

**RIVER PUMPING IRRIGATION TECHNOLOGY 1Q22**

**HHMI Package-6**

**Small Scale Irrigation Development Directorate**

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

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# **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.

## **Package Objective**

### General Objective

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

### Specific Objective

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. So, this package is River pumping HHMI technology package.

## **Irrigation Water Source**

The following water sources are considered:

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

## **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

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.

# **RIVER PUMPING TECHNOLOGY PACKAGES**

## **Definition**

River is a natural flowing water following gradient of the surrounding land. Water from the River can be conveyed to the available land resources either by gravity or lift/pump irrigation. Particularly due to topographic constraints it may not be always possible to irrigate suitable irrigable lands by gravity system and study and design of pumping facility must be considered for such cases. Sometimes pumping is also necessitated to apply water by pressurized irrigation systems.

The study and design incorporates proper site selection for pumping facility, setting design criteria based on hydraulic and structural considerations and evaluation of different design alternatives and selection of most viable one. Design considerations also depend on the water sources for pumping like spring, stream, river, lake or underground water. The pumping facilities include the pump and power unit, the control heads, the housing, suction and delivery outlet and the pipe lines.

The scope of this River pumping HHMI package refers to lifting water directly from the River to irrigable command area by using motor pump. The provision of water storage is not considered in this package while stilling basin should be constructed to reduce velocity of water before distributed to the farm.

River flow estimation can be done by using floating method. Pumps for irrigation can simplify design and construction, eliminate the long intake canals of diversion schemes, and provide greater flexibility in scheme size and in selection of a suitable location near the area to be irrigated. The energy costs of running the pumps; however, off-set the reduced investments costs and prove a major constraint in many small-scale pump schemes.

The detail design and installation techniques can be referred from SSIGL-13 of National Guideline for SSID in Ethiopia (MoA, 2018).

Box 1 Cross Cutting Issues for River Pumping

**Environmental Consideration:** The environmental impacts of River pumping irrigation is related to the changes in Quantity and Quality of soil and water as a result of irrigation and the effects on natural and social conditions in river basins and downstream of the irrigation schemes. Other important points are it can be sources of conflict b/n irrigation farmers if there are no fair water distributions which considers the upper, middle and downstream users.

Other ecological problems the decrease in downstream environmental flow requirement which may harm the wetland ecology and downstream communities. Other environmental issues it may also cause Irrigation water lodging and Erosion in the farm.

**Gender Consideration:** Consult female and male farmers as source of local knowledge to develop reliable river pumping and get relatively actual water demand estimation and construction team should consider the different roles and responsibilities during implementation and scheduling for activities.

## **Water lifting**

The water lifting devices to be considered for this River pumping HHMI should be managed operated and maintained by the farmers and the cost of the pump should also be affordable. Centrifugal pumps are widely used for agriculture, generally handle large quantity of fluids, provide very high flow rates, and have the ability to adjust their flow rates over a wide range. To avoid cavitation, suction height (the difference between the sump water level and pump suction axis) should be calculated by considering the areal elevation and temperature.

The source of energy for motor pump in most rural area of Ethiopia is either diesel or petrol. During pump selection the available fuel (Diesel, petrol) should be taken in to consideration to avoid stops due to fuel shortage/absence.

* We should consider women labor, time, and weight of pump, simplicity in management and operation should be taken in to account during pump selection.
* Train jobless youth girls about motor pump maintenance to make the service women friendly as an addition jobs opportunity creation.

Box 2 Key Points for Motor Pumps

Generally in the next topic water pumps with their basic parameters are recommended to be used in this HHMI package.

### Engine Pump

Engine pump is a motorized pump operating using benzene or diesel fuel to pump water from suction head not greater than 6m. Small low-cost motorized engine pumps, make attractive and successful technology suitable for an individual farmer or a group of small-scale farmers. Individual farmers may extend their farm plots to irrigate a larger area because of the motorized pump, while groups of farmers can irrigate a common or collective area. It requires good storages, conveyance and distribution systems, preferably with lined canals or low-pressure Polyvinylchloride (PVC) pipe and flexible hose outlets for smaller pump systems. Since river pump is subjected to seasonal fluctuation, to maintain optimum river water flow and the suction head from the sump, it is recommended to excavate a pump house at reasonable depth as per the recommended formula depending on type of subsoil and minimum flow of a river.

Table 1 Engine pump parameter (at sea level)

|  |  |  |
| --- | --- | --- |
| **Size of the pump** | **Max**. **Head** | **Max. Discharge** |
| 2” pump | ≈ 26 m | ≈ 600 l/min (10 l/s) |
| 3” pump | ≈ 25 m | ≈ 1000 l/min (16.67 l/s) |
| 4” pump | ≈ 31 m | ≈ 1600 l/min (26 l/s) |

Table 2 Engine Pump Technical Features

|  |  |  |
| --- | --- | --- |
| **Technical conditions** | **Requirements** | **Constraints** |
| * Perennial river flow available in the vicinity of irrigated areas. * Suction head minimum 6\* m * Opportunity for extension of irrigated area for single & group of farmers * Standard river water quality for irrigation. | * Engine pump is commercially available with maintenance services and spare parts * Access to regular supply of fuel at affordable price * Access to markets for product * Advisory services on selection and installation | * High investment costs * Availability of fuel * Operational costs * Management problems |

**\* N.B.** The altitude at which a pump is operated will enhance or diminish its performance. At higher elevations atmospheric pressure is decreased reducing suction lift. For this reason the pump should be located as close to the water source as possible. Altitude affects engine performance as well. **A rule of thumb** is that benzene and diesel engines will lose 3% of their power for every 304.8m (1000ft) of elevation. This is due to the "thinner air" or lack of oxygen at higher altitudes. The reduced engine speed results in reduced flow and head (see Table 8 and Table 9 below).

