

**Spring Development Technology Package**

**HHMIT Package-1**

**Small Scale Irrigation Directorate**

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

# **Introduction**

## **Background and rationale**

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

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

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

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

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

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

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

## **HHMIT Package objective**

### **General**

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

### **Specific**

The specific objective of the package includes to:

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

## **Scope of the package**

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

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

## **Where to implement?**

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

## **Beneficiaries**

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

# **HHMI package components**

HHMI technology package will have the following three basic components:

## **Irrigation water source**

The following water sources are considered:

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

## **Water lifting devices**

The following water lifting devices are considered:

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

## **Irrigation water application**

The following irrigation water application are considered:

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

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

# **Spring Development Technology Package**

## **Water source**

Spring water is a natural flow of water from the ground at a single point and/or several points within a restricted area, usually along hillsides, at the base of slopes, or in low areas/valley bottoms. Spring water originates normally from part of rainwater which infiltrates into the soil and seeps through the permeable layer. The water seeps down until it meets with an impervious layer of material like clay or rock that prevents it from flowing deeper downwards into the ground. At those places where the impervious layer reaches the surface, the groundwater flow is forced to the surface and forms a spring. The outflow may be at one spot only such as at a rock fissure or along the length of a layer such as a gravel bed. The spring water flows freely under gravity i.e. gravity type, or under pressure from below i.e. artesian type. The yield of different springs varies, from the gentle dripping at a small spring to the strong flow of large quantities of water at a bigger spring.

Springs are usually used for different purposes including source of water supply for domestic, livestock and irrigation. They are also not capped naturally. Consequently, they are exposed for contamination and wastage and thus it needs a protection headwork which also supplies irrigation water on one side or on both sides. It has to be noted that spring development for irrigation should be considered after satisfying the domestic and livestock need of the community.

Spring yield estimation can be done by using volumetric simple bucket and floating method. The layout of the spring development varies based on the spring types, yield and topographic condition (for detail refer the HHMI training manual).

The scope of this package refers to where the capping structure is constructed at the eye of the spring and the spring discharge can be abstracted by gravity or pumping.

**Environmental Consideration:** Spring usually hold water which can attract various pathogen, disease vectors and pollution. It could be the breeding place for mosquitoes and other vectors causing 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.

Spring, as surface water, is subject to contamination from a number of sources such as sediment, chemicals and animals around. It may create favorable Environmental conditions for breeding of Algae, bacteria and protozoa where spring water used for drinking. In case it is used, it should be carefully treated and boiled. For safety and security, appropriate fencing should be done to protect entrance of animals and children. Other environmental issues it may also cause Irrigation water lodging and Erosion in the farm.

The other important issues are the issues of use right by beneficiaries as spring is not mostly owned by individual. Agreements should be designed to avoid a use conflicts.

**Gender**

Consult female and male farmers as source of local knowledge to develop reliable spring and get relatively actual water demand estimation and construction team should consider the different roles and responsibilities during scheduling for activities

## **Water abstraction / lifting**

The common water abstraction method from spring is by gravity method using pipe or canal. If there is sufficient spring discharge for the proposed command, irrigation water can be applied directly for surface irrigation (furrow, basin) without providing storage. However night storage pond can be provided if yield of the spring is not adequate for the proposed command area.

If the elevation of the command area is higher than the spring eye, motor pump will be employed to lift the water to the proposed command. In this case, sump will be constructed downstream of the spring to create a temporary storage and to provide enough sump depth for pumping.

The type of pump usually recommended for this particular case is surface centrifugal motor pump driven by petrol or diesel engines. The size/capacity of the motor pump is fixed based by taking into account different factor including the yield of the spring, head, and command size and crop water requirement. Generally for this HHMI package it is recommended to use the following pump size:

### **Engine pump**

Table 1-Engine pump parameter

|  |  |  |
| --- | --- | --- |
| **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 details

|  |  |  |
| --- | --- | --- |
| Technical conditions | Requirements | Constraints |
| * Adequate surface or groundwater sources available in the vicinity of irrigated areas * Water level not to exceed 7 m at pump site * Opportunity for extension of irrigated area for single farmers | * Engine pump is commercially available * with maintenance services and spare parts * Access to regular supply of fuel at affordable price * Access to markets for * produce * Advisory services on * Selection and installation | * High investment costs * Availability of fuel * Operational costs * Management problems |

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 spring 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 spring 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.

