

**Farm Pond Irrigation Technology Package**

**HHMIT Package-1**

**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 areas 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 preparing HHMIT package 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 mechanismhighlighted 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 needs 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 is 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 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 individualor 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 pump

## **Irrigation water application**

The following irrigation water applications 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.

# **FARM POND TECHNOLOGY PACKAGE**

## **Water Sources**

A pond serves compatible multi- purposes such as irrigating one or more field crops, water for live-stock and for fish production. Storage requirement for each purpose is considered to be sure of an adequate supply for all intended uses. Farm ponds and reservoirs may be divided into two general types; namely, embankment and excavated ponds. An embankment pond is a body of water created by constructing a barrier across a stream or watercourse and is usually built in areas where land slopes range from gentle to moderately steep and where stream valleys are sufficiently depressed to permit the storage of water to a considerable depth. An excavated pond is a body of water created by excavating a pit or dugout. These usually are constructed in relatively level areas. The fact that their capacity is obtained almost entirely by excavation limits their use to locations where only a small supply of water is required.

In this package, a household pond having water storage capacity of 80-201 m3capacity is considered. The water stored can be harvested from ground surface runoff water, river or spring. And Geo-membrane and Masonry are used as a lining material. Farmers could use the ponds either for full or supplementary irrigation. Different size and lining of ponds are presented in Table-1

Table 1-Scenario Based Different Kinds of farm ponds

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Lining material** | **Volume** | **Silt trap material** |
| Case-1 | Geo-membrane | 80.8 m3 | Masonry |
| Case-2 | Geo-membrane | 84 m3 | Masonry |
| Case-3 | Masonry | 80.8m3 | Masonry |
| Case-4 | Masonry | 84 m3 | Masonry |
| Case-5 | Masonry | 156 m3 | Masonry |
| Case-6 | Masonry | 201 m3 | Masonry |

NB: Refer Detail design of farm pond based on different pond sizes and side slopes in HHMI training manual and National specifications.

|  |
| --- |
| **Environmental Consideration:**Ponds usually hold stagnant water which can attract various pathogen, disease vectors and pollution. For instance, mosquitoes breed in rainwater storages and they are vectors of serious diseases such as malaria, yellow fever, dengue fever and filariasis. Several approaches to mosquito control have been tried with some success. These include the addition of small amounts (5 ml per 1000 liters) of domestic kerosene and mechanical disturbance of the stored water. Basically pond water is for Irrigation purposes but not for drinking. However; in a very water scarce areas, people are used to drink and for other domestic uses. It is strongly advisable to not use. In case it is used, it should be carefully treated and boiled or treated with chemeical (Agar). For safety and security, appropriate fencing should be done to protect human and animals’ entrances.  **Gender**   * Farm pond development near the homestead increases the women’s irrigation water management, so that agricultural productivity can increase. * . Family nutritional status can also be improved due to diverse crop intensification. * Provide equal access to water service and employment and empower women economically |

## **Water Lifting Technologies**

Alternative water lifting technologies for farm pond can be selected using the following criterion;

* Low Head & discharge
* Ease of utilization
* Low operation and maintenance cost
* Easiness of maintenance and repairs
* Environmental and women friendly

Based on above criterion suitable water-lifting devices for the aforementioned farm ponds are; Watering Can, Hip Pump (Hand Pump), treadle Pump and Solar pumps.

**Watering Can:**

Table 2-Watering can Technical condition and limitations

|  |  |
| --- | --- |
| Technical conditions | limitations |
| * Farm pond should be in immediate vicinity (< 50m) * Simple and accessible * Women friendly * Less cost * Applicable both in rural and Urban areas | * High labor input * Access to a nearby water source * Cover Small area (50-100m2) * Application for small vegetable production |

**Hip Pump: -** Hip pumps are hand-operated with support from hips. The hip pump allows users to use their legs, body weight, and momentum, rather than the small muscles of the upper back and shoulders. Hip pumps are used to pump water from hand-dug wells, rivers, streams, lakes and ponds. It is ideal for micro sprinkler irrigation, filling overhead water tanks and for direct application with nozzles and sprays attached to the end of the delivery hose. It does not need unique installation; it is like a hand bicycle or ball air pumping. It has light weight and good performance.

**Treadle pump: -**

Table 3-Treadle pump condition, requirements and constraints

|  |  |  |
| --- | --- | --- |
| Technical conditions | Requirements | Constraints |
| * Farm pond should be close to irrigated area * Suction lift not more than 7 m * Total head up to 14m * Extension of existing irrigated garden area 2000-3000m2 * Daily operation time less than 4 hours * Average Discharge, 1 l/sec * Two types (pressurized and overflow) * Push water distance on the flat ground, 200m * Potable no need of installation | • Farmers familiar with garden irrigation and access to market  • Capacity for local manufacturing and after sales service  • Demonstration and advisory services for improved field irrigation system | * Labor intensive and restricted to 3–4 hours/day * Area limited to 2000–3,000 m2 * Poor quality of local manufacturing * Inadequate field irrigation system * To make it women friendly, need to choose the easy one * the gravity overflow model, as the small volume of water cannot be transported over any distance to the crop |

For detail operation &maintenance procedures please refer HHMI-TM training manual.

**Low Head solar pump: -** Solar panels operate more efficiently when pointed in direction sun’s rays. Set the solar panel at allowable distance, considering the suction length and depth.

Table 4-Solar pump Technical condition, requirements and constraints

|  |  |  |
| --- | --- | --- |
| **Technical conditions** | **Requirements** | **Constraints** |
| * total maximum head 6m * Adequate sunshine (8 to 12 KWh/m2/day) | * Panels and suitable pumps availability in the local market * Construction of reservoir for 2 to 3 days storage to increase discharge and periods of low sunshine * Low-pressure pipe system or drip irrigation * Competent technical advisory services for design and installation | * High investment costs * Low discharge * Only small garden areas (of 0.3 ha) can be irrigated |

Table 5-Effectiveness of solar pump

|  |  |  |  |
| --- | --- | --- | --- |
| Irrigation Method | Application Efficiency | Typical Head | Suitability with solar |
| Furrow | 50-60% | 0.5-1 | x, require high flow rate |
| Sprinklers | 70% | 10-20 | X, the head is less |
| Drip | 85% | 1-2 | Ok |
| Flood | 40-50% | 0.5 | X, require high flow rate |

Therefore, based on solar pump effectiveness drip irrigation is much more effective than other kind of water application technologies. Based on the available farm pond and water devices recommended, possible water application devices and command area are given in Table-6 below:

Table 6-Water lifting technologies

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Water lifting type** | **Max head (m)** | **Discharge** | **Max Command area** | **Cost (birr)** | **Operation time** | **Application method** | **Remark** |
| Watering Can | 4m | 0.25lit/sec | 50-100m2 | 70 | 4hrs/day | Direct by sprinkling, pouring or dropping | Used for emergency intervention |
| Hip pump | 7.0 |  | 0.25 ha | 2000 | 4 hrs/day | Drip |  |
| Treadle | 7.5 | 1 lit/sec | 0.30 ha | 4025 | 4 hrs/day | Furrow & Drip |  |
| Low head Solar Pump | 6.0 | 0.4 lit/sec | 0.30ha | 30,000 | 8 hrs/day | Drip | Operation of pump is depend on effective sunshine hours |

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Figure 1.Hip, treadle, solar pump and watering can from left to right

## **Irrigation Water Application Techniques**

Low head drip irrigation technology conditions, requirements and constraints and Drip Kit Specification and Cost of installation including estimated of cost of developing household micro irrigation development using farm pond and water lifting technologies are explained in the next Table 8, 9 and 10.

