**HOUSEHOLD MICRO IRRIGATION TECHNOLOGY (HHMIT) PACKAGE**

# Introduction

## Background and rationale

As a means of improving agricultural production and productivity, Irrigation development is one of the key prioritized area of intervention in Ethiopia. As part of irrigation development, Household micro irrigation (HHMI) is equally considered as an important opportunity to transform the lives of smallholder farmers, increasing incomes and ensuring food security at the household level.

The overall objective of HHMIT is to promote irrigated farming at the household level by introducing suitable household micro irrigation systems, including selecting sustainable water sources, low cost and effective water lifting and irrigation application technologies. The HHMI system is referred to household-level micro irrigation practiced by an individual household (up to 0.5 ha) or a group of smallholder households covering an area up to 5 ha. The command area can be under subsistence or cash crops.

This package clearly defines the water sources, water lifting devices, irrigation methods, crop to be grown, area to be irrigated, and technology dissemination mechanism highlighted with the possible benefits in terms of socio economics, environment and gender.

It is also aligned with the government policy “*to let every rural household have at least one alterative water source for irrigation*” to improve their food security status and increase their household income.

It is also believed that frequently asked question and challenges during planning and implementation as well as across its value chain can be answered. These are the following but not limited to:

1. What are the most commonly used types of water sources for household irrigation development?
2. What are the possible and feasible water lifting devices to be used for household irrigation development based on the available type of water source?
3. What are the possible and feasible irrigation application technologies to be used for household irrigation development based on the available type of water source and water lifting devices?
4. How large area a single household or group of household can irrigate based on the type of water source, type of water lifting device and type of irrigation method adapted?
5. Which crop/s need to be considered to make HHMI development be feasible?
6. Is HHMI financially feasible? Or what feasibility indicators we should consider while promoting/developing HHMIT?
7. What irrigation extension tool needed to follow in order scale out HHMIT intervention
8. What are the possible marketing strategy with respect to HHMIT intervention?
9. What are the possible M&E tools to be used in this intervention?

This package is, therefore, prepared to introduce and provide users’ guidelines how appropriately integrate different household micro irrigation technologies for sustainable development and extension intervention. The effort will be able to improve the livelihoods of smallholder farmers by contributing to Ethiopia’s overall vision of achieving middle income level by 2025.

## HHMIT Package objective

### General

Introducing and implementing best combined HHMI technologies in Ethiopia to improve agricultural productivity and living standard of smallholder farmers.

### Specific

The specific objective of the package includes to:

* Introduce and promote best bet HHMI systems, technologies, practices for good outcome
* Develop HHMIT intervention extension and monitoring tools as to the national standard
* Develop HHMI social and financial evaluation tools

## Scope of the package

This package presents how successfully HHMI technologies can be implemented at individual households and group of households. In this regard, the package outlines technology combinations, which are largely practiced in Ethiopia. These combinations include; household irrigation water sources, appropriate and low cost water lifting devices and water application system.

Based on these combinations, the package recommends possible command area to be irrigated and crops to be grown. The package will also include the required irrigation extension tools, marketing strategy, social and economic analysis. The package also includes indicators and tools for monitoring and evaluation of Household micro irrigation intervention.

## Where to implement?

The HHMI package could be implemented all over in Ethiopia where irrigation is viable and where irrigation water resources both surface (river, spring, lake, and rain) and groundwater are easily taped and used for irrigation purpose by individual or group of households.

## Beneficiaries

Directly or indirectly, all individual households and group of households living in all agro ecology of Ethiopia and engaged in crop production, livestock development or mixed farming.

# HHMI package components

HHMI technology package will have the following three basic components:

## Irrigation water source

The following water sources are considered:

* Farm pond
* Roof top rainwater harvesting
* Hand dug well
* Manual tube well
* Spring
* River

## Water lifting devices

The following water lifting devices are considered:

* Treadle pump
* Engine pump
* Rope and washer pump
* Rope and bucket lifting
* Pulley
* Solar

## Irrigation water application

The following irrigation water application are considered:

* Drip irrigation
* Furrow irrigation
* Water can
* Pitch irrigation

To enable beneficiaries to use appropriate technology options from the above package components, in the next sections a package combination based on water resources are presented.

1. Roof Top Water Harvesting Technology Package

## Water sources

Under this package component, a roof top catchment rainwater harvesting system is considered. It is assumed that the system is owned by individual household. The rainwater harvested from the roof catchment is stored either in underground rainwater tank/cisern or in a rainwater tank constructed above ground cistern. Storage capacity of the structures are considered based on Ethiopian experience that is for above ground structures average 12m3/12000 liter and structures constructed below ground, 35m3 /35000 liter (photo below).