### **Pressure Treadle pump**

The Pressure Treadle Pump is a foot-operated option for delivering pressurized water for depth to water less than 7 m. The pressure treadle pump is a simple foot-operated for small-scale irrigation. It is a modification of the suction-only treadle pump, using suction to draw water to the surface but which can then force the water out of the pump under pressure. This allows water to be moved a distance of up to 50 m across the ground, or to a height of 6 m above the pump.

Table 3-Treadle pump condition, requirements and constraints

|  |  |  |
| --- | --- | --- |
| Technical conditions | Requirements | Constraints |
| * Appropriate water source (surface or groundwater) 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** |
| * Water source (river, wells) with limited depth <10 m) * Tube well development in case of groundwater * 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 |

## **Water application**

Irrigation water is applied to land by three general methods: surface, sprinkler and drip irrigation systems. The choice of irrigation method is site specific and depends on topography, the amount of water available, the quality of the water and soils, as well as economic and social considerations.

The water application methods chosen for this spring development HHMI package are furrow, basin, watering can and drip. The basic description and suitability of the water application method is presented in the table below

Table Basic description and suitability of water application method for spring development

| **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 | * Good quality of water is required to protect the clogging of emitter * More efficient use of available water compared to other water application method (85 to 95%) * If the water lifting device for the drip irrigation is pressurized treadle pump, the discharge varies from 0.3 to 1l/s. * If solar pump is used, the discharge can vary from 0.1 l/s to 14.83 l/s |
| 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 |
| Water can | * The watering can provides a simple and accessible irrigation technique * and widely practiced by small-scale farmers for vegetable production * The technology requires low * investments, but is labour intensive and allows irrigation of only a * small garden/area (50 to 100 m2) | * Suitable for vegetable production (e.g. Onion, potato, cabbage, pepper, tomato); fruits (mango, papaya, avocado) & seedling | * Suitable for all types of soil | * Can be adopted to all types of slope |  |

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

### **Low cost Family Drip**

Table Summary of Drip Kit (FDK) 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)** | **Family Drip Kit (1000m2)** |
| Emitters tubes No @0.30m spacing | 165 | 330 | 670 | 835 | 1670 | 3340 |
| 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  12.5 m | 25 lines  20 m | 40 lines  25 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  20 m | 25-mm OD  25 m | 25-mm OD  25 m |
| Screen Filter Size | 25mm inlet  & outlet | 25 mm 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 | 2.5 meter |
| Emitter Flow | 2.2 liters/hour | 2.2 liters/hour | 2.2 liters/hour | 2.2 liters/hour | 2.4 liters/hour | 2.4 liters/hour |
| Water Storage | 20 liters | 200 liters | 300 liters | 500 liters | 1000 liters | 2000 liters |
| Crops |  |
| **Estimated cost (ETB)** | **2000** | **6000** | **12000** | **14000** | **16000** | **28000** |

### **Furrow 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 7-Furrow slope, stream size and Irrigation depth for different soil types

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Furrow slope (%)** | **Maximum stream size (l/s) per furrow** | **Clay** | | **Loam** | | **Sand** | |
| **Net irrigation depth (mm)** | | | | | |
| **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 |

Table 8-Watercan technology conditions and constraints

|  |  |
| --- | --- |
| **Technical conditions** | **Constraints** |
| * Water source (Ponds, rivers, streams, canals, drains, open shallow wells) in immediate vicinity (< 50m) * simple and accessible * women friendly * less cost * applicable both in rural and Urban areas | * High labour input * Access to a nearby water source * Cover Small area (50-100m2) * Application for small vegetable production * Labour intensive |

**Key points**

* Watering cans- have been supplied in many emergency interventions, usually for small-scale vegetable production in groups – often women’s groups. To help generate additional income, nearby markets are important for the sale of the vegetables; therefore, most irrigated vegetable gardens are usually found around rural & urban centers.
* 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.
* Solar pump is not labor intensive, has no energy cost, easy operation, time saving, gender responsive, and above all is climate smart.

## **Crop selection**

Since spring 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 spring 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 9- 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 10-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 |

**Key Issue**

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

## **Command area**

The command area for a given a spring 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 spring yield.

Table 11- Command area for different spring discharge for Highland, midland and Low land agro ecology for different irrigation hours

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | command area (ha) for each Spring Discharge for 12 hr irrigation | | | | | | | |  |
| Spring  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 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 |
|  | command area (ha) for each Spring Discharge for 10 hr irrigation | | | | | | | |  |
| Spring  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 |
|  | command area (ha) for each Spring Discharge for 8 hr irrigation | | | | | | | |  |
| Spring 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 |

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

## **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 12-Irrigation interval







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 | | Frequency | 4 | 4 | 4 | 4 |
| Seed (tuber) | | Quintal | 22 | 22 | 22 | 22 |
| Spacing | | cm | 75 x 30 | | | |
| fertilizer | NPS | Quintal | 2.42 | 2.42 | 2.42 | 2.42 |
| Urea | Quintal | 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 | | Frequency | 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 | | Quintal | 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)

## **Extension and Market strategy**

### **Extension strategy intervention**

In promoting spring development technology farmer, appropriate extension approach is important for success full dissemination and adoption of the technology.