Table 7-Drip Irrigation technology conditions, requirements and constraints

|  |  |  |  |
| --- | --- | --- | --- |
| **Irrigationtechnology** | **Technical conditions** | **Requirements** | **Constraints** |
| Family drip kits | * Optimizing the available scarce water resources(dry season) * Water supply available from open well, hand pump or other water source * High efficiency, 90% * Used for row crops, vegetables and fruits * Women friendly | * Dripper equipment commercially available * Family drip elevated tanker, 300-1000 Liters capacity * Bucket drip elevated tanker, 20-200liters * Adequate provisions for lifting water in reservoir (treadle pump) * Technical advice on operation of drip system and frequency of irrigations * Good water quality (clean) | * Small area to irrigate(<500m2) * Labor to fill water reservoir * Cloggingof drippers * Cleaning of filters * High investment Cost |
| Bucket drip  Irrigation | * Small vegetable garden (50–100m2) * Water from well or drinking water source | * Equipment fabricated from local materials * Technical adviceon operation of the system | * Very small irrigated area (50m2) * Frequent filling of the bucket * Unfamiliarity with dripper system |

•

Table 8-Summary of Drip Kit Specification and Cost of installation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Specification | Bucket Drip Kit (50 m2) | Bucket Drip Kit (100m2) | Family Drip Kit (200m2) | Family Drip Kit (250m2) | Family Drip Kit (500m2) |
| Emitters tubes No­ @0.30m interval | 165 | 330 | 670 | 835 | 1670 |
| Number and Length of drip Laterals@1m spacing, LDPE, 16mm | 10 lines  5m long | 10 lines  10 m long | 20 lines  10 m long | 20 lines  12.5m | 25 lines  20 m |
| Sub-main Outer  Diameter and  Length, HDPE | 25-mm OD  10 m | 25-mm OD  10 m | 25-mm OD  20 m | 25-mm OD  25 m | 25-mm OD  40 m |
| Screen Filter Size | 25mm inlet  & outlet | 25 mm inlet &  outlet | 25 mm inlet &  outlet | 25 mm inlet &  outlet | 25 mm inlet &  outlet |
| Operating Head  (Height of Tank) | 1 meter | 1 meter | 1-2 meter | 2 meter | 2 meter |
| Emitter Flow | 2.2 liters/hour | 2.2 liters/hour | 2.2 liters/hour | 2.2 liters/hour | 2.4 liters/hour |
| Water Storage | 20 liters | 200 liters | 300 liters | 500 liters | 1000 liters |
| Estimated cost (ETB) | 2000 | 6000 | 12000 | 14000 | 16000 |

Table 9-The total estimation cost of developing household micro irrigation development using farm pond and associated technologies

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario of Farm pond Development | | | Water lifting | | Total Cost of Investment (Eth Birr) | | | | |
| Scenario with Size (m3) | | Cost (Birr) | Type | Cost (Birr) | Type of application Tech. | Total cost of Invest (Pond+ Lifting+ unit area (by application Technology)) | | | |
| Scenario | Dimension |
| 100 m2 | 200 m2 | 250 m2 | 500 m2 |
| Case-1+129m3 | D = 3 m, b = 5 Side slope = 1:1 1V:0.5H), T = 8 m, 0.5mm thick Dimension of geo-membrane ; 12.4 m x 14 m or 13 m x 13.5 m (length x width) Silt trap with Stone pitched masonry | 26911 | Watering Can | 70 | Canning | 32981.2 |  |  |  |
| Hip pump | 2000 | Drip | 34,911.2 | 40,911.2 | 42,911.2 | 44,911.2 |
| Treadle | 4025 | Drip | 36936.2 | 42936.2 | 44936.2 | 46936.2 |
| Low head Solar Pump | 30,000 | Drip | 62,911 | 68,911 | 70,911 | 72,911 |
| Case-2+ 84m3(for black cotton soil) geomeberane lined pond | Pond size: D = 3 m, b = 2 m, Side slope = 1:1 (1V:1H), Top width, T = 8 m  Geo-membrane lined (0.5mm) 12.4 m x 14 m or ; 13.5 m x 13.5 m (width x length),Silt trap with Stone pitched masonry | 27735 | Watering Can | 70 | Canning | 33804.7 |  |  |  |
| Hip pump | 2000 | Drip | 35734.7 | 41734.7 | 43734.7 | 45734.7 |
| Treadle | 4025 | Drip | 37759.7 | 43759.7 | 45759.7 | 47759.7 |
| Low head Solar Pump | 30,000 | Drip | 63,735 | 69,735 | 71,735 | 73,735 |
| Case-3 + 80.4m3 | Depth, D = 2.5 m, b = 3 m, Side slope = 1:1 (1V:1H), T = 8 m, Thickness of masonry = 0.4 m , Mix ratio of mortar for wet masonry = 1:4, Thickness of concrete = 6 cm, Mix ratio of concrete: 1:2:4 | 66813 | Watering Can | 70 | Canning | 72883.2 |  |  |  |
| Hip pump | 2000 | Drip | 74813.2 | 80813.2 | 82813.2 | 84813.2 |
| Treadle | 4025 | Drip | 76838.2 | 82838.2 | 84838.2 | 86838.2 |
| Low head Solar Pump | 30,000 | Drip | 102,813 | 108,813 | 110,813 | 112,813 |
| Case-4 +84 | Depth of the pond , D = 2.5 m, Bottom width, b = 3 m, Side slope = 1:1 (1V:1H), Top width, T = 8 m, Thickness of masonry = 0.4 m , Mix ratio of mortar for wet masonry = 1:4, Thickness of concrete = 6 cm and Mix ratio of concrete: 1:2:4 | 69085 | Watering Can | 70 | Canning | 75155.2 |  |  |  |
| Hip pump | 2000 | Drip | 8000 | 83085.2 | 85085.2 | 87085.2 |
| Treadle | 4025 | Drip | 10025 | 85110.2 | 87110.2 | 89110.2 |
| Low head Solar Pump | 30,000 | Drip | 36000 | 111,085 | 113,085 | 115,085 |
| Case-5 + 156 | Masonry pond :, D = 3 m, b = 4 m, Side slope = 1:1 (1V:1H), T = 10 m, Thickness of masonry = 0.4 m , Mix ratio of mortar for wet masonry = 1:4, Thickness of concrete = 6 cm and Mix ratio of concrete = 1:2:4 | 102866 | Watering Can | 70 | Canning | 108935.9 |  |  |  |
| Hip pump | 2000 | Drip | 110865.9 | 116865.9 | 118865.9 | 120865.9 |
| Treadle | 4025 | Drip | 112890.9 | 118890.9 | 120890.9 | 122890.9 |
| Low head Solar Pump | 30,000 | Drip | 138,866 | 144,866 | 146,866 | 148,866 |
| Case-6+ 201 | Design of Pond , D = 3 m, b = 5 m, Side slope = 1:1 (1V:1H), T = 11 m, Thickness of masonry = 0.4 m, Mix ratio of mortar for wet masonry = 1:4, Thickness of concrete = 6 cm and Mix ratio of concrete = 1:2:4 | 125137 | Watering Can | 70 | Canning | 131206.5 |  |  |  |
| Hip pump | 2000 | Drip | 133136.5 | 139136.5 | 141136.5 | 143136.5 |
| Treadle | 4025 | Drip | 135161.5 | 141161.5 | 143161.5 | 145161.5 |
| Low head Solar Pump | 30,000 | Drip | 161,137 | 167,137 | 169,137 | 171,137 |

## **Crop Selection**

The water reserved in pond is temporary and seasonal. Due to this, it may not enough for the whole growing season of medium and long season crops. It is more advisable for supplementary irrigation and seedling production. In area where there is high evaporation loss it is better to cover the pond with low cost materials. For efficient utilization of pond water, it is also recommended to use deficit irrigation, alternative irrigation and also mulching. The crops that must be selected for growing using pond water should be:

* Low water consumption
* High Value Crops
* early maturing crops
* Nutritionally dense crops
* farmers preference and production experience
* water stress and pests tolerance

The following vegetables and fruit are recommended for this technology.