Figure -Underground rainwater tank/cistern

These structures are considered for multiple use. These includes, domestic water supply (washing household utensils, and for sanitation plus watering for small animals (30 lit per day for about 6 months=5.4m3 ) and for growing of seedlings or fruit trees or in combination (the remaining amount of water in the rainwater harvesting structures. The rainwater harvesting structures are considered to be full once in year that is at the beginning of the dry month/no rain season. In this case, the available of water volume from the roof top rainwater harvesting system is given in Table below:

Figure -Aboveground rainwater tank/cistern

Table 1-Tanker capacity, water allocation and cost

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Type of structure | Total volume (m3) | Water loss due to evaporation and seepage | Volume of water allocated for domestic use | Volume of water allocated for HH irrigation (m3 | Total cost (April 2019) | Service life (year) |
| 1 | Aboveground roof top RWH | 12 | Minimal or nil | 5.4 | 6.6 | 27548 | 20 |
| 2 | Underground roof top RWH | 35 | Minimal or nil | 5.4 | 29.6 | 35504 | 20 |

## Water lifting devices

Water lifting devices that ae required to lift water from cisterns considered are presented in Table 2

Table 2-Water lifting devices and their cost

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/N | Type of structure | Lifting devices recommended | Total cost (April 2019) | Service life (year) |
| 1 | Aboveground roof top RWH | Gravity with flexible hose (20 meter) | 400 | 2 |
| 2 | Underground roof top RWH | Pulley | 800 | 5 |
| Rope and washer (1 inch) | 4000 | 5 |

## Water application method

The water available in the proposed size of cisterns is too small. In this regard, efficient water saving technologies are considered. Detailed description of application techniques/technologies proposed is given in Table below:

Table 3-water application devices and their costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/N | Type of structure | Application technique recommended | Total cost (April 2019) | Service life (year) |
| 1 | Aboveground rooftop RWH | Hose irrigation | 400 | 2 |
|  |  | Water can(20 lit) | 110 | 1 |
| 2 | Underground roof top RWH | ~~Drip irrigation~~ |  | 3 |
|  |  | Water can | 110 | 1 |

## Command area and crop selected

Under this package component, avocado and mango are selected for lowland and mid highland where as apple is selected for highland. The total area to be irrigated using roof top rainwater rain water harvesting for the proposed crops varies according to the size of the storage structure, crop selected and the agro ecology condition. Accordingly, the area is varying from 11m2 to 120m2. Furthermore, the number of fruit trees varies accordingly, in the lowlands, mango or avocado only one with above ground where as 9 apples can be grown with the above ground structure together domestic water supply. With the underground structure, the number in both cases is increased, Table below:

Table 4-shows crops recommended and the possible size of command area estimated.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S/N | Type of structure | Crop recommended | | Command area estimated based CWR:·         Avocado, Mango,=1200mm, canopy=3m, Apple 750mm , canopy 1m, efficiency 90-100%, Irrigation,    Irrigation application for 6 months (gross irrigation estimation, 4 moths for highland and 6 month for lowland= 1200/365\*180-for mango , 1200/365\*180 for avocado and 750/365\*120 for apple (highland) | |
|  |  | Highland | lowland and mid highland | Highland | lowland |
| 1 | Aboveground rooftop RWH (6.6m3) | Apple | Mango/Avocado | 27 | 11 |
| 2 | Underground roof top RWH (29.6m3) | Apple | Mango/Avocado | 120m2 | 49m2 |

Number of fruit trees

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frits | RWH tank size=6.6 m3 | | RWH tank size=29.6m3 | |
| Highland | Low land and mid highland | Highland | Low land and mid highland |
| Avocado |  | 1 |  | 5 |
| Mango |  | 1 |  | 5 |
| Apple | 9 |  | 40 |  |

## 3.5 Extension, Supply chain and Market strategy

### 3.5.1 Extension strategy intervention

Table 5-Summary of participatory Extension Communication method & Tools to promote Roof top water harvesting Technology

