの時間を漁業以外の労働に従事せざるを得ない。漁業はほぼ年間を通じて操業され、冬季（10 月～5 月）には殆どが手釣り漁業に従事（まれに刺網）するが、酷暑期（6 月～9 月）には刺し網が主となり手釣りは稀となる。冬季の漁獲対象種はグルクマ、小型アジ類、ホシミゾイサキ、小型のイケガツオなどの小型魚が中心であり、酷暑期にはボラ、フエダイ類、ハタ類、フエフキダイ類などが主となる。

マイワシ類、カタクチイワシ類、ヨコシマサワラ、サメ、ヒラアジ、オニカマスなどの魚は、適切な漁具が無いことや販売の機会が限られているため生存漁民の利用することのできない潜在的水産資源である。これは特に資源量の多いマイワシ類・カタクチイワシ類について言える。

漁業者の年間出漁日数は 156～260 日（3～4 日／週）、1 操業当たりの漁獲量は 2～10 kg である。ヒルギゴ村内には市場はないため、漁獲物の多くはマッサワ市場で販売せざるを得ないが、魚価は 20～30 ナクファ／kg で変動し不安定である。漁業所得は使用する漁具の種類、漁法、漁獲量、魚価によって異なり正確に把握することは難しいが、推定の漁業所得は 6,240~31,200 ナクファ／年の範囲である。

漁業支出には漁具類の購入費に加えて漁獲物の輸送費が含まれ、年間 4,000～8,500 ナクファと推定される。また、世帯の月間支出は 1,500～3,000 ナクファの範囲であるが、多くの漁業者は漁業収入の殆どを支出に充てることになり、貯蓄に回す余裕はないとのことである。漁家の収支はしばしば赤字となり、裕福な人からの借金や、もしくは他の収入源を探す必要に迫られていることから、漁獲の少ない時期は木炭作りや畜産・農業・政府の臨時雇用など他の仕事に従事している可能性がある。

以下、表 1-7～1-10 に漁業者・世帯の状況を示す。

表 1-7: 漁期別の漁法と対象魚種

漁期	漁法	対象魚種
冬季（盛漁期）	手釣り	グルクマ、小型アジ類、小型のイケガツオ
夏季（酷暑期）	刺し網	ボラ、サバヒー
	手釣り	フエダイ、ヒラアジ、ハタ、イケガツオ

表 1-8: 漁獲操業費（ERN：ナクファ）

費目	単価（ERN）	償却期間	月間支出額（ERN）
釣り糸	25.00	2 週間	50.00
釣り針	20.00	2 週間	40.00

表 1-9: 世帯収入と支出

世帯所得（ERN）	世帯支出（ERN）	残高（ERN）
100～1,500	1,000～1,300	-900～200
4,000	500～1,000	3,500~3,000

表 1-10: 問題・ニーズ

項目	現状
潜在的なリソース	漁業者の漁業スキル ニーズ：乗組員や船長になるための漁業訓練
漁具と漁法	問題はない
流通･販売（マーケティング）	村には市場がないため、自転車で輸送しマッサワで販売している。
水産物加工	加工は行っていない
女性と若者の可能性	男性の若者が家業として父親の漁を手伝うことがある。漁業者としての潜在的な可能性がある。

2 - 2 ズラ村

（1）コミュニティの概要

ズラ村は、マッサワ市から南に約 56 キロ離れた北部紅海州フォロ郡の行政区の 1 つである。ズラ湾西側の平地に位置し、海岸線にはマングローブ林が続いている。4 km 離れた場所には、古代アクスム王国の商業の中心地であり港湾都市であったアデュリス遺跡がある。ズラ村には 650 世帯 3,250 人が住んでおり、漁業・畜産・農業を主な収入源としている。村には小学校と中学校はあるが保健所はまだ設置されていないため、村人はフォロの医療施設へ通っている。

表 1-11: コミュニティの概要

項目	現状
コミュニティの名前	村名：ズラ　　郡名：フォロ
人口	約 3,250 人
世帯数	650 世帯
主な職業/収入源	農業、漁業（マッサワを拠点とする漁船漁業の乗船員）
魚市場	なし
学校	小・中学校
保健施設	なし

（2）地域の漁業概要

ズラ村の生存漁業者は約 50 人と推定され、刺し網と手釣りの 2 種類の漁業が営まれている。生存漁民の多くは、主な漁場が沿岸の浅瀬である冬季（10 月～5 月）に積極的に操業している。夏季（6 月～9 月）には表層水温が上昇し魚群が深いところに移動するため、より水深の深い水域での操業を余儀なくされる。ヒルギゴの漁業者と同様に、発泡スチロールで作った浮き具をカヌー代わりに利用している。オールを使わない手漕ぎで漁場まで移動し、アンカーを投入した上で手釣りを行う。なお、ヒルギゴ村と同様に村内には水揚げ場、衛生施設、加工施設などの関連インフラは整備されていない。また、資源を保護するための伝統的な管理手法や、漁業を営むための権利や義務も定められていない。

表 1-12: ズラの漁業の概要

項目	現状
漁業階層別の漁業者数	零細漁業：不明（マッサワを拠点とする漁船員は登録済み） 生存漁業：約 50 人
漁法	1.ボラ刺し網 2.浮体を利用した手釣り（小型浮魚・底魚を対象）
主な漁場と季節	・村の前浜（背の立つ範囲）：10 月～5 月 ・村の前浜（浮き具を使用する水深帯）：12 月～5 月
漁業関連インフラ	該当なし
水揚げ場	該当なし
加工施設	該当なし
漁業管理に関する慣習	なし

（3）漁業関連団体

ズラには、生存漁業に関連する漁業協同組合とズラ漁網修繕・製作組合の 2 つの関連団体が存在する。後者は 2019 年に女性メンバーによって結成されている。

ズラ漁業協同組合は 40 名で構成されている。この団体は、漁業活動の強化を通じて組合員の収入向上を目的とし、現在のところ海洋資源省からの資材提供や融資支援を受けるための手続きを検討している。しかしながら、組合組織として具体的な活動を行っておらず、明文化された戦略等も策定されていない状態である。

表 1-13: ズラの漁業に関連する団体

	団体名	目的	人数
1	ズラ漁業協同組合	生存漁民のための漁業団体	40
2	ズラ漁網修繕・製作協同組合	収入を得るための女性の団体	48

ズラ漁網修繕・製作協同組合は、わずか 4 ヶ月前に設立されたばかりの組合である。組合員は 48 名で、組合の主な目的は雇用機会を創出し組合員と漁家の収入の向上を図ることである。設立されたばかりの段階であるため、公的な融資・支援は受けておらず、また収入も支出もない。

両団体は、政府や関連団体からの資材や技術訓練支援に関するニーズが高い。例えば、ズラ漁網修繕・製造協同組合のメンバーの多くは漁網の製造・修理に関する研修を受けたことがなく、また品質の高い漁具や漁業資材や氷、水産加工研修を必要としている。また、村内では水産物の需要が低いため、漁獲物をフォロに輸送する手段が不足していることも問題の一つである。

(4) 漁民の状況

ズラ村の生存漁民 7 名に漁業活動について聞き取り調査を行った。ズラの漁業集落も調査結果では貧弱な姿を映し出していた。漁民は、ほぼ一年を通して手釣りと刺し網漁を行っているが、暑い時期（6 月～9 月）には活動が減少している。漁民の多くは、暑い時期には農作業に移行しており、次の農作業に向けて農地の準備をしていた。寒い季節（10 月～5 月）には、刺し網漁と手釣りの両方が行われている。刺し網は、夜の時間帯（暗夜）にのみ使用され、手釣りは昼間に行われている。

主な対象魚種は、イケガツオ、ヨコシマサワラ、グルクマ、サメ、ヒラアジ、ミナミクロサギ、ホシミゾイサキ、ボラ、フエダイ、ハタなどである。これらの魚類のうち、暑い時期の対象魚は岩礁魚とボラで、主な漁場はズラの浅い沿岸海域である。漁の装備については、漁船やカヌーは所有していないが刺し網（数に限りがある）と手釣り糸は所有しており、主に木材やプラスチック水容器をカヌーとして使用している。

表 1-15: 漁期別の漁法と対象魚種

漁期	漁法	対象魚種
寒い季節（盛漁期）	手釣り	グルクマ, ムロアジ、イケガツオ
	刺し網	ボラ、サバヒー、サメ、ヒラアジ
暑い季節（貧漁期）	手釣り	フエダイ、ヒラアジ、ハタ、イケガツオ
	刺し網	ボラ、サバヒー

個人の平均年収は、出漁日数、漁獲量、市場価格、輸送費など多くの要素に依存する。調査によると、収入は 7,200～27,300 ナクファ と推定される。手釣り糸、刺し網（50m×4 個）、釣り糸用シンカー、釣り針などの操業費は、輸送費を除くと年間約 5,200 ナクファとなる。

表 1-16: 操業経費

品目	単価（ナクファ）	使用期間
手釣り糸	135	2 年
糸（40 サイズの網）	270	1 年
糸（80 サイズの網）	90	1 年
釣り針	6 – 15	1 日
錘	300	3 年
網（50 m）	375	1 年

表 1-17: 世帯収入と支出

収入	支出（ナクファ）	残高（ナクファ）
600 ナクファ（漁業からの収入）と 500 ナクファ（農業からの収入）	1,500 - 2,000	-400 - -900
漁業による 2,600 ナクファ、農業による 600 ナクファ	3,000	N/A

表 1-18: 問題点と必要性

項目	現状
可能性のある資源	漁業活動での研修、乗組員・船長を目指して
漁具と漁法	問題はない
流通と販売 （マーケティング）	村には市場がない 自転車を使って、マッサワの人々に魚を売っています。
魚の加工	加工なし

女性と若者の可能性	私の息子たちは学生で今は何もしていないが、長男は私が釣りをしていた時にたまに手伝ってくれる。

2 - 3 デヒル島

(1) コミュニティの概要

デヒル島（15 53 890' N、039 376 011' E）は、マッサワの北 20 マイル（32km）に位置するエリトリアのダハラク諸島の数少ない有人島の一つである。第二次世界大戦のイタリア軍の重砲の名残は、北西と西北にデヒルを囲む 3 つの島、ダハレト島、デヒル・ボフル島、バラドゥ島の美しく比較的手つかずの海での水中冒険に加えて、観光名所の 1 つとなっている。島の西側では、西南方向に沿ってサンゴ礁が発達し、色とりどりの魚、海洋無脊椎動物、貝殻などの海洋生物が生息している。海岸沿いの海浜と潮間帯には海鳥が生息しており、特に冬場にはアフリカやヨーロッパからの渡り鳥が広く営巣し、特別な色鮮やかで魅力的な楽園となっている。島には海草、海藻、塩生植物が豊富で、絶滅危惧種のウミガメやジュゴンを含む様々な海洋生物の生息地であり、餌となっている。島はナマコと観賞魚採取でもよく知られている。加えて、フエダイ、フエフキダイ、ハタなどの異なる岩礁魚は、村人の主なタンパク源であり、収入源でもある。島の乾燥地域にはヤギ、ロバ、猫などの家畜が飼われている。

ダラク諸島で最大の島の一つであるデヒルの総人口は約 600 人（90 世帯）と推定される。島には、主に漁業とある程度の貿易で生計を立てているアファー族とティグレ族が主に居住している。調査中には、木工、仕立屋、その他の職業が小規模な活動として観察された。島には小中学校や保健所などの社会サービスが確保されている。飲料水の唯一の供給源はマッサワからのもので、1 バレル(200 リットル)あたり 200 ナクファである。島は比較的有利な漁場を近距離に持っているものの、漁師たちはマッサワかイエメンへの市場を求めて長距離を移動しなければならない。島の生存漁民にとっては、僅かばかりの市場機会があると言える。

表 1-19: コミュニティの概要

項目	現状
コミュニティ名	村名：デヒル　　郡名:ダハラク
人口	約 600 人
世帯数	90 世帯
主な職業・収入源	漁業、貿易
魚市場	村に市場なし、マッサワとイエメンに市場あり
学校	有、小・中学校
保健施設	有

(2) コミュニティの漁業事情

この島の零細漁業は、マッサワに拠点に拠点を置き登録されている。零細漁民と生存漁民の正確な数は明らかにされていないが、コミュニティの生計の大部分は漁業に依存しており、成人年齢層のかなりの割合が漁民である。島の漁民は、北部紅海州の中で最も活発で意識の高い漁民グループの一つであると考えられている。イエメンからの新しい漁法は、主に島の漁師によって適応されている。寒い季節と暑い季節には、刺し網、手釣り、マズルール（地元のトローリング）と燈火漁の 4 つの漁法が採用されている。主な対象魚であるヨコシマサワラ、スマ、カマス、ヒラアジ、サメ、フエフキダイ、フエダイ、ハタなどが通常漁獲され、マッサワかイエメンの市場に販売されている。主な漁場は、ハラット島、ヘルミル島、ゲビフ島、イスラトゥ島、ドルガム島の近海と本土沿岸のグルブブである。詳細な漁期、漁場、対象種については、以下の漁業の概要で示した。

ダラク群島の主要な漁場の一つであるにもかかわらず、水揚げ・加工施設などの漁業インフラは整備されていない。海洋資源の管理と利用に関する文書はないかもしれないが、地元の人々は、ビジネス関連の活動ではなく、恵まれない人々の生活のために魚を利用すること、有害な漁業活動を制限することなど、価値ある伝統的な経営を実践している。クジラやイルカなどの鯨類を意図的に捕獲することはタブー（漁業規制違反でもある）であり、それら鯨類の肉は地元で消費されることはない。この地域の周辺での漁業については、村の権利・義務は実践されていないため、他の村・場所の漁師が島周辺で漁業をする権利を持っている。しかし、これまでのところ、権利・義務や漁法に関する違反は報告されていない。

表 1-20: デヒルの漁業の概要

項目	現状
漁業階級別の漁民数	零細漁民：該当なし（マッサワを拠点に登録） 生存漁民：該当なし
漁法	1. ヨコシマサワラ刺し網（普通の網とマックバー漁の網） 2. サメ網 3. 手釣り
主な漁場と漁期	1. 暑い時期（6 月～9 月）: 主にデヒル付近、ハラート諸島とその周辺の島々 2. 寒い時期（10 月～5 月）: デヒル島、ハラート島、ヒルメル島、ゲビフ島、イスラトゥ島、ドゥルガム島、グルブブ海岸

(3) 水産業とその他の関連団体

島内で設立された漁業組合は、設立から 1 カ月も経っておらず、設立初期の段階にある。

選ばれた漁民（男女）は、省から組合の予備的なオリエンテーションを受け、即座に登録された。15 人のメンバーで構成される男性グループの協同組合は、漁具の不足を緩和し、市場へのアクセスを改善するために、政府からの支援を期待している。女性が結成した協同組合は、主に島での水産雇用を通じて代替的な収入を生み出すことを期待している。州の関連省庁と一緒に海洋資源省は、これらの確立された協同組合に漁具や船外機、無利子または実現可能で手頃な利子の貸付制度へのアクセスを提供することが期待されている。

表 1-21: コミュニティの漁業関連団体

	団体名	目的
1	デヒル漁業団体	生存漁民のための漁業団体
2	デヒル貝蓋採取組合	収入を得るための婦人団体

漁業団体は新たに結成されたばかりで活動が行われておらず、活動している団体の視点からは、漁協の問題点やニーズを把握することが出来なかった。しかし、協議の結果、帰納的な情報として利用できる個々の漁民の問題点やニーズが以下に示された。

(4) 漁民の状況

今回の調査では、デヒル村の漁民 9 名に漁業活動について聞き取り調査を行い、その結果は以下の通りであった。漁船の種類は、グラスファイバ・ホウリ（大半がこれ）、木造・ホウリ、グラスファイバ・サンブク、木造・サンブク（稀に）の 4 種類で、全長は 4〜18m であった。漁船ごとに必要な乗組員は異なり、船長を含む乗組員数は 4〜18 人で、1 隻あたりの平均乗組員数は 8.5 人であった。月収は乗組員によって大きく異なり、最低で 400 ナクファ、最高で 31,500 ナクファであった。操業回数は年に 6 回から 24 回、平均 12.5 回で、各回の操業日数は 5 日から 15 日間であった。同様に、漁獲量は 1 回あたり 500〜5,000kg の範囲であった。操業にかかる主な費用は、燃料（4,050〜27,000 ナクファ）、エンジンオイル（720〜8,400 ナクファ）、氷（960〜10,200 ナクファ）、食糧（1,500〜6,000 ナクファ）のほか、アンカーレンタル（1 回 20 ナクファ）、維持費、サービス費、固定費などであった。運行コストは 1 隻 1 航海あたり 5,360〜7,330 ナクファ、年間コストは 1 隻あたり 91,625〜670,000 ナクファであった。このコストには、サービス、メンテナンス、減価償却費、固定費は含まれていない。

一般的に年間通して用いられる漁法には、刺し網、手釣り、ローカル・トローリング、刺し網（メクベル）を使った燈火漁の 4 つの漁法がある。寒い時期（10 月〜5 月）には、刺し網に続いて手釣りが主流となる。ヨコシマサワラ、スマ、カマス、サメ、イケガツオなどの大型浮魚をターゲットに、水深 7〜12m でサワラ網とサメ網を使用している。そのほか、フエダイ、ハタ、フエフキダイ、ヒラアジなどのサンゴ礁魚には手釣り（現地名 Jeleb）や稀にトローリング（現地名 Majrur）を使用している。疑似餌は地元で入手可能な材料で作られ

たものと、イエメンから購入したものが魚を誘うために使用されている。寒い季節に、ヨコシマサワラのために改良した刺し網を使って、燈火漁を行うと報告した漁師が極僅かにいた。

表 1-23: 漁期別の漁法と対象魚種

漁期	漁法	対象魚種
寒い季節（盛漁期）	刺し網、手釣り、トローリング	ヨコシマサワラ、コシナガマグロ、スマ、カツオ、カマス、イケガツオ、ヒラアジ
暑い季節（貧漁期）	刺し網、集魚灯漁、手釣り、トローリング	ヨコシマサワラ、ヒラアジ、フエフキダイ、フエダイ、ハタ

寒い漁期（10 月～5 月）の主な漁場は、デヒル島、ハラート島、ヘルミル島、ゲビフ島、イスラトゥ島、ドゥルガム島、グルブブ海岸などの島々周辺で、まれにデフニエン島（ダハラク島から最北端のサンゴ礁魚の島）などの遠方の漁場を探している。しかし、暑い季節には、漁師たちは長距離の移動を避け、島周辺の漁場に集中していた。

暑い漁期（6 月～9 月）には、ヨコシマサワラを狙って改造したサワラ網を使った燈火漁が多く行われている。水深 24～30m の場所に網を展開し、集魚灯（発電機からの光）をセットする。この漁法は、ここ 4～5 年でイエメンの漁師から導入されたものである。燈火漁の他にも、手釣り、トローリング、刺し網を使ってフエダイ、フエフキダイ、ハタ、ヒラアジ、ヨコシマサワラなどを狙っている。

表 1-24: 漁船操業費（2019 年漁師 1 隻あたり

品目	漁毎の数量	漁毎の経費(ナクファ)	漁船毎の年間経費(ナクファ)	
Fuel	135-900 lt	4,050.00 - 27,000.00	Minimum	Maximum
Stroke oil	4-49 ltrs	720.00 - 8,400.00	50,625.00	337,500.00
Ice	28-300 blocks	960.00 - 10,200.00	9,000.00	105,000.00
Food		1,100.00 - 6,000.00	12,000.00	127,500.00
others		500.00 - 2,000.00	13,500.00	75,000.00
	Total	7,330.00 - 53,600.00	91,625.00	670,000.00

(5) 漁業世帯

ベースライン調査では地域の漁民 9 名にアプローチし、インタビュー結果を総合的に記載した。平均家族規模は 9.4 人で、女性(5.3 人)、男性(4.1 人)、18～40 歳の成人(3.7 人)、17

歳未満(3.9 人)であった。その結果、女性の方が男性よりもやや多く、労働力（18～40 歳）が世帯の構成要素として最も低いことがわかった。最小家族規模は 5 人、最大は 20 人で、最も多く観測されたのは 1 世帯あたり 10 人であった。

島の主な収入源は貿易で、木工、仕立屋、漁網修理がそれに続いた。交易は消耗品、一般商品、飲料水の取引であった。相談に応じた漁民によると、漁民世帯あたりの平均月収と支出には大きな違いがあり、収入は 1,100～15,000 ナクファ、月支出は 1,200～11,000 ナクファであった。収入と支出の平均純残高は 1,083 ナクファ/月と若干の余剰が見られ、貯蓄はあるものの非常に低いことが示された。しかし、一部の世帯では、マイナス収支となっており、店や親戚、友人から現金や現物を借用せざるを得ない状況となっている。

世帯における女性の役割は、主に炊事、洗濯、育児などの家事やその他の家事に集中していた。このように、世帯の収入創出における女性の貢献度は非常に低いが、インタビューした 9 人のうち 1 人の漁民の世帯では、女性が服の仕立や買い付けに従事しており、毎月 400～800 ナクファの収入を得ていることを確認した。漁民には、島での女性の潜在的な仕事の機会についての傾向、意見、ビジョンを尋ねた。ある回答者は、仕立屋、貝蓋の採取、網の修理などは女性にも良い機会があると答えたが、文化的な属性のある他の回答者は、女性は自分たちの漁業コミュニティでは重要な役割は持っていないと思っていた。

このコミュニティは魚をよく食べる習慣があり、少なくとも 1 日に 1 回は魚を食べている。通常、0.5kg 以上の魚を茶色く焼いて、ご飯やパスタ、zegni（魚の肉を油、玉ネギ、トマト、苦い粉を混ぜて煮込んだもの）に混ぜて食べている。サメは人肉を食べると信じているため、サメの肉は食べない。

表 1-25: 世帯の収入と支出（単位：ナクファ）

収入	支出	残高
1,100 - 15,000	1,200 - 11,000	100 - 4,000

3. 漁村の問題点とニーズ

調査結果からは、1)マーケティングと流通、2)生存漁業の生産性、3)零細漁業の漁具、4)女性の所得創出、に大別されるいくつかの問題点とニーズが明らかになった。

＜マーケティングと流通＞

ヒルギゴでは、漁師が多く、村内の魚の需要が満たされていたため、漁獲物のほとんどがマッサワ市場で販売されている。しかし、商品量の割に輸送コストが高く、漁民の経済発展を阻害する要因となっている。デヒル島の零細漁民は、1）遅い水揚げ時間と時間制限（水揚げ時間は通常午前 6 時から 8 時までと非常に短い）、2）マッサワ市場のみで合法的に漁獲物を売らざるを得ないなど、独占された流通の問題を認識している。

＜生存漁業の生産性＞

他方、ズラの漁民は少ないが、村の魚の需要はかなり高い。また、ズラの漁民たちは、ズラから徒歩 1 時間の距離にあるフォロ郡の中心街のフォロに第二の市場を持っている。そのため、より多くの収入を得て生活を向上させることができるという恵まれた条件を持っている。しかし、彼らの漁具は量、質、機能ともに非常に限られており、それが生産量の増加を妨げる要因となっている。この問題については、ヒルギゴも全く同じ状況下で漁具や漁法を使っていたので、同じことが言える。

＜零細漁業の漁具＞

デヒル島の零細漁民は、いくつかの大きな問題点を指摘しており、重要度に応じて以下のような点が提示された。

・ 漁具の量と質が限られている。
・ ヨコシマサワラ用の刺し網のような漁具のデザイン・構造が不十分である。
・ 利用率の低い資源を探索するための新しいタイプの漁具（延縄など）の不足。
・ 魚群探知機、GPS などの漁具の不足。
・ 漁具や操業にかかるコストの高さ

＜女性の所得創出＞

ヒルギゴ村とズラ村では、収入を得るための女性団体はあるが、残念ながら現在は機能していないようである。しかし、コミュニティの女性たちの意見として、やはり収入を生み出す必要性は非常に高かった。

第２部　魚の流通と家庭消費

本調査は、ポストハーベスト活動の現状を把握し、魚の流通や家庭での魚の消費における問題点や制約を明らかにするために実施したものである。調査対象地は、エリトリアの代表的な魚消費都市である沿岸都市マッサワ、首都アスマラ、地方高地都市メンデフェラの 3 都市である。マッサワは 2019 年 11 月 11 日と 12 日、アスマラとメンデフェラは 2020 年 3 月 14 日と 15 日の、それぞれ漁獲量の多い時期に調査を行った。北部紅海州の水揚げ場はマッサワの EriFish のみで、そこから 3 つの都市に配送されている。

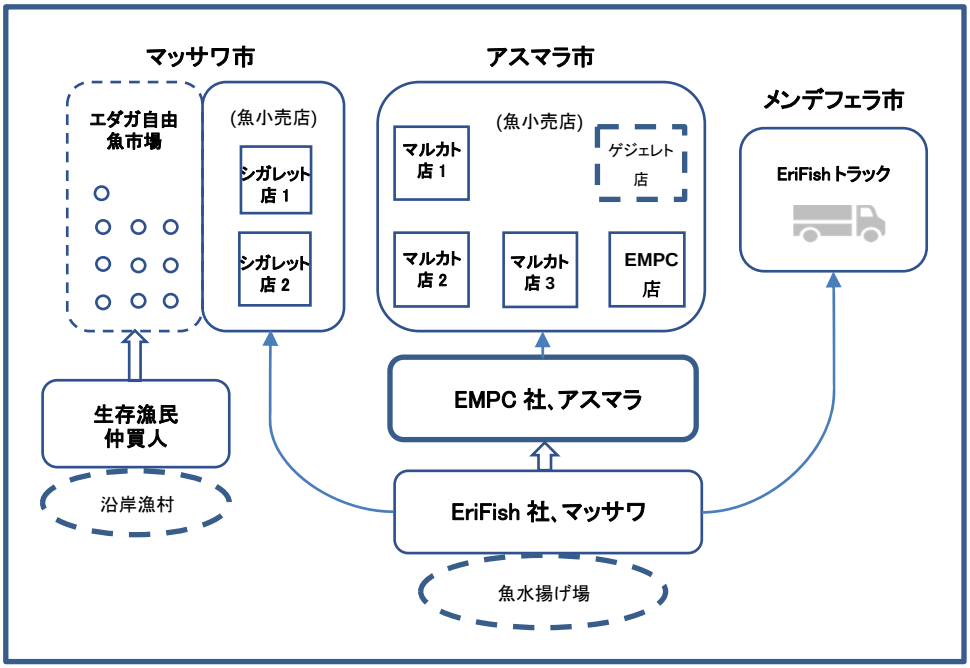


図 2-1：代表的な 3 都市への魚の流通

1. 調査方法

魚類の流通に関する調査は、主に以下の 2 つの要素に焦点を当てて行われた。

(1) 魚の供給情報：魚種、販売量と頻度、魚の産地、魚の輸送方法、販売時間、最も人気のある魚、の情報について。

(2) 販売者の意見：魚の販売者の問題点や制約、魚の販売に関するコメントや推奨事項などについて。

一方、家計の魚消費に関する調査では、主に以下の 4 つの要素に焦点を当てている。

(1) 世帯情報：世帯規模（性別・年齢）、収入源、家計支出、購入した魚の種類、重量、価格など。

(2) 魚食の習慣：魚の加工方法（天日干し、塩干、燻製)、調理方法（方法や香辛料)、魚食の頻度（家庭やレストラン)、魚介類を食べる文化や習慣など。
(3) 顧客の満足度：市場における魚の量、品質、価格について。
(4) 顧客の意見:この部分には､魚市場に対する顧客のコメントや推薦が含まれている。

インタビュー対象者から収集したデータは、本調査のために作成したアンケート票に基づき、販売者 16 名、顧客 42 名の計 58 名の回答を、表と図を用いて記述形式で報告している。

2. マッサワの調査結果

マッサワにおける魚の流通と家庭での消費に関するベースライン調査は､マッサワの 2 つの魚市場、エダガ露天魚市場とシガレット鮮魚販売店を対象に実施した。この 2 箇所はマッサワで鮮魚を販売する場所としてよく知られている。エダガ市場は鉄道沿いの幹線道路に隣接したエダガ区にあり､活発に魚の販売が行われている。もう一つの魚市場であるシガレット販売店は、シガレット区のシガレット・ケタン（土手道）と呼ばれるコーズウェイのそばにある。今回のマッサワでの調査では、魚の販売者として 12 人、顧客として 12 人の計 24 人が参加したが､その内､エダガ市場がそれぞれ 10 人と 10 人､シガレットが 2 人と 2 人であった。

その特殊性ゆえに､エダガ露天魚市場の調査結果は､シガレット鮮魚販売店の結果とは一緒にせず､別々に分析されている。後者は､エリトリアの他の地域でも見られる典型的な鮮魚店である。

2 - 1 エダガ露天魚市場

エダガ露天魚市場は、警察署近くの幹線道路沿いにあるマッサワのエダガ行政区内にある市場である。それは、小さなスナックやパン屋に隣接した空き地にあり、売り人は街路樹で少し日陰になった場所で魚をカゴに入れて販売している。

2019 年 11 月 11 日、12 日の 2 日間、エダガにおける調査は、魚の流通に 10 人、家庭での消費に 10 人の計 20 人を対象に実施した。調査から得られた回答は、それぞれのトピックについて以下の段落に記載している。

2 - 1 - 1 エダガ露天魚市場における魚の流通

魚の流通に関する調査は、エダガ市場の 10 名の魚売り、生存漁民と仲買人、を対象として実施した。これらの調査対象者は､魚類販売業者のために予め用意されたアンケートに回答した。

(1) 魚の供給情報

エダガの露店市場での魚売りは、その日の朝に村の前で魚を収穫したり、マサワ周辺の沿岸部の村々から魚を集めたりする生存漁民や仲買人である。市場の売り手の数は一定ではなく 10 人前後で、エリトリアの他の魚小売業者とは異なり、政府の営業許可を必要としない。

この市場に供給される魚は、主にマッサワ周辺（シェイク・シエド、ヒルギゴ、グルグスム）やエンベレミ周辺の漁場で生存漁民が捕獲した一夜越しの新鮮な小型の浮魚と底魚、およびマルサ・グルバブ、ズラ沿岸、デヒル、デジエ、ダハラク島で零細漁民が漁獲した 2〜3 日経た魚が中心である。

エダガ市場の魚の価格は 1kg 当たり 40〜50 ナクファであった。これらの価格は政府が決めたものではなく、売り手が決めたものである。この市場の一店舗あたりの魚の販売量は、一日あたり 10〜200kg であり、エダガ市場全体での一日の魚の販売量は平均で 473kg であった。

基本的に売り手の魚の輸送手段は、自転車や三輪自転車にカゴと紐を付けた原始的なものであった。しかし、一部の仲買人は氷箱を積んだピックアップ・トラックを使っていたり、自家製の氷を使って魚保存をしたりしている仲買人もいた。この市場で売られていた魚種は、ボラ、ハタ、ヨコシマサワラ、ヒメフエダイ、フエダイ、ホシミゾイサキ、カマス、スマ、スギ、ヒラアジ、アイゴ、ミナミクロサギ、カニ類、ときにはハマギギなどであった。

表 2 - 1：エダガ露天市場の魚供給情報

売人	魚の販売			漁場		輸送手段
	魚種	量 kg	販売頻度	生存漁民	零細漁民	
1.	ハタ、ボラ、カマス、スマ、スギ、ヨコシマサワラ、ヒラアジ	20-100	毎日	マッサワ周辺（ヒルギゴ）	ダハラク、ズラ、デヒル	自転車、かご、賃借氷箱
2.	ヒラアジ、ボラ、ハタ、フエダイ、フエフキダイ、ヨコシマサワラ、カマス、ハマギギ	10-80	毎日	マッサワ周辺 (ヒルギゴ、シェイク・シェド)	ダハラク、デシエ、デヒル	3 輪自転車、かご
3.	ブラ、ヒメフエダイ、カニ、ホシミゾイサキ	200	週 2 回 (67kg/日)		マルサ・グルバブ、ウェキロ、エンベレミ	車、氷箱に氷蔵
4.	ボラ、ハタ、ホシミゾイサキ	30-40	毎日	マッサワ周辺（ヒルギゴ）		自転車
5.	ボラ、フエダイ、ハタ、ヒラアジ	10-20	毎日	マッサワ周辺		自転車、小型氷箱、自家製氷塊
6.	ボラ、フエダイ、ハタ、ホシミゾイサキ、イケガツオ、ヒラアジ、カマス、ヒメフエダイ	300-500	月 3 回 (36-60kg/日)	マルサ・グルブブ		車、賃貸氷箱、薄片氷
7.	ボラ、ヒラアジ、ヒメフエダイ、サケ、フエダイ、ホシミゾイサキ, イケガツオ、ハタ	10-15	毎日	マッサワ周辺 (シェイク・シェド)		賃貸カヌー、自転車、かご

8.	ボラ、スギ、カマス、ハタ、ヒメフエダイ、ホシミゾイサキ,ヒラアジ、フエフキダイ	50-200	毎日	マッサワ周辺(シェイク・シェド、ヒルギゴ)	ダハラク、デシエ、デヒル	自転車/賃貸車、氷箱氷蔵、かご
9.	イケガツオ、カマス、ボラ、フエダイ、ヒメフエダイ、ハタ、ヨコシマサワラ、ヒラアジ	20-80	毎日	マッサワ周辺(シェイク・シェド、ヒルギゴ)	エンベレミ、デシエ	自転車、3 輪自転車
10.	ヒメフエダイ、ハタ、ボラ、スマ、 ヒラアジ、イケガツオ	10-20	毎日	マッサワ周辺(シェイク・シェド、グルグスム、ヒルギゴ) カヌー生存漁民		3 輪自転車、自家製氷、賃貸氷箱、氷蔵、かご
売上高: 263 – 682kg/日 (平均 472.5kg/日)						

魚の販売時間は、売り手が通常の魚の保存設備を持っていないため、毎日６時から１２時までの午前中だけとなっている。エダガ露天市場で最も人気のある魚種は、ボラ、ヒラアジ、ヒメフエダイ、フエフキダイ、ハタ、サワラ、グルクマの順であった。

表 2 - 2: エダガ露天市場の魚販売

売人	販売時間帯	最も人気のある魚種
1	8:00 am -12:00 pm	ヒラアジ、ヒメフエダイ、ヨコシマサワラ、ボラ
2	8:00 am -12:00 pm	ボラ、フエフキダイ、ハタ、ヒラアジ
3	8:00 am -12:00 pm	ボラ、フエダイ
4.	8:00 – 10:00 am	ボラ
5.	6:00- 11:30 am	ボラ、ハタ
6.	8:00 am - 11:30 am (3-10 days)	ボラ
7.	8:00 am - 11:30 am	ボラ、ハタ、ヒメフエダイ、ヒラアジ
8.	8:00 am -12:00 pm	ヒメフエダイ、フエフキダイ、ボラ
9.	6:00- 12:00 am	ヨコシマサワラ、ハタ、ボラ、フエダイ、フエフキダイ
10.	8:00 am -12:00 pm	ヒメフエダイ、ボラ、ハタ、ヒラアジ

(2) 売人の意見

エダガ露天魚市場の魚売りたちは、移動手段に悩んでいる。彼らは三輪自転車やソーラー自転車で直接顧客に魚を配ることを望んでいる。また、日陰で舗装された売場、魚を洗うための十分な水の供給、廃棄物処理場の指定、魚保存に適した氷や大きさの異なる氷箱、魚を保存するための冷蔵庫などを推奨している。魚の販売人の中には生存漁民もいるところ、魚の供給量を増やすためには、5～8 馬力のエンジンを搭載したカヌー、釣り針と釣り糸、漁業活動中の怪我のための安全装置なども必要とされた。

2 - 1 - 2 エダガ露天魚市場における家庭内の魚の消費

エダガ市場の家庭内の魚の消費調査は、その日に魚を購入していた 10 名の顧客を対象に実施した。これらの顧客は、家庭の魚消費用に準備された質問票に基づき、調査チームがヒアリングを行った。その回答は以下の通りである。

(1)世帯情報

エダガ魚市場の 10 人の聞き取り調査対象者の総世帯数は 68 人で、そのうち男性 51 人、女性 49%であった。1 世帯あたりの平均は 6.8 人であった。そのうち、若者（18～40 歳）が 38%、未成年（0～17 歳）が 51%で、残りは 40 歳以上であった。

世帯の主な収入源は、船員としての漁業活動、アルバイト、三輪自転車所有者（運送業者）、兵士、日雇い労働者で、収入は月 300～4000 ナクファであった。世帯の支出は、毎日の食費、家賃、電気代、水道代などである。インタビュー対象者が最も多く購入している魚は、ボラ、ヨコシマサワラ、ヒメフエダイ、ヒラアジ、スギの丸ごとまたは切り身であった。魚の価格は 1kg 当り 45~50 ナクファであった。

表 2 - 3: エダガ露天市場の世帯情報

顧客番号	世帯情報									
	世帯規模*				収入源	収入額(ナクファ/月)	世帯支出項目	購入した魚		
	男性	女性	青少年	幼年				魚種	量 kg	値段(ナクファ/kg)
1	4	3	2	3	漁業(乗組員)	400-500	魚、毎日の食費	ヒラアジ	1	50
2	4	2	5	1	パート職	600-700	家賃、毎日の食費、魚	ボラ	6	40
3	1	2	2	1	手押し車運搬	日雇い賃	毎日の食費、魚	ボラ、ヨコシマサワラ、サメ	1	40
4	7	5	2	9	漁業(乗組員)	3000-4000	毎日の食費	ボラ、ヨコシマサワラ	2	45
5	2	3	2	3	軍人	300-600	毎日の食費、魚	ヨコシマサワラ	2	50
6	4	4	5	2	漁業(乗組員)	800-1000	毎日の食費、魚	ボラ	1	40
7	2	4	1	4	漁業(乗組員)	1500-2500	毎日の食費、魚、米	ヒメフエダイ	1.5	40
8	5	6	2	9	店主	-	毎日の食費、魚	ヒラアジ	1	40
9	2	1	2	1	日雇い	日給	家賃、毎日の食費、電気・水道代	ボラ	0.5	40
10	4	3	3	2	月給取り	2000-2500	家賃、毎日の食費、電気代	スギ	1	50
計	35	33	26	35				(平均 kg/人)	1.70	

*青少年：18-40 歳、幼年：0-17 歳

(2) 魚食の習慣

下の表は、インタビュー対象者の小型魚の加工方法、調理方法、調理人、家庭や外食での魚食頻度、魚介類の食文化を示したものである。家庭では、魚を調理する前に、断首、内臓除去、切り身、煮沸などの方法で加工している。サメのような特定の魚については、天日干し、塩干しなどの方法で加工している人もいる。主な調理人は女性（母と娘）で、調理方法

はフライ、魚のスープ、ジグニ（魚醤)、魚とご飯、焼き物、サンドイッチなどである。料理に使用した香辛料は、黒胡椒、青胡椒、ニンニク、玉ねぎ、トマト、油、パセリ、生姜、塩である。

Table 2 - 4: エダガの魚食の習慣

顧客番号	魚の加工			調理方法		調理者		魚食の頻度		魚介類食習慣
	日干し	塩干	燻製	調理法	食材	男性	女性	家庭	飲食店	
1	×	×	×	揚げ物、煮物、焼き物、スープ、ジグニ	黒胡椒、玉ねぎ油、にんにく、生姜		母	毎日	無	魚のみ
2	○	○	×	揚げ物、煮物、サンドイッチ、スープ	黒胡椒、玉ねぎ、にんにく、トマト、ピーマン		母、姉妹	毎日	時々	魚のみ
3	×	×	×	揚げ物、スープ			母	毎日	No	エビ､abu-tara
4	×	×	×	スープ、ジグニ、揚げ物、煮物	青唐辛子、黒胡椒、ニンニク、玉ねぎ		母、娘	毎日	時々	魚のみ
5	×	×	×	揚げ物、ジグニ、スープ、煮物	パセリ、黒胡椒、ニンニク、ピーマン		母	月一回	無	魚のみ
6	×	×	×	揚げ物、スープ	黒胡椒、ニンニク、玉ねぎ、トマト		娘	週 2-3 回	無	魚のみ
7	×	×	×	揚げ物、ジグニ、スープ、煮物	黒胡椒、にんにく、青唐辛子、油		母、娘	毎日	無	魚、エビ、sapia, カニ
8	×	×	×	揚げ物、魚のごはん	黒胡椒、にんにく、塩		母、娘	時々	無	魚のみ
9	○サメ	○,サメ	×	揚げ物、ジグニ、魚のごはん、焼き唐辛子	黒胡椒、ピーマン、青唐辛子、ニンニク、トマト、玉ねぎ		母、娘	時々	無	時々エビ, sapia、サメ
10	×	×	×	ジグニ、揚げ物、煮物、スープ、魚の炊き込みご飯	-		母	時々	無	魚のみ

エダガ魚市場での調査結果によると、以下のように毎日家庭で魚を食べている世帯が 5 割を占めているのに対し､8 割の世帯は飲食店で魚を食べる習慣がないと回答している。沿岸部の住民は、7 割の世帯が魚を食べる習慣があり、時にはエビ、コウイカ、カニ、アブ・タラなどを食べることもあった。

50% 毎日	10% 2-3/週	10% 1/月	30% 時折

図 2 - 1: マッサワ市エダガの家庭で魚を食べる頻度

(3) 顧客の満足度

市場に出回っている魚の数量、品質、価格に関する顧客満足度の情報は、ほぼポジティブなものであった。魚の量については、ほとんどの回答者が満足しているが、一部の回答者は閉漁期の魚種が少ないことに不満を持っている。また、品質については、回答者全員が魚の品質には満足しているが、市場の質の状況には満足していないと回答している。また、魚は裸土の上にカゴに入れて陳列されているため、日当たりや埃などの影響で魚が劣化するのではないかと心配されている。

表 2 - 5: エダガ市場の顧客の満足度

顧客	魚の量	魚の品質	魚の価格
1	○	○	× (高価)
2	○	○	○
3	×、閉漁期	○	×、閉漁期
4	○	○	○
5	○	○	高価
6	○	○	○
7	○	○	○
8	○	○	○
9	○	日光の影響で劣化することがある	高価
10	○	○	○
合計、○：×	9：1	9：1	6：4

(4) 顧客の声

インタビューした人の意見は以下の通り。

- 市場の整理整頓が行き届いておらず、改善すべきである。
- 冷蔵や冷凍などの保存体制が整っていない。
- 魚の品質や鮮度の確保が求められている。
- 市場内のほこりや日光、ハエなどからの適切な保護が必要である。
- 禁漁期の魚の供給量を増やし、魚の価格を下げてほしい。

2 - 2 シガレット魚市場

シガレット魚市場は、シガレット海中堤防（Sigalet Qetan）の近くにあり、北紅海州政府の許可を得た、魚の小売店が 2 店舗ある。この魚市場はエダガ市場のように活気がなく、魚の値段が高いことや、住宅街から少し離れた場所にあるため、1 日に 1kg の魚も売れないこともある。しかし、インタビューした顧客は、衛生状態や魚の保存状態がエダガ市場より

も良いことを考慮して、ここでしか魚を買わないと言っていた。この魚市場での調査は 2019 年 11 月 14 日に行い、インタビューには 4 人が参加し、魚の流通に 2 人、家庭での魚の消費に 2 人が参加した。

2 - 2 - 1 シガレット魚市場における魚の流通

シガレット魚市場には、魚の小売店が 2 店舗しかない。そのうちの 1 軒は 1994 年から元戦闘員の女性が経営している。この店は 1993 年にユニセフによって建設されたもので、冷蔵庫と天秤が追加で供給されていた。もう 1 つの店は、20 年ほど前からこのビジネスをしている男性が経営していた。これらの店はマッサワの市行政府の下で免許を取得しており、年間 5000～9000 ナクファの税金を政府に、5%の消費税を EriFish に支払っている。

(1) 魚の供給情報

この魚市場では、魚はマッサワの EriFish 水産食品加工工場から供給されたもので、大型の魚のみであった。魚類の輸送には傭上自家用車が使われ、氷箱に氷を入れた状態で 1 回の輸送に 350～500 ナクファ程度の費用がかかっている。シガレット魚市場で販売されている魚の量は、1 店あたり 1 日 20～50kg であった。平均すると、シガレト市場での 1 日の魚の総販売量は 65kg であった。この市場で購入された魚種は、ヨコシマサワラ、ヒメフエダイ、ハタ、カマス、ヒラアジ、スマであった。価格は政府によって、1 等魚が 1 キログラムあたり 63 ナクファ、2 等魚が 42 ナクファと定められている。

表 2 - 6: シガレット市場の魚類供給情報

店舗	魚の販売			魚の供給	搬送方法
	魚種	販売量(kg)	頻度		
1.	ヨコシマサワラ、ヒメフエダイ、ハタ、カマス、ヒラアジ、スマ	20-50	毎日	EriFish	自家用車傭上、アイスボックスに冷凍
2.	ヨコシマサワラ、ハタ、ヒメフエダイ、スマ	25-35	毎日	EriFish	自家用車傭上、アイスボックスに冷凍
販売量：45 – 85kg/d 日 (平均 65kg/日)					

シガレット魚市場では、ヨコシマサワラ、ヒメフエダイ、ハタが最も人気のある魚であった。この市場の営業時間は午前 7 時から午後 2 時までで、1 日に 10～12 人の顧客が購入し、1 日に 45～85kg の魚が販売されている。

表 2 - 7: シガレット市場での魚の販売状況

店舗	販売時間	最も人気のある魚
1.	7:00 am- 2:00 pm	ヨコシマサワラ、ヒメフエダイ、ハタ

2.	7:00 am- 1:00 pm	ヨコシマサワラ

(2) 売主の意見

シガレット市場で魚を売る人の意見は以下の通り。

- 冷蔵庫や冷凍庫などの保存システムが古い。
- 店舗のインフラ全体の整備が必要。
- 輸送コストが高い。
- 天秤、まな板、包丁、手袋、衛生帽、防護服などの加工キットが不足している。
- 暑い時期には水が不足しているため、洗濯槽や水タンクが必要である。

2 - 2 - 2 シガレット魚市場における家庭内の魚の消費

シガレットの顧客 2 名を対象に、調査チームが作成したアンケートに基づき、家庭の魚消費調査を実施した。調査対象者からの回答は、以下の段落と表にまとめられている。

(1)世帯情報

顧客の平均世帯員数は 6.0 人であった。収入源はバーの経営者および建築請負業者としてのものであった。顧客の家計支出はエダガ市場とほぼ同じであった。毎日の食費、家賃、電気代、水道代、従業員の給料などに支出している。

客は一等魚であるサワラやコビア(cobia)を購入していた。一回の仕入れ量（平均 2.5kg）はエダガ市場（平均 1.7kg）よりも多く、魚の価格は政府定価の 63 ナクファ/kg と 26%も高かった。

表 2 - 8：シガレットの世帯情報

顧客	世帯規模				収入源	収入額(ナクファ/月)	世帯支出項目	購入した魚		
	男性	女性	青少年	幼年				魚種	量(Kg)	値段(ナクファ/kg)
1	1	3	2	1	バー経営者	1000	毎日の食費、電気代、社員給与	スギ	2.5	63
2	5	3	5	1	請負業者	-------	毎日の食費、魚代	ヨコシマサワラ	2.5	63
計	6	6	7	2				(平均 kg/人)	2.50	

*青少年：18-40 歳、幼年：0-17 歳

(2) 魚食の習慣

インタビュー対象者は、すでに加工された魚（刻んだり切り身にしたもの）を購入していた。天日干し、塩干し、燻製などの加工はしていない。家庭での調理は主に女性（母娘）が

行い、その方法はフライ、スープ、ジグニ、スプリスなどである。これらの料理に使われている香辛料は、黒胡椒、青胡椒、ニンニク、鶏肉の風味、ローズマリー、パン粉、卵、レモンなどであった。彼らは週に 2〜3 日、または月に 1 回は家で魚を食べ、たまにレストランで魚を食べる習慣がある。

表 2 - 9：シガレットにおける魚食の習慣

顧客	魚の加工			調理方法		調理者		魚食の頻度		魚介類食習慣
	日干し	塩干	燻製	調理法	食材	男性	女性	家庭	飲食店	
1	×	×	×	揚げ物、スプリス	黒胡椒、鶏肉の風味、ローズマリー、パン粉、卵		母	2-3 日/週	0	魚とエビ
2	×	×	×	揚げ物、スープ、ジグニ	黒胡椒、青胡椒、ニンニク、レモン		母、娘	1 日/月	時々	魚のみ

(3) 顧客の満足度

顧客は全体的に魚の量には満足しているが、市場に出回っているヨコシマサワラの量には満足していない。これはヨコシマサワラの需要が増えたためである。魚の品質には全員が満足しているので、エダガ自由魚市場では購入していないが、一人は、この市場は値段が高いと感じている。

表 2 - 10：シガレット市場における顧客の満足度

顧客	魚の量	魚の品質	魚の価格
1.	×、魚種に不満	○	○
2.	×、魚種に不満	○	高価
合計：○：×	0：2	2：0	1：1

表 2 - 11：顧客の満足度、エダガ市場とシガレット市場の組み合わせ

顧客	魚の量	魚の品質	魚の価格
エダガ市場：○：×	9：1	9：1	6：4
シガレット市場：○：×	0：2	2：0	1：1
合計、○：×	9：3	11：1	7：5
合計%、○：×	75%：25%	92%：8%	58%：42%

(4) 顧客の意見

シガレット魚市場でのインタビューでは、以下のような意見があった。

・ 魚の供給が十分ではない、特にヨコシマサワラが不足している。
・ 保存体制は良いが、エダガ魚市場に比べて魚の価格が高い。
・ この地域での魚の消費に対する意識が低い。

2 - 3 マッサワの問題点とニーズ

マサワでは、捕獲された魚は、マッサワ周辺の生存漁民や仲買人らがエダガ露店魚市場に運び自ら販売する方法と、EriFish からシガレット魚市場に運ばれて利権小売業者の 2 店で販売する方法の 2 つの方法で販売されている。1 日の平均販売量は、エダガ市場が 473kg、シガレット市場が 65kg であった。エダガ市場は個人の販売者で運営されている唯一の市場であり、小型の魚を彼らの価格で販売している。一方、シガレット市場は政府認可の魚市場で、大型の魚を政府定価で販売している。

人々には魚を良く食べる習慣があり、マッサワではインタビュー対象者の 42%が 1 世帯あたり 1.70kg をエダガ市場から、2.5kg をシガレット市場から、それぞれ魚を毎日購入している。漁場に近いこともあり、マッサワの 75%の顧客は市場で手に入る魚の量に満足している。

両魚市場のインタビュー対象者が改善を求めた主な課題は以下の通りであった。

(1) エダガ魚市場は、魚を洗うための十分な水の供給と指定された廃棄物処分場を備えた、適切に選定された日陰のある魚売り場を必要としている。
(2) 異なるサイズの氷箱、冷蔵庫や冷凍庫などの魚のための良い保存器材。
(3) 直接顧客に魚を配るための 3 輪自転車やソーラー自転車などの輸送手段、自動車を輸送用に使用した場合の燃料や油などが必要。
(4) シガレット魚市場では、既存のインフラの改修が必要。
(5) 天秤、まな板、切断ナイフ、手袋、サニタリーキャップ、保護服などの魚加工キット（シガレット店の販売者用）。
(6) 閉漁期間中の魚の供給量を増やし、魚の価格を下げる。
(7) 魚の加工、調理方法のトレーニング。
(8) 魚の消費に関する国民の意識の向上。

3. アスマラの調査結果

首都アスマラ市の魚市場は、(1)マエケル・ケテマ（市の中心）のマルカト魚市場、(2)マイ・チョットにある EMPC（Eritrean Marine Products Company Pvt.Ltd.）の水産加工工場内の小売店、(3)ゲジェレト地区のゲジェレト魚市場の 3 カ所である。これら 3 つの市場のうち、最もよく知られている魚市場であるマルカト魚市場と EMPC の小売店の 2 つの販売所でベースライン調査を実施した。

マルカトは、特定の建物の中に食料品、果物、野菜、肉、家庭用品、魚を販売するミニスーパーマーケットが集まる歴史的かつ賑やかな市場エリアである。マルカトの魚市場は 3 つの小売店で構成されている。このため、このマルカト魚市場の 3 店舗と、EMPC の 1 店舗の計 4 店舗が調査対象となった。

アスマラでは、魚の販売者 4 名と顧客 20 名の計 24 名が調査に参加した。彼らは 2020 年 3 月 14 日と 15 日にアンケートに沿って調査チームのインタビューを受け、その回答は以下の通りであった。

3 - 1 魚の流通

魚の流通調査の対象となった魚類小売店は、マルカト魚市場のドルフィン、紅海、トーマスの 3 店と EMPC の水産加工工場内の 1 店の計 4 店舗である。この調査では、魚種、1 日あたりの販売量、販売頻度、魚の産地、輸送方法、販売時間、人気のある魚種、販売者の意見などの魚の供給情報を調査した。

(1) 魚の供給情報

アスマラで販売されている魚類は、マッサワの EriFish 社が EMPC を通して隔週冷蔵トラックで供給している大型の遠洋魚・底魚である。また、EMPC はマルカト魚市場をはじめとするアスマラ市内の小売店に配送しているほか、同社の敷地内にある小売店でも顧客に直接販売している。4 店の小売店へ供給された魚に関する情報を表 2-12 に示す。

表 2 - 12 アスマラの魚類供給情報

店舗	魚の販売			魚の供給	搬送方法
	魚種	量(kg)	販売頻度		
マルカト市場					
1.	1. サメ、2.ハマギギ、3.スマ、4.Alsan、5.ヒラアジ、6.カマス、7.ボラ、8.ヨコシマサワラ、9.フエダイ、	200	毎日	EMPC	保冷車
2.	1. スマ、2.サメ、3.ハマギギ、4.イケガツオ	300-1200	毎日	EMPC	保冷車
3.	1.スマ、2.カツオ、3.サメ、4.イケガツオ、5. ハマギギ、6.サバヒー	300-800	毎日	EMPC	保冷車
EMPC					
4.	1.ハタ、2.フエフキダイ、3.スマ、4.サメ、5.ハマギギ、6.フエダイ、7.Malabar、8.ヨコシマサワラ、9.イケガツオ 10.ボラ	切身 1000、一匹 3000-4000	毎日	EriFish マッサワ	保冷車
販売量: 4,800 – 7,200kg/日 (平均 6,000kg/日)*					

(*これら店舗は隔週でのみ営業)

これらの小売店で販売されている魚種は、サメ、カマス、スマ、カツオ、イケガツオ、ハタ、フエダイ、フエフキダイ、Malabar、ヨコシマサワラ、ハマギギ、ボラ、サバヒー、ヒラアジであり、1 店舗あたりの 1 日の販売量は、丸ごと 1 匹で 200kg から 4000kg、切り身で

1000kg となっていた。アスマラの小売店 4 店舗での魚の販売量を平均すると、1 日あたり 6000kg であった。

下記の魚類販売の表は、販売時間とアスマラで最も人気のある魚種を示したものである。魚類小売店の従業員は、顧客の要望に応じて魚を販売した後、頭落し、内臓処理、切り身処理などの加工を行っていた。

表 2 - 13. アスマラにおける魚の販売

店舗	販売時間	最も人気のある魚
マルカト市場		
1	8:00 am -2:00 pm	ヨコシマサワラ
2	8:00 am -2:00 pm	スマ、サメ、ハマギギ、イケガツオ
3	7:30 am -3:00 pm	スマ、サメ、イケガツオ、フエダイ、ヒラアジ、カマス、ボラ
EMPC		
4.	6:00 am – 6:00 pm	フエダイ、ハタ、ヨコシマサワラ(切身).

マルカトの小売店では、EMPC から供給される魚の在庫状況に応じて、隔週のほぼ毎日午前 8 時～午後 2 時の間に魚を販売している。最も人気のある魚は、ヨコシマサワラ、ハマギギ、スマ、サメ、イケガツオ、フエダイ、ヒラアジ、カマス、ボラであった。一方、EMPC の小売店では、販売時間は午前 6 時～午後 6 時で、人気のある魚はフエダイ、ハタ、ヨコシマサワラ（切り身）であった。

(2) 売主の意見

魚の販売を改善するために、マルカト魚市場でインタビューした魚の販売者（企業のオーナー又は組合のメンバー）は次のことを推奨した。

(1) 市場のインフラと廃棄物排水システムの復旧。
(2) 水の供給や水源へのアクセスの容易さ。
(3) 公正なライセンス料と家賃の費用負担。
(4) 冷蔵庫、製氷箱、調理キット、エプロン、手袋、洗浄剤などの加工機具のサポート。
(5) 顧客の要望を満たす十分な量の魚の供給。

また、EMPC 小売店の魚販売人の勧めは、

(1) 冷蔵倉庫の復旧・改装。
(2) オフィス家具や備品のサポート。
(3) 公正な魚価と低価格化の導入。
(4) 輸送用トラック（保冷車、水輸送用タンカー）の支援。

3 - 2 家庭における魚の消費

アスマラの家庭における魚消費調査は、マルカト魚市場で魚を購入していた顧客 12 名とその日は魚を購入していなかった顧客 6 名と、EMPC の小売店で魚を購入していた顧客 2 名の計 20 名を対象に実施した。

(1)世帯情報

アスマラにおける家庭の魚消調査の前半は、世帯規模（年齢・性別)、収入源、支出、マルカト市場や EMPC の小売店で購入した魚の種類、量、価格などの世帯情報を調査した。

表 2 - 14. アスマラの世帯情報

顧客	世帯規模				収入源	収入額(ナクファ/月)	世帯支出項目	購入した魚		
	男性	女性	青少年	幼年				魚種	量(kg)	値段(ナクファ/kg)
マルカト市場 (その日魚を買っていた顧客)										
1	3	2	2	3	日雇い	2500	家賃、日常の食費、教育費、電気代、水道代	ハマギギ、イケガツオ、スマ	3-5	42
2	3	4	3	2	3 輪自転車運搬 (lambreta)	2000	家賃、日常の食費、教育費、電気代、水道代	ハタ、ヨコシマサワラ	6-7	171 or 63
3	3	5	2	5	月給	3000	水道代、電気代、日常の食事代、教育費	ハマギギ、イケガツオ	4	42
4	3	-	1	1	無職	-	電気代、水道代、日常の食費	ハマギギ、イケガツオ、スマ	0.5-1	42
5	5	5	3	6	日雇い	2000	家賃、日常の食費、電気代、水道代	ハマギギ	1-5	42
6	2	3	2	3	無職	-	水道代、電気代、日常の食費	ハマギギ	1	42
7	-	20	-	-	不明	-	P 司祭連盟費、日常の食費	ハマギギ	2	120
8	4	4	5	3	公務員	1300	家賃、電気代、水道代、日常の食費	ハマギギ	3-4	42
9	4	3	3	2	公務員	1500	電気代、水道代、日常の食費、学校費	ハマギギ	2	42
10	2	3	3	1	-	-	家賃、電気代、水道代、日常の食費	ハマギギ	3-7	42
11	1	5	1	4	個人	1000	電気代、水道代、日常の食費	ハマギギ	2-3	42
12	3	3	2	4	日雇い	3000	家賃、日常の食費	ハマギギ	2	42
マルカト市場(その日魚を買っていなかった顧客)										
13	1	1	-	-	-	-	日常の食費	ハタ	3	-
14	1	1	1	-	月給	1000	家賃、電気代、水道代、日常の食費	ヨコシマサワラ、スマ	3	-
15	3	4	2	5	日雇い	1000	家賃、電気代、水道代、日常	-	5	-

							の食費			
16	2	2	2	2	公務員	1600	家賃、電気代、水道代、日常の食費	-	1-1.5	-
17	3	5	4	1	カイロ外交官, シーメンズ支配人	30000 Euro	日常の食費、軽油燃料、子供養育費	-	-	-
18	1	2	3	-	月給	1200-3200	日常の食費、大学教育費、水道代、電気代	-	-	-
EMPC (その日魚を買っていた顧客)										
19	4	3	2	5	日雇い	500-600		ヨコシマサワラ、カマス	0.5-1	171
20	3	1	2	-	軍俸給	500	家賃、電気代、水道代、日常の食費	ヨコシマサワラ	3	63
計	51	76	43	47				(平均 kg/人)	2.86	

マルカト市場と EMPC でインタビューを受けた顧客 20 人の世帯構成員は 127 人で、1 世帯あたり平均 6.35 人であった。このうち、女性が 60%、男性が 40%であった。そして、34%が若者（18～40 歳）、37%が未成年（0～17 歳）で、残りの 29%が 40 歳以上であった。

世帯の主な収入源は、公務員、日雇い労働者、月給労働者、支配人または個人労働者、軍人、3 輪自転車の運送業者であった。収入は、ドイツ在住の外交官・会社経営者で 3 万ユーロの収入を持つ 1 人を除いては、月 500～3,200 ナクファ、平均 1,596 ナクファであった。家計支出は主に家の家賃、毎日の食費、教育費、司祭連盟費、電気代、水道代であった。

アスマラで購入された人気の魚は、ハマギギ、スマ、イケガツオ、ヨコシマサワラ、ハタ、カマスで、購入者数はそれぞれ 11 人、3 人、3 人、2 人、2 人、1 人であった。購入した魚の量は、価格や種類によって一人当たり 0.5～7kg と幅があった。魚の価格は政府により決められ、1 等級が 63 ナクファ、2 等級が 42 ナクファ、切り身が 171 ナクファである。マルカトの店で購入された魚はほとんどが 2 等級であったが、EMPC の店では 1 等級であった。

(2) 魚食の習慣

下の表は、消費者の魚介類の加工方法、調理方法・者、魚食の頻度、魚介類の食習慣を示したものである。頭落し、内臓処理、切り身などの魚の加工は、魚の小売店の従業員が行っていた。インタビュー対象者のうち 2 名は自宅で塩干加工を実践していた。

表 2 - 15. アスマラにおける魚食の習慣

顧客	魚の加工			調理方法		調理者		魚食の頻度		魚介類食習慣
	日干し	塩干	燻製	調理法	食材	男性	女性	家庭	飲食店	
マルカト市場 (その日魚を買っていた顧客)										
1	×	×	×	ジグニ、揚げ物、時々ご飯と一緒に	ニンニク、玉ねぎ、黒胡椒、青胡椒	父	母	月 1-3 日、スマ、ボラ、イケガツオ、ハマギギ	×	No
2	×	×	×	ジグニ(胡椒有/無), 揚げ物、カツレツ.	ニンニク、黒胡椒、青胡椒	-	母	週 2-3 回、ハタ、スマ、ヨコシマサワラ	×	No
3	×	×	×	ジグニ、揚げ物、ご飯にフリタタ	ニンニク、黒胡椒、青胡椒、玉ねぎ、油、赤胡椒	父	母	月 1 回、イケガツオ	たまに、カツレツ	No
4	×	×	×	揚げ物、カツレツ	ニンニク、香料、青胡椒、黒胡椒、赤胡椒	-	母	月 2-3 日、イケガツオ	×	No
5	×	○	×	揚げ物、焼き物、時々ご飯と	ニンニク、黒胡椒、青胡椒、油、玉ねぎ	父	母	月 1 回、手に入ればもっと、ヨコシマサワラ、ハタ	マッサワで○、燻製魚も	No. May be in Massawa, shrimp.
6	×	×	×	レモンと水で洗って揚げ物、バターと小麦粉/パン粉でカツレツ	黒胡椒、ニンニク	-	母	たまに、ハマギギ	×	×
7	×	×	×	揚げ物、焼き物、卵に小麦粉/パン粉でカツレツ、フィンガー揚げ	ニンニク、青胡椒、トマト	-	母	たまに、スマ、ハマギギ	×	×
8	×	×	×	ジグニ、揚げ物とご飯	-	-	妻	手に入れば週 2 回	×	×
9	×	×	×	揚げ物	-	-	母	月 1 回	×、経済的理由	×
10	×	×	×	揚げ物、Mifa (@Anhanae レストラン) ヨコシマサワラとハタはニンニクと黒胡椒でオーブン	ニンニクと黒胡椒	父	母	手に入れば毎日	マッサワで○、@Mifa	エビ
11	×	×	×	ジグニ、揚げ物			母	月 1 回、ヨコシマサワラ	×	×
12	×	○	×	野菜と一緒に	ニンニク、玉ねぎ、胡椒	父	母	手に入れば毎日	×	ザリガニ
マルカト市場 (その日魚を買っていなかった顧客)										

13	×	×	×	揚げ物	黒胡椒、ニンニク		母	月 1-2 回	月 1 回	エビ
14	×	×	○切身で	揚げ物、魚の頭スープ、ジグニ	黒胡椒、ニンニク	父(自分)	-	月 1 回	×	海鳥の卵
15	×	×	×	ジグニ、揚げ物とご飯	ニンニク、ローズマリー、黒胡椒	-	母	月 1 回	×	×
16	×	×	×	揚げ物、ジグニ	ニンニク、黒胡椒		母	年に時々	×	×
17	×	×	×	カツレツ、揚げ物	香辛料のパックを購入	父	母(全家族)	たまに毎日､月1回は必ず	月 1 回	×
18	×	×	×	揚げ物、ジグニ	黒胡椒、パセリ、ローズマリー、ニンニク		母	遠い昔、魚があれば	たまに	×
EMPC(その日魚を買っていた顧客)										
19	×	×	×	サンドイッチ、カツレツ、揚げ物、ジグニ	ニンニク、黒胡椒、玉ねぎ、青胡椒、クミン	父	母	魚があれば、月 1-2 回､ヨコシマサワラ	×	肉より魚、けど高過ぎる
20	×	×	○切身で	揚げ物、ジグニ	黒胡椒、ニンニク、ロースマリー	-	母	魚があれば月 3 回	時々マッサワ○	○ Zurumbak(Voigea)

アスマラで聞き取り調査を行った 20 世帯のうち、12 世帯では母親のみ、8 世帯では両親共、1 世帯では父親のみが家庭で調理すると回答した。料理に使う食材は、にんにく、玉ねぎ、黒胡椒、青胡椒、油、赤胡椒、小麦粉、トマト、クミン、ローズマリー、パセリであった。家庭で調理された人気のある魚種は、スマ、ボラ、イケガツオ、ハマギギ、ハタ、ヨコシマサワラなどであった。

魚を食べる頻度の高い場所は以下のようになっている。55%の人が月に 1 ～ 3 回は魚を食べている。一方、レストランで魚を食べる習慣はないと回答した人が 7 割を占めた。

10%	15%	55%	20%
毎日	2-3 回/週	1-3 回/月	たまに

図 2 - 2：アスマラの家庭で魚を食べる頻度

(3) 顧客の満足度

下の表は、アスマラで入手可能な魚の量、質、価格に対する家庭消費者の回答を示したものである。

表 2 - 16. アスマラでの顧客満足度

顧客	魚の量	魚の質	魚の価格

マルカト市場 (その日魚を買っていた顧客)			
1	×	○	×、高価
2	×	×	×
3	○	○	×、非常に高い
4	×	○	×、非常に高い
5	×	×	×
6	○	○	○
7	×	○	×、非常に高い
8	×	○	×
9	×	×	○
10	×	○	×
11	×	○	○
12	×	×	×、非常に高い
マルカト市場 (その日魚を買っていなかった顧客)			
13	×	×	×
14	×	×	×、少し高い
15	×	○	×
16	×	○	×
17	○	○	×、非常に高い
18	×	○	×、非常に高い
EMPC (その日魚を買っていた顧客)			
19	○	○	非常に高い、特に切身
20	×	○	×
合計、○:×	4:16	14:6	3:17
%、○:×	20:80	70:30	15:85

魚の品質に満足している人の割合は 70%と多いが、供給量と魚の価格では、それぞれ 20%、15%にとどまっている。

(4) 顧客の意見

マルカト魚市場で魚を買っていた消費者は以下を推奨：

- 魚が手に入るのは毎週ではなく、毎日であること。
- 最近の市場で入手可能な魚のハマギギは顧客の第一選択ではないため、イケガツオ、ヨコシマサワラ、スマ、グルクマ、ヒメフエダイ、ハタ、ヒラアジの供給を増やすこと。
- 一夜限りの鮮魚（冷凍ではない）や加工魚（切り身）の供給と、一等級魚のみの供給ではないこと。
- テレビ・ラジオ・新聞等のマスメディアを通じた魚の加工・保存・調理方法の研修や実演。
- 零細漁民へ漁具を供給することで、市場の魚価の低下に大きく貢献すると思われる。

この日、マルカト魚市場で魚を買わなかった消費者からも要望があった。

- 自由流通によって、魚を手の届く価格に下げること。
- 顧客の好みの魚の供給を、最低毎日に増やすこと。
- 市場内や従業員の衛生状態の検査※。

(注 : 市の行政官によると、市場の場所を定期的に無作為に検査し、違反が確認された場合はペナルティを科しているとのこと)

3 - 3 アスマラの問題点とニーズ

アスマラでは、EriFish がマッサワから魚を運び、EMPC が 3 つの販売所にある政府認可の小売店に配送し、政府価格で販売している。マルカトと EMPC の 2 つの主要販売所にある 4 つの小売店での販売量は 1 日平均 6,000kg であったが、供給は隔週に限られており、1 日の平均販売量は 2 分の 1 と考えるべきである。インタビュー対象者の約半数が月に 1〜3 回魚を食べていると回答しており、1 世帯あたり平均 2.86kg の魚を購入している。8 割の顧客は市場の魚の量が限られていると不満を述べているところ、これはもっと増やせる可能性がある。

両市場でインタビューした人が改善を求めた主な課題は以下の通りであった。

(1) 魚の供給量・種類が限られており、毎日ではなく隔週日でマッサワから配達されている。
(2) 自由販売で価格を下げる必要がある。
(3) 小売店には、市場棟、保冷庫、排水設備、給水設備などのインフラ整備が必要である。
(4) また、魚の配送用の保冷車や水槽、大きさの異なるアイスボックス、冷蔵庫、冷凍庫、水産加工器材などの設備も必要とされている。
(5) マスメディアを利用した魚の加工方法や調理方法の研修、魚の消費に関する世間の認知度を上げてほしい。

4. メンデフェラの調査結果

メンデフェラは、アスマラから南に 60km のところに位置するデブブ（南）州の首都である。嘗てメンデフェラ市によって建設された魚市場があった。しかし最近、この魚市場は営業していない。この地域で消費されている魚は、マッサワの EriFish 社から供給されている海の魚である。淡水魚はまだ市場に出回っていない。

4 - 1 魚の流通

前述したように、メンデフェラの魚市場はほぼ閉鎖されており、魚は不定期に EriFish から供給され、彼らのトラックの上で売られている。人々は魚が必要になると、ほとんどの場合アスマラへ行っている。このため、メンデフェラにおける魚の流通に関するインタビュー調査は実施されなかった。

4 - 2 家庭での魚の消費

この調査は、2020 年 3 月 15 日にメンデフェラのエダガ・ベレーにて、10 世帯を無作為に抽出して実施したものである。調査チームは、調査票に沿ってインタビューを行い、その回答を以下に示す。

(1)世帯情報

世帯情報調査では、世帯規模、収入、支出、購入魚に着目した。その結果を下表に示す。

表 2 - 17. メンデフェラの世帯情報

顧客	世帯規模				収入源	収入額(ナクファ/月)	世帯支出項目	Fish purchased		
	男性	女性	青少年	幼年				魚種	量(kg)	値段(ナクファ/kg)
1	2	3	2	3	教員	900	家賃、食料費	イケガツオ、サバヒー	1	60
2	4	1	3	2	教員	2700	家賃、食料費	イケガツオ、サバヒー	1	60
3	2	3	2	3	教員	2600	家賃、食料費、電気代	イケガツオ、サバヒー	1	60
4	2	2	2	2	飲食店主	2000	家賃、食料費、燃料代	ヨコシマサワラ	1	171
5	5	4	9	-	店主	3000	家賃、食料費、燃料代	ヨコシマサワラ	1	120
6	2	1	2	1	商人	3000	電気代、水道代	ヨコシマサワラ	1	171
7	-	5	3	2	給仕婦	800	家賃、食料費	イケガツオ、サバヒー	1	40
8	2	4	5	1	給仕婦	1700	家賃、食料費	イケガツオ、サバヒー	1	60
9	3	3	3	3	マネージャー	2000	家賃、食料費、電気代	イケガツオ、サバヒー	1	60
10	1	1	2	-	ホテル経営	3000	原料費、電気代、燃料代	ヨコシマサワラ	1	171
合計	23	27	33	17				(平均 kg/人)	1.00	

メンデフェラの 10 人のインタビュー対象者の総世帯員数は 50 人で、1 世帯あたり平均 5.0 人であった。そのうち 46%が男性、54%が女性で、66%が若者（18〜40 歳）、34%が未成年（0〜17 歳）であった。

世帯の主な収入源は、教員、マネージャー、ホテル経営者、飲食店主、店主、商人、ウェイトレスなどの月給である。月給は 800〜3000 ナクファ、平均 2,170 ナクファであった。主な支出は、家賃、食料費、燃料代、水道代、電気代である。世帯が消費する魚種は、イケガツオ、サバヒー、ヨコシマサワラ（Derak）を丸ごとまたは切り身にしたものであった。

(2) 魚食の習慣

下の表は、インタビュー対象者の魚の加工、調理方法、調理者、魚を食べる頻度、魚介類を食べる習慣を示したものである。各家庭では、調理の前に頭落し、内臓処理、切り身、バター処理を行っていた。しかし、10 世帯中、天日干し、塩干し、燻製を行っている世帯はなかった。

表 2 - 18. メンデフェラの魚食の習慣

顧客	魚の加工			調理方法		調理者		魚食の頻度		魚介類食習慣
	日干し	塩干	燻製	調理法	食材	男性	女性	家庭	飲食店	
1	×	×	×	揚げ物	-		母	希に	×	×
2	×	×	×	揚げ物			母	年 2 回		○、他の魚
3	×	×	×	揚げ物	-		母	月 1 回	2 週間に 1 回	○、他の魚も
4	×	×	×	サンドイッチ	-		母	週 2 回		○
5	×	×	×	揚げ物	-		母	月 1 回		×
6	×	×	×	揚げ物、カツレツ、サンドイッチ、棒状揚げ物	-		母	週 2 回		○
7	×	×	×	サンドイッチ	-		母	希に	Rarely	○
8	×	×	×	揚げ物とシチュー	-		娘	半年 2 回		○
9	×	×	×	揚げ物、棒状揚げ物、カツレツ	-		母	半年 2 回		○
10	×	×	×	カツレツ	-		ホテル料理人	最低週 2 回	Min. twice a week	○

主な調理者は女性（母が 80%、娘が 10%と圧倒的に多い）、ホテル料理人が 10%となっており、女性か男性のどちらかであった。調理方法は、揚げ物が最も多く（70%）、残りはサンドイッチ、カツレツ、棒状揚げ物（Finger）、魚シチューであった。具体的な食材については言及していないが、一般的には油、玉ねぎ、トマト、塩などが使用されている。

