Association of Irrigation Acceleration Platform (AIAP)

WATER PRODUCTIVITY IN PRACTICE KNOWLEDGE & ACTION (WATERPIP-KAN)

REPORT NO. 4

TRAINING WORKSHOPS ON INNOVATIVE DRIP IRRIGATION IN THE UPPER EWASO NG'IRO BASIN, KENYA

Report prepared by:

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Stichting Delft Institute for Water Education[1]

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ABOUT THIS REPORT

Synopsis

The Association of Irrigation Acceleration Platform (AIAP) based in Kenya, is working collaboratively under a contract with the Stichting IHE Delft Institute for Water Education (IHE-Delft), as part of the DUPC3 Programme. This implements the Water Productivity in Practice Knowledge & Action Network (WaterPIP-KAN) project. The project duration is 4 years, from 27th November 2023 to 31st December 2027.

This is the **fourth** progress report submitted by AIAP to IHE-Delft. This particular report is entitled: "*Training Workshops on Innovative Drip Irrigation in the Upper Ewaso Ng'iro Basin, Kenya".* The WaterPIP-KAN project decisively targets and is inclusive of remote and marginalized communities who constitute the grassroots beneficiaries and implementation partners of the project in Kenya.

This report responds to the project Terms of Reference (ToR) specifically, *WP1: "Taking data to the margins*". The Training Workshops were conducted at the two sites identified in the Upper Ewaso Ng'iro Basin (UENB). These are (i) Naromoru Water Resources Users Association (NaWRUA) in Laikipia County; and (ii) Elsa Water Project in Burat, Isiolo County. Both sites have small-scale farmers engaged in irrigation amid water scarcity challenges, and where improvements in water productivity of crops is desired. Also, both sites have vulnerable and marginalized communities.

The training content was based on the findings of the Needs Assessment which had identified improving irrigation water application efficiencies in the two sites. The training covered drip irrigation theory and practices, and a practical session on making home-made drippers A total of 42 participants took part combining both sites. The workshop's objectives, activities and outcomes are outlined in this report

ACKNOWLEDGEMENTS

This report was developed as part of the Water Productivity Improvement in Practice Knowledge & Action Network (WaterPIP-KAN) project, which is supported by the Directorate-General for International Cooperation (DGIS) of the Ministry of Foreign Affairs of the Netherlands under the IHE Delft Partnership Programme for Water and Development (DUPC3). AIAP team thanks the Stichting Delft Institute for Water Education (IHE-Delft) of The Netherlands, for financial support for this project.

Prof. Bancy Mati
WaterPIP-KAN Project Team Leader, at AIAP, Kenya

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1. INTRODUCTION

1.1 Background

The Association of Irrigation Acceleration Platform (AIAP) is a partner in the implementation of the international project entitled: "Water Productivity Improvement in Practice, Knowledge & Action Network (WaterPIP-KAN)". The project is funded under the *Water Development Partnership Programme (WDPP) of IHE-Delft of The Netherlands and* runs for 4 years, from 11th November 2023 to 31st December 2027. The other partners are from The Netherlands, Kenya, Ethiopia, Sudan, Egypt, Niger and India. The WaterPIP-KAN project aims to decisively target and be inclusive of remote and marginalized communities engaged in agriculture and where improving water productivity, especially under irrigation, and who will constitute the grassroots beneficiaries and implementation partners of the WaterPIP-KAN project. AIAP's role as an NGO is to support the project with facilitating grassroots activities and knowledge transfer in Kenya.

1.2 Project progress

This is the **fourth** progress report submitted by AIAP, entitled: "***Training Workshop on Innovative Drip Irrigation in the Upper Ewaso Ng'iro Basin, Kenya***". It follows on the heels of three earlier reports, i.e.: (i) *Report 1: Methodology for Identifying Marginalized Groups for WATERPIP-KAN Project Engagement*. That report presented the salient features of what constitutes vulnerable and marginalize groups (VMG). It also charted the methodology for identifying and engaging VMGs in scientific research and participatory project implementation. In February 2024, AIAP applied this methodology to identify candidate sites and communities in the Upper Ewaso Ng'iro Basin (UENB) of Kenya for engagement in the formative WaterPIP-KAN project. The process involved desk studies followed by field verification visits culminating in the identification of the two choice sites/communities. The findings were compiled and presented in *Report 2:* "*Identifying sites for community engagement for implementation of WaterPIP-KAN project in Kenya. Report 3 was* is entitled: "*Needs Assessment of the Readiness by Small-Scale Farmers for Satellite Data to Study and Improve Water Productivity in Upper Ewaso Ng'iro Basin, Kenya".* It is from the Needs Assessment that Drip Irrigation was identified as a topic of interest for the Training Workshops