|  |  |  |  |
| --- | --- | --- | --- |
| Technology promotion and implementation stages | Extension approach and method | Extension tools | Key issues |
| Awareness creation | Individual - Contact | * Farm visit & house to house visit | * Increase participation of women farmers by identifying appropriate time and place for training, and inform them on time * Make group member small number (20-30) and have women only group to let them actively participate * Group farmers with common problems * The extension worker has to be aware of the culture and social norms of the community while reaching female farmers * Printed medias have to be women inclusive, and descriptive |
| Group - contact | * Method Demonstration * Field days & Farm walks * Group meetings/GMF * Formal training in FTCs * Experience sharing |
| Mass - contact | * Brochures, poster and pamphlets * Audio visual aids |
| Technology selection | Individual - Contact | * Farm visit * personal experience sharing | * Make sure female farmers are equally consulted to choose technologies suitable to them. They have to be well informed about the technologies. * Farmers have to be group to male only and female only to ensure female farmers full participation. * Ensure women and men have equal access to information about the technology |
| Group - contact | * FTC Demonstration * Field days & Farm walks * Experience sharing |
| Farmers and site selection | Group - contact | * Group meeting * Model farmer/GMF[[1]](#footnote-1) | * Extension worker should have to target female farmers deliberately. * Target husband and wife instead of head of the house only |
| Technology dissemination and adoption | Individual - Contact | * Farm visit & house to house visit * Personal experience sharing | * Knowledge differences of male and female farmers must be understood to improve the effectiveness of any technology dissemination or extension process * Make sure that technical assistance programs target both men and women. * Pictures and/or movies should have to clearly show women using the technology as men |
| Group - contact | * Demonstrations * Field days & Farm walks, * Experience sharing |
| Mass - contact | * Billboard and posters * Printing media |
| Technology feedback | Individual - Contact | * Farm visit * Interview | * Technology feedback has to be collected separately from male and female farmers. * Encourage women to participate through women only group formation * Develop gender sensitive checklist to record gender disaggregated data |
|  | Group - contact | * Field days * Group meetings |

### 3.5.2 Market strategy

The extension system needs to provide market-demanded HHMI technologies, link producers with buyers, input and credit suppliers, providing market information, and promoting collective marketing through harnessing vibrant linkage among potential actors. Men and women hold gender specific marketing knowledge; the extension worker should account for these differences.

### 3.5.3 Access to credit

In order to cover the purchase costs of HHMI technologies and to finance operational and maintenance costs of the irrigation equipment, farmers need to have access to credit. Although consideration can be given to initial subsidies in post-emergency situations, micro-credit institutions should be involved in establishing a sound rural credit system to make irrigated agriculture economically viable.

## 3.6 Evaluation of Economic Performances



The economic variables involved in this package component were evaluated based on the objective of promoting household irrigation targeting smallholder farmers living in both highlands and moisture stressed areas. Therefore, all the necessary input-output data were considered based on the rainwater water source, 6.6 m3 for above ground and 29.6 m3 for underground rainwater structure.

In this regard, production costs consisting of both fixed and variable costs per command are per water source were determined.

The main items considered as fixed costs were rainwater tank, water hoses and watering cans as a main hardware components and hand tools for fruit tree production. Variable costs were costs associated with farm inputs in the form of material and labor costs. Variable materials included; seedling, mineral fertilizers, mulch materials, and irrigation water. Labor recorded in variable costs were for land preparation, transplanting, harvesting, transporting, chemical spraying, applying fertilizers and weeding.

The cost of labor for site clearing, seed bed preparation, transplanting, fertilizer application, pesticide spraying and harvesting were all the same to all levels of treatments. The labor cost for placement of mulch material, however, was different. The cost of irrigation water was calculated based on the pumping cost per irrigation per treatment. The total production cost was then the summation of all these costs. The costing of labor in this package for all activities was based on average at woreda twon level and at a rate of 100 birr per day.

The revenue generated from each crop was estimated on the basis of marketable fruit crop from area considered. Fruit trees considered here are expected to give fruit after three years of planting. Hence, the revenue generated from each level of treatment was determined by obtaining the gross income from the sale of fruit crops every year but after three years of planting date.

The total revenue generated was also calculated based on the assumption that fruit trees are annual plants and cultivation is once in a year.

The total production cost was subtracted from the gross income (revenue) generated from the fruits sale to obtain the profit made in both cases. The production costs incurred in producing the fruits were the cost (C), while the income obtained in each case as the revenue generated from the sale of fruits was the benefit (B). The benefit-cost ratio (B/C) was then calculated by dividing the total gross revenue to the total production cost.

In calculating the costs of production involved in this package component, life cycle costing method was used. Life cycle costing is done by taking into account all the potential fixed costs such as different types of basic hardware, land preparation, energy, maintenance and management costs and it can be calculated using Capital Recovery Factor, CRF (SCS, 1978). CRF as defined by SCS (1978) is the uniform series annual payment, which takes into account the time value of money and depreciation over the life cycle. In the life cycle costing method, the interest rate, i (the time value of unsecured money to the developer), and the expected life of the item, n, are the main variables involved in calculating the capital recovery factor.