* Vegetables: Tomato, Potato, onion, garlic, shallot, cabbage, lettuce, swiss chard, cauliflower, Ethiopian kale, green beans, pepper, carrot, beetroot,
* Fruit (supplementary irrigation): - papaya, mango, avocado, appel
* Seedling production: Onion, tomato, pepper, cabbage and fruits
* Cereals: - maize
* Pulses: Snap bean

Table 10- Crop selection based on agro ecological 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 11-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 |

## **Command area**

To determine the command area under each pond capacity: evaporation loss from pond and crop water requirements for each crop type are considered. However, for seedling production high area can be covered by supplementary and short period of full irrigation application. The area as given in Table-12 is calculated for vegetables at Highland(>2300 masl), Mid land (1300-2300 masl), and Low land (<1300 masl) agro ecology. The application efficiency for furrow, watering can and drip irrigation is taken as 60%, 75% and 90% respectively.

For fruit crops, supplementary irrigation for four months will be applied by using micro basin irrigation method. The spacing between the trees is proportional to their canopy. Accordingly, the area coverage for each tree and the total number of the fruit tree to be cultivated is determined based on the available net water volume in the pond.

Table 12- Command area under each capacity of pond for Highland, midland and Low land agro ecology



Table 13-Number of fruit trees by supplementary irrigation



## Irrigation Interval

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 14-Irrigation interval (days)







Table 15-Agronomic practice of cabbage production by furrow and drip irrigation (sample)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Description | | Unit | Furrow | | Drip | |
| High land | Mid land | High land | Mid land |
| Area | | m2 | 100 | 100 | 100 | 100 |
| Seed (ገመ) | | gm | 4.0 | 4.0 | 4.0 | 4.0 |
| Fertilizer (kg) | NPS | kg | 2.4 | 2.4 | 2.4 | 2.4 |
| Urea | kg | 2 | 2 | 2 | 2 |
| Insecticide | Dimatot | ml | 20 | 20 | 20 | 20 |
| Fungicide | Mancozeb | gm | 20 | 20 | 20 | 20 |
| Spacing | | cm | 60 X 40 | | 60 X 40 | |
| Irrigation amount and Interval | |  |  |  |  |  |
| heavy soil | Initial/ dev't | days | 6 | 5 | 4 | 3 |
| Mid/ late | days | 8 | 7 | 4 | 3 |
| Medium soil | Initial/dev’t | days | 5 | 4 | 4 | 3 |
| Mid/late | days | 7 | 6 | 4 | 3 |
| Light soil | Initial/dev’t | days | 4 | 3 | 4 | 3 |
| Mid and late | days | 6 | 5 | 4 | 3 |
| Crop water requirement | | M3 | 58 | 71 | 21 | 26 |
| Yield | | Qt | 4 | 4 | 5 | 5 |

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

## **Extension, SupplyChain and MarketStrategy**

### **Extension strategy intervention**

Promoting improved HHMI technologies play a great role in improving the livelihood income and enable the small scale household to achieve food security and nutrition sensitive agriculture through the implementation of pluralistic extension system by providing **demand-driven**, and market-oriented extension services to male, female and youth farmers.

Farmers are not homogeneous. Extension approach that works for men may not equally work for women. To achieve a gender equitable agricultural extension that empowers women (FHH and FMHH) to contribute to agricultural production to their fullest potential, their status with regard to access to and control over resources and their level of decision making at HH and community level should have to be considered. The extension worker has to be aware of culture and religion of the targeted community while addressing female farmers.

During pond preparation which requires a physical work, a community indigenous support groups like ‘debo’, ‘wenfel’ can be used to support FHHs who have less man power. Women in most cases involve directly through provision of water and indirectly by preparing and providing food and drink for the workers.

Table 16-Participatory Extension Communication approach, method and Tools to promote farm pond

|  |  |  |  |
| --- | --- | --- | --- |
| Technology promotion and implementation stages | Extension approach and method | Extension tools | Key issues |
| Awareness creation | Individual - Contact | * Farm visit & house to house visit | * During farm visit instead of addressing only HH head good to address the whole family including women * The extension worker has to arrange visit on appropriate time for both women and women with prior information |
| Group - contact | * Method Demonstration * Field days & Farm walks * Group meetings/GMF[[1]](#footnote-2) * Formal training in FTCs * Experience sharing | * During group meeting to have women’s active participation, women only group is required |
| Mass - contact | * Radio &Television * print media and audio visual aids | * Printing Medias and audio visuals have to be in a descriptive way so women who in most cases unable to read can easily understand. |
| Technology selection | Individual - Contact | * Farm visit * personal experience sharing | * Both men and women may have different preference of technologies; discuss separately with both men and women farmers. |
| Group - contact | * Method Demonstration * Field days & Farm walks * Formal training in FTCs * Group experience sharing |
| Farmers selection | Group - contact | * Group meeting * Model farmer/GMF | * During farmer selection the expert has to deliberately target women farmers. |
| Technology dissemination and adoption | Individual - Contact | * Farm visit & house to house visit * Personal experience sharing | * Women enjoy learning from success story of other women; use a model women farmer to share their live experience on public gatherings. Recognize their success to motivate others. * 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 |

### **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.

### **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.

## **Financial Analysis**

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 Natural Resources Development sector with its Small scale Irrigation Directorate took the initiative for technology package development to 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 and 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 Financially viable the project, If NPV<0, then reject the project and If NPV=0, Financially viable 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 1 below.

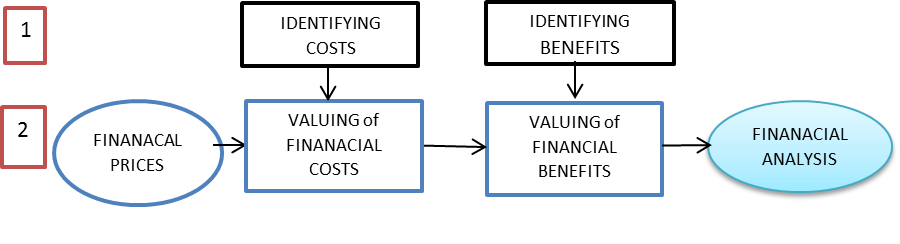


Figure 2 Overall concepts and frameworks for both financial analyses

With the above rationalities for house hold micro irrigation technology package such as farm pond of different scenarios financial analysis with selected high value crop has been done as follows.

### **Financial analysis of farm pond with different scenarios**

Table 17 Scenario Based Different Kinds of farm ponds

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Lining material** | **Volume** | **Silt trap material** |
| Case-1 | Geo-membrane | 80.8 m3 | Masonry |
| Case-2 | Geo-membrane | 84 m3 | Masonry |
| Case-3 | Masonry | 80.8m3 | Masonry |
| Case-4 | Masonry | 84 m3 | Masonry |
| Case-5 | Masonry | 156 m3 | Masonry |
| Case-6 | Masonry | 201 m3 | Masonry |

NB: Refer Detail design of farm pond based on different pond sizes and side slopes in HHMI training manual and National specifications.

