Feed the Future Tanzania Kilimo Tija Activity

Technical Bulletin: Drip Irrigation

INTRODUCTION

Agriculture is a backbone of Tanzania's economy, employing more than 65 percent of the workforce.[1] Smallholder farmers produce more than 90 percent of the country's food crops, though face ongoing challenges like water scarcity, low productivity, and climate change impacts.[2] Traditional irrigation practices such as surface flooding are inefficient and wasteful, resulting in poor uniformity and growth, soil nutrient depletion, and unnecessary overuse of scarce water resources.

Drip irrigation technology presents a viable solution to tackle these challenges by precisely delivering water to the crop at the right time and location, leaving unproductive areas dry. Drip is a highly efficient method of irrigation, saving up to 50 percent of water compared to traditional irrigation methods.[3] Additionally, drip irrigation effectively controls weeds, minimizes the risk of fungal diseases, and enhances crop yields per volume of water applied, and drip lines facilitate the direct application of water-soluble nutrients to the crop's root system, a process known as fertigation, which prevents excessive use of chemical fertilizers.

Figure 1: Drip irrigation installed in an onion plot
Photo: Fintrac Global Inc.

[1] National Bureau of Statistics Tanzania: https://www.nbs.go.tz/
[2] USAID Tanzania Agriculture Fact Sheet, 2018: https://www.usaid.gov/tanzania/agriculture-and-food-security
[3] Low-cost Drip Irrigation Systems for Smallholder Farmers in Tanzania. https://cgspace.cgiar.org/rest/bitstreams/b8fe082d-fae0-41b0-b863-a2552ae84db8/retrieve

WHAT IS DRIP IRRIGATION?

Drip irrigation, also called micro-irrigation, is a low-pressure, highly efficient system that delivers water directly to plant roots through a system of tubes and emitters. Water is applied as drops or tiny streams at very low flow rates, for smallholders ranging from 1.5 or 2 liters per hour to 4 liters per hour. Unlike traditional irrigation methods that flood or spray water, drip irrigation's slow, targeted application minimizes evaporation and runoff, resulting in improved water use efficiency and ultimately crop productivity.

ADVANTAGES OF DRIP IRRIGATION

Drip irrigation offers several benefits for smallholder farmers:

Water Efficiency

- Precise water delivery minimizes water wastage and optimizes water use.
- Reduces water stress on crops and improves overall water productivity.

Improved Crop Health and Productivity

- Provides consistent moisture to the root zone, promoting healthy plant growth.
- Minimizes foliar diseases by keeping foliage dry and reducing fungal growth.
- Enables fertigation, which facilitates better nutrient uptake and leads to improved crop yield and quality.

Weed and Pest Control

- Water is targeted directly at the plant roots, reducing weed growth.
- Reduces pest and disease incidences by limiting leaf wetness and humidity.

Figure 2: Healthy tomato plot benefits from drip irrigation
Photo: Fintrac Global Inc.

Resource Conservation

- Reduces soil erosion and nutrient leaching.
- Saves labor and energy by reducing the need for manual watering.
- Cost savings in water, fertilizer, and labor are realized over time.

Scalable and Simple

- Systems can be designed to fit anything from a small vegetable garden to a large farm.
- Systems can be installed without the use of sophisticated tools and can be set up by local technicians.
- Most systems are gravity-fed and do not require a power source or pumps, making it ideal for off-grid use.

DRIP IRRIGATION SYSTEM COMPONENTS

A drip irrigation system consists of several components that work together to ensure the proper distribution of water to crops or plants.

1. **Water source:** The water source is the origin of the water used for irrigation. It can be a well, pond, river, reservoir, or any other sort of water storage tank or facility. Water availability and quality are crucially important.
2. **Water pump:** The water pump pushes the water from the source into the pipelines of the irrigation system in the field. It can run on electricity, petrol, or diesel.
3. **Agrochemical/Fertilizer Injection:** Injectors and diffusion tanks are used to apply agrochemicals and fertilizers through the system.
4. **Mainline:** The mainline is the primary pipe that transports water from the source to the field or the area that requires irrigation. It is a larger diameter pipe and forms the backbone of the system, connection the water source to the sub-main lines. The mainline can be composed of PVC pipe, poly pipe, or layflat.
5. **Sub-main lines:** Sub-main lines are secondary pipes branching off from the mainline. These pipes distribute water across different areas of the field. They have a slightly smaller diameter than the mainline and supply water to the lateral lines.
6. **Lateral lines:** Lateral lines are smaller pipes that extend from the sub-main lines and are used to carry water to individual crop rows or specific plants. These lines are strategically placed along the rows, delivering water at or near the plant roots.
7. **Drip connectors:** Drip connectors connect the lines to each other and the water source.
8. **Emitters:** Emitters are the heart of the drip irrigation system. They regulate the flow of water and disperse it in a controlled manner directly to the plant root zone. Emitters come in various types, including drip emitters, micro-sprayers, or drip tapes. The choice of emitter depends on factors such as the crop type, soil type, and water requirements. During drip installation, all emitters should be placed face-up to avoid clogging.
9. **Filters:** Filters are essential components that prevent clogging of emitters by removing debris, particles, and sediments from the water. Common types of filters used in drip irrigation systems include screen filters, disc