The annual cost of production for each item then was determined by multiplying its total cost by the calculated CRF value. In estimating the overall cost of production involved in this package, all costs were multiplied by their CRF. The CRF values for each item were calculated using Equation a as given in SCS (1978): 

 (a)

where i= Annual interest rate expressed in decimal

n= Number of years in the life cycle

CRF= Capital recovery factor

Accordingly, Rainwater harvesting system using above ground and below ground RWH storage system in the lowland and highland, the economic analysis can be summarized as follows:

* Using above ground structure, 12 m3 capacity , household water demand for about 3-4 months can be addressed and possible also to grow one mango or one avocado or 9 apple and can generate a net profit of 855 birr per year starting from the fourth year in the case of Mango or avocado. Where as in the case of apple, is not feasible.
* Using underground structure, 35m3 capacity , household water demand for about 6 months can be addressed and possible also to grow 5 mango or 5 avocado, or 40 apple and can generate a net profit of 6084-7575 Birr at beginning of the forth year.
* The B/C ratio in the case of 35 m3 capacity for both highland and lowland crop is feasible in which result shows, in the range of 1:77 to 2:06, in the case of growing of Mango/avocado in the lowland/mid highland and apple in the highland, respectively.

## 3.7 Monitoring and Evaluation (M&E) tools

Table 6-Roof top water harvesting M&E tools ( Water source)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Criteria/Principle** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Water volume | M3 | On-situ at household | Tank size measurement |
| Roof Catchment Area | M2 | On-situ at household | Roof area Measurement |
| First flush drainage functionality | None/Functional/ Non-Functional | On-situ at household | Observation |
| **Simplicity** | Ease of water abstraction | Simple/Moderate/Difficult | Farmers/Users | Interview |
| Ease of construction | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Safety** | Safety (cover, etc.) | Yes/No | Site Visit | Site Visit |
| **Operation & Management** | Use of local construction material | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Affordability** | Cost of construction | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |
| Cost of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |
| Quality[[2]](#footnote-2) and size of gutter, down-pipe and fittings | Bad/Good | On-situ at household | Observation |
| **Maintainability** | Local maintainability | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Reliability** | Frequency of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |
| **Gender Responsiveness** | Gender responsive | Labour, time, empowerment | Site Visit/Farmers | Site Visit/Interview |
| **Environmental Impact** | Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Availability** |  |  |  |  |
| **Demand Generation** |  |  |  |  |
| **Satisfaction** |  |  |  |  |
| **Documentation/User Manual** |  |  |  |  |

Table 7-Water lifting Technology

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Rope (and Washer[[3]](#footnote-3)) Pump** | | | | **Pulley system** | | | |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Water discharge | Litre/min | On-situ at Pump | Discharge Measurement | Water discharge | Litre/min | On-situ at Pulley System | Discharge Measurement |
| Total Head | Meter | On-situ at Pump | Head Measurement | Total Head | Meter | On-situ at Pulley System | Head Measurement |
| Power Requirement | Person per hour[[4]](#footnote-4) | On-situ at Pump | Power Measurement | Power Requirement | Person per hour | On-situ at Pulley System | Power Measurement |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Pump efficiency | % | On-situ at Pump | Measurement | Pump efficiency | % | On-situ at Pump | Measurement |
| **Operation Management** | Ease of use (through bearing or bushing) | Yes/No | On-situ at Pump | Measurement | Ease of use (especially for women sensitivity) | Yes/No | On-situ at Pulley System | Measurement |
| Proper construction of pump wrt to design (spacing for washer (piston) including slab, handle, delivery point, etc.) | Standard/Non-standard | On-situ at Pump | Observation | Proper construction of pump wrt to design | Standard/Non-standard | On-situ at Pulley System | Observation |
| Proper installation of the pump as per the design | Yes/No | On-situ at Pump | Measurement | Proper installation of the pulley system as per the design | Yes/No | On-situ at Pulley System | Measurement |
| **Maintenance** | Local maintainability on rope, bushing, bearing, etc. | Yes/No | On-situ at Pump | Measurement | Local maintainability on rope, pole, pulley, etc. | Yes/No | On-situ at Pulley System | Measurement |
| Frequency of maintenance on rope, bushing, bearing, etc. | None/Low/Medium/  High | On-situ at pump | Measurement | Frequency of maintenance on rope, pole, pulley, etc. | None/Low/Medium/  High | On-situ at Pulley System | Measurement |
| Cost of maintenance on rope, bushing, bearing, etc. | None/Low/Medium/  High | On-situ at Pump | Measurement | Cost of maintenance on rope, pole, pulley, etc. | None/Low/Medium/  High | On-situ at Pulley System | Measurement |
| Spare part availability on rope, bushing, bearing, etc. | None/Low/Medium/  High | Local market survey | Interview | Spare part availability on rope, pole, pulley, etc. | None/Low/Medium/  High | Local market survey | Interview |
| Cost of spare parts on rope, bushing, bearing, etc. | None/Low/Medium/  High | Local market survey | Interview |  |  |  |  |
| **Cross cutting** | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |

Table 8-Water application technology

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **criteria** | **Hose** | | | | **Watering can** | | | |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Efficiency | % | Site Visit/Farmers | Site Visit/Interview | Efficiency | % | Site Visit/Farmers | Site Visit/Interview |
| Standard hose size (length and width) | Yes/No | On-situ | Site Visit/Interview |  |  |  |  |
| Quality of Material | Poor/Good | Site Visit/Farmers | Site Visit/Interview | Quality of Material | Poor/Good | Site Visit/Farmers | Site Visit/Interview |
| Service life | Years | Site Visit/Farmers | Site Visit/Interview | Service life | Years | Site Visit/Farmers | Site Visit/Interview |
| Water saving | Bad/Good | Site Visit/Farmers | Site Visit/Interview | Water saving | Bad/Good | Site Visit/Farmers | Site Visit/Interview |
|  |  |  |  |  |  |  |  |
| **Operation and Management** | Hose as per the standard | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
|  |  |  |  | Ease of use | Simple/Difficult | Farmer | Farm Survey |
| Ease of use | Simple/Difficult | Farmer | Farm Survey |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Use of local hose material | Yes/No | Site Visit/Farmers | Site Visit/Interview | Cost of watering can/initial investment | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |
| Cost of hose/initial investment | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| **Maintenance** |  |  |  |  | Clogging problem for sprinkler | Low/Medium/High | Site Visit/Farmers | Observation |
| Local maintainability | Yes/No | Site Visit/Farmers | Site Visit/Interview | Watering Can accessibility at local market | None/Low/Medium/  High | Local market survey | Interview |
| Frequency of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| Cost of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| **Cross Cutting** | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview | Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |

**Annexes:**

Table: Fixed and Variable costs

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rainwater harvesting tanktype |  | Fixed costs (Birr/year) | | | | | | Variable costs (Birr/year) | | | |
|  | Material | Maintenance | variable cost (material and labour) -the first three years | | variable cost (material and labour) after 3 years | | Total production cost, first three years | | Total production cost, after 3 years | |
| Capacity (m3) | Rainwater tank and irrigation equipment | Rainwater tanks | lowland (mango/avocado) | Higland Apple | lowland (mango/avocado) after 3 year | Higland Apple | Lowland (mango/avocado) | Hihland (apple) | Lowland (mango/avocado) | Hihland (apple) |
| RWH tank 12m3 (aboveground) | 12 | 3921.84 | 196 | 79.8 | 3625 | 26.6 | 1208 | 4197.64 | 7742.84 | 4144.44 | 5326 |
| RWH 35m3 (underground | 35 | 6219.65 | 252 | 2109 | 4332 | 703 | 1444 | 8580.65 | 10803.65 | 7174.65 | 7916 |

* 9 and 40 apple per 12 m3 and 35 tank RWH1 and 5 mango/avocdo per 12 m3 and 35 tank RWH, respectively

Table: Production cost and Yield

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Total production cost, the first 3 years** | | **Total production cost, after 3 years** | | **Yield (per RWH)-the first harvest after three years and every year the same** | | **Product price** | |
| Lowland (mango/avocado) | Hihland (apple) | Lowland (mango/avocado) | Hihland (apple) | Lowland (mango/avocado) | Highland (apple) | Lowland (mango/avocado) | Highland (apple) |
| 4197.64 | 7742.84 | 4144.44 | 5326 | 2500 | 630 | 2 | 5 |
| 8580.65 | 10803.65 | 7174.65 | 7916 | 12500 | 2800 | 2 | 5 |

**Table: Revenue and B/C calculated**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Revenue (Birr/year) | | Profit the first harvest - after three years | | Profit after three years | | B/C ratio the first harvest | | B/C ratio after three years | |
| Lowland (mango/avocado) | Highland (apple) | Lowland (mango/avocado) | Highland (apple) | Lowland (mango/avocado) | Highland (apple) | Lowland (mango/avocado) | Highland (apple) | Lowland (mango/avocado) | Highland (apple) |
| 5000 | 3150 | 802.36 | -4592.84 | 855.56 | -2175.84 | 1.19 | 0.41 | 1.21 | 0.59 |
| 14749.8 | 14000 | 6169.15 | 3196.35 | 7575.15 | 6084.35 | 1.72 | 1.30 | 2.06 | 1.77 |