To ease its financial analysis average volume of water holding capacity of ponds with two different cases i.e. Geo-membrane and masonry. The average water holding of Pond with geo-membrane is 82.4m3 and with masonry it is found to be about 130.45 m3. With this water holding capacity of Pond estimated average irrigated capacity is about 260m2 and financial analysis of investing on this irrigation infrastructure has been done as follows.

**1.1. Farm Pond construction of scenario 1**

* Water lifting technology : - Pulley and rope
* Application technology is direct application (Watering Can)
* Average command areas is about 100 m2

Table 18:- Financial analysis of farm pond with pulley and rope water lifting and direct application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Fixed cost of scenario 1constructing farm Pondwith Pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 32,981 | 1,508 | 6,673 | 5,165 | (20,775) | <1 | 17 | Needs economic[[2]](#footnote-3) |
| Tomato | 32,981 | 2,955 | 13,867 | 10,911 | (7,199) | <1 | 8 |
| H. Cabbage | 32,981 | 820 | 3,900 | 3,080 | (22,062) | <1 | 19 |
| Potato | 32,981 | 1,165 | 6,933 | 5,769 | (12,534) | <1 | 10 |
| Onion seedling | 32,981 | 630 | 1,259 | 629 | (30,748) | <1 | 76 |
| Tomato seedling | 32,981 | 2,611 | 8,320 | 5,709 | (12,745) | <1 | 10 |
| Papaya | 32,981 | 2,600 | 7,800 | 5,200 | (14,549) | <1 | 9 |
| Avocado | 32,981 | 3,468 | 27,733 | 24,265 | 17,400 | 1.3 | 3 | Financially viable |

**Decision**

Suggested best alternative crops to be cultivated with this technology package is only avocado. Farmers need to select and prioritize the possible best alternative to invest which is avocado under suitable agro ecology.

**1.2 Farm Pond construction of scenario 1(2)**

* Water lifting technology: - Hip pump (Imported)
* Application technology :- Furrow
* Average command areas is about 260 m2

Table-19: Financial analysis of farm Pond of scenario 1 with hip pump water technology and furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Fixed cost of scenario 1constructing Pond with hip pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 40,911 | 1,508 | 6,673 | 5,165 | (9,175) | <1 | 8 | Needs economic analysis[[3]](#footnote-4) |
| Tomato | 40,911 | 2,955 | 13,867 | 10,911 | 26,128 | 1 | 4 | Financially viable |
| H. Cabbage | 40,911 | 820 | 3,900 | 3,080 | (21,985) | <1 | 13 | Needs economic analysis |
| Potato | 40,911 | 1,165 | 6,933 | 5,769 | (5,469) | <1 | 5 |
| Onion seedling | 40,911 | 630 | 1,259 | 629 | (37,044) | <1 | 65 |
| Tomato seedling | 40,911 | 2,611 | 8,320 | 5,709 | (5,835) | <1 | 5.5 |
| Papaya | 40,911 | 2,600 | 7,800 | 5,200 | 4,555 | 1 | 4 | Financially viable |
| Avocado | 40,911 | 3,468 | 27,733 | 24,265 | 81,559 | 2 | 3 | Financially viable |

**Decision**

The above table shows summery of ten years investment cash flow analysis made in different crops on farm Pond with hip pump imported water lifting devise and drip application with average fixed cost ETB 40,911 and average command areas 260m2 for ten years. In this scenario of investing on farm Pond three crops are found to be feasible. These are, Avocado, tomato and papaya are those crops which are found to be promising investment scenarios. If the project is mutually exclusive small holders need to be advised to prioritize those crops with the highest NPV and B/C ratio provided investment made in suitable agro ecology of that prioritized crop

**1.3. Farm Pond construction of scenario 1(3)**

* Water lifting technology: - Treadle (Local)
* Application technology :- Drip
* Average command areas is about 260m2

Table 20 :- Financial analysis of farm Pond of scenario 1 with Treadle local water technology and furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Fixed cost of scenario 1Farm pond Treadle (local) | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 42,936.2 | 1,508 | 6,673 | 5,165 | (11,200) | <1 | 5 | Needs economic analysis[[4]](#footnote-5) |
| Tomato | 42,936.2 | 2,955 | 13,867 | 10,911 | 24,102 | 1 | 4 | Financially viable |
| H. Cabbage | 42,936.2 | 820 | 3,900 | 3,080 | (24,010) | <1 | 14 | Needs economic analysis |
| Potato | 42,936.2 | 1,165 | 6,933 | 5,769 | (7,494) | 1 | 7 |
| Onion seedling | 42,936.2 | 630 | 1,259 | 629 | (39,069) | <1 | 64 |
| Tomato seedling | 42,936.2 | 2,611 | 8,320 | 5,709 | (7,860) | <1 | 8 |
| Papaya | 42,936.2 | 2,600 | 7,800 | 5,200 | 2,529 | 1 | 6 | Financially viable |
| Avocado | 42,936.2 | 3,468 | 27,733 | 24,265 | 90,859 | 2 | 3 | Financially viable |

**Note:** ‘Needs economic analysis’ meansas per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable.

Decision

With this technology package only avocado, tomato and papaya are feasible to invest where agro ecology is suitable for proposed crops.

**1.4. Farm Pond construction of scenario 1(4)**

* Water lifting technology: - Low head solar pump
* Application technology :- Drip
* Average command areas is about 260m2

Table 21:- Financial analyses of farm Pond of scenario 1 with low head solar pump water technology and furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Fixed cost of scenario 1Farm pond Low head Solar Pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 68,911 | 1,508 | 6,673 | 5,165 | (34,550) | 1 | 13 | Needs economic analysis |
| Tomato | 68,911 | 2,955 | 13,867 | 10,911 | (1,872) | 1 | 6 |
| H. Cabbage | 68,911 | 820 | 3,900 | 3,080 | (49,985) | 0 | 22 |
| Potato | 68,911 | 1,165 | 6,933 | 5,769 | (33,469) | 1 | 12 |
| Onion seedling | 68,911 | 630 | 1,259 | 629 | (65,044) | 0 | 109 |
| Tomato seedling | 68,911 | 2,611 | 8,320 | 5,709 | (23,445) | 0 | 12 |
| Papaya | 68,911 | 2,600 | 7,800 | 5,200 | (23,445) | 0 | 9 |
| Avocado | 68,911 | 3,468 | 27,733 | 24,265 | 53,559 | 2 | 3 | Financially viable |

**Decision**

The above table shows as all crops except avocado are found to be non-feasible. Overhead cost or initial investment in this scenario is found to be so high and most crops fail to be promising investment in such scenarios.

**2.1. Farm Pond construction of scenario 2 5**

* Water lifting technology : - Pulley and rope
* Application technology is direct application (Watering Can)
* Average command areas is about 100m2

Table 22 Financial analysis of farm Pond of scenario 2 with Pulley and rope water technology and direct application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 2 pond construction pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 33,804.7 | 1508 | 6,673 | 5,165 | (20,775) | <1 | 17 | Needs economic analysis[[5]](#footnote-6) |
| Tomato | 33,804.7 | 2,955 | 13,867 | 10,911 | (7,199) | <1 | 8 |
| Cabbage | 33,804.7 | 820 | 3,900 | 3,080 | (25,702) | <1 | 28 |
| Potato | 33,804.7 | 1,165 | 6,933 | 5,769 | (19,348) | <1 | 15 |
| Onion seedling | 33,804.7 | 630 | 1,259 | 629 | (31,496) | <1 | 105 |
| Tomato seedling | 33,804.7 | 2,611 | 8,320 | 5,709 | (11,873) | <1 | 12 |
| Papaya | 33,804.7 | 2,600 | 7,800 | 5,200 | (31,496) | <1 | 16 |
| Avocado | 33,804.7 | 3,468 | 27,733 | 24,265 | 24,361 | 2 | 3 | Financially viable |

**Decision**

As the above analysis indicates only investment made on avocado is found to be promising. As this investment is too intensive in small plot of land farmers should be advised to engage in very high value crop so as to make this investment visible as the land under development compared to investment of capital is so small.