Figures (top to bottom), 3: Layflat; 4: PVC pipe; 5: Blind pipe, connectors, and lateral line; 6: Air valve and filter.
Photos: Fintrac Global Inc.

filters, and sand filters. Proper filtration ensures the uninterrupted and efficient functioning of the system.

10. **Air valves:** Air valves help remove air that comes with the water directly from the source via the mainline.
11. **Pressure regulators:** Pressure regulators maintain a consistent and appropriate water pressure throughout the drip irrigation system. Different emitters have specific pressure requirements to function optimally. Pressure regulators help ensure uniform water distribution and prevent emitter damage due to high water pressure.

INSTALLATION GUIDELINES

Proper planning, design, and material selection play a significant role in ensuring the success of the system and maximizing crop yields while conserving water.

Figure 7: Drip emitters placed face-up.
Photo: Fintrac Global Inc.

1. **Design the system** based on crop water requirements, soil type, and field topography:
    a. Before installing a drip irrigation system, it is essential to thoroughly understand the water requirements of the crops being cultivated. Different plants have varying water needs at different growth stages, and the system should be designed to meet these demands.
    b. Consider the soil type and its water-holding capacity. Sandy soils may require more frequent irrigation with lower application rates, while clay soils can hold water for longer periods but may need lower application rates to prevent waterlogging.
    c. Analyze the field topography to determine the proper placement of mainlines and sub-main lines, and the direction of the raised beds, ensuring that water flows smoothly and evenly throughout the entire area. During rainy season, these preparations will prevent soil erosion and runoff.
    d. Calculate the amount of drip roller required for the given area to order the correct quantity. For example, in a plot 20 meters wide and 80 meters long, divide the width of 20 meters by 1.5 meters (the international standard for the distance between raised beds) to determine the number of raised beds needed: 13. The total amount of drip line required is the number of raised beds multiplied by the length of the plot: 13 raised beds x 80 meters = 1,040 meters of drip line. Note that for uniform water distribution, the length of the plot should not be greater than 80 meters.
2. **Lay out the mainline**, sub-main lines, and lateral lines with proper spacing:
    a. Plan the layout of the mainline, sub-main lines, and lateral lines in a way that optimizes water distribution and minimizes pressure fluctuations.
    b. Proper spacing between the lateral lines is essential to ensure uniform water coverage for all plants. Consider the water distribution pattern of the emitters and the crop's plant density.

3. **Install emitters** near plant roots, ensuring uniform water distribution:
    a. Emitters should be placed at an appropriate distance from the plants' roots to ensure water is delivered directly to the root zone, which promotes efficient water uptake and reduces water wastage.
    b. Emitter flow rates should match the water requirements of the specific plants being irrigated. Plants with higher water demand will require emitters with higher flow rates.
4. **Incorporate filtration and pressure regulation** components for optimal performance:
    a. Filtration is essential to prevent clogging of emitters and ensure consistent water flow. Filters should be installed at various points in the system, such as after the water source and before the emitters.
    b. Pressure regulation helps maintain a steady flow of water for the emitters to work properly. Pressure regulators should be installed at appropriate locations in the system to minimize pressure variations.
5. **Use quality materials** to ensure system durability and longevity:
    a. Invest in high-quality drip tubing, fittings, emitters, filters, pressure regulators, and other system components. High-quality materials are less likely to degrade over time and are more resistant to wear and tear.
    b. Choose UV-resistant materials as much as possible.

MAINTENANCE PRACTICES

Regular inspections, cleaning, and adjustments can help prevent issues such as water wastage, uneven irrigation, and system damage.