1.3 Why Conduct Training on Innovative Drip Irrigation

One of the most pressing challenges facing small-scale farmers in Kenya is limited water resources. Within the context of the Water Productivity in Practice Knowledge & Action (WaterPIP-KAN) project, the Association of Irrigation Acceleration Platform (AIAP) conducted a training workshop with small-scale farmers in Naromoru Water Resources Users Association (NaWRUA, Laikipia County) and Elsa Water Project (Isiolo County).

1.4 Purpose and Objectives

The Training Workshop aimed to equip farmers with practical knowledge and skills on water management technologies, with a particular emphasis on the implementation of innovative drip irrigation systems.

Specific Objectives

1) To raise awareness among small-scale farmers about sustainable water management practices.
2) To promote the adoption of innovative drip irrigation systems to enhance water productivity in irrigated agriculture.
3) To provide hands-on training on the installation, operation, and maintenance of innovative drip irrigation systems; i.e. (i) Tied pipe dripper and (ii) Threaded pipe dripper.

2. CONDUCTING THE TRAINING WORKSHOP

Each of the two workshops were conducted through a combination of plenary presentations followed by question and answers sessions. Thereafter, hands-on demonstration training was conducted together with the farmers showing how to make and maintain drip emitters made from local materials (see Annex 1).

2.1 Workshop participants

Two sets of workshops were implemented as follows:

i) Naromoru Water Resources Users Association (NaWRUA), Laikipia County.
ii) Elsa Water Project in Burat, Isiolo County.

The total participants (Annex 2) at the two training workshop were 42 for both Laikipia and Isiolo, of which 21 were male and 21 were female (Table 1). It is clear that NaWRUA had mostly men, while Elsa had more female participants.

Table 1: Participants at the two Training Workshops

Training site	Participants (male)	Participants (female)	Total
NaWRUA Laikipia	14	7	21
ELSA Water Project, Isiolo	7	14	21
Total	**21**	**21**	**42**

2.2 Plenary Sessions

In these sessions, PowerPoint presentations (see Annex 3) were made and other notes shared on WhatsApp to participants' phones. The topics covered included

introduction to the conventional drip irrigation systems with focus on conditions suitable for drip irrigation, components of a drip irrigation system, installation and maintenance of the drip irrigation system, and benefits of drip irrigation. Detailed explanations were provided on the environmental and soil conditions that make drip irrigation effective. Participants were also trained on importance of water quality and ensuring low levels of sedimentation and salinity to prevent clogging of the system.

The key components of the system and the role of each component was presented, including water sources, filters, mainlines, sub-mainlines, lateral pipes, emitters, and valves. The step-by-step process of laying out a drip irrigation system was outlined to the participants, starting from land preparation to the installation of drip lines and emitters. Emphasis was also placed on ensuring regular maintenance by cleaning filters, flushing pipelines to remove sediment, and inspecting emitters for blockages.

During the question and answer sessions, farmers were encouraged to ask questions and responses could come from bot the trainers and the trainees. In particular, they wanted to know how drip irrigation saved water, reduced labor costs, enhanced early maturity of crops, improved crop yields due to precise water delivery, high quality of produce, and reduced weed growth.

2.3 Hands-on Demonstration Training

In this session, participants were trained on making cost-effective home-made drippers using locally available materials such as PVC pipes. The main aim was to make the farmers aware of affordable alternatives to conventional drip irrigation systems, which are often costly. Given the huge potential of drip irrigation systems in water resources management, this was seen as key in enabling the small-scale farmers to adopt drip irrigation without significant financial barriers. Using a step-by-step guide, farmers created a dripper using a PVC pipe perforated to create emitters at a preferred spacing. These home-made drippers showed significant benefits as they are cost-effective and farmers can modify them to irrigate different crops ranging from closely spaced vegetables to fruit trees and banana.