**2.2. Farm Pond construction of scenario 2 6**

* Water lifting technology: - Hip pump (Imported)
* Application technology :- Furrow
* Average command areas is about 260m2

Table 23 Financial analysis of farm Pond of scenario 2 with hip pump imported water lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 2 pond construction Hip pump (Imported | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 41,734.7 | 1,508 | 6,673 | 5,165 | (9,999) | <1 | 5 | Needs economic analysis[[6]](#footnote-7) |
| Tomato | 41,734.7 | 2,955 | 13,867 | 10,911 | 40,262 | 1 | 2 | Financially viable |
| H. Cabbage | 41,734.7 | 820 | 3,900 | 3,080 | (22,808) | 1 | 14 | Needs economic analysis |
| Potato | 41,734.7 | 1,165 | 6,933 | 5,769 | (6,293) | <1 | 5 |
| Onion seedling | 41,734.7 | 630 | 1,259 | 629 | (37,868) | <1 | 67 |
| Tomato seedling | 41,734.7 | 2,611 | 8,320 | 5,709 | (6,659) | <1 | 7 |
| Papaya | 41,734.7 | 2,600 | 7,800 | 5,200 | 57,709 | 1.1 | 6 | Financially viable |
| Avocado | 41,734.7 | 34,68 | 27,733 | 24,265 | 80,736 | 2 | 3 | Financially viable |

**Decision**

In this technology package also only investment made on head Avocado, tomato and papaya is found to be feasible. As a resource of capital for initial investment allocated to this operation those crops which are very high values are advisable to undertake such investment in suitable agro ecology. Therefore, avocado, tomato and papaya are the top ranking crops in this technology package.

**2.3. Farm Pond construction of scenario 2 7**

* Water lifting technology: - Treadle (Local)
* Application technology :- Drip
* Average command areas is about 260m2

Table 24 Financial analysis of farm Pond of scenario 2 with Treadle local water lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 2 pond construction Treadle(Local) | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 43,759.7 | 1,508 | 6,673 | 5,165 | (12,024) | <1 | 8 | Needs economic analysis |
| Tomato | 43,759.7 | 2,955 | 13,867 | 10,911 | 23,279 | 2 | 4 | Financially viable |
| H. Cabbage | 43,759.7 | 820 | 3,900 | 3,080 | (24,833) | <1 | 14 | Needs economic analysis |
| Potato | 43,759.7 | 1,165 | 6,933 | 5,769 | (8,318) | <1 | 8 | Needs economic analysis |
| Onion seedling | 43,759.7 | 630 | 1,259 | 629 | (39,893) | <1 | 70 | Needs economic analysis |
| Tomato seedling | 43,759.7 | 2,611 | 8,320 | 5,709 | (3,039) | <1 | 7 | Needs economic analysis |
| Papaya | 43,759.7 | 2,600 | 7,800 | 5,200 | 1,706 | 1.1 | 6 | Financially viable |
| Avocado | 43,759.7 | 34,68 | 27,733 | 24,265 | 78,711 | 2 | 3 | Financially viable |

**Note:** ‘Needs economic analysis’ meansas per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable.

**Decision**

As the above table shows onion, Head cabbage, onion and tomato seedling development are found to be non-feasible project with this technology package. The other crops like avocado, Tomato and papaya are found to be feasible and need prioritization of these feasible commodities based on agro ecology suitability.

**2.4. Farm Pond construction of scenario 2 8**

* Water lifting technology: - Low head Solar Pump
* Application technology :- Drip
* Average command areas is about 260m2

Table 25 Financial analysis of farm Pond of scenario 2 with low head solar pump water lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 2 pond construction Low head Solar Pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 69,735 | 1,508 | 6,673 | 5,165 | (37,999) | <1 | 14 | Needs economic analysis |
| Tomato | 69,735 | 2,955 | 13,867 | 10,911 | (2,696) | <1 | 12 | Financially viable |
| H. Cabbage | 69,735 | 820 | 3,900 | 3,080 | (50,809) | <1 | 23 | Needs economic analysis |
| Potato | 69,735 | 1,165 | 6,933 | 5,769 | (34,293) | <1 | 12 | Needs economic analysis |
| Onion seedling | 69,735 | 630 | 1,259 | 629 | (65,868) | <1 | 102 | Needs economic analysis |
| Tomato seedling | 69,735 | 2,611 | 8,320 | 5,709 | (34,659) | <1 | 12 | Needs economic analysis |
| Papaya | 69,735 | 2,600 | 7,800 | 5,200 | (24,269) | <1 | 9 | Needs economic analysis[[7]](#footnote-8) |
| Avocado | 69,735 | 3,468 | 27,733 | 24,265 | 117,658 | 1.4 | 3 | Financially viable |

**Decision**

As the above table depicts only avocado is found to be feasible with technology package provided that it is applied in suitable agro ecology of avocado. Other crops are found to be non- feasible with this technology package.

**3.1 Farm Pond construction of scenario 39**

* Water lifting technology: - Pulley and rope
* Application technology :- Direct application (Watering Can)
* Average command areas is about 100m2

Table 26 Financial analysis of farm Pond of scenario 3 with Pulley and rope water lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 3pond construction Pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 72,883.2 | 1,508 | 6,673 | 5,165 | (60,677) | <1 | 37 | Needs economic analysis |
| Tomato | 72,883.2 | 2,955 | 13,867 | 10,911 | (49,575) | <1 | 18 |
| H. Cabbage | 72,883.2 | 820 | 3,900 | 3,080 | (65,604) | <1 | 62 |
| Potato | 72,883.2 | 1,165 | 6,933 | 5,769 | (59,250) | <1 | 33 |
| Onion seedling | 72,883.2 | 630 | 1,259 | 629 | (71,398) | <1 | 133 |
| Tomato seedling | 72,883.2 | 2,611 | 8,320 | 5,709 | (59,392) | <1 | 33 |
| Papaya | 72,883.2 | 2,600 | 7,800 | 5,200 | (60,595) | <1 | 11 |
| Avocado | 72,883.2 | 3,468 | 27,733 | 24,265 | (55,268) | <1 | 25 |

**Decision**

In this technology package no proposed crops are found to be feasible. As it has been repeatedly stated these irrigation resources such as irrigable land and water as well as irrigation water lifting materials are very expensive we need to choose those crops which enables to yield the first best profit. Moreover, command areas and technology invested on this Pond is not proportional to make it feasible with these proposed crops.