Table 3 Suction Lift at Various Elevations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Suction Lift At Various Elevation** | | | | |
| **Altitude** | **Suction Lift (m) according to** engine manufacturers | | | |
| Sea Level (0 m a.s.l) | 3.05 m | 4.57m | 6.10 m | 7.62 m |
| 609.60 | 2.68 | 4.02 | 5.36 | 6.71 |
| 1,219.20 | 2.38 | 3.57 | 4.75 | 5.94 |
| 1,828.80 | 2.10 | 3.17 | 4.21 | 5.27 |
| 2,438.40 | 1.89 | 2.83 | 3.78 | 4.72 |
| 3,048.00 | 1.74 | 2.62 | 3.47 | 4.36 |

Many engine manufacturers offer methods of overcoming this loss by offering high altitude cylinder heads, as well as carburetor jets and air cleaners designed for use at higher elevations.

Table 4 Performance Loss at Various Elevations

|  |  |  |
| --- | --- | --- |
| Performance Loss at Various Elevations | | |
| **Altitude, M** | Discharge Flow | Head |
| Sea Level | 100% | 100% |
| 609.60 | 97% | 95% |
| 1,219.20 | 95% | 91% |
| 1,828.80 | 93% | 87% |
| 2,438.40 | 91% | 83% |
| 3,048.00 | 88% | 78% |

If there is a plan to use drip irrigation system as water application method, there are at least two options to lift water to the elevated water tank which can be used to create the required operating pressure for the drip system. The first option is to lift the water directly from the sump constructed around the river to the elevated header tank using motor pump. The second option is to lift the water from the storage constructed around the command area while the water from the river is conveyed to the storage by gravity. For the second option either solar or treadle pump can be used to lift the water from the storage to elevated water tanker depending on the amount of discharge required for the drip system.

The discharge of pressurized treadle pump generally varies from 0.3 to 1 l/s and the initial investment cost is relatively low. Though it is possible to get solar pump with different range of discharge and head, the initial investment cost especially for higher discharge is high compared to other water lifting device.

## **Water Application**

The water application methods chosen for the system are furrow, basin and drip. The basic description and suitability of the water application method is presented in the table below.

### Low cost Family Drip

Table 5 Summary of Drip Kit (FDK) Specification and Cost of installation

|  |  |  |
| --- | --- | --- |
| **Specification** | **Family Drip Kit (500m2)** | **Family Drip Kit (1000m2)** |
| Emitters tubes No @0.30m spacing | 1670 | 3340 |
| Number and Length of drip Laterals@1m spacing, LDPE, 16mm | 25 lines  20 m | 40 lines  25 m |
| Sub-main Outer  Diameter and  Length, HDPE | 25-mm OD  25 m | 25-mm OD  25 m |
| Screen Filter Size | 25 mm inlet & outlet | 25 mm inlet &  outlet |
| Operating Head  (Height of Tank) | 2 meter | 2.5 meter |
| Emitter Flow | 2.4 liters/hour | 2.4 liters/hour |
| Water Storage | 1000 liters | 2000 liters |
| Crops |  |  |
| **Estimated cost (ETB)** | **16000** | **28000** |

### Furrow /Basin Irrigation System

In furrow irrigation, only a part of the land surface (the furrow) is wetted thus minimizing evaporation loss. Furrow irrigation is adapted for row crops like corn, banana, tobacco, and cabbage. It is also good for grains. Irrigation can be by corrugation using small irrigation streams.

The width of the furrows varies from 250-400 mm, the depth from 150-300 mm and the spacing between the furrows from 0.75-1.0 m, Slope 0.05-2%, furrow length depending on soil type, crops and stream size to be applied to the furrow. From farmers practice the furrow length should be limited to less than 10m.

Table 6 Furrow slope, stream size and Irrigation depth for different soil types (for smallholder)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Furrow slope (%) | Maximum stream size (l/s) per furrow | Clay | | Loam | | Sand | |
| Net irrigation depth (mm) with furrow length (m) | | | | | |
| 50 | 75 | 50 | 75 | 50 | 75 |
| 0.0 | 3.0 | 100 | 150 | 60 | 90 | 30 | 45 |
| 0.1 | 3.0 | 120 | 170 | 90 | 125 | 45 | 60 |
| 0.2 | 2.5 | 130 | 180 | 110 | 150 | 60 | 95 |
| 0.3 | 2.0 | 150 | 200 | 130 | 170 | 75 | 110 |
| 0.5 | 1.2 | 150 | 200 | 130 | 170 | 75 | 110 |

Source: FAO SAFR – 2002, Irrigation Manual module 7 (pp 17).

Table 7 Table 5 Basic description and suitability of water application method for river pumping.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type of water application | Basic description | Suitability | | | |
| Crop | Soil | Slope | Water |
| Drip | Slow and regular application of water, directly to the root zone of plants, through the network of economically designed plastic pipes. It involves dripping water onto the soil at very low flow rates (0.2–20 l/h) from a system of small-diameter plastic pipes fitted with outlets.  Initial investment cost is high compared to other application method.  The labour requirement is lower compared to other water application method | Suited for vegetables (Onion, potato, cabbage, pepper, tomato), and most row and fruit tree crops (mango, papaya, avocado) | Best suited to sandy soils although it is adaptable to most soils due to possibility of a more frequent application of water at small flow rate than surface & sprinkler systems | Adaptable to any farmable slope, whether uniform or undulating, but slope of the land has a factor in uniformity of emitter discharge especially for low pressure drip system | River water should be filtered to the standerd of good quality to protect the clogging of emitter  More efficient use of available water compared to other water application method (85 to 95%) |
| Furrow | Furrows are small, parallel channels, made to carry water in order to irrigate the crop. The crop is usually grown on the ridges between the furrows  Furrow irrigation stream sizes are usually 0.2–3.0 l/s | * row crops such as maize, sunflower, sugarcane, soybean; * crops that would be damaged by inundation, such as vegetables (Onion, potato, cabbage, pepper, tomato), beans; * fruit trees such as mango, papaya, avocado, citrus, grape * broadcast crops (corrugation method) such as wheat | Furrows can be used on most soil types | 0.05 to 0.5% | Stream sizes up to 0.5 l/sec will provide an adequate irrigation provided the furrows are not too long. When larger stream sizes are available, water will move rapidly down the furrows and so generally furrows can be longer. The maximum stream size in any case should not larger than 3 l/sec |
| Basin | Basin irrigation where water is applied to a flat area surrounded by dikes. The water ponded in the basin area continues to percolate into the soil sometime after the stream has been turned off. Basin irrigation stream sizes are usually 15–240 liters per second depending on soil texture, field size, required depth of irrigation and bund height | * pastures, e.g. alfalfa, clover; * trees, e.g. mango, avocado, papaya, citrus, banana, * crops which are broadcast, such as cereals; * to some extent row crops such as tobacco | * Clays & loamy soils * Coarse sands are not recommended | The flatter the land surface, the easier it is to construct basins. On flat land only minor levelling may be required to obtain level basins | Stream size of the basin can vary from 5 to 90 l/s |