家庭での魚食の頻度は以下の通りであった。3 割の人が週に 2 回は魚を食べている。7 割の人は外食で魚を食べる習慣はないが、残りの人は週に 1〜2 回、またはめったに食べないとのこと。

30% 2 回/週	20% 1 回/月	20% 4 回/年	10% 2/年	20% 希に

図 2 - 3：メンデフェラの家庭で魚を食べる頻度

(3) 顧客の満足度

魚の量、品質、価格における顧客の満足度調査の結果を以下の表に示した。

表 2 - 19. メンデフェラにおける顧客満足度

顧客	魚の量	魚の品質	魚の値段
1	×	×	×、非常に高価
2	×	×	×、非常に高価
3	×	×	×、非常に高価
4	×	○、最高	×、非常に高価
5	×	○	×、非常に高価
6	×	○	×、非常に高価
7	×	○	×、非常に高価
8	×	×	×、非常に高価
9	×	×	×、非常に高価
10	×	○	○
合計、○:×	0:10	5:5	1:9
%;、○:×	0:100	50:50	10:90

その結果から、市場での魚の量や価格には非常に否定的であり、いずれも市場での魚の入手率の低さを不満に思っていることがわかる。魚の品質については、満足度が 50%であった。

(4) 顧客の意見

メンデフェラの消費者は、市場に十分な魚の供給があることを求めている。また、ホテルやレストランを経営する際には、アスマラから魚を購入しているとのことである。彼らは、自分たちの地域でもっと多くの魚が手に入ることを強く願っている。また、魚の加工・消費に関する国民の意識向上も要望した。

4 - 3 メンデフェラの問題点とニーズ

今はメンデフェラの魚市場は閉鎖されており、魚は定期的に配達されるのではなく、不定期に EriFish の配送トラックで配達され、その上で販売されている。このような限られた状況下でも、インタビュー対象者の 3 割が週に 2 回、1 世帯あたり 1.0kg の魚を購入して食べていた。

メンデフェラでインタビューした人たちが改善を求めた主な課題は以下の通りであった。

(1) 魚はいつでも手に入るわけではない。EriFish のトラックが突然来て、それを見て人々は魚を買うことができる。

(2) しかもめったに配達されない魚は、牛肉や山羊の肉に比べて非常に高価である。

(3) レストランの経営者は魚が必要になると、アスマラまで走って魚を取りに行く。そのため、魚は傷みやすく、余計なコストが必要になる。

5. 魚の流通・消費調査の結論

魚の流通と消費において典型的な 3 つの都市でインタビューを行った 42 人の顧客の意見から、エリトリアの魚流通業者は、限られた配送システムや劣化した販売所という状況の中でも、消費者にとって満足のいく品質管理を維持していることが明らかになった。それ故に、顧客の 71%は小売店の魚の品質に満足している。魚の供給量や価格に不満を示す人が多い中、現状を受け入れている人はそれぞれ 31%、26%にとどまっている。ただ 3 都市の中でマッサワは例外的だった。それはマッサワが漁場に近いというだけではなく、エダガ露天魚市場という、行政の統制が少ない独自の売り場が存在しているからではないかと思われる。エダガ市場には解決すべき課題もあるが、そのシステムはマッサワ周辺の生存漁民のための市場としてよく機能している。

表 2 - 20. 代表的な 3 都市の顧客満足度

都市名	顧客の数	数量		品質		価格	
		○	×	○	×	○	×
マッサワ	12	75%	25%	92%	8%	58%	42%
アスマラ	20	20%	80%	70%	30%	15%	85%
メンデフェラ	10	0%	100%	50%	50%	10%	90%
平均		31%	69%	71%	29%	26%	74%

第３部：漁具と漁法

1. 調査方法

漁業活動に積極的に参加している漁業者にインタビューを行い、漁具や漁法のデータを収集した。漁民から得られた情報は、プロジェクトにより解決すべき課題としてまとめたデータシートに整理された。

漁具や漁法の調査は、2019 年 11 月 4 日から 8 日まで、漁民が獲った魚を販売している港町マッサワ（漁港当局とクトゥムヤ内）で行った。この調査では、適切な情報を得るためそれぞれの漁具や漁法に基づいた質問票を準備し、刺し網漁業、生存漁業および底延縄漁業に分類した。漁民へのインタビュー項目は以下の通りである。

表 3 - 1 漁具・漁法に関するインタビュー項目

対象	分類	質問項目
刺し網漁業 (零細漁業)	漁業の現状	漁船、エンジン、装備品、漁場、漁期、漁獲対象魚、販売と売り上げ、一航海の経費
	費用と支出	漁船の仕様、漁船とエンジンの購入価格、借入金、漁具費用、漁具の対応年数、航海/通信機器の費用、一航海の日数、一航海の経費、平均漁獲量と売上金、利益分配方法
	刺し網漁具のデザイン	刺網の種類、長さ、重量、縮結割合、浮子や沈子種類と数量、漁具の沈降力と浮力等
	問題と課題	刺網漁業を行う理由、紛争、漁具資材の問題、その他の問題、問題や課題の解決方法
生存漁業 (自給自足的漁業)	漁業の現状	漁場(海域、水深、海底質)、漁期、漁獲対象魚、漁具の仕様、操業時間と周期、漁獲後の取扱い、水揚げ場、漁況
	問題と課題	生存漁業を行う理由、紛争、漁具資材の問題、その他の問題、問題や課題の解決方法
底延縄漁業 (NFC 商業船)	漁業の現状	漁船、エンジン、装備品、漁場、漁期、漁獲対象魚、販売と売り上げ、一航海の経費、その他
	問題と課題	底延縄漁業を行う理由、漁業に関する紛争、漁具資材の問題、その他の問題

2. 刺し網漁業（零細漁業）

2 - 1 刺し網漁業の状況

北部紅海州の零細漁業の刺し網漁の状況を把握するために、8 名の漁民にインタビューを行った。これらの漁民には、個別に刺し網漁業の信頼性の高い情報提供を依頼し、聞き取り調査の結果をエクセルデータシートに整理した。

それによると、インタビューした漁民の船の大きさの分布は、No.4 マッサワの漁民が所有する最小 11 x 2 x 0.8m から、No.8 ダハラクの漁民が所有する最大 18.5 x 3.6 x 1.8m までの範囲であった。インタビューしたほとんどの漁船には、漁の効率を向上させるような専門的な道具は装備されていなかった。アイスクラッシャーを装備していた漁船は 1 隻のみであった。ほとんどの零細漁民は、ライフジャケットやライフリングなどの基本的な安全資材を装備していなかった。しかし、インタビューした 8 人のうち 6 人は、船上での事故に備えてシュノーケルとナイフを装備していた。また、インタビューを受けた漁民は全員、75 馬力のアウトボードエンジンか、33、35、60 馬力のヤンマー製インボードエンジンを搭載していた。

暑い時期には水深 20m～40m、寒い時期には水深 10m～20m で刺し網による漁を行っていた。漁獲量は寒い時期に多く、暑い時期とラマダンの祝日には少なくなっていた。漁場は Dahlak 諸島、特に Dhil, Madot, Mujedih, Dihil fadol, Nahleg, Isratu, Meserie Asarka, Hermil 周辺に集中していた。刺し網漁業で捕獲される魚種は、サワラ、カマス類、フエダイ類、フエフキダイ、サメ、スマ、イケガツオ、ヒラアジ類などであった。

Table 3-2 Results of fishing gear and method survey for Gillnet fishery (1)

No	Interviewee	Fishing boat				Engine	Auxiliary equipment	
	Community	Boat name/ID	Length, width, depth	Fishing equipment	Safety measure	Type, HP, maker	Mark buoy, anchor	Anchor rope (size, length etc.)
1	Gelalo	Al-muhajir; 40312/13	16m*3.5m*1.6m	NA	Knife,eye google	Out board (YAMAHA) /75HP	Hard plastic float, Anchor rope	70m to 100m length, around 50kg
2	Gelalo	Samaha/31323/12	9.25m*1.8m*0.55m	NA	snorkle, iron rod, knife	Out board (YAMAHA) /60HP	Mark buoy with light, anchor rope	Anchor for gill net, 10kg(w), 0.5m (L): For boat, 50kg(w), 2m (L)
3	Wekiro	Halibay-4	10.5m*3.3m*1.25m	NA	life jaket, snorkle, iron rod, knife	In board YANMAR (3piston), 33HP	Mark buoy, anchor rope	Anchor for gill net, 10kg(w), 0.5m (L): For boat, 30kg(w), 2m (L)
4	Massawa	Bisha	11m*2m*0.8m	NA	knife	Out board (YAMAHA) /75HP	Hard plastic float, Anchor rope	Anchor for gill net, 20kg(w), 1m (L): For boat, 5kg(w), 0.5m (L)
5	Dihil	Taj/31708	13m*2.18m*0.95m	NA	snorkle, knife	Out board (YAMAHA) /75HP	Hard plastic float, Anchor rope	Anchor for gill net, 7kg(w), 0.5m (L): For boat, 15kg(w), 1m (L),
6	Dihil	Albedil	15m*3.5m*1.25m	ice crusher	knife	Out board (YAMAHA) /75HP	Hard plastic float, Anchor rope	Anchor for gill net, 17kg(w), 1m (L): For boat, 35kg(w), 1.5m (L),
7	Derbushet	Dahlak/31315/12	12.25m*3m*1.75m	NA	Life jacket, snorkle, knife	In board YANMAR (3piston), 35HP	Hard plastic float, Anchor rope	Anchor for gill net, 15kg(w), 1m (L): For boat, 35kg(w), 1m (L),
8	Dahlak	Taiba/31815/2019	18.5m*3.60m*1.80 m	NA	snorkle, knife	Out board (YAMAHA) /75HP	Hard plastic float, Anchor rope	Anchor for gill net, 7kg(w), 1m (L): For boat, 15kg(w), 1m (L),

Table 3-3: Result of fishing gear and method survey for Gillnet fishery (2)

Inteviewee		fishing ground	Fishing season	Tartget	Fishing operation		Catches	Sales and catch	
No.	Community	Area, depth, bottom substrate	Each period of hot,cool season (by fish calendar)	Name of fish species	Setting time	Retrieving time	Handling/ Preserving	Landing site	Trends in catch
1	Gelalo	hot; 40m-60m cold;10m-20m	Dihil,Madot,Mujedeh,Jemhile,dahlak.	Spanish Makrel,Tuna,Grouper,Snaper,Shark,Barakuda	6:00pm-7:00pm	9:00pm - 11:00pm (1cycle 3 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
2	Gelalo	hot; 40m-60m cold;10m-20m	siniet, Asmoha, Gabi-hu, selaabay, Jenjebilo, Dihil, Dulanchibat, Nahlik, Dahlak archipelago	shark, grouper, snapper, baracuda, king fish, tuna, benito.	6:00pm-6:40pm	8:30pm - 9:30pm (1cycle 2 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
3	Wekiro	cool: 14m-16m	Gabi-hu, Dulfidol, Dulanchibat, Nahlik, Dahlak archipelago	Spanish Mackerel, baracuda, shark, coral reef fishes	6:00pm-7:00pm	9:00pm - 10:00pm (1cycle 2 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
4	Massawa	hot; 28m-40m cold;16m-17m	Dihil, Asarka, Madot, Dahlak archipelago	Spanish Mackerel, baracuda, shark, coral reef fishes	6:00pm-7:00pm	9:30pm - 10:30pm (1cycle 3 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
5	Dihil	hot; 24m-30m cold;10m-20m	Dihil, Asarka, Madot, Dahlak archipelago, Dulfidol, Hawatb, Segala, Gabi-Hu, Isratu.	Spanish Mackerel, shark, king fish	6:00pm-7:20pm	9:30pm - 10:30pm (1cycle 3 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
6	Dihil	hot; 28m-40m cold;10m-20m	Gabi-Hu, Isratu, Dihil, Asarka, Madot, Dahlak archipelago, Dulfidol, Hawatb, Segala,	Spanish Mackerel, baracuda, shark, coral reef fishes.	6:00pm-6:50pm	9:30pm - 10:30pm (1cycle 2 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
7	Derbushet	hot; 28m-40m cold;15m-20m	Isratu, Museri, Dihil, Asarka, Dahlak archipelago	Jack fish, Spanish Mackerel, baracuda, shark, coral reef fishes.	6:00pm-7:00pm	9:00pm - 10:00pm (1cycle 3 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig
8	Dahlak	hot; 20m-30m cold;10m-17m	Dihil, Asarka, Dahlak archipelago,, Isratu,Harmil.	Spanish Mackerel, baracuda, shark, coral reef fishes	6:00pm-7:00pm	9:00pm - 11:00pm (1cycle 2 hrs)	Splashing and rinsing with water, then preserving in insulated fish box filled with ice.	ERI Fish	Decreasig

Table 3-4: Result of fishing gear and method survey for Gillnet fishery (3)

Gill net fisher			Issue/Problem			How are the problem solved?	Remarks
No.	Community	what are the main reason for engaging gill net fishing?	Fisher conflict associated with gill net fishing?	Fishing gear and fishing equipments (Boat, Engine)	Other prblems		
1	Gelalo	Yet no any new fishing methods introduced to our area.	Not that much	No engine spare parts, no technical person for repairing and maintainance, no workshops	short life span for Gill net, the type of floats, sinkers and gill-nets are not quality	conflicts are solved by traditional law of the sea within the local community	Some spare parts are not available even with local market.
2	Gelalo	Yet no any new fishing methods introduced to our area.	Not that much	no technical person for repairing and maintainance, no workshops, no engine spare parts.	there is no second way of fishing.	assembling and mending of nets are done by the fishers.	there is no privately owned shops for marketing fishing materials.
3	Wekiro	Yet no any new fishing methods introduced to our area.	Not that much, unless few exceptions with industrial fishing vessels	no technical person for repairing and maintainance, no workshops, no engine spare parts.	there is no local markets for long line materials, short life span for gill net	the fishermen themselves repair and mend fishing gears.	Some spare parts are not available even with local market.
4	Massawa	Yet no any new fishing methods introduced to our area.	Not that much, unless few exceptions with industrial fishing vessels	No engine spare parts, no technical person for repairing and maintainance, no workshops	There is no more skills about other types of fishing equipments.	the fishermen themselves repair and mend fishing gears.	there is no privately owned shops for marketing fishing materials.
5	Dihil	There is no more skills about other types of fishing equipments.	Rear may it happen	No work shops for maintenance of fishing boats.	there is no local markets for long line materials, short life span for gill net	Traditionally the fisher man repaier their engines and their gill net by them self.	there is no sufficient materias for fishing equipments.
6	Dihil	their experience is more in gill net.	Some times conflict may happen with the industrial fishing vessels.	No quality gill net	there is no local markets for long line materials, short life span for gill net	They have little skills based on the repairing of gill net and engines.	The materials that purchuse in the shope are not qulity.
7	Derbushet	Yet no any new fishing methods introduced to our area.	Not that much, unless few exceptions with industrial fishing vessels	No engine spare parts, no technical person for repairing and maintainance, no workshops	Not sufficient materials in the lokal markets.	the fishermen themselves repair and mend fishing gears.	there is no privately owned shops for marketing fishing materials.
8	Dahlak	Yet no any new fishing methods introduced to our area.	Not that much, unless few exceptions with industrial fishing vessels	No engine spare parts, no technical person for repairing and maintainance, no workshops	Not sufficient materials in the lokal markets.	the fishermen themselves repair and mend fishing gears.	there is no privately owned shops for marketing fishing materials.

2 - 2 費用と支出および収入

上記で引用した 8 人の漁民に、漁業資本財（ボート、エンジン、漁具、レーダーや GPS などの他の設置された機器があれば）の費用についてヒアリングを行った。調査結果から、ボートの最大のコストは、30 年の予想寿命で ERN 500,000 を要した No.7 漁民によって所有されているボートだった。また、漁船の最小価格は、No.2 ゲラロ村の漁民が所有するボートで、40,000ERN しかなく、予想寿命は 30 年までであった。漁民はまた、エンジンのコストについても情報を提供するよう求められた結果、最小コストは 50,000ERN、最大エンジンコストは 200,000ERN であることが明らかになった。漁船は、5～30 組の刺し網漁具を搭載していた。漁具の価格は、漁具の品質や購入先によって、10,000～17,000ERN であった。漁具の寿命は 3 年から 10 年と様々である。漁師はすべてコンパスを使って航海をしていたが、中には GPS を搭載している者もいれば、携帯電話に GPS プログラムをインストールして漁場の位置を確認している者もいた。

漁船の情報に加えて、1 回の航海で消費した日数、燃料や潤滑油の量、食料品なども記録されている。これに関して、漁師は、船の大きさ、魚の入手可能性、海の天候に応じて、1 回の漁に 7 日から 18 日間を費やしていた。漁船は 1 回の漁で最低 200 リットルまたは最高 1,400 リットルの燃料を消費したため、漁 1 回の燃料費は 1 リットルあたり 30ERN の燃料価格で 6,000ERN から 42,000ERN の間であった。また、漁船の氷の消費量は、氷箱の大きさや漁の予想日数にも依存していた。インタビューによると、氷の最小支出は 2200ERN、最大支出は 10,000ERN であった。水と食料の支出は ERN 3,000～ERN 8,000 であった。漁船、エンジン、漁具のメンテナンスは毎回の漁の終わりに、または 3 ヶ月ごとに行われ、メンテナンスの総費用は 1 漁あたり 1,200ERN から 20,000ERN まで様々である。全体では、1 回の漁あたりの漁業活動の総支出は、15,087 ERN から 73,765 ERN まで、平均 42,954 ERN で変動した。

最後に、各魚種の漁獲量と単価を教えてもらい、得られる収入を計算した。漁獲量は漁師によってまちまちであった。平均的な漁獲量は、ハイシーズンで 700～5000kg、ローシーズンで 200～1500kg であった。最終的に、1kg あたりの平均価格を 30 ERN とし、ハイシーズンでは 21,000 ～150,000 ERN、ローシーズンでは 6,000 ～45,000 ERN の収入となる。最終的に純利益は 2 つに分け、まず半分はオーナーに、残り半分を全乗組員と船長で分ける。ただ、各乗組員は 1 人 1 人分、船長は 2 人分の取り分を得る。

Table 3-5: Result of fishing gear and method survey for Gillnet fishery (Cost & Expenditure) (1)

Interviwee		Fishing boat				Engine			Cost of gill-net gear			Other installed equipments	
No.	Community	Fishing boat (ID)	Boat type/Length/ width/depth	Price (ERN)	How many year does it last?	Type/ HP/maker	Price (ERN)	How many year does it last?	1 unit of completed net (ERN)	How many gears carry per trip?	How many year does it last?	GPS, compass, Echo sounder, VHF radio, others	Price (ERN)
1	Gelalo	Al-muhajir; 40312/13	16m*3.5m*1.6 m	134,000 ERN	About 30 years	Out board (YAMAHA) /75HP	116,00 0 ERN	about 15 years	14,000 ERN	30 units per trip	Up to 10 years	Compass,battery working GPS	NA
2	Gelalo	Samaha/3132 3/12	9.25m*1.8m*0 .55m	40,000E RN	Up to 30 years	Out board (YAMAHA) /60HP	60,000 ERN	about 20 years	10,000 ERN	20 units per trip	about 10 years	Compass, magelan GPS	NA
3	Wekiro	Halibay-4	10.5m*3.3m*1 .25m	70,000 ERN	More than 50 years	In board YANMAR (3piston), 33HP	80,000 ERN	about 30 years	13,000 ERN	10 units per trip	about 6 years	Compass, magelan GPS	NA
4	Massawa	Bisha	11m*2m*0.8m	60,000E RN	Up to 50 years	Out board (YAMAHA) /75HP	50,000 ERN	about 2 years	14,000 ERN	5 units per trip	about 3 years	Compass	NA
5	Dihil	Taj/31708	13m*2.18m*0. 95m	75,000E RN	Up to 20 years	Out board (YAMAHA) /75HP	110,00 0ERN	about 5 years	14,000 ERN	15 units per trip	about 13 years	Compass, mobile installed GPS	NA
6	Dihil	Albedil	15m*3.5m*1.2 5m	60,000E RN	Up to 15 years	Out board (YAMAHA) /75HP	50,000 ERN	about 7 years	16,000 ERN	20 units per trip	about 3 years	Compass, magelan GPS, mobile installed GPS.	NA
7	Derbushet	Taj/31708	13m*2.18m*0. 95m	500,000 ERN	Up to 30 years	In board YANMAR (3piston), 35HP	200,00 0 ERN	about 20 years	12,000 ERN	11 units per trip	about 5 years	Compass, mobile installed GPS	NA
8	Dahlak	Taiba/31815/ 2019	18.5m*3.60m* 1.80m	375,000E RN	Up to 30 years	Out board (YAMAHA) /75HP	116,00 0 ERN	about 10 years	17,000 ERN	30 units per trip	about 3 years	Compass	NA

Table 3-6: Result of fishing gear and method survey for Gillnet fishery (Cost & Expenditure) (2)

Interviewee		1 trip expense					Sales				Expenditure		Profit distribution system		
No	Community	How many days for 1 trip?	Fuel expense (ERN)	Lubricant expense (ERN)	Ice (ERN)	Food/ water (ERN)	Average catches(kg) in peak season	Average catches (kg) in low season	Total sales	Price per (kg)	Expense for 1trip	maintenance cost	Profit	Total distribution money (Owner, Captain, Crew)	Reserve fund
1	Gelalo	15-18 days	petrol: 900 liters *30 per ltr, cost 2,7000 ERN	45 ltrs*171 ERN/ltr, cost 7,695 ERN	250 blocks*36,cost 9000ERN	water 200 ,for food 7000-8000ERN	3 tonnes	1.5 tonnes	100,000-150,000 ERN	30ERN		3000 ERN		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
2	Gelalo	12 days	petrol: 360 liters *30 per ltr, cost 10,800 ERN	15 ltr *171 ERN/ltr cost,2,565 ERN	cost 2,304ERN	water 100ERN , for food 3,700 ERN	1.6 tonnes	8 quintals	30,000-50,000ERN	30ERN		1500 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
3	Wekiro	8 days	diesel: 200 liters*20 cost, 4,000ERN	20 ltr *171 ERN/ltr cost,3,420 ERN	2,880 kg, cost 3,420ERN	water 80ERN , for food 3,000ERN	1.5 tonnes	6 quintals	25,000-45,000ERN	30ERN		7,000 ERN for every 3 months		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
4	Massawa	7 days	petrol: 300 liters *30 per ltr, cost 9,000 ERN	20 ltr *171 ERN/ltr cost,3,420 ERN	cost 2,200ERN	water 80ERN , for food 3,000ERN	7 quintals	3 quintals	13,000-14,000ERN	30ERN		2,000 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
5	Dihil	15 days	petrol: 1,200 liters *30 per ltr, cost 32,000 ERN	40 ltr *171 ERN/ltr cost,6,840 ERN	cost 10,000 ERN	water 200ERN , for food 5,000ERN	5 tonnes	1.5 tonnes	100,000-150,000 ERN	30ERN		15,000 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
6	Dihil	10 days	petrol: 1,200 liters *30 per ltr, cost 36,000 ERN	15 ltr *171 ERN/ltr cost, 2,565 ERN	cost 7,000ERN	water 200ERN , for food 8,000ERN	5 tonnes	2 quintals	15,000-150,000 ERN	30ERN		20,000 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
7	Derbushet	15 days	diesel; 400 liters *20 per ltr, cost 8,000 ERN	20 ltr *171 ERN/ltr cost,3,420 ERN	cost 3,000ERN	water 100ERN , for food 8,000ERN	2 tonnes	4 quintals	12,000-60,000ERN	30ERN		1,200 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA
8	Dahlak	15 days	petrol: 1,400 liters *30 per ltr, cost 42,000 ERN	50 ltr *171 ERN/ltr cost,8,550 ERN	cost 2,688ERN	water 220ERN , for food 6,000ERN	5 tonnes	5 quintals	13,000-14,000ERN	30ERN		7,000 ERN in each trip.		50% to the owner, 50% divide by no. of crews + captain + 1 (the captain takes 2 shares, 1 share as crews & 1 share as captain)	NA

2 - 3 刺し網漁具の仕様

刺し網には、魚種ごとに異なる種類の刺し網が設計されていた。漁民が使用している刺し網は、一般的には「流し刺し網」と「旋刺し網」であった。本調査では、3 名の MMR 職員が網の詳細設計仕様調査を実施し、その結果を表 3-7 に示した。

Table 3-7: Result of fishing gear and method survey for Gillnet fishery (Gillnet specification)

	Type of gill-net	Netting specification	Net length(m)	Netting weight(g)	S.G of netting	Netting weight under water(g)	Sinker rope(m),PE	H.R (%)	Weight of a sinker	S.G of sinker	sinking force of a sinker(g)	Num. of sinkers(pcs.)	Total sinking force(kg)
1	Floating Gill net	PA multi. 210d/36 120mm x 70G x 169m	169	23000	1.14	2825	108	36%	547	1.65	215	26	**8.4**
2	Surrounding gill net	PA multi. 210d/36 110mm x 280G x 420m	420	276000	1.14	33895	294	30%	500	2	250	420	**138.9**
3	Floating Gill net	PA multi. 210d/36 110mm x 105G x 192m	192	35000	1.14	4298	120	38%	700	1.65	276	29	**12.3**

	Float rope(m),PE	H.R (%)	weight of a float(g)	S.G of float	Buoyancy of a float(g)	Num. of floats(pcs)	Total buoyancy of floats	Total weight of rope(g) PE	S.G of rope, PE	Total buoyancy of ropes (g)	Total buoyant force(kg)	Total buoyancy /Total sinking force
1	108	36%	73	0.2	292	47	13724	7700	0.95	405	**14.1**	0.60
2	256.5	39%	75.5	0.15	428	465	198942.5	73750	0.95	3882	**202.8**	0.68
3	120	38%	46	0.15	261	54	14076	8640	0.95	455	**14.5**	0.85

※ Netting specification 210d/36 (mesh size) x (Num. of meshes in depth) x (length of netting)

※ H.R : Hang-in ratio (%)　　※ S.G : Specific gravity

2 - 4 問題点とニーズ

刺し網漁師からは多くの問題点が指摘されている。それらは漁具のデザインや素材の品質などの技術的な問題、エンジンやモーターの修理の制約、市場の問題などに分類される。漁師は限られたスペアパーツしか持っておらず、エンジンの修理やメンテナンスの技術も不足していた。また、整備された作業場を持っていなかった。これらエンジンやスペアパーツの問題の他に、漁網やウキやシンカーなどの付属品の品質が悪く、寿命も短く、網目の大きさも十分ではない。漁師は、効率的な代替漁法を実行するための技術にも疎い。また、プロジェクトの専門家の見解として、暑い時期に使用される旋刺網の資材が重く非効率であった。深海に到達するために 3 つの網が垂直に接続されているため、網の総重量が重くなり

取り扱いが難しくなるだけでなく、漁獲率が低下するという問題があった。

3. 生存漁業（自給自足的漁業）

3 - 1 生存漁業の状況

生存漁業は最もシンプルな漁法である。生存漁民は動力船を所有しておらず、小型カヌーや素足で海岸から遠くないところまで漁に出ている。この漁法は一日漁と呼ばれている。漁師の多くは漁獲物を保存するための氷を使用していない。彼らは夕方に網をセットし、早朝に網を回収している。刺し網を使い、主にボラを獲っていた。また、手釣り漁具を使ってグルクマやハタ、フエダイ類、ホシミゾイサキ、フエフキダイ、ニザダイ類などの珊瑚礁の魚を獲っていた。

2019 年 11 月 12 日、MMR 北紅海支部で生存漁業の状況を把握するために 3 名の生存漁民に聞き取り調査を行った。生存漁業は、マッサワ、ヒルギゴ湾、シェイク・シエド島周辺の水深１ｍから２０ｍまでの所で周年操業が行われていた。漁の頻度は、手釣りは毎日、刺し網を使用する場合は１日おきである。

3 - 2 問題点とニーズ

マッサワの 3 人の生存漁民に、刺し網漁に関連した争いがあるかどうかを質問した。1 人の漁師はスペースの奪い合いがあると答え、他の 2 人の漁師は生存漁業に関連した争いはないと答えた。しかしながら、漁師は漁具や機材に関連した問題を抱えていた。エンジンやボートを購入することができず、漁網、釣り糸、カヌー、ウキ、錘などの漁具も不足している。加えて、漁業資本材のコストが高い。その他の問題点としては、漁場が海岸から遠いこと、漁具をレンタルするための費用がかさむこと、漁具の小売店がないことなどであった。他方、エリトリア人社会の魚食習慣の乏しさも、マッサワの生存漁業に関連した問題といえる。

Table 3-8: Result of fishing gear and method for Foot fisheries (1)

Inteviewee		Fishing ground	Fishing season	Tartget	Gill net fishing gear	Fishing operation		Catches		Sales and catch	
No.	Community	Area, depth, bottom substrate	Each period of hot,cool season (by fish calendar)	Name of fish species	Main line material, line, size and length	Setting time	Retrieving time	Operation cycle (from setting procedure)	Handling/ Preserving	Landing site	Trends in catch
1	Massawa	Around Sheeik sied Island, 1m-3m, in coral area (hand line), in clay area (gill net)	They fishes in both hot and cold seasons.	By gill net; (Mulet, Jack fish, S.grant,) by hand line; (Emperer, Grouper, Snapper)	Hook Number 5, line number 0.4mm monofilament nylon	Handline 3:00 P.M for gill net 5:00 P.M	Handline 6:00A.M gill net 5:00 P.M 6:00A.M		Ice and fish hold	Around kutumya selling to the community, restauarants and local market	Decreasing
2	Massawa	1 meters depth, Sundy and muddy bottom where no coral is available	High season from September to June Low Season no fishing at all	Mullet,Jack and trevalleys, milk fish, indian mackerel,	Gill net, Hook and line	No moon high tide, from 6:00 P.M -12:00 A.M	Retrieving time after two hours	First week daily and Second Week for every other day cylcle	Ice and fish hold	Around kutumya selling to the community, restauarants and local market	Decreasing
3	Massawa	It depends on the gill net length, if the length of the gill net is 2 meters he deploys at a depth of 1.5 meters if it is 5 meters he deploys at 5 meters deep. Coralline bottom, sandy bottom, Hook and line from 20 up to 30 meters deep	Through out the year, mostly active from October to April	Emperor, Grouper, Snapper,Grunt, Barracudas, Parrot fish, Jack, Indian Mackerel, Mullet, Rabbet Fish.	Gill net, Hook and line(6cm thickness)	High tide, 6:00 P.M-3:00 A.M depends on the Availablity of Ice for preservation	After 3 hours of setting time	Gill net fishing for every three days, Hook and line daily	Ice and fish hold	Around kutumya selling to the community, restauarants and local market	Decreasing

Table 3-9: Result of fishing gear and method for Foot fisheries (2)

Interviewee		Foot Fishery	Issue/Problem			How are the problem solved?	Remarks
No.	Community	what are the main reason for engaging gill net fishing?	Fisher conflict associated with gill net fishing?	Fishing gear and fishing equipment (Boat, Engine)	Other problems		
1	Massawa	To support his family interms of food, and source employment and capital	There is conflict among foot fishers because of competion for fishingground	Shortage of gill net, Cost of gill net is very high, Short life span of the gill net. In case of handline shortage of hooks and baits.	The fishing ground is sometimes so far from the coastal area, that they spent more money to rent gill net and boat	They try to solve the problem by renting fishing gear and then they share the profit among themselves.	
2	Massawa	Because they don't have enough materials to work with other fishing gear	No conflict associated with gill net fishing	They don't have boat and engine He don't have proplem of purchasing gill net, because he is supplied by the Ministry	Shortage of retailing shops, fishing eating behavior of the society is very	Awarness campaign to increase fish eating habit of the community, Supply of fishing input should be increased	
3	Massawa	Hoby	No conflict associated with gill net fishing	Shortage of fishing gear, such as gill net, hook, line sinker and float.	He don't have canoes	Group in to cooprative so that they can get support from the Ministry of Marine Resources	

4. 底延縄漁業

4 - 1 底延縄漁業の状況

マッサワを漁業基地とする零細漁船の一部が餌魚となる小型魚を入手できた際に底延縄漁業が行われている。刺し網漁業と比べて資材購入費も安く漁獲効率も高いが餌魚の入手が難しいことから操業船への調査は出来なかった。ただ、零細漁民への聞き取り調査から小型底延縄漁業への期待は高い印象を受けた。

幸い、11 月 8 日に NFC (National Fisheries Cooperation)の協力により同公社が所有している 20～30 トンクラスの底延縄漁船の操業状況調査を実施することができた。操業は、油圧のリール式マグロはえ縄用リール(PA モノフィラメント幹縄)に枝縄をハンガースナップで取り付ける方法で行っている。漁獲される魚種は、ハタ、フエダイ、ハマギギ、ロウニンアジ、サメなどで主に底魚を狙って周年操業を行っている。漁場やその他の情報など調査結果は、表 3-10～3-12 に示した。

4 - 2 問題点とニーズ

調査した NFC 所属船は、餌の入手が比較的容易であると思われる。一方、零細漁業者の多くが餌魚の入手が難しいと話していた。漁港には漁業者が自由に使える餌魚を保存しておく施設もないことから、今後の零細漁業者への小型底延縄漁業普及には、餌魚の安定的な確保体制が課題となる。

エリトリアの紅海域では、酷暑期に海面近くの水温が上昇しその為に魚群が深い水深の海域に移動する。小型底延縄漁業は餌魚の入手難という解決すべき課題があるが、酷暑期における漁業生産に対応できない漁業者にとって有効な漁業と考えられる。

Table 3-10: Long -line fishery survey in Eritrea (1)

No	Fishing boat					Engine	Auxiliary equipments	Longline Fishing Gear		
	Boat name/ID	Length, width, depth	Fishing equipments	Navigational Instruments	Safety measure	Type, HP, maker	Mark buoy, anchor	Main line (material, line size, length)	Branch line (line size, length)	Interval of branch line
1	Vasco	18.3m*5.6m*1.6m	Trawler and long-line (multisystem fishing), hydraulic-hauling machine	GPS, Compass, Eco-sounder, VHF-radio (idle)	life ring, life jaket, knife, fire extingusher, snorkel	Cater-pillar, 400HP, 1800RPM, speed 10-12 nautical miles/hour	Mark buoy and chained anchor	Nylon mono main line, 10mm diameter, 3.5 up to 5 miles	1.5m in length, 2.5mm in diameter	3m up to 6m
2	Vasco	18.3m*5.6m*1.6m	Long-line, hydraulic-hauling machine	GPS, Compass, Eco-sounder, VHF-radio (idle)	life ring, life jaket, knife, fire extingusher, snorkel	Cater-pillar, 400HP, 1800RPM, speed 10-12 nautical miles/hour	Mark buoy and chained anchor	Nylon mono main line, 10mm diameter, 3.5 up to 5 miles	1.5m in length, 2.5mm in diameter	3m up to 6m
	※ Boat photos(deck, engine, boat)			※ Fishing ground indication on chart			※ Mark buoy, anchor rope structure diagram			

Table 3-11: Long-line fishery survey in Eritrea (2)

No	fishing ground	Fishing season	Tartget	Fishing operation		Catches		Sales and catch	
	Area, depth, bottom substrate	Each period of hot,cool season (by fish calendar)	Name of fish species	Setting time	Retrieving time	Average Catches in peak season	Average Catches in low season	Landing site	Trends in catch
1	**Hot season:** deeper fishing ground, >30m; **Cool season:** 20m-30m	Mostly around Dehil, Asrato, Siniet, Amnamagus, Hawakil, Dulfidol,	**Trawler Fishing:** shrimps, squids, crabs **Long-line |Fishing:** queen fish, cat fish, jack fish, copia, sharks, coral reef fishes	Longline: the set-up time is 1 hour at any time as per the fishing ground during the day	2-3 hours to retrieve the lonline and collect the fishes	5.5 tonnes	2-2.5 tonnes	Eri-fish	Gradually decreasing
2	**Hot season:** deeper fishing ground, >30m; **Cool season:** 20m-30m	Mostly around Dehil, Asrato, Siniet, Amnamagus, Hawakil, Dulfidol,	Long-line |Fishing: queen fish, cat fish, jack fish, copia, sharks, coral reef fishes	Longline: the set-up time is 1 hour at any time as per the fishing ground during the day	2-3 hours to retrieve the lonline and collect the fishes	5 upto 6 tonnes	2 tonnes	Eri-fish	Gradually decreasing

Table 3-12: Long-line fishery survey in Eritrea (3)

No	1 trip expense						Issue/Problem			Remarks
	Num. of fishers on board	How many days for 1 trip?	Fuel expense （ERN)	Ice (ERN)	Food/ water (ERN)	Other Expenditure	what are the main reasons for engaging Long-line fishing?	Fishers conflicts associated with long-line fishing	Issue/probrem associated with long-line (material. Boat. Engine. Etc)	
1	8 Fishers	7 days	**Longline:** 1,800 litres*20 ERN, Costs; 36,000 ERN **Trawler:** 3,500 litres*20 ERN Costs; 70,000 ERN	Both block & flake ice: "Longline; 3,500 kg costs 4,000 ERN" Trawler; 5,000 kg costs 6,000 ERN	Fresh water 210 ERN, For food 3,000 ERN		The fishing vessels are designed for long line fishing activities	Rarely with foreign fishing vessels	severance of main & branch lines, the aft and ahead movement destructs pumps of the engine	
2	8 Fishers	8 days	**longline:** 2,000 litres*20 ERN, Costs; 40,000 ERN	Longline; 160 blocks of ice costs 4,000 ERN	Fresh water 200 ERN, For food 3,000 ERN	Bait cost 4,000 ERN	The fishing vessels are designed for long line fishing activities	Rarely with foreign fishing vessels	severance of main & branch lines, the aft and ahead movement destructs pumps of the engine	

2. Technical Report Current Situation, Issues and Constraints of the Coastal Fisheries in Eritrea

TECHNICAL REPORT

CURRENT SITUATION, ISSUES AND CONSTRAINTS OF THE COASTAL FISHERIES IN ERITREA

The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development

15th of March, 2023

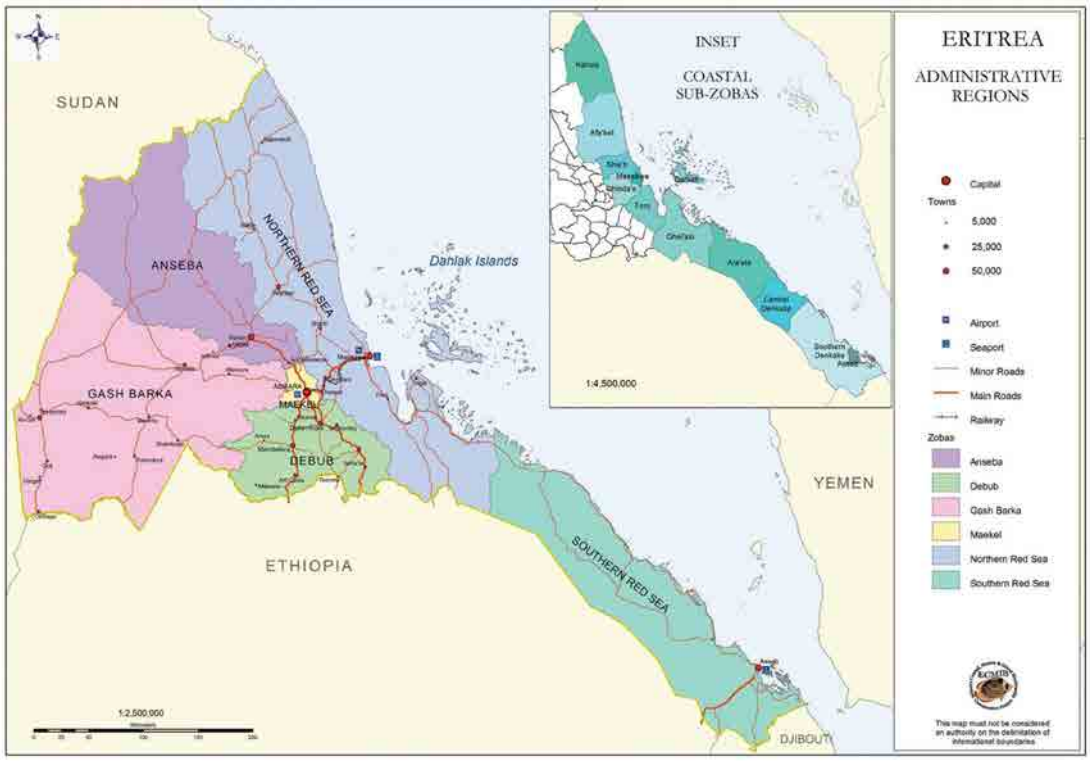
Ministry of Marine Resources, the State of Eritrea

Supported by

Japan International Cooperation Agency

Prepared by: Kidane Berhane

Member of PMU



Map of Eritrea: Administrative divisions of Eritrea

(Source: Edited by Dr. Alain Jeudy de Grissac and Kaleab Negussie, Eritrea's Coastal Marine and Island Biodiversity Conservation Project, Printed in December 2007)

Abbreviations and Acronyms

EEZ	Exclusive Economic Zone
EMPC	Eritrean Marine Products Company
ERN	Eritrean Nakfa
FAO	Food and Agriculture Organization of the United Nations
FRP	Fiberglass Reinforced Plastic
FSS	Food Security Strategy
GIS	Geographic Information System
JICA	Japan International Cooperation Agency
MMR	Ministry of Marine Resources
NFC	The National Fisheries Corporation
PMU	Project Management Unit

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INTRODUCTION

This Technical Report is prepared for the purpose of providing basic information to establish "The Technical Guidelines of the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea" that to contribute sustainable coastal fisheries development of Eritrea under the "Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development in the State of Eritrea (FSPAC)" that implemented by the Ministry of Marine Recourses (MMR) and Japan International Cooperation Agency (JICA) since October 2019.

The Technical Report is composed of three chapters that "Chapter 1. Current Situations and Overview of The Coastal Fisheries", "Chapter 2. Issues and Constraints of Coastal Fisheries Development" and "Chapter 3. Challenges to Solve Issues and Constraints". The first chapter depicts the overview of the Eritrean Red Sea coast, state of the typical fisheries communities, coastal fisheries productions, fishing gears and methods, distribution and consumption of fisheries products and others. The second chapter analyze problems and constraints of coastal fisheries development for both of the artisanal fishery and subsistence fishery from the survey results by FSPAC project and any relevant information of MMR. Particularly, the issues and constraints facing by coastal communities of Hirgigo, Zula and Dehil are grasped by baseline survey and problem analysis of FSPAC. The third chapter include to arrange necessary challenges to solve the issues and constraints which are found in chapter 2.

Results of analysis and information all mentioned above shall be important and basic materials to draw up "The Technical Guidelines of the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea". The challenges to solve issues and constraints which are found in this Technical Report will be examined carefully and going to be used for developing the practical approaches of the Technical Guidelines.

CHAPTER 1: CURRENT SITUATIONS OF THE COASTAL FISHERIES

1.1 Eritrean Red Sea Coast

Eritrea is situated on the horn of Africa in a strategic position along the coast of the Red Sea. Eritrea's exclusive economic zone (EEZ) covers 120,000km^2 of the Red Sea with a mainland and islands coastline more than 3,300 km in length, stretching from Djibouti in the south to the Sudanese boarder in the north. The continental shelf surface is approximately 55,000km^2. Over 350 offshore islands lie within the EEZ. The main area of coral reef, sea grass and sandy bottom surrounds the islands of the Dahlak Archipelago. The main sources of nutrients and organic matter in the coastal waters are the seasonal rivers which flow through the wades which carrying soil and other organic matter to the sea, supporting the productivity of the marine resources. The northern coastline is sand deserts and salt marshes and southern coastline is arid and desert-like, consisting mostly of volcanic rock-stream desert wastes. Wind directions and strength vary according to the seasons: from November to April south to southern easterly winds is predominant and from July to November frequent sandstorms are observed which adversely affect the activities of the artisanal fishers. Climatically the coastal area is arid or semi-arid with temperatures ranging from 32^{o}C to 45^{o}C during hot months and 22^{o}C to 32^{o}C during cool months. The average water temperature is 18^{o}C-21^{o}C in cool months and 21^{o}C-26^{o}C in hot months. In spite of its economic and historical importance, because of the arid climates, lack of fresh water resources and inhospitable environmental conditions, the coastal area population is very small.

1.1.1 General Outlook of the Coastal Fisheries

The Eritrean Red Sea coastal areas are more conducive to artisanal fishing than to industrial fishing. This is because of the extensive coral reefs and shallow waters which characterize the fishing grounds around the islands and much of the extended coastal area, limiting opportunities for the use of bottom trawls. The fishing zones have been mapped for the Eritrean artisanal fishery. By 2011, there were a total of 54 fishing villages recognized, distributed in the Zoba Northern Red Sea (17) and Zoba Southern Red Sea (37). The artisanal fishers population those who are involved only in fishing activities, are small in number. These fishers are scattered along the shoreline of the mainland and the islands. The fishing vessels used by the fishers vary in terms of size and type. Usually the fishing operations are mainly carried out using the two different types of wooden boats (Houris and Sambuks). Most of the Artisanal fishers operate traditional boats, of which 80% are Houris and 9% Sambuk boat types; there are also 11% fibreglass reinforced plastic boats, which are operated by few Fishers. Fiberglass boats are newly introduced medium sized boats made of fiberglass material and used for all types of artisanal fishing. Besides there are foot fishers (including women and children) who utilise hooks and mullet gillnets mainly for subsistence fishing.

Canoe: This is a small plank built canoe with flat bottom and vertical sides. It is a non-motorized boat normally paddled by one man. Canoes are generally used for transferring people from shallow water to the anchored Houris or Sambuks and to some extent like in Massawa are also used by some fishers for day fishing near the shore.



Figure 1: Canoe

Houri: Medium sized wooden boats with open deck and cut off stern that enables the use of one or two outboard engines. Houris typical size measuring 4-13m long with an outboard engine and catching on average 16.5 tons of fish per year. The outboard engine is powered by petrol with an average power of 40HP. Crews are 5 up to 9 persons for line fishing and gillnetting. These boats normally undertake fishing expeditions lasting 6-12 days per trip.



Figure 2: Houri

Sambuk: The Sambuk is a locally built traditional boat. The shape of the hull is pointed and high in bow and stern which makes it a good boat for hard weather conditions in the Red Sea. The boat has a good carrying capacity and ample space for gear and crew. Average dimensions are 20m x4m and they are powered with an inboard engine with an average power of 30HP. Crews include up to 20 persons involved in line fishing and gillnetting.



Figure 3: Sambuk

1.1.2 The Coastal Fishing Communities of Hirgigo, Zula and Dehil (Island)

The fishing communities around Massawa Hirgigo village (Massawa sub-Zoba), Zula village (Foro sub-Zoba), and Dehil Island (Dahlak sub-Zoba) are small-scale fishers, subsistence traders and other small business owners. These coastal communities have the limited infrastructure and difficulties of life, keep their traditional way-of-life and many continue to adhere to strict tribal laws and traditions. Nature is respected and water is carefully conserved (particularly in the island villages) due to its scarcity. Women are mainly involved in indoor activities (cooking, washing, fetching potable water, collecting fuel and caring for children), although some women also practice foot fishing for household consumption. The situation of the fishing communities in the villages mentioned above looks like as follows.

i. Hirgigo Village

The village of Hirgigo has a population of about 2,000 people and 466 households. The main sources of income are agriculture and fishing (artisanal fishing) using fishing boats based in Massawa fishing port. Fisheries infrastructures such as markets and landing facilities have not been developed. The fisheries operated in the village are hand line fishing for Indian mackerel and other small fishes and small gillnet fishing for mainly mullet in the shallow waters of the foreshore, and both of which are classified as the subsistence fishery. No one owns a fishing boat, but they fish by hand using floating gear made of polystyrene boards wrapped in bags and reinforced with ropes. During the good fishing season, the fishers focus on small fish such as Indian mackerel, scads, and small snapper in shallow fishing grounds, while during the hot season, when the sea surface water temperature is high, they target larger fish such as trevallies, groupers, and barracuda in slightly deeper fishing grounds. The gillnet fishing is conducted throughout the year within the depth range of the standing water, using small mesh nets during the hot season (June to September) and slightly larger mesh nets during the peak fishing season (October to May).

There are about 50 people engaged in the subsistence fishing, 16 of who belong to the Hirgigo Fishery Cooperative. Most of them are mainly engaged in hand line fishing, and only a few own gillnet. The main problems identified are difficulty in obtaining fishing gear and materials, inadequate facilities for fish processing to keep quality, and difficulty in accessing markets. There is also a women's association for repairing and making fishing nets in Hirgigo, which has 40 members who have been trained by the MMR to repair and make fishing nets. At present, however, there is almost no activity.



Figure 4: View of Hirgigo village

As per the survey conducted in 2019, most of the catches are sold at the market in Massawa, where the fish price is estimated to be 20-30 ERN/kg and the fishing income is about 6,000-30,000 ERN/year. On the other hand, fishing expenditure, including transportation cost to the market, costs 4,000 to 8,500 ERN, thus the profit is very small. In general, household expenditure is estimated to be 1,500-3,000 ERN per month, and most of the household depends on non-fishing income such as charcoal production, agriculture, and livestock, etc.

ii. Zula Village

Zula village is in Foro sub-Zoba, Northern Red Sea Zoba, about 56 km south of Massawa. It is a village of 650 households with a population of 3,250 whose main livings are fisheries, agriculture, and livestock farming. The fisheries structure is similar to that of Hirgigo village, and the fishery operated in the village is the subsistence fishing of hand line and small gillnets, without the use of fishing boats. There are about 50 subsistence fishers and fisheries infrastructure such as landing sites and processing facilities are not yet developed, and there is no customary fisheries management system.

A Zula fishery cooperative has been organized with 40 subsistence fishers, but no concrete activities have been carried out as a cooperative yet, and no financial or technical support has been provided by the MMR because no clear plan has been formulated. As for the problems related to the fishery production and sales, it was pointed out that there is a shortage of fishing gear and materials, ice is not available to maintain the quality of the catches, and there is no market and consumer demand for fishery products in the village is low. So, they want to sell their catches in Foro, the center of the region, but there are limited means of transportation and sales. In addition, a cooperative for the repair and manufacture of fishing nets in Zula village has been established for women, as in the village of Hirgigo, but many members have not had the opportunity to receive technical training.



Figure 5: View of Zula village

The catches are sold in the village and in Foro. Fishing income is estimated to be about 7,000-27,000 ERN/year, while fishing expenditure is estimated to average 5,200 ERN/year, making fishing income negligible. Household expenditures range from 1,500 to 3,000 ERN per month, and it is still difficult to support a household with only fishing income.

iii. Dehil Island

Dehil Island is one of the few inhabited islands in the Dahlak Archipelago, located about 32 km off the coast of Massawa, with a population of about 600 people and 90 households. The island's main income source is fishing, unlike the two villages mentioned above, and it has a fishing structure based mainly on the artisanal fishing with fishing boats. After landing in Massawa, the fishers load ice, drinking water, food, and daily necessities for consumption in the island onto their boats, and return to the island where they drop off their daily necessities before heading out to sea. Most of the fishing boats are Houri type. The main fishing methods are driftnets, surrounding gillnets with fish aggregating lights, and hand-line fishing, as well as the traditional trolling line “Majruur”. The main fishing methods during the peak fishing season (October to May) are driftnets and hand-line fishing, and surrounding gillnets during the hot season (June to September). The main target fish species are Spanish mackerel, queenfish, barracuda, trevallies, sharks, snapper, and groupers. The fishing grounds are widely located in the waters around the Dahlak Islands, but during the hot season, fishers avoid traveling long distances and concentrate around Dehil Island.

The artisanal fishers and boats belong to the fishery cooperative in Massawa, while the Dehil Fishery Cooperative is organized for the subsistence fishing for the islanders and the Dehil Shellfish Collecting Cooperative for women. The fishery cooperatives are expected to be recipients of government loan support to alleviate shortages of fishing gears and materials and to improve access to markets. However, these cooperatives have been in existence for a short period of time, but yet no concrete activities had been undertaken.

The fishing boat of artisanal fishery had 6-24 fishing trips per year (average 12.5 trips), 5-15 days of operation per trip, and monthly per capita income of 400 - 31,500 ERN. Fishing household income, including non-fishing income, ranges from 1,100 to 15,000 ERN per month, and household expenditure ranges from 1,200 to 11,000 ERN per month, with some households having negative household income. There is no drinking water on the island, and the environment is too harsh for agriculture and livestock farming, so little subsistence production is possible.



Figure 6: Dehil Island

1.1.3 Structure of Fisheries Production

The Government has designated official fish landing sites along the coast where fish is collected by NFC, although subsistence fishers also land fish in other locations. The designated landing sites are; Massawa (Ghibi), Massawa (Erifish), Dahlak, Gelalo, Assab, Tio, Eddi, and Barasole. Other smaller landing sites exist, some which are under construction or being considered for possible development. The cold chain of fish production and market linkages is fully supported by the NFC through its subsidiaries Beilul Fishing Company, the Eritrean Marine Products Company (EMPC), the Erifish Processing Plant, the Tio Fish Collecting Plant and the Assab Processing Plant. Erifish plant has the capacity to process 15 tonnes of fish and 4 tonnes of shrimp per day. It has two blast freezing machines and a large cold storage unit which can hold up to 250 tonnes of fish. EMPC Asmara has the capacity to process 10 tonnes of fish per day. The main products of Erifish and EMPC include fresh fillet (skin-on, skinless or steak fish) and whole fresh fish (whole round or whole gutted). Beilul Fishing Company mainly produces fresh fish products, most of which it sells to the government owned buying firms though smaller amounts are sold to licensed fish retailers. For the dry fish production and market linkages the only major institutional player is a government entity based in Massawa which produces fishmeal from small pelagic fishes.

Based on the catch per trip for 5-9 days for Houri and 6-12 days for Sambuk, the maximum and minimum catches were estimated at between 60 to 140 kg per day and 88 to 160 per day respectively. Beside the artisanal fishers which mainly work in the inshore areas, there is also fishing with industrial and semi-industrial vessels operating in offshore areas. These fishing trawlers operate mostly in the northern fishing zones (northeast of Dahlak Archipelago, North

of Norah Island, and east of Massawa), central fishing zones (bordering near Tio and extending northwards) and southern fishing zones (north of Assab). The foreign fishing vessels (industrial) are not in operation every year as the number of licenses administered is reviewed seasonally.

1.2 Fishing Gears and Methods

Gill net is one of the most popular fishing methods in Eritrea and other commonly practiced fishing techniques are use of beach seines, hand lines, and to some extent long lining. The artisanal fishers mainly uses hook and line, gillnet or a combination of both types at the same time. Most of the foot fishers operate with hand-line and mullet gillnets mainly for subsistence fishing.

Artisanal fishers use passive fishing gears to catch fish at sea. Fishing boats are normally equipped with multi-purpose fishing gears such as gill nets that can stretch up to 1000 meters by distance and 8-12 meters by depth from the surface of the sea. In addition, the whole crew carries on hand lining of fish till the nets catch fish (3-5 hours). All fishing activities at sea are done by hand and it requires very strong labor force. To drag the wet nets with fish against the drift of the sea is not an easy task to the fishermen. In most cases fishermen combine two methods of fishing gears like gill nets and hand lines. The average number of nets in use in one boat is 10 to 20 pieces; larger boats could use up to 30. The fishermen lack modern supporting fishing technologies, such as Echo Sounder, GIS, Fish Finder, Map Plotter and Radio Communication, which are vital in facilitating fishing activities for higher production.

The nets are used to catch large pelagic such as sharks, spanish mackerel, queenfish and tuna whereas handlines are used for high value reef fishes like groupers. There are two types of gillnet fisheries; driftnets and surrounding gillnets. Drift gillnets are mainly operated during the cool fishing season, and surrounding gillnets, which are operated at night during the hot season using fish aggregating lights. The sea depth range of the driftnet is about 10 to 20 meters, while the surrounding is about 20 to 40 meters. The main catches using these nets are spanish mackerel, skipjack, tunas, sharks, barracuda, and queen fish. There are also many snappers, emperor and trevallies that are probably caught by the hand line fishing method operated at the same time.



Figure 7: Gillnets and landings of artisanal fishing boat

1.2.1 Drift gillnet

Drift gillnets are among the commonly used fishing nets by the artisanal fishers. It has been the dominant fishing practice, because it seeks low initial investment and can easily be operated manually. However, since drift gillnets used by the fishers are manually operated, which is a labor intensive, fish catching efficiency is low. The factors that lowers the relative catch efficiency of the traditional drift gillnet are;

- The nature of the twine is multifilament which is thicker, so the probability of fish catch is low
- The color and thicker twine make high visibility which can easily be detected by the fishes and it is difficult to use such type of gillnets during full moon.
- Moreover traditional drift gillnets are not light to operate large number of crews are engaged to operate a few number of gillnets.

1.2.2 Encircling gillnet

This first encircling fishing trial was carried out for a period of 11 days in August, 2021. The trial relied on the fish catch from the net by the opinion of fishers in directing the fishing ground and depth. The engaged fishers is dweller of Dehil Island and had participated five crews. Along with encircling fishing trial fishers were deployed another nine pelagic drift gillnet. The fishing ground where the trials conducted were north of Massawa and east Dahlak archipelago mostly in Madeban and a few Derdia, Mekemera, Umawd and Harat. An average of three fishing trial were done in every night. The dominant fish catch showed was queen fish, while the remained catch was in similar quantity like spanish mackerel, silver grunt, common silver biddy and barracuda. The total catches and proportion of each species within the catch was similar between fishing ground, and during the trial days queen fish recorded highest catch in all sites.

The superiority of the encircling gillnets produced in the pilot project cannot be proved by the data because it cannot be operated at the same time with the existing fisher's encircling gillnets. Nevertheless, the following opinions were obtained from fishers. The nets are light and the labor works is reduced, it is possible to operate with a small number of people, the profitability surely be improved by higher catching efficiency than the existing encircling gillnets. In the trial operation of the pilot project, it is necessary to verify not only the superiority of the newly introduced gillnet fishing gear but also the problems, so there is a plan to continue the trial operations and collect information and monitoring data.

1.2.3 Small Scale Bottom long line

Some of the artisanal fishing boats based in Massawa sometimes operates the bottom long line fishing when small fishes are available that could be used as bait. Although it is known to be cheaper and more efficient than gillnet fishing, it is not operated consistently due to the difficulty in obtaining the bait. National Fisheries Cooperation (NFC) operates the bottom long line fishery as the semi-industrial fishery using 18m class FRP fishing vessels and reel

gear of tuna long line. The fishery operates year-round catching groupers, snappers, catfish, giant trevally, sharks, queen fish, and cobia. The fishing grounds are mainly around islands near Massawa, and the fishers operate in 20 to 30m depth during the peak fishing season, and over 30m depth during the hot season. The catch amount per operation is 5 to 6 tons during the peak season and 2 to 2.5 tons during the hot season, and the catch seems to be gradually decreasing due to technical problems of the fishing vessels and shortage of fishing inputs.



Figure 8: Bottom long line gear appropriated from tuna long line and catches

In the Red Sea, the sea surface water temperature rises during the hot season, causing fish populations to move to deeper waters, making it impossible to operate the main driftnets. During this season, fishers switch to the surrounding gillnets at deeper waters in nighttime but catches decline. Bottom long lines are a promising alternative during this season. On the other hand, the lack of widespread use of bottom long lines by artisanal fishers was attributed to the difficulty of obtaining the bait, but since NFC fishing vessels operate year-round, it does not mean that the bait itself is not available. In order to promote the use of bottom long lines among artisanal fishers in addition to developing appropriate fishing gears and methods, measures such as the supply of bait and storage facilities for artisanal fishers seem to be important.

1.2.4 Coastal mullet gillnet and hand line fishing for subsistence fishery

There are two types of subsistence fisheries in operation; the gillnet fishing for mullet and the hand line fishing for Indian mackerel, and small demersal fish in shallow waters using polystyrene floats and canoes. Some fishers (like the fishermen living in Massawa) rent fishing gears and boats to operate the fishing activities. The fishing grounds are around coastal towns/villages and islands.

Problems commonly claimed by fishers, are that they need boats and engines for more efficient operations but could not afford them due to high prices, the quality of fishing nets and gears is low and the supply is insufficient, the price of gillnets is high, fishing grounds are far away, rental fees are high if they did not own fishing gears or boats, and there are no fishing gears and methods that are more efficient to utilize their fish resources.



Figure 9: Gillnets used in subsistence fishery (left) and fishing line sold at a shop (right)

1.3 Fish Distribution and Consumption

1.3.1 Fish landing and distribution by NFC

Fish trade takes place at various stages starting at the coastal landing sites, local Zoba settlements and in inland town markets. Massawa is the port city where most of the fish trading companies are located. The products sold at Massawa market are mostly fresh products, on direct sales from fish supplier to buying firms, NFC. The post-harvest level of the cold chain fish production and market linkages is dominated by the National Fisheries Corporation (NFC). Fishers have to sell fish to NFC or through one of its subsidiaries, who then handles the post-harvest activities, including transportation, distribution, processing and marketing especially in the main urban areas across the country. Private sector fish retailing business have been established in urban areas, which buy fish at wholesale prices from NFC and sell to consumers through smaller strategically located seafood shops and restaurant outlets.



Figure 10: Eri-fish landing site and fish reception

1.3.2 General overview of fish consumption, food and nutrition strategy

Food and nutrition security is one of the priorities and cornerstones for sustainable growth and poverty eradication in Eritrea. Several strategies, including the national plans and strategies on nutrition have been developed in the State of Eritrea to address the problems of malnutrition. Eritrea's food security strategy (FSS) contains two inter-related sub-strategies: a) National food Security Strategy; and, b) Household Food Security Strategy. The goal of the FSS is to ensure that all Eritreans have sufficient nutritious food at all times so that they would be able to lead healthy and productive lives. Household food and nutrition security strategy involves enhancing productive capacity of small scale farmers and enhancing household's purchasing power. The national food security strategies are pertinent to fisheries sector with the aim of developing and promoting artisanal and semi-industrial fisheries. The strategies pursued by the Ministry of Marine Resources (MMR) to develop and manage the fisheries sector in Eritrea involve enhancement of community-based fisheries production and development of fisheries infrastructure in key fishery centres to handle higher volumes and improve quality of production.

The six administrative regions/Zobas in Eritrea (Anseba, Debub, Maekel, Gash-Barka, Northern Red Sea and Southern Red Sea) have a number of ethnic groups and different cultural practices. These six Zobas fall within three geographic zones: the western lowlands, coastal plains (known as eastern lowlands) and the high lands (central and northern part of the country). The main sources of livelihoods in the three geographic Zones are subsistence agriculture, **fishing**, and pastoralism. Annual per capita fish consumption in Eritrea is very low compared to average consumption in Africa and the world (9.6 kg and 18.5 kg, respectively). This low consumption of fish, especially communities that are far away from the sea are not familiar with fishing activities and tend to have poor fish eating habits.

1.3.3 Fish distribution and consumption in Massawa, Asmara and Mendefera

The problems and constraints in fish distribution and household fish consumption of the three typical cities of Eritrea have been studied in 2019. Massawa is a coastal city; Asmara is a metropolitan city and Mendefera is one of the local-highland cities. There is only one fish landing site in Northern Red Sea region i.e EriFish in Massawa from which the fishes are distributed to three cities. The survey was conducted in November 2019 in Massawa and March 2020 in Asmara and Mendefera during the cold season.

1.3.2.1 Fish distribution channel and market in Massawa

The fish distribution in Massawa is carried out by the two fish market places, Edaga open fish market and Sigalet fish market. Those two places are officially licensed fish markets in Massawa.

i. Edaga open fish market



Figure 11: Edaga open fish market

Fish sellers such as foot fishermen or middlemen who harvest fishes in front of their villages in the morning or collect fishes from coastal villages around Massawa sell their fish in Edaga open fish market. The numbers of sellers in the market are not constant and they did not require a business license of the government unlike other fish retailers in Eritrea. Mainly fishes supplied to this market are small size pelagic and demersal fishes which are mostly fresh one-night fished from around Massawa. The price of fishes in Edaga market is between 40 and 50 Nakfa/kg. These prices are not ruled by the regulatory body of the government but defined by sellers. The amount of fish sold per shop in this market ranged from 10 to 200 kg per day. On average, the total amount of fish sales per day at Edaga open market was 473kg. Basically, means of fish transportation of sellers are ordinary as using bicycle and tri-cycle with basket and strings. But some middlemen sellers are using a pick-up truck with ice box on it, and some were using home-made ice for preservation. The species sold in this market were mullet, grouper, Spanish mackerel, red snapper, snapper, silver grant, barracuda, tuna, cobia, jackfish, milkfish, marbeled spine foot, silver diddy, crab and sometimes catfish. The fish selling hours are from 6:00 to 12:00 daily in the morning only because sellers didn't have ordinary fish preservation equipment. The most popular species in Edaga open market were mullet, jackfish, red snapper, emperor, grouper, salmon, spanish mackerel and Indian mackerel as in their order.

Fish sellers in Edaga open fish market were struggling with means of transportation. They wanted three-wheel bicycle to distribute their fish to the customer directly. They also recommended well shaded and paved market place, adequate water supply for washing fishes, specified waste disposal area and good preservation materials like ice, icebox of different size, refrigerator for the fish storage. The most purchased fishes by consumers are mullet, spanish mackerel, red snapper, jackfish and cobia as whole or chopped. The fish prices were between 45 and 50 Nakfa/kg. The consumers who purchase fish in Edaga, 50% of them eat fish every day. In Massawa, the fish consumers do not have the habit of eating fish at restaurants, indicating that Edaga market plays a major role in the supply of fish products to general consumers. In all households, mothers or daughters are responsible for cooking, and common cooking methods are frying, zigney, and soup. Most of the buyers were satisfied with the quantity and quality of fishes, while almost half were dissatisfied with the high prices. In other words, the potential demand for fishery products in Massawa is high, and if the prices could be kept down, consumption would increase.

The following problems were identified in the Edaga market; 1) lack of sanitation facilities for washing the fish to be sold and disposal of processed residues, 2) lack of facilities to maintain the quality such as roof for sales area, cooler box, refrigerator, and freezer, 3) lack of means and funds for transportation such as bicycle and automobile (or their fuel), and 4) shortage of fishes during the hot season, causing the fish prices to soar.

ii. Sigalet fish retail shops



Figure 12: Sigalet fish shop

Sigalet fish retail shops are two fish retailing outlets with the license given by the Northern Red Sea administrative zone. This fish market is not active like Edaga, because of higher fish price. Some clients prefer to buy fish only from this market considering its sanitary condition and preservation of fishes which are better than Edaga open fish market. One of the fish retail shops is built by UNICEF in the year of 1993. Both shops are licensed under the municipal administration of Massawa sub zoba and paying annual tax to the government and 5 % sales tax to EriFish. In this fish market, fishes are supplied by EriFish see food processing plant in Massawa. Fishes are transported by a rented private car which costs about 350-500 Nakfa per trip with ice in an icebox. The species purchased in this market are spanish mackerel, red snapper, grouper, barracuda, jackfish and tuna. The prices are regulated by the government as 63 Nakfa for 1st grade and 42 Nakfa for 2nd grade fishes per kilogram. At Sigalet fish market, spanish mackerel, red snapper and grouper were the most popular fish. The working hours in this market is from 7:00am to 2:00pm, 10-12 customers purchase fish per day, approximately of 45-85 kg amount of fish are sold per day.

iii. Problems and needs in Massawa

The average amount of fishes sold in a day was 473kg at Edaga market and 65kg at Sigalet market. Edaga open fish market is the only market operated by private sellers and selling small size fishes at their prices. Whereas Sigalet is government licensed fish market and selling large size fishes at fixed prices.

The following problems are identified in the Edaga market; 1) lack of sanitation facilities for washing the fish to be sold and disposal of processed residues, 2) lack of facilities that maintain the quality such as roof for sales area, fish box, refrigerator, and freezer, 3) lack of means and funds for transportation such as bicycle and automobile (or their fuel), and 4) shortage of fishes during the hot season, causing the fish prices to soar.

The other problems identified in Sigalet fish retail shops were; 1) Aging of facilities.2) Lack of materials for processing (scales, cutting boards, knives, gloves, sanitary caps, etc.). 3) Lack of processing and cooking skills for quality control and value addition.

1.3.2.2 Fish markets and consumption in Asmara

There are three fish market places in the metropolitan city of Asmara; Markato fish market in the center of the city (Maekel Ketema), EMPC Asmara (Eritrean Marine Products Company Pvt. Ltd.) retail shop at EMPC fish processing plant in Mai-chihot (local area administration), and Gejeret fish market in Gejeret district.

Markato is a historical and busy market area consisting of mini-super markets for groceries, fruits, vegetables, meats, household goods, and fishes which are sold in a designated building. The fish market in Markato consists of three fish retail shops.



Figure 13: EMPC fish processing plant



Figure 13: Markato fish market

i) **Fish supply information**

The fishes sold in Asmara are large size pelagic and demersal fishes supplied from EriFish landing site of Massawa through EMPC Asmara with refrigerated trucks in every other week. EMPC distributes fishes to retail shops in Asmara, including the Markato fish market and it is also sells fishes directly to customers at a retail shop in their premises as well.

The fish species available in those shops were shark, barracuda, tuna, bonito, queen fish, grouper, snapper, emperor, malabar, kingfish, catfish, mullet, milkfish and jackfish. Fish retail shops in Asmara sale whole fishes and fillets. The employees at fish retail shops use different method such as de-heading, gutting and filleting after selling fish upon the request of customers. Markato retail shops sell fish from 8:00am - 2:00pm almost every day in every other week, depending on availability of fish supplied by EMPC. The most popular fishes are kingfish, catfish, tuna, shark, queen fish, snapper, jackfish, barracuda and mullet. The selling hours EMPC retail shop is from 6:00am – 6:00pm, and the most popular fishes are snapper, grouper and kingfish (including fillets).

ii) **Household fish consumption**

The fish consumption in Asmara depends on the availability of fish on fish retail shops. There is a potential high demand for fish if fish is available at affordable price in the fish markets. Generally, inclusion of fish in the restaurant menus in Asmara is a well-established tradition. About half of the restaurants serve fish every day, and the rest for at least three times in a week.

The main sources of income for fish buyers in Asmara are as government employees, daily subsistent workers, monthly salary workers and private workers. Their incomes are between 500 and 3,200 Nakfa per month, in average 1,596 Nakfa. The household expenditures are mainly house rent, daily food expenses, electricity and water bills.

The popular fishes purchased in Asmara were catfish, tuna, queen fish, spanish mackerel, grouper, kingfish and barracuda. The fish prices are regulated by the government as 63 Nakfa for the A-grade fishes, 42 Nakfa for the B-grade and 171 Nakfa for fish fillets per 1 kilogram.

iii) **Fish eating habit**

Fish consumption in Asmara is still low due to inconsistent supply of fish, leaving most of the population to rely on livestock for their animal protein demand. Despite the availability of fish in the retail shops, most of the households in Asmara prefer to cook fish at home. The ingredients used for fish cuisine preparation are garlic, onion, black pepper, green pepper, oil, red pepper, flour, tomato, cumin, rosemary and parsley. The popular species cooked at home are tuna, mullet, queen fish, catfish, grouper, kingfish and spanish mackerel.

iv) **Problems and needs in Asmara**

The main problems which need improvements in Asmara are as follows:

a. Limited fish supply in amount and species, and fish delivery is every other week

b. Prices of fish are not affordable as compared to other sources of animal proteins.

c. Retail shops require rehabilitation of infrastructure and their equipment.

d. Awareness raising on fish consumption is required.

1.3.2.3 Fish markets and consumption in Mendefera

Mendefera is the capital city of the Zoba Debub. There is one fish market in the town which had been built by the administration of Mendefera. The fish consumed in this area is the marine fish supplied by Erifish from Massawa. The fresh water fish is also available in the market to a small amount.

The main sources of income of the household in Mendefera is the same as in Asmara, the monthly salary (as teacher, manager etc.), hotel owner, restaurant owner, shop owner, and small traders. Their monthly salary ranged between 800 and 3000 Nakfa, on average 2,170 Nakfa. The main expenditures are house rent, daily food expenses, fuel and water and electricity bills. The fish species consumed by the households are queen fish, milkfish and spanish mackerel as a whole or filleted.

i. Fish distribution and eating habit

The fish market in Mendefera is almost closed, and fishes are irregularly supplied by Erifish and directly sold from the hired truck. Usually, when the people need to buy fish, they go to Asmara. Almost all the households process the fish by de-heading, gutting, filleting and buttering before cooking. Frying is the mostly practiced method of cooking (70%) and the other methods of fish preparation are sandwich, cutlet, finger and fish stew. Ingredients such as oil, onion, tomato and salt are used for the above-mentioned cooking.

ii. Problems and needs in Mendefera

Household in Mendefera gave a recommendation in order to improve consumption of fish, there should be enough supply of fish in the market. They mentioned that they are buying fish from Asmara when they wanted to run their hotel or restaurant business. They deeply hoped to get more fish in their area.

The main problems which need improvements in Mendefera are as follows:

a. Fish is not available any time. The only supply is by the hired truck of Erifish, which distributes fish irregularly. Most of the time it comes suddenly and only few people who access to the truck buy fish.

b. The rarely delivered fish is also very expensive in comparison with beef and goat meats.

c. When people need fish for their restaurant, they go to Asmara to get fish. This makes the fish vulnerable to spoilage and also requires additional cost.

CHAPTER 2: ISSUES AND CONSTRAINTS OF COASTAL FISHERIES

The issues surrounding coastal fisheries and the constraints that are hindering coastal fisheries development as identified from the results of the baseline survey and the problem analysis workshop are reflected from two sides, the artisanal and subsistence fisheries.

2.1 Issues of the Artisanal Fisheries

2.1.1 Issues in Fishing Gears and Methods

The Government of Eritrea aims to make effective use of the abundant fishery resources in the Red Sea in order to improve the domestic food and nutrition situations. For achieving that purpose, it is essential to strengthen the capacity building of the MMR staff and those involved in fisheries, improve the fishing gears and methods, and increase and stabilize the fishery production by disseminating the fishing technology. The following issues on fishing gears and methods for coastal fisheries development are recognized after considering the current situation and problems.

i. Insufficient capacity of MMR to support fishers

The MMR staff must understand the actual fisheries theoretically and practically in order to support the development of fisheries in Eritrea. For this purpose, it is necessary to prepare appropriate textbooks and audiovisual materials for conducting fishery training at the MMR Fisheries Training Center in Massawa.

ii. Engine repairing and Fishing gear assembling workshop

In order to increase fishery production in Eritrea, it is necessary not only to improve fishing gears and fishing methods, but also to obtain modern fishing boats and high-quality fishing gears. However, catches are declining due to the poor performance and inefficiencies of the fishing gears currently used in both of artisanal and subsistence fisheries. In addition, it is difficult for fishers to secure appropriate profits because the catches are purchased at a fixed price. Resolving these issues is expected to increase fish production. In general, fishers hesitate to work if they are unable to earn enough income in the harsh and dangerous conditions in the sea. As aiming to increase the number of new fishers, it is important to introduce effective fishing gears and methods, adequate supply of appropriate fishing equipment, and increase of production and income.

iii. Fishing gear used during the hot season

The Red Sea is a closed sea with slow current. Schools of fishes move to deeper waters as sea surface temperatures rise during the hot season. As a result, the fish production declines. However, well-capitalized fishers continue to operate using the surrounding gillnets with fish aggregating lights during the hot season. To achieve the goal of increasing fish production even in the hot season, it is important to introduce new types of fishing gears and methods that can be used by many artisanal fishers.