**3.2. Farm Pond construction of scenario 3 10**

* Water lifting technology: - Hip pump (Imported)
* Application technology :-Furrow
* Average command areas is about 260m2

Table 27 Financial analysis of farm Pond of scenario 3 with Hip pump water lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 3 pond construction pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 80,813.2 | 1,508 | 6,673 | 5,165 | (49,077) | <1 | 16 | Needs economic analysis |
| Tomato | 80,813.2 | 2,955 | 13,867 | 10,911 | (13,775) | 1 | 7 |
| H. Cabbage | 80,813.2 | 820 | 3,900 | 3,080 | (61,887) | <1 | 26 |
| Potato | 80,813.2 | 1,165 | 6,933 | 5,769 | (45,371) | <1 | 14 |
| Onion seedling | 80,813.2 | 630 | 1,259 | 629 | (76,946) | <1 | 102 |
| Tomato seedling | 80,813.2 | 2,611 | 8,320 | 5,709 | (45,737) | <1 | 14 |
| Papaya | 80,813.2 | 2,600 | 7,800 | 5,200 | (35,348) | <1 | 9 |
| Avocado | 80,813.2 | 3,468 | 27,733 | 24,265 | 41,657 | 1.5 | 3 | Financially viable |

**Decision**

In this technology package also only avocado is found to be feasible. Because as water lifting technology and cost of constructing Pond increase only those high value crops are found to be feasible.

**3.3 Farm Pond construction of scenario 3 11**

* Water lifting technology: - Treadle (Local)
* Application technology :-Drip
* Average command areas is about 260m2

Table 28 Financial analysis of farm Pond of scenario 3 with treadle local lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 3pond construction Treadle (Local) | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 75,357 | 1508 | 6673 | 5,165 | (43,621) | <1 | 15 | Needs economic analysis |
| Tomato | 75,357 | 2955 | 13867 | 10,911 | (8,318) | <1 | 7 | Needs economic analysis |
| H. Cabbage | 75,357 | 820 | 3900 | 3,080 | (56,431) | <1 | 24 | Needs economic analysis |
| Potato | 75,357 | 1165 | 6933 | 5,769 | (39,915) | <1 | 13 | Needs economic analysis |
| Onion seedling | 75,357 | 630 | 1259 | 629 | (71,490) | <1 | 120 | Needs economic analysis[[8]](#footnote-9) |
| Tomato seedling | 75,357 | 2611 | 8320 | 5,709 | (40,281) | <1 | 13 | Needs economic analysis |
| Papaya | 75,357 | 2600 | 7800 | 5,200 | (29,891) | <1 | 11 | Needs economic analysis |
| Avocado | 75,357 | 3468 | 27733 | 24,265 | 47,113 | 1.4 | 3 | Financially viable |

**Decision**

As it has been analyzed on the above table only avocado NPV is found to be positive. In the rest alternative crop production this technology package is found to be non-feasible. The reason is that command area is so small and fixed cost of construction of Pond is found to be high as no crop except avocado is found to be feasible. Moreover, payback period of all crop is found to be very long and beyond the service year of Pond constructed.

**3.4 Farm Pond construction of scenario 3 12**

* Water lifting technology: - Low head solar pump
* Application technology :-Drip
* Average command areas is about 260m2

Table 29 Financial analysis of farm Pond of scenario 3 with low head solar pump lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 3pond construction low head solar pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 101,332 | 1508 | 6673 | 5,165 | (69,596) | <1 | 20 | Needs economic analysis |
| Tomato | 101,332 | 2955 | 13867 | 10,911 | (34,293) | 1 | 9 | Needs economic analysis |
| H. Cabbage | 101,332 | 820 | 3900 | 3,080 | (82,406) | <1 | 33 | Needs economic analysis |
| Potato | 101,332 | 1165 | 6933 | 5,769 | (65,890) | <1 | 18 | Needs economic analysis |
| Onion seedling | 101,332 | 630 | 1259 | 629 | (97,465) | <1 | 161 | Needs economic analysis |
| Tomato seedling | 101,332 | 2611 | 8320 | 5,709 | (66,256) | <1 | 18 | Financially viable |
| Papaya | 101,332 | 2600 | 7800 | 5,200 | (55,866) | <1 | 23 | Financially viable |
| Avocado | 101,332 | 3468 | 27733 | 24,265 | 149,255 | 1.1 | 3 | Financially viable |

**Decision**

As it has been analyzed on the above table only avocado NPV is found to be positive. In the rest alternative crop production this technology package is found to be non-feasible. The reason is that command area is so small and fixed cost of construction of Pond is found to be high as no crop except avocado is found to be feasible. Moreover, payback period of all crop is found to be very long and beyond the service year of Pond constructed.

**4.1 Farm Pond construction of scenario 4 13**

* Water lifting technology: - pulley and rope
* Application technology : Direct application (Watering Can)
* Average command areas is about 100m2

Table 30 Financial analysis of farm Pond of scenario 4 with pulley and rope lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 4pond construction Pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 62,909 | 2,900 | 12,833 | 9,933 | (62,949) | <1 | 38 | Needs economic analysis[[9]](#footnote-10) |
| Tomato | 62,909 | 5,684 | 26,667 | 20,983 | (49,373) | <1 | 18 | Needs economic analysis |
| H. Cabbage | 62,909 | 1,576 | 7,500 | 5,924 | (67,876) | <1 | 63 | Needs economic analysis |
| Potato | 62,909 | 2,240 | 13,333 | 11,093 | (61,522) | <1 | 34 | Needs economic analysis |
| Onion seedling | 62,909 | 1,211 | 2,421 | 1,210 | (73,670) | <1 | 52 | Needs economic analysis |
| Tomato seedling | 62,909 | 5,021 | 16,000 | 10,979 | (61,664) | <1 | 34 | Needs economic analysis |
| Papaya | 62,909 | 5,000 | 15,000 | 10,000 | (62,867) | <1 | 38 | Needs economic analysis |
| Avocado | 62,909 | 6,670 | 53,333 | 46,663 | (17,813) | <1 | 7 | Needs economic analysis |

**Decision**

No crop is feasible under this technology package with this small plot and such huge investment with proposed crops. Farmers need not to be advised as alternative to invest on this technology package.

**4.2 Farm Pond construction of scenario 4 14**

* Water lifting technology: - Hip pump
* Application technology : Furrow)
* Average command areas is about 500m2

Table 31 Financial analysis of farm Pond of scenario 4 with hip pump lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 4 pond construction hip pump. | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 64,321 | 2,900 | 12,833 | 9,933 | (3,291) | <1 | 6 | Needs economic analysis[[10]](#footnote-11) |
| Tomato | 64,321 | 5,684 | 26,667 | 20,983 | 64,600 | 2 | 3 | Financially viable |
| H. Cabbage | 64,321 | 1,576 | 7,500 | 5,924 | (27,924) | <1 | 11 | Needs economic analysis |
| potatoes’ | 64,321 | 2,240 | 13,333 | 11,093 | 3,836 | 1 | 6 | Financially viable |
| Onion seedling | 64,321 | 1,211 | 2,421 | 1,210 | (56,884) | <1 | 53 | Needs economic analysis |
| Tomato seedling | 64,321 | 5,021 | 16,000 | 10,979 | 3,133 | 1 | 6 | Financially viable |
| Papaya | 64,321 | 5,000 | 15,000 | 10,000 | (2,881) | <1 | 6 | Needs economic analysis |
| Avocado | 64,321 | 6,670 | 53,333 | 46,663 | 222,379 | 4 | 3 | Financially viable |

**Decision**

Tomato, potato, tomato seedling and avocado are those crops which are found to feasible in this irrigation technology package. Under condition of resource scarcity avocado followed by tomato are crops which are prioritized for investment in this irrigation technology package.