* Participatory extension approach and methods – In using these method farmers have the chance of selecting the technology and participate in the whole planning up to implementation process supported by development agent during introduction and implementing period of the technology.
* Promoting the technology – during the introduction of spring development as source for irrigation, mass- extension methods tools such as leaflet, brochures, IVR - technology, can be used in making clarity and as means of technology promotion.

| **Technology implementing stage** | **Extension Approach and Methods** | **Extension tools** | **Key intervention**  **Gender** |
| --- | --- | --- | --- |
| Awareness creation and | * Individual –contact | * Farm and home visit * office calls and inquiries, * Informal contact, Personal letters / * telephone calls | * Participation of women farmer (FHHs and Wife in MHH) in field day and motivational tour at all level from planning up to evaluation has to be ensured * Culture and religion of the community has to be respected when reaching female farmers individually. |
| * Group-contact | * Group meetings / group discussions * Field day, ,Study tours / field trips |
| Technology selection | * Individual | * Farm and home visit, Informal contact, | * Visit and meetings have to be arranged at a convenient time and place for female farmers. * Ensure the participation of women farmer (FHHs and Wife in MHH) in field days and study tours at all level * Brief introduction on the available technologies have to be given to male and female farmers |
| * Group | * Group meetings / group discussions * Field day, Study tours / field trips |
| Farmer-selection and group formation | Individual | * Farm and home visit, Informal contact, ***at this stage farmers are on individually/group form to participate in resource mobilization and lab our contribution to build spring dev’t*** | * Women farmers have to be deliberately included during farmers selections * Meeting time and place should be at women and men farmers convenience with prior notifications * Understand women’s special needs, interests and constraints by having women only group during group meetings and discussions * Target the household as a whole instead of one person from the HH, GM[[1]](#footnote-1)F |
| Group method | * Formal training preferably in FTCs * Method and Result demonstrations, * Field days, Farm walks, * Group meetings, Folk media, , * Farmer field schools. |
| Technology dissemination | Mass methods | * mass media (Leaflet, brochure, poster, * Documentary video) , Movie Film, * Television and video ,Newspapers * technology promotion festivals, | * Pictures and/or movies should have to clearly show women using the technology as men * Printing Medias and audio visuals have to be in a descriptive ways so women who in most cases unable to read can easily understand. |

* Awareness creation –. Mass extension methods are preferred methods because they can reach many irrigation water users at the same time; Development agent play great role in awaring farmer using group discussion and also individual contact method in making brief description of the technology to farmers..
* **Technology selection- after i**dentification of problems on availability of irrigation water and prioritizing the identified problems with possible intervention technology that is, affordability, durable, safe, applicable, scalable, as well as the costs of agricultural inputs and market values of the crops to be produced through ***participatory approach and demand-driven extension approaches.***
* Farmer selection-After making awareness about spring development as source of irrigation water, selection of interested innovated farmer (model farmer) is conducted for inception of the technology. Extension methods such as leaflet, brochures, IVR –technology can also be used.
* Training and demonstration (method and result demonstration approach at FTC, farmer’s field school & on-farmer field level. During training and demonstrating spring development farmer need to be trained on the technics at farmers training center side by side on field practically for further intensification of the technology.
* Extension tools to disseminate technology – Right after the technics of spring development demonstrated to farmer for more broad- dissemination extension agent can use different tools of extension such as mass media (Leaflet, brochure, poster, Documentary video), technology promotion festivals, and conducting Expert and farmers forum at Regional and Federal level in scaling up the technology in wider areas.
* Identification and documentation of best practices

Male and female 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.