2.1.2 Engine maintenance of artisanal boats

In addition to the lack of fishery-related facilities for repairing and maintaining fishing boats, it is difficult to obtain spare parts for fishing boat engines. At the time of the baseline survey, it was confirmed that many non-operating fishing boats were moored around the port of Massawa. Thus, there are many issues to be solved for the improvement of fishery status, such as the provision of available fishery-related services to fishers and the modernization of the fishing technology.

2.1.3 Infrastructure for fishing port and markets

In addition to the baseline survey, to get a bird's eye view of the issues surrounding each fishing community, a workshop on "Problem Analysis for Coastal Fisheries Development" was conducted on November, 2019 by inviting coastal fishery key stakeholders. Based on the result of the problem analysis, key issues of fisheries infrastructure and market problems have been identified.

Since Dehil island is a community that mainly engages in artisanal fishing (boat fishing), there is a significant difference in the background of problem awareness compared to the two fishing villages mentioned above.

The reasons for the "Lack of fishing infrastructure and facilities" were the lack of a pier, desalination equipment, and a place to maintain fishing boats and engines. Dehil Island is an island formed by uplifted coral reefs and relies almost entirely on transportation from the mainland for the water for not only for fishing but also for daily life, which is provided by fishing fleets of Dehil Island. As the island is hardly able to produce food for its own consumption, fishing income has become a major means of obtaining daily necessities, and fishing infrastructure and livelihood infrastructure have become almost synonym. Other direct causes of the lack of fishing boat and engine maintenance facilities are the inability to maintain engines, lack of availability of parts, and inadequate structure of fishing boats, all of which are characteristic of Dehil Island’s reliance on boat fishing. "Lack of supply of goods necessary for production and livelihood" was directly caused by the lack of water supply, insufficient number of fish boxes; and inadequate supply of fuel, ice, and food. The causes of "Many constraints due to inadequate institutions" include: inadequate supply of fishing gear of the right size, quality, and quantity; poor marketing environment for the catch; and inadequate financing system. As for the poor marketing environment, the respondents strongly pointed out their dissatisfaction with the current marketing systems, such as the slow supply of ice, fixed fish prices, limited landing time, and limited sales to one company, NFC.

2.2 Issues of the Subsistence Fisheries

The main issues and challenges of the subsistence fishery in the fishing community are briefly described the following areas.

2.2.1 Main issues of the subsistence fishery

The village of Hirgigo is primarily a community of small-scale subsistence fishers. The central problem is limited fishing activities, and problems that cause these are: lack of fishing boats, inefficient fishing methods, low income due to low fish prices, and high prices of fishing gears. Lack of market capacity resulted from the low purchasing power of consumers and the lack of ice and fish boxes to keep fishes fresh. The main reason cited for both "Lack of cooperative capacity" and "lack of labor skills" was a lack of opportunities to improve capacity through training.

Zula village, like Hirgigo, is a community centered on the subsistence fishing. Inappropriate fishing technology, results due to the absence of suppliers of fishing materials and therefore no access to appropriate fishing gears. Many fish catches are discarded due to the long distance to the fishing grounds, limited opportunities to sell the fish in the market, lack of roads to transport the fish, and lack of refrigerator-freezers. Lack of income opportunities for women in the fishing industry was resulted from the lack of training opportunities in fishing technology, lack of training opportunities in fish processing and quality control technologies, and lack of training opportunities to start a retail shop, indicating the need to provide appropriate training opportunities.

2.2.2 Fishing gears and methods of subsistence fishery

The gears used for the subsistence fishery along the coast are low quality hand line and gillnets. And there are no fishing boats except floating gears made of polystyrene, thus the fishing efficiency is very low considering the quality of gears. The target species are all small-size pelagic fish such as mullet, Indian mackerel, scud and small-size Spanish mackerel, which are thought to have large amounts of resources. So, there is a great room for resource development. Current fishing gears are neither qualitatively nor quantitatively sufficient for the development of this resource. It is necessary to introduce fishing gears and methods with high catch efficiency to promote the fishery development.

2.2.3 Marketing and distribution

In the coastal villages, there are many fishers and most of the catches are sold in the market in Massawa, but the high transportation cost is a cause of downward pressure on the fishery income. Efforts to reduce transportation costs or increase the value added to raise the price of fish for sale are needed. On the other hand, most of the Zula fishes are sold and consumed within the village due to the limited catches. But since the village is located next to Foro, which is expected to have a large demand, the village envisages increasing its catches and sales volume in the future. However, they are unable to sell their catches frequently due to limited means of transportation, and they are unable to keep their catches for long period of time due to the lack of storage facilities and means of keeping them cool in the village. In

addition, there is no market for fishery products in Foro, so there are limited opportunities to sell them.

Under the FSPAC project, the community development pilot projects are implemented to take place in the villages of Hirgigo and Zula. The number of subsistence fishers in both communities is about 50, but the population of Hirgigo village is 2,000 and that of Zula is 3,250, which means that one in 40 people in Hirgigo and one in 65 people in Zula are subsistence fishers. This difference can be attributed to the fact that the village of Hirgigo, which is close to the largest port town in Eritrea, Massawa, is geographically close with good distribution conditions for fishes they catch, thus fishing activities are conducted throughout the year in response to the high demand for fishery products.

On the other hand, for the village of Zula located 56 km away from Massawa, is the consumption point for fishes. But it takes about an hour's walk on a 6 km dirt road to reach Zula village, and another 6 km walk in the opposite direction to the village foreshore. This geographic accessibility problem is reflected in the fishing activities of the fishers, as most of them fish only during the peak fishing season and engage in agriculture during the hot summer months, which presents different challenges from that of Hirgigo village. The distribution and marketing issues of the two fishing villages could be summarized as follows.

i. Issues in the Hirgigo village

The fishes are sold and consumed in the village or transported to the Edaga open market in Massawa, which is 10 km away and easily accessible. A group of three or four fishers rent a motorcycle to transport their catch in baskets to the market for sale, but most fishers have no means of transporting their catch to the market, so much of the catch is sold for 10-20 ERN per kg in the village of 2,000 people. However, when sold at the Edaga market, the same fish costs 30-40 ERN/kg. The Edaga open market is in the center of the town, where fishers from the surrounding area bring fishes in hand-woven baskets and put them on the open-air ground without sufficient shade, so the fishes deteriorate quickly. Therefore, customers have pointed out the hygienic condition to be improved. Since the fish is not kept cold, the sales hours are also short, only in the morning. The hygienic improvement of the sales environment, such as placing the fishes in ice cold containers and selling them on shaded tables, will improve the quality of the fishes. This would in turn improve the selling price and extend the selling hours, and contribute to increase sales.

ii. Issues in Zula village

The demand for fish in the village is high, and the harvested fishes are always sold quickly. Fishes are also sought after in Foro, the nearest town to the village along the main road, but it takes an hour to get there on the dirt road, about 6 km west of the village. Because it takes time to transport the fishes after harvested and needs to maintain the quality, the fishers rent two fish boxes and fill them with ice bought from Massawa by car and camel. Since it takes about 1-1.5 hours to walk from the village to catch the fishes, and it takes another one hour to walk in the opposite direction from the village to sell the fishes in Foro town, so the conditions for distribution are not so good. The population of Zula village is 3,250, about 1.5

times of Hirgigo village, and with the small harvest, most of the fishes caught are consumed within the village. The price of fish in the village is 10 to 20 ERN per kg, however, when it is transported to Foro, the price doubles to 40 ERN.

Although it was not recorded during the baseline survey, it is noted that the village used to produce salted and dried mullet, Indian mackerel, and shark for sale to nearby mountain villages and for export to countries on the other side of the Red Sea. These days, these fishes are rarely processed and are only distributed as fresh fishes. However, villagers are interested in smoking fish as well as salted and dried fish as a way of preserving fish after catching, and they want to be trained to improve their fish processing skills.

2.2.4 Source of income for women

In coastal villages, the fishing net mending and making cooperative has been organized to improve women's income, but none of them are functioning. However, there is a high need for women to improve their income, and it is clear that there is a need to develop any kind of income sources.

2.3 Constraints of the Artisanal Fisheries

2.3.1 Lack of know-how in improving fishing gear and method

Artisanal fisheries face a number of challenges in improving and developing fishing gears and methods that are suitable for both the peak season and the hot season. However, there is currently a lack of expertise to develop these technologies.

2.3.2 Limited transport links to inland areas

Fish trucks of EriFish are used to transport fresh fishes from Massawa to Asmara/inland areas, but this is not sufficient with increased fishery production and supply in the future. The lack of cold chain transport capacity from Massawa is one of the major constraints to the development of coastal fisheries.

2.3.3 Limited fish landing capacity of Massawa

Similarly, the current landing capacity of the Massawa fishing port is not sufficient in terms of institution and facility capacity to increase the supply to Asmara/inland area.

2.3.4 Fish prices are controlled

The prices of fishes are perceived by both fishers and consumers to be inappropriate. Fair pricing can be a major driver of fisheries development to motivate fishers to catch and consumers to buy, and it makes benefits for both. To promote making this market environment, the controlled price currently set by the NFC is one of the major constraints to the development of coastal fisheries.

2.4 Constraints of the Subsistence Fisheries

2.4.1 Lack of fishing technology for small pelagic fish resources

The development and effective use of small pelagic fish resources is fundamental to the future development of subsistence fisheries, but the fishing gears currently in use are limited to simple gillnets and handline only, making it difficult to further increase catches. Subsistence fishers' lack of fishing vessels and the difficulty of making large investments have also been constraints to the development and introduction of efficient small pelagic fisheries technology.

2.4.2 Inadequate supply of fishing gears

The stable supply of good quality fishing gears and materials is essential for the future development of the fishery, but only a few are currently available in the villages. Even in Massawa, fishing gears and materials are sold exclusively by the government and fishers cannot choose what they want.

2.4.3 No facilities for quality control and logistics bases

There is no infrastructure or facilities in the villages to serve as a base for quality control, processing, and distribution of fishery products. This condition is limiting means of fish distribution, but infrastructures/facilities such as cold storage, processing and transport are essential for improving the distribution of fishery products and strengthening sales to large markets of Massawa and Asmara.

2.4.4 Lack of fish processing techniques

A key to the development of subsistence fisheries is the expansion of sales channels for small pelagic fishes to Asmara/inland areas where people are not accustomed to eating them. For this reason, the development of processed products that offer new ways of eating fish is a challenge. For villages where electricity and refrigerators are not widely available, the development of processed fish products that can be preserved without cool storage is required. MMR has attempted to develop processed products, but to date there has been no demonstration of product development for the widespread consumption of small pelagic fish and there is a lack of expertise in these villages.

CHAPTER 3: CHALLENGES TO SOLVE ISSUES AND CONSTRAINTS

3.1 Challenges of the Artisanal Fisheries

3.1.1 Challenges for fishing gears and methods

During the peak fishing season, gillnet fishing (drift nets) is the main fishing method of the artisanal fishery and is thought to account for a large proportion of the catch, but fishers have pointed out problems such as inadequate mesh sizes and the high effort required to operate them. On the other hand, the demand for seafood in Asmara/inland areas is higher than the supply, hence there is a need to improve fishery production and increase the supply. Increasing fishery production and supply by improving fishing gears and methods for production efficiency is a high priority for Eritrean coastal fisheries.

As noted above, supply is not keeping pace with demand for seafood in Asmara/inland area, this is more conspicuous in the hotter season when production is lower. During the hot season, large pelagic fishes, which are the target of gillnet fishing, move to deeper water as the surface temperature of the sea rises drastically. Also, the extreme heat in hot season makes working conditions uncomfortable, so fishers switch to the surrounding gillnets and operate at night, but catch amounts are lower than in the peak fishing season. Many subsistence fishers also engage in bottom handline fishing which is particularly important during the hot season because it allows them to operate during the night and early morning. There are still opportunities for the exploitation of bottom fish resources, thus the development and introduction of simple and widely used fishing gears and methods that enable more efficient use of resources are also required. Improvement of fisheries production in some way to increase fishers' income and supply to consumer during the hot season is a big challenge.

3.1.2 Challenges for market development

i. Sales promotion for market development

As mentioned repeatedly, the fish supply to Asmara and other inland areas is not keeping pace with the increasing demands as the fish consumption becomes more widespread. While it is necessary to increase fishery production to cope with this issue, the challenge is to improve the environment to ensure a stable supply of fishery products to inland areas. To achieve this, it is necessary to strengthen the EriFish's purchasing function at Massawa fishing port and the EMPC's fresh fish transportation capacity, and to prepare sales points in inland cities such as Mendefera.

ii. Fish price liberalization

The biggest complaint of fish consumers in Asmara/inland area is the high prices as well as the lack of supply. As fish consumption becomes more widespread and potential demand increases, the supply of fishery products at affordable prices can initiate further consumption. Conversely, for fishers, the low landing prices are seen as a problem and seem to encourage many fishers to illegally land in neighboring countries. It is thought that the official price set

by the NFC based on the government policy is causing this mismatch in fish prices. In the past, the official pricing of fishery products was very effective policy to combat famine and to promote fish consumption. But at present time that the famine has passed and fish consumption has become more widespread, it seems that the role of official pricing is gradually coming to an end. The challenge is to promote price liberalization in the seafood trade and to strive to formulate prices that are appropriate for both fishers and consumers.

3.1.3 Challenges for improvement of infrastructure and facilities

The artisanal fishers depend on the coastal areas of the mainland and islands, most of which lack fishing infrastructure and facilities such as jetties, boats and engine maintenance facilities. As a result, boats are anchored offshore of the island and maintenance is carried out in Massawa inconveniently. As these islands are also a place of livelihood for the villagers, mainly fishers, the development of fishing infrastructure and facilities will also improve the livelihood of the communities. The development of fishery infrastructure and facilities in those islands is considered a necessary issue for the development of artisanal fisheries.

Fish landings for artisanal fisheries are limited to the Massawa and Assab fishing ports only. In particular, the Massawa fishing port is responsible for the supply of seafood to major inland centers such as Asmara, but has only one landing facility where EriFish buys the products. In addition, because of the limited access to the port from 6 am to 6 pm and the fish landing is accepted only for a short time in the morning, fishing boats are sometimes anchored in the harbor for days waiting for landing. Increasing production to meet the high demand in Asmara and inland area will be difficult if the landing capacity of the Massawa fishing port remains low. Therefore, strengthening the landing capacity of Massawa fishing port is also an essential part of coastal fisheries development.

3.2 Challenges of the Subsistence Fisheries

3.2.1 Challenges for fisheries production

a) Efficient use of the small pelagic fish resources

The coastal areas of Eritrea where subsistence fisheries are operated, are assumed to be less abundant in fishery resources than offshore areas, and the resources are not used effectively because of few numbers of fishers. While the accurate fish catch amounts and Allowable Biological Catch are awaiting specific studies, the main target species of subsistence fisheries, such as mullet (*Mugil cephalus*) and Indian mackerel (*Rastrellinger kanagurta*), are considered to be the sufficient potential for exploitation. The efficient use of small pelagic fish resources is a major challenge for Eritrean coastal fisheries, both in terms of improving the livelihoods of fishers and supplying food to consumers.

In addition, small sardines such as bluestripe herring (*Herklotsichthys quadrimaculatus*) and shorthead anchovy (*Encrasicholina heteroloba*), which are prolific small pelagic fishes, are assumed to be more abundant than mullet and Indian mackerel, and their effective use has long been an issue. These species are caught by beach seines and their current fishing grounds are solely in the southern coastal areas around Assab, Eddie, Korum and Berasole. It

is processed by sun drying and used as a livestock feed. Though various efforts have been made to make it edible for human, it has not yet become as an established food since its quality deteriorates rapidly due to the fact that it is caught by seine netting and processed without boiling, as well as the Eritrean's custom that has not eaten small sardines.

b) Increasing fisheries production

According to the results of the baseline survey, seafood consumption has traditionally been high in coastal areas such as Massawa, and there is a shortage of supply in Asmara and inland areas despite high demand on seafood. The MMR and FAO's efforts since the 1980s to promote fish eating in inland areas have been successful, and have now entered a stage where a larger supply chain is required. Increasing production to meet this high demand is important from a food security perspective, and also provides an opportunity for fishers to improve their livelihoods. Together with the issue of expanding fisheries production of the artisanal fisheries, which will be discussed below, there is a social need to increase the production of subsistence fisheries based on the development of small pelagic fish resources described above.

3.2.2 Challenges for sales and marketing

a) Reducing transport costs

The fishers of Hirgigo village sell many fishery products at the Edaga Market in Massawa. But there is a problem that transport costs are high when transporting fishes to the market in small batches each time the catch landed. In case of Zula village, transport costs are not a major issue due to the high demand within the village, but as mentioned above, the distribution outside the village is essential if fisheries production is to be improved through the development of small pelagic fish resources. A promising market is in the neighboring town of Foro, where ice is essential to maintain the quality of the product as it has been carried over rough roads for many hours. However, necessary ice has to be ordered from Massawa as it is not available in the village. Minimizing these transport costs is a major challenge in economic management to fishers and its necessity will become more apparent as fisheries production improves.

b) Improvement of the distribution environment for Massawa and other towns

When Hirgigo fishers want to increase the volume of fish products sold to Massawa market, it will have to improve its distribution environment. At present, ice for quality control is not usually used and transportations are only motorbikes basically. And there are no sales facilities at the Edaga market; hence the fishes are sold in baskets placed on the street which are not well shaded. It is not possible to increase the volume of sales in this environment because it is difficult to increase the transport volume and to keep fishes in fresh for a long time. The improvement of distribution environment is an essential task for improving fishery production and sales volumes.

As mentioned above, Foro is the most promising market for increasing fisheries production for Zula village. However, there is no fish market in Foro like Edaga in Massawa, and the ice needed for transport has to come from Massawa. The improvement of an environment for the

distribution of fresh fishes to Foro by ensuring sales opportunities and means of quality control will be a key issue for the successful development of the fishery in Zula village.

c) Establishment of distribution methods and promotion of sales to inland areas

As mentioned above, meeting the demand for fishery products in inland areas including Asmara is required from the perspective of national food security, but to date, there has been only little experience of selling fishes to inland areas by subsistence fishers, and distribution methods have not been established. Larger fishes such as Spanish mackerel, queen fish and groupers have become widespread fishes consumed in Asmara and inland area. However, the fisheries products would be supplied by the subsistence fishery are mainly small pelagic fishes. As large fishes are a substitute for livestock meat, consumers favor large portions to be edible and limited ways to cook the fish. There is a need to establish a way of distributing the fish products of subsistence fisheries such as mullet and Indian mackerel, and to promote their consumption.

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3. Final Report of the Pilot Projects of Fishing Gear and Method for FSPAC

Final Report
of
the Pilot Projects of
Fishing Gear and Method

for

Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development

(FSPAC)

March 2023

Mulugeta Mahdere Tesfazghi
Yosief Redae
Filmon Bereket Bairu
Dita Amanuel
Filmon Bereket Berhe
Osman Ibrahim Ahmed
Temesgen Amanuel
Morimitsu Ritsuo

Ministry of Marine Resources

Japan International Cooperation Agency

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Source: Eritrea Map from Wikipedia

Introduction

"The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development in the State of Eritrea (FSPAC)" was implemented by the Ministry of Marine Recourses (MMR) and Japan International Cooperation Agency (JICA).

This report summarizes the activities of the pilot project from November 2019 to March 2023.

In developing the fishing technology, three pilot projects were selected through the baseline survey and implemented in cooperation with Project Implementation Unit (PIU) of MMR.

PP1: Pilot Project for Improvement of Gillnet and its Making Capacity Building
PP2: Pilot Project for Development of Small Scale Bottom long-line Fishing
PP3: Pilot Project for Introducing Small Scale Set net (Pound net) Fishing

The PIU team members(C/P) and their responsibilities

15 March 2023

	Photo	Name/contact	Position	Main activities in charge
1		Mulugeta Mahdere Tesfazghi (7365064)	Leader (Fishing gear development)	1. Oversee Project activities 2. Operation management of sea-going practice 3. Report making 4. PP3 Activity video editing 5. Set net report making
2		Yosief Redae (7568380)	Assis. leader (Fishing gear development)	1. Support the leader for project activities 2. Operation management for PP1 3. Training material making for Gillnet and basic computation of fishing net 4. Report making
3		Filmon Bereket Bairu (7278712)	Fishing coordinator (MRDD)	1. Arrange fuel and maintenance operations 2. Data management for PP2 3. Training material making for basic computation of fishing net 4. Report making of PP2 trial operation
4		Dita Amanuel (7156024)	(MRDD)	1. Presentation materials making for fishery training 2. Training material making for basic computation of fishing net 3. Report making of PP1
5		Filmon Bereket Berhe (7656705)	(MRDD)	1. Data management for PP2 and PP3 2. Leader of PP3 3. Training material making for Gillnet 4. Report making of PP2 trial operation
6		Osman Ibrahim Ahmed (7493036)	(MRRSD)	1. Operation management for PP1 2. Training material making for Gillnet 3. Report making of PP2 trial operation

7		Temesgen Amanuel (7170333)	(MRDD)	1. Data management for PP1 and PP2 2. Training material making for Gillnet 3. Report making of PP2 trial operation

Table-1: MMR PIU Team Members

The project has a strong need for human resource development through the capacity building of MMR staff in relation to fishing techniques and knowledge. Under these circumstances, counterparts have been reassigned several times due to staff movement within MMR. In the end, the above seven members were active as PIU team members in the Fishing Gear and Fishing Methods Division, and each of them played an important role in improving their fishing skills and knowledge.

This pilot project final report is prepared for dedicating the technical improvement and implementing the development strategy in the field of fishery in the state of Eritrea.

PP1: Pilot Project for Improvement of Gillnet and its Making Capacity Building

PP1 Drift Gill Net

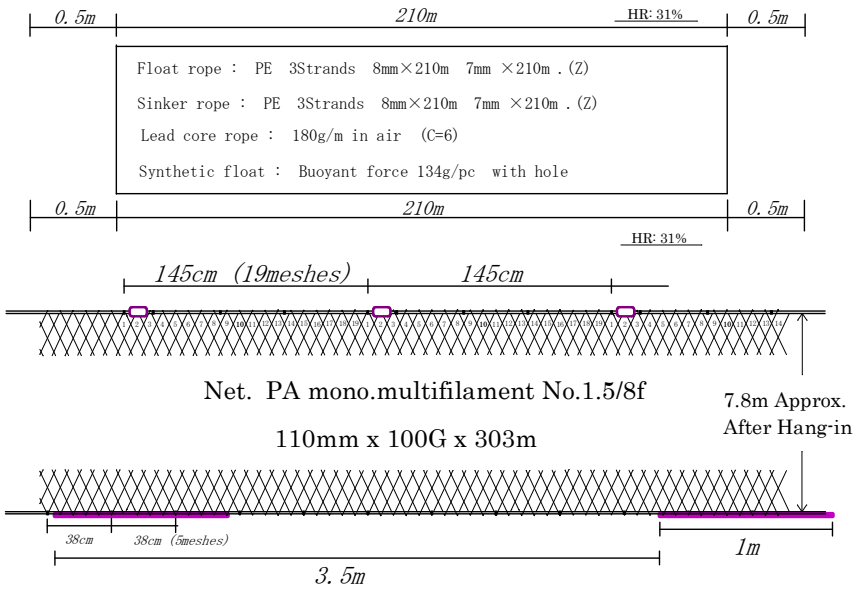


Figure1: PP1 produced drift gillnet

1-1. Outline and purpose of the pilot project

The baseline survey clearly showed that many improvements in materials and technology are needed to develop the drift gillnet fishery in Eritrea. Those improvements will require the improvement of fishing techniques and support for fishermen by the Project Implementation Unit (PIU) team, which is comprised of officials from the MMR.

In this project, the PIU team will acquire practical knowledge by conducting at-sea training and monitoring surveys in collaboration with fishermen using gillnet that they have prepared through lectures and gear construction. Activities were conducted in the following order: lecture, gear making, operational practice, and monitoring evaluation. In the monitoring survey to improve gillnet fishing, differences in operational workability and fishing efficiency were verified by comparing fishing gears provided by PP1 with those of fishermen. Based on these results of the comparative study, the introduction of effective technologies to improve fishing techniques will be supported by MMR.

In addition, PP1 has developed the necessary fishery textbooks and presentation materials as part of fishery education.

The main objectives of PP1 are

(1) Improve the efficiency of gillnet fishery and strengthen the fishery technology dissemination service.

(2) PIU team and fishery officials of MMR will understand the gillnet fishery and acquire construction technics.

(3) Improve the efficiency and productivity of fishing gear and fishing methods through the proposed gillnets by the project.

1-2. Gill net fishery training and related documentation

MMR staff and the PIU team conducted a workshop on gear configuration, basic calculations, gillnet construction and hands-on training at sea to gain a better understanding of the drift gillnet fishery.

The main contents of the workshop were as follows.

- ○ Gear characteristics and materials, basic net calculations, buoyancy and sink forces of gear materials, and hang-in ratio calculations.
- ○ Learn how to calculate gillnets and how to cut the netting material.
- ○ Hands-on training in net construction for the pilot project.
- ○ At-sea training on the pilot project by PIU team members
- ○ Preparation of textbooks, manuals and presentation materials for fisheries training by PIU team members.

1-3. Pilot project implementation schedule

Implemented period of PP1: March 2020 – March 2023 (37months)

1-4. Implementation plan and project sequence

PP1 has conducted trials of nylon monofilament gillnets with lead core sinkers, which are highly regarded worldwide for their ability to improve productivity. However, Eritrea has been slow to adopt this gillnet gear, so this project decided to verify its effectiveness and efficiency by comparing it with gillnets used by the fishermen.

The project procured netting materials for drift nets, encircling nets, and depth adjustable drift nets and constructed these nets with the PIU team in Massawa. Then, the PIU team selected a person in charge of the on-board survey and conducted data collection in cooperation with local fishermen through test operations at sea.

As for the project cooperative fishing boat, the boat was selected in cooperation with the Northern Red Sea Branch of MMR and consensus was reached with the boat owner for the project activities.

See Appendix1：Work plan for PP1 and Appendix2：Gillnet test operation survey plan

1-5. Outline of the project implementation

Since the Massawa area was also closed due to COVID-19, the pilot project was led by PIU team leader Mr. Mulugeta, who negotiated with reliable fishing boat owners, and the survey activities were conducted by sending observers from the PIU team to collect data at sea. Finally, the PIU team conducted the project, including three pilot drift gillnet operations, two pilot night encircling gillnet operations, and two pilot depth adjustable

drift gillnet operations. The survey results showed that the performance evaluation of the fishing gear and fishing method proposed by PP1 as a prototype was generally favorable and can be evaluated by the report.

1-5-1 First trial Drift floating gill net:

Boat name, Mesgna1
Captain, Mohamedali Mohamed
Register No. 31155/06,
Boat size, 13 meter



Boat for first trial drift gillnet

1-5-2 Second trial drifts floating gill net

Boat name, Mesgna-2
Captain, Ahmed Reshed.
Register No. 31831/19
Boat size, 15.8 meter



Boat for second trial drifts gillnet

1-5-3 First trial Drift floating gill net (depth-adjustable gill net) and 1ST trial Net hauler machine

Boat name, Selam 3
Captain, Ahemed Ibrahim
Register No.31747/18
Boat size, 20 meter



Boat for first trial Drift gillnet (adjustable gill net)

1-5-4 Second trial Drift floating gill net (depth-adjustable gill net) and third Drift floating gill net

Boat name, Alqiema
Captain, Mohamed Omer Gieder
Register No.31859/19
Boat size, 18.14 meter



Boat for 2nd trial Drift gillnet (adjustable gill net)

1-5-5 First & second trial encircling gill net

Boat name, Alnesiem

Captain, Mussa Ali Mussa

Register No.3001/9

Boat size, 17 meter



Boat for first & second trial encircling gillnet

1-6. Drift Gillnet Project

1-6-1. Construction of drift gillnet

During this training, MMR staff and the PIU team learned about fishing gear and fishing methods in general, as well as how to configure gillnets and calculate the buoyancy and sink force of the nets. New gillnets were then constructed by the PIU team as PP1 experimental gear.

In the end, the PIU team produced a total of 4 drift gillnets for the experimental operation, and the participants strengthened their fishing gear manufacturing skills through the construction of drift gillnets. In addition to materials purchased in Japan, some gillnet materials, such as floats and sinkers were purchased from MMR.

	
Meeting before gillnet construction	Assemble an entire drift gillnet

1-6-2. Drift gillnet test operation

The first drift gillnet test operation was conducted by Mr.Temesgen Amanuel of the PIU team aboard the sambuk boat Msgna-1 for 13 days from December 2020 to January of the following year. During the test operation, the PP1 proposed drift gillnet (214 m long x 7.8 m net depth) and the fishermen's drift gillnet (260 m long x 5.6 m net depth) were connected together. Although it was the full moon season and the sea was rough, the necessary catch data were collected.

The PIU team also reported the results of the second drift gillnet test operation conducted by Mr.Yosief Redae aboard the sambuk boat Msgna2 for 19 days in November 2021. The survey was conducted using the drift gillnet proposed by PP1 (total length 214

m x net depth 7.8 m) and the fishermen's drift gillnet (total length 1485 m x net depth 9.75 m).

The third test operation was conducted in December 2022 for 15 days by Mr.Filmon Bereket Berhe and Mr.Yosief Redae of the PIU team aboard the fishing boat Alqiema.

See Appendix 3: 012021 First Trial Report Sinking Gill Net.

Appendix 4: Second Trial Report Fishing.

Appendix 5: Report on Fishing Demonstration of Depth- adjustable Drift Gillnet (2nd) and Drift Floating Gillnet (3rd)



PP1 drift gillnet and fishermen's drift gillnet are connected

Operation processes are as follows:

(1) As the skipper moves the boat forward, two fishermen throw the nets into the sea and finally tie the ends of the nets to the boat.

(2) After 3 hours of soaking, the nets are hauled up on deck and the caught fish are stored in a cooler box.

	
Setting drift gillnet	Retrieving drift gillnet

1-6-3. Results and evaluation

Summarized operation data of Drift gillnet 1st. 2nd.						
Boat name- msgna-1			Boat type and length: Sanbuk(inboard engine), 13 meter			
1st operation: 2020/12/19- 2021/01/03 (13days)						
PP1: Produced Gillnet	PA Mono-mult. No.1.5/8f 110mm x 100G x 303m HR: 31%			Fisher's Gillnet	PA Multi 36 yarn x 110mm x 72G x 260m HR: 31%	
The total area of the netting when assembled	214 x 7.8 =1670 1670/100 =16.7			270 x 5.6 = 1512 1512/100 = 15.1		
Date	Length of net	Total No. of catch	Total weight of catch(kg)	Length of net	Total No. of catch	Total weight of catch(kg)
12/19-01/03 Total	214	228	535.5	270	128	268.5
Number of fish per 100m²			**13.7**	Number of fish per 100m²		**8.5**
Weight of fish per 100m²			**32.1**	Weight of fish per 100m²		**17.8**
Boat name- msgna-2			Boat type and length: Sanbuk(inboard engine), 15.8 meter			
2nd operation:2021/11/08 - 2021/11/26 (19days)						
PP1: Produced Gillnet	PA Mono-mult. No.1.5/8f 110mm x 100G x 303m HR: 31%			Fisher's Gillnet	PA Multi 36 yarn x 110mm x 125G x 1485m HR: 31%	
The total area of the netting when assembled	214 x 7.8 =1670 1670/100 =16.7			1485 x 9.75 = 14479 14479/100 = 144.8		
Date	Length of net	Total No. of catch	Total weight of catch(kg)	Length of net	Total No. of catch	Total weight of catch(kg)
11/08-11/26 Total	214	113	175	1485	104	188
Number of fish per 100m²			**6.8**	Number of fish per 100m²		**0.7**
Weight of fish per 100m²			**10.5**	Weight of fish per 100m²		**1.3**

Table 2: Results of drift gillnet operations

In the 1st test operation, the number of fish caught per 100m² was 13.7 and 8.5, respectively, so the drift gillnet proposed by PP1 caught 1.6 times more fish than the fishermen's drift gillnet. 13.7÷8.5=1.6

The catch weight per 100m² was also 32.1kg and 17.8kg, respectively, so the drift gillnet proposed by PP1 caught 1.8 times more fish than the fishermen's drift gillnet. 32.1÷17.8=1.8

In the second trial, the number of fish caught per 100m² was 6.8 and 0.7 respectively, so the drift gillnet proposed by PP1 caught 9.7 times more fish than the fisherman's drift gillnet. 6.8÷0.7=9.7

The catch weight per 100m² was also 10.5kg and 1.3kg, so the drift gillnet proposed by PP1 caught 8.1 times more fish than the fisherman's drift gillnet. 10.5÷1.3=8.1

The results of the number of fish caught and the weight of fish caught by two types of drift gillnets obtained from these two test operations confirmed that the fishing efficiency of gillnet proposed by PP1 was high. The fishermen also pointed out the superiority of the drift gillnet proposed by PP1.

	
Produced drift gillnet	Fisherman's drift gillnet

1-6-4. Conclusion

Through the test operation, the fishermen provided the following information on the catch rate and workability of the proposed PP1 drift gillnet fishing gear.

The advantages are as follows:

(1) The thin monofilament net makes it easy for fish to get caught and entangled in the mesh.

(2) The color of gillnet is green, which reduces the visibility of fish and makes them easier to catch. From these characteristics, it would be possible to operate under a full moon.

(3) The fishing net is light and can be operated by a small number of fishermen, which is also the advantage of operating cost.

On the other hand, the following disadvantages are also pointed out:

(1) The netting line is weak and easy to break, but it is difficult or impossible to mend.

(2) It is difficult to remove fish entangled in the net.

(3) The buoyancy is too strong, so seaweed is easily caught while fishing.

(4) Small fish are caught and entangled in the net.

From these three reports and the fishermen's indications, the following information was found that the drift gillnets produced by the project were more efficient in catching and workability than the fishermen's drift gillnets. On the contrary, they also had problems such as weak lines and difficulty in repair.

Based on the information obtained, it is necessary to reconsider the material, line thickness, and mesh size of the nets. In addition, the buoyancy and sinking force and hang-in ratio should also be recalculated in order to introduce appropriate fishing nets. Fortunately, the PIU team has mastered the basic calculations and construction methods of gillnets and is ready to implement measures to improve the gear.

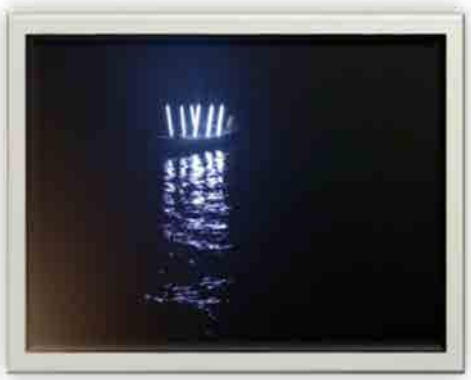
1-7. Encircling Gillnet Project

1-7-1. Construction of encircling gillnet

In March 2020, the JICA experts had to urgently return to Japan due to COVID-19, but the PIU team took the lead in completing the necessary number of encircling gillnets (three sets of 100 m in length and 16 m net depth) in May of the same year and conducted test operations.

Prior to the following year's fishing season, the fishermen suggested that the sinking force and buoyancy of the encircling gillnets could be used to quickly deploy them in the sea during the operation. Accordingly, PP1 provided the necessary fishing materials for this purpose, and the fishermen modified the net and verified its effectiveness.

1-7-2. Encircling gillnet test operation

	
Encircling gillnet preparation	Lighting from fish attraction boat

The hot season encircling gill-net operation consists of three fishing boats: a mother boat, a FRP netting boat, and a FRP fish attraction boat equipped with a generator. The size of the net is as follows: finished length: 100m x 3 = 300m, net depth: about 16m, and the operation order is as follows.

① Select a fishing ground and turn on the attraction light for about 3 hours to aggregate fish at night.

② Encircling gillnets are deployed counterclockwise around the fish-attraction light boat.

③ Stone throwing is done in the surrounding circle area to intimidate the fish and entangle them in the net

④ The encircling gillnet is retrieved onto the boat and the catch is taken out from the net.

The 1st test operation of the encircling gillnet was conducted in August 2021 by Mr.Yosife Redae of the PIU team aboard the fishing boat Alnesiem for 11 days. The total catch in this survey was 1074.8 kg, but sales and other information were not recorded,

so the survey items were modified for the next survey. *For more details, see Appendix 6: Report on encircling gillnet first trial fishing.*

The 2nd encircling gillnet test operation was conducted by Mr.Temesgen Amanuel of the PIU team aboard a Sambuk fishing boat for 9 days from the end of May to the beginning of June 2022, using an encircling gillnet modified by the fishermen.

The test operation resulted in a catch of 2,587 kg (skipjack, Spanish mackerel, milkfish, and shark), sales of 80,405.5 nakfas, expenses of 22,500 nakfas, and gross profit was 57,905.5 nakfas (approximately 550,000 yen). 80,405.5 – 22,500 = 57,905.5

For more information, see Appendix 7: Report on encircling gillnet second trial fishing.



Encircling gillnet operation



Catches by encircling gillnet operation

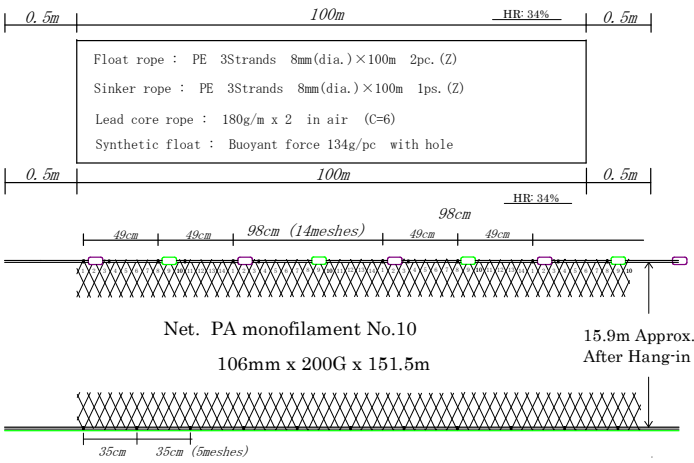


Figure2: Modified encircling gillnet

1-7-3. Results and evaluation

Encircling Gillnet test operation data 1st, 2nd			
Boat Name– Alnesiem		**Boat Length: 17 meter**	
1st operation: 2021/8/07 – 8/17 (11days)		Observer: Yoief Redae	
PP1 Produced Encircling Gillnet		PA Monofilament No.10 106mm x 200G x 300m	
The total of the netting when assembled		300 x 16 = 4800 4800/100 = 48	
Date	Length of net and height(m)	Total number of fish catch	Total fish catch in kg
2021/8/8– 2021/8/16	300m x 16m	251	1074.8
Number of fish per 100m²		**5.2**	
Weight of fish per 100m²		**22.4**	
Boat Name–		**Boat Length:**	
2nd operation: 2022/5/24 – 6/2 (9days)		Observer: Temesgen Amanuel	
PP1 Produced Encircling Gillnet		PA Monofilament No.10 106mm x 200G x 300m	
The total of the netting when assembled		300 x 16 = 4800 4800/100 = 48	
Date	Length of net and height(m)	Total number of fish catch	Total fish catch in kg
2022/5/24– 2022/6/2	300m x 16m	1016	2599
Number of fish per 100m²		**21.2**	
Weight of fish per 100m²		**54.1**	

Table 3: The result of encircling gillnet operation

The PIU team has conducted two test operations of encircling gillnets with a fish-attracting light during the hot season and prepared the report, but the superiority of the encircling gillnets produced by the PP1 could not be proven by data because they could not be operated at the same time as the fishermen's encircling gillnets. At the suggestion of the fishermen, the buoyancy and sinking force of the PP1 net were increased in the second test operation, allowing the net to deploy more quickly in the water. Although the second operation days with the modified PP1 net were fewer than in the first operation, the catch per 100 m² was higher.

However, it is not possible to determine the superiority before and after the net modification due to the large differences in operation date, fishing grounds, and fish aggregation effectiveness. At all events, the fishermen evaluated the PP1 encircling gillnet work as more effective in terms of operational and economic efficiency compared to their own encircling gillnets.

1-7-4. Conclusion

The fishermen provided the following information on the proposed encircling gillnets of PP1.

(1) The net is lighter and requires less labor, making it more profitable.

(2) Higher catch rate than the fishermen's encircling nets.

(3) The use of lead core sinker makes less noise when cast into the water, preventing fish from escaping.
(4) With lead core sinker rope, net deployment and hauling is smooth and does not get tangled in the net during operation.
(5) Fish are easily caught due to less visibility of the net

On the other hand, the disadvantages are as follows:

(1) The netting line is thin and light, so the nets break easily and are difficult to repair.
(2) The net is too slow to deploy in the sea due to the lack of sinkers and floats. (Modified by fishermen)
(3) The net depth is 16m, which is shorter than the fishermen's net depth of 28m.

The selection of materials for monofilament type of encircling gillnets also needs to be reconsidered because of the weakness of the netting line and the difficulty of repairing it. When monofilament net is used, the size of the netting line should be increased to strengthen the durability.

Although the multifilament twine is slightly more expensive than the monofilament twine, it is easier to repair and more durable. In the case of gillnets made of multifilament twine in this country, it is recommended to use thinner twine. (For example: 210D/18-24)

In addition, the buoyancy and sinking force are recalculated as necessary to increase the working efficiency and the catching efficiency.

1-8. Depth-adjustable drift gillnet project

The new prototype drift gillnet is designed to sink gradually in the water and has no floats attached to the head rope.

The unique feature of this gear is that buoys are attached to the head rope at intervals of 10 to 20 m. By adjusting the length of the buoy rope, the net can be deployed at any depth of the target fish, which varies with the seasons and growth of the fish. In addition, the net is lightweight and easy to use, reducing the amount of labor required for operation.

1-8-1. Construction of depth-adjustable drift gillnet

The depth adjustable drift net workshop was held in March 2022. After the workshop, the PIU team and the expert worked together to make 2 different types of depth-adjustable drift nets with different net depths. Another four nets of the same type were made by the PIU team.

See Appendix8：The Drift gillnet fishery for Spanish mackerel in Japan

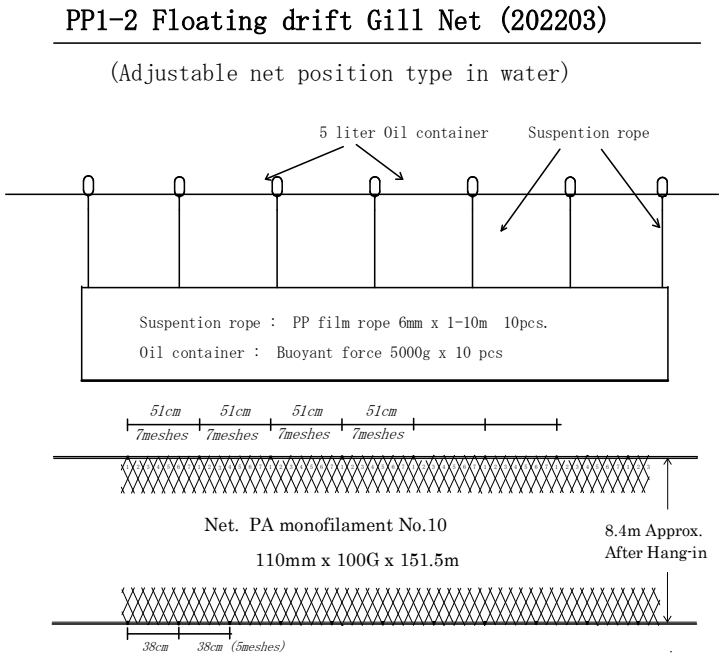


Figure 3: Depth-adjustable drift gillnet

1-8-2. Depth-adjustable drift gillnet test operation

The depth-adjustable drift gillnet was tested by the PIU team on April 5 and 6 (two days) in the waters off the southeast coast of Green Island in Massawa at a sea depth of 25-35m. As a result of trial operation, the functions of the net were verified that the drift gillnet could be set at the required depth with stable net shape in the seawater as expected. At the same time, the trial operation at sea provided a valuable opportunity for the PIU team to gain practical experience in real fishing activities. For more details, *see Appendix 9: Report on a series of floating drift gillnets making and trial operation.*

The 1st test operation of the depth-adjustable drift gillnets was conducted by Mr.Yosief Redae and Mr.Filmon Bereket Berhe in collaboration with the fishermen on board for 10 days starting from October 20, 2022,. A total of 6 sets of nets were used for the test operation: 110 mm (mesh size) x 100 m (total length) x 8 m (net depth) x 3 sets, and 110 mm (mesh size) x 100 m (total length) x 16 m (net depth) x 3 sets.

The 2nd test operation of the depth-adjustable drift gillnets was conducted for 15 days in December 2022, by Mr.Yosief Redae and Mr.Filmon Bereket Berhe in collaboration with fishermen on board. To set the net, one fisherman handles the head rope and another one handles the sinker side to deploy the net properly while the skipper navigates the fishing boat forward and finally ties the end of net with the boat.

After 3 hours of soaking, the net is started to retrieve for harvesting fish. During retrieval, while the boat is moving slowly forward, fishermen start to haul the net manually. While hauling the net, nets are stacked properly.

During the survey period, a total of two test operations were conducted, and CP provided a detailed report on the catch and operation status. *See Appendix 10: Report Demonstration on depth-adjustable drift gillnets (PP1).*

However, since only a few operations have been performed and no operations have been conducted in deeper water, it was reported that it is necessary to conduct continuous test operations in order to make appropriate evaluations.

	
Test operation with fishermen	Used container buoy

1-8-3. Results and evaluation

The results of the test operation of the depth-adjustable drift net are as follows.

Adjustable drift Gillnet operation data 1st.

Boat name–　　Boat type and length: Sanbuk(inboard engine), 20 meter

1st operation: 2022/10/20– 2022/10/30 (11days)

PP1: Produced Gillnet	PA Mono. No. 110mm x 100G x 300m HR: 31%			PP1: Produced Gillnet	PA Mono. No. 110mm x 200G x 300m HR: 31%	
The total area of the netting when assembled		300 x 8 = 2400 2400/100 = 24		300 x 16 = 4800 4800/100 = 48		
Date	Length of net	Total No. of catch	Total weight of catch(kg)	Length of net	Total No. of catch	Total weight of catch(kg)
8/20	300	4	6.5	300	3	14
8/21	300	12	37.5	300	20	40
Total	**600**	**16**	**44**	**600**	**23**	**54**
Number of fish per 100m²			**0.7**	Number of fish per 100m²		**0.5**
Weight of fish per 100m²			**1.8**	Weight of fish per 100m²		**1.1**

Table 4: 1st depth-adjustable drift gillnet

This depth-adjustable drift gillnet is a new type of fishing gear and cannot be compared to others in Eritrea. The fishermen who conducted the joint survey indicated that there

is no problem with the operation, but it is necessary to secure a place to store the buoys on board.
However, since the number of surveys is not sufficient, it is necessary to continue the test operations and make appropriate judgments.

1-8-4 Conclusion

Through the test operation, fishermen provided the following information about the PP1 depth-adjustable drift gillnets.

(1) The monofilament nets used are lighter and easier to cast and lift than multifilament nets because they do not absorb water.
(2) Fishing expenses can be reduced because operations can be carried out by a small number of people.
(3) The fishing gear can be deployed to the required depth by adjusting the length of the buoy rope.
(4) The use of lead core sinker rope avoids the net tangling and enables smooth net casting.
(5) The nets are difficult to see in the water, so this net can be operated even under a full moon.

On the other hand, some problems have been pointed out.

(1) The netting material is weak, and even new nets may break during operation or due to catch.
(2) Sinker ropes are light and easily affected by waves and currents.
(3) There is no space to keep buoys in the small boat

The above information shows that the advantages and disadvantages of monofilament nets are almost the same as those of drift nets and encircling nets. Therefore, it is necessary to determine which material should be used for better distribution in Eritrea. The advantages of using multifilament nets are the high durability of the material and the ease of repair.

Spanish mackerel and queen fish, which are the main targets of the Eritrean drift gillnet fishery, are subject to seasonal changes in seawater temperature and swimming depth during their growth process. However, the fishermen's drift net is not suitable for year-round operation because the depth of the net cannot be adjusted. To solve these problems, a depth-adjustable drift net was designed and implemented as a pilot project. From this pilot project, it was judged that this net was effective in increasing the operating time and improving the productivity of small-scale fishing boats. However, the fishing gear used in the survey is a prototype and should be optimally improved in terms of gear buoyancy, sinking force, appropriate length of suspension rope, buoy shape and buoyancy, etc. In addition, it is important that fishermen are able to procure related materials such as nets, buoys, and sinker ropes domestically. At the same time, technical assistance to the fishermen by MMR will be essential to promote this type of fishing. The

fishing demonstration was carried out together with the artisanal fishermen at their expense. As a result, it was driven by their conditions, sometimes they use gillnet and other days they use encircling gillnet which made it difficult to operate the experimental in the same fishing trip. As a result, the frequency of operation was very few. Therefore, such experiments should be tested independently to get comprehensive data.

Lessons Learned

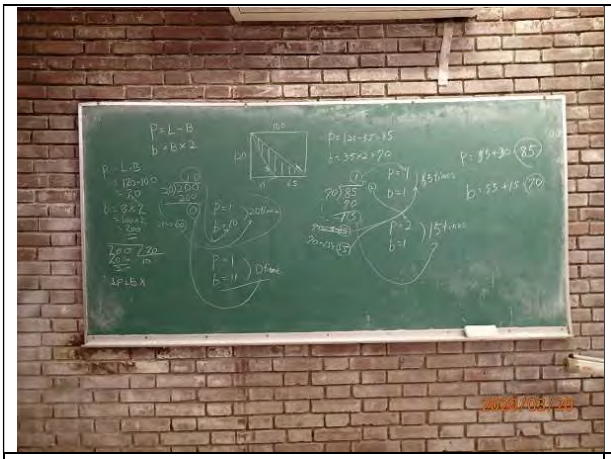
- It is important to compare the performance of experimental gillnets with that of conventional gillnets.
- The experimental gillnet and the conventional gillnet should be evaluated objectively and subjectively.

1-9. Input materials for the project

The materials and equipment prepared for the PP1 project are as shown in *Appendix 11: PP1 Material list*, but unused materials and equipment are being stored in the MMR warehouse.

1-10. Training to improve fishing techniques

Knowledge of fishing experience, basic gear calculations, and net cutting methods are important in the construction and modification of net fishing gear. This knowledge and skills training was implemented throughout the pilot project, as it is not only necessary to improve the fishing skills of the PIU team members, but is also an essential skill for the modification and construction of many types of net gear.



Formulas required for net cutting



Calculation of fishing gear construction

1-11. Electric net hauler for gillnets

Gillnetting in Eritrea is inefficient because it requires a large number of fishermen due to the thicker line and heavier net. To address these problems, MMR requested a feasibility study on the introduction of a net hauler. In response, the PP1 project planned

to procure three electric net haulers and verify its usefulness through the trial operation on a fishing boat.

As a preliminary step, in April 2022, the PIU team set up an electric net hauler on a pallet at the MMR facility in Massawa and conducted a test operation to prepare it for training and local demonstrations.

The test operation of the net hauler for gillnet fishing was conducted by the PIU team and Mr. Zenawi Frezghi and Mr. Bilen Alazar on board the fishing boat Selam3 with the fishermen.

For details, please refer to *Appendix 12: REPORT FOR HAULING MACHINE.*

From the results of the test operation, it was concluded that the gill nets used by the Eritrean fishermen are heavy and therefore some modifications to the net hauler are necessary. In addition, this net hauler was left on the fishing boat for further testing. So far, according to the fishermen's opinion, the drum of this net hauler is convenient for the use of bottom gillnet fishing, since the bottom gillnet fishing is operated as deep as 80 meters, which is difficult to haul manually. Even this machine could be effective for long-line fishing if the drum was made bigger to roll longer main line.

As a solution, the PIU team reviewed some photos of the Japanese case study and planned to modify the net hauler by lengthening the shaft of the roller and installing a bearing on the opposite side like the Japanese style.

	
Net hauler machine installed at MMR	Trial operation on a fishing boat

1-12. Fisheries training materials and technical reports

The development of the Eritrean fishing industry requires the procurement of appropriate fishing gear and the development of fishing-related facilities. At the same time, the existing fishing gear needs to be improved by introducing more efficient fishing gear and fishing methods. This, of course, requires fishery training to improve the skills of fishery workers, including newly recruited fishermen. To this purpose, the PIU team also worked on the development of effective fisheries education materials such as texts and videos that introduce new fishing methods.

In addition, technical reports of 3 pilot projects were prepared based on the information obtained from the pilot project activities.

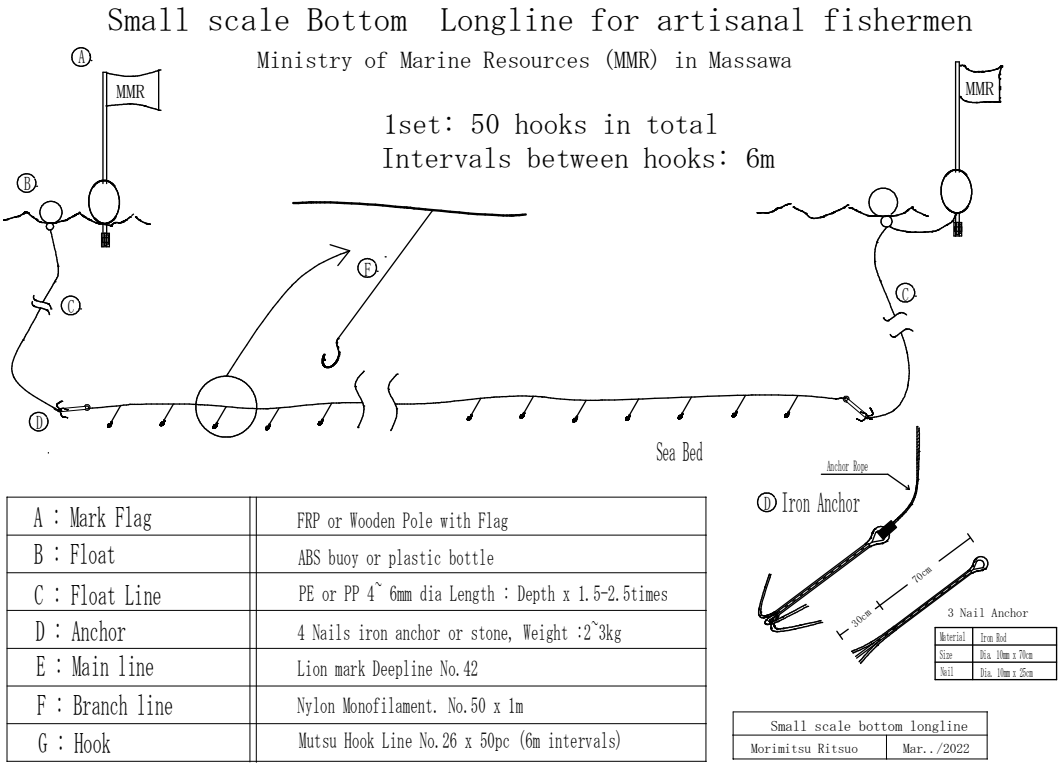
1-13. Results and evaluation

In this activity, the PIU team assigned a person in charge to develop each educational text and gave them the opportunity to improve their knowledge of fishing techniques through the preparation of training materials. In addition to this, the PIU team completed a technical report based on the knowledge and experience gained through the pilot project.

The following fisheries training materials in the local language (Tigrigna) were completed through the efforts of the PIU team.

Material Name:

(1) BASIC FISEHRY 1 (Tigrigna)
(2) BASIC FISHERY COMPREHENSIBLE (POWER POINT)
(3) Basic knowledge of fishing gear material & basic calculation in connection with fishing gear (Tigrigna)
(4) BASIC WORKS ON ROPE & NET(Tigrigna)



A : Mark Flag	FRP or Wooden Pole with Flag
B : Float	ABS buoy or plastic bottle
C : Float Line	PE or PP 4~ 6mm dia Length : Depth x 1.5-2.5times
D : Anchor	4 Nails iron anchor or stone, Weight :2~3kg
E : Main line	Lion mark Deepline No.42
F : Branch line	Nylon Monofilament. No.50 x 1m
G : Hook	Mutsu Hook Line No.26 x 50pc (6m intervals)

Figure4: Modified small bottom long-line fishing gear

2-1. Outline and Purpose of the pilot project

This pilot project was designed to explore the potential of different production methods for underutilizing bottom fish resources. Although Eritrea's bottom fish resources are considered abundant, resource development by small-scale fishermen has been slow and there is a strong need to expand fishery production. Especially during the period of rising sea surface temperatures (May-September), the operating environment is harsh and fishery production drops drastically as many fish migrate to deeper waters. Under such a climate condition, the small-scale bottom long-line fishery is considered to have high fishing efficiency due to its low initial investment and relatively simple operation methods.

At present, only semi-commercial vessels owned by the National Fisheries Cooperation (NFC) are engaged in bottom long-line fishing, and some small-scale fishermen are also engaged when bait fish are available, but many others are not. This may be due to lack of access to suitable long-line gear and difficulty in obtaining bait fish. This fishery could easily be operated by small boats and canoes of small-scale fishermen, and the plan was

to explore the possibility of developing the fishery using a variety of fishing gear, even in the hot season, as requested by the Eritrean government.

Project objective：

- Develop new fishing techniques to increase catches and diversify fishing gear and fishing methods
- Ensure the effectiveness of small bottom long-lines fishing for increasing fisheries production and income
- Promote the development of bottom and mid-water fish stocks

2-2. Pilot project implementation schedule

Implemented period of PP2: March 2022 - March 2023 (13 months)

2-3. Implementation plan and project sequence

In addition to the information obtained from the baseline survey, the small size of the fishing boats meant that bottom long-line gear was considered to occupy less space on board and be easier to operate. The selection of fishing gear for the Red Sea area was also determined in accordance with the target fish to be caught as follows.

(1) Main line: "Deep line No. 42" braided polyester line with a diameter of approximately 3 mm was selected to avoid disturbing the working efficiency.
(2) Branch line: No. 50. Nylon monofilament with a length of 1.5 m or less was selected in consideration of working efficiency. (Longer branch line is easily twisted on the main line)
(3) Hook: No. 26 Mutsu type with the tip bent inward to prevent the hooks from getting caught on the seafloor and fish from escaping.

The project started with a training session on small bottom long-line fishing → gear-making → operational practice at sea. Then PIU team conducted a small bottom-long-line test operation in cooperation with the fishermen and prepared reports.

The proof of increased profits from this small bottom long-line fishery is a prerequisite for the development and dissemination of this fishery. The selection of a cooperative fishing boat was determined in cooperation with the Northern Red Sea Branch of MMR, and PIU team observers were on board to collect information and support activities.

As for the project activities and process, *See Appendix13: Work plan for PP2* and *Appendix 14: Small-scale bottom long-line fishing test operation survey plan*

2-4. Briefing contents for project cooperating fishermen are as follows

- Overview of the project
- Purpose of the project and provision of fishing gear
- Activity plan (implementation period and schedule)
- Support structure from MMR

- Demonstration of the advantages of this fishery compared to other fisheries (fuel, food, bait, ice, and other expenses, sales)
- Questions and Answers

	
Hook hold attachment on basket	Bottom longline gear making

2-5. Outline of the project implementation and operation survey

From March to April 2022, after learning about long-line fishing in general, the PIU team prepared five sets of small-scale bottom long-line gear for small boats and for canoes, respectively, and conducted trial operation practice by MMR boat at sea.

For more information on the PIU team's training on small-scale bottom long-line gear making and operation, *please refer to Appendix15: REPORT ON SERIES OF SMALL SCALE BOTTOM LONG LINE FISHERY of JICA pilot project.*

This fishing operation is in cooperation with Captain Mr.Kadir Mohamed Ali who is a member of fishery cooperatives of Northern Red Sea with a lot of skills and 30 years of experience in fishing. The size of the fishing boat is 13 meters long, wooden (so-called sambuk) named as Misgna1, license number 31155/06 and has Yanmar 4 piston inboard engine.

The first small bottom long-line test operation was conducted by PIU team member Osman Ibrahim and the above-mentioned fisherman for 11 days starting from the end of June 2022. During this research period, sea conditions, casting and hauling times, fishing grounds, catch amounts, species composition, etc. were recorded in each operation. For more information, *see Appendix 16: Report on the Demonstration of Small Scale Bottom Long-line Fishing (Artisanal fishers)(PP2), Appendix 17 : Report on 3rd Long Line Trial Fishing*

2-6. Contents of activities for operation

(1) Attach bait to all hooks before fishing.

(2) Decide on a suitable fishing ground. (Taking into consideration of the direction and strength of the wind and tidal current, as well as the seafloor condition)

(3) Buoy and anchor are connected with the rope of 1.5 times of sea depth, and main line is attached with anchor.
(4) The casting order is from the buoy, anchor rope, anchor, and main line.
(5) One person casts the branch line with baited hooks one by one along with the boat speed.
(6) A small buoy and weight are attached to the connecting part of the main line with the rope at 1.5 times of the sea depth to prevent the fishing gear from being lost.
(7) After 3-4 hours, hauling the main line along with the boat speed.
(8) One person hauls the main line, while the other person collects the catch and stows the branch line into the basket.

Later, the diagram of the fishing gear configuration is modified by actual operations with fishermen. (6m branch interval and strengthened the attachment parts between the main line and the branch line).

	
Baiting work on the hook	Stored Queen fish in the ice

2-7. Activity Results and Evaluation

2-7-1. 1st test operation

The first test operation was conducted during the period 26/06/2022 to 06/07/2022, in different fishing ground conditions (around coral reef and muddy area) when the weather was rough and hot season. The operations were continued during this period in order to determine the feasibility of the fishing conditions, including catches. The test operations were performed manually in the early morning and evening. The operation was conducted with a member of fishing cooperatives of the Zoba Northern Red Sea with boat type hurri 13m in length and it is powered by diesel inboard engines of 160 HP (3 piston) navigating speed of 6-7 knots.

Initially, the fishing grounds were chosen in accordance with the widest possible coverage of the area. As per the predetermined fishing grounds, the fishing operations conducted by gillnet achieved good fish catch. Later, some caught fish were used as bait for the trial operation of the bottom long-line fishing. By using that bait, the bottom long-line fishing gear was set and soaked for one hour. The species used as bait were Indian

mackerel, ray fish, tuna, catfish, and barracuda. These species were cut off into small pieces before being hooked.

During the bottom long-line fishing, the fishermen operated 12 units of gillnets and caught approximately 600 kg. Although the number of gillnet operations was not recorded and accurate comparison between small bottom long-line fishing and gillnet fishing cannot be made, the fishermen expressed their desire to operate bottom long-line at the un-operation time of gillnet.

The summarized result of the test operation of bottom long-line fishing is as follows:

Number of operation: 7 times. Number of hooks: 900

Total catch: 345.5kg (64pcs) Average catch rate: 0.38 kg per hook

Catch data are recorded in Table 1

Comparing the harvested catch with the cost it was profitable because the total cost of the trial was 6,050 Nakfa and the total revenue of the selling price of fish was 10,135.75 Nakfa.

2-7-2. 2nd test operation

The second bottom long-line test operation was conducted by PIU team members Mr. Filmon Bereket Berhe and Mr.Yosief Redae at Dolphidol. The fishing operation was conducted from 18 to 29/08/2022 in the morning. It was operated by a fiberglass reinforced boat 7m in length, 4m width, and with another mother boat 20m in length, 4m width, and it was driven by a skipper namely Mohamed Abdela Mohamed. The main species used for bait was fresh Spanish mackerel that was caught by gillnet. The gear was set and retrieved manually after three hours of soaking.

The results were summarized as follows:

Number of operations: 2 times Number of hooks: 250

Total catch: 20.2kg (10 fish). Average catch rate: 0.08 kg per hook

This trial operation was not convenient because of the shortage of bait and the fishermen was shifted to use other fishing gear of encircling gillnet and drift floating gillnet. However, this fishery is advantageous in terms of fuel, labor, and other costs, and it is also easy to change fishing grounds.

2-7-3. 3rd test operation

The third bottom long-line test operation was conducted by PIU team members Mr.Filmon Bereket Berhe and Mr.Yosief Redae. It was involved in different islands (Desei, Madot, and Dahlak (Nokra)) from 17 to 23/12/2022. The lines were laid on the coral reef for fishing in the morning and in the evening. The main species used for bait were fresh jackfish and Spanish mackerel.

The results can be summarized as follows:

Number of operations: 7 times Number of hooks: 350

Total catch: 64.7 kg (32 fish) Average catch rate: 0.18kg per hook

Compared with other fishing gear, PP2 bottom long-line fishing has several characteristics of selectivity of catch, simple to prepare and easy to handle when setting and hauling, and also the harvested catch was higher in price and quality.

The obtained results from the bottom long-line test operation are as follows

Table 1: Recorded catch data of PP2 — **27/6/2022~3/7 (6times operation)**

date	setting time	retrieval time	No. of Basket (hook bin)	fish name	No. of catch	weight of catch kg	fishing ground	depth (meter)	Sea condition
6/27	8:30	11:30	3	red snapper	6	15	Ras dalal	36	Wavy
				emperor	1	2			
				catfish	1	3			
				guitarfish	1	15			
				grouper	2	5			
				shark	2	55			
6/28	8:00	14:00	4	grouper	4	12	Harat Island	10	Wavy
				emperor	1	1			
				shark	2	8			
				barracuda	1	6.5			
6/29	10:00	16:00	3	queen fish	9	54	Wekiro	6	Calm
				barracuda	1	5			
				catfish	2	6			
				shark	7	15			
6/29	17:00	22:30	3	queen fish	9	50	Wekiro	6	Calm
				shark	2	4			
				red snapper	2	10			
6/30	7:30	11:30	2	shark	1	40	Wekiro or Halibay	12	Wavy
7/1	7:30	12:30	2	jack fish	1	10	Imberemi	11	Calm
				queen fish	1	6			
7/3	7:30	11:30	2	jack fish	1	6	Wekiro or Halibay	18	No Calm nomal
				queen fish	1	5			
				shark	6	12			
6days (7 time operations)		Total	19		64	345.5			

Table 2: Recorded catch data of PP2 — **24/8/2022~26/8 (2times operation)**

date	setting time	retrieval time	No. of Basket (hook bin)	fish name	No. of catch	weight of catch kg	fishing ground	depth (meter)
8/24	8:00	11:00	3	jack fish	1	5	dolphidol	4
				queen fish	1	5.2		
				grouper	4	5		
				emperor	2	2		
8/26	8:00	11:00	2	grouper	2	3	dolphidol	5
2days (2time operations)		Total	5		10	20.2		

Table 3: Recorded catch data of PP2 — **17/12/2022~20/12 (3times operation)**

date	setting time	retrieval time	No. of Basket (hook bin)	fish name	No. of catch	weight of catch kg	fishing ground	depth (meter)
12/17	13:00	17:00	3	grouper	8	14	desei	6–23
				shark	1	2		
				red snapper	1	4		
12/19	9:45	15:00	1	red snapper	2	6	madot	10–20
				grouper	1	2		
				grouper	1	4.5		
12/20	10:00	16:00	1	grouper	4	4	madot	11–20
				red snapper	3	10		
6days (7 time		Total	5		21	46.5		

Table 5: Operation data of PP2

2-8. Input materials for the project

	PP2 : Pilot Project for Development of Small Scale Bottom-longline Fishing			
	Materials list			
No.	Items	Specification/discription	Amount	Unit
	Materials for bottom longline			
1	Main line	Lion mark, Deepline No.42 x 500m 4kg	7	ps
2	Nylon Monofilament	No.16 100m(coil type)	7	ps
3	Nylon Monofilament	No.18 100m(coil type)	7	ps
4	Nylon Monofilament	No.30 1000m(large coil type)	1	ps
5	Nylon Monofilament	No.50 1000m(large coil type)	1	ps
6	Hook	Mutu type No.16 x 300pcs.	2	bag
7	Hook	Mutu type No.20 x 300pcs.	4	bag
8	Hook	Mutu type No.25 x 100pcs.	5	bag
9	Mark light	LED waterproof flashing light type	3	ps
10	PE sheet	PE forming sheet	1	ps
		sub-total		
No.	Items	Specification/discription	Amount	Unit
1	Main line	Lion mark, Deepline No.8 x 500m	3	ps
2	Nylon Monofilament	No.12 1000m(coil type)	1	ps
3	Nylon Monofilament	No.8 1000m(coil type)	1	ps
4	Hook	Mutu type No.14 x 500pcs.	1	bag
5	Rope	PP cross rope 3mm x 500m	1	ps
6	Hook	Mutu ring type No.28 x 100pcs.	1	ps
7	Hook	Mutu type No.28 x 100pcs.	2	ps

Table 6: Material list of PP2

2-9. Overall results and evaluation

2-9-1 Overall evaluation

The test operations with three different boats were carried out in the period from June 26/2022 up to December 23/2022 including the hot season. In overall trial operation was carried out 16 times, 1500 hooks and the total harvested catch was 430.4kg (106pcs) and also the average catch rate was 0.28kg/hook. In general, the fish caught were profitable and the dominant fish were coral reef species and large pelagic species. Cooperating fishermen suggest based on their skill and experience that the gear should have a loop or eye in the main-line to reduce twisting and make it easy to repair. The main bottleneck to the expansion of the small-scale bottom long-line fishery is the shortage of bait, which was the main concern of most of the fishermen.

The small bottom long-line fishery in Eritrea is an irregular operation, making it difficult to obtain the necessary information that can be compared with the fishing gear proposed by PP2. The PIU team recognized that the small bottom long-line fishery is highly advantageous because of the small amount of investment money needed to make the gear, and the small amount of operating expenses since this fishing can be operated with few fishermen.

In the case of the test operation, the project had to provide fuel and other necessities to the fishermen; without such support, the fishermen focus on their fishing and it is difficult to obtain the necessary data.

2-9-2 Best practices and the potential of the gear for dissemination

(1) In the small-scale bottom long-line fishery, it is important to make a profit with low fishing expenses.

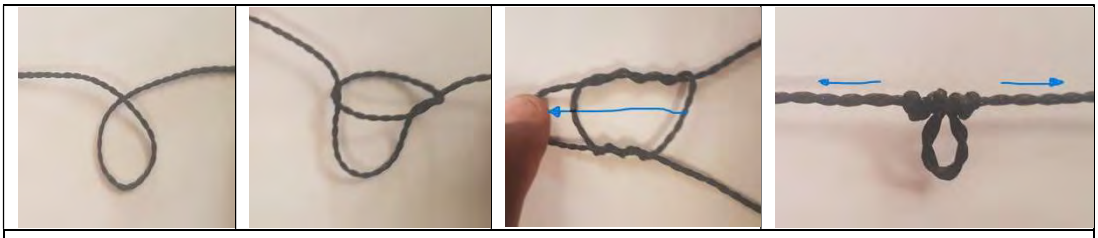
(2) Most Eritrean artisanal fishermen use loop or eye in the main line for proper attachment with branch line.

(3) For the gear capacity building to the fishermen, providing some training on fishing gear and fishing methods are useful.

(4) Supply of fishing gear and fuel for the test operation to fishermen.

(5) Supply of fishing gear material at an affordable price.

(6) Coordinate for further trial operation and give the necessary support for dissemination such as (small clips, swivel, basket gear, stainless still wire, monofilament main line, and hooks).



Preparation of loop in main line

2-10. Lesson learned

The lessons learned from this pilot project are:

(1) Bottom long-line fishing gear can be prepared by a simple method through the locally available materials

(2) The skill and knowledge of fishing gear can be enhanced by practicing practical works

(3) The results of these small-scale bottom long-line fishing trials encourage further efforts to develop bottom long-line fishing.

(4) Further trials should be undertaken in other areas.

(5) Fishing methods are already established and should be made available to Eretria fishermen.

(6) The MMR need to assist the fishermen by providing adequate supply of fishing gear materials at affordable prices.

(7) Provide sustainable supply of fishing gear and training to improve the skills and knowledge in fishing operation.

The key points for the dissemination of this fishing could be the provision of materials and the accessibility of baits.

2-11. Conclusion

The fishermen expressed the following opinions concerning the small scale bottom long-line fishery.

Advantages and disadvantages

(1) This bottom long-line fishery is simple, takes up little space on a fishing boat, and can be easily moved from one fishing ground to another.
(2) It can be operated by a small number of fishermen.
(3) The fish caught is fresh and can be sold at a high price.
(4) With the right size of hooks, it is possible to catch a large number of fish.
(5) The branch line is easily detached loosed from the mainline when a fish is hooked.
(6) The main line is easily broken when hooking the line in coral reef.
(7) It is necessary to catch bait fish before operation.
(8) Sometimes, the bottom long-line cannot be operated due to a lack of bait fish.

The disadvantageous points that need to be solved, Regarding point (5), "the branch line comes off when a fish is hooked", and the problem has been solved by improving the making method of the fishing gear. Regarding (6), it is necessary to prevent damage to fishing gear by avoiding coral reefs. In addition, some types of fishing equipment like fish finder and GPS will be important in the future for the stable development of bottom long-line fishing. Regarding (7) and (8), it is necessary to utilize inexpensive fish caught by operating with gillnets as bait.

If the fishermen can keep their bait fish in cold storage at the Massawa fishing port facilities, it is likely that the small-scale bottom long-line fishery will be quickly promoted.

The Eritrean drift gillnet fishery is often forced to stop operations at sea during stormy weather or around the full moon period.

In such cases, the small bottom long-line fishing can operate not only during the full moon but also during stormy weather, in the shadow of islands, or in bays where the fishermen can avoid the effects of wind and waves.

These many advantages are considered to have been verified through the test operation. If this fishery can be operated year-round, including during periods of the hot season. It is expected to increase the income of the fishermen and improve their livelihoods by expanding fishery production, and providing a stable supply of marine products to the people of Eritrea.

To date, no major technical problems have been identified in the dissemination of this fishing technology. It is expected that MMR will promote the small-bottom long-line fishing technology and approach the fishermen based on the information obtained from this project. In that case, MMR should establish a specific and practical support system focusing on the economic aspects of sustainable fishing.