NB: The detail description of the above water application method can be referred from SSIGL-15 & SSIGL-18 of National Guidelines for SSID in Ethiopia (MoA, 2018)

Box 3 Key Issues for Drip on River Pumps

* **Drip** – women extensively contributed to vegetable farming under the drip irrigation system .that it reduce women work load and have a significant impact on family food and nutritional intake. This also had a positive impact on women decision making role and alternative livelihood.
* While selecting the water application method and water lifting device option, due emphasis should be given to the interest of women farmers.

## **Crop Selection**

Since Perennial River pumping has continuous water supply throughout the year it is possible to cultivate crop more than one time by full irrigation. It is also possible to cultivate by supplementary irrigation and seeding production. The crop that grown by river pumping should be:

* Low water consumption crops
* High Value crops
* Early maturing crops
* Nutritionally dense crops
* The crops that the farmers prefer and production experience
* Tolerance to water stress and pests

The following vegetables and fruit are recommended for this technology.

Vegetable: Tomato, Potato, onion, garlic, shallot, cabbage, lettuce, swiss chard, cauliflower, Ethiopian kale, green beans, pepper, carrot, beetroot,

Fruit: - papaya, mango, avocado,

Seedling production: Onion, tomato, pepper, cabbage

Cereals: - maize

Pulses: Snap bean

Table 8 Crop selection based on agro ecology zone

|  |  |  |  |
| --- | --- | --- | --- |
| Crop category | High land (>2300masl) | Mid ( 1300-2300masl) | Low lands (<1300masl) |
| Vegetable | Potato, cabbage, garlic, lettuce, carrot , beet root, swiss charge, cauliflower, broccoli, Ethiopian kale, shallot, hot pepper | Cabbage, potato, carrot , beet root, Swiss chard, cauliflower, broccoli, Ethiopian kale, Tomato, onion, pepper | Tomato, onion, pepper |
| Fruit | Apple, peach, | Apple Peach, Guava, Pina apple | Papaya, mango, avocado, banana, Guava, |
| Cereals |  | maize | maize |
| Pulse |  | Snap beans/green beans | Snap beans/ green beans |

Table 9 Sensitive growth period of vegetable crops for water shortage

|  |  |
| --- | --- |
| Crop | Growth periods sensitive to water deficit |
| Cabbage | During head enlargement and ripening |
| Carrot | Throughout the growth period |
| Onion | Bulb enlargement, particularly during rapid bulb growth > vegetative period (and for seed production at flowering) |
| Pepper | Throughout but particularly just prior and at start of flowering |
| Potato | Period of stolonization and tuber initiation, yield formation > early vegetative period and ripening |
| Tomato | Flowering > yield formation > Vegetative period, particularly during and just transplanting |

Box 4 Key Issues for Generation of Additional Income

To generate additional income, nearby markets are important for the sale of the vegetables and fruits; therefore local market demand and access should be taken in to consideration. Moreover, involvement of women in seed selection, planting and sales of the final product should be ensured. This enforces choice of women and also ownership of the product sale.

For irrigation interval calculation, soil water holding capacity (Heavy, medium and light), effective crop root depth, crop development stage and manageable allowable depletion is taken in to account.

## **Command Area**

The command area for a given a river pump yield depend on crop water requirement which it turn depend on various factor including climate, crop type & characteristics. The table below shows indicates preliminary estimation of the command area for river pump yield.

The command area for a given a river pump yield depend on crop water requirement whichin turn depend on various factor including climate, crop type & characteristics. The table below shows indicates preliminary estimation of the command area for river pump yield.

Table 10 Command area for different river pump discharge for Highland, midland and Low land agro ecology for different irrigation hours