### **Marketing**

In most cases male dominate the selling of high value crops and if crops are higher in volume. An approaches like GMF, which encourage joint family decision should have to be introduced to ensure women making informed decisions. Focus on identifying how women and men experience and value ongoing changes and use this to both meet their own interests while addressing concerns about short and long term household survival;

## **Financial Analysis**

### **Investment Cost (infrastructure, technology supply)**

Water for Irrigation development from spring water sources has different alternative to invest. These different cases have different magnitude of initial investment which yields different result of feasibility analysis results. These different scenarios of spring development have different water lifting devise, irrigation application and different ranges of capping structure. These scenarios of spring development are,

Case 1: spring capping + Gravity (pipe or irrigation canal)

Case 2: Capping structure + water lifting (motor pump)

Case 3: Capping structure + gravity + storage+ Water lifting (treadle pump) + drip system

Case 4: Capping structure + gravity + storage+ Water lifting (solar pump) + drip system

Case 5: Capping structure + water lifting (motor pump) + drip system

Moreover, in each case there are minimum and maximum estimated costs per hectare. In a case of minimum case scenario the estimated average cost of investment is found to be high while in the case of maximum irrigable areas investment cost is over distributed and the cost is too low.

This source of irrigation enables to irrigate the land through the year and irrigation development is assumed to be under take in two rounds with in a year. Based on the above specification for those annual crops time of financial analysis has made for five years and ten cycle of production while for perennials the analysis has been made for ten years.

Base on the above assumption financial analysis of developed spring irrigation has been made as follows

**Case 1 water source spring capping**

**Water lifting devise: - Gravity (pipe or irrigation canal)**

**Application: - Furrow**

**Estimated irrigable areas 1ha**

Table Financial analysis of spring, lifting devise is gravity and furrow application

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of spring irrigation case 1 with minimal. Capping structure. | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 17,000 | 87000 | 385000 | 298,000 | 2,241,840 | 4 | <1 | Accept |
| Tomato | 17,000 | 170,506 | 800,000 | 629,494 | 4,754,565 | 5 | <1 | Accept |
| H. Cabbage | 17,000 | 47,281 | 72000 | 24,719 | 170,372 | 1 | 1 | Accept |
| Potato | 17,000 | 67,197 | 480,000 | 412,803 | 3,112,049 | 7 | <1 | Accept |
| Onion seedling | 17,000 | 7,264 | 24,000 | 16,736 | 109,859 | 2.5 | 1 | Accept |
| Maize | 17,000 | 15,000 | 150,000 | 135,000 | 1,005,800 | 9 | <1 | Accept |
| Papaya | 17,000 | 100,000 | 150,000 | 50,000 | 5,420,440 | 50 | 1 | Accept |
| Avocado | 17,000 | 134,400 | 1,230,060 | 1,095,660 | 5,771,111 | 8 | <1 | Accept |

Under this case the schemas is considered to be owned by individual farmers or limited to one hectare. Total cost of initial investment is incurred to only one hectare and there is no probability to over distribute to the maximum potential of the spring developed 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.

**Case 1: water source spring capping**

**Water lifting devise: - Gravity (pipe or irrigation canal)**

**Application: - Furrow**

**Estimated irrigable areas 20ha.**

Table Financial analysis of spring, lifting devise is gravity and furrow application with maximum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of spring irrigation case 1 with max. capping structure . | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable Decision |
| Onion | 1,750 | 87000 | 385000 | 298,000 | 2,257,090 | 4 | <1 | Accept |
| Tomato | 1,750 | 170,506 | 800,000 | 629,494 | 4,769,815 | 5 | <1 | Accept |
| H. Cabbage | 1,750 | 47,281 | 72000 | 24,719 | 185,622 | 2 | <1 | Accept |
| Potato | 1,750 | 67,197 | 480,000 | 412,803 | 3,127,299 | 7 | <1 | Accept |
| Onion seedling | 1,750 | 7,264 | 24,000 | 16,736 | 125,109 | 3 | <1 | Accept |
| Maize | 1,750 | 2,611 | 72,000 | 69,389 | 1,018,300 | 10 | <1 | Accept |
| Papaya | 1,750 | 100,000 | 12,600 | -87,400 | 4,913,450 | 9 | <1 | Accept |
| Avocado | 1,750 | 133,400 | 1,230,060 | 1,096,660 | 5,880,352 | 9 | <1 | Accept |

**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.

Under this case the spring developed is assumed to irrigate the maximum potential it supposed to irrigate. Therefore, total cost of initial investment is distributed all over the 20 hectare that the spring can irrigate and the initial investment cost incurred to the individual is minimum.