2.4 Synthesis of the Question & Answer Session

The following is a summary of the responses based on question and answer sessions by both groups.

a) Advantages of using Drip Irrigation

Compared to farmers who use conventional types of irrigation like use of sprinklers and furrow, farmers at the workshop preferred drip irrigation due to the following:

i) Crop harvests of farmers using drip irrigation are harvested 15 days earlier than those using conventional methods.
ii) Harvests are more in quantity due to water consistency; Farmers using drip irrigation do not encounter losses on their farms due to using too much water causing crops to rot or less water causing crops to dry up.
iii) Drip irrigation is manageable and can easily be delegated even to someone unskilled. A farmer can open their drip liners under their own time schedule.
iv) Drip liners need to have enough pressure to expel water well into the farms. One of the techniques used by farmers is the Mini-valve regulator. This is whereby farmers regulate the pressure through closing the valve of one dripline so that water flows in the other drip lines in order to acquire the right pressure. This also helps in removing airlock from the drip liners due to increased pressure.

b) Ideal time for Irrigation

i) Best time to irrigate crops is in the early morning before arrival of the midday heat. This allows the crop to absorb more water and avoid water loss due to evaporation. Healthy crops need three things to grow
   - Water
   - Oxygen
   - Photosynthesis
ii) Those crops watered in the afternoon lose a lot of water due to evaporation thus; crops might seem under watered or eventually dry up.
iii) While evening might seem like a great option, some crops might end up rotting since they will not have time to dry during nightfall.

2.5 Key Outcomes of the Workshops

(i) Farmers gained a clear understanding of the principles and benefits of drip irrigation.
(ii) Participants learned about cost-effective home-made alternatives to conventional drip irrigation systems.
(iii) Farmers successfully developed functional home-made drippers during the practical sessions.
(iv) The participants demonstrated the ability to identify and address basic operational issues in drip irrigation systems.
(v) Women and youth actively participated in the workshop, promoting their confidence in proper management of water resources.
(vi) Farmers in both groups were very fascinated during the practical session. In terms of willingness, all the farmers showed interest to engage in the use of water efficient irrigation technique that would help them manage water and achieve more crop production in their farms.

ANNEX 1: PHOTOS OF THE TRAININGS IN SESSIONS

a) Farmer training ant Naromou Water Resources Users Association (NaWRUA), Laikipia

b) Farmer training at Elsa Water Project, Isiolo

ANNEX 2: PARTICIPANTS AT THE TWO TRAINING WORKSHOPS

a) Narmoru Water Resource Users Association (NaWRUA), Laikipia

Sno.	NAME	Gender
1.	Justin Munene	M
2.	Kenneth Githinji	M
3.	Patrick Wambugu	M
4.	Ann Wanjiru	F
5.	Peter Wanyeki	M
6.	Alfred Waiharo	M
7.	Richard Kiiru	M
8.	Esther Munyiri	F
9.	Eunice Mugo	F
10.	Wanjohi PS Muriuki	M
11.	Lucy M Waithaka	F
12.	Ephraim Kahenya	M
13.	Patrick M Mwangi	M
14.	David Muthee	M
15.	Richard Waweru	M
16.	Isaac Kiragu Kung'u	M
17.	Charles Gachuci	M
18.	Prof. Bancy Mati	F
19.	John Musau	M
20.	Irine Jeptum	F
21.	Betty Nyaga	F

b) Elsa Water Project, Isiolo County

SNo.	NAME	Gender
1.	Ekiru Ekita	M
2.	Winnie Nduna Ekimat	F
3.	Josphine Narunyei	F
4.	Mary Achwa Ekimati	F
5.	Winnie Nakorodi Achichi	F
6.	John Taipi	M
7.	Milka Nasieku Lemunem	F
8.	Alex Lekwale	M
9.	Martin Mutethia	M
10.	Simon Lekwale	M
11.	Mary Lohio	F
12.	Tango Lekursai	F
13.	Enzina Wakeno	F
14.	Mary Lekwawi	F
15.	Jacinta Akowm	F
16.	Duncan Kimathi	M
17.	Florence Mwangangi	F
18.	Prof. Bancy Mati	F
19.	John Musau	M
20.	Betty Nyaga	F
21.	Irine Jeptum	F

ANNEX 3: TRAINING NOTES ON INNOVATIVE DRIP IRRIGATION SYSTEMS

By: Prof. Bancy Mati, Dr. John Musau, Betty Muthoni and Irine Jeptum

Drip Irrigation

What is drip irrigation?