PP3: Pilot Project for Introducing Small Scale Set net (Pound net) Fishing

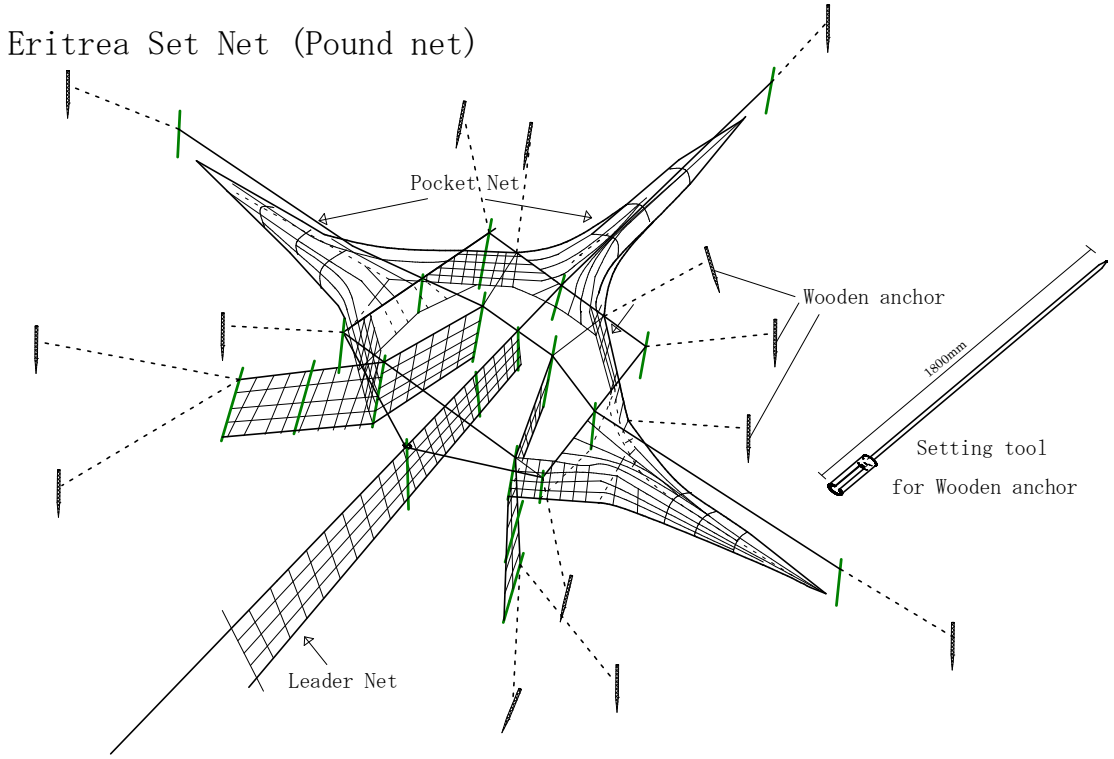


Figure5: Pound net

3-1. Outline and purpose of the pilot project

Eritrea has a coastline of approximately 1,350 kilometers, and many subsistence fishermen (foot fishers) live along the coast. They mainly fish with small-scale gill nets and hand lines during the fishing season from October to May of the following year, when the water temperature is low.

The purpose of this pilot project was to verify the effectiveness of this new fishing method by constructing small-scale Set net (Pound nets) and conducting test operations in collaboration with subsistence fishermen in the villages of Hirgigo and Zula. The proposed Pound net fishery is a nature-friendly fishing method that utilizes the habits of fish migration in coastal areas. Once set up the net in the sea, it is an efficient fishing method that requires only one to two hours of operation each day, except for net changes every three weeks. Furthermore, this fishing method is expected to increase fishery production and improve livelihoods in fishing village through community development as the net is managed by village fishermen who survive in the coastal areas. In addition, in the construction of fishing gear for Pound nets, the project aimed to improve the fishery knowledge and technical skills of the PIU (Project Implementation Unit) team members of MMR staff, such as calculation and practice of net cutting and splicing of ropes.

Project Objective:

- To introduce Pound net to subsistence fishermen as a new technology to increase fish production and improve fishing efficiency.
- Acquire knowledge and practical skills in Pound net fishery by MMR (Ministry of Marine Resources) officials, PIU (C/P) team members and other fishery stakeholders.
- Diversify marketing opportunities by catching live fish species that come to coastal waters.

3-2. Pilot Project implementation schedule

Implemented period of PP3: Nov.2021~Mar.2023 (17 months)

3-3. Implementation plan and project sequence

For this Pound net project, the net scale and net type were determined and the net height was set at 1.5 m to allow for operation by a small number of fishermen without the use of fishing boats. The project also used locally available fishing materials such as wooden stakes and wooden anchors. In addition, JICA expert provided the following assistance for the project.

(1) Lecture: General information on Set-net fishing, fishing grounds, fishing gear configuration, and fishing methods.
(2) Materials: Those materials that cannot be procured locally were purchased in Japan and constructed locally through practical training.
(3) Operation: Practical training on how to determine fishing grounds, operation methods, management of fishing gears, and fish handling methods.

The project planned for the Working Group (WG) to conduct pilot operations and collect data, while the PIU team will provide support the WG and prepare the reports. *For details, see Appendix 18: Work plan for PP3.*

3-4. Outline of the project implementation

This pilot project was initiated by the PIU team and the JICA expert in cooperation with the foot fishermen in the villages of Hirgigo and Zula. In November and December 2021, prior to the start of the project, the project meeting was held and agreed upon in both fishing villages where the Pound nets will be installed. At the same time, the members of the working group (WG) were appointed in Hirgigo before the project started. After that, the Pound net fishing gear for Hilgigo was completed in cooperation with a JICA expert and the PIU team at the MMR facility in Massawa.

Then, in February 2022, the PIU team constructed the Pound net for Zula by making the necessary calculations and cutting the net based on the design paper. Through these activities, the PIU team proved their high level of knowledge and technical skills in this net.

3-5. Hirgigo village

3-5-1 Pound net construction practice

According to the design prepared by the JICA expert and under his guidance, the Pound net construction was carried out at the MMR head-quarter from 02 to16 December 2021. After learning about the Set-net fishery through the workshop, the MMR staff and the PIU team started the practical training of Pound net making according to the work plan. This net making was conducted with explanations of basic calculations for net construction, net cutting methods, and design features. It took about two weeks to complete the Pound net fishing gear by 7 members a total of MMR staff and PIU team.
As for the design of the Pound net, see Appendix 19: Eritrea Pound Net 20211218.

	
Discussion on the Pound net design	Net cutting practice

3-5-2 Working process of the Pound net

(1) Inspection of fishing gear materials, preparation of materials, and revision of the net design
(2) Learn about net fishing gear materials and Set net fishery in the workshop
(3) Making anchor ropes and frame ropes and designing anchoring tools
(4) Learning how to cut the net mesh and cut out the required net parts
(5) Making of the leader net (attaching the head rope and sinker rope) and procuring the PVC frame for the pocket net
(6) Cutting out the pocket net parts, reinforcing the net edge, and practicing the method of diagonal net cutting method
(7) Cutting out the playground net parts, reinforcing the net edge, calculating and practicing the diagonal net cutting by the participants
(8) Attaching PVC frames to pocket nets, assembling of playground nets (attaching of head ropes and sinker ropes)
(9) Connecting three pocket nets to the playground net, preparing wooden stakes and wooden anchors
(10) Preparation of other materials and necessary tools for Pound net deployment work at sea

3-5-3 Pound net deployment and operation survey

In the early morning of December 16, 2021 Prior setting of the Pound net, in consensus with Hirgigo working group (WG) there was a selection of the right fishing ground conducted. Next day after determination of the appropriate fishing ground, at 06; 00 a.m. low tide the Pound net sequential setting of its parts evolved.

The sequence of the main parts included;

- Setting the wooden stake with its frame rope.
- Setting the wooden anchor in diagonal line from the wooden stake.
- Adjusting the entire frame.
- Attaching the pocket net unit on the offshore side from the outside of the frame rope.
- After the entire net was attached to the frame, the three pocket nets were extended to the outside.
- The leader net is stretched from the offshore side to the land side and the end of the land side of the net is secured with a wooden anchor.
- The whole net was adjusted.

Next day after installation, the PIU team visited to the site, as per checking the situation of Pound net and its catch. The net that we found in good manner as per it installed. Regarding the catch in the first day of fishing, they harvested around 4kg mainly barracuda.

3-5-4 Pound Net Fishing Operation in Hirgigo

After deploying the Pound net, the WG recorded 1, 3, 2 and 2 kg of fish catch respectively in the given data sheet during the first four days. The PIU team supported the project activity and provided the necessary tools such as cooler, baskets and scale. Later on, this fishing ground was changed by consensus of the WG and PIU team due to low catch as well as seaweed and marine algae problem. Very soon in mid-January 2022, the net was moved to another deeper position by PIU team and WG for better catch. Unfortunately, one week later, the net was completely distorted by the current and covered with seaweed and algae. At that time, the WG leader was not available, so the PIU team discussed with the two available WG members. At the discussion with WG, the following opinions were expressed:

- Very low catch, difficult to stay long without profit
- The fishing ground is far from the coast, and the intertidal zone is poor in fishery resources.
- This type of fishing gear would be efficient around the coral reef area, but this coast is muddy all around.

Ultimately, the PIU team decided to retrieve the net completely.

A key to the success of the Pound net operation depends on the willingness of the WG for proper care of the net. So, the PIU team discussed with the village administrator for

better operational measure whether to replace the WG member or to change the operation site.

3-5-5 Pound Net Redeployment in Hirgigo

Replacement works of the Pound net were carried out on January of 2022. However, the activities were hampered by wave that damaged to wooden stake and negligence of WG. In countermeasure of the problems faced, the replacement of the WG member was implemented and net deployment was undertaken on 23-24/11/2022 for test operation. Accidentally, one day after the net deployment, the net was damaged by strong current and wave action and most of the wooden stakes that holding the net were broken and lost. Consequently, all parts of the Pound net were retrieved. As for the problems related to the fishing site, especially the nature of the bottom material is mostly sand and the location is exposed to wave action. Therefore, the site may not be suitable for setting this type of fishing gear. But the Hirgigo WG wants to try again and is ready to find another suitable site.

	
Project meeting at Hirgigo	Completion of the Pound net deployment

3-6. Zula village

3-6-1 Pound net construction practice

The key points of the net construction are the design. The Zula Pound net was constructed from early January to mid-February 2022 by the PIU team without the assistance of the expert based on the design guideline.

This indicated that the C/P had acquired sufficient skills and knowledge of the Pound net construction through on-the-job training. This complicated net construction consists of many different parts, such as diagonal net cutting and then joining to create the desired design. During the construction of this Pound net, the following activities were evolved;

① Make a frame rope to hold the shape of the pound net.
② Make a leader net and two wing nets by attaching the head and sinker lines.
③ Assemble the main body of the net and attach the head and sinker lines.

④ Attach the PVC pipe ring frame to the pocket net (three pocket nets) and connect it to the body net.

⑤ Prepare wooden stakes and wooden anchors to secure the net frame.

	
Slope net cutting practice by C/P	Net attachment work to PVC frame

3-6-2 Pound net deployment and operation

The Pound net deployment work in the coastal waters of Zula was carried out by the PIU team and other relevant members in cooperation with the Zula Pound net WG from 14 to 19 March 2022.

Prior to the deployment of the Pound net, the following procedures were performed. On March 10, 2022, before the site selection, the PIU team instructed the WG on the overview and characteristics of the Pound net. Then, after discussing and sharing enough information about the Pound net, the WG and PIU team agreed to deploy the net in the east of Zula village, which is a bit exposed to wave action and current. Considering the problems encountered in Hirgigo, the PIU team decided to deploy only the leader net. After two days, on March 16, 2022, the leader net was found to be dismantled by wave action. Thereupon, the PIU team and the WG had a meeting on that matters to be resolved that the site is difficult to deploy the net. Therefore, through discussion and consensus between the two groups, it was decided to change the fishing site and redeploy the leader net to the southeast of Zula, which is protected from waves and currents. The deployed leader net was found to be stable as it was fixed after two days of relocation, and then the group confirmed that the site was suitable for the Pound net. On March 18, 2022, the Pound net were deployed by the PIU team and Zula WG in the early morning at low tide.

3-6-3 Pound Net Fishing Operation in Zula

After the installation of the net, the PIU team briefed the WG on the importance of daily operation and catch data recording. In order to verify the effectiveness of this net, one record sheet was prepared and given to the WG. The net started catching fish from the first day of operation. Mainly the following fish were caught, Indian Mackerel, Guitar Shark, Small Talang Queen Fish (local name - Alsan), Barracuda, Marbled Spinefoot, Cobia etc. According to the result of this demonstration, this type of net is quite important for the coastal fishing community to acquire daily fish for subsistence and income. Currently, the members of the WG share the catch among themselves for their daily household consumption. Once the supply of ice and cold storage is prepared in Zula, it will help them to sell their catch to villagers or Foro town.

3-6-4 Redeployment of the pound net in Zula

The re-deployment work of the Pound net was agreed in consensus with Zula WG. According to the deployment plan, the PIU team visited Zula (01/11/2022) to check whether all materials of Pound net are available or not. The materials were pre-checked together with WG and confirmed that some materials were missing or broken like wooden stakes. So the PIU team ordered the WG to prepare the missing materials. One week later, on 08/11/2022, the Pound net was deployed in the same fishing ground that was previously deployed in the east of Zula village.

The characteristics of the Pound net compared to the subsistence mullet gill net are as follows:

- ○ Daily operation time is short
- ○ High initial cost of materials and construction
- ○ Difficult to construct and install, especially for fishermen
- ○ Easy to operate once set, even women or elderly can operate it.
- ○ Fish caught alive, so it has high quality.
- ○ Operation and catch are greatly influenced by fishing ground.
- ○ Important source of income for rural foot fishermen.
- ○ Foot fishermen along the long coastal line have high potential of dissemination.

	
Training for fishing operation	Catch data recording

3-7. Input materials for the project

Fishing gear materials used in this Pound net project were procured from Japan, including polyethylene (PE) nets and polypropylene (PP) ropes, which were difficult to purchase locally. Used floats and lead core ropes for sinkers were purchased from an MMR subsidiary in Massawa. To reduce project costs, wooden stakes and wooden anchors were procured in Asmara, and iron tools for setting the net frame into the seabed were ordered to one division of MMR.

For more information, please refer to Appendix 20: PP3 Materials list.

3-8. Result and evaluation of the Pilot Project

The Pound net project in Hirgigo started in December 2021, but the fishing gear was damaged due to the miss selection of fishing grounds, and the inflow of seaweed caused to low catches. As the WG lost motivation to work, the PIU team continued to support the pilot project but eventually made the decision to suspend operations and retrieve the fishing gear from the sea. *For more information, see Appendix 21: Report on Implementation of Small scale Set net fishing pilot project for foot fishers (PP3) in Hirgigo.*

On November 23, 2022, after the restart of the pilot project with new WG members, the PIU team worked with the WG to deploy the net in the sea. However, the fishing net was damaged by unexpected stormy weather that night and the net was retrieved from the sea the next day.

The Pound net project in Zula started operation after the WG and the PIU team jointly conducted a fishing site survey in March 2022. The Pound net operation in Zula had good results, which verified that the Pound nets in the coastal area targeting foot fishermen are effective when appropriate fishing grounds are selected. However, the wooden anchors are not strong enough to hold the nets in place when the sea is rough, so some improvements are needed, such as strengthening the fixing power of anchors. *See Appendix 22: Report on Implementation of Pilot Project for Introducing of Small Set net fishing (PP3) in Zula.*

On November 8, 2022, on the deployment of net in Zula Pound net was completed and the WG continued the operations. And later, in January 2023, the WG retrieved the Pound net for maintenance and now it is on its way for redeployment.

Record Sheet for Fish Catch of Zula Pound Net			
		Year:	2022
Catch records			
Date	Species (fish) Name	Total Weight(kg)	Total Number of fish
3/18	Indian mackerel	1	15
3/19	Indian mackerel, small queen fish	4.5	20
3/20	Guitar fish, White shark, Jack fish, Others	20.2	
3/21	Indian mackerel, small talang queen fish	8	
3/23	Indian mackerel, Barracuda, Jack fish	19.6	
3/24	Indian mackerel, small talang queen fish, Needle fish	80	172
3/25	Indian mackerel, small talang queen fish, Grouper	38	10
3/26	Cobia, Shark, talang queen fish	27	
3/27	Indian mackerel, Needle fish	11	
3/28	Indian mackerel, talang queen fish	22	
3/29	Catfish	13	
3/30	Catfish, spinefoot	11	
	Total	**255.3**	217

Table 7: Fish catch data of PP3

The above catch data represents 12 days of operation of the Zula Pound net in March 2022, with a total catch of 255 kg, or an average of 21 kg per day. The catch was good despite the net depth of 1.5 m.

3-9. Conclusion

As it is known, the Pound net is a stationary fishing gear that is used in the intertidal area. And it would create a favorable atmosphere for coastal communities. Before deploying the Pound net, some conditions are required such as the sea bottom should be muddy, protected from waves (calm sea condition) and close to coral reef area or fish habitat.

There are many differences between the two villages that implemented the Pound net project for subsistence fishermen, including the fishing grounds and where the catch is sold, as well as the attitude of the WG towards the project.

In the case of Hirgigo village, it is located near Massawa city and many villagers commute to work. In terms of fishing, foot fishermen engage the small scale gillnet fishing and hand line fishing by Styrofoam float and the catches are sold at a relatively good price. However, there is a problem of suitable fishing grounds for the Pound net project.

On the other hand, operations in Zula remained stable after the net was transferred to a suitable fishing ground in March 2022. This village is located 1.5 hours away from Massawa by car, and the price of the catch is low. Furthermore, it takes more than an hour to walk to the sea.

In addition, the living conditions in Zula were assumed to be more difficult than those in Hirgigo because there are only a few places to work near Zula. Under these circumstances, the Pound net project was expected to be a new source of income. The positive result of the project was probably led by the motivation of the WG in Zula.

From the results obtained in these two fishing villages, the following requirements and characteristics of Pound-net fishing by the subsistence fishermen in the Eritrean coastal areas were clearly identified.

① Good fishing grounds are in small bays or coves where the less effect of wind and waves.
② Deploy the leader net for intercepting the way of migratory fish.
③ The seabed should be muddy and suitable for holding wooden anchors in place.
④ Fishing grounds should be located as close as possible to the village.
⑤ Daily operation time is short as 1 to 2 hours, therefore, fishermen can engage in other work after the operation.
⑥ Seaweed and floating debris must be removed in each operation. The nets should be taken out from the sea every three weeks for maintenance.
⑦ Fish caught are live and fresh. If live fish are kept in fish cages, the sales and consumption can be adjusted.
⑧ If the fishing grounds are located near coral reefs, there is a possibility of catching more fish.
⑨ This fishery will be one of the fishing methods of fish production for the subsistence fishermen in Eritrea.

At the October 2022 activity plan meeting in Zula, the WG requested additional Pound net fishing gear, which is also likely to be effective for local fishermen. The PIU team has already constructed one Pound net for Zula, so it is possible to construct another one if they have enough materials. In addition, the Zula Pound net WG has requested a workshop on net mending.

As this village is far away from the MMR, it is desired that the PIU team will be able to provide sufficient support using the fisheries textbooks that are being prepared.

3-10. Development Strategy and Recommendations

Currently, the abundant sardine resources in the coastal areas of Eritrea are underutilized. Therefore, the Eritrean government is currently researching ways to process and distribute these resources, but effective fishery production methods have not yet been established.

At present, this stock of sardines is caught by beach seine nets in the southern coastal areas of Eritrea when they migrate to the coast during the low sea temperature season. However, sardines need to be handled with ice because their freshness declines quickly after being caught. On the other hand, live sardines are caught by Choko-ami which is one of the Set nets in Japan. This net can keep live fish in the net, and the selling amount and date of landing can be adjusted by using the fish cage.

Considering the current fishing environment in Eritrea, a suitable scale of the Choko-ami for catching sardines would be set in waters 5 to 8 meters depth. Of course, there are issues to be solved in this fishery, such as the purchase of necessary equipment and materials, the number of fishermen engaged in the fishery, management rules, etc. But it is worth considering as an alternative fishery to beach seine nets. *For more information on the net, see Appendix 23: Choko ami (8m).*

4: Others

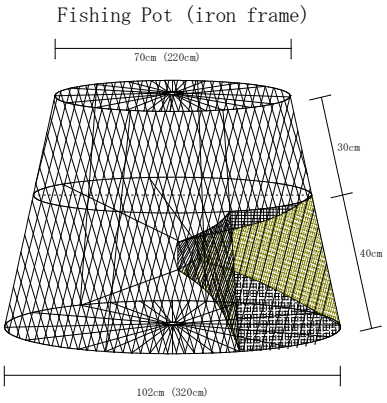
4-1. Additional fishery: The Pot fishing potential.

Pots (baited traps) are a fishing technology that typically has lower impacts than many other industrial fishing gears. In this study, JICA expert designed pots (baited traps) with MMR counterparts. Pots (also commonly referred to as traps) are stationary fishing gear widely used in commercial fisheries around the world. Pots are transportable and typically use bait to attract target species, with retention devices to prevent escape. The benefits of using pots include lower by-catch rates, minimal impact on marine habitats, and a reduced contribution to ghost fishing (when constructed with biodegradable twine) compared to gill-nets. Pots have also been classified as Low Impact and Fuel Efficient (LIFE) gear because they require less fuel to catch fish than other fishing gear. In addition, fish caught in pots remain alive until the gear is retrieved. As a result, the flesh quality of fish caught in pots often exceeds that of other types of gear, because of the fish are immediately damaged by the act of capture. In addition, un-targeted species can be returned to the water with a high probability of survival.

During the pilot project, the PIU team conducted a test operation using pot fishing gear to investigate its potential as a new fishing method to catch bottom fish in coral reef areas. The results of the at-sea surveys using two types of pot fishing gear demonstrated that good gear selection can reduce gear damage and allow for efficient fishing in coral reef areas. This fishery is easy for even small-scale fishermen to engage in, and will be effective in developing a variety of fisheries in the future. In addition, the pots constructed by MMR are designed to be stacked on board and occupy little space.

In the future, we expect to collect appropriate information through test operations of the pot fishing gear in order to promote the pot fishing industry. The following photos are pot fishing gears used in the test operations.





Collapsible type of Pot	Stackable type of Pot

Figure6: utilized two type of pots

4-2. Strategies for coastal fisheries development and recommendations for practical approaches and dissemination

○ Continuously exchange information with fishermen and build a strong relationship with them through the dissemination of fishery technologies.

○ The MMR need to consider and implement practical measures to strengthen the technology dissemination system.

○ The MMR should have technical expert in fishing gear design as it is a cornerstone for fisheries development.

○ The MMR will contribute to the development of the fishery industry in Eritrea by effectively using the data and materials accumulated through the pilot project, including the knowledge and experience (lessons learned).

○ The MMR will take the leadership in extension activities, while assuming the sense of responsibility and independence of the fishermen.

○ Focus on economic aspects such as fishery income and expenditure for sustainable fisheries management.

○ Ensure that fishermen can locally procure appropriate fishing gear (nets, buoys, ropes, etc.) and fishing boats for the development and expanding of fisheries production.

○ Expand support services for fishing activities through the preparation of fishery-related facilities.

○ For tender documents, specifications such as material lists should be reviewed and prepared for procurement.

○ The pilot project was designed and implemented as a practical approach and we expect it to be used effectively as a guideline.

○ MMR will continue to produce fisheries education materials and technical reports in line with the actual situation of fisheries for the development of fisheries in Eritrea.
○ For the reason of easy net making, measuring stick for easy marking on the net is useful.
○ Provide tools and specific example to fishermen which are more convenient and efficient.
○ Support the improvement of fishermen's livelihood by increasing fishery production and income.
○ Prepare attractive measures to promote fishing to young generations.
○ Provide various supports to subsistence fishermen living in coastal areas (foot fishermen).

Acknowledgment

Primarily we would thank God for being us able to complete this project with success. Then we would like to express our special thanks of gratitude JICA fishing gear expert Mr. Morimitsu Ritsuo for his valuable assistance who generously shared his skill and knowledge and finally helped in reviewing this technical report. We also thankful to the JICA team leader Echigo Manabu and Tsurusaki Tsuneo from fishing community development team for their warm and kind support. Our appreciation to project manager Eng. Idris salh acting of Marine Resources Development Department and Project Coordinator, Mr adonay Hrui Head of Projects and Commissions coordination office for their guidance and also thanks to Northern Red Sea Division and collaborative fishers for their contribution in fishing Demonstration

Acknowledgement from JICA Expert

I would like to express my deepest gratitude to the MMR staff and fishermen for their assistance during the project implementation.

In particular, I would like to express my sincere gratitude to the PIU team members led by Mr. Mulugeta Mahdere for their continuous efforts to implement the pilot project through the difficult period of COVID-19.

Your warm and kind support made the project a pleasure to work on. I look forward to the opportunity to meet again someday.

End

APPENDICES

Appendix1

Work plan for PP1

Pilot project for improvement Gill net and its making capacity building (PP1)

April 2022 PIU team

1. **Gillnet fishery**
2. **Capacity building of Gillnet fishery for PIU(Project Implementation Unit team)**
3. **Work content by (JICA expert, PIU team and MMR staff)**

Working venue: MMR facility, Fishing gear and method team office

① Lecture: Gillnet fishery in general
② Inspection of purchased equipment and materials (any shortages to be procured in Massawa)
③ Training for the PIU team on basic calculation methods for prototype drift gill nets
④ Discussions on the construction of drift gillnet fishing gears (leaders, quantity, design, etc.)
⑤ Practical training on drift gillnet gear making
⑥ Inspection of completed fishing gears and confirmation and inspection of materials required for test operation (anchors, ropes, buoys, life jackets, etc.)
⑦ Securing the boat and skipper for the test operation at sea
⑧ Conducting the test operation by the PIU team and verification of the net formation in the sea
⑨ Modification of fishing gear design and study of operation methods based on the information obtained from the test operation
⑩ Prepare a report on the drift gillnet test operation by the PIU team

Note: CP and MMR staff will start the fabrication work after understanding the design drawings.

4. **Preparation work: Selection of fishermen for drift gillnet test operation**

The MMR counterpart will work with North Red Sea regional office to select appropriate project counterpart of fisher.

5. **Confirmed cooperating fishing boats at fishing port of Massawa and will interview fishermen (explanation and consent of activities)**

The explanation items of the PP1 by the PIU team are as follows.

① Outline of gillnet fishing technology improvement project
② Purpose (reason) of PP1 and provision of fishing gear
③ Activity plan (implementation period, schedule)
④ Potential increase in profits from gillnet fishing

⑤ Support system from MMR for PP1

⑥ The method to show the superiority of fishing gear proposed by the project "Compare the catches, sales, fuel cost, food cost, bait, ice, easiness of handling etc. By comparison with existing fishing gear"

⑦ Q & A

6. PP1 implementation Fishing boats and members

Fishing boat specifications:

Captain: ( ) Crews: ( )

7. Implement PP1 in cooperation with fishermen

① Logbook and record of catch data (The form is provided by MMR, so fill it out accurately)

② Discussion on whether or not to board an observer

③ Communication methods with MMR and fishing boats (telephone, etc.)

④ Discussion on how to receive catch data for each operation

① Summary, management and analysis of operation data (CP in charge)

② Preparation and submission of report by PIU

Note) Pilot project should be operated with safety first. Accurate fishing data is a must important for the project.

8. Encircling gillnet

9. Preparation : Selection of fishermen for encircling gillnet test operation

The MMR counterpart will work with North Red Sea regional office to select appropriate project counterpart of fisher.

10. Confirmed cooperating fishing boats at fishing port of Massawa and will interview fisher (explanation and consent of activities)

Same as No.5

11. Pilot project implementation Fishing boats and members

Fishing boat specifications:

Captain: ( ) Crews: ( )

12. Work content by (JICA expert, PIU team and MMR staff)

Work place: MMR facility, Fishing gear and method team office

① Inspection of purchased equipment and materials (any shortages to be procured in Massawa)

② Training for the PIU team on basic calculation methods for prototype encircling gillnets

③ Discussions on the construction of encircling gillnet (leaders, quantity, design, etc.)

④ Practical training on encircling gillnet gear making

⑤ Inspection of completed fishing gears and confirmation and inspection of materials required for test operation (anchors, ropes, buoys, life jackets, etc.)

⑥ Modification of fishing gear design and study of operation methods based on the information obtained from the test operation

Note) CP and MMR staffs need to understand the contents of PP1 in advance.

13. Implementation of encircling gillnet test operation with fishermen

① Logbook and record of catch data (The form is provided by MMR, so fill it out accurately)

② Discussion on whether or not to board an observer

③ Communication methods with MMR and fishing boats (telephone, etc.)

④ Discussion on how to receive catch data for each operation

⑤ Summary, management and analysis of operation data

⑥ Preparation and submission of report (PIU team leader and all others)

Note) Pilot project should be operated with safety first. Accurate fishing data is a must important.

Appendix2

Gillnet test operation survey plan

Prepared by PIU (Project Implementation Unit) team

Specific plans and measures are as follows

1. Objectives:

① The project survey will compare the working efficiency and catch efficiency of the fishermen's gillnets and gillnets provided by PP1.

② Data results obtained from the project survey will be reviewed and reported.

③ PP1's report will be shared with MMR staff and other stakeholders for effective use in future fisheries development.

2. Proposed items and contents

The monitoring survey for PP1 will be conducted by the PIU team with the following components

① Gillnet fishers participating in the monitoring survey activities shall be selected with the cooperation of MMR officials.

② The cooperating fishermen shall be selected as reliable persons who regularly conduct gillnet fishing operations.

③ Registration information of fishing vessels and names of captains shall be confirmed and recorded.

④ The PIU team researchers will record the catch of the fishermen's gill nets and PP1's gill nets for each operation at sea.

⑤ The PIU team will contact the captain and collect necessary information.

⑥ During the survey at sea, the fishermen's gill nets and PP1's gill nets will be connected and prepared before casting nets.

⑦ If a fisherman cooperating with PP1 is inappropriate, the fisherman will be changed.

⑧ The PIU team will be in charge of the survey and analysis of the test operation data, and will prepare a report.

⑨ The PIU team will be led by Mr. Mulugeta Mahdere with the assistance of Mr. Morimitsu.

3. Monitoring survey methods

PIU team members should be aware of the importance of the monitoring survey and share information. In addition, data sheets on the following items will be prepared and information will be collected.

① Survey the catch data from the fishermen's gill nets and PP1's gill nets, respectively.

Appendix2

② Record the operation data, time of casting and hauling the nets, and the conditions at each fishing ground.
③ Operation surveys shall be conducted for each trip.
④ PIU team observer will keep accurate records.
⑤ The on-boarded observer and project leader will prepare the report including catch data and report it to the PIU team.
⑥ The advantages and disadvantages of the fishermen's gillnets and PP1's gillnets will be compared and discussed.
⑦ The PIU team will prepare a final report in collaboration with the JICA team based on the evaluation and analysis of the data obtained from the operational survey.

Appendix3

The Project for Formulation of The Strategies and Practical Approaches for Coastal Fisheries Development In The State of Eritrea

Report on floating gillnet first trail fishing

February, 2020

Floating Gillnet First Trail Fishing

1. Introduction

This implementation was initiated by delivering lecture from 9-10 march 2020 by JICA fishing gear expert (Morimitsu Ritsuo) about basic of nets, buoyancy/ sinking force of fishing gear materials, calculation method of hanging ratio, cutting method of netting and other necessary calculation method to the counterparts and also to many related staffs. Thereafter from 11-18 March 2020 according to the lecture given the trained staffs did assemble 0ne floating gillnet and one encircling gillnet through the guidance of the JICA fishing gear expert. Unfortunately due to the COVID-19 pandemic the fishing gear expert forced to go to his home country without finishing the scheduled. Nevertheless, the remained plan to complete for assembling the other two encircling gillnet was incorporated from 01-09 May 2020 by trained staffs through the guidance of the counterparts. Therefore a total of 0ne floating gillnet (214 meter length and 7.8 meter depth) and three encircling gillnets (100 meter length and 16 meter depth) are assembled. In the case of fishing trail point view, for encircling gillnet last hot season could not tested the net due to this pandemic, but hopefully to trail the coming hot season.

For floating gillnet fishing trail, attempts have been started since November to found budget for allowance by submitting proposal of one person on boat data collector and then allowed to cover from recurrent budget. Thereafter in late November artisanal boats had suspended for fishing due to same reasons, meanwhile we had tried to found reliable fishers to trail the net immediately as the fishers resume fishing. Significantly as the suspension for fishing become over, first trail fishing the floating gillnet was carried out from December 18, 2020 up to January 4, 2021 on inboard engine boat 13 meter long.

Purpose of the fishing trail is;

- ✓ To compare the performance of gillnets produced by the project with the existing gillnets used by fishermen.
- ✓ Numerical and clarify the difference between the two gillnets.
- ✓ After analyzing the obtained data and compiling it into a report, share the information with MMR and related parties and use it for future fishery development.

2. Methodology of the fishing trail

The dimension of the produced floating gillnet is 214 meter long and 100 mesh depth, while the existed gillnets fishers is 130 meter long and 72 mesh depth. The thickness of twine is 210D/36 and 0.3/8 respectively. The mesh size was equal which is 110 millimeter. During the fishing trail on the sea, the produced gillnet was tied series among with the existed gillnet fishers. The parameter measured which is the length of the nets used are different, because it could not available as long as with produced gillnet.

The required data was recorded during the operation, on board of the fishing boat in the

prepared datasheet in every fishing trail by delegated fishing gear staff. Moreover it was accompanied from the fishers fishing trial point of view subjective ideas also noted.

In the prepared data sheet the parameters included are; Date, length of gillnet, mesh size, setting time, retrieval time, fish caught in (species, number, and weight), depth, fishing ground, condition of the sea.

3. Result

A total of 228 fishes by produced gillnet (one net) and 128 fishes by existed gillnet (two nets) were caught. In terms of weight approximately 535.5 kilogram and 268.5 kilogram respectively from produced gillnet and existed gillnet were recorded. The length of the produced gill net is 214 meter and for ordinary gillnet length 135 meter each and in total the fishers net has 270 meter long. When we compare the catch efficiency;

The total area of the produced drift gillnet : 214 x 7.8 = 1670m^2 1670m^2/100m^2 = 16.7

The total area of the fisher's drift gillnet : 270 x 5.6 = 1512m^2 1512m^2/ 100m^2 = 15.1

The average catch number from the produced gillnet for every 100m^2 =228/16.7 = 13.7 fishes

The average catch number from ordinary gillnet for every 100 meter =128/15.1 = 8.5 fishes

Catch efficiency; average catch of produced gillnet divided average catch of ordinary gillnet.

= 13.7 / 8.5 = 1.6 times more fish catch.

Therefore, the produced gillnet have catch efficiency of 1.6 times more number of fish from the fishers gillnet.

In terms of weight the produced gillnet and the fishers gillnet is caught 535.5 and 268.5 kilogram of fish respectively.

The average catch weight from the produced gillnet for every 100m^2 = 535.5/16.7 = 32kg

The average catch weight from ordinary gillnet for every 100m^2 meter =268.5/15.1 = 17.78kg

Catch efficiency; average catch of produced gillnet divided average catch of ordinary gillnet.

= 32 / 17.78 = 1.8

= 1.8 times more fish catch.

To that effect, the produced gillnet have catch efficiency of 1.8 times kilogram of fish from the fishers gillnet.

The color of the produced gillnet is green, which is very similar with color of the water. That color along with mono-multifilament nature of the twine, create ambiguous to detect the fish from the water. Resulted one dolphin was entangled and same part of the net is torn when removed the dolphin from the net.

4. Discussion

In Eritrea artisanal fishing, gillnet has been the dominant fishing practice, because it seek low initial investment and easily operated. Since it has been manually operated which is a labor intensive, induction of new fishing technique have been needed to minimize the expense. To handle this effect such trial is necessary. According to the result of this trial significant proportion of fish (in terms of number, weight) were recorded by the produced gillnet in comparing existed gillnet. From the fishers fishing trail view point the factors contribute the relative catch efficiency of the produced gillnet rather than the existed gillnet might be;

- The nature of the twine is mono-multifilament that is thinner, so the probability of fish catch is not only enmeshed but also more entanglement.
- The green color and thinner twine make low visibility result more fish encountered even it can be used during full moon.
- Moreover fishers prefer more because it is very light they can operate large number of such gillnet by less number of crews.

Even though, the produced gillnet has good catch efficiency. On the other hand it might also have a few problems that could negatively affect fisher's productivity which are needed to re-adjust. The points are;

- The nature of the twine is mono-multifilament, so once the twine detached difficult or impossible to mend.
- Same fish when enmeshed or entangled difficult to remove from it, so that forced to tear the twine.
- The float line of the produced gillnet drifted above surface of sea, because the sinking force of the attached sinker was a bit lighter. As a consequence a burden of drifted seaweed was twisted over the float line during the operation.
- Small size fishes were caught probably the mesh size might be small.

Moreover the field trial was conducted in late December, which were appearance of full moon and wave. The practical fishing trial was not under taken consecutively in the all night time of the specified total number of trial days, same times the boat was anchored without any trial and same times only one trial in the whole night. Therefore the catch efficiency of these nets also affected by those factors. But incidentally the produced gillnet was acquired that, it could be used during full moon.

5. Conclusion

Generally little is known about the produced gillnet in comparison to the existed gillnet. Because customizing the optimum type of gillnet that have different dimension or structure cannot be estimated by one trial without many fishers involvement. Experimental fishing with artisanal boats of different fishers will provide the data for estimating optimum gillnet fishery to obtain the desired fishery development. Therefore to develop a comprehensive report, sufficient fishing trial is necessary.

Appendix3

boat owner- Azmera habtetsion	**licence No- 31155/06**
boat name- msgna-1	**boat length-13 meter**
skipper- mohamedali mohamed	**boat type- sanbuk (inboard engine)**

PP1: Produced Gillnet

date	setting time	retrieval time	Length of Gill net(m)	fish catch	fish catch in number	Total No.of catches	total fish catch in kg	Total weights of catch(kg)	fishing ground	depth (meter)	environmental condition
2020/12/19	6;05 pm	10;35 pm	214	shark	6	6	16	16	dessie	60	cold
12/20	12;10 am	5;55am	214	0	0	0	0	0	dessie	65	cold
12/21	5;30 am	12;10 am	214	tuna	6	11	12	22.5	dehil	68	wave
				shark	3		3.5				
				kingfish	1		3				
				cobia	1		4				
12/22	1;.30 am	6;30 pm	214	tuna	10	10	19.5	19.5	dehil	70	wave
12/23	12;55 am	6;00 am	214	shark	2	7	2	12	dehil	75	wave
				tuna	5		10				
	5:40 pm	10;50 pm	214	tuna	13	15	23	25			
				shark	2		2				
12/24	12;10 am	5;40 am	214	tuna	9	9	13	13	dehil	75	wave
	6;10 pm	11;05 pm	214	tuna	18	19	40	43			
				kingfish	1		3				
12/25	12;20 am	6;00 am	214	tuna	14	17	32	35.5	dehil	75	wave
				kingfish	3		3.5				
12/26	12;30 am	5;55 am	214	tuna	5	8	15	21	dehil	67	wave
				bonito	3		6				
12/30	5;50 pm	7;30 pm	214	tuna	8	8	16	16	dehil	70	wave
12/31	6;00 pm	8;05 pm	214	kingfish	7	8	9.5	10.5	dehil	70	wave
				shark	1		1				
2021/1/1	5;55 pm	9;00 pm	214	tuna	7	18	21	47.5	dergile	85	wave
				bonito	9		22.5				
				cobia	1		3				
				shark	1		1				
1/2	6;10 pm	10;05 pm	214	tuna	17	55	59.5	154.5	dergile	85	wave
				bonito	38		95				
1/3	12;20 am	5;40 am	214	sea horse	2	6	26	39	dergile	85	cold
				tuna	3		9				
				emperor	1		4				
	5;55 pm	11;00 pm	214	bonito	24	31	36	60.5		82	cloud
				tuna	6		24				
				shark	1		0.5				
13days		Total	3424		228	228	535.5	535.5	No.of fish per meter		

Appendix3

boat owner- Azmera habtetsion	**licence No- 31155/06**
boat name- msgna-1	**boat length-13 meter**
skipper- mohamedali mohamed	**boat type- sanbuk (inboard engine)**

PP1: Fisher's Gillnet

date	setting time	retrieval time	Length of gillnet(m)	fish catch	fish catch in number	total fish catch in kg	fishing ground	depth (meter)	environmental condition
2020/12/19	6;05 AM	10;35 pm	270	shark	3	3	dessie	60	cold
				cobia	1	2		65	
				tuna	1	1.5		68	wave
2/20	12:10Am	5:55AM	270	Shark	1	2	dessie	65m	cold
12/21	5:30PM	12:10AM	270	tuna	1	1	dessie	68m	wave
				Shark	1	2.5			
12/22	1:30Am	6:30AM	270	tuna	6	8	dehil	70	wave
12/23	12:55Am	6:0AM	270	Shark	2	2	dehil	75	wave
				tuna	19	43			
	5:40Pm	10:50PM		tuna	15	30			
				shark	1	1			
12/24	12:10Am	5:40AM	270	tuna	7	10.5	dehil	75	wave
	6:40Pm	11:5PM		tuna	7	17.5			
				shark	1	1			
12/25	12:20AM	6:00AM	270	tuna	1	3	dehil	75	wave
12/26	12:30AM	5:55AM	270	tuna	2	5	dehil	67	wave
				bonito	5	7.5			
12/30	5:50PM	7:30PM	270	bonito	6	12	dehil	70	wave
				tuna	2	6			
12/31	6:00PM	8:05PM	270	shark	1	1	dehil	70	wave
				kingfish	1	1			
2021/1/1	5:55PM	9:00PM	270	tuna	10	30	dergul	85	wave
				bonito	8	12			
1/2	6:10PM	10:05PM	270	tuna	9	27	dergul	85	wave
				bonito	8	20			
1/3	12:20AM	5:40AM	270				dergul	82	cold,cloud
	5:55PM	11:00PM		bonito	5	5			
				tuna	4	14			
									cloud
13days				total	128	268.5			

Appendix4

Floating Gillnet Second Trail Fishing

1. Introduction

Implementation of the first pilot project for improving of gillnet was initiated by delivering lecture from 9-10 march 2020 by JICA fishing gear expert (Morimitsu Ritsuo) about basic of nets, buoyancy/ sinking force of fishing gear materials, calculation method of hanging ratio, cutting method of netting and other necessary calculation method to the counterparts and also to many related staffs. Based on the lecture given by the fishing gear expert, one floating gillnet (214-meter length and 7.8-meter depth) and three encircling gillnets (100-meter length and 16-meter depth) were constructed.

Last year first fishing trail to both gillnets (floating gillnet and encircling gillnets) was undertaken. The catch efficiency for thus trial have been very considerable. To capture comprehensive data substantial fishing trial is necessary. To that effect second fishing trial was accomplished from 09 - 29 November 2021 with Artisanal fishing boat 15.8-meter-long inboard engine.

2. Methodology of the fishing trail

During the fishing trial, the fishing boat loaded a total of 12 gillnet (01 the produced and 11 the ordinary gillnet). The dimension of the produced gillnet is 214-meter-long and 100 mesh depth, while the ordinary gillnets of fishers were eleven, each net has 135-meter-long and 125 mesh depth. The thickness of twine is 210D/36 and 0.3/8 respectively. The mesh size is equal 110 millimeters wide for those gillnets. During the fishing trail on the sea, the produced gillnet was tied series with the existed gillnet fishers. The catch of the produced gillnet and all ordinary gillnets was recorded separately and analyzed.

The required data was recorded during the operation, on board of the fishing boat in the prepared datasheet in every fishing trail by delegated fishing gear staff. Moreover, it was accompanied from the fishers fishing trial point of view subjective ideas also noted.

In the prepared data sheet, the parameters included are; Date, length of gillnet, mesh size, setting time, retrieval time, fish caught in (species, number, and weight), depth, fishing ground, condition of the sea.

Appendix4

	
Preparation for setting	Setting of the net
	
Net retrieval	Fishing boat used in 2nd trial

3. Result

In 12 days of fishing trial, a total of 113 fishes by produced gillnet and 104 fishes by existed gillnet (11 gillnets) were caught. The length of the produced gill net is 214meter and for ordinary gillnet 135 meter length each and in total the fishers net has 1485 meter long. When we compare the catch efficiency;

The average catch number from the produced gillnet for every 100 meter =113/214*?/100

=52.8 fish

The average catch number from ordinary gillnet for every 100 meter =104/1485*?/100

=7 fish

Catch efficiency; average catch of produced gillnet divided average catch of ordinary gillnet.

=52.8/7

=7.4 more fish catch.

Therefore, the produced gillnet have catch efficiency of 7.5 times more number of fish from the fishers gillnet.

In terms of weight the produced gillnet and the fishers gillnet is caught 175 and 188

kilogram of fish respectively.

The average catch weight from the produced gillnet for every 100 meter =175/214*?/100

=81.7 kg fish

The average catch weight from ordinary gillnet for every 100 meter =188/1485*?/100

=12.6 kg fish

Catch efficiency; average catch of produced gillnet divided average catch of ordinary gillnet.

=81.7/12.6

=6.5 kg more fish catch.

To that effect, the produced gillnet have catch efficiency of 6.5 times kilogram of fish from the fishers gillnet.

The fish caught were predominantly the Spanish mackerel, which is the primary target of the artisanal fishers.

4. Discussion

In Eritrea artisanal fishing, gillnet has been the dominant fishing practice, because it seeks low initial investment and easily operated. Since it has been manually operated which is a labor intensive, induction of new fishing technique have been needed to minimize the expense. To handle this effect such trial is necessary. According to the result of this trial significant proportion of fish (in terms of number, weight) were recorded by the produced gillnet in comparing existed gillnet. From the fishers fishing trail view point the factors contribute the relative catch efficiency of the produced gillnet rather than the existed gillnet might be;

- The nature of the twine is mono-multifilament that is thinner, so the probability of fish catch is not only enmeshed but also more entanglement.
- The green color and thinner twine make low visibility result more fish encountered the net and even it has been fished during full moon.
- Moreover, fishers prefer more because it is very light they can operate large number of such gillnet by less number of crews.

Even though, the produced gillnet has good catch efficiency. On the other hand, it might also have a few problems that could negatively affect fisher's productivity which are needed to re-adjust. The points are;

- The nature of the twine is mono-multifilament, so once the twine detached difficult

- Small size fishes were caught probably the mesh size might be small or have high encounter for entangling of the fish.

Last year the first trial was carried out on late November, which was appearance of full moon and wave. Similarly, the second trial was faced as in the first trial. The practical fishing trial was not under taken consecutively in the all night time to the specified total number of trial days, same times the boat was anchored without any trial and same times only one trial in the whole night. Therefore, the catch efficiency of these nets was affected by those factors. But incidentally the produced gillnet was acquired that, it could be used during full moon.

5. Conclusion

The catch efficiency of that net has no compromise. It has a competitive advantage over the ordinary gillnet. But to measure its catch efficiency quantitatively, the unit of measurement for both nets would be same. Thus, to find same measurement with the produced gillnet has same challenges, because the fishing trial has been conducted along with artisanal fishers in their expense, so they might use gillnet that has different dimensions and quantities with in the fishing trip.

Appendix4

boat owner- Azmera habtetsion					**licence No- 31831/19**				
boat name- msgna-2					**boat length-15.8 meter**				
skipper- ahmed reshed					**boat type- sanbuk (inboard engine)**				
date	setting time	retrieval time	Net length (m)	fish catch	fish catch in number	total fish catch in kg	fishing ground	depth (meter)	environmental condition
2021/11/8	5;30 pm	9;30pm	214	spanish makerel2	2	4	emoasla	20	cold
2021/11/9	6;30 pm	10;30 pm	214	0	0	0	mekaterat	15	wave
2021/11/10	3;00 am	6;30 am	214	cobia	2	5	mekaterat	15	wave
2021/11/10	7;00 pm	10;00 pm	214	spanish makerel	7	12	mekaterat	15	cloud
2021/11/12	1;00 am	6;00 am	214	spanish makerel	9	18	gobata ojem	20	wave
				shark	1	3			
2021/11/13	2;00 am	6;00 am	214	shark	1	3	rase entalo	20	wave
2021/11/14	2-00 am	6;00 am	214	emperor	5	3	rase dafegu	20	wave
				grouper	3	2	rase dafegu	20	wave
2021/11/21	5:00pm	8;00 pm	214	shark	2	8	delem	20	wave
				spanish makerel	10	7	amunamuse	20	wave
2021/11/22	5;30	8;30 am	214	spanish makerel	4	8	amunamuse	16	wave
				needlefish	2	2	amunamuse	16	wave
2021/11/23	5;30 pm	9;00 pm	214	spanish makerel	5	10	ameal ajeze	16	wave
2021/11/24	5;30 pm	9;00 pm	214	spanish makerel	10	20	deloit		cloud
2021/11/25	5;30 pm	10;30 pm	214	spanish makerel	30	40	deloit		cloud
2021/11/26	5;30 pm	11;00 pm	214	spanish makerel	20	30	deloit	15	cloud
total					113	175			

Appendix4

boat owner- Azmera habtetsion					**licence No- 31831/19**				
boat name- msgna-2					**boat length-15.8 meter**				
skipper- ahmed reshed					**boat type- sanbuk (inboard engine)**				
date	setting time	retrieval time	Net length (m)	fish catch	fish catch in number	total fish catch in kg	fishing ground	depth (meter)	environmental condition
2021/11/8	5;30 pm	9;30 pm	1485	spanish makerel	1	1	emuasla	20	cold
2021/11/9	6;30 pm	10;30 pm	1485	trevally	1	0.5	mekaterat	15	wave
				tuna	1	0.5			wave
				spanish makerel	1	1			
2021/11/10	3;00 am	6;30 am	1485	sailfish	1	4	mekaterat	15	cold
2021/11/10	7;00 pm	10;00 pm	1485	shark	1	2	mekaterat	15	cold
				spanish makerel	1	2	mekaterat	15	cold
2021/11/12	1;00 am	6;00 am	1485	spanish makerel	4	8	gobta ajen	20	wave
				tuna	1	1			
2021/11/13	2;00 am	6:00 AM	1485	spanish makerel	3	6	rasentalo	20	wave
2021/11/14	2;00 am	6;00 am	1485	spanish makerel	5	3	ras dafgur	20	wave
2021/11/21	5;00 Pm	8;00 PM	1485	shark	8	16	deleme	20	wave
				spanish makerel	2	2			
				queen fish1	1	1			
				barracuda	1	1	amunames	16	wave
2021/11/22	5;30 pm	8;30 pm	1485	spanish makerel	4	8	amunames	23	wave
2021/11/23	5;30 pm	9;00 pm	1485	spanish makerel	9	18	amelajes	16	wave
2021/11/24	5;30 pm	9;00 pm	1485	spanish makerel	20	30	deloit	15	wave
				shark	2	6			
2021/11/25	5;30 pm	10;30 pm	1485	spanish makerel	20	40	deloit	15	cold
				shark	1	5			
				snaper	1	2			
2021/11/26	5;30 pm	11;00 pm	1485	spanish makerel	15	30	deloit	15	cold
total					104	188			

Appendix5

The Project for formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC) In The State of Eritrea

Report on Fishing Demonstration of Depth-Adjustable Drift Gillnet (2nd) and Drift Floating Gillnet (3rd)



Observed and Reported by
Filmon Bereket
Yosief Redae

Edited and Translated by;
Mulugeta Mahdere

February, 2023

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Fishing trial of depth-adjustable drift gillnet and drift gillnet

1. Introduction

As it known the main task of Fishing Gear Technology Development Unit is to identify effective and efficient fishing gear, through conducting different fishing demonstrations and trials, thereby introduce the successful one to local fishers. As per the task, previously tremendous effort has been conducted by the staff of the ministry alone as well as in collaborations with different stakeholders. In continuation of this effort, since 2019 this project (FSPAC) financed by Government of Eritrea and JICA has evolved three pilot project in the case of fishing gear and method to boost the fishing activities.

Hence, part of this project, floating gillnets and longline fishing demonstration with Artisanal fishers has been incorporated end of December 2022. As mentioned, the floating gillnet that was tested include two type drift floating gillnet and depth-adjustable floating gillnet. The nature of the netting is mono-multifilament and monofilament respectively.

- The depth-adjustable floating gillnet used in fishing demonstration comprises three (3) sets of gillnets, each set has 100 meter length, 8 meter depth and 110 millimeter mesh size and another type of gillnet which is drift floating gillnet one set of 210 meter length, 8 meter depth and 110 millimeter depth. Assembling method is similar with ordinary method except in footrope the net is mounted with lead core sinker rope.
- The nature of the ordinary drift floating gillnets that were used for comparison have, a mono-multifilament type of netting, 135 meter length, 12 meter depth, 110 millimeter mesh size and the footrope is assembled with concrete of around 250 gram weight in air.

1-1 Objective

- ❖ To assess the effectiveness and efficiency or production and productivity of drift floating gillnet and depth-adjustable floating gillnet in comparison with the ordinary drift floating gillnet.

2. Materials evolved

In conducting this fishing trial operation the following physical inputs had been engaged; 19 meter length inboard engine boat (so-called Sambuk), 12 pieces of buoy, 11 pieces of plastic 5 liter container, 3 sets of depth-adjustable floating gillnet, 1 set of drift floating gillnet, 23 pieces of 135 centimeter length rope for connecting buoy with head rope of the net, 8 sets of ordinary drift floating gillnet, weight balance, data sheet template etc…

Appendix5

Appendix5

3. Implemented activities

On 15/12/2022, prior departure to the sea, all nets was properly checked and then all nets separately arranged on the deck of the boat. First, the ordinary nets of fishers were arranged, afterwards the depth-adjustable floating gillnet of the head rope was connected with buoy by 135 centimeter long suspension rope an interval of 15 meter length. In addition to this, light signal with buoy and also anchor prepared.

In test fishing operation two methods were applied. Firstly in the starting side of net, before the start of setting light signal was attached with head rope and the footrope was attached with concrete sinker around 2 kg weights in air and when all nets set in the sea the ending side of the head rope of the net attached with forward of boat. Secondly, both ends of head rope was attached light signal with buoy and both ends of foot rope attached with concrete sinker and finally when setting finished left it to drift with current.

During setting two crews were participated, one crew on the foot rope to through the concrete sinker away from the body of the net for quick and proper setting and one crew in head rope to guide the head rope. While during retrieving, at a time minimum 4 crews were participated, the extra from setting are one for pulling and arranging the netting body and another one is for removing fish caught from the net.

		
picture-1: depth-adjustable floating gillnet prepared for setting	picture-2: drift floating gillnet prepared for setting	picture-3: ordinary drift floating gillnet

In this trip of fishing trial operation, the nets were soaked three times. The data available in every operation were captured in the prepared data sheet format. The captured data in the data sheet format was presented below in the figure.

Appendix5

Boat owner Name; Ahmed Mohamed license Number 31859/19 Boat Net weight

Boat Name; Alqiema Boat length 18.14 Boat Gross weight 36.90

Boat Skipper; Omer Geder

Table-1; data recorded in prepared data sheet format

Date	Experimental gillnet	Mesh size, length, depth	No of nets	Common name of fish	Number of fish caught	Weight of fish caught (kg)	Fishing ground	Sea depth and length of suspension rope	Setting time	Retrieving time	Sea condition
16/12/22	Depth-adjustable MMR	12ሜ/100ሜ	3	s.mackerel	15	30	Gedem	23 m/0.5m	5.30 pm	9.00 pm	calm
	Drift floating gillnet MMR	12/210ሜ	1	s.mackerel	15	30					
	Drift floating gillnet fishers	12/135ሜ	2	s.mackerel	6	10					
				tuna	3	15					
12/22	Depth-adjustable MMR	12ሜ/100ሜ	3	barracuda	7	18	Madot	17m/0.5m	6.00 pm	9.00pm	
	Drift floating gillnet MMR	12/210ሜ	1	Benito	1	0.5					
	Drift floating gillnet fishers	12/210ሜ	8	Benito	1	0.5					
20/12/22	Depth-adjustable MMR	12ሜ/100ሜ	3	0	0	0		23m/0.5m	5.30 pm.	10.00 pm	
	Drift floating gillnet MMR	12/135ሜ	1	0	0	0					
	Drift floating gillnet fishers	12/210ሜ	1	0	0	0					

4. Result

In the fishing trial operation, three type of net were tested and the fish catch were captured separately. Thus the nets are namely, depth-adjustable floating gillnets (monofilament netting), drift floating gillnets (mono-multifilament netting) and the ordinary drift floating gillnets (multifilament netting).

Accordingly, the amount fish catch efficiency of each gillnets could be calculated as below;

- In comparison of catch efficiency between depth-adjustable floating gillnets and ordinary drift floating gillnets in the first day of one soaking operation is;-

  Day-1
  Ordinary drift floating gillnets fish caught = 9 fishes
  Area of netting 135 x 8 x2 = 2160m²
  2160 / 100 = 21.6 9 / 21.6 = 0.416 = 0.42

  Depth-adjustable floating gillnets fish caught = 15 fishes
  Area of netting 100 x 8 x 3 = 2400m²
  2400 / 100 = 24 15 / 24 = 0.625 = 0.6

Therefore to compare the catch efficiency per 100m²of both gillnets, the catch efficiency of fisher's gillnet is smaller than the depth-adjustable gillnet could be computed as:-

0.6 / 0.42 = 1.428 = 1.4

Accordingly, in one day fishing trial operation the ratio of catch efficiency, depth-adjustable floating gillnets had 1.4 times more catch efficiency than to the ordinary drift floating gillnet.

- The stated above is the comparison of one day fishing trial operation, in the case of all trial operation result is calculated below.
  Total fish caught by depth-adjustable floating gillnet = 22
  Total area of the netting 100 x 8 x 9 = 7200m²
  7200m² / 100m² = 72 22 / 72 = 0.305 = 0.31

Total fish caught by ordinary drift floating gillnets = 10
Total area of the netting 135 x 8 x 11 = 11880
11880m²/ 100m² = 118.8 10 / 118.7 = 0.084
Therefor to compare the catch efficiency per 100m² of both gillnets, the catch efficiency of fisher's gillnet is smaller than the depth-adjustable gillnet could be computed as;-

0.31 / 0.084 = 3.69 = 3.7

This computation showed that, the ordinary drift floating gillnets having 900 meter length had a capacity to caught **6** fishes, while the depth-adjustable floating gillnet who

had 900 meter length have proved to caught **22** fishes at given time and site. Moreover the ratio of fish catch efficiency is;-

$$\boldsymbol{Ratio = \frac{fish\ caught\ by\ adjustable\ gillnets\ per\ 100\ meter\ squire}{fish\ caught\ by\ fisher's\ gillnets\ per\ 100m\ meter\ squire}}$$

$$\boldsymbol{= \frac{0.31}{0.084} = 3.7}$$

For the overall demonstration the ratio of fish catch efficiency of depth-adjustable floating gillnet found noticeable difference of 5 times higher than fisher's drift gillnets.

- In line with above stated out, there were also another type of drift floating gillnets which did fishing experiment. This type of gillnet has similar mesh size and soaked at same water level with fisher's gillnet. The only difference was the experimental gillnets had green color and mono-multifilament type of netting; whereas the ordinary gillnet had grey color and multifilament netting. The relative catch efficiency of these two type of gillnets was;-

Total fish caught by PP1 drift floating gillnet = 16
The area of the netting 210 x 7.8 x 3 = 4914
4914m²/ 100m² = 49 16 / 49 = 0.326 = 0.33

Total fish caught by fisher's drift floating gillnets = 10
The area of the netting 135 x 8 x 11 = 11880
11880m² / 100m² = 118.8 10 / 118.8 = 0.084 = 0.08
Therefor to compare the catch efficiency of both gillnets, the catch efficiency of fisher's gillnet is smaller than that of PP1 produced drift floating gillnet could be computed as;-

$$\boldsymbol{\frac{fish\ caught\ by\ PP1\ produced\ gillnets\ per\ 100m^2}{Fish\ caught\ by\ fisher's\ gillnets\ per\ 100m^2}}$$

$$\boldsymbol{\frac{0.33}{0.08} = 4.1}$$

This computation found that, the PP1 produced drift floating gillnets fish catch efficiency is 4.1 times higher than fisher's drift gillnets.

In general the ratio of catch efficiency of the PP1 produced drift gillnets is higher than the fisher's drift gillnets. Since the PP1 produced drift gillnets was mono-multifilament netting, which makes the net not only gilling but also to entangle the fish. Consequently, the experimented gillnets encounter higher catch efficiency.

The objective of this fishing demonstration was to assess the efficiency and effectiveness and handling of the experimental gillnets in comparison with the ordinary

gillnets. Therefore based on the finding of fishing experiment and observation of the ordinary fishers the following points were expressed.

- ✓ The experimental gillnet netting structure was mono-multifilament and monofilament which is light in weight. Thus, easy to handle that can be operated with less crews, while the ordinary gillnet was multifilament when it soaked it absorbs water, eventually become heavier which seek more labor to retrieved.
- ✓ Besides, the color of the netting resemble with color of the water, which led to the low visibility by fishes for fishing, even it might be used during full-moon. However, the ordinary gillnets are used only during new-moon, where the period of dark night.
- ✓ The fish caught were not only by gilling, but they also encountered to entanglement. Therefore, higher and variety size of fish could caught. On the contrary, the ordinary gillnet was thicker and less flexible, thus the highest proportion of fish caught is more or less through gilling or wedging.
- ✓ In contrary to the above, the negative aspects of the experimental gillnets are. Once when this netting faced to hard bottom, easy to damage and difficult to mend. To that effect the life span is short. Whereas the ordinary gillnets easy to mend and make it to use for longer time as per the preference of the fishers.
- ✓ The depth-adjustable floating gillnets were set same distance below from the surface of the sea water by adjusting the length of suspension rope connecting to the buoy and the head rope of the net. Hence the head rope of the net set below the sea surface and not has a chance to drift with wave, current. Ultimately, fish catch efficiency would be negatively affected.
- ✓ In the experimental gillnets the assembled sinker was lead core sinker rope. When the net faced with current or catch big fish, such sinker could lead to entanglement of the nets. Therefor the preferred one is the locally produced concrete sinker, which stretched the net properly.
- ✓ Furthermore, for the experimental gillnet, the preferred one in netting structure is monofilament from the mono-multifilament. Because, with time on operation the mono-multifilament holds some dust and changed its color.
- ✓ The fishers informed that they can use as a complementary, but not to substitute to their existed gillnet. Because in all aspects or conditions the preferred net is multifilament netting expressed the fishers.

5. Challenges

The fishing demonstration was operated with artisanal fishers along to their fishing activity on their fishing expense. Therefore, the experimental fishing trials were

determined by the conditions of fishers, not by plan of observer. To that effect, the number of trials conducted was very limited which was soaked three times only, due to some problems encountered to the fishers. Thus were;

1. scarcity of fuel;- the fuel allowed to that fishing boat was not enough which was 400ml and the net soaked for drift floating gillnet was not promising catch. As a result, to save fuel the fishers forced to change net in to encircling gillnet which was different from the experimental fishing technique.

2. Bad weather condition;- the fishing demonstration the was effected by bad weather condition like though wind and wave, thunderstorm. To that effect some days were left without trial and then forced to return to the destination site with a few drift floating gillnet fishing.

6. Conclusion

As per the computation of the result, the relative catch efficiency of depth-adjustable floating gillnet was 3.7 to the ordinary gillnet and the use of monofilament netting for the depth-adjustable gillnet resulted in increased number of captured fish over the ordinary drift floating gillnet multifilament netting. Similarly, another netting structure which was mono-multifilament netting also examined over the ordinary multifilament netting structure and it was found that in the ratio of relative catch efficiency 3.8 to 1 fishes respectively. This value indicating that mono-multifilament netting had relatively better fish catch than the multifilament netting.

Based on demonstration of the observation, even though, the experimental gillnet had higher fish catch than the ordinary gillnet, the fishers preference for offshore fishing was to use the multifilament netting. Because, the multifilament netting is easy to mend and use for longer period of year and resistant any damage. In the case of the depth-adjustable gillnet, it seeks more buoy and need more space in the deck of boat. Furthermore when soaked in water could not drift with current as if the headline is submerged from the surface of water and thereby fish counter to the net is minimized.

In conclusion, the demonstration conducted in trip was with a very limited number of test operations (soaking) and the degree of accuracy of the finding would be more compromised. Therefore, such demonstration should be scheduled with enough budgets to perform year round at different depth, fishing ground and time with different fishing boats.

Appendix6

The Project for Formulation of The Strategies and Practical Approaches for Coastal Fisheries Development In The State of Eritrea

Report on encircling gillnet first trail fishing

August, 2021

Appendix6

1. Introduction

Since the project has been started in 2019, sequential activities were implemented. Moreover in the early 2020 one of the three pilot projects which is gill-net fishing gear improvement pilot project was started delivering theoretical lecture by fishing gear expert to the counterparts. After the theoretical training the counterparts with other development department staffs assembled one drift pelagic gillnet and three encircling gillnet based on the calculation formula obtained in the training.

Though the theoretical training and assembling of the encircling gillnets were completed on the defined plan. To test work efficiency, operation and catch rate of the net on the sea was suspended last hot summer due to COVID 19. Even this season attempts have been started since May to find reliable boat owner for conducting trail fishing. But many fishers were not reluctant same fishers asked payment as boat renting, others hesitating the net from being unproductive. Fortunately in late July with the collaboration of Northern Red Sea Division extension staff, genius fishers from Dehil Island agreed to conduct trial fishing on his boat. The fishers agreed to take the net onboard of his boat to run the trial in the expense of him, who would then take all fish caught.

Purpose of the fishing trail is;

To compare structure, work efficiency, operation, production and catch rate of the produced gillnets with the existed gillnet.

2. Methodology

This first encircling fishing trial was carried out for a period of 11 days (from 07-11 August, 2021). The trial relied on the fish catch from the net by the opinion of fishers in directing the fishing ground and depth. The engaged fishers is dweller of Dehil Island and had participated five crews. Along with encircling fishing trial fishers were deployed anther nine pelagic drift gillnet. The fishing ground where the trials conducted were north of Massawa and east Dahlak archipelago mostly in Madeban and a few Derdia, Mekemera, Umawd and Harat.

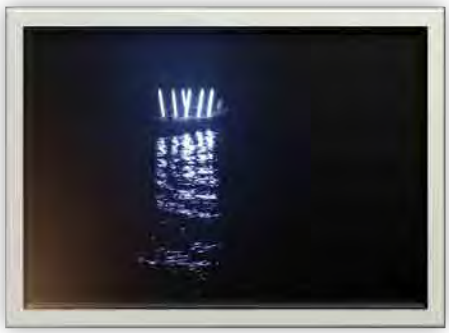
Materials used; to conducting fishing for encircling gillnet other than net, many accessory is required. It was accomplished by using our net and the remained other materials were assets of fishers. The materials that was used are listed as follows;

a) Three encircling gillnet (nylon monofilament No.10, 106 mm mesh size, 200 mesh depth, 150 meter length). These nets were assembled by using Y-20 float, lead line rope sinker. Besides,

double rope on the head rope and foot rope with hanging ratio 65 were used. To the end after assembled the dimension of the nets are reached 100 meter length and 16 meter depth.

b) Bigger boat (Sambuk) inboard engine fish holder.
c) Fiber glass reinforced boat outboard engine for encircling the fish.
d) Fiber glass reinforced boat outboard engine for holding lighting fluorescent lamp.
e) Generator
f) 6 Fluorescent lamp

Fishing trial; on the sea onboard of the boat prior conducting fishing trial, attaching the nets series by four millimeter thickness rope and arranging all necessary materials were confirmed by the fishers with one member of fishing gear staff. After preparation process, several encircling have been made to experiment the net to determine effectiveness. On the selected fishing grounds, experiment was started with turning on the light of six fluorescent on the small fiberglass reinforced boat to gather the fishes. Then after three hours of lighting, the second fiberglass reinforced boat encircled with the three attached net to the gathered fish. Encircling was done as the boat navigate anticlockwise direction, the crews removed the starting line of the net to the water and paying out until the ending line reached and then encircling ended as both tips of the net were tied to the boat. To this end, the encircled fish were disturbed by throwing several stones for being the fishes enmeshed and entangled in the net. Finally the net was retrieved to onboard of the boat and the fish caught were released from the net.

	
Picture-1 boat for encircling the net	Picture-2 boat holding light fluorescent

3. Result

An average of three fishing trial were done in every night. The highest numbers of fish obtained were queen fish 206, silver grunt 18, Spanish mackerel 15, common silver biddy 11 and barracuda 1. In contrast to the by catch 95 Indian mackerel were discarded.

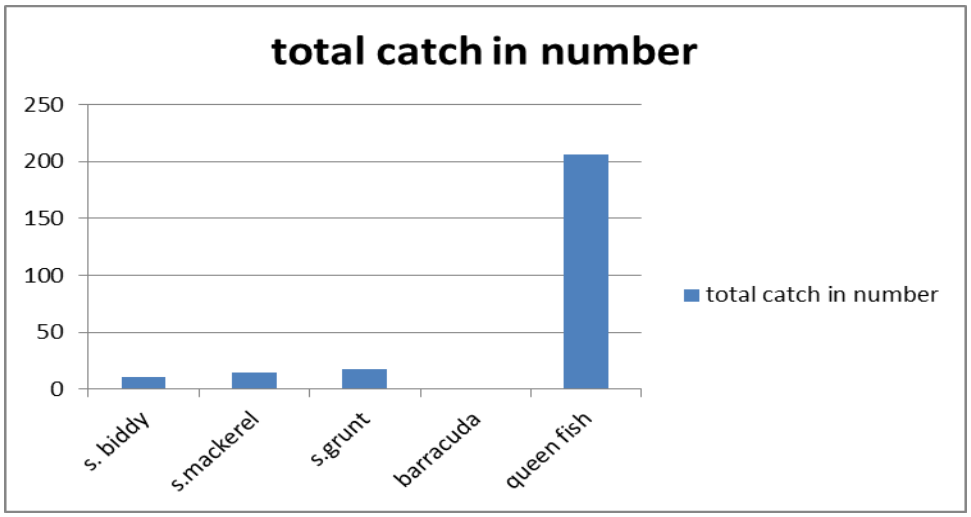


Figure 1 total fish catch in number

Similarly, the dominant biomass catch showed was queen fish 1030 kilogram, while the remained catch was in similar quantity like Spanish mackerel 30kg, silver grunt 9 kg, common silver biddy 5.5 kg and barracuda 0.3kg.

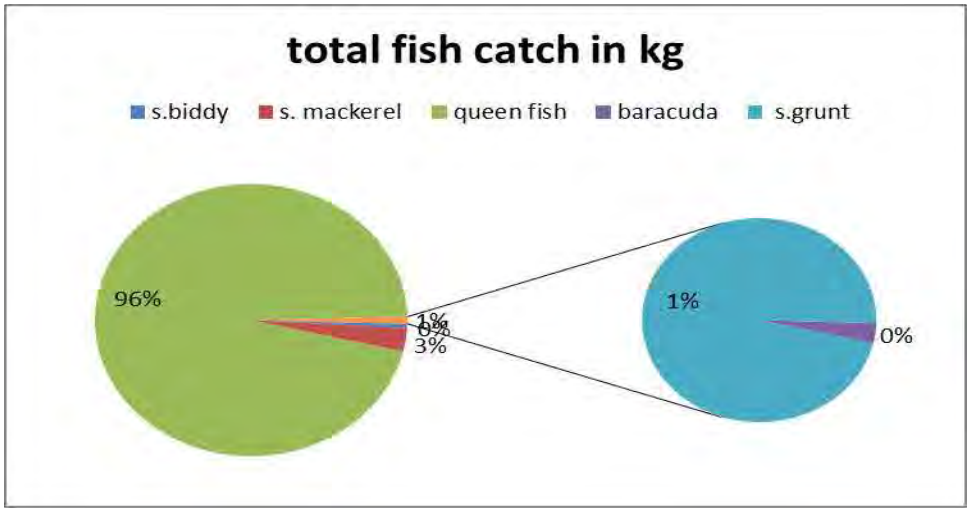


Figure 2 total fish catch in kg

The depth of net is 16 meter, thus to avoid escape of encircled fish beneath the net, in the eleven days of fishing trial the water depth undertaken ranges from 14 meter up to 25 meter which is an average of 18 meter.

In general the total catches and proportion of each species within the catch similar between fishing ground. Fortunately, Queen Fish recorded highest catch in all sites.

4. Discussion

The result from the fishing trial, when the fishers try to compare the prototype net with their existed net; the prototype net advantage is stated as follows.

A. Less labor demanded; since this net is produced from monofilament, while the existed net is produced from multifilament, thus it is very light in weight. Thus why the prototype net seek less crew, to that effect minimize labor expense.

B. Catch efficiency; the footrope of the net is assembled with lead line rope sinker, Thus fishers noted several points. Firstly, during encircling the lead line did not create noise or disturbance, eventually fishes cannot escape. Secondly, during retrieval the lead line did not entangle with the net which create smoothness and simplicity to fishing. Thirdly, the color of the net is similar with color of the water and has little thickness, so that fishes cannot see the net and even can use during full moon. Even though this trial conducted during late season of encircling gill net fishing, appreciable amount of fish were caught. For instance in Derdia a total of 131(655 kg) fishes were caught in one encircling trial.

Though, the prototype net has good points, it occur some limitations which needed to amend;

A. The prototype net is produced from monofilament which is very light thickness, thus it was easily damaged, seek great care and difficult to repair the damaged one.

B. The assembled sinker was lighter in weight and during encircling it sinks gradually which allow the encircled fish to escape. Besides the depth of the net was a bit short (16m) when we compare with fishers (28m) used.

5. Recommendations

This trial was conducted during late season of encircling gillnet fishing, so that the data might not give accurate result. Thus, for the next trial is should be done on right season from April –July. Besides the head rope and foot rope should address the required additional float and sinker, prior the next fishing trial reached.

Points to be account, for future procurement the type of the twine should be multi-monofilament to extend life of the net and to allow repair when damaged.

Appendix6

On the fishing trial, assets of the fishers like 100 meter rope, anchor and buoy were lost due to strong current. Therefore in order to collaborate our performance the fishers' property should compensate.