**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.

**Case 2: Water source Spring: - capping structure**

**Water lifting (motor pump)**

**Application: - Furrow**

**Estimated irrigable area: - 1ha.**

**Scenarios: - minima**

Table Financial analysis of spring, lifting devise is motor pump and furrow application with minimum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Average fixed cost of spring irrigation case 2 with minimal. Capping structure. | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 25,000 | 87000 | 385000 | 298,000 | 2,233,840 | 4 | <1 | Accept |
| Tomato | 25,000 | 170,506 | 800,000 | 629,494 | 4,746,565 | 5 | <1 | Accept |
| H. Cabbage | 25,000 | 47,281 | 72000 | 24,719 | 162,372 | 1 | 1 | Accept |
| Potato | 25,000 | 67,197 | 480,000 | 412,803 | 3,104,049 | 7 | <1 | Accept |
| Onion seedling | 25,000 | 7,264 | 24,000 | 16,736 | 101,859 | 2.27 | 1.5 | Accept |
| Maize | 25,000 | 15,000 | 15,000 | 0 | 998,300 | 8 | <1 | Accept |
| Papaya | 25,000 | 2,600 | 900,000 | 897,400 | 5,488,626 | 135 | 1 | Accept |
| Avocado | 25,000 | 2,600 | 1,800,000 | 1,797,400 | 6,566,746 | 161 | <1 | Accept |

This schemas is different from the first one is that its water lifting structure is motor pump. In the case of minimum irrigation scenarios the total cost of initial investment is incurred on one hectare.

**Decision**

As the above the above analysis indicates all proposed crops are feasible under suitable agro ecologies but the producers are advised to prioritize those crops with the highest NPV and B/C ratio with shortest payback period.

**Case 2: Water source Spring: - capping structure**

**Water lifting (motor pump)**

**Application: - Furrow**

**Estimated irrigable area: - 1ha.**

**Scenarios: - maxima**

Table Financial analysis of spring, lifting devise is motor pump and furrow application maximum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 2: Capping structure + water lifting (motor pump) max | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 5,000 | 87000 | 385000 | 298,000 | 2,253,840 | 4 | <1 | Accept |
| Tomato | 5,000 | 170,506 | 800,000 | 629,494 | 4,766,565 | 5 | <1 | Accept |
| H. Cabbage | 5,000 | 47,281 | 72000 | 24,719 | 182,372 | 2 | 1 | Accept |
| Potato | 5,000 | 67,197 | 480,000 | 412,803 | 3,124,049 | 7 | <1 | Accept |
| Onion seedling | 5,000 | 7,264 | 24,000 | 16,736 | 121,859 | 3 | 1.5 | Accept |
| Maize | 5,000 | 15,000 | 150,000 | 135,000 | 1,018,300 | 9 | <1 | Accept |
| Papaya | 5,000 | 100,000 | 900,000 | 800,000 | 4,910,200 | 9 | 1 | Accept |
| Avocado | 5,000 | 133,400 | 1,230,060 | 1,096,660 | 5,783,111 | 8 | <1 | Accept |

**Decision**

In this scenario’s also all proposed crops are supposed to be feasible and advisable to invest as rotational crop. Moreover, in this scenario’s initial investment is over distributed to the potential irrigable areas and therefore, early initial investment is distributed all over the total potential hectare to be developed. This enables for most of the crop proposed to be developed. However, producers need to be advised to invest on those crops with the highest NPV under suitable agro ecology.

**Case 3: Spring water source capping structure**

**Gravity + storage+**

**Water lifting (treadle pump) + drip system**

Table Financial analysis of spring, lifting devise is treadle pump and drip application with minimum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 3: Capping structure + gravity + storage+ Water lifting (treadle pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 420,000 | 87000 | 385000 | 298,000 | 1,838,840 | 3 | 1.5 | Accept |
| Tomato | 420,000 | 170,506 | 800,000 | 629,494 | 4,351,565 | 4 | <1 | Accept |
| H. Cabbage | 420,000 | 47,281 | 72000 | 24,719 | (232,628) | <1 | 16 | Needs economic analysis |
| potatoes | 420,000 | 67,197 | 480,000 | 412,803 | 2,709,049 | 4 | 1 | Accept |
| Onion seedling | 420,000 | 7,264 | 24,000 | 16,736 | (293,141) | <1 | 25 | Needs economic analysis |
| Maize | 420,000 | 15,000 | 150,000 | 135,000 | 603,300 | 2 | 3 | Accept |
| Papaya | 420,000 | 100,000 | 900,000 | 800,000 | 4,495,200 | 5 | 1 | Accept |
| Avocado | 420,000 | 133,400 | 1,230,060 | 1,096,660 | 1,239,610 | 5 | 1.5 | Accept |

**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**

In this technology combination Onion seedling and head cabbage are non-advisable to be under take their development with current output market prices as their NPV result is negative. Moreover, other crops needs to be prioritized to be taken as the first best alternative based on their agro ecological suitability.