**4.3 Farm Pond construction of scenario 4 15**

* Water lifting technology: - treadle local
* Application technology : Drip
* Average command areas is about 500m2

Table 32 Financial analysis of farm Pond of scenario 4 with treadle local lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 4pond construction treadle | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 75,659 | 2,900 | 12,833 | 9,933 | (14,629) | <1 | 8 | Needs economic analysis[[11]](#footnote-12) |
| Tomato | 75,659 | 5,684 | 26,667 | 20,983 | 53,262 | 1 | 4 | Financially viable |
| H. Cabbage | 75,659 | 1,576 | 7,500 | 5,924 | (39,262) | <1 | 13 | Needs economic analysis |
| potatoes’ | 75,659 | 2,240 | 13,333 | 11,093 | (7,502) | <1 | 7 | Needs economic analysis |
| Onion seedling | 75,659 | 1,211 | 2,421 | 1,210 | (68,222) | <1 | 63 | Needs economic analysis |
| Tomato seedling | 75,659 | 5,021 | 16,000 | 10,979 | (8,205) | <1 | 7 | Needs economic analysis |
| Papaya | 75,659 | 5,000 | 15,000 | 10,000 | (14,219) | <1 | 8 | Needs economic analysis |
| Avocado | 75,659 | 6,670 | 53,333 | 46,663 | 211,041 | 3 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**4.4 Farm Pond construction of scenario 4 16**

* Water lifting technology: - low head solar pump
* Application technology : Drip
* Average command areas is about 500m2

Table 33 Financial analysis of farm Pond of scenario 4 with low head solar pump lifting technology and Drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 4 pond construction low head solar pump. | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 101,634 | 2,900 | 12,833 | 9,933 | (40,604) | <1 | 10 | Needs economic analysis[[12]](#footnote-13) |
| Tomato | 101,634 | 5,684 | 26,667 | 20,983 | 27,287 | 1 | 5 | Financially viable |
| H. Cabbage | 101,634 | 1,576 | 7,500 | 5,924 | (65,237) | <1 | 17 | Needs economic analysis |
| potatoes’ | 101,634 | 2,240 | 13,333 | 11,093 | (33,477) | <1 | 9 |
| Onion seedling | 101,634 | 1,211 | 2,421 | 1,210 | (94,197) | <1 | 64 |
| Tomato seedling | 101,634 | 5,021 | 16,000 | 10,979 | (34,180) | <1 | 9 |
| Papaya | 101,634 | 5,000 | 15,000 | 10,000 | (40,194) | <1 | 10 |
| Avocado | 101,634 | 6,670 | 53,333 | 46,663 | 142,614 | 3 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**5.1 Farm Pond construction of scenario 5 17**

* Water lifting technology: - pulley and rope
* Application technology : Direct application (Watering Can)
* Average command areas is about 100m2

Table 34 Financial analysis of farm Pond of scenario 5 with pulley and rope lifting technology and direct application (Watering Can) application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 5 pond construction pulley &rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 108,936 | 2,900 | 12,833 | 9,933 | (96,730) | <1 | 55 | Needs economic analysis[[13]](#footnote-14) |
| Tomato | 108,936 | 5,684 | 26,667 | 20,983 | (83,154) | <1 | 26 |
| H. Cabbage | 108,936 | 1,576 | 7,500 | 5,924 | (101,657) | <1 | 92 |
| Potato | 108,936 | 2,240 | 13,333 | 11,093 | (95,302) | <1 | 49 |
| Onion seedling | 108,936 | 1,211 | 2,421 | 1,210 | (107,450) | <1 | 451 |
| Tomato seedling | 108,936 | 5,021 | 16,000 | 10,979 | (95,445) | <1 | 50 |
| Papaya | 108,936 | 5,000 | 15,000 | 10,000 | (96,648) | <1 | 40 |
| Avocado | 108,936 | 6,670 | 53,333 | 46,663 | (51,594) | <1 | 10 |

**Decision**

No proposed respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to high intimal investment cannot qualify feasibility. Therefore, under taking such investment on limited plot of land is not promising.

**5.2 Farm Pond construction of scenario 5 18**

* Water lifting technology: - Hip pump
* Application technology : Furrow
* Average command areas is about 500m2

Table 35 Financial analysis of farm Pond of scenario 5 wit hip pump lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 5 pond construction Hip pump imported | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 116,865.9 | 2,900 | 12,833 | 9,933 | (32,407) | <1 | 9 | Needs economic analysis[[14]](#footnote-15) |
| Tomato | 116,865.9 | 5,684 | 26,667 | 20,983 | 35,484 | 1 | 4 | Financially viable |
| H. Cabbage | 116,865.9 | 1,576 | 7,500 | 5,924 | (57,040) | <1 | 16 | Needs economic analysis |
| potatoes’ | 116,865.9 | 2,240 | 13,333 | 11,093 | (25,280) | <1 | 8 |
| Onion seedling | 116,865.9 | 1,211 | 2,421 | 1,210 | (86,000) | <1 | 77 |
| Tomato seedling | 116,865.9 | 5,021 | 16,000 | 10,979 | (25,983) | <1 | 9 |
| Papaya | 116,865.9 | 5,000 | 15,000 | 10,000 | (31,997) | <1 | 9 |
| Avocado | 116,865.9 | 6,670 | 53,333 | 46,663 | 193,263 | 2 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**5.3 Farm Pond construction of scenario 5 19**

* Water lifting technology: - treadle local
* Application technology : Drip
* Average command areas is about 500m2

Table 36 Financial analysis of farm Pond of scenario 5 wit treadle local lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 5 pond construction treadle local | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 104,775.5 | 2,900 | 12,833 | 9,933 | (43,745) | <1 | 11 | Needs economic analysis[[15]](#footnote-16) |
| Tomato | 104,775.5 | 5,684 | 26,667 | 20,983 | 24,145 | 1 | 5 | Financially viable |
| H. Cabbage | 104,775.5 | 1,576 | 7,500 | 5,924 | (68,379) | <1 | 18 | Needs economic analysis |
| Potato | 104,775.5 | 2,240 | 13,333 | 11,093 | (36,618) | <1 | 9 |
| Onion seedling | 104,775.5 | 1,211 | 2,421 | 1,210 | (97,339) | <1 | 87 |
| Tomato seedling | 104,775.5 | 5,021 | 16,000 | 10,979 | (37,321) | <1 | 10 |
| Papaya | 104,775.5 | 5,000 | 15,000 | 10,000 | (43,336) | <1 | 10 |
| Avocado | 104,775.5 | 6,670 | 53,333 | 46,663 | 181,924 | 2 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**5.4 Farm Pond construction of scenario 5 20**

* Water lifting technology: - Low head solar pump
* Application technology : Drip
* Average command areas is about 500m2

Table 37 Financial analysis of farm Pond of scenario 5 with low head solar pump lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 5 pond construction low head solar pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 130,750 | 2,900 | 12,833 | 9,933 | (69,720) | <1 | 13 | Needs further economic analysis[[16]](#footnote-17) |
| Tomato | 130,750 | 5,684 | 26,667 | 20,983 | (1,829) | <1 | 9 |
| H. Cabbage | 130,750 | 1,576 | 7,500 | 5,924 | (94,353) | <1 | 22 |
| Potato | 130,750 | 2,240 | 13,333 | 11,093 | (62,595) | <1 | 12 |
| Onion seedling | 130,750 | 1,211 | 2,421 | 1,210 | (123,316) | <1 | 108 |
| Tomato seedling | 130,750 | 5,021 | 16,000 | 10,979 | (63,296) | <1 | 12 |
| Papaya | 130,750 | 5,000 | 15,000 | 10,000 | (69,310) | <1 | 13 |
| Avocado | 130,750 | 6,670 | 53,333 | 46,663 | 155,950 | 2 | 3 | Financially viable |

**Decision**

Only one crops avocado can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit that can be developed by this investment under climatic condition for avocado.