Drip irrigation (or trickle irrigation), is an irrigation system in which water is slowly applied at or near the root of the plant, drop by drop (Figure 1). The system is based on the fundamental concept of irrigating only the root zone of the crop, which would maintain excellent soil-water-plant relationship. Only the crop root zone is wetted thus reducing water wastage, weeds and other pests.

Figure 1. Drip irrigation of green beans, a high value crop

Conditions Suitable for Drip Irrigation

Crop types

Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Generally only high value crops are considered because of the high capital costs of installing a drip system.

Suitable slopes

Drip irrigation is adaptable to any farmable slope. Normally the crop would be planted along contour lines and the water supply pipes (laterals) would be laid along the contour also. This is done to minimize changes in emitter discharge as a result of land elevation changes.

Preferred soils

Drip irrigation is suitable for most soils. On clay soils water must be applied slowly to avoid surface water ponding and runoff. On sandy soils higher emitter discharge rates will be needed to ensure adequate lateral wetting of the soil.

Water quality

For drip irrigation, it is essential to use clean water which is free of sediments. Generally, water used in drip irrigation is usually filtered. Blockage may occur if the water contains sediments, algae, fertilizer deposits and dissolved chemicals which precipitate such as calcium and iron. Drip irrigation is particularly suitable for use with saline water.

Water management

An optimum soil-moisture regime is maintained by applying the required amount of water at the right frequency. Shallow sandy soils require more frequent (1–2 day interval) irrigation; deep clay loam soils allow less frequent (3–7 day interval) irrigation. During the early stages of crop growth the plant roots are shallow and therefore there is a need for more frequent irrigation and less water per irrigation event. During the flowering or late vegetative stage of the crop, water consumption is highest and an adequate water regime is vital. It is important to ensure that the crop does not experience moisture stress during this period.

Drip Irrigation design and installation

Components of a drip irrigation system

There are different kinds of drip irrigation systems. However, the basic components (Figure 2) of a typical drip irrigation system has the following:

i. Water source—to provide the amount of water required at the necessary pressure to distribute and push water out of the drip emitters;
ii. Main and sub-main lines - carry and distribute water to the drip laterals;
iii. Drip laterals—to carry the water and distribute it to the drip emitters;
iv. Filter - removes sediments from the irrigation water;
v. Emitters—to control the flow of water from the laterals into the soil;
vi. Accessories and control valves.