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| River Pump discharge (l/sec) | Command area (ha) for each well Discharge for 12 hr irrigation | | | | | | | | |
| furrow, basin irr | | | watering can irr | | | drip irr. | | |
| Highland | Mid | low | Highland | Mid | low | Highland | Mid | low |
|  | Irr Duty (l/sec/ha) for 12 hr full irrigation | | | | | | | | |
|  | 1.5 | 1.87 | 2.24 | 1.2 | 1.5 | 1.79 | 1 | 1.25 | 1.5 |
| 1.00 | 0.67 | 0.53 | 0.45 | 0.83 | 0.67 | 0.56 | 1.00 | 0.80 | 0.67 |
| 2.00 | 1.33 | 1.07 | 0.89 | 1.67 | 1.33 | 1.12 | 2.00 | 1.60 | 1.33 |
| 3.00 | 2.00 | 1.60 | 1.34 | 2.50 | 2.00 | 1.68 | 3.00 | 2.40 | 2.00 |
| 4.00 | 2.67 | 2.14 | 1.79 | 3.33 | 2.67 | 2.23 | 4.00 | 3.20 | 2.67 |
| 5.00 | 3.33 | 2.67 | 2.23 | 4.17 | 3.33 | 2.79 | 5.00 | 4.00 | 3.33 |
| 6.00 | 4.00 | 3.21 | 2.68 | 5.00 | 4.00 | 3.35 | 6.00 | 4.80 | 4.00 |
| 7.00 | 4.67 | 3.74 | 3.13 | 5.83 | 4.67 | 3.91 | 7.00 | 5.60 | 4.67 |
| 8.00 | 5.33 | 4.28 | 3.57 | 6.67 | 5.33 | 4.47 | 8.00 | 6.40 | 5.33 |
| 9.00 | 6.00 | 4.81 | 4.02 | 7.50 | 6.00 | 5.03 | 9.00 | 7.20 | 6.00 |
| 10.00 | 6.67 | 5.35 | 4.46 | 8.33 | 6.67 | 5.59 | 10.00 | 8.00 | 6.67 |
| 12.00 | 6.12 | 4.91 | 4.10 | 7.63 | 6.12 | 5.12 | 9.16 | 7.34 | 6.24 |
|  | Command area (ha) for each well Discharge for 10 hr irrigation | | | | | | | |  |
| River Pump discharge (l/sec) | furrow, basin irr | | | watering can irr | | | drip irr. | | |
| Highland | Mid | low | Highland | Mid | low | Highland | Mid | low |
|  | Irr Duty (l/sec/ha) for 10 hr full irrigation | | | | | | | | |
|  | 1.8 | 2.24 | 2.69 | 1.44 | 1.8 | 2.15 | 1.2 | 1.5 | 1.76 |
| 1.00 | 0.56 | 0.45 | 0.37 | 0.69 | 0.56 | 0.47 | 0.83 | 0.67 | 0.57 |
| 2.00 | 1.11 | 0.89 | 0.74 | 1.39 | 1.11 | 0.93 | 1.67 | 1.33 | 1.14 |
| 3.00 | 1.67 | 1.34 | 1.12 | 2.08 | 1.67 | 1.40 | 2.50 | 2.00 | 1.70 |
| 4.00 | 2.22 | 1.79 | 1.49 | 2.78 | 2.22 | 1.86 | 3.33 | 2.67 | 2.27 |
| 5.00 | 2.78 | 2.23 | 1.86 | 3.47 | 2.78 | 2.33 | 4.17 | 3.33 | 2.84 |
| 6.00 | 3.33 | 2.68 | 2.23 | 4.17 | 3.33 | 2.79 | 5.00 | 4.00 | 3.41 |
| 7.00 | 3.89 | 3.13 | 2.60 | 4.86 | 3.89 | 3.26 | 5.83 | 4.67 | 3.98 |
| 8.00 | 4.44 | 3.57 | 2.97 | 5.56 | 4.44 | 3.72 | 6.67 | 5.33 | 4.55 |
| 9.00 | 5.00 | 4.02 | 3.35 | 6.25 | 5.00 | 4.19 | 7.50 | 6.00 | 5.11 |
| 10.00 | 5.56 | 4.46 | 3.72 | 6.94 | 5.56 | 4.65 | 8.33 | 6.67 | 5.68 |
| 12.00 | 6.12 | 4.91 | 4.10 | 7.63 | 6.12 | 5.12 | 9.16 | 7.34 | 6.24 |
|  | Command area (ha) for each well Discharge for 8 hr irrigation | | | | | | | |  |
| River Pump discharge (l/sec) | furrow, basin irr | | | watering can irr | | | drip irr. | | |
| Highland | Mid | low | Highland | Mid | low | Highland | Mid | low |
|  | Irr Duty (l/sec/ha) for 8 hr full irrigation | | | | | | | | |
|  | 2.25 | 2.81 | 3.36 | 1.8 | 2.24 | 2.69 | 1.5 | 1.87 | 2.24 |
| 1.00 | 0.44 | 0.36 | 0.30 | 0.56 | 0.45 | 0.37 | 0.67 | 0.53 | 0.45 |
| 2.00 | 0.89 | 0.71 | 0.60 | 1.11 | 0.89 | 0.74 | 1.33 | 1.07 | 0.89 |
| 3.00 | 1.33 | 1.07 | 0.89 | 1.67 | 1.34 | 1.12 | 2.00 | 1.60 | 1.34 |
| 4.00 | 1.78 | 1.42 | 1.19 | 2.22 | 1.79 | 1.49 | 2.67 | 2.14 | 1.79 |
| 5.00 | 2.22 | 1.78 | 1.49 | 2.78 | 2.23 | 1.86 | 3.33 | 2.67 | 2.23 |
| 6.00 | 2.67 | 2.14 | 1.79 | 3.33 | 2.68 | 2.23 | 4.00 | 3.21 | 2.68 |
| 7.00 | 3.11 | 2.49 | 2.08 | 3.89 | 3.13 | 2.60 | 4.67 | 3.74 | 3.13 |
| 8.00 | 3.56 | 2.85 | 2.38 | 4.44 | 3.57 | 2.97 | 5.33 | 4.28 | 3.57 |
| 9.00 | 4.00 | 3.20 | 2.68 | 5.00 | 4.02 | 3.35 | 6.00 | 4.81 | 4.02 |
| 10.00 | 4.44 | 3.56 | 2.98 | 5.56 | 4.46 | 3.72 | 6.67 | 5.35 | 4.46 |
| 12.00 | 4.88 | 3.91 | 3.28 | 6.12 | 4.91 | 4.10 | 7.34 | 5.88 | 4.91 |

**Note:** The maximum command area for group of household, by river pump, furrow and basin irrigation is up to 5 ha, and for drip irrigation is up to 0.50ha.

## **Irrigation Water Management**

For irrigation interval calculation, soil water holding capacity (Heavy, medium and light), effective crop root depth, crop development stage and manageable allowable depletion is taken in to account.