**6.1 Farm Pond construction of scenario 621**

* Water lifting technology: - pulley and rope
* Application technology : Direct application (Watering Can)
* Average command areas is about 100m2

Table 38 Financial analysis of farm Pond of scenario 6 with pulley and rope lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of scenario 6 pond construction pulley and rope | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 131,206.5 | 2,900 | 12,833 | 9,933 | (119,000) | <1 | 66 | Needs economic analysis[[17]](#footnote-18) |
| Tomato | 131,206.5 | 5,684 | 26,667 | 20,983 | (105,424) | 1 | 31 |
| Cabbage | 131,206.5 | 1,576 | 7,500 | 5,924 | (123,927) | <1 | 111 |
| Potato | 131,206.5 | 2,240 | 13,333 | 11,093 | (117,573) | <1 | 59 |
| Onion seedling | 131,206.5 | 1,211 | 2,421 | 1,210 | (129,720) | <1 | 542 |
| Tomato seedling | 131,206.5 | 5,021 | 16,000 | 10,979 | (117,716) | <1 | 60 |
| Papaya | 131,206.5 | 5,000 | 15,000 | 10,000 | (118,919) | <1 | 66 |
| Avocado | 131,206.5 | 6,670 | 53,333 | 46,663 | (73,865) | <1 | 14 |

**Decision**

No proposed respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to high intimal investment cannot qualify feasibility. Therefore, under taking such investment on limited plot of land dose not promised.

**6.2 Farm Pond construction of scenario 6**

* Water lifting technology: - Hip pump imported
* Application technology : Furrow
* Average command areas is about 500m2

Table 39 Financial analysis of farm Pond of scenario 6 with Hip pump lifting technology and Furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 6 pond construction hip pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 110,002 | 2,900 | 12,833 | 9,933 | (48,972) | <1 | 11 | Needs economic analysis[[18]](#footnote-19) |
| Tomato | 110,002 | 5,684 | 26,667 | 20,983 | 18,919 | 1 | 5 | Financially viable |
| H. Cabbage | 110,002 | 1,576 | 7,500 | 5,924 | (73,605) | <1 | 11 | Needs economic analysis |
| Potato | 110,002 | 2,240 | 13,333 | 11,093 | (41,847) | <1 | 10 |
| Onion seedling | 110,002 | 1,211 | 2,421 | 1,210 | (102,568) | <1 | 101 |
| Tomato seedling | 110,002 | 5,021 | 16,000 | 10,979 | (42,548) | <1 | 10 |
| Papaya | 110,002 | 5,000 | 15,000 | 10,000 | (48,562) | <1 | 11 |
| Avocado | 110,002 | 6,670 | 53,333 | 46,663 | 176,698 | 2 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**6.3 Farm Pond construction of scenario 6**

* Water lifting technology: - Treadle local
* Application technology : Drip
* Average command areas is about 500m2

Table 40 Financial analysis of farm Pond of scenario 6 with treadle local lifting technology and drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 6 pond construction treadle local | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 121,340 | 2,900 | 12,833 | 9,933 | (60,310) | <1 | 12 | Needs economic analysis[[19]](#footnote-20) |
| Tomato | 121,340 | 5,684 | 26,667 | 20,983 | 7,581 | 1 | 6 | Financially viable |
| H. Cabbage | 121,340 | 1,576 | 7,500 | 5,924 | (84,943) | <1 | 20 | Needs Economic analysis |
| Potato | 121,340 | 2,240 | 13,333 | 11,093 | (53,185) | 1 | 11 |
| Onion seedling | 121,340 | 1,211 | 2,421 | 1,210 | (113,906) | <1 | 100 |
| Tomato seedling | 121,340 | 5,021 | 16,000 | 10,979 | (53,886) | <1 | 11 |
| Papaya | 121,340 | 5,000 | 15,000 | 10,000 | (59,900) | <1 | 12 |
| Avocado | 121,340 | 6,670 | 53,333 | 46,663 | 165,360 | 2 | 3 | Financially viable |

**Decision**

Only two crops avocado and tomato can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit followed by tomato from vegetable under suitable agro ecology for each crops.

**6.4 Farm Pond construction of scenario 6**

* Water lifting technology: - Low head solar pump
* Application technology : Drip
* Average command areas is about 500m2

Table 41 Financial analysis of farm Pond of scenario 6 with low head solar pump lifting technology and drip application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | average fixed cost of scenario 6 pond construction Low head solar pump | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 147,315 | 2,900 | 12,833 | 9,933 | (86,285) | <1 | 15 | Needs economic analysis[[20]](#footnote-21) |
| Tomato | 147,315 | 5,684 | 26,667 | 20,983 | (18,394) | <1 | 7 |
| H. Cabbage | 147,315 | 1,576 | 7,500 | 5,924 | (110,918) | <1 | 25 |
| Potato | 147,315 | 2,240 | 13,333 | 11,093 | (79,160) | <1 | 13 |
| Onion seedling | 147,315 | 1,211 | 2,421 | 1,210 | (139,881) | <1 | 125 |
| Tomato seedling | 147,315 | 5,021 | 16,000 | 10,979 | (79,861) | <1 | 13 |
| Papaya | 147,315 | 5,000 | 15,000 | 10,000 | (85,875) | <1 | 15 |
| Avocado | 147,315 | 6,670 | 53,333 | 46,663 | 139,385 | 2 | 3 | Financially viable |

**Decision**

Only one crops avocado can be feasible while others cannot respond enough return to the investment in this irrigation technology. As cost of investment increase, most crops which are not high value relative to others cannot qualify feasibility. Therefore, avocado is the first best alternative from fruit that can be developed by this investment under climatic condition for Avocado.

Generally, as investment on farm pond increase under a given command areas feasibility of most vegetable crops is found to be under question as yearly variable cost of production escalate total cost of production. Therefore, it is advisable to select high value crop for this technology package.

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

The farm pond irrigation technology package performance will be monitored and evaluated as per the indicators given in Table 42, 43 and 44.

Table 42- M&E tools for farm pond (Water source)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Criteria/Principle | Indicator | Unit | Data Source | Data Collection Method |
| Performance | Water volume (holding capacity) | M3 | On-situ at pond | Pond size measurement |
| Water loss (evaporation, seepage) | M3 | Meteorology | Meteorology station |
| Silt volume | M3 | On-situ at pond | Siltation measurement |
| Silt trap availability | Yes/No | Site Visit | Site Visit |
| Pond lining | Yes/No | On-situ at pond | 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 | 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 |
| 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 43-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 | Littre/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 44-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[[21]](#footnote-22) | % | 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[[22]](#footnote-23) 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[[23]](#footnote-24) 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-2)
2. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-3)
3. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-4)
4. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-5)
5. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-6)
6. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-7)
7. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable. [↑](#footnote-ref-8)
8. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-9)
9. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-10)
10. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable. [↑](#footnote-ref-11)
11. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-12)
12. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-13)
13. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-14)
14. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-15)
15. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-16)
16. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-17)
17. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-18)
18. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-19)
19. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-20)
20. ‘Needs economic analysis’ means as per the financial analysis it is not feasible however if it considers economic and social benefits, it may be viable [↑](#footnote-ref-21)
21. Efficiency refers to application efficiency where water abstracted is delivered from the source versus amount of water used by the crop. [↑](#footnote-ref-22)
22. Uniformity refers to application of water from head to tail. [↑](#footnote-ref-23)
23. Refers to whether the community uses local materials and indigenous knowledge [↑](#footnote-ref-24)