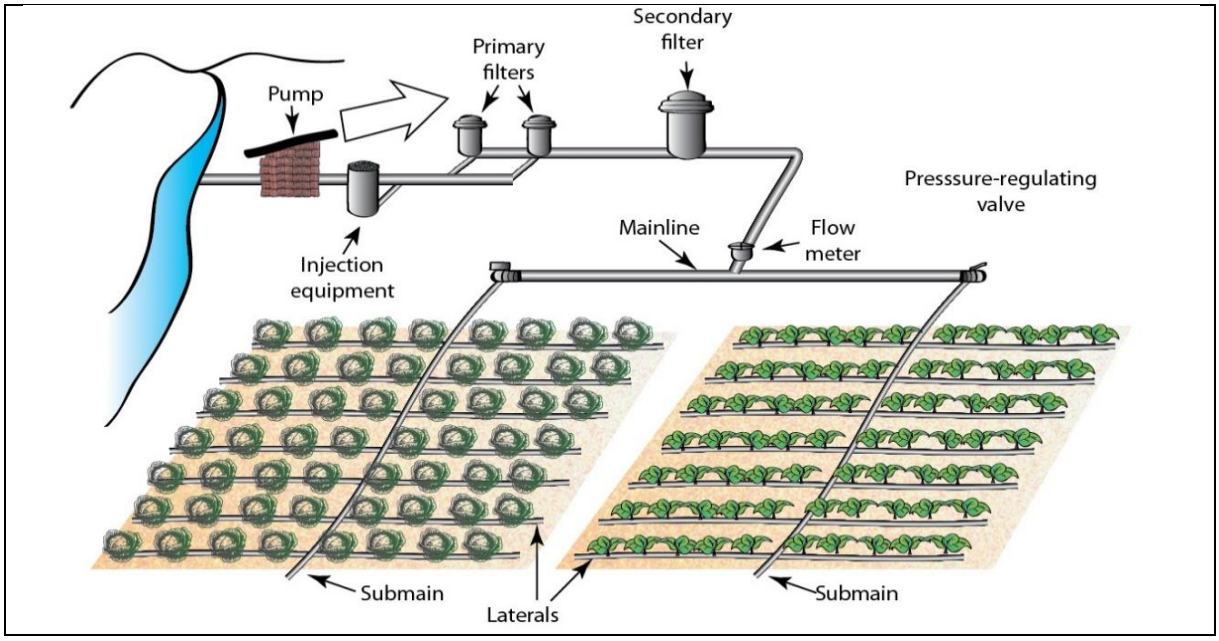


Figure 2: Components of a drip irrigation systems

Installation of the drip irrigation system

Proper installation is crucial to the effectiveness and long-term operation of any inline drip system. Observe the following guidelines:

- Keep all pipes and fittings clear of dirt and debris, protect exposed ends by taping or plugging while assembling other components,
- Flush the system thoroughly prior to installing the last connections,
- Install all inline drippers at an even depth,
- Use loop-type galvanized fabric staples or pins to keep tubing in place,
- Verify the location of each air/vacuum relief valve in field, ensuring one is installed at each localized high point, and
- During and after installation, keep off the already installed inline drip tubing and be careful when working around the system to avoid damage.

Maintenance

To ensure well performance of the system, routine inspections are critical. Some of the maintenance activities include unclogging or replacing Emitters, and frequent cleaning of filters. Using clean water minimizes blockages, while proper storage extends component life.

Benefits of drip irrigation

- Drip irrigation is the most efficient method of irrigating. While sprinkler systems are around 75-85% efficient, drip systems typically are 90% or higher. If managed properly, evaporation and runoff are minimized.
- Higher crop yields due to uniform water application as drip irrigation takes place on a frequent basis and soil moisture remains at optimal level.

- Improved crop quality due to targeting water at the root zone compared to other irrigation methods.
- Reduced pests and diseases, including reduced weeds, as the land between the plants remains dry.
- Reduced labor costs especially since agronomic practices such as weeding are reduced. A drip irrigation system can be automated such that water is automatically switched on and off for pre-set depths of irrigation.
- Low energy requirement compared to conventional pressurized system because of the lower operational water pressure required for drip systems.
- Reduced salinity hazard since drip irrigation does not substantially raise the water table.

Water harvesting pan for drip irrigation in Baringo

Limitations of drip irrigation

- **High cost** – Fully equipped drip irrigation systems have high initial costs
- Technical limitations - A higher level of design, management and maintenance is required with drip irrigation than other methods.
- Drip irrigation **emitters may get clogged**. Emitters have very small nozzle ranging 0.2-2.0 mm in diameter which becomes blocked easily.
- Drip irrigation **requires clean water** free of sediments, e.g. it is not recommended for water from sandy formations and water pans
- Poorly developed crop root zone, as plant root activity is limited to the zone wetted by the drip emitters.
- Restricted movement of machinery and farm operations since drip lines are spread around the cropped land.