**Case 3: Spring water source capping structure**

**Water lifting devise: - Gravity + storage+**

**Water lifting (treadle pump) + drip system**

Table Financial analysis of spring, lifting devise is treadle pump and drip application with maximum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 3: Capping structure + gravity + storage+ Water lifting (treadle pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 362,000 | 87000 | 385000 | 298,000 | 1,896,840 | 3 | 1.5 | Accept |
| Tomato | 362,000 | 170,506 | 800,000 | 629,494 | 4,409,565 | 4 | <1 | Accept |
| H. Cabbage | 362,000 | 47,281 | 72000 | 24,719 | (174,628) | 1 | 14 | Needs economic analysis |
| Potato | 362,000 | 67,197 | 480,000 | 412,803 | 2,767,049 | 4 | 1 | Accept |
| Onion seedling | 362,000 | 7,264 | 24,000 | 16,736 | (235,141) | <1 | 21 | Needs economic analysis |
| Maize | 362,000 | 15,000 | 150,000 | 135,000 | 661,300 | 2.5 | 3 | Accept |
| Papaya | 362,000 | 100,000 | 900,000 | 800,000 | 4,553,200 | 6 | 1 | Accept |
| Avocado | 362,000 | 133,400 | 1,230,060 | 1,096,660 | 5,426,111 | 7 | 1.5 | Accept |

**Decision**

In this technology package even though initial investment is distributed over the potential irrigable area crops like onion seedling and head cabbage production are not feasible enough to be developed. The other proposed crops are found to be feasible as NPV and B/ ratio of their analysis shows. However they need to be prioritized by producers based on the agro ecologies suitability and affordability of the inputs required for investment.

**Case 4:- Spring water source Capping structure +**

**Water lifting devise: - gravity + storage+ Water lifting (solar pump)**

**Application method: - drip system**

Table Financial analysis of spring, lifting devise is solar pump and drip application with minimum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 4: Capping structure + gravity + storage+ Water lifting (solar pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 728,000 | 87000 | 385000 | 298,000 | 1,530,840 | 2 | 2.5 | Accept |
| Tomato | 728,000 | 170,506 | 800,000 | 629,494 | 4,043,565 | 3 | 1 | Accept |
| H. Cabbage | 728,000 | 47,281 | 72000 | 24,719 | (540,628) | <1 | 29 | Needs economic analysis |
| Potato | 728,000 | 67,197 | 480,000 | 412,803 | 2,401,049 | 3 | 1.5 | Accept |
| Onion seedling | 728,000 | 7,264 | 24,000 | 16,736 | (601,141) | <1 | 43 | Needs economic analysis |
| Maize | 728,000 | 15,000 | 150,000 | 135,000 | 295,300 | 1.4 | 5 | Accept |
| Papaya | 728,000 | 100,000 | 900,000 | 800,000 | 4,187,200 | 4 | 1 | Accept |
| Avocado | 728,000 | 133,400 | 1,230,060 | 1,096,660 | 5,060,111 | 4 | 2 | Accept |

**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**

In this technology package also crops like onion seedling and head cabbage production are not feasible enough to be developed. The other proposed crops are found to be feasible as NPV and B/C ratio of their analysis shows. However they need to be prioritized by producers based on the agro ecologies suitability and affordability of the inputs required for investment.

**Case 5:- Spring water source Capping structure +**

**Water lifting devise: - gravity + storage+ Water lifting (solar pump)**

**Application method: - drip system**

Table Financial analysis of spring, lifting devise is solar pump and drip application with maximum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 5: Capping structure + gravity + storage+ Water lifting (solar pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 728,000 | 87000 | 385000 | 298,000 | 1,708,840 | 2 | 2 | Accept |
| Tomato | 728,000 | 170,506 | 800,000 | 629,494 | 4,221,565 | 3 | <1 | Accept |
| H. Cabbage | 728,000 | 47,281 | 72000 | 24,719 | (362,628) | <1 | 22 | Needs economic analysis |
| potato | 728,000 | 67,197 | 480,000 | 412,803 | 2,579,049 | 3 | 1 | Accept |
| Onion seedling | 728,000 | 7,264 | 24,000 | 16,736 | (423,141) | <1 | 32 | Needs economic analysis |
| Maize | 728,000 | 15,000 | 150,000 | 135,000 | 473,300 | 2 | 4 | Accept |
| Papaya | 728,000 | 100,000 | 900,000 | 800,000 | 4,365,200 | 5 | <1 | Accept |
| Avocado | 728,000 | 133,400 | 1,230,060 | 1,096,660 | 5,238,111 | 5 | 1.5 | Accept |
|  |  |  |  |  |  |  |  |  |

**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**

In this technology package even though initial investment is distributed over the potential irrigable area crops like onion seedling and head cabbage production are not feasible enough to be developed. The other proposed crops are found to be feasible as NPV and B/ ratio of their analysis shows. However they need to be prioritized by producers based on the agro ecologies suitability and affordability of the inputs required for investment.