* Lowland fruit= Mango or Avocado
* Highland= Apple

Table Material specification and qtity required for aboveground rainwater tank (12m2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No** | **Item Description and specification** | **Unit** | **unit Qty** | **Unit Rate** | **Total cost** |
| 2 | Cement | Qntl | 15 | 250 | 3750 |
| 3 | Water | Barrel | 5 | 60 | 300 |
| 4 | Stone | M3 | 1 | 450 | 450 |
| 5 | Sand | M3 | 8 | 575 | 4600 |
| 6 | Pumis for Brick production | M3 | 7.5 | 250 | 1875 |
| 7 | Gravel (01mm) | M3 | 2 | 500 | 1000 |
| 9 | PVC pipe (110mm) | Pcs | 5 | 350 | 1750 |
| 10 | PVC Elbow (110mm) | pcs | 3 | 80.5 | 241.5 |
| 11 | PVC T (110mm) | pcs | 2 | 46 | 92 |
| 12 | gutter | m | 30 | 50 | 1500 |
| 13 | Chicken mesh wire | m2 | 60 | 35 | 2100 |
| 14 | cover (60\*60) | pcs | 1 | 600 | 600 |
| 15 | GIS Pipe (1/2 inch) - class – B | pcs | 0.5 | 700 | 350 |
| 16 | GIS Elbow (1/2 inch) | pcs | 0.5 | 46 | 23 |
| 17 | GIS T (1/2 inch) | pcs | 1 | 46 | 46 |
| 18 | GIS Nipples (1/2 inch) | pcs | 1 | 46 | 46 |
| 19 | Gate valve (1/2 inch) | pcs | 1 | 92 | 92 |
| 20 | Foucet (1/2 inch) | pcs | 1 | 92 | 92 |
|  | **Labor** |  |  |  |  |
| 21 | Excavation work | m3 | 2 | 50 | 100 |
| 22 | Gutter worker | pd | 4 | 300 | 1200 |
| 23 | Assistance Gutter worker | pd | 4 | 150 | 600 |
| 24 | Masonary work | pd | 8 | 345 | 2760 |
| 25 | Assistant Mason | pd | 8 | 138 | 1104 |
| 26 | Plumber | pd | 3 | 287.5 | 862.5 |
| 27 | Assistant Plumber | pd | 3 | 138 | 414 |
| 28 | Brick production wage | Bricks | 800 | 2 | 1600 |
|  | **Total** |  |  |  | **27548** |

Table Material specification and qtity required for aboveground rainwater tank (35m2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No** | **Item Description** | **Unit** | **unit Qty** | **Unit Rate** | **Total cost** |
| 1 | Cement | Qntl | 30 | 250 | 7500 |
| 2 | Water | Barrel | 8 | 60 | 480 |
| 3 | Stone | M3 | 1 | 450 | 450 |
| 4 | Sand | M3 | 8 | 575 | 4600 |
| 5 | Pumis for Brick production | M3 | 10 | 250 | 2500 |
| 6 | Gravel (01mm) | M3 | 2 | 500 | 1000 |
| 7 | Gravel (02mm) | M4 | 1 | 500 | 500 |
| 8 | PVC pipe (110mm) | Pcs | 5 | 350 | 1750 |
| 9 | PVC Elbow (110mm) | pcs | 3 | 80.5 | 241.5 |
| 10 | PVC T (110mm) | pcs | 2 | 46 | 92 |
| 11 | gutter | m | 30 | 50 | 1500 |
| 12 | Chicken mesh wire | m2 | 60 | 35 | 2100 |
| 13 | cover (85\*85) | pcs | 1 | 800 | 800 |
| 14 | Man hole with cover | pcs | 1 | 300 | 300 |
|  | **Labour** |  |  |  | 0 |
| 15 | Excavation work | m3 | 35 | 50 | 1750 |
| 16 | Gutter worker | pd | 4 | 300 | 1200 |
| 17 | Assistance Gutter worker | pd | 4 | 150 | 600 |
| 18 | Masonary work | pd | 8 | 345 | 2760 |
| 19 | Assistant Mason | pd | 8 | 138 | 1104 |
| 20 | Plumber | pd | 3 | 287.5 | 862.5 |
| 21 | Assistant Plumber | pd | 3 | 138 | 414 |
| 22 | Brick production wage | Bricks | 1500 | 2 | 3000 |
|  | **Total** |  |  |  | **35504** |