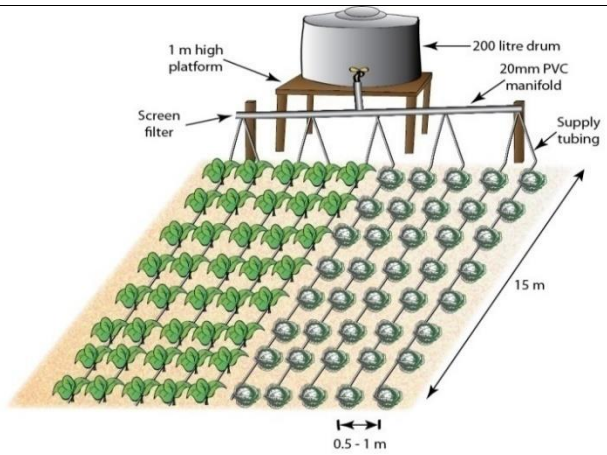
Q & A

INNOVATIVE DRIP IRRIGATION (OTHER WAYS TO DO DRIP IRRIGATION)

Types of Home-made Drip Irrigation Kits

Various kits are tailored to fit the needs of different farmers:

- **Bucket Kits:** Suitable for small gardens, utilizing gravity-fed water from an elevated bucket.
- **Waterboys Kits:** Cost-effective systems for small kitchen gardens with pre-filtered water.
- **Drum Kits:** Larger systems for plots up to 1,000 m², relying on low-pressure gravity flow from elevated drums.
- **Wagon Wheel Systems:** Circular drip arrangements ideal for vegetables and grapes in arid areas.
- **Home-**made drippers

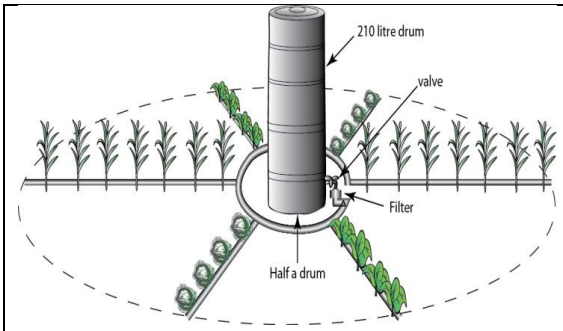


(a) Sketch of a drum drip kit

(b) Drum drip irrigation for vegetables

Wagon wheel system

The wagon wheel is a localized method of drip irrigation, which is used to grow vegetables and grapes in arid zones. The **wagon wheel irrigation system** uses a circular arrangement of several drip lines all connected directly to a central reservoir drum of about 200 litres, hence its name. The length of each drip line is about 6 m but this can vary. Wagon wheels can also be used for kitchen gardens and in urban agriculture. Several types of crops can be grown each with different spacing.

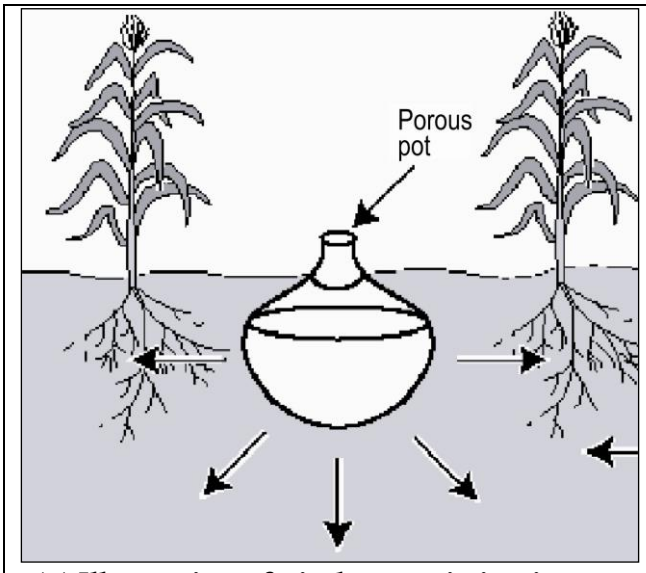


Sketch of wagon wheel drip irrigation system

(b) **Wagon wheel drip irrigation system**

Pitcher pot irrigation

Pitcher Irrigation or 'Pot Irrigation' is a traditional, low-volume irrigation technology that uses baked clay pots buried adjacent the roots of the crop to be irrigated. Such pots are made by women in the traditional way, but the clay is mixed with saw-dust to create porosity when the pot is fired during curing. A hole is usually dug adjacent the tree crop to be irrigated and the pot placed within. The soil is then packed around the neck of the pots so that the necks protrude a few cm above the ground surface. The pots are made of locally available clay with optimum properties of strength (to resist crushing), permeability (to exude water into the soil at an approximately steady rate), and size (to hold enough water for at least one day's supply). The pot is filled with water and covered with a clay slab or polythene paper, to reduce evaporation losses. Water seeps slowly through the porous sides of the pot. The minute hairs of nearby plants pull the water out from the pots. The method encourages deeper rooting and reduced evaporation. The method is commonly used for fruit-tree crop production.