Appendix6

Boat Owner- Ali MusSa Mohammed				Licence No- 3001/9							
Boat Name- Alnesiem				Boat Length-17 meter							
Skipper- Mussa Ali Mussa				Boat Type- Sanbuk (inboard engine)							
Date	Turning on light	setting time	Retrieval time	Fish catch in common name	Fish catch in number	Total fish catch in kg	Fishing ground	Depth (meter)	Discarded fish	Discarded fish in number	Environmental condition
2021/8/8	6:30 pm	11:30 pm	12:00 am	s. mackerel	4	8	Maedeban	19	I.mackerel	10	calm
				queen fish	33	165			crab	2	
2021/8/9	12:00 am	4:00 am	4:30 am	queen fish	31	155	Maedeban	19	I.mackerel	15	calm
2021/8/9	6:30 pm	10:00 pm	10:30 pm	silver biddy	1	0.5	Drdia	15	crab	1	calm
				baracuda	1	0.3					
2021/8/9	11:30 pm	12:00 am	12:30 am	silver biddy	10	5	Drdia	15	I.mackerel	6	calm
2021/8/10	12:30 am	4:00 am	4:30 am	queen fish	4	20	Maedeban	19	I.mackerel	5	calm
2021/8/10	6:30 pm	10:00 pm	10:30 pm	0	0	0	Maedeban	19	I.mackerel	8	calm
2021/8/10	10:30pm	11:30 pm	12:00 am	0	0	0	Maedeban	19	I.mackerel	5	calm
2021/8/11	12:00 am	3:45 pm	4:10 am	queen fish	2	10	Maedeban	19	I.mackerel	4	calm
				s. mackerel	1	2					
2021/8/11	6:30 pm	10:00 pm	10:30 pm	0	0	0	Drdia	16	0	0	current
2021/8/12	6:30 pm	11:30 pm	12:00am	s. mackerel	7	14	Drdia	14	I.mackerel	10	calm
				s.grunt	8	4					
2021/8/13	12:00 am	3:00 am	4:00 am	queen fish	131	655	Drdia	16	I.mackerel	20	calm
2021/8/13	6:30 pm	12:00 am	12:30 am	s.grunt	10	5	Drdia	16	I.mackerel	5	calm
				s. mackerel	3	6					
2021/8/14	12:30 am	4:00 am	4:30 am	queen fish	5	25	mekemera	15	I.mackerel	4	calm
2021/8/15	6:30 pm	12:30 am	1:00 am	0	0	0	umawed	24	0	0	s.current
2021/8/16	8:00 pm	12:20 am	12:40 am	0	0	0	harat	25	0	0	s.current

Appendix7

The Project for Formulation of The Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC)

Report on Encircling Gillnet 2nd trail fishing

Ministry of Marine Resources in Eritrea

Observed and reported by,
Temesgen Amanuel

Edited by,
Mulugeta Mahdere

July, 2022

Outline of activities

1. Introduction

One of the three pilot projects is Pilot Project for Improvement of Gillnet and its Making Capacity Building (PP1). Implementation of this pilot project has been started through delivering theoretical lecture by JICA fishing gear expert to the counterparts in March 2020. During this time one drift pelagic gillnet and one encircling gillnet were constructed. After JICA expert dispatch on 2020, the counterparts with other development department staffs assembled another two encircling gillnet in order to complete the necessary numbers for conducting trial operation.

The first test operation using the encircling gillnet has already been carried out in August 2021, and the knowledge of gillnet fishing operation and the fishing gear making technology of PIU members are being strengthened.

This trial operation of produced encircling gillnet was operated alone, not along with the ordinary encircling gillnet, because it cannot be found willing fishers to operate both the ordinary and new one. However, the following opinions were obtained in the first trial operation from fishers.

① The nets are light and the labor works is reduced.

② It is possible to operate with a small number of people.

③ The profitability surely is improved by higher catching efficiency than the existing encircling gillnets.

④ The lead core type sinker type is smooth

In the trial operation, in contrast to the superiority of the newly introduced gillnet fishing gear but also some problems were identified.

① The assembled lead core type sinker had low sinker force, which has low sinking speed.

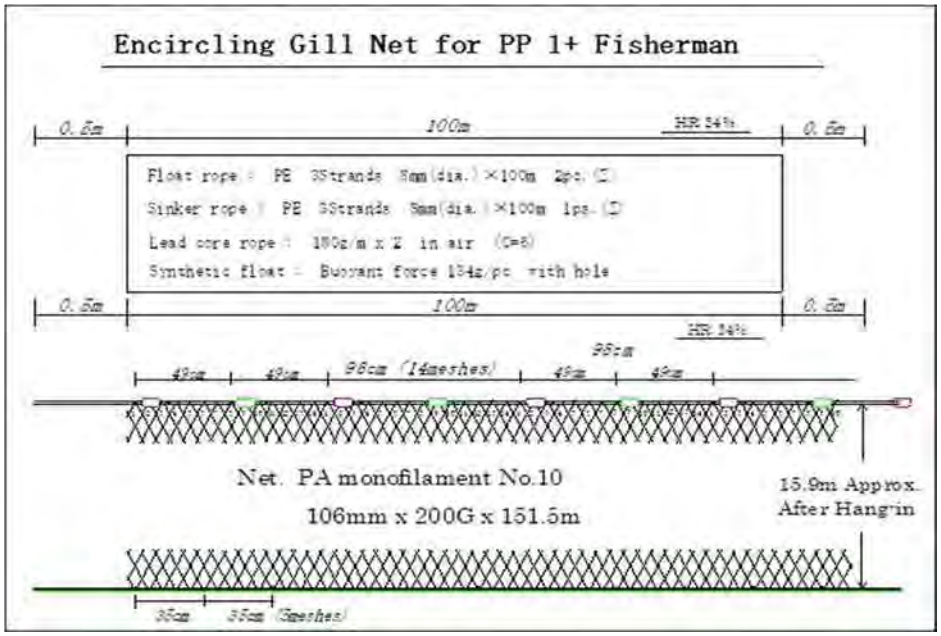
② The monofilament type net is not able to mend and has short life span.

In consideration to the problem identified, the fisher suggested a newly designed based on the first demonstration and they would like to increase the sinking force and buoyant force of the fishing gear for quick setting of net. Responding to the fishermen's request, the necessary fishing gear materials (float and lead core type sinker) and encircle gillnet were provided by the JICA expert. By using these materials, modification part of the encircling gillnet were completed by the fishermen themselves on April 2022. The modification made by the fishermen is, the intervals between floats were 98 centimeter before, but currently it becomes 50 centimeter. Besides in the sinker line the lead core type sinker assembled had 180gram per meter, currently the same type of sinker rope was added on.

For verifying the effectiveness of the modified net and to continue the trial operations and collect more information including identify efficiency, operation, production and catch rate of the produced net in comparison to the existed net, this second

demonstration was operated on mid of May 2022.

Modified encircling gillnet by fishermen



2. Observed and reported by Temesgen Amanuel,
Edited by Mulugeta Mahdere (MMR PIU)

3. Periods: 24 May 2022 – 02 June 2022 (9days)

4. Implemented fishing boat: Sambuk

5. Methodology

This second encircling fishing trial was carried out for a period of 9 days (24/05/22-02/06/22). It was conducted mostly in one enclosed area particularly in Dorguman Island, because there was disturbance of wave. In every trial the necessary data like common name of the catch, weight and number of catch, sea condition, depth, setting time, retrieving time were collected by the observer. The selection of the fishing ground was led by the fishermen, as due the expense covered by boat owner.

6. Materials used;

The materials used were similar with the first trial. These generally include;

a) Three encircling gillnet (nylon monofilament No.10, 106 mm mesh size, 200 mesh depth, 150 meter length). These nets were assembled by using Y-20 float, lead line rope sinker. Besides, double rope on the head rope and foot rope with hanging ratio 65% were used. To the end after assembled the dimension of the nets are reached 100 meter length and 16 meter depth.

b) Bigger boat (Sambuk) inboard engine fish holder.

c) Fiber glass reinforced boat outboard engine for encircling the fish.

d) Fiber glass reinforced boat outboard engine for holding lighting fluorescent lamp.

e) Generator

f) 6 Fluorescent lamp

7. Fishing trial;

On the sea onboard of the boat prior conducting fishing trial, attaching the nets series by four millimeter thickness rope and arranging all necessary materials were confirmed by the fishers with one member of fishing gear staff. After preparation process, several encircling have been made to experiment the net to determine effectiveness. On the selected fishing grounds, experiment was started with turning on the light of six fluorescent on the small fiberglass reinforced boat to gather the fishes. Then after three hours of lighting, the second fiberglass reinforced boat encircled by the connected three nets to the gathered fish. Encircling was done as the boat navigate anticlockwise direction, the crews removed the starting line of the net to the water and paying out until the ending line reached and then encircling ended as both tips of the net were tied to the boat. To this end, the encircled fish were disturbed by quick navigation the boat, for being the fishes enmeshed and entangled in the net. Finally the net was retrieved to onboard of the boat and the fish caught were released from the net.



Picture-1; the two fiber glass boat prepared for fishing



Picture-2; after encircling (setting) the gathered fish.

8. Result

This operation test was started around Dehil Island north of Massawa and carried out for two days. In this Island the fish caught was not more than 5 kilogram per night, because the sea condition was became inconvenient by strong wave disturbance. Two days later on 26 May, the operation switched to north east around Nora Island and the catch was very promising. There from 26-29/05/2022, the average fish catch per night

estimated, queen fish 440 kg, Spanish mackerel 54.75 kg, milk fish 36 kg was harvested. Nevertheless in the late date 30/05/2022 up to 01/06/202 the estimated catch per night queen fish dropped to 156.6 kg, in contrary Spanish mackerel raised to 100.3 kg. In generally the dominant catch obtained was queen fish and Spanish mackerel. In terms of weight the recorded catch shows an average of 5-9 kg for queen fish which are large enough size. Whereas, in case of Spanish mackerel maximum catch was 2 kg, which is smaller size from the typical catch of ordinary fishing.

This fishing operation carried out in water depth of around 20 meter deep, which is similar with the depth of net. Therefore, these fishes available at all level of water were encircled and had no chance fish to escape toward the bottom.

Similarly but not as equivalent to the above, another fish catch was milk fish and recorded an average of 6 kg, additionally shark also fished in small quantity.

Appendix7

Figure-1; data captured from data sheet template

date	Net dimensions (m)	Searchlight setting time	Encircling time	Fish caught	Catch in number	Catch in weight	Fishing ground	Depth (m)	Sea condition
24/05/22	300	06.45	09.30	sardine	7	2 kg	Dehil	20	windy
				barracuda	2*1 kg	2 kg			
				I.mackerel	1	0.5 kg			
				S. mackerel	1	2 kg			
25/05/22	300	-	-	-	-	-	-	-	windy
26/05/22	300	7.00	09.45	Queen fish	140*5kg	700 kg	Dorguman	15	cold
				S. mackerel	103*1kg	103 kg			
				milkfish	8*6kg	48 kg			
27/05/22	300	06.05	10.00	Queen fish	53*6kg	78 kg	Dorguman	15	
				S. mackerel	90*1kg	91 kg			
				milkfish	2*6kg	12 kg			
		11.10	02.30	Queen fish	86*5 kg	430 kg			
28/05/22	300	06.50	10.45	Queen fish	55*6 kg	330 kg	Dorguman	15	
29/05/22	300	12.00	02.30	Queen fish	37*6 kg	222 kg	Dorguman	14	cold
				S. mackerel	50*0,5 kg	25 kg			
				milkfish	2*6 kg	12 kg			
30/05/22	300	07.10	11.45	Queen fish	8*5 kg	40 kg	Dorguman	15	windy
				S. mackerel	76*1kg	76 kg			
				shark	5*1kg	5 kg			
		12.50	3.05	Queen fish	6*5 kg	30 kg			
				S. mackerel	75*1 kg	75 kg			
31/05/22	300	7.00	10.10	Queen fish	28*5 kg	140 kg	Dorguman		
				S. mackerel	48*1 kg	48 kg			
		11,05	2.45	Queen fish	3*5 kg	15 kg			

Appendix7

				S. mackerel	77*1 kg	77 kg			
01/06/22	300	6.30	10.30	Queen fish	2*5 kg	10 kg	Dorguman	16	
				S. mackerel	51*0.5 kg	25.5 kg			
Total					**1,015**	**2,587 kg**			

9. Discussion

Based on the above recorded data, the overall catch obtained reaches about 2587 kg. The net income of this operation has been estimated by calculated selling of the total catch minus cost of expenditure and proved below how the magnitude of the profit is from this type of net.

The computation below is calculated the total catch (kg) of each species multiplied by the unit price.

- Queen fish:-1995 kg*28 Nakfa unit price = 55860 Nakfa
- S.mackerel:-522.5 kg*45 Nakfa unit price = 23512.5 Nakfa
- millkfish:-72 kg*14 Nakfa unit price = 1008 Nakfa
- shark:-5 kg*5 Nakfa unit price = 25 Nakfa
- **total fish price = 80405.5** Nakfa
- ice expense = 6000 Nakfa
- fuel (petrol and diesel) expense = 12000 Nakfa
- foodstuff expense = 4500 Nakfa
- **total running cost expense = 22500** Nakfa
- royalty 3% of total selling price = 2412.15 Nakfa

The net income = total selling price – total expense

= 80405.5 – (22500+2412.15)

= **55493.5 Nakfa**

In general the net income obtained from the above calculation is just to indicate some view, not an accurate and precise value. Because many expense like the maintenance cost, transporting materials cost (fuel, foodstuff, ice), operation materials cost (searchlight, generator, torch) etc are not captured, similarly fishermen self-consumed fish on the sea as well as fish took to their home and relatives are included in the total catch. As for these limitations the total net income estimated 55,493.5 Nakfa and finally through the local general fishery law, it is shared equally halve the boat owner and the remained halve to the crew members with the captain. So that, the net income for the boat owner is estimated to be around 20,000 Nakfa, while for six crews each 1500 Nakfa and skipper 3000 Nakfa, making this net is noticeable.

On the other hand, according to fishermen observation for these test operation, many opinion were given. These opinions are; the fishing net is made of monofilament, thus

fishing efficiency is high and light in weight operated by few crews (5 crews) that minimize cost of crews. Whereas the ordinary fishing net is made of multifilament, thus when it is soaked absorbs more water and seek more crews (10 crews) to operate, which could be double number of crews from this monofilament type. Unlike the ordinary type, these new net not only fish catch by gill operculum but also more by entailment. To that effect considerable amount of queen fish 77% from the total were caught which is not happened in the typical multifilament net.

	
Picture-3;-after encircled fishermen haul the net	Picture-4;-fish caught, queen fish and mackerel

The design of the new net in the sinker line assembled a lead core type that resemble rope, which create smoothness during operation, while the ordinary net used concrete in the sinker line, thus create noise during setting and forced fish to escape from being encircled. Moreover this new net is light in weight. As a result it could be operated in shallow water by small boat where no rock and coral reef area.

Unlike to positive opinion, some disadvantages needed to be improved are; the new net is made of monofilament which is very light in weight, eventually may be difficult to operate in wavy and current condition. Similarly the Spanish mackerel which is far more the main target caught were usually small in size, the reason guessed that the bigger size might escaped by tear up to the light net. Nevertheless, the fishermen suggested that could be easily damage if any rough bottom faced, as a result it has to be operated only in mud and sandy area.

10. Conclusion

When the encircling fishery is proposed, there are preconditions needed to emphasize. The first point is the net should have high breaking strength. However the new net is made of monofilament, as a result bigger fish might tore out and might not uv tolerant. To that effect the duration of that could be short lifespan. Therefore, other than the monofilament type, the multi-monofilament type net might be preferable.

The second point needed to consider is that the net should have great sinking speed. The sinking speed is influenced by the kind of netting material as well as construction of the gear. In the first trial the net had low weight of sinker, consequently sunk slowly and negatively affected the catch efficiency. Based on the first operation, the fishermen modified the net by assembling the additional sinker and float, in order to attain the required sinking speed. Ultimately, this second operation showed considerable difference from the first operation and proved point to account, attention on the required sinker.

So far, the trial operation has been conducted with the same boat owner at similar depth not more than 20 meter depth of water. Therefore if another fisher's accessible, test operation with these fishers is crucial to verify the result.

Appendix8

The Drift gillnet fishery for Spanish mackerel in Japan

April 2022 Morimitsu

① The catch rate of the nylon monofilament drift gill net for Spanish mackerel is better in comparison with the conventional nylon multifilament net even in daytime operations.

② As for the net, the PA monofilament passes the tidal flow more easily and the net is lifted lighter than the PA multifilament from sea water. In addition, catch rate of fishes improves.

③ In case of the net of 100 fathoms (151.5m) by a tan (Japan unit), the finished net is about 105m long for shrinkage of 30%. In the Set inland sea area, about 6~20 tans of the net per ship is used.

④ As for the enmeshed rate is greatly influenced by the balance of the floats and sinkers, it is necessary to make sure how the whole net sinks after assembling. It is to be desired that the net floats on the surface of the water for a while and that the net gets sink gradually and slowly.

⑤ At the time of net casting, 7 to 8 floats are usually attached on the sea surface of the water in each unit (around 100m). It is desirable that the weakness of float is good so that force is not directly impacted strongly to the float rope by wind waves or tides.

⑥ It is better to make the sinker as light as possible to catch large, medium and small fish. On the other hand, when the sinker is heavy, the fishes according to mesh size are mainly caught. The choice of light or heavy sinker will be depend on the fishing status and the fisherman's decision.

⑦ As long as the thread thickness of the net should be strong enough to stop the swimming Spanish mackerel, using a thread that is as small as possible will increase the catch rate, however the thread is too small, the durability on netting will decrease. Therefore, fishers carefully determine the thickness of the thread size.

⑧ At present in Japan, labor-saving type of fishing boat that uses a reel winch installed at the stern deck to wind the entire net is increasing as a method of deploying and retrieving net.

Appendix9

Report on a series of floating drift gillnet making

And trial operation

(Adjustable net depth type)

April 19/2022

Reported by Filmon Bereket Bairu
Filmon Bereket Berhe

Appendix9

INTRODUCITON

Gillnet is one of the most practiced passive fishing gears in the world, which is a simple wall of netting with a certain mesh size, and it is set vertically in the water to interrupt the path of fish, in which fish are caught gilled or entangled. Gill nets are mounted in the water vertically where at the top hanged with a floating material, and at the bottom line with sinkers to maintain a rectangular shape in the water.

From the previous MMR and JICA project has been doing some works about fishing gear modification and introducing new techniques of fishing, and this is also as a continuation of that project specially for the gill net modification, in the previous time some works like gill net modification for drifting gill net and surrounding gill net had been done and they had good results. As the continuity for the drifting gill net this one also different in which net is assemble without floats instead floating ropes and buoys with suspension rope in certain distance are assembled to it. The buoys with suspension ropes uses are to hang the net in a depth where the fisherman likes to set.

OBJECTIVE

The main purpose of this adjustable drifting gillnet operation is fishermen to use it in any depth of the sea by adjusting the suspension rope so that they can catch any kind of fish in any time, and it's also help full in case of seaweed and wave .

Floating drifting gill net and trial operation

Modification for drifting gill net

Methodology

- First lecture about the new drifting gill net was given by the JICA expert (Morimitsu)
- Net making was done in FGTD unit office by the guidance of JICA expert
- Trial operation of drifting gill net in the sea was done in the presence of all team

Discussion

Lecture

In this project lecture about assembling the new drifting gill net, and the calculation to find out the requirement for assembling gill net was given briefly by the JICA expert the lecture includes

Introduction to the materials those are used for making the net and how to identify the materials, what they are made from, basic calculation for gill net making and also practice for the calculation.

CALCULATION

- The calculation part lecture about, how to find out hanging ratio, sinking force, buoyance force, and also height of netting had been given.

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- To find hanging ratio **H.R =L-l/L*100** where L is stretched length of the net and l is length of the netting after hanged
- To find sinking force we use **S=W-V OR S=W (1-1/C)** where S is sinking force, W is weight of an object, V is volume of an object and C is specific gravity of an object.
- To find buoyance force we use **F=V-W OR F=W (1/C-1)** where F is buoyancy force, V is volume of an object, W is weight of an object and C is specific gravity of an object.
- To find height of netting we use **L= l/H.M (%)/100** where L is stretched length of netting, l is height of netting after hanged and H.M is height of meshes. from these formulas we can also find the other requirement by deriving the formulas.

Using these formulas we had practiced some exercises, and everybody has good understanding about them.



Picture for lecture

Net making

At the end of lecture everybody was able to calculate the requirement for making the new drifting gill net. the net that we had was monofilament poly amide (PA nylon) with stretched net length 151.5m,mesh size 110mm,100mesh in depth and second one was 151.5m,mesh size106mm,200mesh in depth, both light grey in color, and also which is poly propylene(Pp) braided type rope with 8 strand, one with 8mm and second with 6mm diameter, and there was sinker rope with 50g/m by using all these materials and the calculation above we were able to find out what is necessary for the net making using the hanging ratio 34% for the head rope and 31% for the foot rope.by using this the net becomes 100m length at the head after hanged and 104.5m at the foot, the difference in length between the head rope and the foot rope helps the net to be set properly in the water. We use two ropes for the head rope, 8mmand 6mm each, the net hanged 7 meshes in every 51cm, and also in every 10m we prepare suspension rope for it. For the foot rope we use 6mm rope and lead rope, in every 38cm 5 meshes were hanged. And for the second net we use hanging ratio 35% for the

head rope and 34% for the foot rope, in every 50cm 7meshes are hanged with two head ropes same as the first one and for the foot rope, in every 36cm 5meshes were hanged and the foot rope includes lead rope and 6mm polypropylene braided type rope. At the end we attached the suspension rope which is 2m long with the float line. And also we prepare the buoys which are 5litrs oil container and sinkers which are stones.



Pic 1 net making for 100meshes of depth (G1)



pic 2 net making for 200meshes of depth (G2)

Sea going practice and discussion

Date 5-6/4/2022

Time 8:30-11:00am

Loading was done at 8:00 o'clock, and we load every single material that we need for the trial, including safety material, on a boat, which is 8m long with 40hp out board engine, and leave at 8:30. The fishing ground for the trial that we chose was around Green Island which, is sited near Massawa port. The trial operation was done on the east side of the island, first we check the direction of wave and current and also depth of the sea, using rope with a stone at the end of it and float at the other end, in case of the wave and current we use longer rope to see where the float goes, when we check these things we proceed on to net setting, it was simple one man from the float line and another from the sinker line, we set the net aside of the wave, from the side of the boat while the boat was moving stern side while the others were attaching the buoys with the suspension rope, at the first day we were not able to consider ,the effect of wave during setting, the boat was crossing over the net due to wave and causing entangling the net on the bottom side of the boat, but, the next day we arrange all these things, and the CP group were able to set net properly themselves, on their own way without any problem, at the first day the suspension rope was long ,that means the net goes deeper, that is why we were not able to see how it was set clearly, but the next day we make it shorter so that we can see the net clearly, at the same time we tie buoys, into two different intervals one in 10m and the other In 20m and we find out that 15m interval is the best way in considering the number of floats necessary for one net.in this trial operation there was no catch, and that is because

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setting was done during the day time and also for one and have an hour only, and this kind of operation is hard to catch a fish because during the day time net Is more visible , the probability fish to swim toward the net is low, in addition to it the time between setting and retrieving it was very short , and also timing was suppose, to be either late evening or early morning, to catch fish while moving for feeding. But it's okay because it was done only to check on the net how it works and it was very good.



Pic 3.1 loading



pic 3.2 setting the first day



Pic 3.3 setting the second day



pic 3.4 retrieving

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Conclusion

The whole training was a very good experience to all of us. It was like eye opening that we can prepare any fishing gear specially gill net in any different way. This net possibly can disseminate to the fishermen, but before dissemination, trial operation should be done together with the fishermen, in order to hear their opinion and also to see its catch efficiency, so that we can decide whether to disseminate it to the fishermen or modify it.

Appendix10

Project for Formulation of the Strategies and Practical approaches for Coastal Fisheries Development in The State of Eritrea

Report Demonstration on of depth-adjustable drift gillnet (PP1)

Onboard Observer and Reported by;
Yosief Redae

Compiled by;
Andemichael Hdru
Mulugeta Mahdere

October-2022

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1. Introduction

It is known that the duties and responsibilities of the fishing gear technology unit, is conducting different demonstrations on fishing gears and techniques to transfer and adopt it to the coastal fishing community specially to the artisanal fishermen (local and traditional fishers). This moment in collaboration of Ministry of Marine Resource and JICA has been implemented a project FSPAC as pilot project comprises of three pilot projects (PP1, PP2, and PP3). So far in PP1, two fishing demonstrations for each of the drift gillnet and encircling gillnet has been carried out. In continuation of these trial, another technique of gillnet fishing demonstration which is depth adjustable gillnet was also incorporated on August. The fishing net was assembled by the team members under the guidance of the JICA fishing gear expert. After completion of assembling two depth-adjustable gillnet, prior fishing demonstration, on March 2022 two days of setting and retrieval test of the fishing net was conducted around Green island by the team and the JICA expert, moreover to evaluate the fishing efficiency, this fishing operation was conducted with the artisanal fishers under onboard observer from the team.

The net is monofilament type with stretched length of 150 meter, of which three nets are with 100 meshes and three others with 200 meshes in depth but all of them are 110mm mesh size. The difference from the ordinary gill nets is that it is assembled the foot rope with lead rope sinker and the headrope without floats, but tied by rope with buoys at certain interval to serve as floats. And this feature gives chance to fishers to deploy it at various depths of the sea by adjusting the length of the rope from the headrope to the buoy**.**

1.1Objective

- To conduct fishing trial of the depth-adjustable drift gillnet
- Compare and contrast the newly designed net with that of the artisanal gill net as well as assess the advantages and disadvantages of the gear

2. Materials and methods used

The fishing demonstration was conducted in north of the Dahlak Island, namely Delfidol and Meateban fishing. The site selection was relied on the willingness of the fishers; as a result, though the observer stayed at sea for 10 days October 20-30/2022, the numbers of trials conducted were only three. Because, the Artisanal fishing boat that we used was, engaged in their ordinary drift gillnet and encircling gillnet, thus once they got good catch through encircling gillnet, they were suspended to for using drift gillnet fishing. The number and weight of fish caught were counted and measured and finally recorded in the data sheet along with same other parameters.

The fishing boat used was an inboard engine, which has 20 meter length and 14.6 ton net weight. And also it is fiberglass reinforced and quite equipped with fishing inputs. Name of the owner is Mohamed Abdela Mohamed a residence of Dahlak Island.

The following gears were used;

- A total of three 100 meter length and 8 meter depth, depth-adjustable gillnet monofilament 110 mesh sizes.
- A total of three 100 meter length and 16 meter depth, depth-adjustable gillnet monofilament 110 mesh sizes.
- 12 buoys and 30 plastic 5-liter container to use as float
- One roll rope no. 6 for adjusting the depth of the head rope with buoy.
- Four stones (5 kg in total) by attaching on beginning of the footrope to stretch the net properly.
- Balance and camera for measuring and recording
- Record data sheet for recording data

	
Figure1_ trial boat	**Figure 2 plastic container, buoys and rope**

3. Activities conducted

3.1Net deployment

On 20 August 2022, net was prepared at the deck. During the preparation of the net, half meter rope was tied to the buoys, then these buoys was tied up at an interval of 15 meter apart, at the upper part of the net. In addition to this at both ends of the net signal light was tied with the first and last buoys and Parallel to that at the footrope four stones was tied. After preparation was completed, at the determined fishing ground gillnet deployment evolved sequentially, which means one crew manipulated the headrope and another one the sinker side to deploy net properly while the skipper was navigated the fishing boat forward and finally net was set to be tied with the boat.

3.2Net retrieval/hauling

After 3 hours soak time, net was started to be retrieved for harvesting fish. During retrieval, while boat was slowly moving forward, fishermen started to retrieve net by holding net one with the float side and another with the sinker side. While hauling net, at the same time both fish was harvested and net was stacked properly.

In general, in this fishing demonstration the depth-adjustable gillnet was soaked three times and fish harvested was recorded as in the table below.

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Table 1 catch and other activities record

Date	Mesh size in mm	Gillnet depth in m	No. of gillnet (pcs)	Species	Catch in No. (pcs)	Catch in kg.	Fishing ground	Depth/rope depth	Setting time	Retrieval time	Current condition
20/8/2022	110mm	12	3	Spanish mackerel	4	6.5	Taeteban	24m/2m	7:00 pm	10:00 pm	Calm
		20	3	Queen fish	3	14	Taeteban	24m/2m	7:00 pm	10:00 pm	
21/8/2022	110 ㎜	12	3	Queen fish	3	12	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Shark	8	24	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Spanish mackerel	1	1.5	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Shark	13	36	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Silver grunt	5	2	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Cat fish	1	1.5	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Jack fish	1	0.5	Taeteban	17m/2m	7:00 pm	10:00 pm	Calm
				Cat fish	2	6.5	Delfidol	20m /0.5m	7:00 pm	10:00 pm	Calm
				Spanish mackerel	11	16	Delfidol	20m/0.5m	7:00 pm	10:00 pm	Calm
				Silver grunt	5	2.5	Delfidol	20m/0.5m	7:00 pm	10:00 pm	Calm
				Spanish mackerel	13	18	Delfidol	20m/0.5m	7:00 pm	10:00 pm	Calm

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Date	Mesh size in mm	Gillnet depth in m	No. of gillnet (pcs)	Species	Catch in No. (pcs)	Catch in kg.	Fishing ground	Depth/rope depth	Setting time	Retrieval time	Current condition
	110mm	12	3	Spanish mackerel	4	6.5	Taeteban	24m/2m	7:00 pm	10:00 pm	Calm
		20	3								
	110mm										
	110mm	20	3								
				Silver grunt	11	7	Delfidol	20m/0.5m	7:00 pm	10:00 pm	Calm
26/8/2022		12	3	Queen fish	3	15	Delfidol	20m/0.5m	7:00 pm	10:00 pm	Calm
	Total catch				84	163					

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4. Discussion of the results observations

As stated above, at every trial, net was soaked for three hours and during setting, buoys rope length was 0.5 meter and 2 meter in Dolfodol and Taeteban fishing grounds respectively. As well as fishing depth was 20 meter in Dolfodol and 17-24 meter Maeteban which is similar with the depth of the gillnet. And species caught, in pieces and weight in both fishing grounds are as in the table above. Species caught abundantly is Spanish mackerel and least caught is cat fish. Though the gillnet was intended to be set at different depths, it was only tried in shallow waters due to the fishermen were operating in shallow areas along with an encircling gillnet at around 24 meters only and we cannot oblige them to go to the deeper waters as we do not able to provide them with fishing supplies. So, the adjustable drift gillnet was not set to be tried in the mid and deep waters. Therefore, further trials are recommended for reliable results of the net. The fishermen witnessed, the trial made in the shallow water indicated that, this type of gill net is relatively efficient than the other gill nets.

Generally, from the trial, the fishing net was found to be suitable for fishermen due to：

- The net is monofilament type; it is light and easy to set. It cannot absorb water as multifilament nets.
- It can be operated with less man power and reduces fishing cost.
- It has the advantage to be set at various depths by changing the length of the buoys rope.
- As the sinker is lead rope, during setting net sinks properly and do not entangle as that of other sinkers do with mesh. So, it is comfortable for fishermen during setting.
- Since net has similar color to the sea, it is less visible even during full moon

During the trial, the disadvantages/drawbacks observed were;

- Strength; The net was observed to be cut by fish and by hand during hauling though it is new
- Weight; since the net by itself and the lead sinker are light in weight, can easily drift by wave and current action.

- It is observed that net needs more buoys, and small boats have limited space to store buoys.

5. Conclusion

In this fishing operation the number of trials conducted was few. And also, it was soaked in shallow area which was not deeper from the depth of the fishing net; eventually there was no chance to test by setting at different depth through adjusting the length of the rope from the headrope to the buoy. Therefore, for proper estimation another fishing operation with Artisanal fishers who use relevant fishing technique needed to be conducted. On the other hand, the fishers were likely to operate this technique by their easiness of handling.

Appendix11

PP1 Material list

PP1 : Pilot Project for Improvement of Gillnet and its Making Capacity Building

Materials list Unit: Japanese Yen

No.	Items	Specification/discription	Amount	Unit	Price	Sub-total
	Materials for gill-net					
1	Gill net (Netting)	PA Mono. No10×116㎜(Mesh size)×200(Num.of Mesh in depth)×151.5m	3	tan	36,000	108,000
2	Gill net (Netting)	PA Mono-Multi. No.1.5/8 110.5㎜(Mesh size)×100(Num.of Mesh in depth)×151.5m	1	tan	65,000	65,000
3	Twine	Reox twine 20/21	1	kg	2,200	2,200
4	Twine	Reox twine 20/18	1	kg	2,200	2,200
5	Netting needle	ABS #3	30	ps	220	6,600
6	Netting needle	ABS #6	50	ps	170	8,500
7	Netting needle	ABS #8	30	ps	155	4,650
8	Scissors	Stainless steel type for fishing net	5	ps	2,500	12,500
9	Cover sheet	DCM blue sheet	2	ps	1,628	3,256
10	Cutting board	DCM cutting board antibacterial type	1	ps	602	602
11	Knife	Stainless steel type 145mm	1	ps	2,728	2,728
12	Whetstone	DCM Cobination type	1	ps	437	437
13	Head light	LED Gentos GTR-831D	5	ps	1,419	7,095
14	Hand light	LED Hand light Gentos endurance type	2	ps	4,279	8,558
		sub-total				232,326

No.	Items	Specification/discription	Amount	Unit	Price	Sub-total
	Materials for gill-net					
15	Rope for float side	PP rope 8 strands Dia.8mm (200m)	15	coil	8,670	130,050
16	Rope for float side	PP rope 8 strands Dia.6mm (200m)	15	coil	5,040	75,600
17	Rope for sinker side	Tetron braid rope(lead core 50g/m) (200m)	12	box	14,500	174,000
18	Gill net (Netting)	PA Mono. No10×106㎜(Mesh size)×200(Num.of Mesh in depth)×151.5m	10	tan	95,170	951,700
19	Gill net (Netting)	PA Mono. No10×110㎜(Mesh size)×100(Num.of Mesh in depth)×151.5m	12	tan	48,000	576,000
20	Twine	Reox 20/24 1kg/spool for gill net making	5	kg	4,030	20,150
21	Twine	Reox 20/21 1kg/spool for gill net making	5	kg	4,030	20,150
22	Tool box	Ringster D-7000 (697x 330x 250)	3	box	3,950	11,850
23	Netting needle	ABS #5	50	ps	180	9,000
24	Netting needle	ABS #7	100	ps	150	15,000
25	Netting needle	ABS #9	50	ps	130	6,500
26	Suspension rope	PP film rope 6㎜ 200m	5	coil	3,650	18,250
27	Scissors	Stainless steel type for fishing net	5	ps	2,310	11,550
		sub-total				2,019,800
		Total				2,252,126

Purchased materials list from MMR Unit: Nfa

No.	Items	Specification/discription	Amount	Unit	Price	Sub-total
1	Floats	Y-20 122x56x16	300	pcs	6.59	1977
2	Floats	Y-50	170	pcs	12.69	2157.3
3	Rope	7mm Diameter 200m	5	pcs	305.24	1526.2
4	Rope	8mm Diameter 200m	5	coil	337.37	1686.85
5	Rope	9mm Diameter 200m	2	coil	481.95	963.9
6	Sinker rope	6mm lead core rope 180g/m x 180m	5	coil	4739.18	23695.9
7	Twine	210d/36 spool Grey coloer	1	coil	96.39	96.39
		Sub-total				32103.54

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Others

Materials list

Unit: Japanese Yen

No.	Items	Specification/discription	Amount	Unit	Price	Sub-total
	Materials for Net hauler and FRP maintenance					
1	Net hauler machine	Koshin, Mag-roller MR-4024	3	ps	247,880	743,640
2	Drum for Net hauler	Roller MR-360	3	ps	124,820	374,460
3	Rope holder	Hasami roll MR-25	3	ps	17,600	52,800
4	Grease	ENEOS Epinoc(AP-1) 400g or equal quality grease	5	ps	480	2,400
5	Transformer	Swallow PAL-1500EP	1	ps	34,300	34,300
6	Battery	GS/Yuasa(MRN-130F51)	6	ps	24,590	147,540
7	Battery charger	Meltec MP-230 25A	1	ps	14,000	14,000
8	Battery charger	Ohashi-sangyo SMART CHARGER 25A	1	ps	12,820	12,820
9	Breaker for DC24V	Fuji electric Intermediate circuit breaker for 30A	4	ps	9,160	36,640
10	FRP maintenance set	FRP resin 10kg, grass matt 10m, hardening agent	2	set	14,590	29,180
11	Hardening agent	Hardening agent for FRP 100ml	1	ps	7,870	7,870
12	Brush	Brush for FRP 30mm width	2	ps	310	620
13	Brush	Brush for FRP 50mm width	2	ps	470	940
14	Washing agent	Acetone 4 little can for washing	2	ps	1,570	3,140
15	Roller for FRP	Wool roller 150mm width	3	ps	1,140	3,420
16	Roller for FRP	Small roller 4 inch width	3	ps	420	1,260
17	Handle for roller	Small handle for 4~7 inch, length 38cm	3	ps	310	930
18	Measure cup	Polyethelene measure cup for 1000cc	2	ps	60	120
19	Spout	Polyethelene spout for 40mm	2	ps	330	660
20	Spuit	Spuit for 10ml	5	ps	120	600
21	Covering tape	Musker 300mm width x 25m	2	ps	460	920
22	Gas mask	Sanko chemical, gas mask GH715	1	ps	3,930	3,930
23	Filter for gas mask	Filter for gas mask GH715	1	ps	700	700
24	Primer agent	Primer agent for FRP 1kg	1	ps	1,620	1,620
25	Putty	Polyester putty for FRP 4kg	1	ps	3,980	3,980
26	Rubber grove	MG nitoriru grove black powder free type M size	50	pair	70	3,500
27	Wire brush	SK11 stainless D type brush No.64	2	ps	3,790	7,580
		sub-total				1,489,570

	Others		**202202**			
1	Hard Disc	Cavio 1TB USB3.2	1	ps	5,680	5,680
2	Card reader	Transcend USB3.1 Super speed	1	ps	810	810
3	SD card	Sundisc microSD 128GB UHS-1	1	ps	2,040	2,040
4	Rain wear	Rain suits upper & pant	2	sets	3,900	7,800
5	Battery joint	middle joint J18	2	ps	2,380	4,760
6	Battery terminal	Battery terminal	6	ps	328	1,968
7	Battery cover	Terminal cover black and red	4	ps	198	792
8	Battery terminal	crimp contact	2	ps	268	536
9	Battery terminal	crimp contact	1	ps	448	448
10	Marker	Paint marker gold, silver	2	set	110	220
11	Scissors	Scissors	5	ps	110	550
12	Bag	Soft mesh case	1	ps	110	110
13	Axe	Axe wooden handle	1	ps	2,178	2,178
14	Saw	Silky Gom Boy 210mm	1	ps	2,508	2,508
15	Spare saw blade	Gom boy 210mm spare blade	1	ps	1,518	1,518
16	Battery terminal	crimp contact	1	ps	348	348
17	Battery terminal	crimp contact	1	ps	598	598
18	File	Mead Clamp File60	3	ps	998	2,994
19		**sub-total**				35,858
		Total				**1,525,428**

Appendix12

MINISTRY OF MARINE RESOURCE

DEVELOPMENT DEVISION



REPORT FOR HAULING MACHINE

PRODUCER:-

ZENAWI FREZGHI

BLIEN ALAZAR

FISHING GEAR TECHNOLOGY AND FISHERIES TECHNICAL WORKS DEVELOPMENT DIVISION

FISHERIES TECHNICAL WORKS UNIT

SEPTEMBER 2022

Appendix12

1. Introduction

As we know there is cooperation between the government of Eritrea and government of Japan. This cooperation is based up on the development of technical works and fishing gear technology. As a continuation of the previous pilot project, this trial of net hauling machine was also completed. In this net hauling machine trial, there are many things that have to be considered. In this trial we get the actual observation from the artisanal fisheries since the researching time.

2. Objective

1. To minimize the man power (labor workers) in the artisanal fisheries.
2. To introduce new fishing technology for the artisanal fisheries.

3. Methodology

In this case first the development division discussed about the net hauling machine the northern zoba division of ministry of marine resource. And then the cooperation of the engineering and technical support division with fishing technology and fisheries technical works division made the installation of the net hauling machine on the deck of the artisanal fishing boat to be smooth. The boat that is selected to accommodate the machine is selected due to the specifications that made by the engineering and technical supporting division. The boat that fulfills the specification has selected by the northern zoba division of ministry of marine resource. Then the basement of the net hauling machine is done with in one day on the deck of the selected artisanal boat. Then the net hauling machine installed up on the basement which is prepared before. After completing all the installations, the artisanal fishing boat gets ready to travel the fishing ground area in order to get the actual trial of the net hauling machine.

4. Prospective results

1. The man power (labor workers) in the artisanal fisheries has been minimized.
2. New fishing technology for the artisanal fisheries has been introduced.

3. Results and Discussion

This data of the report is collected through the methods of :-

- Oral questionnaire to the artisanal fisheries
- Deferent observations about the net hauling machine at the time of trial.
- Interview with skipper of the artisanal boat.

In this trial of net hauling, there are many advantages and disadvantages. Same of the advantages of the net hauling machine are:-

- ✓ It works with 24V/DC, so it consumes less power which is simply generates from batteries.
- ✓ The design is simple and easy to monitor it

Some of the disadvantages of the net hauling machine are:-

- ✓ The gill net cannot rotate properly around the rolling drum at the retrieving time.
- ✓ When the drum rotates the draft gill net or the bottom gill net, the fish entangled with the net. At that time the net hauling machine should be off in order to disentangle the fish from the net, so there is more time consumption.
- ✓ At the retrieving time of the gill net, since the float and sinker retrieve together through the net hauling machine, it is difficult to manage the entangled fish.
- ✓ This net hauling machine is not efficient compared to the manual retrieving process of the artisanal fishermen.

In general this net hauling machine can be work for smaller gill net, long line, and for retrieving of anchor, especially at the time of bottom gill net retrieving process.

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Net hauling machine with artisanal fishermen

As a recommendation, this net hauling machine is same of the new fishing gear technology which is introduced by JICA project. So in order to satisfy the artisanal fisheries, the drum of the net hauling machine should be larger. This may get more efficiency and comfortable for the net retrieving process.

Appendix13

Work plan for PP2

Pilot project for development small-scale bottom longline fishing (PP2)

April 2022 PIU team

1. **Bottom longline fishery**
2. **Capacity building of Gillnet fishery for PIU(Project Implementation Unit team)**
3. **Work content by (JICA expert, PIU team and MMR staff)**

Working venue: MMR facility, Fishing gear and method team office

①Inspect the purchased materials and equipment (procure the some materials in Massawa if necessary)

② Meeting with C/P (PIU team) and JICA expert regarding small-scale bottom longline fishing gear construction (leader in charge, number of fishing gears, design, etc.)

③Lecture to PIU team (Longline in general)

④ Small-scale bottom longline fishing gear construction practice (participation of fishermen is also welcomed)

⑤ Confirmation and inspection of the number of completed fishing gear and accessories

Note) CP and MMR staffs need to understand the contents of PP2 in advance.

4. **Preparation work: Selection of fishermen for drift gillnet test operation**

The MMR PIU team will work with North Red Sea regional office to select appropriate project counterpart of fisher.

5. **Confirmed cooperating fishing boats at fishing port of Massawa and will interview fishermen (explanation and getting consensus of activities)**

The explanation items of the PP2 by the PIU team are as follows.

① Outline of small-scale bottom longline fishing project

② Purpose (reason) of PP2 and provision of fishing gear

③ Activity plan (implementation period, schedule)

④ Potential increase in profits from small-scale bottom longline fishing

⑤ Support system from MMR to fishermen for PP2

⑥ The method to explain the superiority of fishing gear proposed by the project "Compare the catches, sales, fuel cost, food cost, bait, ice, easiness of handling etc. By comparison with existing fishing gear"

⑦ Q & A

6. PP2 implementation Fishing boats and members

Fishing boat specifications:

Captain: ( ) Crews: ( )

7. Small bottom longline operation training for PUI team at sea (in case of training boat procure)

① Obtain an operation training permit from MMR.

② Procurement of a small skiff boat with an outboard motor owned by MMR. (Purchase fuel)

③ Wear a life jacket during training at sea

④ Operation training on a small skiff boat will be conducted

⑤ The expected fishing grounds will be discussed in advance with PIU team.

⑥ Operation training is scheduled early in the morning, but it will be judged based on the weather, sea conditions and government regulation.

⑧ JICA expert will provide operational guidance to PIU team.

⑦ PIU team will make necessary preparations such as coordination work with related parties.

8. Implement PP2 in cooperation with fishermen

① Record of catch data (The record form is provided by MMR, so fill it out accurately)

② Discussion on whether or not to board an observer

③ Securing of communication with MMR and fishing boats (telephone, etc.)

④ Discussion on how to receive catch data for each operation

⑤ Summary, management and analysis of operation data (C/P in charge)

⑥ Preparation and submission of report (C/P leader and all others)

Note) Pilot project should be operated with safety first. Accurate fishing data recording is a must important for the project.

End

Appendix14

Small-scale bottom longline fishing test operation survey plan

Prepared by PIU (Project Implementation Unit) team

Specific plans and measures are as follows

1. Objectives:

① The project will examine the possibilities and problems for small-scale bottom longline fishing by fishermen.

② Data results obtained from the project survey will be reviewed and reported.

③ PP1's report will be shared with MMR staff and other stakeholders for effective use in future fisheries development.

2. Proposed items and contents

The monitoring survey for PP2 will be conducted by the PIU team with the following components

① Fishermen participating in the monitoring survey activities shall be selected with the cooperation of MMR officials.

② The cooperating fishermen shall be selected as reliable persons who regularly conduct fishing activity.

③ Registration information of fishing vessels and names of captains shall be confirmed and recorded.

④ The PIU team researchers will record the catch of the fishing in each operation at sea.

⑤ The PIU team will contact the captain and collect necessary information.

⑥ If cooperated fishermen with PP2 are inappropriate, the fishermen will be changed.

⑦ The PIU team will be in charge of the survey and analysis of the test operation data, and will prepare a report.

⑧ The PIU team will be led by Mr. Mulugeta Mahdere with the assistance of Mr. Morimitsu.

3. Monitoring survey methods

PIU team members should be aware of the importance of the monitoring survey and share information. In addition, data sheets on the following items will be prepared and information will be collected.

① Survey data sheet should be prepared by PIU team in advance.

② Record the operation data, time of casting and hauling the longline, and the conditions at each fishing ground.

③ Operation surveys shall be conducted for each trip.
④ PIU team observer will keep accurate records.
⑤ The on-boarded observer and project leader will prepare the report including catch data and report it to the PIU team.
⑥ The advantages and disadvantages of bottom longline fishing will be interviewed by fishermen and discussed.
⑦ The PIU team will prepare a final report in collaboration with the JICA team based on the evaluation and analysis of the data obtained from the operational survey.

Appendix15

REPORT ON SERIES OF SMALL SCALE BOTTOM LONG LINE FISHERY of FSPAC pilot project

Fishing gear and method PIU (project implementation unit) team report

April 2022

Prepared by

Osman Ibrahim

Temesgen amanuel

Appendix15

INTRODUCTION TO SMALL SCALE BOTTOM LONG LINE

Small bottom long line fishing uses a long mainline made of polyester rope or other material to which are attached hundreds or thousands of branch lines, each with a single baited hook. The mainline can be from o.5 to 1 nm long. The line is suspended in the water by float lines attached to floats, anchor, bamboo or stone which may have flagpoles. Long lines are usually set and hauled once a day, or soak, for several hours while fishing.

The main purpose of small scale bottom long line is to introduce fishing method to Eritrean fishermen, as well as to assist those currently involved to improve their fishing success, technics and productivity, particularly used in different sea bottom condition such as muddy ,sandy and coral reef areas . The JICA project experts intended and guide us the principles and techniques of bottom long line fishing, and give as much detail knowledge on the rigging and use of long line fishing gear.

Implemented activities;

- Making up branch lines.
- Mainline and branch line materials and attachment.
- The long line: basic gear configuration and storage.
- Floats, flagpoles, float lines and anchor.
- Preparing for a fishing trip.
- Deciding where to fish: when leaving port.
- Deciding where to fish: when arriving at the fishing ground.
- Deciding where to fish: during the trip.
- Targeting the gear: the bottom fishing.
- Targeting the gear: depth of set.
- Setting and hauling the gear: general.
- Setting malti filament rope long line gear.
- Setting rope gear, setting time, data recording and soak time.
- Some variations on setting.
- Finding the gear.
- Hauling main line
- Hauling branch line
- Encountering problems when hauling the gear.

Appendix15

Materials needed for fishing gear making

A. Mark flag	FRP or wooden with flag
B .Float	ABS buoy or plastic bottle
C. Float line	PE or PP. 4 to 6mm dia length ;depth *1.5-2.5 times
D. Anchor	4 nails iron anchor or stone, weight ;2 to 3kg
E. Main line	Lion mark deep line no.42
F. Branch line	Nylon monofilament. No.50*1m
G. Hook	Mutsu hook line no.26*50pc

Small scale bottom long line fishing gear making

1st. Cut monofilament in to branch line 100cm long.



Fig. 1 Attachment hooks with branch line



Fig.2 Attachment of hook holder basket gear for branch line

2nd. Branch line attached to mainline interval of 4-5m and stored properly on the basket gear.

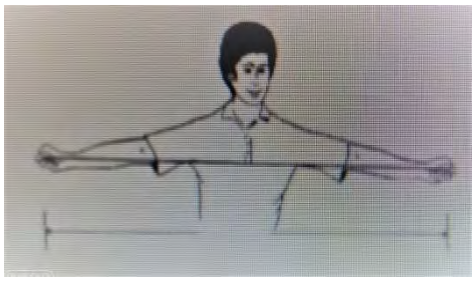


Fig 3 measuring interval between branch lines

3rd. Making middle float 30m long line with sinker or stone

Bait used for small scale bottom long line;

Bait used for bottom longline fishing is usually finfish such as sardines, bony fish, silver biddy, lizard, thread fin, saury, or mackerel scads.

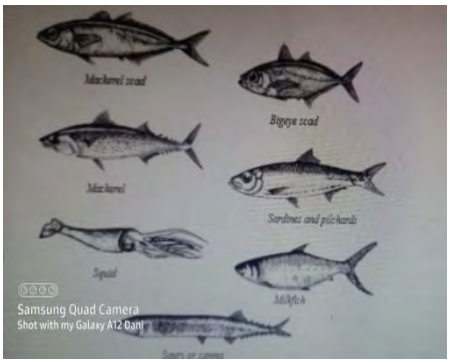


Fig 4.Bait fishes

Sea-going practice (1st trial)

The six counter parts of PIU departure from MMR at six o'clock for 1st trial on 13/04/2022 to the sea from Luna hotel by fibre glass boat 8-meter long with 40hp for bottom long line.

- To set the bottom long line it takes half an hour (7:30-8:00am) and retrieved after one hour (8:30am).
- Trial operation set in sea depth; 22-30m.
- The sea bottom conditions were slope rocky, coral reef and muddy area.

The components of a typical malti filament rope bottom long line setting or casting are:

• make bait to branch line hook;
•immerse the basket gear in sea water for smooth setting
• Buoy with 30m rope length attached to anchor and 10m rope from anchor to mainline;
•set one full basket — 300m of mainline with 60 branch -lines, each 1 m long, attached with snaps at 4.5-5m intervals;
• Middle float 30 m long line with stone;
• Second full basket;
• Middle float 30 m long line with stone until finished step by step;
• at the end, buoy with 30m rope length attached to anchor and 10m rope from anchor to mainline;

The components of a typical malti filament rope bottom long line retrieving or hauling;

- Retrieve the starting from the buoy with 30m rope length attached to anchor and 10m rope from anchor to mainline;
- One person Pull the main line and another person arrange branch line in basket gear properly;
- Retrieve the middle float line with stone and release from main line;

- Full fill the basket gear until finished by arranging branch line properly one by one and Retrieve the middle float line with stone and release from main line;
- Finally at retrieve the end float with 30m rope length attached to anchor and 10m rope from anchor to mainline;

Sea going practise of small scale bottom long line (2nd trial)

The six counter parts of PIU departure from MMR at six o'clock for 2nd trial on 14/04/2022 to the sea from Luna hotel by fibre glass boat 8-meter long with 40hp for bottom long line practice.

- To Set the small scale bottom long line it takes half an hour (7:00am-7:30am) and retrieved after one hour and half at (8:30am).
- Trial operation set in shallow area in sea depth; 3-4m.
- The sea bottom conditions were slope rocky, coral and reef area.

The components of a typical malti filament rope bottom long line setting are:



Fig.5 small scale bottom long line setting

• make bait to branch line hook

•immerse the basket gear in sea water;
• buoy with 10m rope length attached to anchor and 3m rope from anchor to mainline;
•set one full basket — 130m of mainline with 50 branch -lines, each 60 cm long, attached at 3-3.5m intervals;
• middle float 10 m long line with anchor;
• Second full basket;
• middle float 10 m long line with stone until finished step by step;
• at the end, buoy with 10m rope length attached to anchor and 3m rope from anchor to mainline;

Appendix15

The components of a typical malti filament rope bottom long line retrieving or hauling;

•Retrieve the starting buoy with 10m rope length attached to anchor and 3m rope from anchor to mainline;
•One person Pull the main line and another person arrange branch line in basket gear properly;

•Retrieve the middle float line with stone and release from main line;

•Full fill the basket gear until finished by arranging branch line properly one by one and Retrieve the middle float line with stone and release from main line;
•Finally at retrieve the end buoy with 10m rope length attached to anchor and 3m rope from anchor to mainline;

Problem and challenges of small scale bottom long line

- In 1st trial operation no problem is faced. But
- In 2nd trial operation the main line broken off because the breaking strength is weak.
- The branch line was cached and twisted because the sea bottoms were rocky slope and dead coral area.

The main difference between 1st trial and 2nd trial

1st trial (artisanal fisher men)	**2nd trial (foot fishery canoe)**
The interval between branch line is 4-4.5m.	The interval is 3-3.5m.
Breaking strength of main line is strong.	Breaking strength of main line is weak.
Length of branch line 1m	Length of branch line 0.60m
The basket gear is big and hold 60 branch line	The basket gear is small and holds 50 branch line.
Setted in deep water depth from 22-30m.	Setted in shallow water and slope rocky area from 3-4m
Mainly Target species are large bottom fishes and rarely large pelagic fishes.	Mainly Target species are small bottom fishes.

Discussion maked about small scale bottom long line in this training (what we have learnt)

- Cutting branch line.
- Tying hook with branch line.
- Attachment of hook holder to basket gear for properly arrangement of branch line.

- Measuring the interval among branch line in mainline.
- Attachment of branch line with main line.
- Properly handling main line and branch line in the basket gear.
- Rigging the wood with boat.
- Baiting
- Soak the basket gear
- Preparing basket gear on rigged wood on the boat.
- Attachment of anchor line with buoy and mainline.
- Attachment floats line with stone.
- Setting, retrieving and soaking of the gear

The advantage and disadvantage of small scale bottom longline fishery, obtained from the experience of sea-going practice.

Advantage	Dis advantage
• No sea bottom pollution	• It seek more Bait
• Easy to set and retrieve	• It can harm at the time of operation
• Catch fresh fish	
• No ghost fishing	
• Used in different sea bottom	

Conclusion

This training was very effective for the strength the capacity of officials of MMR improved fishing method and improves fishery production by disseminating fishery technics by easy way. Our artisanal fisheries are restricted on gill net, but some of them they use mid water longline.so by this training it easy to disseminate the techniques and fishing method operation.

Appendix16

The Project for formulation of The Strategies and Practical Approaches for Coastal Fisheries Development in the State of Eritrea

Report on Demonstration of Small Scale Bottom Longline Fishing (Artisanal fishers) (PP2)

Reported by:
Osman Ibrahim Ahmed

Compiled by:
Mulugeta Mahdere

August, 2022

Pilot Project for Development of Small Scale Bottom Longline Fishing (PP2)

1. Introduction

Eritrean fishery sector is categorized in to three namely: industrial, semi-industrial and artisanal fisheries. So far, the first two categories are operated by government owned fishing vessels, while the fishing practiced by the communities is classified under artisanal fishery which is considered of low quality gear. Most of the artisanal fishers use drift gillnet and a few fishing boats operate bottom longline fishing. Although the bottom longline is known to be cheaper and more efficient than gillnet fishing, it is not operated consistently due to the difficulty in obtaining the bait and the lack of appropriate gear.

During the hot season, most of the artisanal fishers stop gillnets fishing operation due to decrease of catches. However, small scale bottom longline fishing is considered to be a promising fishery with a small amount of initial investment and a high possibility of all year round operation including the hot season. Therefore, implementation of this pilot project aims to investigate the potential of fisheries production especially bottom fish stocks whose development has lagged behind.

Objective

To demonstrate and verify the fishing efficiency of the produced small scale bottom longline on artisanal fishing boat together with artisanal fishers.

2. Materials and methods

Before conducting fishing demonstration with artisanal boats, the produced small-scale bottom longline verification test was conducted on 13/04/2022 around Green (Sheik Seid) Island. During this operation, setting a total of 6 hook bin bottom long line by the artisanal fishers took half an hour (7:30 – 8:00 a.m.) and was retrieved after one hour 8:30 a.m. The sea depth was 20 – 30 meters and its bottom substrate was rocky, coral reef and muddy. During the test operation, no problem was faced or encountered, setting and retrieving was performed smoothly. Accordingly, the fishing demonstration was preceded.

This first fishing demonstration was carried out with the cooperation of Northern Red Sea Branch of MMR in a 13 meter long artisanal fishing boat having an inboard engine. The observer in charge for thus was Osman Ibrahim and stayed at sea for a period of eleven days, but operated for seven days only i.e. from 27 June up to 03 July, 2022.

The preparation of this longline is a simple method, which is produced by using locally available materials, like the plastic basket was used as hook bin for storing the mainline with its branch lines. Each hook bin had generally about 50 branch lines with hooks attached to a 150 meter long mainline. This method of preparation was guided by the JICA expert, Mr. Morimitsu.

The produced longline is made of the following materials below.

Appendix16

	Hook bin	R.N.	Item	Description
Logline for rtisanal fishers	Local plastic basket	1	Mark flag	Oil container plastic (xx ltrs?)
		2	Float	Oil container plastic (xx ltrs?)
		3	Float line	PE 6mm diameter ; depth 1.5 – 2.5 times
		4	Anchor	Stone weight; 2 to 3kg
		5	Main line	Lion mark deep line No. 42
		6	Branch line	Nylon monofilament. No. 50*1m
		7	Hook	Mutsu hook No.26*50pc

Using longline materials listed in the above table, a total of 4 baskets (local hook bin) were used in this demonstration. Each hook bin had a total of 50 branch lines attached at definite interval to mainline, 150 meter long. The main parts of the longline are: the main line made of braided rope line number 42, the monofilament branch line number 50 having one millimeter thickness and the circle type hook number 26.

The artisanal fishing boat used was driven by an inboard engine with 4 pistons (Yammer), 13 meter long and fiberglass reinforced boat. Its name is Msgna-1 and the owner of that boat is the resident of Massawa sub-zone.

In consensus with the boat skipper, the demonstrations were conducted north direction from the port city Massawa, which are mainly Harat Island and around coastal village Imberemi. Although the fishing boat was using gillnet, the longline was tested during gillnet off hours of each day.

As we know, in longline fishing operation a key factor is the availability of small fishes as bait. To solve these issues, in the first day of the trip a gillnet fishing was operated and some Indian mackerel and tuna were fished. Afterwards, longline fishing trial proceeded by the following procedures;

(1) Baiting hook

① Before the start of setting, all hooks available in the hook bin were baited by using Indian mackerel, shark and tuna.

(2) Setting

① Appropriate site determined.

② At the starting point 1.5 times longer from the sea depth, rope with buoy and anchor were attached to main line.

③ Setting started by navigating the boat forward and the rope with buoy and anchor attached to the mainline thrown to the sea and then simply the mainline lay out to the sea and one person released the baited branch line from the stored hook bin.

④ At every joint of the main lines, 1.5 times longer from the sea depth rope with buoy and anchor were attached to the mainline.

② And carefully the procedure continued until setting end.

(3) Retrieving

① After 3-4 hours of soaking time

② Boat navigating forward

③ One person pulls the main line and another person arranged branch line in the hook bin.

	
Picture-1 crews arranging the branch line in hook bin for setting.	Picture-2 crews retrieving the mainline after soaking.

3. Result

In every operation, common name, number of catch, weight of catch, depths of the fishing ground etc were recorded in prepared data sheet and moreover in order to identify the soaking time, the time when the longline set as well as the time when the longline starts to come into the boat were recorded and are presented in the table-1 below. In first day of demonstration (27/07/2022), the longline was set in coral reef area and a total of 6 species were caught such as, red snapper, grouper, emperor, guitarfish, catfish, and shark. In terms of weight and number of fish groups the catch was 95 kg and 13 respectively. The next day, in Harat Island, the catch was similar with the former day. On 29/072022 highest catch was registered i.e. 32 fish groups were caught of which 8 queen fish, 9 sharks, 2 catfish, 2 red snapper and 1 barracuda were present. In terms of weight, the catch reached 134 kg. On 02 and 04/07/2022 longline fishing was not undertaken due to the difficulty of strong wave and shortage of bait.

In general, the total fishes caught were mostly coral reef fishes and large pelagic namely, red snapper, grouper, emperor, queen fish, shark, barracuda and jack fish. In the seven soaking times of the longline a total of 64 individual or 346.5 kg of fishes were caught. The total weight of catches obtained by species wise was 115 kg queen fish, 79 kg shark, 25 kg red snapper, 17 kg grouper, 16 jack fish, 15 guitarfish, 12 barracuda, 9 catfish and 3 kg emperor. Overall operation, queen fish were the predominantly caught fish.

The number of local hook bin (basket of the longline) or length of longline used in every trial was not same. This was because during operations some part of the mainline and branch lines were detached due to entanglement with hard bottom and lack of bait. However, the result showed that the trial was good &efficient catch and easy method of operation.

Appendix16

	
Picture-3: queen fish caught in the trial	Picture-4: barracuda caught in the trial

As noted in the above, the fishing boat used in this longline demonstration, its primary engagement was drift gillnet fishing and had 12 drift gillnet. The total catch from these 12 gillnets were around 600 kg. Although, the main fishing gear of this fishing boat was gillnet, the total catch from this fishing gear was not much bigger from the experimental longline.

Appendix16

Table-1: data collected in prepared data sheet

date	No. of hook bin	Fish Group	No of catch	Weight (Kg)	Fishing ground	Depth (m)	Setting time	Retrieving time	Sea condition
27/06/2022	3	Red snapper	06	15	Ras dalal	36	8:30 a.m.	11:30 p.m.	Wavy
		Emperor	01	2					
		Catfish	01	3					
		Guitarfish	01	15					
		Grouper	02	5					
		Shark	02	55					
28/06/2022	4	Grouper	04	12	Harat Island	10	8:00 a.m.	2:00 p.m.	Wavy
		Emperor	01	1					
		Shark	02	8					
		Barracuda	01	6.5					
29/06/2022	3	Queen fish	09	54	Wekiro	6	10:00 a.m.	4:00 p.m.	Calm
		Barracuda	01	5					
		Catfish	02	6					
		Shark	07	15					
29/06/2022	3	Queen fish	09	50	Wekiro	6	5:00 a.m.	10:30 p.m.	Calm
		shark	02	4					
		Red snapper	02	10					
30/06/2022	2	Shark	1	40	Wekiro or Halibay	12	7:30 a.m.	11:30 p.m.	Wavy
01/07/2022	2	Jack fish	01	10	Imberemi	11	7:30 a.m.	12:30 p.m.	Calm
		Queen fish	01	6					
03/07/2022	2	Jack fish	01	6	Wekiro or Halibay	18	7:30 a.m.	11:30 p.m.	No Calm rmal
		Queen fish	01	5					
		Shark	06	12					
Total			**64**	**345.5**					

Appendix16

4. Discussion

The result showed that although there were no complete collection between the cost of expenditure and gross income of the total catch. Overall, there were general trends in the bottom longline efficiency of the seven soaking time experiment. Efficiency can be calculated by dividing the total catch by the total effort. As stated earlier, the total catch and total effort were not captured exactly and these gaps might not affect the estimation significantly. Therefore, by taking in to account this limitation, efficiency calculation may attribute to estimate catch efficiency for the experimental bottom longline. As mentioned in the above table-1, the fish caught in terms of species and quantity in comparison to total price is;

- Grouper; 17 kg * 45.50 Nakfa (1^{st} grade) = 773.5 Nakfa
- Barracuda; 11.5 kg * 31.5 Nakfa (1^{st} grade) = 40.25 Nakfa
- Red snapper; 25 kg * 45.50 Nakfa (1^{st} grade) ረኻ) = 1,137.5 Nakfa
- Emperor; 3 kg * 45.50 Nakfa (1^{st} grade) = 136.5 Nakfa
- Catfish; 9 kg * 28 Nakfa (1^{st} grade) = 252 Nakfa
- Guitarfish; 15 kg * 28 Nakfa (1^{st} grade) = 420 Nakfa
- Shark; 127 kg * 28 Nakfa (1^{st} grade) = 3,556 Nakfa
- Queen fish; 122 kg * 28 Nakfa (1^{st} grade) = 3416 Nakfa
- Jackfish; 16 kg * 31.5 Nakfa (1^{st} grade) = 504 Nakfa
- **Total estimated selling price = 10,135.75** Nakfa

As seen in the above calculation, the roughly estimated selling price of the total catch reached 10,135.75 Nakfa. However, this price is highest possible one because many catches were deduct from the total catch for food consumption during fishing, crews took to their household and relatives during landing, some amount of catch might be reduced in quality or discarded due to poor handling but in this calculation the total catch in quality wise is assumed first grade. In contrast, these all stated issues are considered as negligible, because there is no actual estimated value to reduce from the total catch.

In general, based on result of the calculation this demonstration predicted that significant amount of catch would be harvested from this bottom longline. Moreover, the total length of this longline was not more than 500 meter long (4 hook bin) even though practiced as an alternative to the drift gillnet, but the amount of catch definitely would cover the cost of that expenditure and the remained fish caught from drift gillnet would be their net income.

Since this longline is prepared in a simple technique and by accessible materials, if artisanal fishers would try to use as a major fishing gear, it is believed that considerable amount of catch could be attained. Currently, our artisanal fishers are dominantly practicing drift pelagic gillnet and it is operated only during night time and new moon, and during daytime

and full moon they do not go to fishing. However, if such longline is expanded to use either jointly along with drift gillnet or at time of no drift gillnet fishing, it is assumed that such type of longline could enhance productivity and production. Furthermore, fish of high quality can be caught at a low expenditure.

Basically, in this demonstration a total of four baskets which comprise about 200 branch lines were tested. Typically, out of 200 branch lines, 80 due to entanglement by coral reef and 30 due to damage by bigger fish were lost. Therefore, when using such type of longline there is a need to pay attention in coral reef area i.e. thickness of the mainline need to be thicker and attachment of branch line with mainline steady.

Moreover, it is to worth mentioning that some advantages and disadvantage were noted by fishers from their observation and experience. The advantages stated include:

- The preparation of this longline is a simple method and does not seek more space to operate and easy to move from place to place.
- Less labor intensive during operation.
- Fish of high quality and high price are captured at a low expenditure.
- Has appropriate size and type of hook which caught large proportion fishes were caught.

On the other hand, they also stated some disadvantages that need to be addressed in order to be applicable to fishers. These points include:

- The attachment of branch line with mainline was not firm; ultimately when fish were angled the branch line appeared to sliding on the mainline and loss of branch lines.
- The mainline had small thickness and low breaking strength, thus the mainline was detached during hauling especially in coral reef area.
- Requires more bait fish, thus urged to have and use other fishing gear to catch bait fish.
- Lack of bait leads to low use of the longline

Appendix16

Table-2: Difference between existing longline and the experimental longline.

Experimental longline	Existing longline
• Interval among branch lines attached to mainline reached about 4.5 meters long. • Mainline is made of braided type rope line number 16. • Branch line is attached to mainline by tie double sheet bend • The longline is stored in basket gear, thus no chance of entanglement.	• Interval among branch lines attached to mainline reached about 6 meters long. • Mainline is made of twisted type rope 4 and 6 millimeter. • Branch line is attached to mainline in eye splice. • The branch line is detached and stored separately from the mainline.

5. Conclusion

As stated earlier, the fishing boat stayed on the sea was eleven days, but seven times soaking experiment had been done. Even more experiment would be done if enough fish bait were available and calm sea condition. In contrast, the information collected and the findings could be enough to evaluate effectiveness of this small scale bottom longline.

Since many branch lines had been lost during the operation, thus the fishers themselves were repairing from their own property and tried to use. Therefore, it can be said that this fishing gear is accepted by the fishers. Moreover, they suggested that this type of fishing gear is very crucial and no labor intensive and they do have a plan to construct such type and to use during day time off gillnet fishing instead of staying asleep at sea. Although promising information was collected from this experiment, it has to be tested with another fishing boat to fine tune the data to compare it with the existing fishing gears.

Appendix17



Ministry of Marine Resources
Development department
Fishing technology and technical works division
Fishing technology unit

The Project for formulation of
The Strategies and Practical Approaches for
Coastal Fisheries Development
In the State of Eritrea

Report on 3rd Long Line Trial Fishing

Reported by;
Filmon Bereket
Yosief Redae

Edited by; Andemichael Hidru

February, 2023

Appendix17

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➢ To analyze and introduce fishing gear which is suitable and efficient for the artisanal fishers 4

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6. Conclusion and Recommendation 6

1. Introduction

The Ministry of Marine resources in collaboration with the JICA project (FSPAC-JICA) is conducting many pilot projects on small scale fishers. One of the objectives of these pilot projects is to improve the fishing gear and fishing techniques of the coastal communities there by to upgrade their livelihood. Since the duties and responsibilities of the fishing gear technology unit within the MMR, MRDD is to conduct different demonstrations on fishing gears and techniques and hence to transfer and adopt it to the coastal fishing community specially to the artisanal fishermen (local and traditional fishers), under the guidance of the JICA expert, the unit is doing trials of different newly designed and updated fishing gears, which one of them is the longline modified by the JICA expert and assembled under his guidance by the fishing gear unit staff.

This modified longline differs from the common longline in that it is simple with no swivel and clip as well as the mainline is rope not monofilament type as that of the common longline. It is simple and of low cost, that artisanal fishermen can afford and assemble by their own capacity, just tying the monofilament branch line with the main line (rope) and attach the hook at the end of the branch line. It is also low-cost simple fishing technique that select fish catch as well as can be used anywhere at any time.

To adopt the technique, first the JICA expert, gave practical training to the MMR, fishing gear staff on how to assemble the long line and could be able to assemble it independently. Finally, the staff mastered assembling the technique and assembled many sets of longline and made ready for trial. Then team together with the JICA expert made fishing trial at green island. Next, fishing gear staff made two trials with the artisanal fishing boats on June and on late August and early September. Accordingly, the following drawbacks were found;

- Hook size is good but hook quality is poor
- Limitation in the tying of branch line to the main line
- Since the mainline is soft and branch line is small, it was able to be cut easily.

Eventually, third trial was conducted for more observation and assessment of the gear.

2. Objective

- To analyze and introduce fishing gear which is suitable and efficient for the artisanal fishers
- To assess the efficiency and suitability of the longline through practical observation with artisanal fishing boats
- To collect information from artisanal fishers concerning this gear

3. Materials

- 3 sets of long line (3 boxes)
- Buoys
- 6 mm rope
- 2 anchors

4. Methodology

To conduct the trial, visit to the sea with private artisanal fishing boat was done for two weeks on December 2022. On 14 Dec 2022, all materials needed for the trial were loaded on the assigned artisanal boat with 19m length and 4.5m sambuk (out board engine). On the next day the boat departed to the sea for fishing and started fishing around Gedem. For the trial of the long line, bait must be needed and the bait was expected to be the small size fish retained on the way during fishing by the gill net. The bait needed was collected on the third day. Then it was cut to the appropriate size for hooking and immediately trial initiated by following the steps below;

- First bait was harvested
- Bait prepared (bait was cut and put on hook)
- Long line was prepared for setting with in their box
- Long line was set
- Longline retrieval/hauling and fish harvesting conducted
- Catch recorded
- And finally longline was put to the box appropriately

Since the fishing boat used gill net for fishing, long line fishing trial could not be made concurrently with the gill net fishing and we cannot oblige the fishermen to do our convenience. So, longline was tried at the time and space convenient for the fishers.

Appendix17

		
Baiting	Setting	Retrieval/hauling

5. Result

During the visit five trial was conducted and 65kg catch was harvested. The detail of the trials was as in the table below.

Table 1; Each trial catch details

Date	No. of boxes	species name	Catch (pcs)	Catch (kg)	Length frequency	Fishing ground	Depth	Setting time	Retrieval time
17/12/22	3	Grouper	8	14	15-50	Dessie	6-23	1:00 p.m.	5:00 p.m..
		Shark	1	2	40				
		Snapper	1	4	35				
19/12/22	1	Snapper	2	6	30	Madot	10-20	9:45 a.m	3:00 p.m.
		Grouper	1	2	40				
		Grouper (nagil)	1	4.5	57				
20/12/22	1	Grouper	4	4	15-20	Madot	11-20	10:00 a.m	4:00 p.m.
		Snapper	3	10	40-45				
		Emperor	1	3.5	51				
21/12/22	1	Grouper	4	5	15-20	Madot	10-15	11:45 a.m	5:00 p.m.
		Snapper	1	2	28				
		Emperor	2	1	10				
23/12/22	1	Snapper	1	4.5	58	Dahlak (nakura)	18	9:30 a.m	12:00 p.m.
		Grouper	1	2.5	27				
		Emperor	1	0.2	7				

Discussion

At the first trial, 3 sets (3 boxes) longline with about 150 branch lines was deployed around Dessie island on a coralline area at about 6m to 23m depth and it was retrieved/hauled after three hours. Then the cutting of mainline, cutting of branch lines, breakage of hooks and entangling of mainline with corals were the frequent shortcomings observed. When longline was retrieved, mainline was found to be cut and out of the 150 branch lines only 80 branch line (10 of them were cut off) were retrieved and the remaining lost entangled with the corals. When the longline was deployed, the

mainline was immediately sunken and laid to the coral substrate. Since it is soft, it was easily entangled to the coral rocks and easily cut off when hauled. In addition, the hooked fish pulled the branch line as well as mainline towards the coral rocks and aggravated the entangling.

After all the challenges, longline was mended and made ready for fishing trial. During the next trials one set (one box) longline was deployed per trial successively. Experienced from the previous trial, more buoys were tied up to the mainline to remain suspended and avoid the sinking and laying down to the coral and get entangled. Then, it was found ok. But here again, many hooks were broken during retrieving the branches to collect the fish and many fish escaped during retrieval. when excessive weight (big fish hooked) was exerted to hook, it should have been stretched rather than breaking. So, the hook quality is not good.

6. Conclusion and Recommendation

During the visit, out of the total 5 trials conducted, a total catch of 65kg was harvested. In comparison to the total number of hooked branch lines (about 350) deployed, the catch was low. Though this was the case, the species caught were of high value fish that bear high profit to fishermen. So, instead of stopping using the gear, it is better to modify the shortcomings and employ it specially to small boats.