Table: Fixed material cost for rainwater tank, irrigation equipment and hand tools-12m3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Item | Unit | Qty | Unit cost (ETB) | Total cost (ETB) | Life span (year) | CRF | Total annual cost recovery (ETB) |
| **1** | **Aboveground tang, and irrigation equipment** |  |  |  |  |  |  |  |
| 1.1 | Above ground rainwater tank | Number | 1 | 15151 | 15151 | 20 | 0.15 | 2287.59 |
| 1.2 | Flexible hose | meter | 20 | 20 | 400 | 2 | 0.61 | 242.92 |
| 1.3 | Watering can | Number | 1 | 110 | 110 | 1 | 1.14 | 125.40 |
| 1.4 | Rope and washer pump | Number | 1 | 4000.00 | 4000 | 5 | 0.29 | 1165.13 |
| **2** | **Farm tools** |  |  |  |  |  |  | 0.00 |
| 2.1 | Hoe | Number | 1 | 80.00 | 80.00 | 5 | 0.29 | 23.30 |
| 2.2 | Shovel | " | 1 | 120.00 | 120.00 | 5 | 0.29 | 34.95 |
| 2.3 | Chemical sprayer | " | 1 | 120.00 | 120.00 | 7 | 0.23 | 27.98 |
| 2.4 | Rake | " | 1 | 50.00 | 50.00 | 5 | 0.29 | 14.56 |
|  | Total annual fixed costs |  |  |  | 20031.00 | 8.5 | 0.15 | 3921.84 |

* 1US$=10 ETB (January, 2009)
* Bank interest rate =14%
* 50% of its capacity is considered to be utilized for other purposes, cost of structure in this case is 2295.67 Birr/m3 of water storage capacity

Case 1: underground rwh system, 35 m3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Item | Unit | Qty | Unit cost (ETB) | Total cost (ETB) | Life span (year) | CRF | Total annual cost recovery (ETB) |
| **1** | **underground tank, and irrigation equipment** |  |  |  |  |  |  |  |
| 1.1 | underground rainwater tank | Number | 1 | 30026 | 30026 | 20 | 0.15 | 4533.51 |
| 1.2 | Water bucket (metal) | " | 1 | 180.00 | 180.00 | 4 | 0.34 | 61.78 |
| 1.3 | Watering can | Number | 1 | 110 | 110 | 1 | 1.14 | 125.40 |
| 1.4 | pulley | Number | 1 | 800.00 | 800 | 5 | 0.29 | 233.03 |
| 1.5 | Rope and washer pump | Number | 1 | 4000.00 | 4000 | 5 | 0.29 | 1165.13 |
| **2** | **Farm tools** |  |  |  |  |  |  |  |
| 2.1 | Hoe | Number | 1 | 80.00 | 80.00 | 5 | 0.29 | 23.30 |
| 2.2 | Shovel | " | 1 | 120.00 | 120.00 | 5 | 0.29 | 34.95 |
| 2.3 | Chemical sprayer | " | 1 | 120.00 | 120.00 | 7 | 0.23 | 27.98 |
| 2.5 | Rake | " | 1 | 50.00 | 50.00 | 5 | 0.29 | 14.56 |
|  | Total annual fixed costs |  |  |  | 35486.00 | 8.5 | 0.15 | 6219.65 |

* 1US$=10 ETB (January, 2009)
* Bank interest rate =6%
* 50% of its capacity is considered to be utilized for other purposes, cost of structure in this case is 2295.67 Birr/m3 of water storage capacity

Table 4.17 Fixed maintenance cost for irrigation equipment and farm hand tools, 12 m3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Item | Unit | Qty | Total cost (ETB) | Maintenance cost (ETB)\* | Service period (year) | CRF | Total annual maintenance cost (ETB) |
| 1 | **Aboveground tang, and irrigation equipment** |  |  |  |  |  |  |  |
| 1.1 | Above ground rainwater tank | Number | 1 | 15151 | 757.55 | 20 | 0.15099 | 114.38 |
| 1.2 | Flexible hose | meter | 20 | 400 | 20.00 | 2 | 0.60729 | 12.15 |
| 1.3 | Watering can | Number | 1 | 110 | 5.50 | 1 | 1.14 | 6.27 |
| 1.4 | Rope and washer pump | Number | 1 | 4000 | 200.00 | 5 | 0.29128 | 58.26 |
| 2 | **Farm tools** |  |  |  |  |  |  |  |
| 2.1 | Hoe | Number | 1 | 80.00 | 4.00 | 5 | 0.29128 | 1.17 |
| 2.2 | Shovel | " | 1 | 120.00 | 6.00 | 5 | 0.29128 | 1.75 |
| 2.3 | Chemical sprayer | " | 1 | 120.00 | 6.00 | 7 | 0.23319 | 1.40 |
| 2.4 | Rake | " | 1 | 50.00 | 2.50 | 5 | 0.29128 | 0.73 |
|  | **Total annual maintenance cost** |  |  |  |  |  |  | 196.09 |
| 1US$=10 ETB (January, 2019) | |  |  |  |  |  |  |  |
| Bank interest rate =14% | |  |  |  |  |  |  |  |
| \*Estimated at 5% of the total cost | | |  |  |  |  |  |  |