Table 11 Irrigation interval based on water application methods under different Agro- ecology







## Deficit Irrigation Strategy

Deficit irrigation (DI) is needed and/or practiced where essential resources such as water, capital, energy, and/or labor are scarce and limited. The potential benefits of deficit irrigation may be achieved from the following factors:

1. Increased irrigation efficiency
2. Reduced costs of irrigation
3. The opportunity costs of water: As the efficiency and profit are both increased with reduced levels of applied water, the net income per unit of applied water is increased. The awareness on deficit irrigation strategy (objectives and needs) should need serious attentions for end users.

Description of Different Irrigation Scheduling Methods or Approaches reducing the depth of irrigation is then used to bring additional land under irrigation (with the same incremental profit per unit of land, or even something less), the total farm profit is still more. The net income from the additional land represents the opportunity cost of water. It is advisable to use deficient irrigation in area where there is serious water shortage. The stage of the crop that we minimize irrigation water application should be the stage that crop demanded minimum water with minimum impact on yield. This stage is at non-sensitive growth stage of crop as shown on the table above. From the evidence of different research outputs conducted in various locations about 25–40% water compared to continuous water application can be saved in this method, but with negligible or insignificant yield reduction.



Table 12 Deficit Irrigation Technical Features

|  |  |  |
| --- | --- | --- |
| **Technical conditions** | **Advantages** | **Constraints** |
| * Increasing interval between irrigations (irrigation frequencies are reduced). * Increasing the days of interval between successive irrigations. * Omitting irrigation during certain growth stages: Irrigation can be omitted during the stage or stages which are less sensitive to moisture deficit. * Wetting alternate furrows | * Deficit irrigation maximizes water use efficiency. * In water limiting areas, this practice is economically more profitable than maximizing yield per unit area. * It creates less humid environment around the crop than full irrigation, thus decreasing the risk diseases. * Increases quality of the yield. * Reduce nutrient loss through leaching. * Increases assimilate partitioning to grain from vegetative parts. * Reduce cropping growth cycle. | * Yield response to water deficit at different growth stages should be studied carefully. * Water should be available at sensitive growth stages. * In saline area, leaching of salts from the root zone is lower under DI than under full irrigation. |

Table 13 Agronomic recommendation of cabbage cultivating by furrow and drip irrigation at high and mid land (sample)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Activity Description | | Unit | Furrow | | Drip | |
| Mid land | High land | Mid land | High land |
| Land size | | ha | 1 | 1 | 1 | 1 |
| Land clearing preparation | | Freq. | 4 | 4 | 4 | 4 |
| Seed (tuber) | | kun | 22 | 22 | 22 | 22 |
| Spacing | | cm | 75 x 30 | | | |
| Fertilizer | NPS | Kun | 2.42 | 2.42 | 2.42 | 2.42 |
| Urea | Kun | 1.5 | 1.5 | 1.5 | 1.5 |
| Insecticide | Endosulfine | lit | 2 | 2 | 2 | 2 |
| Fungicide | Redomil | kg | 2 | 2 | 2 | 2 |
| Cultivation | | days | 20-30 | 20-30 | 20-30 | 20-30 |
| Cultivation | | Freq. | 3 | 3 | 3 | 3 |
| Irrigation |  |  |  |  |  |  |
| Heavy soil | Initial | days | 4 | 5 | 3 | 4 |
| Dev' ,Mid and late | days | 6 | 8 | 3 | 4 |
| Medium soil | Initial | days | 3 | 4 | 3 | 4 |
| Dev' ,Mid and late | days | 5 | 7 | 3 | 4 |
| Light soil | Initial | days | 4 | 4 | 3 | 4 |
| Dev' ,Mid and late | days | 5 | 6 | 3 | 4 |
| Expected yield | | Qt | 500 | 500 | 625 | 625 |
| Irrigation amount | | M3 | 8330 | 10000 | 3056 | 3667 |

For agronomic practice related to different crops shown above, refer crop extension package (MoA, 2018)

## **Market, Credit and Technology Extension Strategy**

### Extension Strategy

In promoting river pump technology to farmer, appropriate extension approach is important for success full promotion, dissemination and adoption of the technology to beneficiaries.

Participatory extension approach and methods – In using this method male and female farmers have the chance of selecting the technology and participate in planning process with development agent during introduction and implementing period

Table 14 Best Extension approach to be followed in promoting the technologies are in detail described in the table below

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of HHMI technology | Technology implementing stage | Extension Approach and Methods | Extension tools | Key intervention  Gender |
| River pumping | Awareness creation | Individual –contact | * Farm and home visit * office calls and inquiries, * Informal contact, Personal letters / * telephone calls | * Consider women farmers level of understanding and use words and methods appropriate to their level * Increase participation of women farmers by identifying appropriate time, place for training |
| Group-contact | * Group meetings / group discussions (manageable group size for effective message conveyance. * Field day, ,Study tours |
| Technology selection | Individual | * Farm and home visit, Informal contact, * Note, Detailed description of pump type specification that fit to local area(diesel or petroleum) | * Inform female farmers the available technology used for river pumping using descriptive illustrations or physical demonstration * To ensure female active participation good to have women only group * Encourage female farmers to participate |
| Group | * FTC training * Method & Result demonstration, * Group meetings / group discussions * Field day, Study tours / field trips |
| Mass | * poster, leaflet, printing materials, Documentary video, |
| Farmer-selection  And group formation formal or debo…. | Individual | * Farm and home visit, Informal contact, | * Ensure women and men have equal access to information, training and technology * Target HH as a whole instead of head of the household using GMF[[1]](#footnote-1) approach * Consider level of women’s control over resources and decision making and empower them through GMF, and trainings |
| Group method | * Formal training in FTCs * Method and Result demonstrations, * Field days, Farm walks, * Group meetings, Folk media, * Farmer field schools.-for practical training on operation and maintenance of pump |
| Technology dissemination | Mass methods | * mass media (Leaflet, brochure, poster, * Documentary video) , Movie Film, * Television and video ,Newspapers * technology promotion festivals, and | * Printing Medias and audio visuals have to be in a descriptive ways so women who in most cases unable to read can easily understand. * Pictures and/or movies should have to clearly show women using the technology as men |