**Case 6: Water source spring Capping structure +**

**Water lifting devise: - motor pump**

**Water application technology: - drip system**

**Scenarios: - minima**

Table Financial analysis of spring, lifting devise is motor pump and drip application with minimum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 6: Capping structure + gravity + storage+ Water lifting (solar pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decision |
| Onion | 360,000 | 87000 | 385000 | 298,000 | 1,878,840 | 3 | 1.5 | Accept |
| Tomato | 360,000 | 170,506 | 800,000 | 629,494 | 4,391,565 | 4 | <1 | Accept |
| H. Cabbage | 360,000 | 47,281 | 72000 | 24,719 | (192,628) | 1 | <15 | Needs economic analysis |
| potato | 360,000 | 67,197 | 480,000 | 412,803 | 2,749,049 | 4 | 1 | Accept |
| Onion seedling | 360,000 | 7,264 | 24,000 | 16,736 | (253,141) | <1 | 22 | Needs economic analysis |
| Maize | 360,000 | 15,000 | 150,000 | 135,000 | 643,300 | 2.5 | 2.5 | Accept |
| Papaya | 360,000 | 100,000 | 900,000 | 800,000 | 4,535,200 | 7 | <1 | Accept |
| Avocado | 360,000 | 133,400 | 1,230,060 | 1,096,660 | 5,408,111 | 5.5 | 2.7 | Accept |

**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**

In this technology package also crops like onion seedling and head cabbage production are not feasible enough to be developed. The other proposed crops are found to be feasible as NPV and B/C ratio of their analysis shows. However they need to be prioritized by producers based on the agro ecologies suitability and affordability of the inputs required for investment.

**Case 7: Water source spring Capping structure +**

**Water lifting devise: - motor pump**

**Water application technology: - drip system**

**Scenarios: - minima**

Table Financial analysis of spring, lifting devise is motor pump and drip application with maximum scenarios

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | Case 7: Capping structure + water lifting (motor pump) + drip system | Average Variable cost ETB | Average Revenue ETB | Marginal profit | NPV | B/C Ratio | Payback period (year) | Advisable decisions |
| Onion | 360,000 | 87000 | 385000 | 298,000 | 1,878,840 | 3 | 1.5 | Accept |
| Tomato | 360,000 | 170,506 | 800,000 | 629,494 | 4,411,565 | 4 | <1 | Accept |
| H. Cabbage | 360,000 | 47,281 | 72000 | 24,719 | (172,628) | 1 | 15 | Needs economic analysis |
| potato | 360,000 | 67,197 | 480,000 | 412,803 | 2,769,049 | 4 | 1 | Accept |
| Onion seedling | 360,000 | 7,264 | 24,000 | 16,736 | (233,141) | <1 | 21 | Needs economic analysis |
| Maize | 360,000 | 15,000 | 150,000 | 135,000 | 663,300 | 2.4 | 2,5 | Accept |
| Papaya | 360,000 | 100,000 | 900,000 | 800,000 | 4,555,200 | 5.7 | 1 | Accept |
| Avocado | 360,000 | 133,400 | 1,230,060 | 1,096,660 | 5,428,111 | 5.6 | 1.2 | Accept |

**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.

In this technology package even though initial investment is distributed over the potential irrigable area crops like onion seedling and head cabbage production are not feasible enough to be developed. The other proposed crops are found to be feasible as NPV and B/ ratio of their analysis shows. However they need to be prioritized by producers based on the agro ecologies suitability and affordability of the inputs required for investment.

* **Operation and maintenance cost**

The yearly operation and maintenance cost of spring development HHMI package is assumed to 5% of the investment cost.