- Though the mainline is soft and comfortable to set and haul manually and easy to store in the box, it should be a little bit harder and stronger to avoid ease of entangling with corals and rocks and ease of cutting off.
- The hook has good size and design but it has poor quality. It is of breakable type.

Generally, from the trials conducted, this type of long line cannot be a replacement of the existing artisanal fishermen fishing gear, rather it should be a complementary to the gill nets and others. Specifically, this type of gear can be employed by the small fishing boats 10-12m length but not to the big ones.

Appendix18

Work plan for PP3

The Plan for introducing Small-scale Set Net (Pound net) fishing (PP3)

March 2022 JICA expert: Morimitsu Ritsuo

1. Preparation : Selection of fishing communities for the PP3

MMR counterparts(C/P) should work with relevant personnel to provide guidance on selecting suitable communities or fishermen for the project and reaching a consensus with them.

The explanation of the project plan for 2 communities is as follows.

① Activity schedule
② Explanation of the Pound net project
③ Activity plan for fishing gear construction and implementation period of the project
④ Check the items and location of the net construction practice.
⑤ The purpose of the Pound net project
⑥ The benefits of the Pound net project
⑦ How can the fishing village community support the Pound net project?
⑧ Operation and management method of the PP3
⑨ The support system of MMR for PP3
⑩ Q & A

2. Fishing ground confirmation survey and site marking work

3. Determination of the PP3 Working Group

4. Preparatory work for the PP3 by JICA expert, five CPs, and MMR staff

Net construction site: MMR facility, warehouse. (The Pound net design is shown in the attachment)

① Inspection of purchased materials and equipment (shortages are procured in Massawa)
② Meeting with C/P and MMR staff about the Pound net design and construction
③ Learn the calculation method for diagonal net cutting, and calculate each part by C/P and MMR staff.
④ Marking every 100 meshes from the corner of the net (with twine or others)
⑤ Cutting the net for playground net
⑥ Cutting the net for pocket net

⑦ Slope net cutting for attaching the playground net
⑧ Slope net cutting for pocket net
⑨ Triangular net cutting
⑩ Cutting of the leader net
⑪ Inspection and reconfirmation of each net part

Participants from the fishing village are welcome. Net-making practice is done in groups.

Note: C/P and MMR staff will begin work only after fully understanding the design.

5. The construction points of the Pound net

① Net-making site: MMR facility？
② Participants will be divided into 3 groups, and each group leader will guide the work. (depending on the number of participants)
③ JICA experts (Morimitsu) will jointly provide net-making guidance and work process management with each leader.
④ C/P will provide necessary support such as coordination work with Logistics and related parties.
⑤ Person in charge of each part of net-making

Group A leader: Deputy: Playground net
Group B leader: Deputy: Pocket net
Group C leader: Deputy: Leader net / Frame rope

6. Playground net

① Edge net reinforcement work
② Slope net, triangular net joining work
③ Head rope, sinker rope attachment work
④ Rope attachment work to the upright part

7. Pocket net（3 pocket nets in total）

① Reinforcement of slope edge net (12 pieces)
② Slope nets joining work
③ Joining work of pocket net (make it cylindrical)
④ Frame pipe making for pocket net (16 PVC pipes)
⑤ Connection work between pocket net and playground net (3 places)

8. Leader net

① Reinforcing the net edge
② Connection of the leader nets and attachment work of the head rope

③ Sinker rope attachment work to the leader net
④ Rope attachment to the upright part of the offshore side and land side end
⑤ Storage the completed leader net

9. Frame rope

① Ropes splice training
② Ring rope making and rope protection work
③ Frame rope, anchor rope preparation work
④ Preparation of wooden anchor (60cm) and wooden stakes for frame (2m length)
⑤ Frame rope making and assembly work
⑥ Anchor rope measuring and cutting work (check quantity and length)
⑦ Preparation of iron bar tool for anchor stabbing into the seabed (quantity 2, easy-to-use length 1.8 m?)

Note) Completed frame rope should be kept without entanglement.

10. Preparation work for Pound net deployment work

① Preliminary survey should be implemented and determine the fishing ground.
② Preparation of wooden anchors, wooden stakes, and tools such as gaff, scissors, knives, etc.
③ Preparation of ropes for Pound net deployment work and others

11. Frame rope and anchor setting work at sea

① Prepare anchors and anchor ropes according to the deployment order
② Prepare the frame rope for the playground/pocket net according to the deployment order
③ For the frame deployment work, anchors will be set in a diagonal line and stretched it.
④ Move the position of the anchor if necessary and correct the frame shape.
⑤ After setting all the anchors, adjust the entire frame and finish the work at sea.

Note) Deployment work is recommended with safety first.

12. Pound net setting work at sea

① Attach the pocket net unit on the offshore side from the outside of the frame rope.
② After attaching the entire net to the frame, extend the three pocket nets to the outside.
③ The leader net is stretched from the offshore side to the land side and the end of the land side of the net is stopped with an anchor.
④ The entire net should be adjusted cleanly.

⑤ Install a mark frag on the offshore and land sides of the Pound net so that other ships can easily recognize it.

13. Pound net harvest operation, sale of catch

① Loosen the overhanging rope of the pocket net, pull the pocket net up little by little, and take out the fish from the cod-end part of the net. (3 pocket nets)

② After taking out the fish, pull the rope and stretches out the pocket net to the original position.

③ Put the caught fish in the basket and return. If necessary, use ice to keep the catch fresh.

④ The condition of the Pound net should always be checked and maintained the net.

⑤ At the landing site, record the catch data by fish type in each operation.

⑥ Fresh fish will be sold directly at the landing site or in the market. The accountant records necessary information such as the selling price and makes accurate data.

14. Implementation of a small scale Set net project in collaboration with fishermen

① Conducted a trial operation in collaboration with fishermen (foreshore of a fishing village)

② Preparation of operation survey plan and countermeasures for the p

③ Establishment of project implementation structure (WG members?)

④ MMR provides the form for recording catch data (person in charge in WG)

⑤ Ensuring communication between the PIU team and the WG (telephone, etc.)

⑥ Making clear that how can PIU team receive catch data

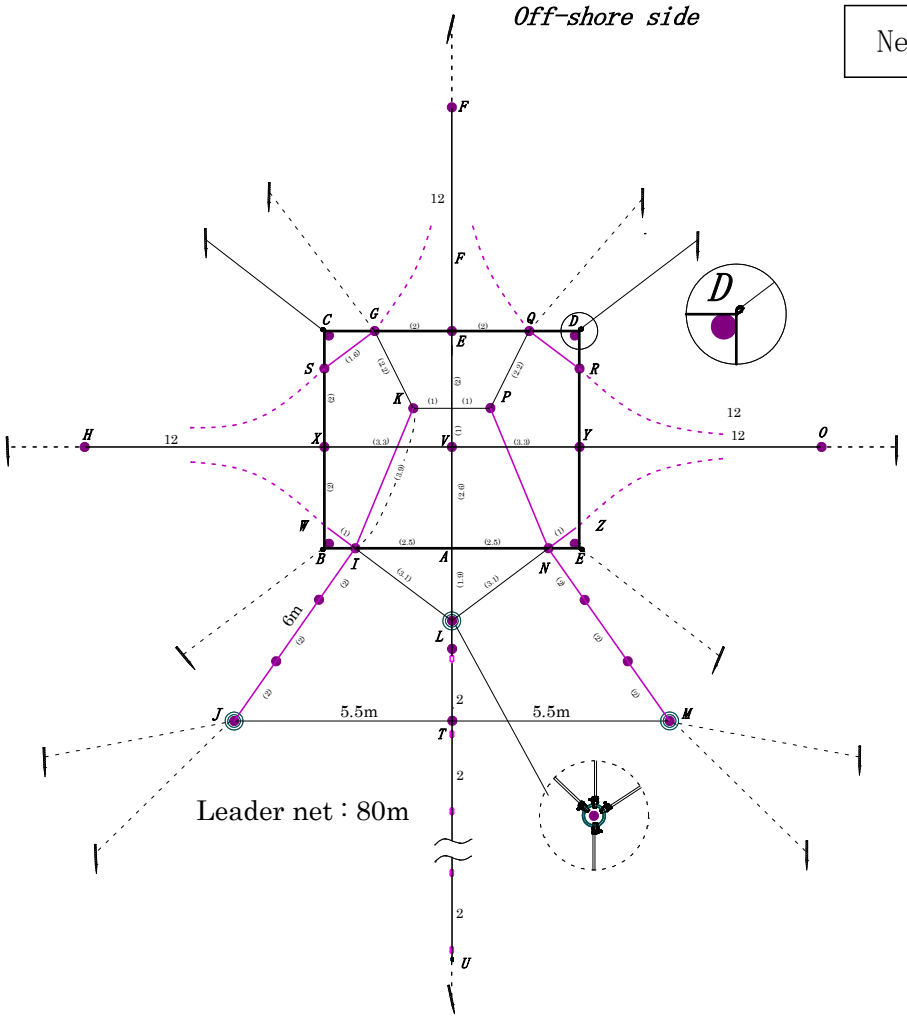
⑦ Data collection and analysis of operation data (C/P in charge)

⑧ Report preparation and submission (C/P leader and all others)

End

Appendix19

Eritrea Pound Net 20211218



Net depth:1.5m

: Wooden or Iron anchor
15pcs + 5pcs(spare)

: Wooden Stick(30~50mm/dia. 2.3m length)
19pcs + 3pcs(spare)

: Rope ring(15cm/dia. ∅9mm rope)
3pcs + 2pcs(spare)

: Anchor rope (8mm/dia.)
6.5m 17pcs + 3pcs(spare)

: Frame rope (8mm/dia.)

: Trap Net netting

Unit : meter

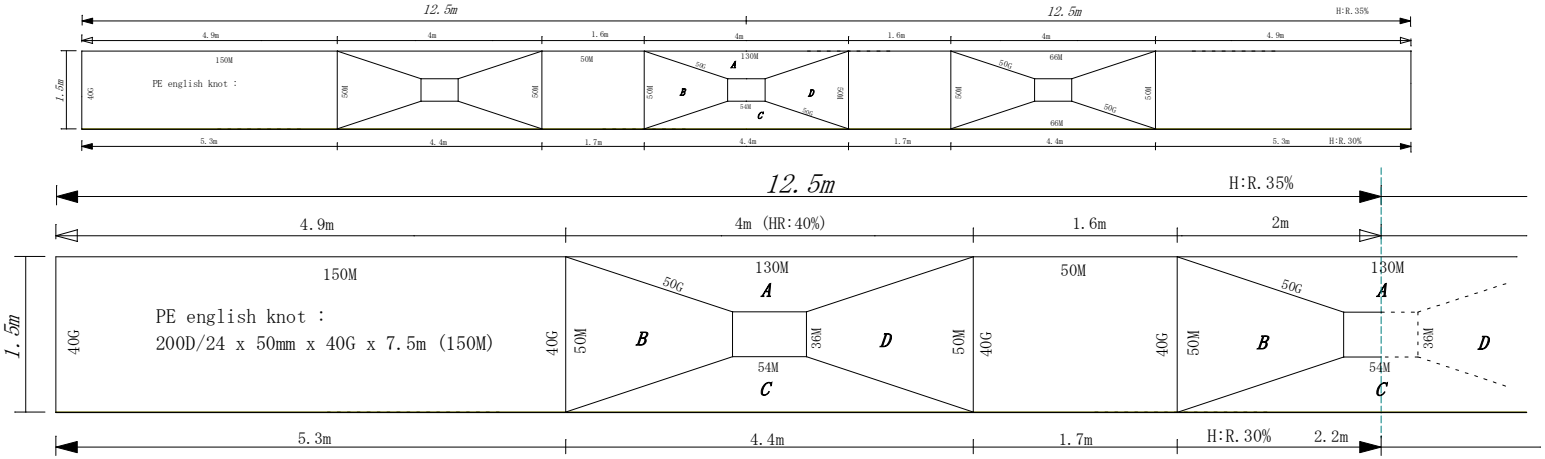
: Float on the leader net

Eritrea Pound Net (Masu-ami)	
Morimitsu Ritsuo	Dec../2021

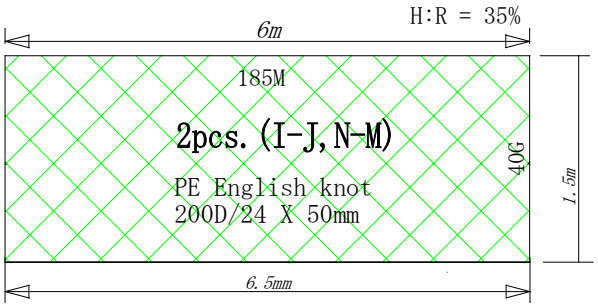
Appendix19

Arrangement of body net

Net depth:1.5m

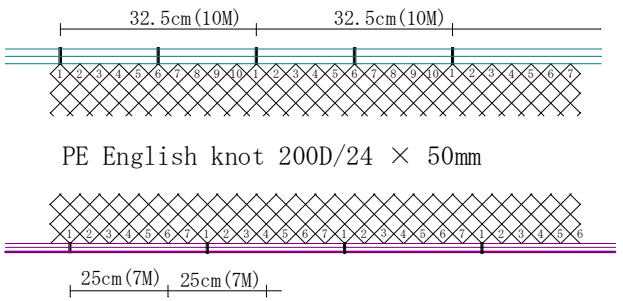


Connecting Net to the playground net



Head rope: PE 6mm x 2pcs

H:R = 35%



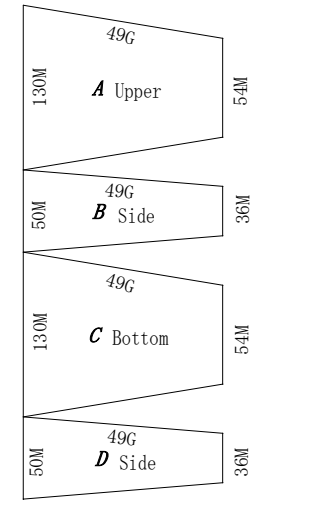
Sinker rope: PES braid with lead core 6mm (180g/m)

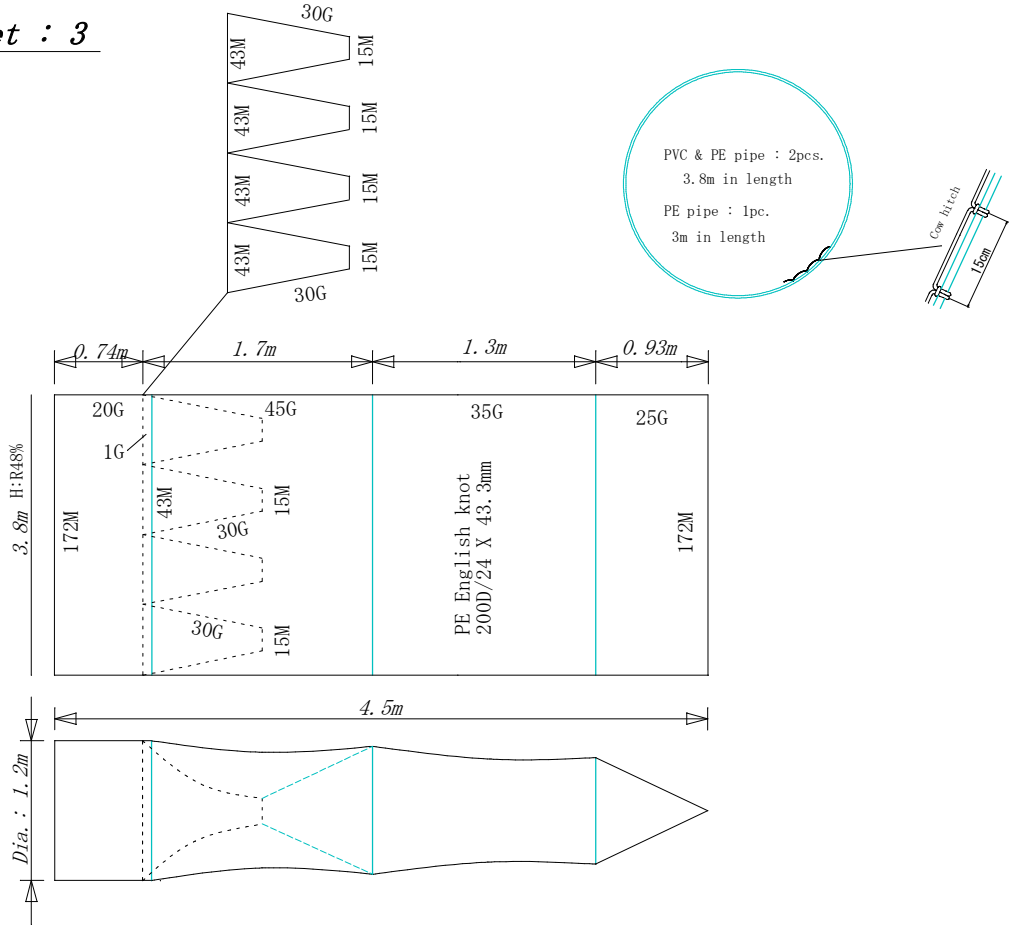
Appendix19

Measurements of pocket net

Net depth:1.5m

Number of Pocket net : 3

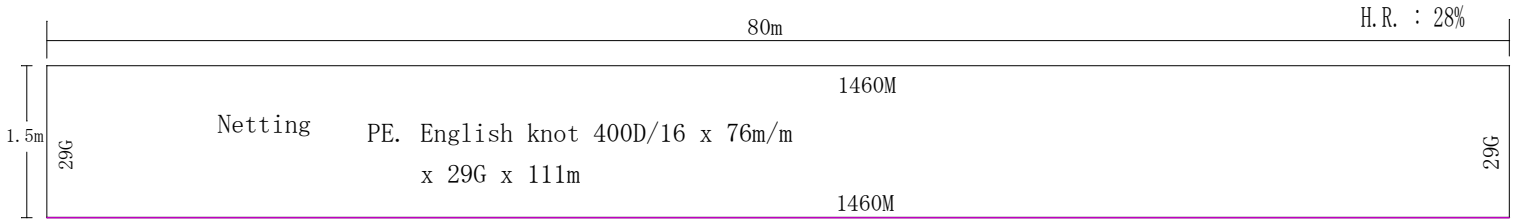




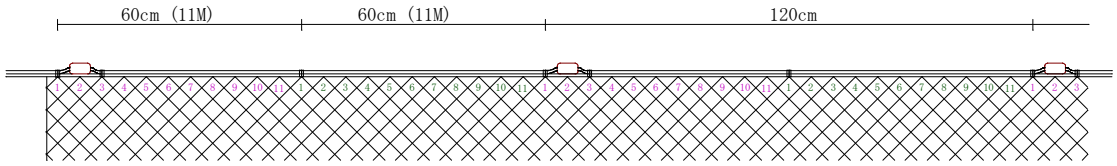
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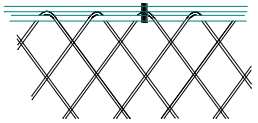
Arrangement of leader net

Net depth : 1.5m

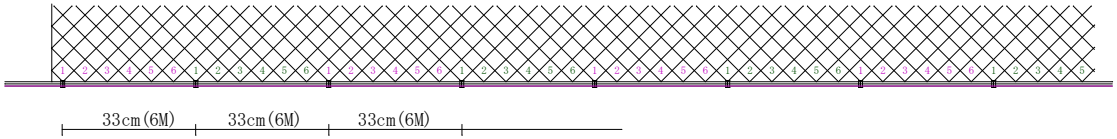


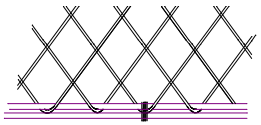
Head rope P.P ∅ 6mm x 82m x 2pcs.





Netting PE. English knot 400D/16 x 76m/m





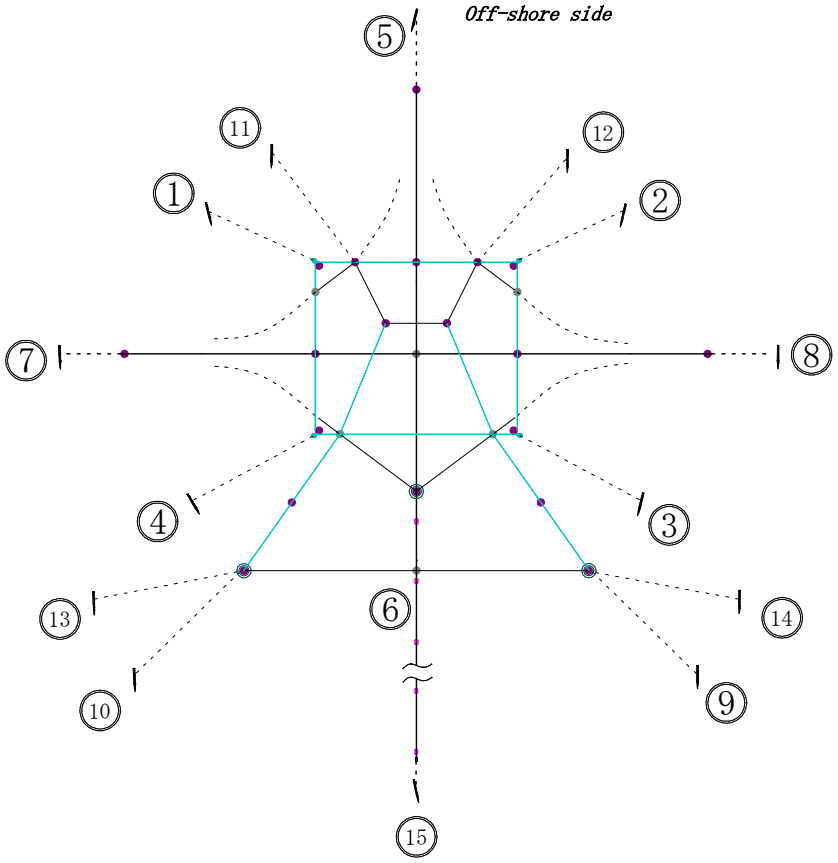
Sinker rope

PES braid rope with lead core (180g/m)

∅ 6mm x 83m x 1pc

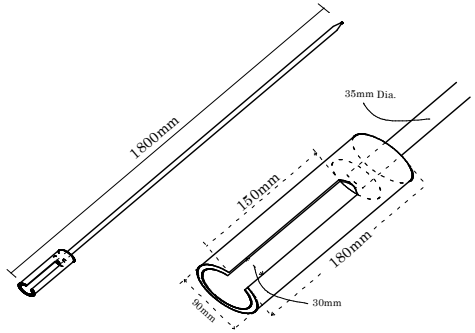
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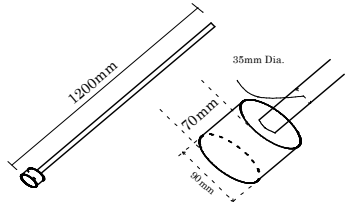
Quantity of each material
Anchor and wooden stick



① : Setting order

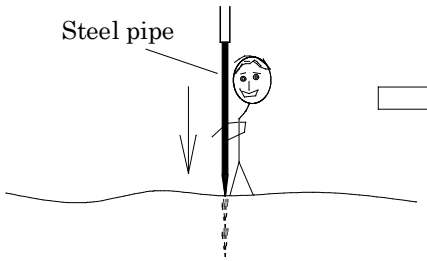
Iron tool for Frame Setting



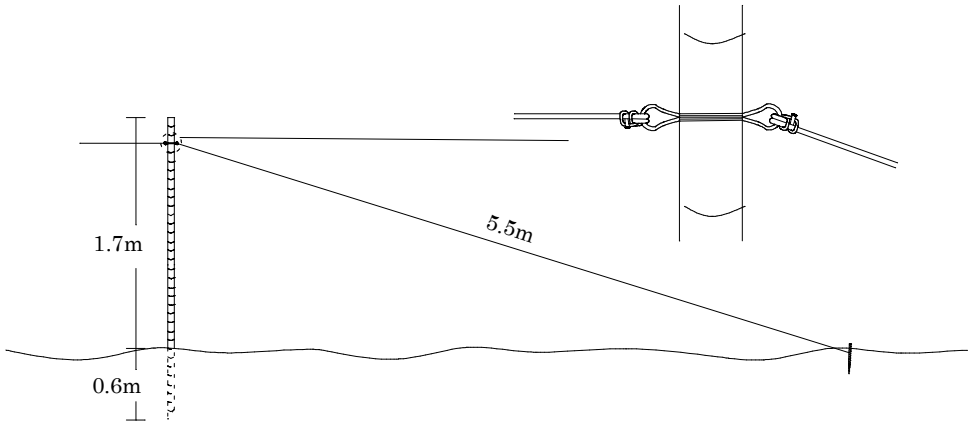


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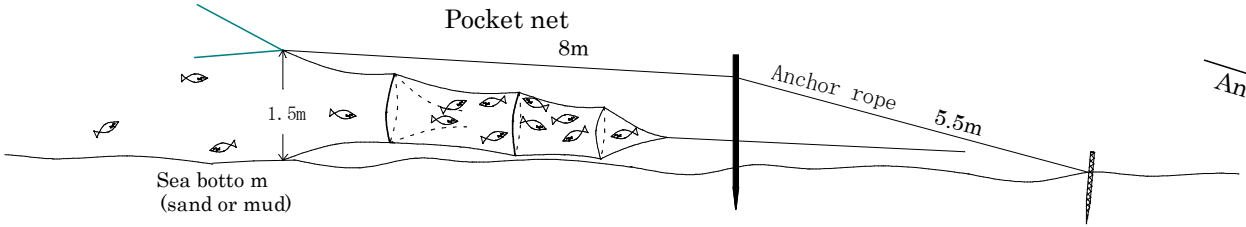
Frame setting by anchor and wooden sticks

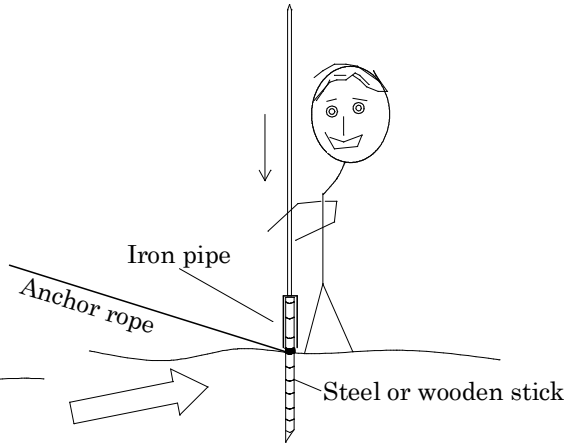


Making hole by Steel pipe



Stabbing Wooden stick into seabed





Appendix20

PP3 Material list

	PP3 : Pilot Project for Introducing Small Scale Set net (Pound net) Fishing					
	Materials list				Unit: Japanese Yen	
No.	Items	Specification/discription	Amount	Unit	Price	Sub-total
Materials for small scale set net						
1	Frame and anchor rope	PP 3strands Z type Dia.:10mm (200m)	3	coil	11,050	33,150
2	Rope for anchor side	PP 3strands Z type Dia.:8mm (200m)	3	coil	7,480	22,440
3	Rope for float side	PP 3strands Z type Dia.:6mm (200m)	5	coil	4,380	21,900
4	Netting for leader n	PE English knot, 400D/15×76㎜(mesh size)×100(Num.of meshes in depth) x 151.5m	1	unit	81,000	81,000
5	Netting for playground net	PE English knot, 400D/12×50.5㎜(mesh size)×100(Num.of meshes in depth) x 151.5m	1	unit	72,670	72,670
6	Netting for pocket net	PE English knot, 400D/12×43.3㎜(mesh size)×100(Num.of meshes in depth) x 151.5m	1	Unit	76,500	76,500
7	Twine	Span nylon 20s 30 1kg	3	ps	2,840	8,520
8	Twine	Span nylon 20s 20 1kg	3	ps	2,840	8,520
9	Twine	PE 200D 80D/60, 2strand type x 1kg	6	spool	2,790	16,740
10	Twine	PE 200D 80D/80, 2strand type x 1kg	6	spool	2,790	16,740
11	Plastic basket	SANKO container A#120 Blue color without handle	3	ps	6,890	20,670
		sub-total				378,850

Appendix21

The Project for formulation of The Strategies and Practical Approaches for Coastal Fisheries Development In The State of Eritrea

Report on Implementation of Small scale Set net fishing pilot project for foot fishers (PP3) in Hirgigo

January 2022

Mulugeta Mahdere

Appendix21

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1. Introduction 2
2. Implementations of activity 2
2.1. Visiting Pilot project selected sites Hirgigo and Zula community 2
2.2 Workshop on Basic knowledge of fishing gear 3
2.3 Pound Net Construction 4
2.4 Pound Net Deployment in Hirgigo 4
2.5 Pound Net Fishing Operation 5
3 Conclusion 6

<ANNEXES>

Annex-1; 1st meeting in Hirgigo and Zula MMR and JICA participants list

Annex-2; 2nd meeting in Hirgigo and Zula MMR participants list

Annex-3; counterparts attended in the lecture and construction of Set net

Annex-4; counterparts traveled to Hirgigo for Set net deployment

1. Introduction

In continuation of the pilot project for improvement of gillnet and its making capacity building (PP1), the implementation of Small scale Set net (Pound net) fishing pilot project for foot fishers (PP3) has been started. The purpose of this pilot project (PP3) is to make a prototype of a small scale Pound net and to conduct fishing trial in collaboration with subsistence fishers in selected coastal villages namely Hirgigo and Zula and eventually to verify the effectiveness of fishing gear and fishing method.

During the period of hot season, the temperature of the sea surface rises and the fish does not come to the shallow area. Therefore, fishers try to catch the fish by hand line fishing with floating raft. However, since the floating raft is driven by using beach sandals, the fishing ground range is accordingly limited. And the efficiency of operations also becomes worse under the rough sea condition. The proposed small scale Pound net is suitable for efficient catching of small fishes because it has the following features. This fishing net blocks the path of migratory fish by a leader net and guides it to the pocket net of the harvest space. Also, since the caught fishes are alive, it is easy to keep them in fish cage and no need to use ice for keeping freshness and it can be sold any time they want because fishes are alive in fish cage. In addition, this fishing method is nature friendly without fear of overfishing and at the same time, it is an effective fishing method for fishing community development because this net is managed by local residents.

Period of implementation; November 24, 2021- December 22, 2021

Activities conducted; implementation of PP3 (Workshop on Basic knowledge of fishing gear, Net cutting methods, Setnet construction, visiting Pilot project selected sites Hirgigo and Zula community and Pound net deployment in Hirgigo.

2. Implementations of activity

2.1.Visiting Pilot project selected sites Hirgigo and Zula community

In the selected sites three meeting with village community was held. In the first meeting on November 25, 2021 briefing about the structure of the pilot project, general objective of the pilot project and activities to be implemented was given to the Hirgigo and Zula village community (*annex-1; 1st meeting in Hirgigo and Zula MMR and JICA participants list*).

In the second meeting on December 7 and 8 respectively in Hirgigo and Zula village, workshop was held with community members. In the workshop in the section of fishing gear and method the following points were stated out; the pilot project comprise three pilot projects namely, pilot project for improvement of gillnet and its making capacity building (PP1), pilot project for development of small scale Bottom longline fishing (PP2), pilot project for introducing small scale Set net (Pound net) fishing (PP3).

The points addressed in the meeting, regarding the three pilot projects, the pilot project (PP1) implementation of fishing trial has been started since 2020 with artisanal fishers and optimistic result has been achieved. Implementation of pilot project (PP2) was

planned to initiate parallel with the Pound net this month December, unfortunately due to limited time of this mission for the JICA expert PP2 activity is postponed for the next arrival of the JICA expert. And after that points stated regarding the pilot project (PP3), fishing trial of Pound net will be done in Hirgigo and Zula. However, the first net deployment will be carried out in Hirgigo during his stay of the expert and later on the counterparts will do for Zula Pound net deployment. Moreover, an over view of the design, method of deployment and fishing methods of the Pound net was given. On the case of fishing trial after net deployment informed that the working group has a full responsibility to follow, harvest and record all fish catch in the given data sheet under the guidance of the counterparts. Additionally, the point mentioned that the number of fishing working group should not be more than 5 fishers who are willing and more committed, because it is a fishing trial that represent the whole coastal fishing community, it should be started with low number of fishers for better estimation.

Besides, the other three pilot projects for improving the livelihoods of fishing communities by increasing the distribution and consumption of small fishes were delivered by the counterparts of other Pilot Project team. In their explanation it has three pilot projects namely, for improvement of fresh fish distribution; solar freezers with meat and bone separator machines in Hirgigo and solar ice making machine, mincer and solar freezer in Zula (PP1), for development of processed fishery products; training on fish handling, processing and preservation such as sun drying, salt drying and smoking (PP2), for new markets development; market identification, food demonstration awareness raising campaign strategies to increase demand (PP3). Additionally, samples of sundry fish sardine, Indian mackerel and shark were displayed.

Last but not least, the head of Cooperative Support Unit (CSU) explained in the formation of cooperative, there is guidance on how the skeleton of the cooperative should be and has criteria for nominating the members. Then according to the general law CSU, the cooperative members must prepare internal bylaw to guide for the existence of the cooperative. After preparation of internal bylaw an official approval will be given (*annex-2; 2nd meeting in Hirgigo and Zula MMR participants list*).

In the third meeting on December 15 and 16 in Zula and Hirgigo, confirmation of the nominated fishing working group as a cooperative as package with processing and marketing working group was undertaken. The number of fishing working group for Hirgigo and Zula is 6 and 7 respectively. The selection of the working group is done by the community member themselves in the guidance of village's administrator and according to the orientation given in the second meeting. And formation of cooperative is confirmed by the participation of unit heads of CSU and Extension from Development Department.

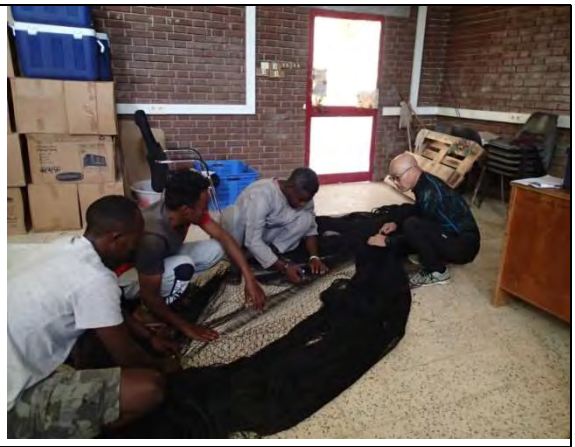
2.2 Workshop on Basic knowledge of fishing gear

On December 30, 2021, the JICA fishing gear expert addressed on basic knowledge of fishing gear, type of netting material, calculation method required for diagonal net cutting , practice on calculation for diagonal net cutting to fishing gear unit staffs and other interested staff,. This diagonal net cutting method is crucial for making different type of fishing gear like trawl, purse seine and other type of fishing gear. To this effect, diagonal net cutting was utilized for construction the Pound net that deployed in Hirgigo.

	
The JICA expert delivering lecture to C/Ps	C/Ps practicing splicing

2.3 Pound Net Construction

According to the design prepared by JICA expert and under his guidance, the Pound net construction was carried out from 02-16 December 2021 in MMR head quarter. This net constriction was performed by joining each part separately and finally installed in the sea. These parts are playground net, pocket net, leader net, frame rope and wooden stake frame and wooden anchor. In making pocket net the following main important points were performed; diagonal net cutting, slope net edge reinforcement, slope nets joining, joining of pocket net. And in the case of playground net; diagonal net cutting, edge net reinforcement, slope net installation and triangular net installation were done (*annex-3; counterparts attended in the lecture and construction of setnet*).

	
C/Ps Preparing pocket net	Diagonal net cutting practice

2.4 Pound Net Deployment in Hirgigo

In early morning December 16, 2021 Prior setting of the Pound net, in consensus with Hirgigo fishing working group there was a selection of right fishing ground conducted. Next day after determination of the appropriate fishing ground, during low tide at 06; 00 a.m. for installing the Pound net sequential setting of its parts evolved. Moreover, the point noted that during installation the sequence of its parts are needed to emphasis. The sequence of the main parts included;

i. Setting the wooden stake with its frame rope.
ii. Setting the wooden anchor in diagonal line from the wooden stake.
iii. Adjusted the entire frame.
iv. Attached the pocket net unit on the offshore side from the outside of the frame rope.
v. After attached the entire net to the frame, extended the three pocket nets to the outside.
vi. The leader net stretched from the offshore side to the land side and the end of the land. Side of net is stopped with a wooden anchor.
vii. The entire net adjusted.

In addition, next day after installation, we the counter parts with JICA expert visited to the site, as per checking the situation of Pound net and its catch. The net that we found in good manner as per it installed. Regarding the catches in the first day of fishing, they harvested around 4kg mainly barracuda (*annex-4; counterparts traveled to Hirgigo for set net deployment*).



Pound net deployment in Hirgigo



A day after deployment, Checking the net

2.5 Pound Net Fishing Operation

After the Set net deployed, in the first four days the fishing group recorded 1, 3, 2 and 2 kg of fish catch in the given data sheet respectively. However, by consensus of the fishing group and counterparts position of the fishing ground has decided to change, due to low catch as well as sea weed and marine algae problem, Very soon on mid-January 2022 for better catch the net was redeployed in another deeper position by counterparts and the fishing group. Unfortunately, a week later when the counterparts visited to the site the net founded completely distorted by current and also covered by marine algae and sea weeds. As it happened, the leader of the fishing group was not available there, then counterparts discussed with available two members of the fishing group. During the discussion opinions raised by the fishing group was "very low catch difficult to stay long period without profit" and "in this coast the fishing ground is far from the inshore, the intertidal is poor in fishery resource" this type of fishing gear would be efficient around coral reef area, but this inshore is muddy all round". From their complaint the main points quoted that the fishing group is not eager and devoted for this operation. Ultimately at that moment, counterparts decided to dismantle the net completely.

A key to the success trial operation is depending upon the willingness of the fishing group for proper look after the net. For this reason, by discussing with the village administrator some operation measure will be undertaken, either to replace or convince the fishing group or by considering their opinion to change site.

3 Conclusion

During the start of implementation Small scale set net fishing pilot project for foot fishers (PP3), the counterparts acquired substantial skill and knowledge on diagonal net cutting, net material, rope work, Pound net construction from the JICA expert. And he supported same points on fishing gear which is beyond his mission. Moreover, this project has a comparative advantage, which means the expert directly applied his skill on the field with the counterparts through on-job-training method.

Regarding the firmness of the wooden anchor and wooden stake in response of current faced is needed more clearly to be determined. In case of Hirgigo most of its wooden anchors were easily removed by current.

Annex- 1; MMR and JICA participants list in the first meeting with Communities of Hirgigo and Zula, Date 25/11/2021).

R/N	Name	Position	Site Visited
1	Eng. Idris salh	Project Manager	Zula and Hirgigo
2	Mr. Adonay Huruy	Project Coordinator	Zula and Hirgigo
3	Mr. Yohans Teklemaryam	ex-project Manager	Zula and Hirgigo
4	Mr. Mulugeta Mahdere	leader of Team Fishing Technology	Zula and Hirgigo
5	Mr. Solomon Brhane	leader of Team Fishing Community Development	Zula and Hirgigo
6	Ms. Yohana Negasi	Member of Team Fishing Community	Zula and Hirgigo
7	Mr. Beraki Haile	Head of Extension Unit in NRSD	Zula and Hirgigo
7	Mr. samuel Habtemaryam	Driver	Zula and Hirgigo
8	Mr. Samson Debesay	Driver	Zula and Hirgigo
9	Dr. Echigo manabu	JICA Team Leader	Zula and Hirgigo
10	Mr. Morimitsu Ritsuo	JICA Fishing Technology Expert	Zula and Hirgigo
11	Mr. Tsurusaki Tsuneo	JICA Fishing Community Development	Zula and Hirgigo

Annex- 2; MMR and JICA participants list in the second meeting with Communities of Hirgigo and Zula, Date 07-08/12/2021).

R/N	Name	Position	Site Visited
1	Mr. Msgna Tesfu	Head Unit CSU	Zula and Hirgigo
2	Mr. Mulugeta Mahdere	leader of Team Fishing Technology	Zula and Hirgigo
3	Mr. Solomon Brhane	leader of Team Fishing Community Development	Zula and Hirgigo
4	MsYohana Negasi	Member of Team Fishing Community	Zula and Hirgigo
5	Mr. Beraki Haile	Head of Extension Unit in NRSD	Zula and Hirgigo
6	Mr. Aklilu Rufael	Engineering workshop	Zula and Hirgigo
7	Mr. Yosief Redae	Member of Team Fishing Technology	Zula and Hirgigo
8	Mr. Tomas	Driver	Zula and Hirgigo

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Annex- 3; Counterparts Attended in the Lecture and Construction of Pound net,
Date 02-16/12/2021 (30 Nov. 2021 – 16 Dec. 2021)

R/N	Name	11/30	12/02	03	06	07	08	09	10	13	14	15	16
1	Mr. Mulugeta Mahdere	√	√	√	√	√	√	√	√	√	√	√	√
2	Mr. Yosief Redae	√	√	√		√	√	√	√	√	√	√	√
3	Ms. Feven Teklegergsh	√	√	√	√	√	√	√	√	√	√	√	√
4	Mr. Filimon Bereket Berhe	–	–	√	–	√	√	√	√	√	√	√	√
5	Mr. Filimon Bereket Bairu	√	√	√	×	√	√	√	√	√	√	√	√
6	Mr. Temesghen Amanuel	–	–	–	–	–	–	√	√	√	√	√	√
7	Mr. Osman Ibrahim	–	–	–	–	√	√	√	√	P	P	√	√

Appendix21

Annex-4; counterparts traveled to Hirgigo for Pound net deployment, checking the net and changing deployment position. (17 Dec. 2021 – 28 Jan. 2022)

R/N	Name	Job title	12/17	12/18	12/21	1/04	1/15	1/28
1	Mr. Mulugeta Mahdere	leader of Team Fishing Technology	√	√	√	P	√	√
2	Mr. Yosief Redae	Member of Team Fishing Technology	√	√	-	P	√	√
3	Ms. Feven Teklegergsh	Member of Team Fishing Technology	×	×	-	×	×	×
4	Mr. Filimon Bereket Berhe	Member of Team Fishing Technology	√	√	√	√	P	P
5	Mr. Filimon Bereket Bairu	Member of Team Fishing Technology	√	√	-	√	√	√
6	Mr. Temesghen Amanuel	Member of Team Fishing Technology	√	√	–	√	×	P
7	Mr. Osman Ibrahim	Member of Team Fishing Technology	√	√	–	√	√	√
8	Mr. Mohamed	Driver	√	√				
9	Mr. Gidey Weldegabr	Development Department					√	√
10	Mr. Samson Debesay	Driver						√
11	Mr. Fatuma Jimee	Driver					√	

Appendix22

The Project for formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC) In The State of Eritrea

Report on Implementation of Pilot Project for Introducing of Small Scale Set net Fishing (PP3) in Zula

Mulugeta Mahdere

Filmon Bereket Berhe

April 2022

Appendix22

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Annex-1; counterparts participated in construction of the Pound net

Annex-2; JICA expert, Counterparts and Others MMR Participated for Pound net Deployment in Zula

Annex-3: Recorded Sheet for Fish Catch of Zula Pound Net

1. Pilot Project for Introducing Small Scale Set net (Pound net) Fishing (PP3) in Zula

1.1 Introduction

.

Currently, coastal small sardines and other small fishes that are considered low-use resources in Eritrea are not being used effectively. The Eritrean government is studying processing and development of small floating fish and measures to expand distribution and consumption, but has not yet established an efficient fishing method. In Eritrea, many small floating fish come to the shallow water at the time of low water temperature in the coastal area, and are mainly caught by the beach seine net.

The proposed small scale set net is fishing methods that uses fish behaviour and catch it after stopping the fish school movement by leader net that comes to the coastal area. This fishing gear is a naturally friendly fishing method that does not overfishing, unlike the fishing method that pursue fishes like the trawl net fishery and the purse seine fishery. In addition, after obtaining the consensus of the fishing community, it is an effective fishing method for fishing village development (regional development), such as being installed at a local fishing ground and managed by local residents.

In this pilot project the main purpose is for introducing small scale Set net (Pound net) fishing (PP3) in Hirgigo and Zula coastal water. Implementation has been launched since December 2021 by deployed Pound net at Hirgigo coastal water. Even though, the fishing operation of that net has been stopped due to the problem of the fishing group and site selection, there is still opportunity to demonstrate by changing the fishing group and then to set in an appropriate site or to change site beyond Hirgigo. Successively, by using similar approach as of Hirgigo Pound net is deployed in Zula coastal water on mid of March 2022.

1.2 Activities evolved

1.2.1 Pound Net Construction

A key to construct every fishing gear is design. For this reason, the counterparts follow attentively the design which was prepared by JICA expert as of Hirgigo Pound net. The former Pound net construction had been done by the counterparts under the guidance of the JICA expert, Conversely the later for Zula, it was constructed by the counterparts themselves based on the design, it is showed that the counterparts acquired some skill and knowledge from this on-job-training. Construction of this Pound net took place since early January until mid of February 2022. It is not an easy task, it has many different parts which are the difficult one is those who prepared by using diagonal cutting and then joining to make the designed desire shape (*Annex-1; counterparts*

participated in construction of the Pound net). During this Pound net construction the following activities were evolved;

i. Frame rope making for keeping the shape of the Pound net.
ii. one leader net and two wing net making by mounting in head rope and sinker rope
iii. Sewing the main body or playground net and mounting in the head rope and sinker rope.
iv. Sewing three pockets, attaching plastic ring frame to the pocket net and assembling to the playground net.
v. Preparing wooden stakes and wooden anchors for fixing the frame rope.

	
Sewing the main body of the Pound net	Pocket net Hanging in the plastic ring
	
Preparing the wooden anchors and stakes for fixing the frame rope of the Pound net	Checking the prepared pocket net

1.2.2 Pound Net Deployment in Zula

Zula is one of the coastal villages in Foro sub-zone, located about 7 km from the coast with a population of 650 households. The inhabitants of Zula their main livelihoods are relying from fishing, agriculture, livestock and trade. Zula as of Hirgigo were decided to be the beneficiaries of this pilot project (the fishing gear and method development and the Fishery Community Development Project).

Parts of this pilot project, the Pound net deployment implementation in Zula coastal water has been carried out by the counterparts and the JICA expert, in the cooperation of Zula fishing group and presence of head of MMR Northern Red Sea Division and extension officer from 14-18/03/2022.

Prior deployment of the Pound net the following producers were evolved. Firstly on 10/03/2022 for site selection, the counterparts started by disclosing the overview nature of that Pound net to the fishing group. Since the information given to fishing group and shared idea between the fishing group and counterparts, agreed to deploy the net on south of the Zula Village which is a bit expose to wave and current. By considering the bottleneck encountered in Hirgigo operation and to be more precise the site for deployment, the JICA expert decided installing the leader net only on the first visit. Two days after, on 16/03/2022 the same group visited to the site. Unfortunately, the leader net found dismantled by current from the area of deployed. Thereupon, the counterparts with the JICA expert and the fishing group as well had discussed about the issue and noted that the site is difficult to deploy such net. Therefore, the site was forced to change and through consensuses redeployment of the leader net only as of the first day took place on east of Zula village which is a sheltered from wave and current.

Similar to the above approach, after two days of the redeployment, when the team arrived on the site, the deployed leader net found steady. Fortunately, for deployment chronologically installation of the Pound net components had undertaken on 18/03/2022 by counterparts and JICA expert in cooperation of the fishing group.

	
Counterparts collected the dismantled leader net by current in the first day for site selection.	The team discussing for better site for redeployment

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The team installing the Pound net on eastern side of Zula.	The structure of the Pound net after deployment finished.

1.2.3 Pound Net Fishing Operation

To verify the effectiveness that fishing gear, a prepared data sheet for regular recording the catch was handed over to the fishing group. Since deployment was over, after several hours not more than one day the net trapped some amount of fish.

According to the data sheet recorded by the fishing group, the following fishes have been caught. Mainly Indian mackerel, guitar shark, small talang queen fish, barracuda, marbled spinefoot, cobia etc. Since deployment in twelve harvesting time a total of 250 kg of fish caught, which means an average of 20.9 kg per one harvesting time. Currently, the fish caught were shared among the fishing group for their house food consumption, due to no access of ice sale opportunity to Foro town yet not reached *Annex-3: Recorded catch in data Sheet of Zula Pound Net.*

	
Trapped fish releasing from the pocket.	Cleaning the attached seaweed.

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First fish caught after deployment.	Fish harvested after 6 hour of interval.
	
Fishing group recorded fish catch in given data sheet	

1.3 Conclusion

After two week of deployment, the net was dismantled by current or wave, the same situation happened in Hirgigo. This implies the frame is not resistant to the typical wave or current, So that, the firmness of the wooden anchor and wooden stake in response of current is needed to be adjusted.

On the base of Hirgigo and Zula trial fishing the following lessons have learned;

- More to consider on site selection which should be muddy and sandy, sheltered from current and wave,
- If the site is closer to the collar reef, the catch efficient could be more.
- Once the net is set, it become stationary and the net has a chance to cover by algae and some dusts so that it should be cleared frequently and retrieve after three weeks.
- Since we have a long coastal line, the applicability of this pound net is no more compromise.

- This type of pound net is a new design to our fishers and the Zula fishers eager by this technique, fortunately could be replicate easily to the other coastal communities.

Annex-1; counterparts participated in construction of the Pound net

R/N	Name	Unit	Duration
1	Mr. Mulugeta Mahdere	MRDD	Jan-mid Feb 2022
2	Mr. Yosief Redae	MRDD	Jan-mid Feb 2022
3	Ms. Dita Amanual	MRDD	Jan-mid Feb 2022
4	Mr. Filimon Bereket Berhe	MRDD	Jan-mid Feb 2022
5	Mr. Filimon Bereket Bairu	MRDD	Jan-mid Feb 2022
6	Mr. Temesghen Amanuel	MRDD	Jan-mid Feb 2022
7	Mr. Osman Ibrahim	MRRSD	Jan-mid Feb 2022

Annex-2; JICA expert, Counterparts and Others MMR Participated for Pound net Deployment in Zula (14 Mar. 2022- 15 Apr. 2022)

R/N	Name	3/14	3/16	3/18	3/20	3/23	4/01	4/15
1	Mr. Morimitsu (JICA)	√	√	√	√	√	√	√
2	Mr. Aklilu Tsehaye	√	√	-	-	-	√	-
3	Mr. Andemichael Hdru	√	√	√	-	-	√	-
4	Mr. Mulugeta Mahdere	√	√	√	√	√	√	√
5	Mr. Yosief Redae	P	P	P	-	-	P	P
6	Ms. Dita Amanuel	√	√	√	-	-	√	√
7	Mr. Filimon	√	√	√	√	√	√	√

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	Bereket Berhe							
8	Mr. Filimon Bereket Bairu	√	√	√	-	-	√	√
9	Mr. Temesghen Amanuel	√	√	√	-	-	√	√
10	Mr. Osman Ibrahim	√	√	√	-	-	√	√
11	Samuel Habtemariam	√	√	-	-	-	√	
12	Salh Mohammedjabr	√	√	√	√	√	√	

Annex-3: Recorded Sheet for Fish Catch of Zula Pound Net

Recorded: by fishers of fishing group Zula

Catch records							
Date	Species (fish) Name	Total Weight(kg)	Total Number of fish	Average size(cm)	Fresh fish (Nkf)	Processed fish (Nkf)	Self-consumption (kg)
18/03/2022	Indian mackerel	1	15				
19/03/2022	Indian mackerel	2	10				
	small queen fish	2.5	10				
20/03/2022	Guitar shark	15					
	White shark	0.7					
	Jackfish	3					
	Others (Indian mackerel, talang queen fish	1.5					
21/03/2022	Indian mackerel	3					
	small talang queen fish	2					
21/03/2022	Indian mackerel	2					
	talang queen fish	1					
23/03/2022	Indian mackerel	3					

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	Barracuda	5					
23/03/2022	Indian mackerel	10					
	jackfish	1.6					
24/03/202	Indian mackerel	71	170				
	talang queen fish	8	1				
	Needle fish	1	1				
25/03/202	talang queen fish	7	2				
	Grouper	18	1				
	grouper	10	1				
	Indian mackerel	3	6				
26/03/2022	Cobia	12					
	Shark	9					
	talang queen fish	6					
27/03/2022	Needle fish	3					
	Indian mackerel	8					
28/03/2022	Talang queen fish	7					
	Indian mackerel	8					
	Talang queenfish	7					
29/03/2022	Catfish	13					
30/03/2022	Catfish	9					
	spinefoot	2					
	Total	**255**					

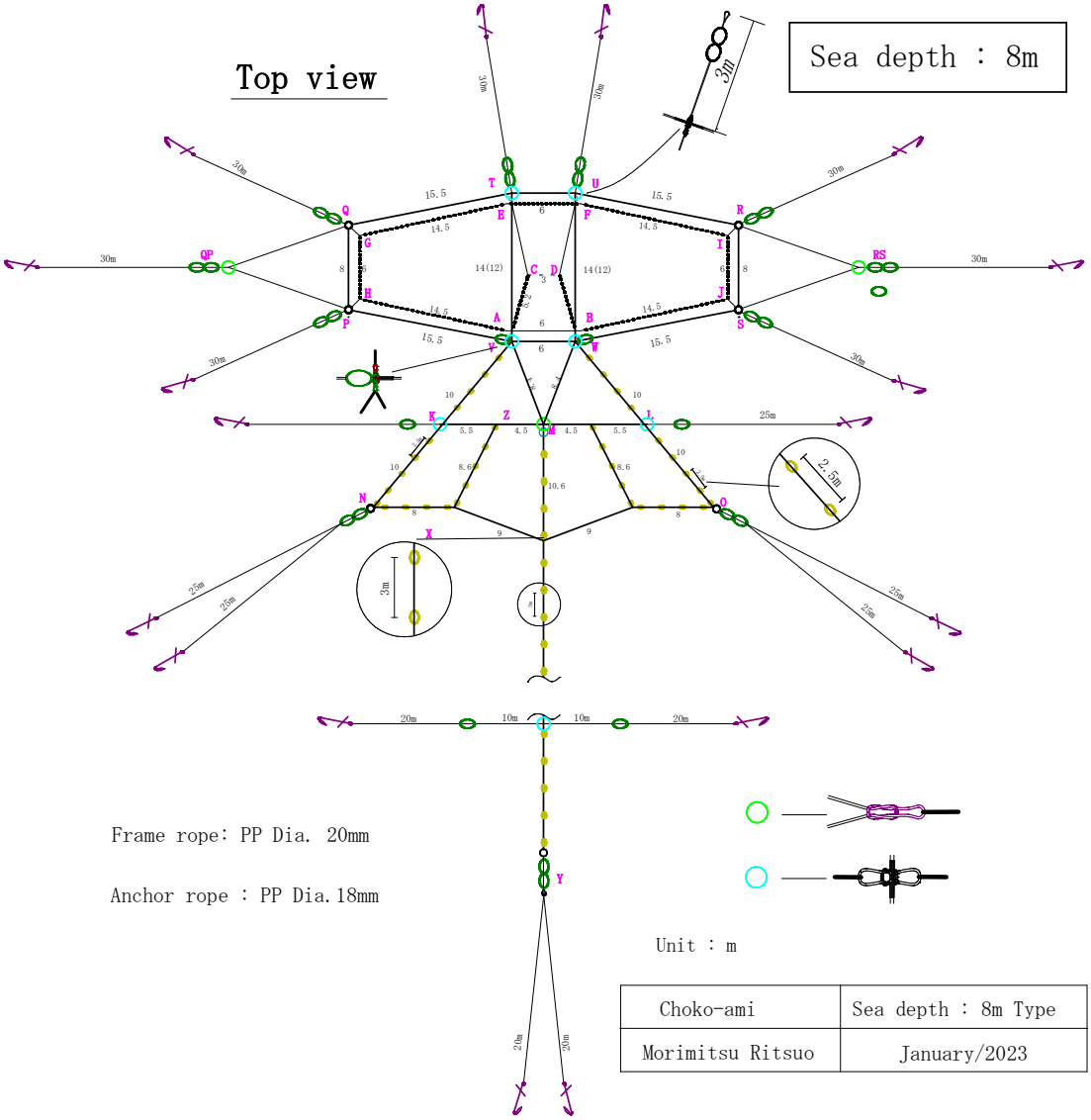
Appendix23

Choko ami 8m

Set Net (Choko-ami)

Sea depth : 8m

Top view



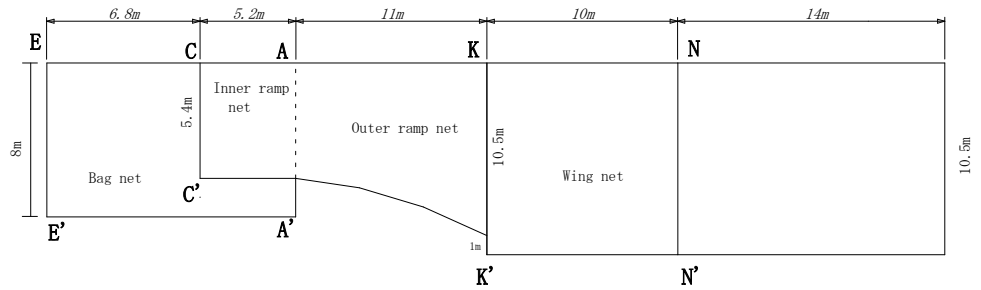
Frame rope: PP Dia. 20mm

Anchor rope : PP Dia.18mm

Unit : m

Choko-ami	Sea depth : 8m Type
Morimitsu Ritsuo	January/2023

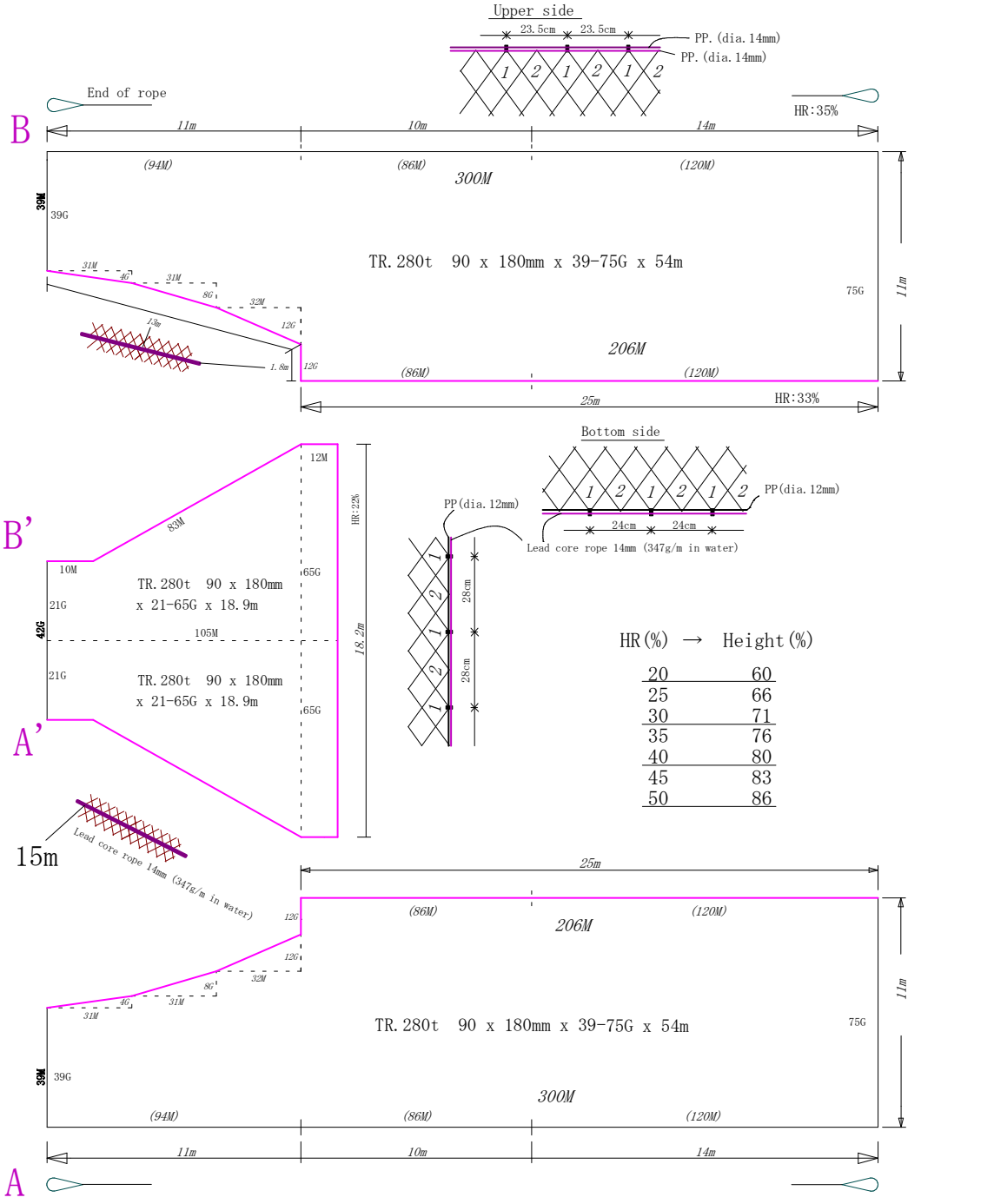
Side view (Bag & Ramp net)



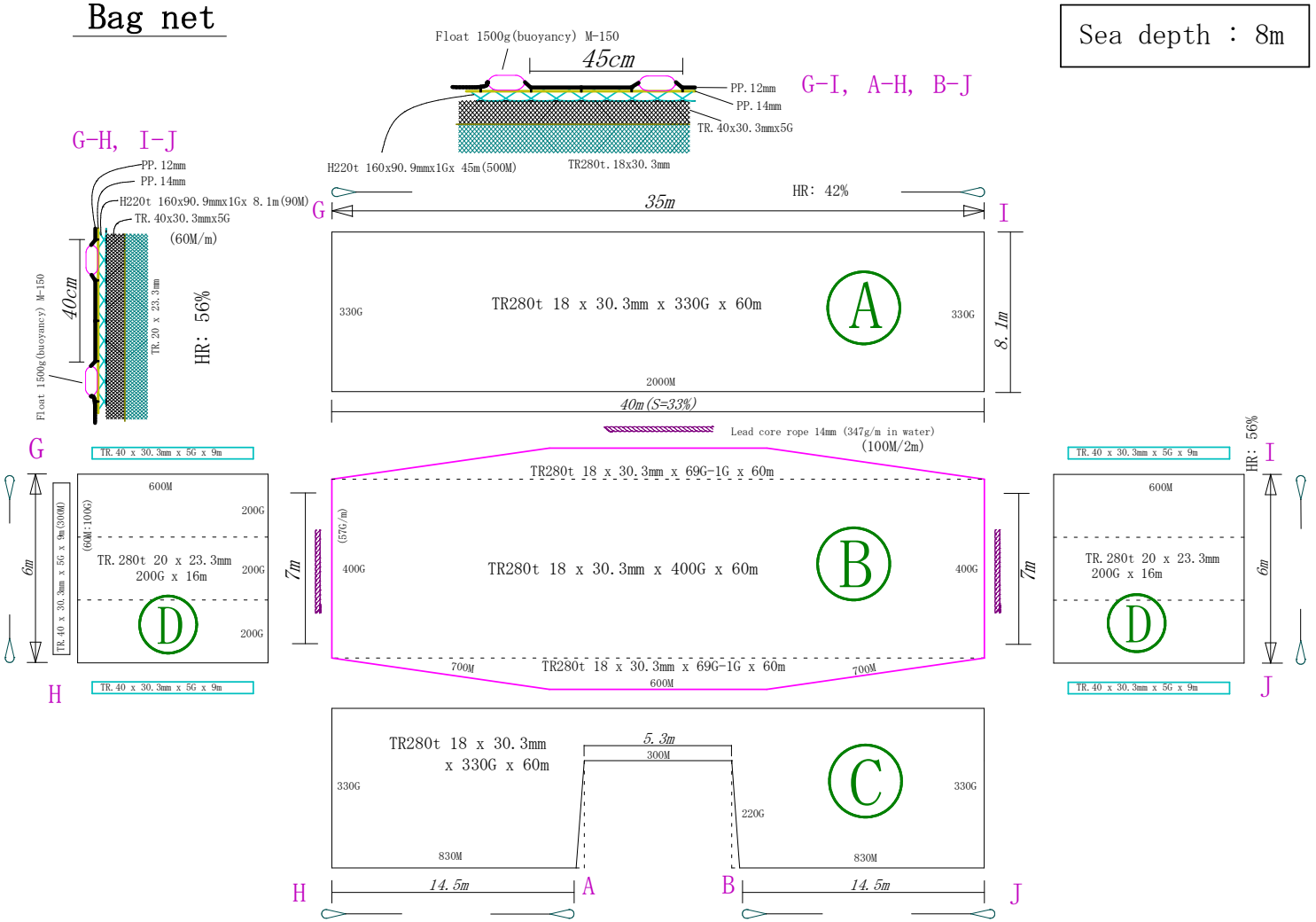
Appendix23

Play ground and Outer ramp net

Sea depth : 8m

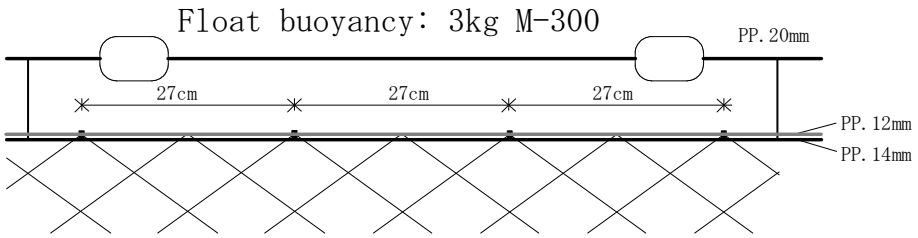


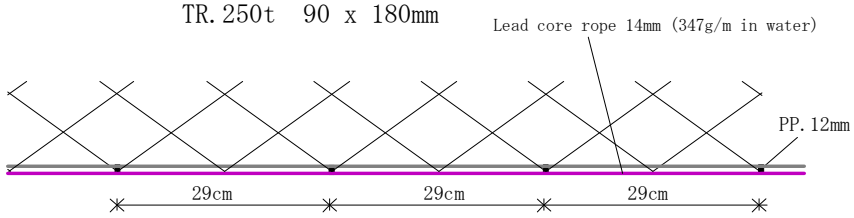
Appendix23


Bag net
Sea depth : 8m
Float 1500g(buoyancy) M-150
45cm
PP. 12mm
PP. 14mm
TR. 40x30. 3mmx5G
G-I, A-H, B-J
H220t 160x90. 9mmx1Gx 45m(500M)
TR280t. 18x30. 3mm
G-H, I-J
PP. 12mm
PP. 14mm
H220t 160x90. 9mmx1Gx 8. 1m(90M)
TR. 40x30. 3mmx5G
(60M/m)
40cm
TR. 20 x 23. 3mm
HR: 56%
Float 1500g(buoyancy) M-150
35m
HR: 42%
G
I
330G
TR280t 18 x 30. 3mm x 330G x 60m
A
330G
8. 1m
2000M
40m(S=33%)
Lead core rope 14mm (347g/m in water)
(100M/2m)
TR. 40 x 30. 3mm x 5G x 9m
TR280t 18 x 30. 3mm x 69G-1G x 60m
600M
200G
(60M:100G)
TR. 280t 20 x 23. 3mm
200G x 16m
200G
200G
6m
TR. 40 x 30. 3mm x 5G x 9m(300M)
D
7m
(57G/m)
400G
TR280t 18 x 30. 3mm x 400G x 60m
B
400G
7m
700M
TR280t 18 x 30. 3mm x 69G-1G x 60m
700M
600M
TR. 40 x 30. 3mm x 5G x 9m
H
TR. 40 x 30. 3mm x 5G x 9m
HR: 56%
I
600M
TR. 280t 20 x 23. 3mm
200G x 16m
D
6m
TR. 40 x 30. 3mm x 5G x 9m
J
TR280t 18 x 30. 3mm
x 330G x 60m
5. 3m
300M
330G
C
330G
220G
830M
830M
H
14. 5m
A
B
14. 5m
J

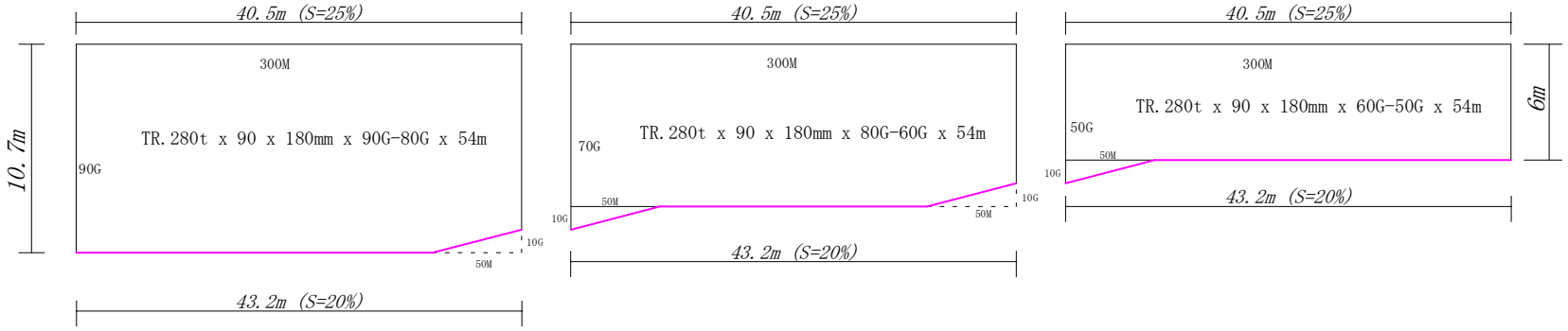
Appendix23

Leader net



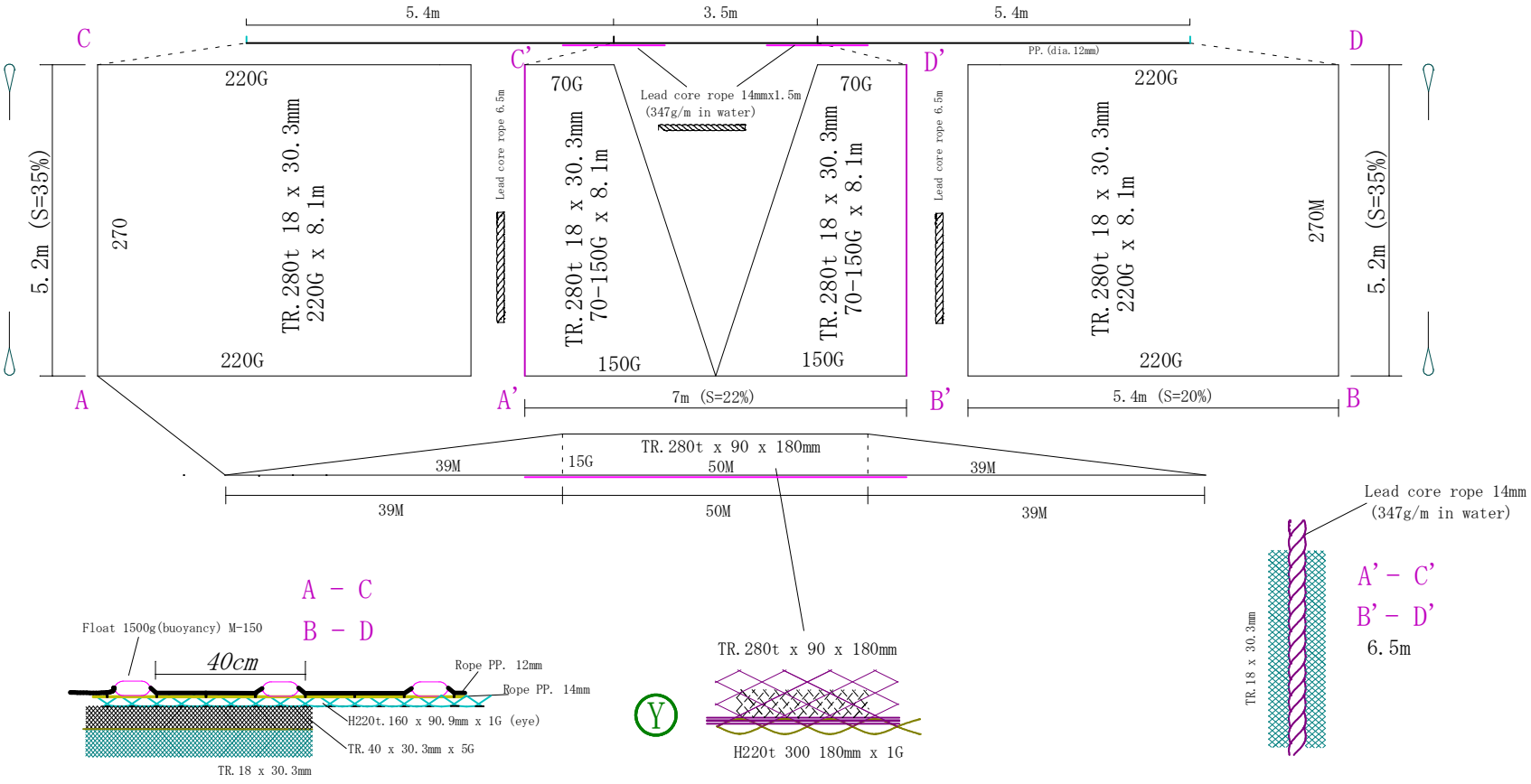


TR: Tetoron (Polyester)
PP: Polypropylene
PE: Polyethlen



Appendix23

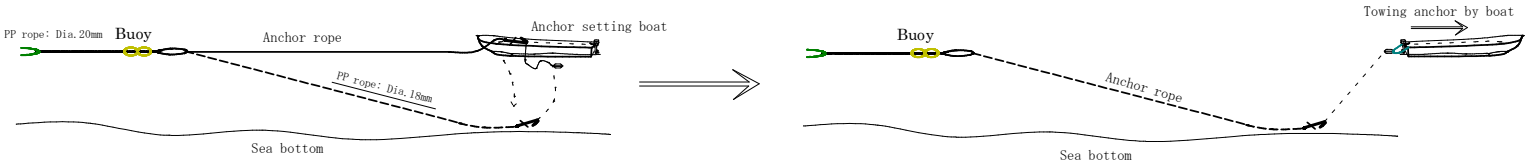
Inner ramp net



Appendix23

Towing anchor rope by boat and cast the anchor

Sea depth : 8m





Buoy : PE 10T-1B(335x260x40) Buoyancy(11.4kg), Weight(1.95kg) 30pcs.



Float : M-300(185x175x32) Buoyancy(3kg), Weight(0.5kg) 80pcs.



Anchor : One nail iron anchor(50kg) 18pcs.