Identification and documentation of best practices needs Female and male farmer’s indigenous Knowledge and experience in adopting technologies are important and need to be identified and documented for scaling out of the technology where it is not reached yet. So, for the dissemination and scale out of best practice extension agent can use experience sharing methods and mass media technology**.**

### Access to Credit and Market Strategy

In order to cover the purchase costs of river pumping 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. In addition to this, the government of Ethiopia is considering develop strategy to access HHMI technologies to have tax free for the rural farmers and this make the technology affordable to the farmers in order to ensure sustainable HHMI development.

## **Financial Analysis**

### Financial Analysis of proposed micro irrigation technology package

Currently irrigation development of any scale is the major focus areas of government and other development partners. This is because; irrigation development is the first best alternative agricultural operation in boosting production and productivity of resources and ensures food security. Moreover, it provides inputs forever expanding industrial park in the country that enables the country to realize structural transformation. House Hold Micro Irrigation (HHMI) is important scale of irrigation which enables to access large number of households, facilitates to realize inclusive irrigation development, ease to apply with reasonable affordability. Moreover; House hold micro irrigation ease youth and women mobilization for economic development as the scale of irrigation is easily applied in the nearby residential areas and manageable with minimum requirement of knowhow of these target groups.

Based on this rationalities and importance of the scale of this irrigation, Ministry of Agriculture and Natural resources develop technology package development for Household Micro Irrigation Technology National Specification:

Promoting irrigated farming at the household level through introducing suitable household and micro irrigation systems, needs under taking financial and economic analysis so as to ensure its sustainability. This analysis includes all supply chain of this development such as, introducing appropriate micro irrigation technology, selecting sustainable water sources, low cost and effective water lifting technologies, irrigation application technologies, farm inputs and first best alternative that yield maximum returns from this investment.

Based on the above rationalities, financial and economic analysis of these micro irrigation technologies based on the national specification manuals has been done as follows.

Financial and economic analyses have similar features. Both financial and economic analysis estimate the net-benefits of a project investment based on the difference between the with-project and the without-project situations.The basic difference between them is that the financial analysis compares benefits and costs to the enterprise; a financial analysis estimates the profitability of a project, from an investor's perspective. In a financial analysis one compare the costs of the project to the expected revenue over the technology package lifespan. This includes costs of financing and taxes/subsidies. While the economic analysis compares the benefits and costs to the whole economy.

Economic analysis is concerned with the true value a project holds for the society as a whole. It incorporates all members of society, and measures the project’s positive and negative impacts. In addition, economic analysis would also cover costs and benefits of goods and services that are not sold in the market and therefore have no market price. While financial analysis uses market prices to check the balance of investment and the sustainability of a project, Economic analysis uses economic prices that are converted from the market price by excluding tax, profit, subsidy, etc. to measure the legitimacy of using national resources to certain projects.

Financial and economic analyses also differ in their treatment of external effects (benefits and costs), such as favorable effects on health environment etc... . Economic analysis attempts to value such externalities in order to reflect the true cost and value to the society. The inclusion of externalities raises difficult questions of their identification and measurement in terms of money. Having these differences in mind we would try to undertake viability analysis of proposed packages of micro irrigation technologies mainly based on its financial feasibility.

### Why Analysis?

As it has been frequently stated by many economists, resources used for production of desirable output are very scarce and demand for output from these resources are unlimited. This paradox phenomenon leads producers and investors to choose where to invest these scare resources so as to get maximum output in order to maximize benefits earned from these resources. Irrigation resources particularly irrigable land and water are extremely scares and current demand for these resources development is alarmingly growing. This paradox is the cause for undertaking financial and economic analysis using different decision making techniques such as Cost –Benefit analysis, Net present value analysis, payback period.

In the analysis the two discounting evaluation criteria are used to come up with feasible conclusions i.e. Net Present Value (NPV), and Benefit Cost Ratio.

**The Net Present Value (NPV)** is the discounted net benefit where the net benefit is the difference between total benefit and total cost.

The criteria of the NPV are: If NPV>0, then accept the project, If NPV<0, then reject the project and If NPV=0, accept most of the time.

**Benefit cost ratio:** The benefit cost ratio is the present value of total benefit divided by the present value of total cost. The larger B/C ratio, the more attractive is a project. In general, the B/C ratio is higher than 1 indicates that a project is viable. Conversely, with a ratio of less than 1, a project would be uneconomic; with a ratio of close to 1, a project’s economic value would be marginal. The overall concepts and frameworks for both financial analyses are presented in the figure below.

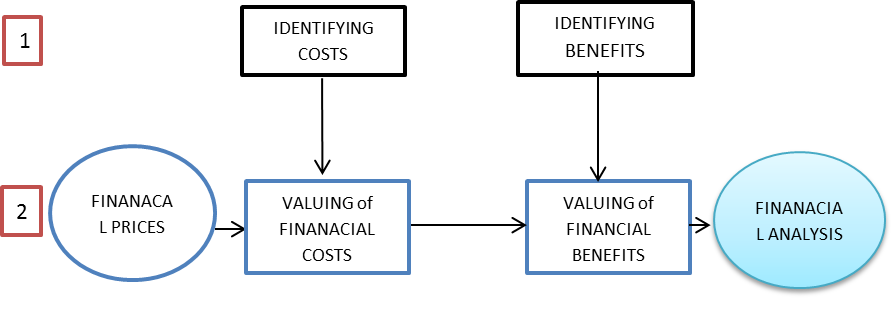


Figure 1 Overall concepts and frameworks for both financial analyses

With the above rationalities for house hold micro irrigation technology package of river pumping financial analysis with selected high value crop has been done as follows.