1. **Regularly inspect the system** for leaks, clogs, or damaged components:
    a. Periodically check the entire system, including the mainline, sub-main lines, lateral lines, and emitters, for any signs of leaks, cracks, or damage.
    b. Look for clogs in emitters or filters that can impede water flow to certain plants. Clogs may be caused by debris or sediment buildup and should be addressed promptly.
2. **Clean filters** periodically to maintain proper water flow:
    a. Filters are essential for preventing debris and sediment from reaching the emitters. Over time, filters can become clogged, affecting water flow and system performance.
    b. Regularly clean the filters based on the manufacturer's recommendations to ensure they continue to function effectively.
3. **Flush the system** to remove sediment and prevent emitter clogging:
    a. Sediment and debris can accumulate in the system over time, potentially leading to emitter clogging and uneven water distribution.
    b. Periodically flush the system by running water through it without turning on the emitters. This helps remove any accumulated sediment and maintains clear water pathways.
4. **Check and adjust pressure regulators** as needed:
    a. Pressure regulators ensure that the emitters receive a consistent and appropriate water pressure for optimal performance. Changes in pressure can affect water distribution.
    b. Regularly check the pressure regulators and adjust if necessary to maintain the desired pressure level.
5. **Perform routine maintenance and repairs** during off-peak irrigation periods:
    a. Schedule routine maintenance and repairs during periods when the system is not actively irrigating, such as during off-peak growing seasons.
    b. This allows for thorough inspections, cleaning, and any necessary replacements or repairs without interrupting the irrigation schedule during critical growth stages.

6. **Monitor water application and plant health** regularly:
    a. Keep an eye on the water application and observe how the plants respond to the irrigation. Adjust the system settings if needed to meet the changing water requirements of the crops as they grow.
    b. Pay attention to any signs of over- or under-watering, which may indicate the need for system adjustments.

TRAINING AND FARMER EDUCATION

By providing the necessary knowledge and skills, farmers can effectively implement and manage drip irrigation systems, leading to improved agricultural practices and sustainable water use. The key aspects of training and farmer education should include the following:

Figure 8: KTA training on drip irrigation installation
Photo: Fintrac Global Inc.

1. **Conduct training programs and workshops** to educate smallholder farmers about drip irrigation principles and techniques:
    a. Organize training sessions and workshops to introduce farmers to the principles and concepts of drip irrigation. This includes explaining how the system works, the benefits it offers, and how it can be tailored to specific crops and soil types.
    b. Cover topics such as water requirements of different crops, irrigation scheduling, emitter selection, and system design based on field conditions.
2. **Provide practical demonstrations and hands-on training** for system installation and maintenance:
    a. Hands-on training is essential for farmers to gain confidence in installing and maintaining drip irrigation systems. Conduct practical demonstrations to show them how to lay out mainlines, sub-main lines, and lateral lines correctly.
    b. Teach farmers how to install emitters and other components near plant roots for efficient water delivery.
    c. Offer guidance on how to identify and resolve common issues like leaks, clogs, and pressure variations.
3. **Emphasize the economic and environmental benefits of drip irrigation** to encourage adoption:
    a. Highlight the economic advantages of drip irrigation, such as increased crop yields, reduced water usage, and lower labor costs.
    b. Explain the environmental benefits, including water conservation, minimized soil erosion, and decreased fertilizer and pesticide runoff, leading to a more sustainable agricultural ecosystem.
    c. Demonstrate how drip irrigation can help farmers cope with water scarcity and erratic rainfall patterns, ultimately making their farming practices more resilient to climate change.

4. **Address potential challenges** and concerns:
    a. Acknowledge and address any concerns or reservations farmers may have about adopting drip irrigation, such as initial investment costs or maintenance requirements.
    b. Provide information on potential financial assistance programs, subsidies, or grants available to support farmers in transitioning to drip irrigation.
5. **Foster peer learning** and knowledge sharing:
    a. Encourage farmers who have successfully adopted drip irrigation to share their experiences and best practices with their peers.
    b. Arrange farmer-to-farmer exchanges or study tours, where interested farmers can visit established drip irrigation systems and learn from those who have first-hand experience.
6. **Follow up and continuous support**:
    a. Maintain regular communication with trained farmers to provide ongoing support and address any challenges they may encounter during the implementation process.
    b. Offer extension services and technical assistance to help troubleshoot issues and ensure the long-term success of the drip irrigation systems.

CONCLUSION

Drip irrigation is a sustainable and efficient irrigation method suitable for smallholder farmers. By delivering water directly to the plant roots with minimal wastage, drip irrigation promotes water conservation, improves crop health, and enhances productivity. Agronomists, extension workers, and input suppliers play a crucial role in training and supporting smallholder farmers in adopting and implementing drip irrigation systems, ensuring their successful integration into sustainable farming practices.