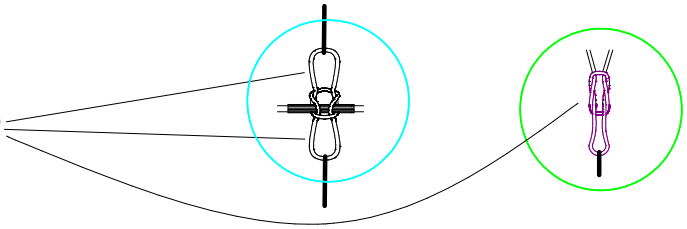
Rope lings for connection parts



Dia.:30cm by double PP18mm rope (7pcs.)



Dia.:30cm by single PP20mm rope (15pcs.)



4. Final Report of the Pilot Projects of Fishing Community Development for FSPAC

Final Report
of
the Pilot Projects of
Fishing Community Development

for

Project for the Formulation of
the Strategies and Practical Approaches for
Coastal Fisheries Development
(FSPAC)

April 2023

Selomon Brhane
Yohana Negassi
Tsurusaki Tsuneo

Ministry of Marine Resources

Japan International Cooperation Agency

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Abbreviations and acronyms

CFC	Community Fishery Center
COVID-19	Corona Virus Disease 2019 (SARS-CoV-2)
EMPC	Eritrean Marine Products Company Pvt. Ltd.
ERN	Eritrean Nakfa
FAO	Food and Agriculture Organization of the United Nations
FSPAC	Project for Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development
IFAD	International Fund for Agricultural Development
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
MMR	Ministry of Marine Resources
NFC	National Fisheries Corporation
PIU	Project Implement Unit
PP	Pilot Project

Counterpart Team Members of Fishing Community Development PIU

No.	Photo	Name & Contact	Position
1		Selomon Brhane (07-330546)	PIU Team Leader, Monitoring & Evaluation
2		Yohana Negassi (07-404185)	PIU Team Sub-leader, Quality Control Laboratory
3		Aklilu Rufael (07-574616)	PIU Team Member Wood work technician
4		Kibrom Issak (07-180426)	PIU Team Member Metal work technician
5		Beraki Haile (07-375368)	Extension Officer (Hirgigo)

Introduction

This report summarizes pilot projects activities for the coastal fishing community development in Eritrea implemented under the "Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC)." The pilot project activities were performed by different divisions of MMR under the leadership of the Fishing Community Development PIU of the Project from October 2019 to March 2023. During this period, main activities implemented were; baseline survey on fishing communities and fish distribution, identification of challenges and formulation of three pilot projects, which were the improvement of fresh fish distribution (PP4), development of fishery products (PP5) and new market development (PP6).

Following its formulation, the implementation of the pilot projects was started from the formation of fishery cooperatives and capacity building, construction of Community Fishery Center (CFC), installation of procured equipment and training, preparation of fish processing devices and manuals, development of new fish products and demonstration workshop, and fresh fish distribution from Zula village to Foro town. As of the end of March 2023, the pilot project activities have not been completed, though the process of project activities was described as step-by-step to show how the development issues were approached for the improvement of coastal livelihood.

Chapter 1. Consensus building for fishing community development

1.1. Discussion and selection of development issues

According to the Strategic Plan (2018-2023) of MMR, two issues were selected by the MMR as priorities for coastal fishery development. These issues were to increase the fish harvest and improve the livelihood of coastal fishing communities. For the latter, MMR selected six potential communities in the Northern Red Sea zone to improve their livelihood through pilot activities. Upon discussions with the JICA team, two villages of Hirgigo and Zula were selected as candidate sites for the pilot project due to their characteristics of the fishing community which were believed that they represent typical coastal fishing communities in Eritrea, and included in the baseline survey.



Fig.1-1 Six potential sites selected by MMR for cooperation with JICA



Fig.1-2 1st JCC meeting in October 2019

1.2. Consensus building with stakeholders in target communities

Meeting was organized in October 2019 with the traditional leaders and administrators in Hirgigo and Zula villages to explain a plan to develop the community as a part of coastal community development according to the policy of MMR. The objectives of pilot projects to be prepared were also explained and received the consensus of the community. In addition, the PIU Team with JICA experts were introduced officially to the community.

Chapter 2. Identifying issues of fishing community development

2.1. Baseline survey on fishing communities

The objective of the baseline survey was for collecting information of issues and constraints to identify crucial conditions in fishery activities and potential local resources applicable for community development. It will be used for the formulating models of fisheries development strategy to vitalize the villages and further similar corresponding villages. The results could also serve as baseline indicators in different developmental stages of the project time period and to see if tangible impacts have been appeared on the target villages and areas. The survey was conducted by interviewing related people in the target villages, and potential market areas for fish products distribution using questionnaires (see Appendix 1. Questionnaire of Baseline Survey).

2.1.1 Fishing community survey in Hirgigo

Hirgigo village is a typical fishing village located close to a populated town and market with relatively good access from the main road. The survey was done on general information, fishery activity, fishery organization, household economy and problems and needs of the community in November 2019.



Fig.2-1 Hirgigo fishing village



Fig.2-2 Hirgigo coast

(1) Community overview

The village of Hirgigo is located 10 km south of the port city of Massawa which has a population of about 2,000 people and 466 households. The main sources of income are agriculture and fishing (artisanal fishing) using fishing boats based in Massawa fishing port. Fisheries infrastructures such as markets and landing facilities have not been developed.

(2) Fishing activity survey

The fisheries operated in the village are hand line fishing for Indian mackerel and other small fishes and small gillnet fishing for mainly mullet in the shallow waters of the foreshore, and both of which are classified as the subsistence fishery. No one owned a fishing boat, but they fish by hand using floating gear made of polystyrene boards wrapped in bags and reinforced with ropes. During the good fishing season, the fishers focus on small fish such as Indian mackerel, scads, and small snapper in shallow fishing grounds, while during the hot season, when the sea surface water temperature is high,

they target larger fish such as trevallies, groupers, and barracuda in slightly deeper fishing grounds. The gillnet fishing is conducted throughout the year within the depth range of the standing water, using small mesh nets during the hot season (June to September) and slightly larger mesh nets during the peak fishing season (October to May).



Fig.2-3 Surveying fishers in Hirgigo



Fig.2-4 Subsistence fisher demonstrate how to navigate

(3) Fishery organization survey

There are about 50 people engaged in the subsistence fishing, and 16 of them, exclusively male, belong to the Hirgigo Fishing Cooperative. Most of them are mainly engaged in hand line fishing, and only a few own gillnets. The main problems identified are difficulty in obtaining fishing gear and materials, inadequate facilities for fish processing to keep quality, and difficulty in accessing markets. There is also a women's association for repairing and making fishing nets in Hirgigo, which has 18 members out of 40 who have been trained by the MMR to repair and make fishing nets. At present, however, there is almost no activity.

(4) Fishers' household survey

Seven subsistence fishers in Hirgigo village were interviewed about their household economy. Most of the catches are sold at the market in Massawa, where the fish price is estimated to be 20-30 ERN/kg and the fishing income is about 6,000-31,000 ERN/year. On the other hand, fishing expenditure, including transportation cost to the market, costs 4,000 to 8,500 ERN/year, thus the profit is very small. In general, household expenditure is estimated to be 1,500-3,000 ERN per month, and most of the household depends on non-fishing income such as charcoal production, agriculture, and livestock, etc.



Fig.2-5 Fisher's house in Hirgigo



Fig.2-6 House kitchen in Hirgigo

2.1.2. Fishing community survey in Zula

Zula village is a typical fishing village located in rural setting, far from a large town and market and relatively not good access from the main road. As same as Hirgigo, the survey was done on general information, fishery activity, fishery organization, household economy and problems and needs of the community in November 2019.



Fig.2-7 Zula fishing village



Fig.2-8 Zula coast

(1) Community overview

Zula village is in Foro sub-zone, Northern Red Sea zone, about 56 km south of Massawa. It is a village of 650 households with a population of 3,250 whose main livings are fisheries, agriculture, and livestock farming.

(2) Fishing activity survey

The fisheries structure is similar to that of Hirgigo village, and the fishery operated in the village is the subsistence fishing of hand line and small gillnets, without the use of fishing boats. There are about 50 subsistence fishers and fisheries infrastructure such as landing sites and processing facilities are not yet developed. They perform almost a year-round, but fairly decrease during the hot season by shifting to agricultural and livestock activities. During the cold season, the small gillnet is only used during the night time (dark night) and the hand line is during the day time. Main harvested species are queen fish, Spanish mackerel, Indian mackerel, sharks, jack, silver biddy, silver grant, mullet, snapper and grouper. During the hot season, reef fishes and mullet are the target fishes. As for the problems related to the fishery production and sales, there is a shortage of fishing gear and materials, ice is not available to maintain the quality of the catches, and there is no market and consumer demand for fishery products in the village is low. So, they want to sell their catches in Foro, the center of the region, but there are limited means of transportation and sales.



Fig.2-9 Gillnet of subsistence fisher in Zula



Fig.2-10 Marketing fish in Zula

(3) Fishery organization survey

A Zula fishery cooperative had been organized with 40 subsistence fishers, but no concrete activities have been carried out as a cooperative yet, and no financial or technical support has been provided by the MMR because no clear plan has been formulated. In addition, a cooperative for the repair and manufacture of fishing nets in Zula village has been established for 48 women as in the village of Hirgigo, but many members have not had the opportunity to receive technical training.

(4) Fishers' household survey

Seven subsistence fishers in Zula village were interviewed about their household economy. Fishing income is estimated to be about 7,000-27,000 ERN/year, while fishing expenditure is estimated to average 5,200 ERN/year, making fishing income negligible. Household expenditures range from 1,500 to 3,000 ERN per month, and it is still difficult to support a household with only fishing income.

Lessons learned

- Base line survey was very useful to obtain firsthand knowledge of communities and related people who would be influenced by a project.
- Directory interviewing to stakeholders was effective and accurate. But some answers seemed to be not relevant and misunderstood the questions.
- Sometimes answers were not clearly recorded on the sheet. It seemed there were inconsistency in asking questions and understanding of interviewees.
- Problems and needs of the village communities were identified by conducting baseline survey.

Recommendations

- Before starting a project in a village, base line survey should be done to assess the potential resources, traditional knowledge and the problems of the village community in addition to collecting basic information from related documents and reports.
- At the stage of preparation for BLS, interviewers should be practiced how to conduct the interview and how to pose a question, and study reports related to the issues.
- It would better to take memos during the interview on a space of interview sheet when interesting opinions and ideas presented by interviewees.

2.2. Issues in fishing communities - problem analysis workshop

In order to get a bird's eye view of the issues surrounding each fishing community, a workshop on "Problem Analysis for Coastal Fisheries Development" was conducted in November 2019 inviting coastal fishery stakeholders. The venue was Anchor Hall near the causeway in Massawa. A total of 31

people participated in the workshop, including 4 representatives (1 administrator, 2 fishers, and 1 woman) from communities of Hirgigo, Zula, and Dehil Island, 2 invited participants from NFC, and 17 people including CPs from various divisions of MMR. Main problems and issues were derived from the “Problem Tree Analysis” and group discussions during the workshop. The results are as follows.



Fig.2-11 Problem tree analysis in workshop



Fig.2-12 Group discussion in workshop

2.2.1. Hirgigo village problem analysis

The central problem in Hirgigo village was "Limited fishing activities," and problems that cause this are "Lack of fishing boats and gears," "Lack of fisheries infrastructure," "Lack of fish markets," and "Weak institutional arrangement.”

In the process of analyzing the problems, the most discussed issues and thus subdivided into the lower levels of the cause-effect diagram were "Lack of fishing boats and gear," "Lack of market capacity," "Lack of cooperative capacity" and "Lack of labor skills." “Lack of fishing boats and gears" was caused by inefficient fishing methods, low income due to low fish prices, and high prices of fishing gears. “Lack of market capacity" resulted from the low purchasing power of consumers and the lack of ice and cooler boxes to keep fishes fresh. The main reason cited for both "Lack of cooperative capacity" and "lack of labor skills" was a lack of opportunities to improve capacity through training.

2.2.2. Zula village problem analysis

The central problem in Zula village was "Low fishing income," and the four direct causes were "Inappropriate fishing techniques," "Many post-harvest losses," "Lack of opportunities for capacity building of fishers," and "Lack of fishing income opportunities for women.”

The problem analysis team of Zula village narrowed down and consolidated the problems after a lively exchange of opinions, so the number of problem cards was reduced, and the problem tree was simply organized. In the case of "Inappropriate fishing technology," it was determined that there were no suppliers of fishing materials and therefore no access to appropriate fishing gears. “Many fish catches are discarded” due to the long distance to the fishing grounds, limited opportunities to sell the fish in the market, lack of roads to transport the fish, and lack of refrigerator-freezers. “Lack of income opportunities for women in the fishing industry" was resulted from the lack of training opportunities

in fishing technology, lack of training opportunities in fish processing and quality control technologies, and lack of training opportunities to start a retail shop, indicating the need to provide appropriate training opportunities.

Lessons learned

- To solve any problem of the community, a problem analysis together with community representatives was very important.
- By conducting problem analysis workshop, the priority problems of the community to be solved were efficiently identified.
- Problem analysis workshop could be hold after the baseline survey on fish distribution and household consumption completed, so that the distribution of fish products from the villages could be considered in a food value chain.

Recommendations

- It is highly recommended to hold a problem analysis workshop with target community representatives and stakeholders.
- It is efficient way to identify problems and get common understanding of the situation of the community they live.
- The problem analysis workshop using the Problem Tree Analysis method requires experienced facilitators to promote discussions and analysis in the groups.

2.3. Baseline survey on fish distribution and household consumption

2.3.1. Selection of three typical markets for fish distribution

This study was conducted to understand the current status of post-harvest activities and to identify problems and constraints in fish distribution and household fish consumption in November 2019. The target sites of the survey were three typical cities of fish consumption in Eritrea, namely Massawa as a coastal city, Asmara as a metropolitan city and Mendefera as a local-highland city. There only one fish landing site in Northern Red Sea zone is EriFish in Massawa from which fishes are distributed to three cities mentioned above.

2.3.2. Distribution and consumption survey in Massawa

The baseline survey of fish distribution and household consumption in Massawa was done on two fish market places in Massawa, Edaga open fish market and Sigalet fish market. Those two places were mostly

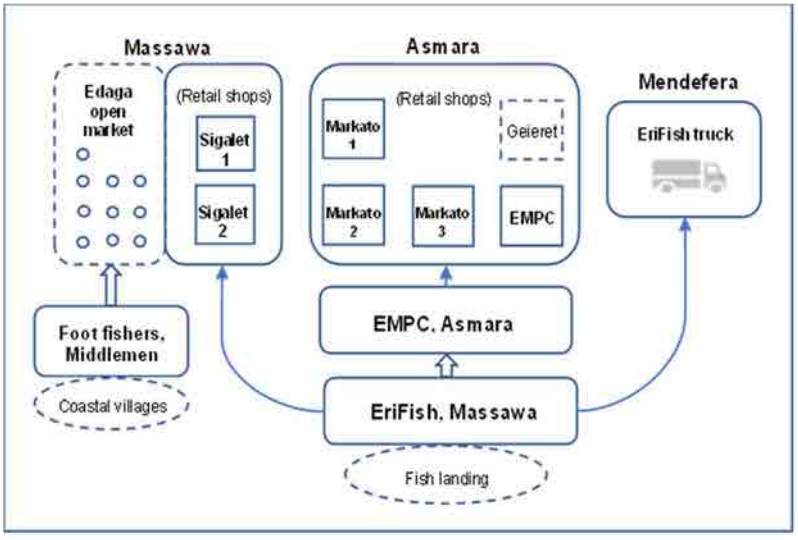


Fig 2-1: Fish distribution from Massawa to three typical cities in Eritrea

known fish markets in Massawa. Edaga open fish market is in Edaga next to the main road along the railway and was an active fish selling place. While the other fish market, Sigalet fish market was found besides the Sigalet Qetan main road (causeway). In this survey in Massawa, 24 interviewees were participated, 12 as fish sellers and 12 as customers of which 10 and 10 were at Edaga open market and 2 and 2 were at Sigalet market respectively.

(1) Fish sales and consumption in Massawa

In Massawa, harvested fish was delivered for sale in two ways; (1) fish from subsistence fishers and middlemen around Massawa to Edaga open fish market and sold by themselves, and (2) fish from artisanal fishers through EriFish to Sigalet fish market sold by two concession retailers. The average amount of fishes sold in a day was 473kg at Edaga market and 65kg at Sigalet market. Edaga open fish market was the only market operated by private sellers, subsistence fishers and middlemen, and selling small size fishes at their prices, 40-50ERN/kg. Whereas Sigalet was government licensed fish market and selling large size fishes caught by artisanal fishers at fixed prices by the government (42-63ERN/kg).



Fig.2-13 Surveying at Edaga open fish market

People had a good habit of eating fish, 42% of interviewees in Massawa were eating fish daily purchasing 1.70kg per household at Edaga market and 2.5kg at Sigalet market. Because of the proximity to the fishing ground, 75% of customers in Massawa satisfied with the number of fish available in the market.

(2) Problems and needs in Edaga open fish market

- Most of fish was sold in baskets on open soil without proper protection from dust and flies in partial shade under the tree.
- There is no water supply and no waste disposal place in the market.
- Sellers didn't have good preservation system like refrigeration or freezing.
- Customer requested more supply of fish during summer season and lower the prices.



Fig.2-14 Sigalet concession fish market

(3) **Problems and needs in Sigalet fish market**

- Preservation system such as refrigerator and freezer were old.
- The total infrastructure of the shops require rehabilitation.

- Cost of fish transportation was high.

2.3.3. Distribution and consumption survey in Asmara

There were three fish market places in the metropolitan city of Asmara; (1) Markato fish market in Maekel Ketema (city center), (2) EMPC (Eritrean Marine Products Company Pvt. Ltd.) retail shop at EMPC fish processing plant in Mai-chot, and (3) Gejeret fish market in Gejeret district. Among these three market places, the survey was conducted at two mostly known fish market places, (1) Markato fish market which consists of three retail shops and (2) EMPC retail shop.

(1) Fish sales and consumption in Asmara

In Asmara, fishes were brought by EriFish from Massawa and delivered by EMPC to the government licensed retail shops in three marketing places, and sold at government prices. The amount sold at four retail shops in two major marketing places, Markato and EMPC, was in average 6,000kg per day, but supply was limited to every other week only, so that the average daily sales should be regarded as a half. About a half of interviewees said that they were eating fish 1 – 3 times per month purchasing in average 2.86kg per household. This could be increased since 80% of customers complained limited amount of fish in the market.



Fig.2-15 EriFish/NFC truck deliver only large fish from Massawa

(2) Problems and needs in Asmara

- Limited fish supply in amount and species, and fish delivery is every other week
- Prices of fish are not affordable as compared to other animal meets.
- Retail shops require rehabilitation of infrastructure and their equipment.
- Household's awareness raising on fish consumption is required.



Fig.2-16 Surveying at Markato fish market in Asmara

2.3.4. Distribution and consumption survey in Mendefera

Mendefera is the capital city of the Debub (South) region located 60 km south of Asmara. There was one fish market which had been built by the administration of Mendefera. But in these days, this fish market was not active. The fish consumed in this area was the marine fish supplied by EriFish in Massawa. The fresh water fish was not available in the market yet.

(1) Fish sales and consumption in Mendefera

The fish market in Mendefera was almost closed, and fishes were irregularly supplied by EriFish and

sold on their truck. Most of time when people need fish, they were going to Asmara fish markets. For this reason, the interview survey of the fish distribution in Mendefera was not conducted. Even under such a limited availability, 30% of interviewees were eating fish two times per week purchasing fishes 1.0kg per household.

(2) Problems and needs in Mendefera

- Fish was not available any time. The EriFish truck came suddenly and people could buy fish when they saw the truck.
- The rarely delivered fish was also very expensive in comparison with beef and goat meats.
- When people needed fish for their restaurants, they ran to Asmara to get fish. This made the fish perishable and required additional cost.

2.3.5. Summary of fish distribution and household consumption survey

Opinions of 42 customers interviewed in three typical cities revealed that the fish distributers in Eritrea were maintaining satisfactory level of quality control for consumers even under the limited delivery system and deteriorated marketing places. As such, 71% of customers satisfied with the quality of fishes at their retail shops. While, majority of them expressed discontent with the amount of fish supply and their prices, only 31% and 26% of customers respectively were accepting current situations. Among the three cities, Massawa was exceptional because of the existence of a unique marketing place functioning under the less government control, Edaga open fish market. Though there were some problems to be solved in Edaga, its system was working well as a market for the subsistence fishers around Massawa.

Lessons learned

- The survey was done for all sellers and randomly selected customers in Massawa and Asmara and house-to-house survey in Mendefera.
- The communities in highlands (Asmara and Mendefera) were highly demanding for fish. Their main challenge was the availability of enough and good quality fish.
- They did not have the habit of consuming small fishes because they did not know how to cook it and small fishes were not available there, but potential seemed to be high.
- This survey could be done in Foro as for Zula fish distribution. It also revealed that there was a fish market in Foro constructed for Zula fishery cooperative years ago and not been used for long time.

Recommendations

- The production and distribution of good quality fish should be secured to the highland communities where the demand is high.
- Open fish market system such as one in Edaga gives good opportunity to subsistence fishers in coastal villages.
- Few years ago, Edaga market had been closed by the administrator, so that subsistence fishers should move from Edaga to new Sigalet open fish market behind of the cinema.
- The same survey should be done in Foro for Zula village fishing communities to know the situation of targeting market.

2.3.6. Additional baseline survey on fish processing in Hirgigo and Zula

During the Problem Analysis Workshop, community members raised “Low fishing income” was the central problem, and one of causes was “Lack of fishing income opportunities for women.” Taking this in consideration, the fish processing could be a solution to create income opportunity for women. Then, the Fishing Community Development Team realized that not enough information of fish processing was obtained from the target communities. So that an additional baseline survey was conducted in Hirgigo and Zula villages by interviewing different groups from the initial baseline survey.

The total of 20 villagers, 10 in each village were interviewed on the method of processing and preserving fish such as salt drying, sun drying and salt sundry. The local cuisines and their ingredients spices for small fresh fish and processed fish were also collected from interviewees.

(1) Result of fish processing survey in Hirgigo

In Hirgigo the preservation process was done mainly on baqa, shark, mullet, Spanish mackerel, jack fish, and sea cucumber. To preserve the fish flesh for source of food, the following steps are required;



Fig.2-17 Survey on traditionally processed fisheries products in Hirgigo

① Fillet the fish by removing the head, fins, and the gut.
② Wash the filleted flesh to remove the blood on it.
③ Slice the washed fish flesh.
④ Put salt on the fish (1 spoon of salt powder for 200g of fish).
⑤ Cover it with mosquito net or some plastic cover to protect fly and dust.
⑥ Dry it for two to four days.
⑦ Pack it in clean container.

(2) Result of fish processing survey in Zula

In Zula salting and sundry were common methods of fish preservation. This preservation process was applicable for shark and mullet species and following steps were required;



Fig.2-18 Processed fish and its cuisine in Zula

① Fillet the fish by removing the head, fins, and the gut.
② Wash the filleted flesh of the fish to remove the blood on it.
③ Slice the washed fish flesh.

④ Put it on inclined mat for water removal and drain it well.

⑤ Put salt on the fish (1kg of salt powder for 10 kg of fish).

⑥ Pack it in air tide wooden box.

⑦ Dry it for three to five days.

⑧ Pack it in clean container

After the survey, the results were summarized into manuals of fish processing, preserving, and cooking fresh and processed fish (see Appendix 2. Report of baseline survey and manual of fish processing and preservation in Hirgigo and Zula).

Lessons learned

- Zula and Hirgigo communities were practicing long-lasting fish processing techniques and even selling products in highland areas and abroad in the past. There were interesting and worthwhile information to learn.
- Having the additional baseline survey, local knowledges obtained were studied and become basic information to develop fish processing manuals for the community.

Recommendations

- Any manuals and processing techniques to be introduced to a community should start understanding the traditional knowledge of the community.
- Local knowledge needs to be respected at the first place in development planning process, so that people live there feel more attachment to the project, and it stimulates their interest to participate and helps fostering community spirits.

Chapter 3. Identifying challenges and formulating pilot projects

The baseline survey revealed issues and constraints to be solved to improve fishery production and distribution, but there were a number of constraints require institutional arrangement by the government which were excluded from this project. For example, although the biggest issues raised by fish consumers in inland cities were the high fish price and the lack of supply, this project focuses on the issue of supply by improving the production, distribution and developing processed fish products.

3.1. Identifying challenges to the fishing community development

The problems and issues are elucidated and selected as the challenges to the fishing community development in Hirgigo and Zula villages. These challenges are as follows.

3.1.1 Challenge for distribution of small fresh fish

(1) Hirgigo village

Subsistence fishers in Hirgigo were selling many fishery products at the Edaga open market in Massawa. But fishers were selling fresh fish in baskets on open soil without proper protection from dust, sunlight and flies. Transport costs were also high when transporting fish to the market in small batches. The improvement of distribution environment is essential for improving fishery production and sales volumes. In addition, meeting the high demand for fishery products in Asmara and inland areas is also required from the perspective of national food security, but there has been no distribution of small fresh fish to inland areas by National Fishery Corporation (NFC) which is the sole fish distributer to cities owned by the government.



Fig.3-1 Hirgigo fisher selling fish in Massawa

(2) Zula village

In case of Zula village, there were high demand within the village, but as mentioned above, the distribution outside the village is essential if fishery production and livelihood of the village are to be improved. A promising market is in the neighboring town of Foro. To target it, ice is essential to maintain the quality of fish, but it was carried over for hours from Massawa as it was not available in the village or vicinity. Minimizing these transport costs and improving the fish quality in distribution are major challenges to economic



Fig.3-2 Zula fisher selling fish in Foro

management of fishers and its necessity would become more apparent as fishery production improves.

3.1.2. Challenge for fish processing techniques in communities

A key to improve the household economy is to create fishery income opportunities for women. So, the development of marketable processed fish products is a challenge. In many villages, electricity and refrigerators are widely not available, thus, the development of processed fish products is also essential to preserve it and prolong the shelve life in ambient temperature. MMR has attempted to develop processed products, but to date, there has been no product development demonstrated for the widespread consumption of small size fish, and there is a lack of expertise in villages.

3.1.3. Challenge for improving consumption of small size fish in inland areas

As mentioned above, meeting the high demand for fishery products in inland areas is also required from the perspective of national food security, but to date, only larger fishes of artisanal fishery such as Spanish mackerel, queenfish, groupers, etc. are distributed by NFC and consumed in Asmara and inland areas. These fishes are a substitute for livestock meat for consumers who favor large portions to be edible and know limited ways to cook. Thus, there are needs to promote consumption of small fish of subsistence fishery such as mullet and Indian mackerel by advertising their nutritional and economical values.

3.2. Formulation of the pilot projects

To respond to challenges identified above, three pilot projects were formulated and details are as follows. Project numbers are sequential numbers from that of Fishing Gear and Methods PIU.

3.2.1 Pilot project for improvement of fresh fish distribution (PP4)

This pilot project aims to improve distribution of small size fresh fish in Hirgigo and Zula. To improve the distribution, three subjects require consideration such as, Quality, Transport and Storage of fresh fish. Thus, (1) ice is required for maintaining the Quality, (2) a cooler box is for Transport and (3) a freezer is for fish Storage. The distribution from Hirgigo to Massawa targeted Edaga open fish market (later changed to Sigalet open fish market prepared by Massawa administration). The distribution to Asmara and inland areas requires negotiation with NFC.

3.2.2. Pilot project for development of fishery products (PP5)

To develop new fishery products in communities, processing manuals and processing equipment are required. To develop the processing manual, the survey was done in the community to respect their way of fish processing and what cuisines they cook using processed fish. Equipment should be prepared using locally available materials according to the fish products to be produced. A place is also required for villagers to perform the processing and sell products.

3.2.3. Pilot project for new market development (PP6)

To create new market for small size fish in Massawa and Asmara, it needs to promote consumption of small fish, which is not familiar particularly for inland people, by introducing the recipes performed by coastal community people. The recipes could include not only for small fresh fish but also for processed fish products developed in the fishing communities. When the PP4 is progressed and started to distribute small fish from Hirgigo, demonstrations of small fish cooking and tasting will be organized in Massawa and Asmara.

Chapter 4. Implementation of pilot projects

This Chapter describes project activities implemented sequentially, not separately by each pilot project. Because some contents of pilot projects were overlapped each other, so that it is difficult to describe and understand the process of each pilot project implementation separately. Thus, at the end of the Chapter, these project activities are summarized in project-by-project.

The project activities were presented as following manner; (1) building organizational capacity, (2) preparation of fish processing devices, manuals and workshops, (3) procurement of equipment, (4) building Community Fishery Center (CFC) and (5) fresh fish distribution by Zula cooperative.

4.1. Building organizational capacity in Zula and Hirgigo (PP4, PP5, PP6)

To implement the pilot projects, building human capacity in the community is the first priority to be organized and enhanced for the success of the projects and sustainable community development in the future.

4.1.1. Consensus workshops

In November 2021, all project team members including; Project Director, Project Manager, Fisheries Extension Officers, Fishing Gears and Methods and Fishery Community Development Teams, and JICA Experts, visited both fishing villages and explained to the village administrators and fishers about the preparation and progress of the project, the outline of the pilot projects, and the implementation plan.



Fig.4-1 All project members meeting with administrator and fishers in Zula

Then, two weeks later, the project team organized Consensus Workshop in both villages and explained the contents and implementation plans of the six pilot projects in detail using flip charts and samples. In Hirgigo village, 19 fishermen and women including the administrator participated, and in Zula, 20 fishermen and women and the administrator participated. The moderator was the extension officer in charge of villages. Main points were as follows:

(1) **The Fishing Gears & Methods Team presented:** (PP1) Improvement of gillnet and its making capacity building, (PP2) Development of small-scale bottom-longline fishing, (PP3) Introducing small scale setnet fishing. And detailed explanation was given to (PP3) Introducing small scale set-net fishery to the villages.



Fig.4-2 Consensus workshop in Zula

(2) **The Fishing Community Development Team presented:** (PP4) Improvement of fresh fish

distribution, (PP5) Development of fishery products, (PP6) New market development. And detailed explanation was given to the installation of ice making and other equipment, fish handling, processing and preserving methods, and construction of working facility in the villages (Community Fishery Center, CFC).

(3) **The MMR Cooperative Division staff presented:** The staff gave a detailed explanation of the conditions, rules, and procedures for the formation of a Cooperative, which is required and serve as the organization to implement these pilot projects.

After presentations by MMR staff, discussion sessions were held (see Appendix 3. Report on Consensus Workshop in Zula and Hirgigo Villages).

Lessons learned

- Consensus building meetings with community authorities and members were important to obtain understanding and generate preparedness and ownership of the community which facilitated project implementation.

Recommendations

- An activity to be planned for a community should start from getting understandings of the community by organizing a meeting in the community.
- It is recommendable to hold this kind of meeting each time when the project activity enters into a new stage.
- It better to involve the traditional leaders who are respected by and influential to the community people and village administrators.

4.1.2 Formation of cooperatives

One week after the Consensus Workshop, a meeting for formation of fishery cooperative was held in each village. Fifteen (15) members were selected according to the MMR's cooperative membership eligibility criteria and they elected leaders such as, Manager, Secretary, Casher and two Committee Members. Then, each member registered as a member of cooperative using the form of MMR. After these documents are approved by the local government administrators, the cooperative will be recognized as an official organization by the MMR. The eligibility criteria of MMR for cooperative membership set priorities to families of female headed households and families with disabled members. In addition, the selection of the cooperative leaders was done by a majority vote of the members.



Fig.4-3 Hirgigo village: Administrator looked on as members selected their leaders by majority vote.



Fig.4-4 Zula village: Each member filled out and signed the registration form at the end.

Table 4-1: Formed cooperatives in Hirgigo and Zula villages

Item	Hirgigo village	Zula village
Cooperative Name	Dekhano Fishing and Fish Processing Cooperative	Kelij Zula Fishing and Fish Processing Cooperative
Address	Northern Red Sea zoba, Massawa sub-zoba, Hirgigo village	Northern Red Sea zoba, Foro sub-zoba, Zula village
Number of Members	15 (male 6, female 9)	15 (male 7, female 8)
Formation Date	16 December 2021	15 December 2021
Aim of the Cooperative	To fish, process and sell of fish at fair price to the community	To fish, process and sell of fish at fair price to the community
Leaders	・ Manager: Mahmud Musa Said ・ Secretary: Zahra Saleh Mahmud ・ Casher: Ahmed Saleh Abubeker	・ Manager: Ibrahim Omer Talte ・ Secretary: Saleh Mahmud Jabera ・ Casher: Asha Osman Hassen
Approved by	・ Hussen Kater Ahmed, Artisanal and Industrial Division, MMR ・ Haile Asfeh, S/zoba Administrator ・ Halima Osman, Hirgigo Administrator	・ Hussen Kater Ahmed, Artisanal and Industrial Division, MMR ・ Osman Arefa, S/zoba Administrator ・ Omer Abrhum Tsaeda, Zula Administrator
Note	Number of members can increase or decrease based on the by-law	Number of members can increase or decrease based on the by-law

Lessons learned

・ It was a good occasion for discussing the pilot projects in details and contribution from the community to the project.

・ Information of cooperative members was not collected enough since few members had participated in the baseline survey at the preparation period.

Recommendations

・ Before the formation of cooperative, the community should be with clear understanding about the objectives of the project and the policy of MMR for cooperative formation.

・ The cooperative will be the core organization to lead project activities and development of the community.

・ The baseline survey on “Fishers’ household survey” should be conducted again when the

members of new cooperative differ from the participants at the initial baseline survey.

4.2. Preparation of fish processing devices, manuals and workshops (PP5)

Fish processing devices for drying and smoking were prepared by the Team together with the Engineering Department, and selected the best one by testing them. Manuals for drying and smoking were also prepared and explained together at the training session of cooperative members. After the training of fish processing, the members demonstrated what they learned through cooking and tasting session.

4.2.1 Preparation of fish dryers and manuals through trials

The objectives of this activity were to (1) confirm processing methods for small-sized pelagic fish and sharks, (2) compare sun-dried products with and without salt, and (3) compare the performance of five types of dryers in order to determine the most suitable one for coastal fishing villages. Prior to this, the Team had conducted an interview survey in each fishing village on production methods of processed fish, and based on this, a manual for processing salted and dried fish was drafted. This manual was examined its practicality through the trials of dryers and elaborated.

Three types of fish were used; sardine, Indian mackerel and shark, and three types of sun-drying method were applied; sun-drying Indian mackerel after soaking in salt water for 5 minutes, sun-drying sardine and Indian mackerel as they were, and sun-drying shark fillet with salt sprinkled on them. Dryers used were (1) bed-style net type, (2) four-layer shelf net type, (3) plastic tent type, (4) hanging net type, and (5) oven type.

The results showed that the Indian mackerel products soaked in salt water had the best appearance and the best degree of drying. The most efficient dryer was the 4-layer shelf net type. Therefore, it was decided to install this dryer in villages of Hirgigo and Zula for the pilot project (see Appendix 4. Report on Driers Drying Efficiency of Small Pelagic Fishes and Shark).



Fig.4-5 Bed-style net type



Fig.4-6 Four-layer shelf net type



Fig.4-7 Hanging net type

4.2.2. Preparation of smoker and manual through trials

To produce smoked fish, the Team created a model of smoker (smoking kiln) using a small drum can

with two layers of wire mesh inside, and 5 kg of mullet was selected for smoking trial. Fish was filleted and soaked in red pepper powder (berbere), a popular spice in the country, and placed on wire mesh shelves in the smoker.

The first attempt, the heat was too strong and the surface of the fish was charred after about 30 minutes. Then later, the fish was smoked for about an hour and half or longer, carefully generating only thin smoke without flame. The result was a brightly colored smoked fish with an excellent taste. Some document also states to be smoked as “Keeping white and thin smoke for three hours.” The fuel wood used was a well-dried tree called "Mesquite tree" (local name, Temri Musa), which is an exotic species that thrives in coastal areas and is allowed to be cut down freely because of its aggressive propagating power and tendency to dry out the land. After the trials, two large smokers were created by the Engineering Department using normal size drum can, and distributed to Hirgigo and Zula cooperatives.

The fish smoking manual was developed by studying publications and elaborated through trials. In addition, a fish paste product, fish meet ball, was also developed by the Team as a marketable fishery product (see Appendix 5. Fish Smoking Manual).



Fig.4-8 A smoker made of a small drum can



Fig.4-9 Successfully smoked mullet at the second attempt



Fig.4-10 Full size drum can smoker

Lessons learned

- The fish dries and smoking kilns were made in different types to compare their efficiency and defined the best device for distributing to the community by the Team.
- It was possible to produce smoked products that looked and tasted good using only locally available materials.
- The first draft of manual was prepared upon the information from the community, and later, it was elaborated by the Team through the trial and adding scientific information. So that the second draft of the manual was appreciated by community.

Recommendations

- Any new equipment or technology should be studied and tested by MMR before distributing it to the community.
- MMR staff should be familiar with equipment how to use it and teach fish processing using it to the community people.
- To prepare a manual for a community, it should start from and based on the knowledge of the community.

4.3. Conducting fish processing trainings and workshops (PP5)

After developing the fish processing devices and manuals, the Team organized fish processing training in both villages for cooperative members to produce marketable fishery products. The members were provided with basic knowledge of fish processing (hygiene, quality control, etc.) and production of different fish products in two days training. A workshop was subsequently held for cooperative members to demonstrate acquired skills to produce fishery products and prepare dishes using the products. In total, the training and workshop session took for 5 days in each community. It was conducted in Zula in November 2022, and in Hirgigo in February 2023 (see Appendix 6. Tentative Timetable of Fish Processing Training and Demonstration in Hirgigo and Zula; Appendix 7. Report of the training on fish processing and preservation; drying and smoking techniques in Zula; Appendix 8. Fish processing and cooking demonstration in Zula and Hirgigo; Appendix 9. Type of food and method of preparation (Fish recipes)).



Fig.4-11 Zula village, lecture on hygiene and quality control



Fig.4-12 Hirgigo village, practice using a salt-drying rack and a smoking kiln



Fig.4-13 Zula Village, prototype fried and smoked

Lessons Learned

- Training was prepared for cooperative members to update their knowledge and skills in fish processing, and following workshop helped members to be confident with their products.
- These programs were well accepted by the cooperative members.
- Demonstration in the workshop gave confidence to cooperatives by not only making fish product, but also cooking using the products.

Recommendations

- Training should be given to the community to increase their awareness and to build their confidence in their products to be marketable.
- Processing the fish meet ball should also be introduced to cooperatives

4.4. Selection and procurement of equipment for the pilot project (PP4, PP5)

The required equipment to be procured for the pilot project was discussed. A highly demanded equipment identified by the baseline survey was to make ice for the cold-chain functional. It is essential for expanding the distribution of quality fresh fish. For this reason, a solar-powered ice block making machine for Zula village (300kg (60pcs) of ice per day) and a solar-powered freezer (380kg

(200pcs) of ice per day or two) for Hirgigo village were selected. Different ice making equipment was selected to examine the suitability of two different equipment in hot environmental conditions. Apart from that, solar-powered freezers for fish freezing and storing (410liter capacity), meet-bone separators for fish processing, vacuum packers and hand mincers were added to the list. The specifications and installation sites of these equipment are shown in the table below.

For the ice block making machine in Zula, it was originally operated by 380V in 3 phase power. Therefore, a request was made to the manufacturer to design a solar power system to produce ice appropriately in the climate condition of Zula where is not covered by the electrical supply grid. In addition, the solar-powered ice making machine and freezers were specified as the tropical type (43℃), the highest category of operational ambient temperature. Some small equipment such as kitchen utensils and other daily necessities were to be procured locally. Total cost for procurement of equipment was provided to MMR for a reference.

Table 4-2 List of major equipment procured in abroad

s/n	Item	Specification	Qty.	Unit	Distributed
1	Solar Ice Block Machine	OMT Co. Model DOTB10, Capacity 1,000kg/24hrs, 1 batch/3hrs/30 blocks, Ice block size 100x95x500mm(4.4kg), Refrigerant HFC(R404a), Ambient temp. max.43°C, Total power 5.2KW, Electricity connection 380V/50Hz/3P. Tropical type, Air cooling, Size L;1800 x W;1100 x H;1200mm,	1	pc	Zula: 1 set
	Solar Power System	Model: OMT, 3 Phase inverter 30KW, Controller MPPT 100A, Solar panel 275W x 32 sheet, Battery 12Vx150Ax16pc,	1	set	
2	Solar Chest Freezer	FREECOLD Co.Ltd., Model PCSI 410L, Type SN-T (10°C - 43°C), Refrigerator/Freezer, 800W/h, 180W-24V, Size 88x156x71cm, 57kg	4	pc	Zula: 1 set, Hirgigo: 3 sets (2 for Ice machine, 1 for freezer)
	Soler Power System	MPPT Controller, Solar panel 2x330Wp, Battery; 2x210Ah AGM,	4	set	
3	Fish Meet-Bone Separator	Luohe Quality Mechanical Equipment Co., Model QT-A11, Capacity 180kg/h, Power 220V-2.2kw, Size 800 x 550 x 800mm, Weight 180kg,	2	pc	MMR: 1 pc Hirgigo: 1 pc
4	Vacuum Sealer	Model Vacuum packed premium, Power AC 100V, Power use 130W, Size 40x19.4x11cm, Weigh 2.8kg,	2	pc	MMR: 1 set Hirgigo: 1 set
	Power Transformer	Model PAL-350E, AC220V-AC100V, 350VA, 3.7kg	2	pc	
5	Cooking Scale	TANITA, 2kg KW-001 WH, Weight 2kg, Waterproof	3	pc	MMR: 1 pc Zula: 1 pc Hirgigo: 1 pc
6	Hand Mincer	Model MT-32, Size 320x160x205mm, Weight 8kg, Plate 4.5mm, Stainless Steel & wood	2	pc	Zula: 1 pc Hirgigo: 1 pc
7	Cooler Box	Coleman USA, Model Polylight 48QT, Capacity 45 L, Ice retention 3 days, Size 63x33x39.5cm, Weight 4.1kg	20	pc	MMR: 2 pc Zula: 9 pc Hirgigo: 9 pc
8	Plastic Container for Ice Making	Plastic container with lid, Size; 1900ml	200	pc	Hirgigo: 200 pc
9	Stainless Tray	Stainless Steel, Model T-QB-4, Capacity 11L, Size 476x332x82mm	50	pc	MMR: 10 pc Zula: 20 pc Hirgigo: 20 pc
10	Ice Pick	Pilot ice pick single, L=240mm	6	pc	Zula: 3 pc Hirgigo: 3 pc
		Pilot ice pick single, L=135mm	4	pc	Zula: 2 pc Hirgigo: 2 pc

4.5. Establishing Community Fishery Center (CFC) in Zula and Hirgigo (PP4, PP5)

During the discussion on pilot project formulation, a facility to install equipment mentioned above in Hirgigo and Zula was requested. It also serves as a place for project activities such as, producing ice, processing and selling fish products, preparing for distribution and meeting of cooperative members. It is called as Community Fishery Center (CFC), a Hub of the fishing community, a place to foster the vitality or Driving Force to nurture and advance the fishing community development. This idea was presented and discussed at the Consensus Workshop in December 2021, and village administrators agreed to reserve a facility or site for CFC. Since then, both communities were looking for a facility applicable for CFC as a priority.

4.5.1. Developing the design of CFC

Both villages prepared solution for CFC to be built in their community. After confirmation received from the village administrators, the design of CFC was prepared.

(1) Zula CFC (Type 1)

First, the village of Zula offered the building of abandoned Arabic elementary school. The building belonged to the village was 5m x 15m in floor area, long from north to south, with concrete block walls and a tinplate roof, and was divided into three rooms by block walls. The distance to the village water tower, the source of water, was 120 meters, and there was an open space around the building where 32 solar panels to be installed for the ice machine. It was hoped that by replacing the partially torn roofing tinplate, repairing and creating windows and doors, and pouring concrete on floors, the facility would be fully usable as CFC. When the fishers offered to provide labor for the repairs, it seemed possible to renovate the building into a CFC by procuring materials and hiring a few additional technicians for special works.

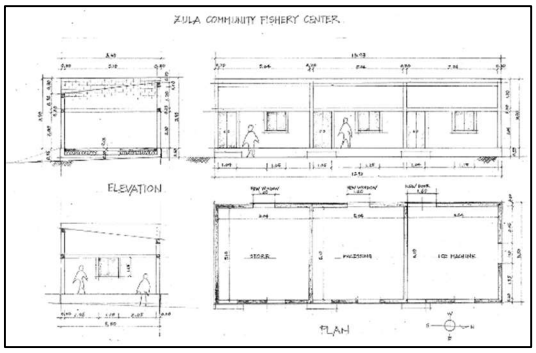


Fig.4-14 Zula CFC, renovation of former Arabic school

(2) Hirgigo CFC (Type 2)

There was not any existing building to be used for CFC in Hirgigo village. So, the village administrator and the leader of the cooperative proposed an idea of building a new house with concrete and blocks. But its construction cost seemed to be far beyond the reach of the planned CFC budget. So, the project team proposed a container CFC. That was to install cargo containers on a vacant plot of village's land near the water supply point in the center of the village. The project team visited a new office of EriFish in Massawa to see two-story building assembled with 10 containers as a reference, and received some

advice from the manager of EriFish. Based on this, the design with installing two 20-foot containers in parallel and a 3-meter space in-between covering with a tinplate roof was proposed. Since the CFC was a new construction, it was also required to apply to the Massawa Sub-zone administration for a permit to occupy the land for CFC construction, so the Team requested the village administrator to take necessary actions.

Then, the original design of CFC was changed later to a single container with eaves based on the following reasons; the ice making method in Hirgigo was different from Zula and did not require the similar floor space as Zula, and the one container CFC could still function as the original design even with a reduced floor space. In addition, the project was also facing the threat of significant construction cost overruns and significant delays in the process at this point. Therefore, it was decided to change the structure of CFC from two containers with a space in between (floor area 46 m^2) to one container with concrete floor in front of it with eaves on it (floor area 29 m^2). This was also preferred by MMR as a simpler and less expensive structure for possible future regional expansion of CFC.

Once the structure was finalized, a detailed design and estimation of the required materials were made with the MMR civil engineer. As a result, it was assumed that the total cost of two CFC construction would almost fit within the originally planned budget of $20,000.

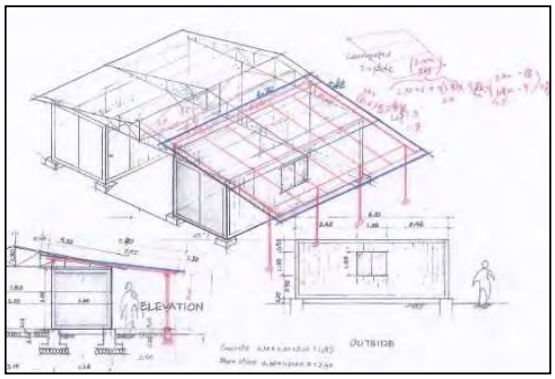


Fig.4-15 Hirgigo CFC, design changed to one container house

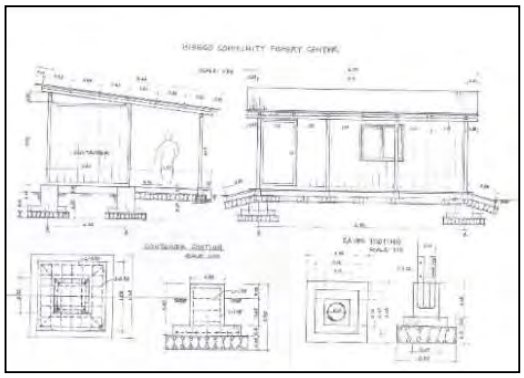


Fig.4-16 Hirgigo CFC, detailed view of final design

Lessons learned

- The budget was indicated at the planning stage, so the designing of CFC was done by adapting and limiting to the local conditions and the budget.
- All materials required were identified and the available resource in the community also surveyed.
- It was good to have voluntary contribution from the community to the construction of CFC.

Recommendations

- Before constructing the CFC, the resources and characteristics of the community should be studies.
- Proper designing and cost estimation should be done with mobilizing local resources as much as possible. Particularly, any contributions from the community are welcome which are

signals of community participation and ownership.

4.5.2. Procurement of construction materials for CFC.

Of the construction materials, major items were planned to be procured domestically through the government corporation. Nevertheless, MMR proposed to procure the materials directly from overseas (UAE, Dubai) due to the complicated governmental procedures, unpredictable duration, and high unit costs for domestic procurement. So, it was decided to procure from overseas through MMR's Procurement Division, but it was stagnant for about two months. In the end, it went back to the domestic procurement, and once this got underway, it was done more quickly than expected.

The governmental procurement agent was Red Sea Cooperation (RSC), and the main materials procured were rebar, L-shaped steel, square timber, roofing tinplate, and water pipe materials, which were priced considerably lower than the market price. After this, cement was procured from the governmental factory, Ghedem Cement Factory, which was also quite inexpensive at 10-20% of the market price, and of good quality. Other small construction materials were procured directly from private building material stores in Massawa and Asmara.

The Engineering Division had already built several prototypes of fish drying racks and smoking kilns. Therefore, the windows, doors, water tower, and container modification for the CFC were also to be made and installed by the department using procured materials by the project. However, the Team was also concerned about delays in some of the work experienced previously, and decided to order a private wood workshop in Massawa for the production of windows (5 pcs) and doors (3 pcs) to be installed in the CFC by providing the materials. The crafted products were installed on the CFC by the Engineering Division staff and on-site workers who were hired by the project (see Appendix 10. Construction Material List of CFC (Hirgigo + Zula)).

Lessons learned

- Procurement through the government was cheaper but took time, and the availability of the materials were limited. Simple/small materials were procured from private shops.

Recommendations

- The material list for procurement should be prepared earlier before starting the construction, because the government’s procurement requires many procedures and time.

4.5.3. Construction of CFC

The construction of CFC was planned to hire a foreman and several workers, procure and provide all construction materials by the project, and implement under the supervision of the MMR civil engineer and the Team. By the end of August 2022, all construction materials were delivered to the site and procurement was completed. Then, the construction of CFC had been started at Hirgigo, whereas the Zula CFC was completed earlier and the installation and commissioning of equipment as well.

(1) Construction of Zula CFC (Type 1)

The construction of Zula CFC took the form of renovating the unused school building. Construction began in September, and the following works were undertaken: (1) replacing and painting the tinplate roof; (2) reinforcing the floor (reinforced concrete) of the machine room, which houses the ice machine; leveling the floor of fish processing room and storage room with mortar; (3) adding three windows, replacing one door and expanding one door; (4) installing drain pipes and sewage treatment tank; (5) installing water tower and water tank; and (6) laying 120 meter of water pipe to connect with the village water main. Of these, (1) through (4) were done by field workers, (5) by the MMR Engineering staff and the Team and (6) by field workers with excavation done by the volunteer work of cooperative members.

Subsequently, for the installation of the solar-powered ice machine (1 unit) and the solar-powered freezer (1 unit), the following works were undertaken: (7) installing 32 solar panels (for ice machine) + 2 solar panels (for freezer) and protective fencing, (8) installing batteries (16 + 2) and controller and wiring, (9) installing ice machine and freezer, (10) installing and piping of cooling tower for ice machine, etc. Of these, the foundation work for (7) and (10) were done by field workers, while all other work was done by MMR Engineering staff and the Team. All construction was completed in November 2022 (see Appendix 11. Schedule for Zula CFC Construction).



Fig.4-17 Pouring reinforced concrete into ice machine room



Fig. 4-18 Renovating windows and doors



Fig.4-19 Roof replaced and painted, new 3 windows installed in the back

(2) Construction of Hirgigo CFC (Type 2)

The construction of Hirgigo CFC was began in August, immediately after concrete materials were procured and delivered. Then, following steps were taken: (1) building concrete foundations for the container, (2) paving floor with concrete in front of the container, (3) modification, transportation and installation of the container, (4) installing and painting of the roof and eaves of the container, (5) installing the water tank with foundation, (6) laying 20 meter of water pipe and connecting to the village water pipe, etc., and completed in late December. During the works between (1) and (2) above, the Zula CFC construction was preceded since a curing period of foundation concrete and the procurement of the container itself which was also delayed.

Accordingly, for the installation of solar freezers (3 units), the following works were undertaken: (7) installation of 6 solar panels and protective fencing, (8) installation and wiring of 6 batteries and controllers, (9) placement of freezers and water supply piping, etc. Of the above items, (1) through (5) were mainly performed by field workers in the site, while the excavation work in item (6) was performed by cooperative members as volunteer work, and the rest was all performed by the MMR Engineering staff and the Team. The construction was completed in December 2022 (see Appendix 12. Schedule for Hirgigo CFC Construction).



Fig.4-20 Concrete foundations for container



Fig.4-21 Installation of modified container by MMR Engineering staff



Fig.4-22 Front view of CFC

Lessons learned

- Zula is far from the city of Massawa, and it was difficult to get field workers from Massawa to work in Zula.
- The field worker was sometime doing sloppy job and careless works.
- Supervising the construction work was very important. The Team was supervising periodically, but when it was difficult to supervise an important process, it was sometimes done by requesting the field worker to take photos to record the works.
- According to the plan, as of the second JCC meeting (December 2021), the CFC construction was to be completed in April 2022, and fresh fish and processed fish products were to be sold during the high fishing season from mid-October onward. However, this didn't go as planned. Zula CFC construction was completed in November and Hirgigo CFC in December 2022.
- The construction schedule had been changed many times due to the fact that MMR's Engineering staff and the Team were dealing with many new challenges that they had not experienced before.

Recommendations

- Selection of contractors/workers requires more attention on their technical quality and working moral which should be an adequate level to complete required works.
- A construction plan should be thoroughly discussed and scheduled at most inclusive ways possible, and it should also be flexible adjusting to any unpredictable happenings.

4.5.4. Installation and commissioning of CFC equipment

(1) Zula CFC (Type 1)

Installation of the solar ice machine in Zula was planned to be done by local electric technician and commissioned by a technician from the manufacture in China, however, the manufacturer ignored sending the technician. It was also revealed that some accessories and small materials were missing for ice machine, freezers, and their solar systems. Having those problems, MMR decided that

installation and commissioning of the ice machine, freezer and their solar systems were to be done by the Engineering Department staff. They installed equipment according to the instruction manual provided by manufacturers. The missing materials were procured in Massawa and Asmara and some accessories were crafted in the MMR workshop.



Fig.4-23 Installed Solar Freezer in Zula CFC



Fig.4-24 Installation of solar panels and protective fences



Fig.4-25 Trial run of ice machine, 30 ice blocks produced

After installation and commissioning was completed in December 2022, the Engineering Department staff provided one week training to technicians selected by the cooperative who are responsible for operation and maintenance of equipment.

(2) Hirgigo CFC (Type 2)

After completion of Zula, three freezers in Hirgigo CFC were installed with solar systems in the CFC in December 2022. Then, MMR engineer planned to commission equipment in March 2023, however, three freezers were not working properly and unable to produce ice. At the time of drafting the report, the consultation with the manufacturer in France is going on through the procurement agent in Tokyo.



Fig.4-26 Solar system installed within the fence



Fig.4-27 Three freezers installed in Hirgigo CFC



Fig.4-28 Preparation for ice, commissioning freezers

4.5.5. Comparison of two CFCs

The two CFCs in the villages of Zula and Hirgigo were of different types/designs for the pilot. Upon completion of construction, the differences between the two types of CFCs were compared. First, the construction and equipment procurement costs for both CFCs were as shown in the table below.

Table 4-3 Cost of CFC Construction and Equipment ($1.0=¥130)

Item	Zula CFC	Hirgigo CFC	Sum
Construction, Local Cost	10,214.93	11,792.00	22,006.93
Equipment (FOB)	34,250.38	13,417.23	47,667.62
Shipping Cost	18,647.90	7,305.12	25,953.02
Total ($)	**63,113.22**	**32,514.35**	**95,627.57**

(1) Zula CFC (Type 1), floor area 77m^2

- CFC renovated from old school building, mainly roof, floor, windows, doors, plumbing and drainage, etc. renovated and newly constructed.
- Construction cost per unit floor area (locally procured): $133/m^2 ($10,214.93/77m^2)
- A building was provided by the village that was considered optimal for the CFC in terms of size and location.
- It is relatively close to the water supply point at 120m.
- There are three independent rooms, divided into an ice machine room, a fish processing working room, and a warehouse.
- It could be used for training and lodging.

(2) Hirgigo CFC (Type 2), floor area 29m^2

- CFC converted from container; windows and doors mounted on container, outdoor workshop under eaves.
- Construction cost per unit floor area (locally procured): $407/m^2 ($11792.00÷29m^2)
- New construction allowed flexibility in site selection.
- Located in the center of the community, close to the water supply point at 20 m.
- Inside the container house are for 3 freezers and a warehouse. Fish processing working are on concrete floors under the eaves.
- The site can be modified relatively freely in the future, for example, by adding more eaves.
- During the daytime in extremely hot weather, indoor temperatures can be quite high if container windows and doors are kept closed.

The above is mainly a comparison of CFC buildings and installation conditions, and the equipment installed in the CFC should be verified and evaluated after a certain period of time. In particular, both CFCs have solar-powered ice machines, and there is no significant difference in the amount of ice produced, but there is a difference in the method of ice production: Zula CFC has an ice block maker and Hirgigo CFC has an ice freezer. As for other pieces of equipment, both CFCs have the same items and the same quantities, but the Hirgigo CFC has a fish meat-bone separator (installed at the Hirgigo Training Center).

Lessons learned

- The commissioning of equipment had been done by the MMR engineering staff because the manufacture cancelled the dispatch of their technician. This should be avoided.
- Installing new type of equipment could be a good chance for MMR staff to learn, but it was very difficult to work on schedule agreed with the responsible staff.
- After delivery of equipment to the site, it revealed that many small materials and accessories were missing in the freight package. It seemed there were problems in procurement and shipping process.
- Because of COVID-19 pandemic, the delivery of equipment delayed and shipping costs were exceptionally high.

Recommendations

- Before making an order of procurement with manufacturers, materials specifications including all accessories and responsibilities of commissioning by dispatching their technicians should be clearly identified and stated on the contract.
- For MMR staff, these experiences provided a good opportunity to accumulate know-how to promote CFC to other fishing communities.

4.5.6. Holding CFC information meetings and workshop

Information meetings and workshops were organized sometime when the project progressed to a new stage. The CFC design and implementation plan were explained by the Team and MMR's civil engineer in March 2022, and construction of CFC started after discussing necessary preparation by the cooperatives. Also, taking these opportunities, the issues of absent cooperative members in the events were discussed and cooperatives decided to replace them by revising the bylaws of cooperatives through the Cooperative Division of MMR. In this way, the organizational capacity of the cooperatives was consolidated and elevated toward the completion of CFC.

In October 2022, nearing to an end of equipment installation in CFC, the Team called a meeting with cooperatives members for preparations of the CFC operation, which included:

(1) Appointment of technicians to manage the operation of the solar ice making and other equipment,
(2) Establishment of rules and price for the sale of ice, fresh fish and processed products,
(3) Start recording activities in diaries and accounting book,
(4) Establishment of a managemental and operational structure for CFC, and
(5) Implementation of periodical monitoring with an extension officer.

When the commissioning and training of technicians had completed, the commencement workshop was organized and confirmed with the cooperatives the preparation for the subjects mentioned above.

4.6. Summary of pilot projects activities

4.6.1. Pilot project for improvement of fresh fish distribution (PP4)

(1) Fresh fish distribution by Zula cooperative

After completing the training on the ice machine and other equipment in CFC, the Zula cooperative

started to produce ice and distribute fresh fish to Foro and Afta (neighboring village). The cooperative agreed with fishers in Zula to give them ice and rent cooler boxes for fishing. They also agreed with fishers to take one quarter of the proceed of fresh fish sales. At the first attempt on 24 March 2023, the total catch was 73.5 kg of which 59.5 kg was sold at a price of 40 ERN/kg generating a rough profit of 2010ERN. Detailed information was given in the Annex attached. The cooperative will continue this arrangement with fishers in Zula for fish distributions until the cooperative would receive a boat and fishing gears from MMR's NRS branch office. MMR tentatively decided the ice selling price to be 5 ERN/5kg/pc. As of April, the Cooperative Division is working on a business plan with FAO expert to determine the price of ice (see Appendix 13. Fresh Fish Sales Record: Kelij Zula Fishing & Fish Processing Cooperative, 24/03/2023); Appendix 14. Introduction for Business Plan Equation (Zula Business Plan).



Fig.4-29 Harvested fish in Zula



Fig.4-30 Distribution to Foro in cooler box with ice

Lessons learned

- The production of ice was a great opportunity to the community but they still have transportation problem from the sea shore to the village and to Foro.
- The Cooperative Division is calculating a possible ice selling price for Zula cooperative based on the business plan of CFC, which was a part of cooperation by FAO expert.

Recommendations

- Means of transportation should be arranged by the cooperative to transport their fish from the sea to the market place in Foro.
- Ice selling price should be discussed among stakeholders and finalized in order for the cooperative to maintain CFC facilities and sustain their businesses.

(2) Fresh fish distribution by Hirgigo cooperative

The distribution of fresh fish from Hirgigo was delayed because the problem of the ice making freezers have not work properly to produce ice. As soon as the problems would be resolved and ice produced, the Hirgigo cooperative will start to distribute fresh fish to the Massawa Sigalet open market, not to Edaga open market which has been closed by the Massawa administration, and to Markato market in Asmara through NFC.

Lessons learned

- This project was not completed in the project period due to the delay of CFC construction and

problem of freezers which were not commissioned successfully.

Recommendations

- Implementation schedule should be flexible and adjustable to any unpredictable happenings as much as possible.
- The Team planned to prepare some pamphlets of small fish recipes to distribute when the Hirgigo fish sales will start at Markato in Asmara.

4.6.2. Pilot project for development of fishery products (PP5)

The project aimed to develop marketable fish products by the cooperative members, particularly women, in the villages. The Team collected traditional methods of fish processing and preservation in the target villages, and based on this, fish drying manual was drafted. Fish processing devices such as fish dryer and fish smoker were also crafted and tested by together with the Engineering Department staff and the Team. Then, the training on fish processing was conducted for cooperatives which followed by the practical workshop to demonstrate what they learned by preparing cuisine using the fish products.



Fig.4-31 Traditional cuisine, deep-fried fish



Fig.4-32 Smoked fish, new product for villagers



Fig.4-33 Tasting fish cuisine in workshop

4.6.3. Pilot project for new market development (PP6)

This pilot project was to promote consumption of small size fish in Massawa and Asmara by holding cooking and tasting events for small fresh fish and their processed products. Because it had been planned to be implemented according to the progress of PP4 in Hirgigo which encountered the equipment problem in March 2023, this project was not completed during the project period.

Chapter 5. Conclusion

The FSPAC project was initiated with the aim of formulating the technical guidelines to undertake MMR's Strategic Plan (2018-2023) priorities for coastal fishery development, which were to increase the fish harvest and improve the livelihood of communities. The pilot project activities of fishing community development, targeting to improve the livelihood of communities, summarized here were performed by different divisions of MMR under the leadership of the Fishing Community Development PIU, which included the understanding of problems and issues, identification of constraints and challenges, formulation of pilot projects, cooperative formation and capacity building, construction of CFC, implementation and evaluation of pilot project activities.

Since this was a pilot, some activities have been carried out in pioneering manner to explore new possibilities, and looked for better solutions for fishing community development. On the other hand, the PIU team was sometime encountering unimaginable challenges to implement activities on schedule. As a result, some activities haven't been completed in the project period as of the end of March 2023. Nevertheless, the process of development steps and result of activities were scrutinized and evaluated, and the lessons learned and recommendations were extracted to lead the development of the technical guidelines for the fishing community development in Eritrea.

APPENDICES

Appendix 1: Questionnaire of Baseline Survey

Interview sheet (1): Situation of the fishing village

Interviewer name:_____ Date:_____

Community overview (1-1)

Items	Answer
Name of the community	Village: Sub-region:
Population	Approximately
Number of households	households
Main occupation / income source	
P/A* of fish market	
P/A of schools	
P/A of health facility	

(* P/A: Presence or Absence)

Outline of fishery (1-2)

Items	Answer
Number of fishermen by fishery class	Artisanal fishery: Foot fishery:
Fishing method / number of fishing boat	1. Gill net (Number of boats:) 2. Handline (Number of boats:) 3. (Number of boats:)
Main fishing ground and season	1. 2. 3.
fishery related infrastructure	
Landing site / facility status / sanitary status	
P/A of processing facility / quality	
P/A of traditional management practice	
Number of violators / content of violations	
Rights & duties to fishing operations	

Appendix 1: Questionnaire of Baseline Survey

Interview sheet (2): Situation of the Fisheries Association/Cooperative

Interviewer name:_____ Date:_____

Overview of the cooperative (2-1)

Items	Answer
Name of the cooperative	Name: Area:
Name of interviewee	
Name of representative	
Number of cooperative members	
Number of fishing boats by type/ active fishing boats	1. ( ) 2. ( ) 3. ( )
Number of fishing boats by fishing method	1. 2. 3. 4.
Role / activity of cooperative	
cooperative income / expenditure	Income: (Source:) Expenditure: (Items:)
P/A* to get loan (in-kind)	

(* P/A: Presence or Absence)

Appendix 1: Questionnaire of Baseline Survey

Implementation status of the fisheries development activities (2-2)

Items	Answer
Implementation items	
Implementing structure of the government, associations and community	
P/A of support/extension activities by governmental agencies / its contents	
P/A of supports by technical & financial partners	
Progress, and expected achievements	

Problems and needs (2-4)

Items	Answer
P/A of potential resources	
Problems & needs of fishing gear and method	
Problems & needs of distribution and sales (marketing)	
Problems & needs of fish processing	
Other problems & needs	

Appendix 1: Questionnaire of Baseline Survey

Interview sheet (3): States of individual fisher / household in community

Interviewer name:_____ Date:_____

Name of village or town	
Name of interviewee	Mr./Ms.

Fishery states (3-1)

Items	Answer
Category	Artisanal fisher / Canoe fisher / Foot fisher
Operated fishing type by season	
Target fish species	
Main fishing ground	
Type of fishing boats / number of crews	
Annual fishery income	Average income per trips/operations: Number of trips/operations per year:
Operating costs	Item 1: Item 2: Item 3: Item 4:

The situation of fishery household (3-2)

Items	Answer
Household size (Number of the family member)	Male: Female: Youth (18~40): Underage (0~17):
Household monthly income by income sources	1. 2. 3.
Household monthly expenditure	
Problems and issues in the household finances	

Job or employment opportunities	
Frequency of eating fish / species / cooking method	
Roles of women in household	
Future ambition for job opportunity of youths	
Customs and culture related to fishery and seafood eating	

Problems and needs (3-3)

Items	Answer
P/A* of potential resources	
Problems & needs of fishing gear and method	
Problems & needs of distribution and sales (marketing)	
Problems & needs of fish processing	
Potential of women and youth	

(* P/A: Presence or Absence)

Appendix 1: Questionnaire of Baseline Survey

No. _____

Interview sheet: Fish Marketing (fish seller)

Interviewer name:_____Date:_____/ 03 /2020_

	Question	Answer
1	Name of place interviewed	in Asmara
2	Name of interviewee (seller)	Tel: 07-
3	Fish you brought to the market today	Species total weight (kg) 1. 2. 3. 4.
4	Where did fishes4 come from? (origin)	
5	How did you bring your fish here (transport method) ?	
6	How often are you selling the fish, and selling hours?	
7	What is the most popular fish?	
8	What are the problems/straggle in marketing the fish?	
9	Any idea/opinion to improve fish marketing?	

Appendix 1: Questionnaire of Baseline Survey

No._____

Interview sheet: Household fish consumption

Interviewer name:_____Date:_____/ 03 /2020_

Name of place interviewed			in Mendefera
Name of interviewee		Tel: 07-	
Fish purchased today	Species:	kg	Price: Nakfa

The situation of household

	Question	Answer	
1	Household size (number of the family member)	Male: Female:	Youth (18~40): Underage (0~17):
2	Household income & sources	(nakfa/mo.) 2.	1. 3.
3	Main items of household expenditure	1. 2.	 3.
4	Who are the main cooking persons in household?		
5	How often you eat fish at home, and what species?		
6	What are your fish cooking methods/ name of cuisines/name of species?		
7	Do you process fish before cooking/eating (i.e. Sun dry, salt dry, smoke, etc)?		
8	How often you eat fish cuisine at restaurant per week/month?		
9	Are you satisfied with quantity of fish supply in the town?		
10	Are you satisfied with quality of fish in the market?		
11	Are you satisfied with the fish prices?		
12	Is there any customs or culture related to seafood eating?		
13	Any idea/opinion to improve fish consumption/marketing?		

REPORT OF BASELINE SURVEY AND MANUAL OF FISH PROCESSING AND PRESEVATION IN HIRGIGO AND ZULA

Prepared by; marketing group

Dec 2020

Base line survey of household fish processing and preservation methods were done in villages around the coastal areas of Massawa; Hirgigo and Zula. Total 20 interviewee, 10 in each village were interviewed in the way of processing, preservation such as salt drying, sun drying and salt sundry for the purpose of manual drafting on fish preservation and processing.

The cuisine and spices and also drying methods from the interview are used for the preparation of seafood processing and preservation manual.

Manual of preserving small size fishes with salting and sundry

Fish represents a valuable source of protein and nutrients in the diet of many people and its importance in contributing to food security is rising significantly. Retaining the nutritional value of fish, preserving the benefits of its rich composition and avoiding costly and debilitating effect of fish-borne illnesses are important. Preservation in general is a process of keeping something in its original state or in good condition and preventing the growth of bacteria, fungi of other microorganisms as well as slowing the oxidation of fats that cause rancidity. Preservation of fish can be done in different ways like salting, sun drying, smoking, frying and others. Those preservation mechanisms remove the moisture content of the fish and inhibit microbial growth. Fish that undergo those preservation methods can last up to six months in dry form without spoilage.

In many parts of the world, especially African countries, there is no access to refrigeration or ice. In the absence of cold storage, placing a stress on the physical, chemical and biological processes that lead to spoilage can slow deterioration of freshly caught fish. By reducing the moisture content of the fish through drying could ensure in a stable source of protein that can be transported to communities with limited access to fresh fish. Drying of fish has been practiced by many societies for centuries and it’s well known around coastal areas of Eritrea.

As fish is in nature one of the fast spoiling foods, to prevent this main problem the preservation processes is important. Depending on the information gathered from base line survey of house hold fish processing done on Zula and Hirgigo coastal villages, sundry and salting are the common mechanism of fish preservation. Those methods of fish preservation are done using locally available materials and can last from two to six months. Those processed fishery products are kept at normal condition without additional preservation technology.

2. Objectives:

- ✓ To improve quality of fish for better shelf life.
- ✓ To improve the view of the community to wards fish as source of income and nutritional diet.
- ✓ To preserve fish as a source of nutritional food.

3. Processing steps

1. Zula: In Zula salting and sundry are the common methods of fish preservation. This preservation process is applicable for shark and mullet species. To preserve shark and Mullet flesh for source of food the following steps are required;

Fillet the fish by removing the head, fins, and the gut.

↓

Wash the filleted flesh of the fish to remove the blood on it

↓

Slice the washed fish flesh

↓

Put it on inclined mat for water removal and drain it well

↓

Put salt on the fish (1Kg of salt powder for 10 Kg of fish)

↓

Pack it in air tide wooden box

↓

Dry it for three to five days

↓

Pack it in clean container





Hirgigo village fish processing and preservation interview 12th March 2020.

2. Hirgigo: in Hirgigo the preservation process is done mainly on baqa, shark, mullet, Spanish mackerel, jack fish, and sea cucumber with the same technique as Zula's system.

Fillet the fish by removing the head, fins, and the gut
↓
Wash the filleted flesh to remove the blood on it
↓
Slice the washed fish flesh
↓
Put salt on the fish (1 spoon of salt powder for 200g of fish)
↓
Cover it with mosquito net or some plastic cover to protect dust
↓
Dry it for two to four days
↓
Pack it in clean container

Wrap-up discussion




Wrap-up discussion of the fish processing and marketing team.

Discussion points

2 drier one based on the design from Mr. Tsurusaki and the other from the team members, one smoke kneel, drafting and reporting of the manual, demonstration of the manual on the target, where the key points discussed during the Wrap-up meeting on March 2020.

After that the dryer were made and it was planned to demonstrate the fish processing and preservation manual on March, 20 in Hirgigo and March 20 in Zula villages, but due to the prevalence of Covid-19 the plan have been terminated.

5. Expected results

As preservation process is applicable in preventing the fish from spoilage and keep it fresh in dried form for prolonged time, we expect these salting and sundry preservation techniques to benefit those coastal area communities to use the natural resources with easy domestic techniques for long time without any worries or claim on food spoilage and nutritional

reduction. In addition these preservation techniques can help the villagers to increase their income by selling the preserved fishery product to highlands and other communities.

Appendix 3

MINISTRY OF MARINE RESOURCES

The Project for Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC)

Report on Consensus Workshop in

Zula and Hirgigo Villages

Prepared by;

Yohana Negassi

Solomon Berhane

10th, Dec 2021

Massawa-Eritrea

1. INTRODUCTION

Based on constrains and problems identified from the Base Line survey, six pilot projects have been launched as mitigation measures. Consensus workshop was held in Hirgigo and Zula villages on 7th and 8th December 2021 respectively to discuss about the overall outline of FSPAC project, pilot projects and structural organization of new cooperative.

2. Objective

The overall objective of the workshop was briefings on the project outline and explanation about structural organization of cooperative.

2.1 Specific objective

- Enlightenment of the purpose of project, pilot projects and future project plan.
- Discussion with the community about construction of community fisheries center (CFC).
- Discussion on the structural organization of cooperative.
- Setting the next meeting.

3. Methodology

3.1. Materials used

The materials used during the workshop are flip chart, marker, and photos, dry and powder fish samples.

3.2. Method

The workshop involved explanation of pilot projects via photos and drawing of the set net design on flip chart, followed by plenary open discussion of the village people. Also translation of speech with local language for better understanding with the villagers was engaged.

Summary of the Workshop

First, welcome speech was given by village administrators Ms. Halima Osman in Hirgigo and Mr. Omer Abrhum in Zula; both expressed their appreciation for the launching of project in their villages and elucidated their heartfelt readiness on behalf of the village people.

Then, introduction about purpose of the project, aim of the workshop was given by Mr. Tsurusaki Tsuneo, JICA study team. He quoted the Latin word 'Genius Loci' (meaning local genius) to elaborate the need of the local people to formulate the local specific strategic approach. He also mentioned the harmony of the people of Eritrea during the struggle for independence as an example of Genius Loci to appreciate the value and willingness of village people for the success of the project.