Investment Cost (infrastructure, technology supply) of River pumping package of HHMI has the following two cases.

**Case1:** Lifting water by using motor pump +Furrow

**Case2:** Lifting water by using motor pump + Drip system

Table 15 Indicative investment cost for River pumping HHMI package

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Item** | | **Case 1** | | | **Case 2** | | |
| Pump size | | 2" | 3” | 4” | 2" | 3” | 4” |
| Pump with accessories | | 12,000 | 16,000 | 30,000 | 12,000 | 16,000 | 30,000 |
| Delivery hose for 200m | | 8,000 | 9,000 | 11,000 | 8,000 | 9,000 | 11,000 |
| Drip system | |  |  |  | 12,000 | 16,000 | 30,000 |
| Total | | 20,000 | 25,000 | **41,000** | 32,000 | 41,000 | **71,000** |
| Area to be irrigated | | 3.3-6.6 | 5.6-11 | 8.7-17.3 | 0.25-0.5 | 0.25-0.5 | 0.25-0.5 |
| Estimated  cost per hectare | Max | 6,061 | 4,464 | 4,713 | 128,000 | 164,000 | 284,000 |
| Min | 3,030 | 2,273 | 2,370 | 64,000 | 82,000 | 142,000 |

For this River pumping HHMI package, minimum size of pump is recommended for drip irrigation system covering 2500 m2 to 5000 m2.However, large size pump can also be used to irrigate additional area by using surface irrigation methods. For case 2, the area is estimated for drip irrigation. However, if we include surface irrigation directly from the pump in addition to drip irrigation, the area will be similar to case1. The estimation of irrigable area in this table is assuming 8hrs working time of pump. Operation and maintenance cost will be calculated by 5% of investment cost for each year.

**Case1:** Lifting water by using motor pump +Furrow

* Command area: 0.5ha

Table 16 Financial analysis of river pumping technology and furrow application.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Lifting water by using motor pump +Furrow | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 30,000 | 29,000 | 128,333 | 99,333 | 336,182 | 3 | <1 | Financially viable |
| Tomato | 30,000 | 56,835 | 266,667 | 209,832 | 1,259,206 | 4 | <1 |
| H. Cabbage | 30,000 | 15,760 | 75,000 | 59,240 | 289,026 | 3 | <1 |
| Potato | 30,000 | 22,400 | 133,333 | 110,933 | 330,983 | 3 | <1 |
| Onion seedling | 30,000 | 12,110 | 24,214 | 12,104 | 44,369 | 3 | <1 |
| Tomato seedling | 30,000 | 50,211 | 160,000 | 109,789 | 614,542 | 3 | 3 |
| Papaya |  | 50,000 | 150,000 | 100,000 | 644,542 | 3 | 3 |
| Avocado | 30,000 | 66,700 | 533,333 | 466,633 | 2,836,995 | 7 | 3 |

Under this case the schemas is considered to be owned by individual farmers or limited to 0.5 hectare. Total cost of initial investment is incurred to only 0.5 hectare and there is no probability to over distribute to the maximum potential of the River pumping due to availability of enough irrigable land or any other cases.

**Decision**

As it has been indicated on the above table all decision criterion shows as investment on all crops are found to feasible. But the resources of irrigation such as irrigable land, water, water lifting and application technologies are too expensive and need producers to invest on relatively high value and high profit margin agricultural commodities. In such cases it is advisable to dictate producers to prioritize avocado, papaya, tomato and potatoes.

**Case2:** Lifting water by using motor pump + Drip

* Command area: 0.5ha

Table 17 Financial analysis of river pumping technology with drip application.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Lifting water by using motor pump +Furrow | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 71,000.00 |  |  |  |  |  |  |  |
| Tomato | 71,000.00 |  |  |  |  |  |  |  |
| H. Cabbage | 71,000.00 |  |  |  |  |  |  |  |
| Potato | 71,000.00 |  |  |  |  |  |  |  |
| Onion seedling | 71,000.00 |  |  |  |  |  |  |  |
| Tomato seedling | 71,000.00 |  |  |  |  |  |  |  |
| Papaya | 71,000.00 |  |  |  |  |  |  |  |
| Avocado | 71,000.00 |  |  |  |  |  |  |  |

**Decision**

This analysis should be worked by the team of expertise.

## **Monitoring and Evaluation**

Monitoring and Evaluation (M&E) tools for monitoring and evaluation of the river pumping technology package is given in Table 13, 14 and 15.

Table 18 M & E tools for river pump (Water source).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Criteria/Principle | Indicator | Unit | Data Source | Data Collection Method |
| Performance | River discharge (l/sec) | M3 | On-situ at river | River Lean flow/discharge measurement |
| Water loss (evaporation, seepage, leakage and abstraction for other purposes) | M3 | Meteorology & measurement at scheme | Meteorology station & application and flow measurement |
| Pump full capacity | Yes/No | On-situ at river pump | 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 (fence, cover, etc.) | Yes/No | Site Visit | Site Visit |
| Operation & Management | Use of local construction material & pump | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| Affordability | Cost of construction and/or pump supply | Affordable/ Expensive | Site Visit/Farmers | Site Visit/Interview |
| Cost of maintenance | None/Low/  Medium/High | Site Visit/Farmers | Site Visit/Interview |
| 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 |