Fixed maintenance cost for irrigation equipment and farm hand tools, 35 m3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 4.17 Fixed mainte+A1:I17nance cost for irrigation equipment and farm hand tools | | | | | |  |  |  |
| S/N | Item | Unit | Qty | Total cost (ETB) | Maintenance cost (ETB)\* | Service period (year) | CRF | Total annual maintenance cost (ETB) |
| 1 | **Aboveground tang, and irrigation equipment** |  |  |  |  |  |  |  |
| 1.1 | underground rainwater tank | Number | 1 | 30026 | 1501 | 20 | 0.15099 | 226.68 |
| 1.2 | Water bucket (metal) | " | 1 | 180.00 | 9 | 4 | 0.3432 | 3.09 |
| 1.3 | Watering can | Number | 1 | 110 | 6 | 1 | 1.14 | 6.27 |
| 1.4 | pully | Number | 1 | 800.00 | 40 | 5 | 0.29128 | 11.65 |
| 2 | Rope and washer pump | Number | 1 | 4000.00 | 200 | 5 |  |  |
| 2.1 | **Farm tools** |  |  |  | 0 |  |  |  |
| 2.2 | Hoe | Number | 1 | 80.00 | 4 | 5 | 0.29128 | 1.17 |
| 2.3 | Shovel | " | 1 | 120.00 | 6 | 5 | 0.29128 | 1.75 |
| 2.4 | Chemical sprayer | " | 1 | 120.00 | 6 | 7 | 0.23319 | 1.40 |
|  | Rake | " | 1 | 50.00 | 3 | 5 | 0.29128 | 0.73 |
|  | **Total annual maintenance cost** |  |  |  |  |  |  | 252.73 |
| 1US$=10 ETB (January, 2019) | |  |  |  |  |  |  |  |
| Bank interest rate =14% | |  |  |  |  |  |  |  |
| \*Estimated at 5% of the total cost | | |  |  |  |  |  |  |

Table Variable cost

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | [1] | [2] |  | Total per year (ETB)\* | Service life (year) | CRF | Total per year (ETB) |
| Avocado (6.6 m3) lowland | 70 | 0 |  | 70 | 1 | 1.14 | 79.80 |
| Mango (6.6 m3) lowland | 70 | 0 |  | 70 | 1 | 1.14 | 79.80 |
| Avocado (29.6 m3) lowland | 350 | 1500 |  | 1850 | 1 | 1.14 | 2109.00 |
| Mango (29.6 m3) lowland | 350 | 1500 |  | 1850 | 1 | 1.14 | 2109.00 |
| Apple (6.6 m3) Highland | 180 | 3000 |  | 3180 | 1 | 1.14 | 3625.20 |
| Apple (29.6 m3) Highland | 800 | 3000 |  | 3800 | 1 | 1.14 | 4332.00 |
|  |  |  |  | |  |  |  |
|  | # trees | Area | Unit cost | |  |  |  |
| Avocado (6.6 m3) lowland | 1 | 12 | 70 |  |  |  |  |
| Mango (6.6 m3) lowland | 1 | 12 | 70 |  |  |  |  |
| Avocado (29.6 m3) lowland | 5 | 49 | 70 |  |  |  |  |
| Mango (29.6 m3) lowland | 5 | 49 | 70 |  |  |  |  |
| Apple (6.6 m3) Highland | 9 | 27 | 20 |  |  |  |  |
| Apple (29.6 m3) Highland | 40 | 120 | 20 |  |  |  |  |
| 1. Seedling (70 birr per for mango and for apple 20 birr per seedling | | | | | |  |  |
| (2) Labor cost (planting, watering, estimated 1000 birr per year and for three years 3000 birr, | | | | | |  |  |
|  |  |  |  |  |  |  |  |

1. Gender Model Family is an approach that helps to improve household gender relation through providing same opportunities to all family members to develop their potential. It is made up of a husband, wife and their children. SMIS Gender Model Family Manual. [↑](#footnote-ref-1)
2. There are quality measures like PN6, PN10… PN16 for pressure tolerance [↑](#footnote-ref-2)
3. Currently these washers (‘rondela’ in local language) are substituted with pistons. The term ‘rope and washer’ could be simply named as ‘rope pump’. [↑](#footnote-ref-3)
4. How many persons operate within one hour to abstract water? Take an average person of 15 years female farmers. [↑](#footnote-ref-4)