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

Table 24- M&E tools for spring development (Water source)

| **Criteria** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| --- | --- | --- | --- | --- |
| **Performance** | Water discharge | Litre/sec | On-situ at spring | Bucket method |
| Water quality for irrigation (salinity, TDS PH) | PPT (EC)/PPM | On-situ at spring | Field test/lab test |
| Type of Spring | Seasonal/ Non-seasonal | Community | Interview |
| Discharge Q-Variability | Low/Medium/  Constant/High | Community | Interview |
| **Simplicity** | Ease of water abstraction | Simple/Moderate/Difficult | Farmers/Users | Interview |
| Ease of construction | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Safety** | Safety (cover, etc.) | Yes/No | Site Visit | Site Visit |
| **Operation & Management** | Use of local construction material | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Affordability** | Cost of construction | Affordable/Expensive | Site Visit/Farmers | Site Visit/Interview |
| Cost of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |
| **Maintainability** | Local maintainability | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Reliability** | Frequency of maintenance | None/Low/Medium/High | Site Visit/Farmers | Site Visit/Interview |
| **Gender Responsiveness** | Gender responsive | Labour, time, empowerment | Site Visit/Farmers | Site Visit/Interview |
| **Environmental Impact** | Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |
| **Availability** |  |  |  |  |
| **Demand Generation** |  |  |  |  |
| **Satisfaction** |  |  |  |  |
| **Documentation/User Manual** |  |  |  |  |

Table 25-Water lifting technologies

| **Motor Pump** | | | | | **Solar Pump** | | | | **Treadle Pump** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Water discharge | Litre/min | On-situ at Pump | Discharge Measurement | Water discharge | Litre/min | On-situ at Pump | Discharge Measurement | Water discharge | Litre/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 | Total Head | Meter | On-situ at Pump | Head Measurement |
| Power Requirement | KW (Hp) | On-situ at Pump | Power 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 | Speed | RPM | On-situ at Pump | rpm Measurement | Weight | Kg | On-situ at Pump | Measurement |
| Fuel Consumption | Litre/hr | On-situ at Pump | Measurement |  |  |  |  |  |  |  |  |
| Pump efficiency | % | On-situ at Pump | Measurement | Pump efficiency | % | On-situ at Pump | Measurement | Pump efficiency | % | On-situ at Pump | Measurement |
| **Operation Management** | Operational duration[[2]](#footnote-2) | Hours/month | On-situ at Pump | Measurement | 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 | 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 | 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 (starting) | Easy/Not Easy | 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 ownership | Affordable/  Expensive | On-situ at Pump | Measurement |  |  |  |  |
| Cost of operation | Affordable/Expensive | On-situ at Pump | Measurement | Cost of operation | Affordable/  Expensive | On-situ at Pump | Measurement |  |  |  |  |
| Storage quality[[3]](#footnote-3) during idle time | Poor/Good | On-situ at Store | Observation |  |  |  |  |  |  |  |  |
| Oil and fuel Usage[[4]](#footnote-4) | Standard/Non-standard | On-situ at Store | Observation |  |  |  |  |  |  |  |  |
| **Maintenance** | Local maintainability | Yes/No | On-situ at Pump | Measurement | 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 | 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 | 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 | 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 | Cost of spare parts | None/Low/Medium/  High | Local market survey | Interview |  |  |  |  |
| **Cross cutting** | Gender responsive | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |  |  |  |  |
| Environmentally friendly | Yes/No | Site Visit/Farmers | Site Visit/Interview |  |  |  |  |  |  |  |  |

Table 26-Water application Technologies

| **Drip Irrigation** | | | | | **Furrow Method** | | | | **Water Can** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Areas** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** | **Indicator** | **Unit** | **Data Source** | **Data Collection Method** |
| **Performance** | Efficiency[[5]](#footnote-5) | % | 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 |  |  |  |  |
| Quality of Material | Poor/Good | Site Visit/Farmers | Site Visit/Interview |  |  |  |  | Quality of Material | Poor/Good | Site Visit/Farmers | Site Visit/Interview |
| Water uniform[[6]](#footnote-6) 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 |
| 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 |  |  |  |  |
| 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 installation | Yes/No | Site Visit/Farmers | Site Visit/Interview | Ease of water abstraction | Simple/Moderate/  Difficult | Farmers/Users | Interview |  |  |  |  |
| Use of local[[7]](#footnote-7) 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 | 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 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 | 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 |  |  |  |  |
| 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 |
| 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. Motor pumps are required to operate 100 hours before servicing fuel pump, motor oil, etc. [↑](#footnote-ref-2)
3. Good storage refers to proper shade, protection from rodents, animals and the way idle pumps are managed, etc. [↑](#footnote-ref-3)
4. Proper oil types, fuel and their utilization is referred here. [↑](#footnote-ref-4)
5. Efficiency refers to application efficiency where water abstracted is delivered from the source versus amount of water used by the crop. [↑](#footnote-ref-5)
6. Uniformity refers to application of water from head to tail. [↑](#footnote-ref-6)
7. Refers to whether the community uses local materials and indigenous knowledge [↑](#footnote-ref-7)