Table 19 Water lifting Technologies.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Solar Pump** | | | | **Treadle/ hip pump** | | | |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Water discharge | litter/min | On-situ at Pump | Discharge Measurement | Water discharge | Littre/min | On-situ at Pump | Discharge Measurement |
| Total Head | Meter | On-situ at Pump | Head Measurement | Total Head | Meter | On-situ at Pump | Head Measurement |
| Power Requirement | KW (Hp) | On-situ at Pump | Power Measurement | Power Requirement | Person per hour | On-situ at Pump | Power Measurement |
| Speed | RPM | On-situ at Pump | rpm Measurement | Weight | Kg | On-situ at Pump | Measurement |
| Pump efficiency | % | On-situ at Pump | Measurement | Pump efficiency | % | On-situ at Pump | Measurement |
| **Operation Management** | Operational duration | Hours/month | On-situ at Pump | Measurement | Ease of use (especially for women sensitivity) | Yes/No | On-situ at Pump | Measurement |
| Safety (fence, cover, etc.) | Yes/No | On-situ at Pump | Measurement | Proper construction of pump wrt to design | Standard/Non-standard | On-situ at Pump | Observation |
| Weight | Kg | On-situ at Pump | Measurement | Proper installation of the pump as per the design | Yes/No | On-situ at Pump | Measurement |
| Easy of operation (with respect to light intensity and direction) | Easy/  Not Easy | On-situ at Pump | Measurement |  |  |  |  |
| Cost of ownership | Affordable/  Expensive | On-situ at Pump | Measurement |  |  |  |  |
| Cost of operation | Affordable/  Expensive | On-situ at Pump | Measurement |  |  |  |  |
| **Maintenance** | Local maintainability | Yes/No | On-situ at Pump | Measurement | Local maintainability on piston, hose, etc. | Yes/No | On-situ at Pump | Measurement |
| Frequency of maintenance | None/Low/ Medium/High | On-situ at pump | Measurement | Frequency of maintenance on piston, hose, etc. | None/Low/ Medium/High | On-situ at pump | Measurement |
| Cost of maintenance | None/Low/ Medium/High | On-situ at Pump | Measurement | Cost of maintenance on piston, hose, etc. | None/Low/ Medium/High | On-situ at Pump | Measurement |
| Spare part availability | None/Low/ Medium/High | Local market survey | Interview | Spare part availability on rope, bushing, bearing, etc. | None/Low/ Medium/High | Local market survey | Interview |
| Cost of spare parts | None/Low/ Medium/High | Local market survey | 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 |

Table 20 Water application technologies.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Drip Irrigation | | | | | Furrow Method | | | | Hose | | | | Water Can | | | |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Efficiency[[2]](#footnote-2) | % | Site Visit/Farmers | Site Visit/Interview | Efficiency | % | Site Visit/Farmers | Site Visit/Interview | Efficiency | % | Site Visit/Farmers | Site Visit/Interview | Efficiency | % | Site Visit/Farmers | Site Visit/Interview |
| Service life | Years | Site Visit/Farmers | Site Visit/Interview | Standard furrow size (depth, length and width) | Yes/No | On-situ | 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 | Quality of Material | Poor/Good | Site Visit/Farmers | Site Visit/Interview |
| Water uniform[[3]](#footnote-3) application | Yes/No | Site Visit/Farmers | Site Visit/Interview | Uniform application | Yes/No | 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 | Water saving | Bad/Good | Site Visit/Farmers | Site Visit/Interview | Water saving | Bad/Good | Site Visit/Farmers | Site Visit/Interview |
| **Operation and Management** | Installation of the drip as per the design | Yes/No | Site Visit/Farmers | Site Visit/Interview | Furrow as per the design | Yes/No | Site Visit/Farmers | Site Visit/Interview | Hose as per the standard | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
| Ease of use | Simple/Difficult | Farmer | Farm Survey | Construction of the furrow as per the design | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  | Ease of use | Simple/Difficult | Farmer | Farm Survey |
| Ease of water abstraction | Simple/Moderate/  Difficult | Farmers/Users | Interview | Ease of use | Simple/Difficult | Farmer | Farm Survey | Ease of use | Simple/Difficult | Farmer | Farm Survey |  |  |  |  |
| Ease of installation | Yes/No | Site Visit/Farmers | Site Visit/Interview | Ease of water abstraction | Simple/Moderate/  Difficult | Farmers/Users | Interview |  |  |  |  |  |  |  |  |
| Use of local[[4]](#footnote-4) construction material | Yes/No | Site Visit/Farmers | Site Visit/Interview | Ease of construction | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |  |  |  |  |
| Cost of drip system/initial investment | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview | Use of local construction material | Yes/No | Site Visit/Farmers | Site Visit/Interview | 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 installation | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview | Cost of furrow/initial investment | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview | Cost of hose/initial investment | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |
|  |  |  |  | Cost of construction | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |  |  |  |  |
|  |  |  |  | Furrow management | Poor/ Medium/Good | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |  |  |  |  |
| **Maintenance** | Clogging problem | Low/Medium/High | Site Visit/Farmers | Observation |  |  |  |  |  |  |  |  | Clogging problem for sprinkler | Low/Medium/High | Site Visit/Farmers | Observation |
| Local maintainability | Yes/No | Site Visit/Farmers | Site Visit/Interview | Local maintainability | Yes/No | Site Visit/Farmers | Site Visit/Interview | 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 | Frequency of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/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 | Cost 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 |  |  |  |  |
| Spare part availability | None/Low/Medium/  High | Local market survey | Interview |  |  |  |  |  |  |  |  |  |  |  |  |
| Cost of spare parts | None/Low/Medium/  High | Local market survey | Interview |  |  |  |  |  |  |  |  |  |  |  |  |
| Drip system accessibility at local market | None/Low/Medium/  High | Local market survey | Interview |  |  |  |  |  |  |  |  |  |  |  |  |
| **Cross Cutting** | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview | 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 | Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview | Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |

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. Efficiency refers to application efficiency where water abstracted is delivered from the source versus amount of water used by the crop. [↑](#footnote-ref-2)
3. Uniformity refers to application of water from head to tail. [↑](#footnote-ref-3)
4. Refers to whether the community uses local materials and indigenous knowledge [↑](#footnote-ref-4)