(a) Illustration of pitcher pot irrigation

(b) **Pitcher pot with citrus tree** *(photo by B. Mati)*

Home-made drippers for Drip irrigation

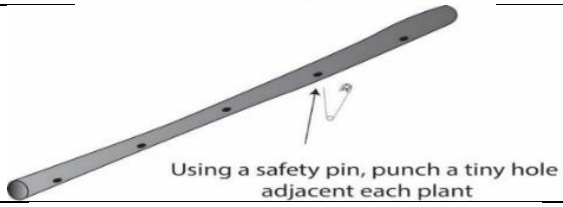
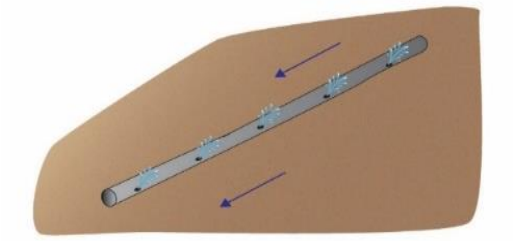
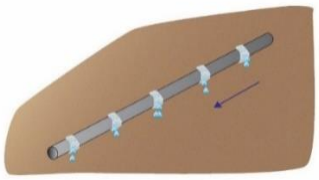
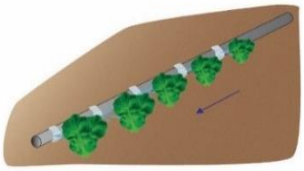
Why home-made drippers?

Drip irrigation kits are factory-made and thus expensive. Farmers can make certain components of the drip system themselves, thus cutting costs. Home-made drippers are easy to maintain and unclog, making drip irrigation amenable to use of water that contains sediments. Also, the method permits the farmer to punch drippers that correspond to the crop spacing. Two methods are discussed here.

(i) Tied pipe dripper, and
(ii) Threaded pipe dripper.

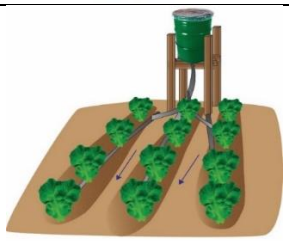
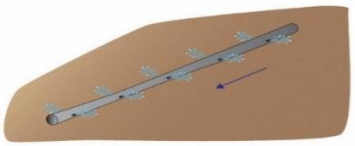
Preparing a tied pipe dripper

This comprises a perforated pipe drip emitter with plastic covering. In construction, a narrow plastic pipe is punctured to create a small hole. The hole is then tied with using a small polythene paper to reduce water out-flow from a jet into drops. This is illustrated here below:

1. Purchase a roll of ½ inch PVC pipe.	
2. Lay the PVC pipe along the crop rows (e.g. papaya)	
3. Using a safety pin, punch a tiny hole adjacent each plant	
4. This small hole releases a small jet. That is not drip irrigation	
5. Cover each hole by tying a plastic strip around the pipe	 
6. The finished perforated pipe drip emitter with plastic sheet covering	 

Preparing a threaded pipe dripper

This comprises a perforated pipe drip emitter with threaded string. In this systems, two holes are punctured directly across the pipe, and then a small thread passed through both holes to reduce water out-flow from a jet into drops. The thread is knotted on both ends so as to retain it in place. The thread can also be used to unclog the emitter in case it gets clogged, by simply twisting it.

1. Purchase a roll of ½ inch PVC pipe.	
2. Lay the PVC pipe along the crop rows (e.g. banana).	
3. Using a big sewing needle, thread it with a nylon string. Pass the needle through the pipe so that you have 2 hole	
4. The two small holes releases water jets in two directions. That is not drip irrigation.	
5. Cut the string and thread knots on both sides.	
6. The finished perforated pipe drip emitter with threaded string.	

Q & A