Next presentation was given by Mr. Mulugeta Mahdere fishing gear C/P, team leader, on three pilot projects (PP1, PP2 and PP3). The pilot project activities include; I) PP1 for improvement of gill net and its making capacity building II) PP2 for development of small scale bottom-long line fishing for the purpose of operating the whole year and III) PP3 for introducing small scale set net. He gave good description on the design and operation of small scale set net and addressed the deploy of the net with in the coming 10 days in Hirgigo, later on after trial in Zula, due to the short stay period of expert. Moreover, Mr. Mulugeta noted that the need of about four to five fishermen to operate the set net and overall responsibility and data collection during the trial will be given to the fishermen. Additionally, training on assembling and net making will be given to fishermen after the evaluation of trial.

After that, the remaining three pilot projects to improve the livelihoods of fishing communities by increasing the distribution and consumption of small fishes were explained by Mr. Solomon Berhane

community development C/P, team leader. The PP activities are as follows; I) PP4 for the Improvement of Fresh Fish Distribution; solar freezers with meat and bone separator machines will be installed in Hirgigo and solar Ice making machine, mincer and solar freezer in Zula, II) PP5 for the Development of Processed Fishery Products; training on fish handling, processing and preservation such as sun drying, salt drying and smoking will be given and III) PP6 for the New Markets Development; market identification, food demonstration and awareness raising campaign strategies to increase consumer demand.

Dry fish samples of sardine, Indian mackerel and shark and fish powder were displayed manually,

Next Ms. Yohana Negassi, community development C/P, explained the need to create a new cooperative, which included the number of persons and overall structural organization with one chair person, secretary, finance and members in charge of fishing, processing and marketing.

Then followed by Mr. Misgina, Head of Cooperative Supporting Unit, on aim of the cooperative highlighting about member selection criteria (e.g. Member of cooperative should be village resident), by-law and responsibility on the machine and PP activities to improve nutrition and livelihood of community. He also gave short brief on MMR Cooperative By-Laws which consisted of 12 legislation/ act in two local languages (Tigrigna and Arabic) for reference.

Mr. Beraki Zoba branch extension officer and Mr. Saleh Foro Sub Zoba extension agent facilitated the workshop and explained the difference between the existing cooperative and new one in Hirgigo and Zula, respectively.

Comments (C) and question (Q) from the participants

I. Hirgigo

Q. Is it possible to deploy the set net on a sandy beach?

Q. Did this project consider the transportation constrains?

Q. Usually we use mosquito net for fishing Sardine, is there any plan regarding the fishing method of small pelagic fish such as Sardine?

C. People awareness on fish consumption is raising since 1990's till now, we are ready to work hard in harmony for the success of this project.

II. Zula

C. There is existing house for the installation of Ice Machine

C. The installation of the ice machine will support the community to produce more fish with good quality.

Conclusion

During the workshop both villagers gave good responses and explained their willingness for the implementation of pilot projects. The community was given one week to select members of the cooperative and prepare internal laws. We agreed to visit the form 14 to 17 December 2021 for the final formation of the cooperative.

Appendix 3

List of participants from MMR and JICA study team

S.No	Name	Responsibility
1	Tsurusaki Tsuneo	JICA study team
2	Solomon Berhane	C/P, team leader
3	Yohana Negassi	C/P
4	Mulugeta Mahdere	C/P, team leader
5	Yosief Redae	C/P
6	Aklilu Rufael	Technical assistant
7	Beraki Haile	Zoba Branch
8	Salih Osman	Extension Agent
9	Fatna Asa	Director of Cooperative Support Unit
10	Misgina Tesfu	Cooperative Support Unit Head

List of workshop participants from Hirgigo

S.No	Full Name	Responsibility
1	Halima Osman Saleh	Village administrator
2	Mehamed Saleh Mantay	Community leader
3	Hasen Musa Mahmud	Community member
4	Ahmed Saleh Abojor	Community member
5	Ibrahim Omer Mehamed	Community member
6	Romadan Ahmed Romadan	Community member
7	Mahmud Musa Said	Community member
8	Husen Seid Adem	Community member
9	Ismaeal Idris Ibrahim	Community member
10	Fatna Ahmed Saleh	Community member
11	Amna Mehamed Nur	Community member
12	Isha Mehamed Idris	Community member
13	Sieda Ibrahim Osman	Community member
14	Fatna Mehamed Osman	Community member
15	Fatna Ahmed Mehamed	Community member
16	Saada Mahmud Ali	Community member
17	Fatna Mehamed Ali	Community member
18	Fatna Mehamed Ali	Village manager
19	Zahra Saleh Mahmud	Community member

List of workshop participants from Zula

S.No	Full Name	Responsibility
1	Abdelkerim Abdulahi	Community Member
2	Humed Ahmed Ali	Community Member
3	Asha Osman Hasen	Community Member
4	Abdu Ismael Mahmud	Community Member
5	Asha Humed Mohamedali	Community Member
6	Halima Ibrahim Romadan	Community Member
7	Fatna Mehamed Hamid	Community Member
8	Ahmed Ismael Kalu	Community Member
9	Halima Ibrahim Saleh	Community Member
10	Saedya Mehamed Osman	Community Member
11	Meryem Ibrahim Jimae	Community Member
12	Alewya Ahmed Osman	Community Member
13	Isha Mehamed Ali	Community Member
14	Salleh Idris Ismael	Community Member

Appendix 3

15	Sofya Abdela Omer	Community Member
16	Mehamed Ali Mahmud	Community Member
17	Osman Omer Saleh	Community Member
18	Osman Jabra Ahmed	Community Member
19	Mehamed Idris Ismael	Village Manager
20	Mehamed Salm Humed	Community Member

Photos



Workshop presentation on Community Development, Hirgigo village



Workshop presentation on Fishing Gears & Methods, Zula village



Workshop participants in Hirgigo village



Workshop participants in Zula village

Appendix 4

Date: 22/03/2021

REPORT ON DRIERS DRYING EFFICIENCY OF SMALL PELAGIC FISHES AND SHARK

Prepared by: Yohana Negassi

Solomon Brhane

March 2021

Massawa-Eritrea

1. Introduction

Fish is a very perishable commodity. So it needs effective methods of preservation. Some of the methods are, cooling, drying, smoking; salting etc. but the best method for the foot fishermen whose do not have cooling system is drying the fish with or without salt.

The main objective of this trial was to test the small pelagic fishes drying method and drying efficiency of four different driers. The drying efficiency test was done in two phases. Phase I wet salt and open air drying of beheaded Indian Mackerel after soaking in a one to three brine solution for 5 min. Phase II, whole and beheaded Sardine, beheaded Indian Mackerel dried without salt in open air, whereas beheaded sliced in a thread like Shark with fine salt was dried on direct sunlight. Then initial wet weight of samples was taken and spread out thoroughly to avoid over stacking. The drying efficiency was tested using the difference in moisture content, time duration and sensory quality of final product.

2. Objectives

- To test small pelagic fishes and Shark drying methods.
- To compare with and without salt drying effect on final product appearance.
- To compare drying efficiency of four different driers.

3. Methodology

3.1 Materials used

The materials used during fish processing and drying are knife, cutting board, fine powder salt, water, balance, small pelagic fishes, shark, driers (oven, bed like, cabinet, JICA and solar tent), container.

3.2 Preparation of brine solution

- One Kg of fine powder salt was mixed with three Kg or Litters of water and it was shake well till totally dissolved.

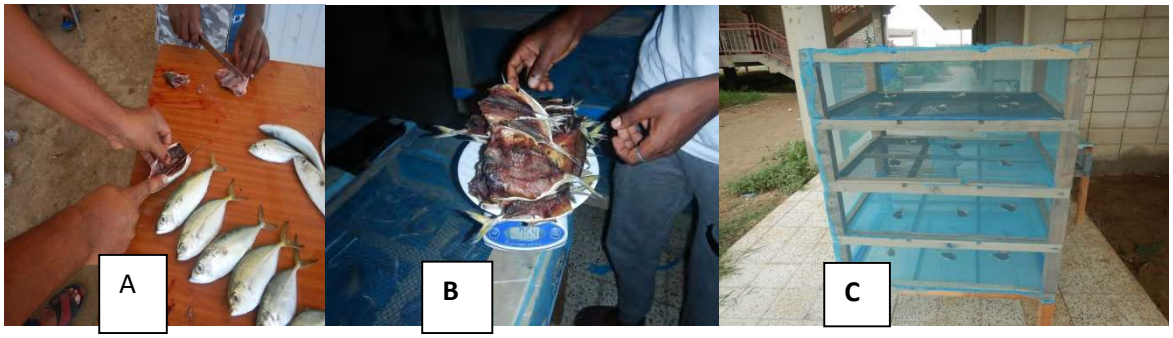
3.3 Principles of drying:

Phase I

Procedure

1. Head and gutting of fish was removed
2. one to three brine solution was Prepared

3. The beheaded and gutted fish was soaked in salt solution for 5 min.
4. wet weight of the fish was taken
5. The fish was spread out over the drier.



A. Gutting Indian Mackerel **B.** Weighing Indian Mackerel **C.** Drying in cabinet like drier

Phase II

Procedure

Sardine

1. The fish was Beheaded
2. Fish was washed and put into four different driers in open air and drying oven to dry

Indian Mackerel

1 Head and gut of fish was removed.
2 Fish was washed with water to remove blood and other visceral part.
3 Wet weight was measured.
4 Fish was spread out over the driers.

Shark

1 The head, fin, tail and the gut of the shark were removed on board at sea
2 The fish was filleted and skinned
3 The fillet was washed and sliced into thread like
4 Enough amount of dry powder salt was put on the fish.
5 The thread like slices was hanged in rope over direct sunlight and covered with clean mosquito net to protect it from flies and birds.

Appendix 4



A. Beheading of Sardine **B.** washing of beheaded Indian Mackerel **C.** drying in oven **D.** weighing of dried Sardine

4 Result and Discussion

Two phases of drying method and drier efficiency test of four different (bed like, cabinet, JICA and solar) was tested from 27/02-05/03/2021 and 20/03-25/03/2021 using one night small pelagic fishes (Sardine and Indian Mackerel) and Shark from around Massawa coastal area; Hirgigo and Emberemi villages. Phase I, Indian Mackerel was beheaded, gutted and sliced, then soaked in one to three salt brine solution, finally spread out on the above mentioned driers. Phase II, whole and beheaded Sardine, beheaded and sliced Indian Mackerel samples were dried in the fore mentioned dries as well in Oven drier. The result of phase I and II drying efficiency and moisture content of driers is listed in the table 1 and 2.

Table 1. Phase I Drying efficiency

Sample		Initial wet weight of brined fish in gm.	Final dry weight in gm.	Moisture content %	Drying time in hours
Bed like drier	Rack 1	579	215	62.86	120-144
Cabinet like drier	Rack 1	230	86	62.6	120-144
	Rack 2	210	80	61.9	120-144
	Rack 3	286	106	62.93	120-144
	Rack 4	210	78	62.85	120-144
	Rack 1	105	39	62.85	120-144

Solar tent drier	Rack 2	105	37	64.76	120-144
	Rack 3	215	69	67.9	120-144
JICA drier	Rack 1	115	43	62	120-144
	Rack 2	120	47	60.8	120-144
	Rack 3	120	46	61.6	120-144

The moisture content of final dried fish product range from 60.8 - 67.9 %, the highest removal rate of moisture content was recorded in the solar tent drier and lowest in the JICA hanging driers. The cabinet like drier was more efficient than the bed like, solar tent and JICA open air racks in dry time duration. The other three driers were almost similar in their efficiency with the solar tent.

Table 2. Phase II drying efficiency

Sample		Initial wet weight of brined fish in gm.	Final dry weight in gm.	Moisture content %	Drying time in hours
Bed like drier	Sardine	500	136	72.8	120
	Indian Mackerel	1500	400	73.3	120
Cabinet like drier	Indian Mackerel	1500	510	66	120
Solar tent drier	Sardine	500	130	74	120
JICA drier	Whole Sardine	300	84	72	120
	Indian Mackerel	750	216	71.2	120
Oven	Sardine	1679	431	74.32	42
	Indian Mackerel	1100	267	75.72	42

The moisture content in this phase range 66-75.72 %, the lowest moisture content removal rate was observed in the cabinet like drier and highest in the oven dried Indian Mackerel.

5 Conclusion

The wet salt dried Indian Mackerel has best appearance and odor than those dried without salt. The moisture content was higher in phase II than phase I, may be this is due to brine solution since salt have water absorbability capability in nature. The cabinet like drier design was more efficient than the Bed like, JICA hanging net and domestic solar driers respectively in phase I.

6. Recommendation

Depending on the result of this pilot trial, more simplified and efficient driers can be modified. But to make more dries different materials are required.

Appendix I photos of drying activities

Appendix 4









Appendix 5

Fish Smoking Manual

Fishing Community Development PIU

1. Materials required

   Hard dry wood, fish, smoking kiln, knife, spices, cutting board

2. Procedures

   (1) First gut, fillet and wash the fish

   (2) Start fire in the smoking kiln

   (3) Stop the flam to make a thin smoke and close the air-intake of the kiln

   (4) Put the fish on the trays of the kiln

   (5) Smoke for about <u>three hours with white and thin smoke</u> to get good flavor

		
(1) Preparing fish fillet	(2) Soaked into red spices (optional, only salt OK)	(3) Putting into smoker
		
(4) Too strong fire (no need fire, only thin white smoke)	(5) Failed example (charred fish with bad taste)	(6) Successful example (this was delicious!)

Appendix 6

Tentative Timetable of Fish Processing Training and Demonstration in Hirgigo and Zula

S.N.	Village	Subject of Training	Date	Materials Required	Methodology	
					Theory	Practical
1	Zula	Fish handling and fish quality	25/01/2022	Flip chart, marker, refreshment (cookie and coca)	100%	0%
		Fish processing and preservation	26/01/2022	Flip chart, marker, refreshment (cookie and coca), knife, fish and cutting board.	80%	20%
3	Hirgigo	Fish handling and fish quality	31/01/2022	Flip chart, marker, refreshment (cookie and coca)	100%	0%
		Fish processing and preservation	01/02/2022	Flip chart, marker, refreshment (cookie and coca), knife, fish and cutting board.	80%	20%
4	Zula	Processing demonstration	O7-11/02/2022	knife, fish, cutting board, drier, smoking kin	20%	80%
5	Hirgigo	Processing demonstration	14-17/02/2022	knife, fish, cutting board, drier, smoking kin	20%	80%
6	Hirgigo & Zula	Checking the products of the drying and making cooking trial	After one week of the processing demonstration	knife, fish, cutting board, spices, cooking oil, cooking pot, frying pan, tea spoon, stove, plastic bowel and water.	20%	80%

Training was given on fish handling preservation and processing for the cooperative members in Zula and Hirgigo. Then later, the demonstration of fish processing and cooking of processed fish were performed by the members.



Appendix 7

Report of the training on fish processing and preservation; drying and smoking techniques in Zula

For

The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC)

June, 2022

Fishing community development team

1. INTRODUCTION

As already stated on the proposal PP5: for the Development of Processed Fishery Products; training on fish handling, processing and preservation such as sun drying, salt drying and smoking was conducted in Zula for Khelij Zula cooperative members.

2. Objective

The objective of the training was;

- To train cooperative on proper fish handling.
- To familiarize with primary processing techniques such as be-heading, gutting, filleting etc.
- To introduce secondary processing techniques such as salt sun dry and smoking.

3. Methodology

3.1. Materials used

The materials used during training were dryer, smoking keen, fish, ice, icebox, knife, cutting board, spice, salt and vegetables.

3.2. Method

The training involved both theoretical and practical approaches. During training trainee participated in practical processing activities. Also translation of speech with local language for better understanding was engaged.

Venue; The training was held on Khelij Zula CFC from 17th - 26th April, 2022 in Zula coastal village.

4. Summary of the training

The training covered topics of fish processing and preservation as well as hygiene and sanitation. To mention some of the topics;

How to prepare fresh fish recipe

Finger fish recipe side dish with salad, potatoes and carrot chips were developed.

Why do we cook fish?

Main advantage of cooking is to kill pathogenic microorganisms, to improve flavor and nutritional content and for longer shelf life (preservation).

Hygiene and sanitation

The hygiene and sanitation issues included sanitation measures such as washing hands before starting processing, wearing aprons, cleaning of utensils, disinfection and sterilization of processing kits, keeping away of processed fish from toxic, hazard, direct sun light, rusted utensils etc.

Appendix 7

Primary and secondary processing techniques and smoking.

Primary processing of small pelagic, Indian Mackerel and large pelagic such as Milk fish and Mullet was done. After that, half of the primary processed fish was marinated in mixed spice (two tsp black pepper, two tsp cumin and one tea spice) and red pepper powder before smoking. The smoking processes take two hours and forty minutes.

Then, salting using fine salt of the other half of the primary processed fish sample was done. The salted fish was distributed over dryer and it was completely dried after three days.











5. Challenges

The challenges encountered during the training were low large fish supply and ice to preserve the fish until the training team brought ice from Massawa Fish Land.

List of participants from MMR

S.No	Name	Responsibility	Remark
1	Solomon Berhane	C/P, team leader	
2	Yohana Negassi	C/P	
3	Jupitier Ghirmay	C/P	
4	Beraki Haile	Zoba Branch	
5	Kibrom Issac	Metal Workshop, C/P	
6	Mohammed Mohammed Sead	Driver	

6. Conclusion

The training was given to the cooperative to increase their knowledge and skill in fish processing, fish preservation, fish quality and handling. This training will help them to do the demonstration on cooking, drying and smoking.

Appendix 8

Fish processing and cooking demonstration in Zula and Hirgigo

Fishing Community Development Unit

1. Demonstrations on cooking of dry fish in Zula

The fish which was dried during the day of drying demonstration with the cooperative members was kept in clean sack by the cooperative members. We practiced cooking of the dry fish with cooperative members. We used different spices and vegetables to cook the dry fish. We used the powder of the dry fish with lentil and with wheat powder to make bread (qicch). The whole dry fish is cooked with vegetables and rice.









Appendix 8







Appendix 8

2. Drying, smoking and cooking demonstration in Hirgigo

Drying, smoking and cooking demonstration was done in Hirgigo for the cooperative members.









Appendix 9

Type of food and method of preparation

(Fish recipes)

1.Fish cans (full supply)

Size,-

- 2 kg fleto fish only (Spanish maekeral/derak); 2 tablespoons black pepper
- 2 tablespoons salt; 1⁄2 cup lemon juice; 2 tablespoons he joked

Procedure of operation

Slice the fish thick and flat.

Next, stir in the salt, garlic, black pepper and lemon juice together and then add the sliced fish.

Let it dry in a cool place for about 5 days.

Cover with a thin cloth to keep it clean. When dry, place in a clean container.

Roast fish and serve us with rice

2.Breakfast with fish bones

Size

- 1 kg of fish bones
- 1 acre of white garlic
- 1 medium garlic red
- 1 tablespoon large ground cideno/parsley/cumin/black pepper
- Salt for sweetening

Procedure of operation

Clean and rinse the fish bones with lemon and salt (peel if skinned).

Cook in a pot with enough water for the broth and the amount listed above:

We can drink the broth or make pastini with it.

3.Fish broth (any filet)

Size: Mint-measured tender fillet

- Slightly in a bowl of fino
- One onion and carrot
- One bucket of water; One chicken broth
- 1 teaspoon cumin black pepper, cumin, garlic cloves

Procedure of operation

1.Offer finely ground zest

2.Serve a little fino in the fondue

3.Grind the garlic, chop the carrots /finely chop them in a pan with a little oil and fry in a pan

4.Stir in the finely chopped tenderloin and the fondue in the fino and add to the chopped garlic and carrots

5.Add a kerry water for a little cooking and broth

6. Add the ingredients namely a baco of chicken broth(dado), a small spoon of white garlic, cumin , black pepper and cook after a few minutes

7. Remove and serve in a deep pan/fondo.

4.Grill fish (Drack filet)

Size: Type of fish Quarter must Derak fish

 1 tbsp - cumin; Pepper black

 1 tablespoon oil in a bucket and nurse(so as not to stick), 1 tablespoon oil in a fondue; A little salt

Procedure of operation

1. First, lay the quarter of the fish on a rubber band and knead it until it is flat

2. Prepare in a fondue/pan/dish as follows

 1 tablespoon of oil

 1 tbsp cumin

 1 tbsp black pepper

 Prepare with a little salt

3. Sprinkle 1 tablespoon in a bowl

4. Then apply the ingredients mixed in fondo in No. 1 on all sides and fry/cook the roasted badella in No. 3 on both sides.

5. When cooked slightly red, contorno in white fondo on a serving plate

5.Zilzil fish (any filet)

Size: Prepare a quarter of a fish fillet the thickness of your thumb

 Prepare in a bowl/pan as follows

 1 tablespoonful of cumin; Black pepper :1 egg

 1 large tablespoon of oil

 1 tablespoon of oil in a bucket and nurse(so as not to stick),;

 1 large mushroom slice (measured for height).

Procedure of operation

1.First, roll the flour thickly (big big).

2Stir in the sliced fish in a spicy batter

3.Cook/cook the netims spices mixed with the garlic in a greased bucket

4.When finally cooked, place in a serving bowl/tasa seasoning

6.Fish cutlet (Drac fillet)

Size: Prepare a quarter derak of fish (must derak) in a round shape with a mortar

 In the first bowl/bowl, prepare as follows

1 tablespoonful of cumin; Black pepper :1 egg

1 large tablespoon of oil

 In the second bowl, prepare a loaf of bread

 Plenty of oil in a bucket and nurse(like for ligaments), 1 tablespoon oil in a fondue; A little salt

Procedure of operation

1. First, prepare a flat-shaped fillet oasa
2. Then mix in the 1st bowl with ingredients and eggs on both sides
3. Add to the fondo/bowl of baked bread and knead a second time(to harden like bread).
4. Then dip/alcohol it in boiling oil(like that of potatoes or legumes)
5. Finally, when cooked and red, remove and serve in a serving fonda /tasa.

7. Finger Fish (Drack Filetto)

Size,- Quarter filter Be sure to prepare a derak for height

In the first bowl/bowl, prepare as follows

1 tablespoonful of cumin; Beat black pepper, 1 egg

1 tablespoon oil,3 grams cooked herbs

 Prepare a second batch of baked bread

 Prepare the third Byati Fino

Procedure of operation

1. Prepare a tender fish fillet 5-10cm high
2. Stir into a bowl/bowl containing fino
3. Then stir into the first bowl containing the ingredients and eggs
4. Stir into a second bowl of baked bread
5. Then dip into melted oil and cook till it gives you bright red colour
6. When finally cooked, remove to a clean bowl and season

8. Fish with coriander

Size,- 1 kg of fish fillets Finely chop

 1 kg of coriander; 1 cup sour cream/girl;

 2 tablespoons flour; 1 teaspoon salt; 1⁄2 cup cheese;

 1 cup milk;1 teaspoon black pepper

Procedure of operation

 Clean the cabbage and cook it in water.

 Dry the water in an oiled bucket

 In another pot, heat the sour cream, flour, salt, black pepper and cook slightly.

 Add cheese and boil until smoky then pour over the crust

 Then put the prepared fish on top of the coriander
 Finally, after 15 minutes, sprinkle with a little salt and black pepper and place in the oven
 Once cooked, remove, cool and serve.

9. Fish with Vegetables (Kawlo Kabuchi)

Size:-

 1 kg of fish fillets rolled and sliced
 1 kg Kawlo Kabuchi measured in height
 2 red onions measured height
 1 tablespoon weakened white garlic
 2 tablespoons of weakened parsley
 4 height-measured gooseberries, 1 tablespoon ginger
 1 teaspoon rosemarino
 1 cup oil.

Procedure: -

1. First, fry the garlic in oil
2. Wash the cauliflower, drain the water and add the chillies, garlic, parsley and cook together.
3. Add the fish and cook until the fish is cooked, dripping with water if necessary.
4. Finally, sprinkle with salt and ginger and combine

10. Zgni fish

Size: 1 kg Clean and medium fish

 2 large finely chopped red onions
 1 cup vinegar/oil:
 2 tablespoons red pepper:
 2 cups cooked tomatoes
 1⁄2 teaspoon -Korerima, teaspoon black pepper, teaspoon kaaka; A little salt

 1 tablespoon white garlic

Procedure of operation

 When garlic is browned in coconut oil
 Add tomatoes and cook
 Then add the cheese and korerima
 When cooked, add the garlic and fish and cook for a quarter of an hour
 Finally, sprinkle with salt, black pepper and coriander and bring to a boil

11. With vegetables (potato/zucchini)

Appendix 9

Size 3 medium potatoes, 2 carrots, 1 zucchini, 2 tomatoes,2 tablespoons oil

 Quarter of fish:

 1 tablespoon garlic, 3 tablespoons gooseberries or 1 tablespoon pepperoni, 1 teaspoon black pepper, 1 teaspoon white garlic, 1 tablespoon parsley(azmarino)

Procedure of operation

First, mash the potatoes, carrots, zucchini, tomatoes in four angles.

 Next, finely chop the garlic and fry in a pan with a little oil.

 Then add the fish and vegetables and add a little water to combine.

 Finally, lower and serve

12. Fish barbeque (around) (any fillet)

Size,- Measure a quarter fillet of fish flat for height and thick;

 Prepare 1 zucchini into slices; Grind 1 garlic clove into slices;

 In the 1st byati/tasa, prepare as follows:

1 tablespoon oil,

1 tablespoon black pepper and cumin, a pinch of salt

Procedure of operation

1. Roll the fish flakes to height and measure thickly
2. In a bowl, heat 1 tablespoon oil, cumin, black pepper
3. Measure a zucchini and garlic into slices
4. Add the ground zest to the bowl in No. 2, the one with the ingredients
5. Heat the mixture with the quinoa and garlic in a frying pan with a tablespoon of oil

13. SPRICE FISH (any filet)

Dosage,- 2 kg fish ,6 eggs,2 cups baked bread,2 teaspoons - black pepper, cumin ,close salt, 1 cup oil

 Let’s prepare low bread in the beaches

Procedure of operation

 Wash and clean the fish and measure by height

 In a deep bowl, beat eggs, cumin, black pepper, salt and stir well

 Add the minced fish to the beaten egg and seasonings for 5 minutes

 Then we pushed into the baked bread

 Fry in melted oil until slightly browned and serve on oiled paper

14. Qilvaasa (small amount of oil)

 Size 1⁄2 fish, 3 tablespoons tomatoes, 3 tablespoons gooseberries, 1 tablespoon garlic, 1 teaspoon black pepper, 1 teaspoon red pepper, 1 teaspoon cumin, 1 teaspoon parsley, a little salt

Method of Preparation

First,-measure the mushrooms, fish, tomatoes, and guava in four angles.

Then fry the garlic in oil in another pan. Next add the cooked fish, tomatoes, gooseberries, black pepper, cumin, salt and parsley.

When cooked, combine and serve

15. Rice with fish (rice with fish)

Size: 1 cup rice, sliced fillet quarters, red garlic, 2 tablespoons chopped tomatoes(haba tomatoes/salsa)

Procedure:

1. First, prepare the minced fish
2. Cook the rice in water
3. Measure a garlic clove and fry in oil
4. Add the mashed fish and then the chopped tomatoes
5. Add black pepper, cumin, and white garlic
6. Finally, combine the cooked fish with the rice or sit in a bowl of rice as a sauce.

16. Makoreni with fish

Size: 400 g pasta macaroni,

- 500 grams of fletto fish:
- 4 cups of tomatoes(freshly chopped):
- 1⁄2 cup cooked tomatoes:
- 1 acre of red garlic:
- 5 tablespoons of oil:
- 1 tablespoon salt, 1⁄2 tablespoon fried gourd

Procedure:

- Fry tomatoes and oil together in a pan for 10 minutes
- Fry the mushrooms in oil until browned
- Cook the pasta in salted water
- Cook fried tomatoes, minced mushrooms and fish together
- Finally, mix the peeled tomatoes and cooked fish with the pasta

17. Zgni fish with clean ades

Size: 1 kg of fish,

- 1/2 cooked birch,
- 2 large finely chopped red garlic, 2 cups roasted tomatoes, 1 tablespoon white garlic, 2 tablespoons white garlic, 2 tablespoons pepper, 1 cup full oil

 1⁄2 teaspoon korerima, 1⁄2 teaspoon black pepper, 1/2 teaspoon kaaka, pinch salt

Procedure:
 Wash the fish with lemon juice and salt.
 Fry the mushrooms in oil until browned
 Add the tomatoes and when they are slightly cooked, add the cheese and korerima
 When well cooked, add white mushrooms and water-cooked chillies
 When it boils, add the fish and cook for a quarter of an hour.

18. Fish with eggs

Size: 0.5 kg fish, 3 eggs, 3 tablespoons flour, 2 tablespoons parsley, 1 tablespoon white garlic, 1 teaspoon black pepper, 2 teaspoons salt

Procedure: Combine the fish, eggs, flour, black pepper, white garlic, parsley and salt in a deep bowl. Heat oil in a pan and fry in the hot oil while spooning out.

19. Roasted uncut fish

Size: 2-3 kg of raw fish, 2 cups flour, 4 eggs, 1 tablespoon black pepper, a pinch of salt, 2 lemons, 2 tomatoes

Procedure: Wash the fish thoroughly and chop

U cut it, nalio if it has shells, tear through the stomach and remove the stomach material. Clean with water, wash and dry with a cloth, hollow out the inside, sprinkle with salt, then heat in a bucket or pot of oil and fry in it. .Once cooked, remove and cool Remove and cook in the hot oil until browned.

20. Grill fish(Drack Filetto)

Size:
 Type of fish Quarter must Derak fish
 1 tbsp cumin black pepper
 1 tablespoon of oil in a bucket and nurse(so as not to stick)
 ,1 large tablespoon of oil in fondo
 A little salt

Procedure of operation

Know that quarter first, Derak Fish

Lay a rubber band on a stick /table until flat

Knead with an iron /thick pan

Prepare in a fondue/pan/dish as follows

1 tablespoon oil , 1 tbsp cumin ,

Prepare 1 small tablespoon black pepper, a little salt

Appendix 9

Sprinkle 1 tablespoon of table oil in a pan

Then in the fondo in v. 2 the drak we've patted in v

Mixed and prepared ingredients on all sides while rubbing the badela in v

Fry/cook, stirring on both sides.

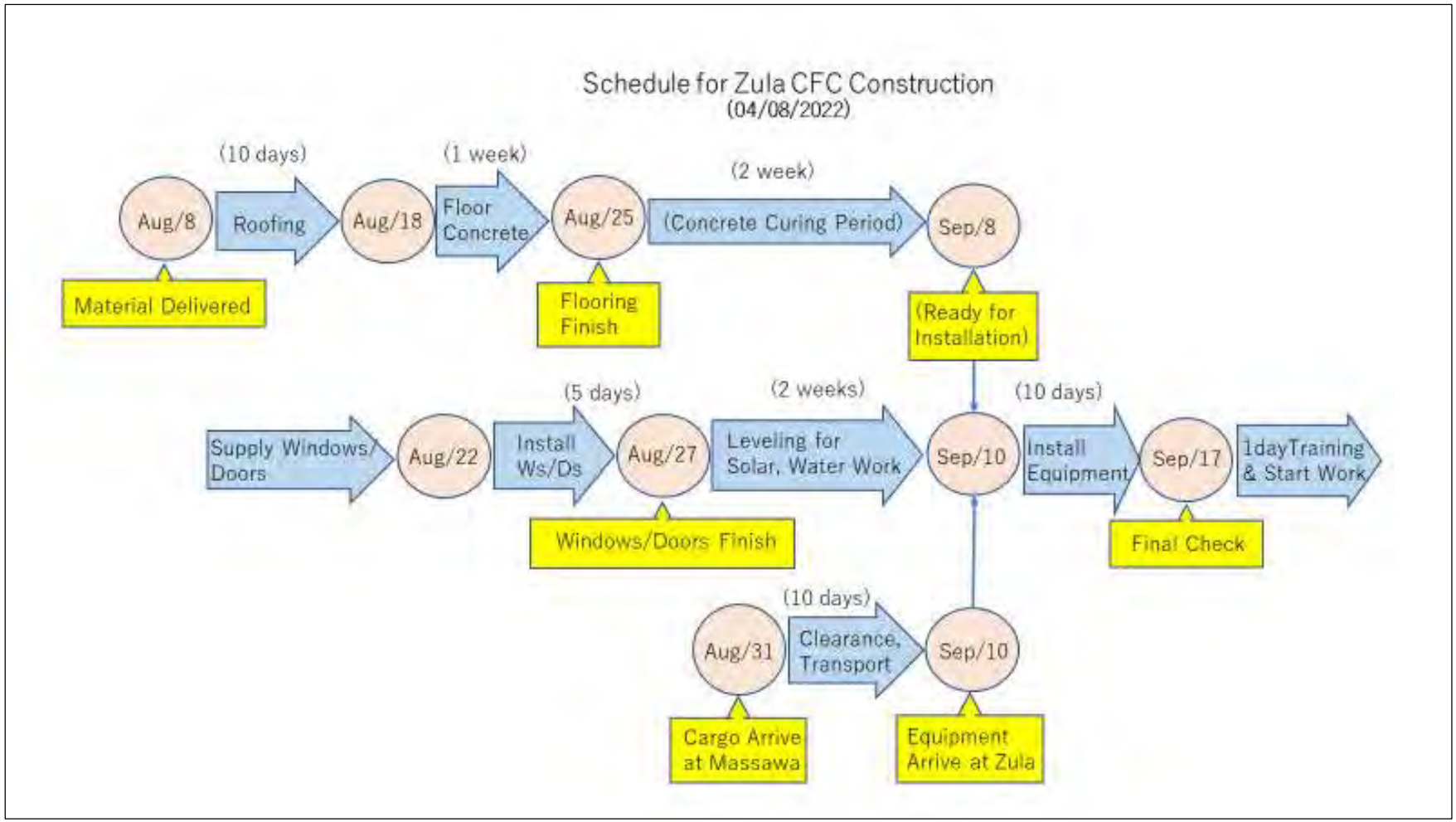
When cooked slightly red, serve

Garnish (contorno) with white fondo and serve

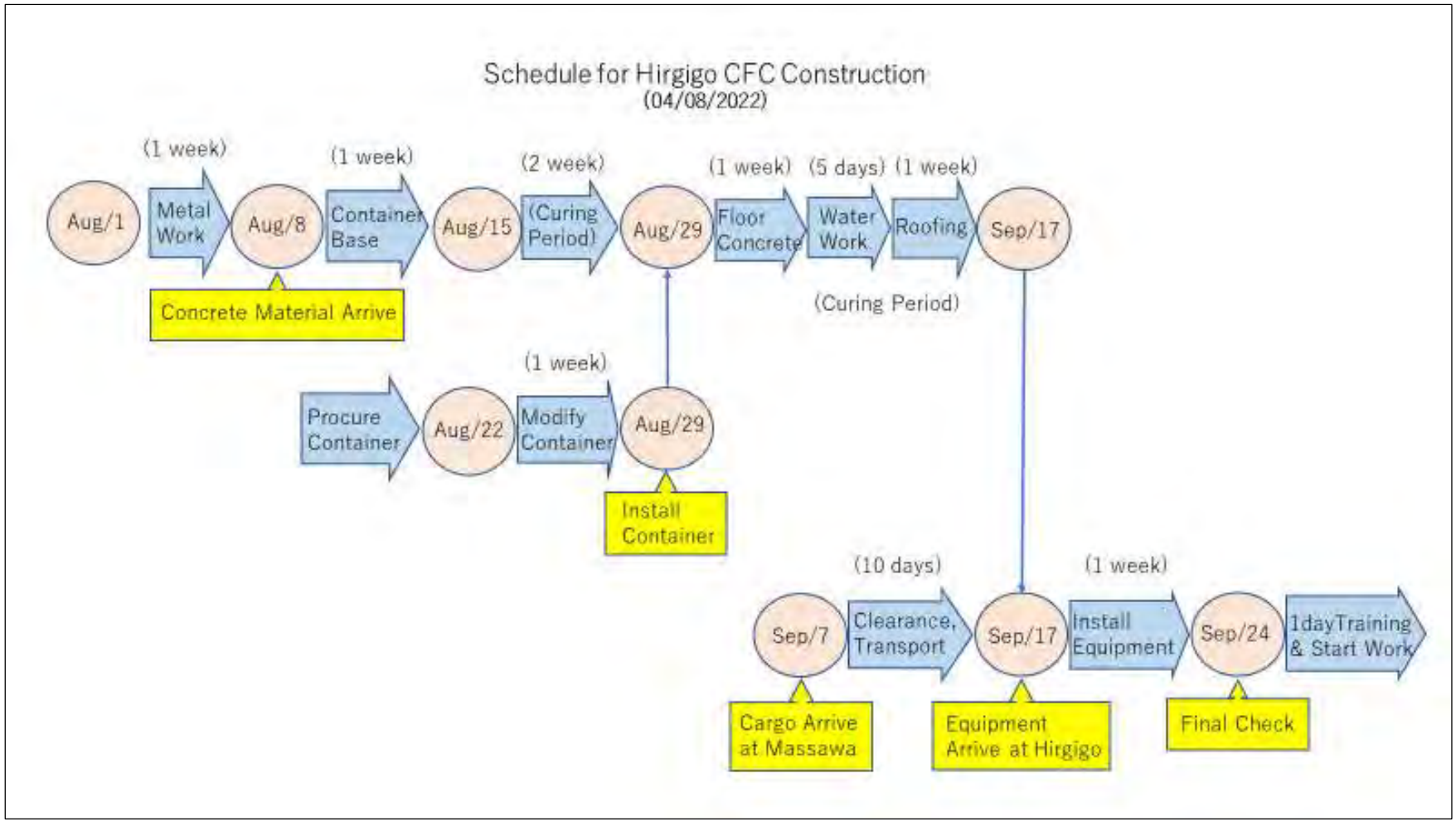
Summary of Construction Materials of CFC (Hirgigo+Zula)									
Prc.	No.	Item	Hirgigo	+OH	Zula	+OH	Ttl.Qty	Ttl.+OH	Unit
G	1	Basaltic stone	5.0	5.3			5.0	5.3	m3
G	2	Crushed gravel for base	0.5	0.5			0.5	0.5	m3
G	3	Steel reinforce bar (φ16mm)	16.8	17.6			17	18	m
G	4	Steel reinforce bar (φ10mm)	73.6	77.3			74	77	m
G	5	Steel reinforce bar (φ8mm)	117.9	123.8	394	413.6	512	537	m
S	6	Tying wire (Black wire 1.5mm)	2.0	2.0	5	5.0	7	7	kg
C	7	Wooden mold	8.0	8.0			8.0	8.0	m2
G	8	Cement (50kg/sac)	29.2	31	43	45	72	76	sac
G	9	Crushed gravel	2.3	2.4	2	2	4.2	5	m3
G	10	Sand	1.9	2.0	3	3	4.8	5	m3
G	11	Container, 20feet	1.0	1			1	1	pc
		Transport of Container to Massawa							
S	12	Wooden window with frame 1.05wx1.05h (1.00wx1.00h)(new/double)	2	2	3	3	5	5	pc
S	13	Wooden window with frame,1.25wx1.05h(1.20x1.00)(replane/double)			0	0	0	0	pc
S	14	Wooden door with frame,1.05hwx2.05h (1.00wx2.00h)(new/single)	1	1			1	1	pc
S	15	Wooden door with frame,1.05hwx2.05h (1.00wx2.00h)(replace/double)			1	1	1	1	pc
S	16	Wooden door with frame,1.65wx2.05h (1.60wx2.00h)(rew/double)			1	1	1	1	pc
		Window/Door materials (see "to Buy")							
G	17	Steel (water tower) L;60x60x3mm, 28.28m+(base)4.8m			35.0	36.8	35.0	37	m
G	18	Steel (water tower) L;40x40x3mm, 36.0m			38.0	39.9	38.0	40	m
		Metal flat bar, @0.50x4=2.00m	2.0	2.0					m
	19	Wood beam (Log, @5.0m) 5.0mx7+6.7mx2+(4)=52.4m	53	55.7			53.0	56	m
	20	Wood post (Log, φ10cm), 2.05mx4+0.2mx4=9.0m	9	9.5			9.0	9	m
		Wood logs transport to Hirgigo							
S	21	Wooden bar 5x7cm (4m/pc)	47	49.4			47.0	49	m
G	22	Corrugated tinplate (heavy-duty) (2.00x0.9m), 7kg	27	28	60	63	87	91	pc
S	23	Dorm headed nail	3	3	6	7	9	10	kg
	23	Dorm headed nail							
S	24	Paint, antirust coating (red)	4	4	5	5	9	10	L
S	25	Thinner for paint 50%	2	2	3	3	5	5	L
G	26	Water PVC pipe φ2" (50mm)	70	74	130	137	200	210	m
G	27	Water PVC pipe φ3/4" (20mm)	6	6	10	11	16	17	m
G	29	Water Gate valve, φ2" (50mm)	1	1	2	2	3	3	pc
G	30	Water Gate valve, φ3/4" (20mm)	2	2	3	3	5	5	pc
		Water straight connector, φ2" (50mm)							
		Water straight connector, φ3/4" (20mm)							
G	31	Water pipe Union, φ2" (50mm, screw)	12	12	10	10	22	22	pc
G	32	Water pipe Union, φ3/4" (20mm,screw)	3	3	4	4	7	7	pc

Prc.	No.	Item	Hirgigo	+OH	Zula	+OH	Ttl.Qty	Ttl.+OH	Unit
G	33	Water pipe Elbow, ϕ2" (50mm, 45 degree)	7	7	4	4	11	11	pc
G	34	Water pipe Elbow, ϕ3/4" (20mm)	3	3	6	6	9	9	pc
G	35	Water pipe Tee, ϕ2" (50mm)	1	1	2	2	3	3	pc
G	36	Water pipe Tee, ϕ3/4" (20mm)	1	1	3	3	4	4	pc
G	37	Water pipe Reducer ϕ4"-ϕ2"	1	1			1	1	pc
G	38	Water pipe Reducer ϕ3"-ϕ2" (75-50mm)			1	1	1	1	pc
G	39	Water pipe Reducer ϕ2"-ϕ3/4"	1	1	1	1	2	2	pc
S	40	Water tank 1200L	1	1	1	1	2	2	pc
G	41	Drainage PVC ϕ4" (100mm)	5	5	5	5	10	10	m
G	42	Drainage Elbow ϕ4"	4	4	3	3	7	7	pc
G	43	Drainage Tee ϕ4" (110mm)	1	1			1	1	pc
G	44	Soak-pit; Stone+Gravel	1	1	1	1	2	2	m3
S	45	HBC block 6x3x2=36pc (corner:24pc, middle:12pc)	36	36			36	36	pc

Appendix 11


Schedule for Zula CFC Construction
(04/08/2022)
(10 days)
(1 week)
(2 week)
Aug/8
Roofing
Aug/18
Floor Concrete
Aug/25
(Concrete Curing Period)
Sep/8
Material Delivered
Flooring Finish
(Ready for Installation)
(5 days)
(2 weeks)
(10 days)
Supply Windows/ Doors
Aug/22
Install Ws/Ds
Aug/27
Leveling for Solar, Water Work
Sep/10
Install Equipment
Sep/17
1dayTraining & Start Work
Windows/Doors Finish
Final Check
(10 days)
Aug/31
Clearance, Transport
Sep/10
Cargo Arrive at Massawa
Equipment Arrive at Zula

Appendix 12


Schedule for Hirgigo CFC Construction
(04/08/2022)
(1 week)
(1 week)
(2 week)
(1 week)
(5 days)
(1 week)
Aug/1
Metal Work
Aug/8
Container Base
Aug/15
(Curing Period)
Aug/29
Floor Concrete
Water Work
Roofing
Sep/17
Concrete Material Arrive
(Curing Period)
(1 week)
Procure Container
Aug/22
Modify Container
Aug/29
Install Container
(10 days)
(1 week)
Sep/7
Clearance, Transport
Sep/17
Install Equipment
Sep/24
1dayTraining & Start Work
Cargo Arrive at Massawa
Equipment Arrive at Hirgigo
Final Check

Appendix 13

Fresh Fish Sales Record: Kelij Zula Fishing & Fish Processing Cooperative, 24/03/2023					
Item		**Qty.**	**Unit**	**Price**	**Sum(ERN)**
Fish harvested (by a fisherman)		73.5	kg		
Fish sold	Foro	21	kg	40	840
	Afta	11	kg	40	440
	Zula	27.5	kg	40	1,100
	family	8	kg	0	0
	unsold	6	kg	0	0
(Total)		73.5	kg		**2,380**
Revenue (a)					**2,380**
(1) Share of fisherman		75	%		1,785
(2) Share of Cooperative		25	%		595
Cost (b)					
(1) Transport (pick-up)	from Sea				300
(2) Transport (pick-up)	to Foro				70
(Total cost, paid by fisherman)					**370**
Profit (a)-(b)					
(1) Fisherman					1,415
(2) Cooperative					**595**
(Total profit)					**2,010**
Contributions					
(1) Fisherman: Canue, fishing gear (gill-net) and fish harvesting					
(2) Cooperative: Ice 75 kg; coller box 6 pc					
Harvested fish species:					
Grouper, Indian mackerel, kingfish, jackfish, barracuda, etc.					

INTRODUCTION FOR BUSINESS PLAN EQUATION

(Zula Business Plan)

Profit = Revenue – Total costs

Revenue = QP

Where Q = Quantity

P = Price

Total Cost = $V_{TC} + F_{TC}$

Where, V_{TC} is variable total cost

F_{TC} is fixed total cost

Therefore, Profit = $QP – (V_{TC} + F_{TC})$

$V_{TC} = V_C \times Q$ Where, $V_C = V_C$ / unit

By definition at Break Even (BE), Profit = zero

Profit = $QP – (V_{TC} + F_{TC})$

So, $0 = QP – (V_{TC} + F_{TC})$

$= QP – (V_{TC} + F_{TC})$

Now, the Equation is $Y = MX + C$

Where, M = Gradient

C = Constant

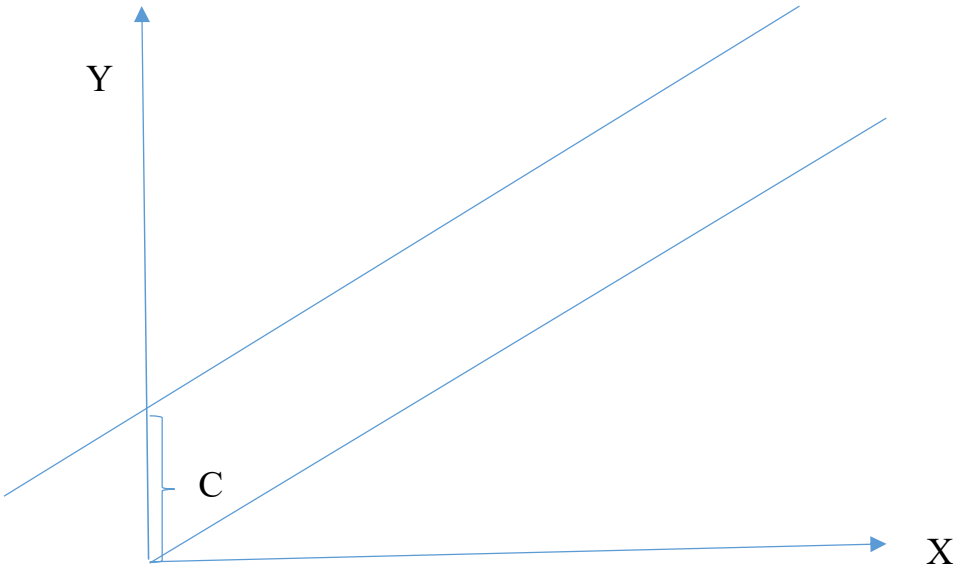
$(V_{TC} + F_{TC}) = QP$

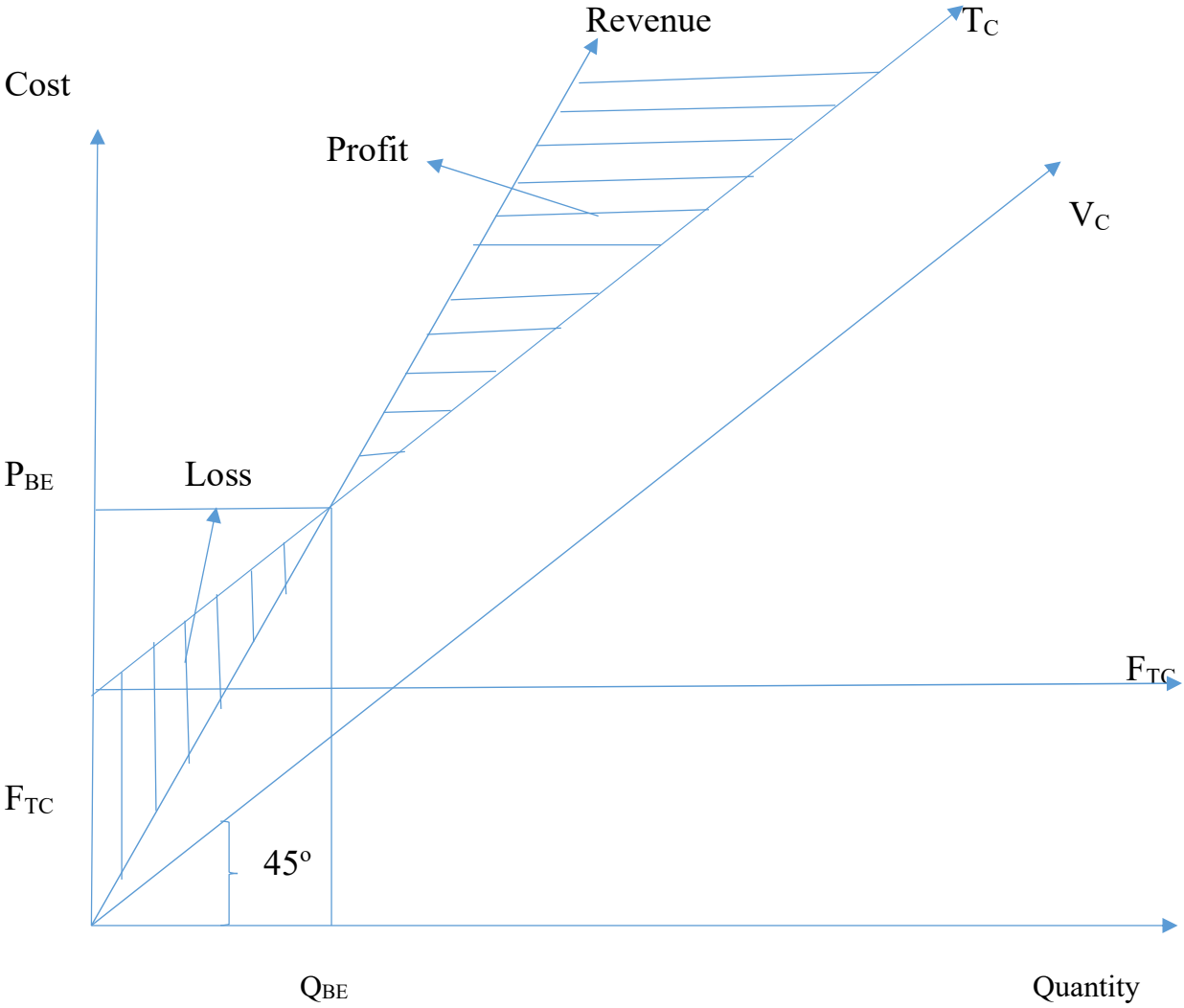
Therefore, $P = \frac{V_{TC} Q + F_{TC}}{Q}$

$= \frac{V_{TC} Q}{Q} + \frac{F_{TC}}{Q}$

$= V_{TC} + F_{TC}/Q$

Appendix 14





$T_C = V_{TC} + F_{TC}$

(1) Y = MX + C

(2) Y = MX

These two equation are parallel because Gradient 1 is equal to Gradient 2

Example of Business Plan for Zula Ice Making Machine

(Kelij Zula Cooperatives)

Kelij Zula Cooperative is one of the formed cooperatives under CSU, this cooperative is aided by JICA. In order to increase their income JICA plant an ice making machine in their vicinity, so in order to set the selling price of the ice and to secure its sustainability this business plan has been prepared. To determine the price of ice first the Break-even analysis must be done, a company's costs can often be separated into its Fixed and Variable Cost components. Fixed costs are those that do not vary with changes in the volume of sales and production. On the other and, variable costs vary directly with changes in the volume of sales or production.

List of variable cost V_C

(1) Water 1 Nakfa/ 40 Liters = 8 blocks of ice/ 1 Nakfa

1 Block of ice = 5 kg = 5 liters

Therefore V_C = 1 Nakfa/ 8 blocks = 0.125 Nakfa/block

Production capacity/ day = 60 blocks/ day

Production capacity/ month = 1,320 blocks/ month (60 blocks * 22 days)

Cost of water/ month = 1,320/8 blocks = **165.00** Nakfa/ month

This is, capacity of water = 1 Nakfa/ 40 liter = 1 Nakfa/ block of ice = 1/8 block

List of Fixed Cost FC

(1) Guard = 600 Nakfa/ guard x 3 guards =1,800.00 Nakfa/ month

(2) Depreciation = 61,736.62 USD * 15 Nakfa = 926,049.30 Nakfa.

= 926,049.30 Nakfa /5 years = 185,209.86 Nakfa/ year.

= 185,209.86 Nakfa /12 months = 15,434.16 Nakfa /month.

(3) Maintenance = 1,200.00 Nakfa/ month

(4) Periodic Service = 200.00 Nakfa/ month

(5) Rent = 900.00 Nakfa/ month

(6) Cleaning Service = 200.00 Nakfa/ month

(7) Technician salary = 1,800.00 Nakfa/ month

(8) Insurance = 940.87 Nakfa/ month

Therefore Fc = 22,475.03 Nakfa/ month

Based on this

(1) <u>If the cooperative pay for Water and Rent to the community</u>

V_C = 1/8 Nakfa/ block,

Fc = 22,475.03 Nakfa/ month

So, $P = V_C + F_{TC}$/1,320 blocks

P = 0.125 Nakfa/block + 22,475.03 Nakfa/1,320 blocks

P = 0.125 Nakfa/block + 17.02 Nakfa/block

P = **17.15** Nakfa/ block

Where Vc = cost of water for one block of ice is 1/8 = 0.125 Nakfa (1 Nakfa/ 40 Liters = 8 blocks of ice/ 1 Nakfa)

Q = production capacity per month 1,320 blocks of ice produced per month

In this case if they pay for Water and Rent, cost of Water is added to variable cost and cost of Rent is added to fixed cost.

(2) <u>If the cooperative pay only for Water</u>

V_C = 1/8 Nakfa/ block,

Fc = 21,575.03 (22,475.03 – 900.00)

So, $P = V_C + F_{TC}$/ 1,320 blocks

P = 0.125 + 21,575.03 Nakfa/1,320 blocks

P = 0.125 Nakfa/block + 16.34 Nakfa/ block

P = **16.47** Nakfa/ block

In this case if they pay for Water only, cost of Water is added to variable cost and cost of Rent is not added to fixed cost.

(3) <u>If the cooperative are not paying for Water and Rent</u>

$V_C = 0$,

Fc = 21,575.03Nakfa/ month

So, $P = 0 + F_{TC}/1{,}320$ blocks

P = 21,575.03Nakfa/1,320 blocks

P = **16.34** Nakfa/block

In this case if they are not pay for water the variable cost is 0 and the cost of rent is free, it is not added to the fixed cost.

N.B. This calculation is only to know the breakeven point, so to this, we add up profit to determine the selling price of the ice.

5. Pilot Project Report of Examination of Coastal FAD by Artificial Seaweeds

Pilot Project Report

of

Examination of Coastal FAD by Artificial Seaweeds

for

Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development

(FSPAC)

May-2023

ISHIKAWA Satoshi (JICA Expert)
Mulugeta Mahdere (Fishing Gear Unit)
MohamedSraj Abdelhafiz (Documentation Unit)

Ministry of Marine Resources

Japan International Cooperation Agency

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1. Introduction

Coastal areas of Eritrea are sparsely wooded and have limited nutrient supply from land. In addition, there are few large seaweed beds that provide spawning and nursery grounds for marine organisms, due to the sandy and muddy bottom in coastal areas. In this respect, it is not easy to develop “blue cardon” that aims to promote the absorption of carbon dioxide in the ocean and the effective use of sea resources, which is currently attracting attention in the world.

On the other hand, we can expect further development of large fish resources such as Queen Fish and King Fish, because they are currently being caught with simple fishing gear it could be suggesting their resources being large. However, these large fish take a long time to grow to available body size. For this reason, these resources have low resource recovery capacity, and there is a high risk of over fishing caused by a rapid increase in catches. Therefore, in the regional development of the coastal areas of Eritrea, it is important to promote the utilization of small pelagic fish, which has not been promoted so far and those have high recovery capacity.

In resource management of small pelagic fish, environmental improvement of spawning grounds and nurseries is most important. Recently, the changes in the marine ecosystem due to environmental changes resultant a decrease in coastal fish resources has been heighted as big issue, in Japan. Then in many coastal areas, seaweed and seagrass beds creation projects have been conducted as national projects, because these seaweed and seagrass beds act as spawning grounds and nursery grounds for many marine organisms. However, since it takes time for seagrass bed to grow, it is difficult to rapidly increase resources and catches by creating seaweed and seagrass beds. In addition, global environmental changes such as high-water temperature and strong waves, make difficult natural seaweeds and seagrasses to grown also.

In the sea areas where it is difficult to create seaweed beds, seaweed bed creation experiments using artificial seagrasses are underway in Japan. An artificial seaweed bed can be created simply and in a short time even in a sandy bottom where large seagrasses do not normally grow. In Japan, it has been confirmed that fish gather around one week after installation. In addition, spawning of squids and cuttlefish have been confirmed several months after installation.

The impact of creating seaweed beds in the tropical area with artificial seaweed on the fisheries sector is still undetermined. However, artificial seaweed beds are expected to function as a spawning bed for fish and marine organisms especially in tropical sandy coastal areas as well as fishing ground. Therefore, we conducted Fish Aggregating Device (FAD) development examination using artificial seaweed ‘C-lant’ in Hirugigo coastal area.

As a whole, the main purpose of FAD by artificial seaweeds is used as fishing ground, spawning and nursery grounds for many marine organisms. Thereby assist subsistence canoe fishermen to increase their catch and reduce their operating costs.

This FAD trial and monitoring was operated from May-August 2022, was funded by Government of Eritrea and Japan International Cooperation Agency (JICA) under the statement "The Formulation of Strategies and Practical Approaches for Coastal Fisheries Development (FSPAC) project". This FAD deployment was implemented in the coastal village Hirgigo jetty and the general requirements of this trial were;

- To generate new fishing ground in the coastal area.
- To increase fishing trip opportunity and decrease fishing effort.
- To increase biodiversity of the ecosystem
- To enhance fisheries resource

2. Activities Implemented

2.1 Selecting suitable areas for FAD deployment

On 20 April 2022, JICA experts and MMR counterparts selected three sites which could be suitable for the placement of FAD through snorkelling and SCUBA diving. The three selected sites are one around green island and two sites around Hirgigo shore which are northern ($N15^0$ 33 054, E03927784) and southern (N15032653, E039 27 898) side of Hirgigo jetty. Comparatively the southern part of Hirgigo jetty found suitable. Because the sea bottom is sandy, devoid of sea grass and sea weed, as well as coral reefs, less turbidity, easy to monitor and the depth is approximately 3-4 meter. As of the site selected, its position marked with floating plastic container (buoy) attached by rope to anchor and also its coordinates marked using GPS.

During site selection the important points considered was; the potential site should be less exposed to current, easy to monitor, less turbidity, sandy flat substrate area and depth (3-4m)

2.2 Preparation of c-lant FADs

Materials used for preparation of c-lant FADs were;

Table-1; - Materials used for making bottom artificial seaweed

S/N	Materials	Quantity
1	Sand bag	15*20kg
2	Plastic net	15
3	Connecters	Small
4	c-lant belt	90
5	cutter	1

On 21 April 2022, guided by the JICA expert, preparation of FAD by counterpart's using the above materials was accomplished in the office of MMR. The procedures applied was; (1) for

anchorage and basement of the c-lant belts, 15 sand bags each weigh 20kg were prepared, (2) thus all sandbag were wrapped by a square mesh net using connectors and (3) finally six c-lant (artificial sea weed) attached to every sandbag by using belts to the square meshed net.



Fig-1;- Preparation of sandbag



Fig-2;- Sandbag wrapped by square meshed net

2.3 Setting of the FAD

As mentioned above the preparation of FAD was completed in headquarter of MMR. Afterwards on April 22 2023, these materials were transported by track to Tiwalet boat harbour and then a fiberglass boat had being used to reach to the predetermined FAD position. Prior to deployment operation the JICA expert gave orientation to divers, on deployment procedure of the FAD. At the deployment position, sandbags with attached C-lants sunk one by one at 3-4 meter depth. When the entire FAD sunk in water, the SCUBA divers deployed a set of three and two FADs serially parallel to the coast and each set have an interval of one meter distant, that mean arranged in 3-2-3-2-3-2 patterns and in total covered an area of 25m2. Moreover, the SCUBA divers took photos for checking the proper deployment of the FAD by expert. As it confirmed, an underwater camera was fixed on stand two meter apart from the FAD for periodic recording the situation.



Fig-3;- Loaded FAD navigated for setting



Fig-4;- Photo of c-lants FAD at initial

to the site	deployment

2.4 Monitoring of FAD

The study plan for effectiveness of the Artificial Seaweeds' Fish Aggregating Device (FAD) was scheduled to monitor and video data every month by underwater camera since April up to October 2022. Unfortunately, in the early month of April and finishing month of October monitoring was not accomplished, because in April the camera became dropped to the ground from the stand camera and in October due to some technical error the camera damaged. Therefor the monitoring was carried out five (5) times (May to September 2022). The FAD method of monitoring is prepared by the JICA expert through underwater camera and the period of a term of recording by underwater camera was one (1) week, and then took interval three (3) weeks for the next month. The data collection method was, by fixing underwater camera on camera-stand two meter apart from the deployed FAD by SCUBA diving and left it there for one week for recording through time-lapse. Moreover, the SCUBA divers were also took photo and video record by another underwater camera at the designated time while fixing the camera-stand.

Table-2;- FAD monitoring plan by underwater camera

Study plan for effectiveness of the Artificial Seaweeds' Fish Aggregating Devise in the coastal area of Massawa										
						Planned by Dr. Ishikawa and the Monitoring team of FSPAC on 22 April 2022.				
Study stages	Responsible members	2022								
		April	May	June	July	August	September	October	November	December
1. Setting the FADs and preparations of	JICA team & monitoring	20-25								
2. Monitoring by under-water camera*	Monitoring team		1 16-23	2 13-20	3 11-18	4 8-15	5 5-12	6 3-10		
3. Evaluation of the effectiveness	JICA team & monitoring				Tsurusaki				Ishikawa	
4. Reporting	Monitoring team									
*The period of a term of monitoring by under-water camera is one (1) week, and then take interval three (3) weeks.										

3. Result

According to the schedule of the survey, for recording the required data the underwater camera was fixed seven times from April to September 2022. In the early of April, the record was not undertaken, because after fixing the underwater camera for recording, was found dropped from stand. However next month in May, the underwater camera showed that the area seems a natural marine ecosystem, because significant numbers of Indian mackerel and an ornamental fish of butterfly fish have been aggregated in schools. Moreover, the head parts of c-lant move with movement of the water current, similar as natural sea weeds does, which eager the fishes to aggregate around.

In June typically the dominant aggregation happened were great barracuda, butterfly fish and Indian mackerel respectively. In addition, the black-spot snapper fish were also found in great

quantity in shoal, which were not recorded in May. And also, some other fishes have seen in few numbers include emperor, black-spot snapper and turtle. On the other hand, the c-lant encountered expose on attachment of fouling organisms like barnacles, oysters, marine algae and even sedimentation, ultimately that artificial sea weed have been started to drop to sea ground.



Fig-5;- Record of great barracuda in June

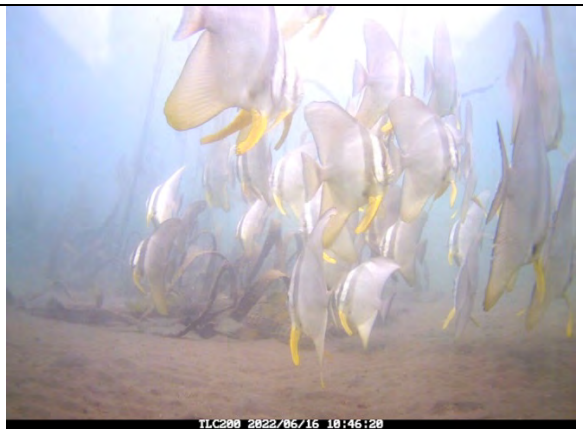


Fig-6;- Record of butterfly fish in June

July is one of the hottest months in hot season, thus the number of fish aggregated were reduced from the last month. Especially Indian mackerel and butterfly fish, the size of their school were comparatively lower from the previous record. However, the school size of black-spot snapper fish was flourished in this month. The reason could be either black spot fish may be less competitive or tolerant against hot season. Conversely, due to prey predator relationship and enticement of fish aggregation, bigger size fish like barracuda and jackfish were occurred to swim around. Moreover, in some record the area became poor visibility, which means turbidity and considered the position is an area where current is existed.



Fig-7;- Record of black-spot snapper in July



Fig-8;- Record of big barracuda in July

In continuation of the monitoring on August and September and the record showed similar aggregation. In both months, the dominant aggregation happened was typically plenty school of black-spot snapper fish which is preferable bait for line fishing by the local canoe fishers. And the great barracuda appeared significant reduction from the earlier months. As for the

large fishes stimulated by school of black-spot snapper and some other small fish, scattered coral reef fishes like emperor , grouper and other species of barracuda, sepia, turtle were recorded on moving around.

4. Analysis of the results

4.1 Analysis methods

A time-lapse camera was set up to take one snapshot every 10 seconds after the installation of the FAD with C-lant. Taking images using this time-lapse camera took place from May 16 to 23, June 13 to 20, July 11 to 18, August 8 to 15, September 5 to 12, and October 3 to 10. Installation and recovery of the camera were conducted by MMR staffs. The captured image data were sent to Japan and image analysis was performed.

The captured images were divided into individual files using Free Video to JPG Converter. After that, the still images were enlarged using Adobe Photoshop, and the number of fish was counted for each still image. Also, it is calculated for the average number of fish per one image for each day. And the percentage of still images showing fish for each day was determined. In addition, we recorded the condition of the C-lant being filmed and the characteristics of the fish that gathered.

4.2 Results

A total of 839 images were used for analysis. There were 501 Appearance (Photo with fish images). Both Appearance and Average number of fish increased from April 23rd to May 14th. This indicated that fish were gathering around the FAD immediately after it was set up on April 22nd.However, images in April did not cover the entire outside of the FAD because the time-lapse camera was not installed properly. Therefore, the numerical values of Appearance and Average number of fish would be underestimated from the actual gathering state of fish.

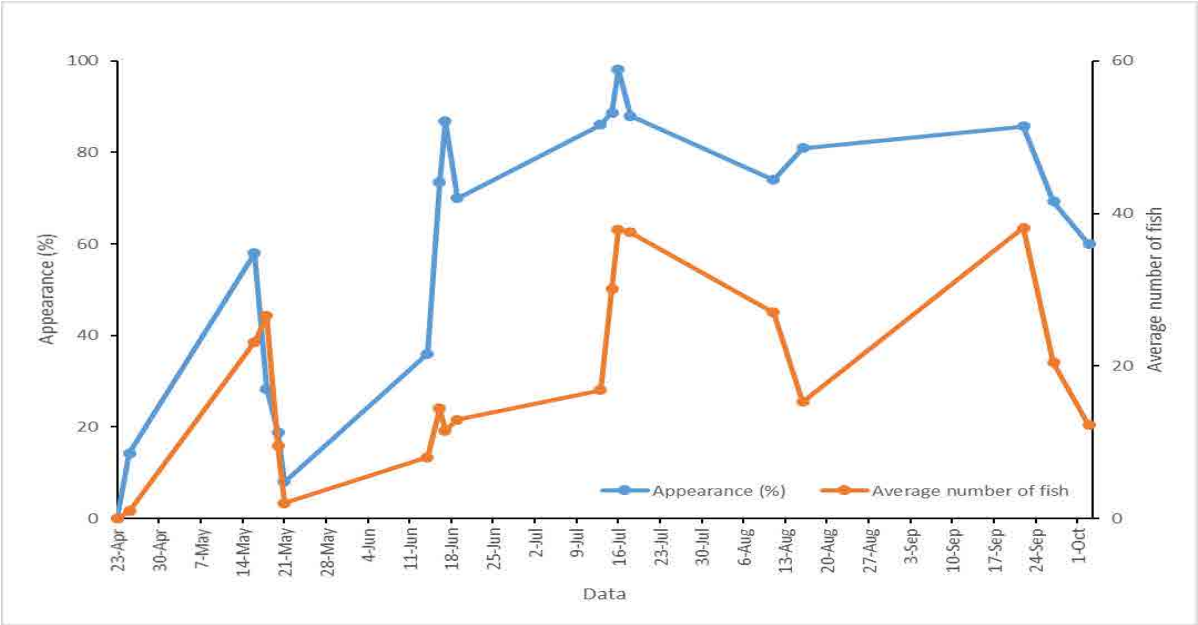


Fig.1 Average number of fish and Appearance percentage of Time laps Photos.

The May image captured the entire FAD, and we were able to see the effect of fish gathering. It turned out that a large number of Indian mackerel gathered around the FAD in May. In addition, it can be determined from the image that the fish gathered around the seagrass bed are taking predatory behavior. For this reason, it can be inferred that the FAD and their surroundings serve as feeding grounds for fish.



Fig.2 School of fish taking predatory behavior

Around May 20th, Appearance and Average number of fish decreased temporarily. This is largely due to the unclearness of the image. In particular, the images from May 20th to 23rd were unclear and almost impossible to analyze. However, it is certain that fish were gathering around the FAD even during this period, as there were images in which fish shadows could be confirmed.



Fig.3 An image showing fish shadows on May 20

After June 11th, although there were some fluctuations, fish were always gathering around the seagrass bed. In mid-June, some C-lants were sinking to the sea bottom due to the weight of their attached organism. However, even after such a subsidence phenomenon occurred, fishes could be maintained around the FAD.

Fish species that could be confirmed around the FAD, batfish and others often appeared between April and May. Around June, barracudas, rabbitfish, Indian mackerel and emperor fishes appeared. In July, large fish such as striped bonito began to appear. In addition, swimming crabs in June and sea turtles in August were also appeared.

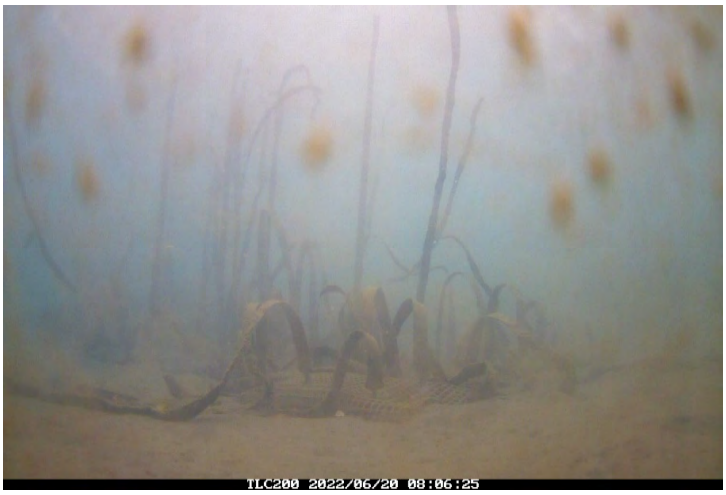


Fig.4 Part of C-lant sinking (taken on June 20)

5. Discussion

The nature of the study area is a gentle slope stretched long distance shallow onshore area. Since it is sandy and muddy substrate and the fish biodiversity is not abundant. In order to solve such problem, it is necessary to introduce FAD for enhancing the marine ecosystem in that area.

The aggregation in species type and number of fishes obtained from May- September 2022 shows that the area had comparatively similar in size of school and species. It is probably, because the data collection was captured relative during same hot season. In general fish are fascinated with floating objects. They use them to mark location for mating activities and other. To that effect, they aggregated in considerable number of Indian mackerel, butterfly fish and rabbit fish around the FAD artificial seaweeds (c-lant). Moreover, the FAD appeared to offer shelter for prey (juvenile fish) from predators and after certain period of time or two months later (July and August), the gatherings of prey, in turn, were supported by turtle as well as large predator's fish like big barracuda, emperor and jackfish. On the other hand, the FAD has been attached by barnacles and marine algae; ultimately the c-lant is dropped to the bottom. Therefore, durability is the main concerns that weather it could be transformed to natural habitat or lost.

Certainly, since the FAD is deployed, the canoe fishers of Hirgigo villagers have recognized that, there has been an aggregation fish in their surroundings, thus they have been appeared to use handling, gillnet and have caught some big fish like jackfish. Moreover, as the dominant aggregated fishes were black-spot snappers and Indian mackerels, which are the preferable

bait for hand line fishing of Hirgigo fishers, therefore such FAD method of fish aggregation would be obtained easy access of bait.

The importance of FAD is clearly observed in this operation, which the area become the home of many fishes. Therefore, if wide areas close to fishing community would be deployed by FAD, a tendency of enhancing fish stock and thereby the fishing community could become the main beneficiaries through increased catch per unit effort, reduction in fishing effort, improved earnings for fisheries. Simultaneously, it is likely that FADs provide protection to juvenile which increases their chances of survival. Additionally, such FAD has a wide range to create ecotourism for doing recreational fishing and snorkelling.

6. Recommendations

The artificial seaweed's FAD examination on the coast of Eritrea using C-lant revealed that it has the function of fish aggregating in a short period of time after installation. It was also confirmed that this fish aggregation effect continued at least for half a year after installation. However, it was confirmed that organisms adhered to the surface of C-lant in three months after installation, causing C-lant to lose its buoyancy and sink to the sea bottom. Although the effect of fish aggregation was maintained even after subsidence, some kind of treatment will be necessary in order to maintain the FAD function in the long term.

From the above results, it was found that a new fishing ground for both small pelagic fish and large fish can be formed by installing artificial seaweed's FAD in relatively shallow coastal areas in Eritrea. However, in order to ensure the long-term fish aggregating effect of the FAD, it is necessary to take care (maintenance) such as cleaning the surface of C-lant. In addition, since shallow water fishing grounds are easily accessible to everyone, there is a danger of overfishing easily. For this reason, it is considered necessary to impose some restrictions, in other words to making some limited entry system, for the sustainable use of fishing grounds. It would be suggested that a community contributed to making the fishing grounds and doing maintenances on the FAD, has exclusive using right of the fishing grounds. According this strategy, community enhancements and stable fishery catch could be achieved.