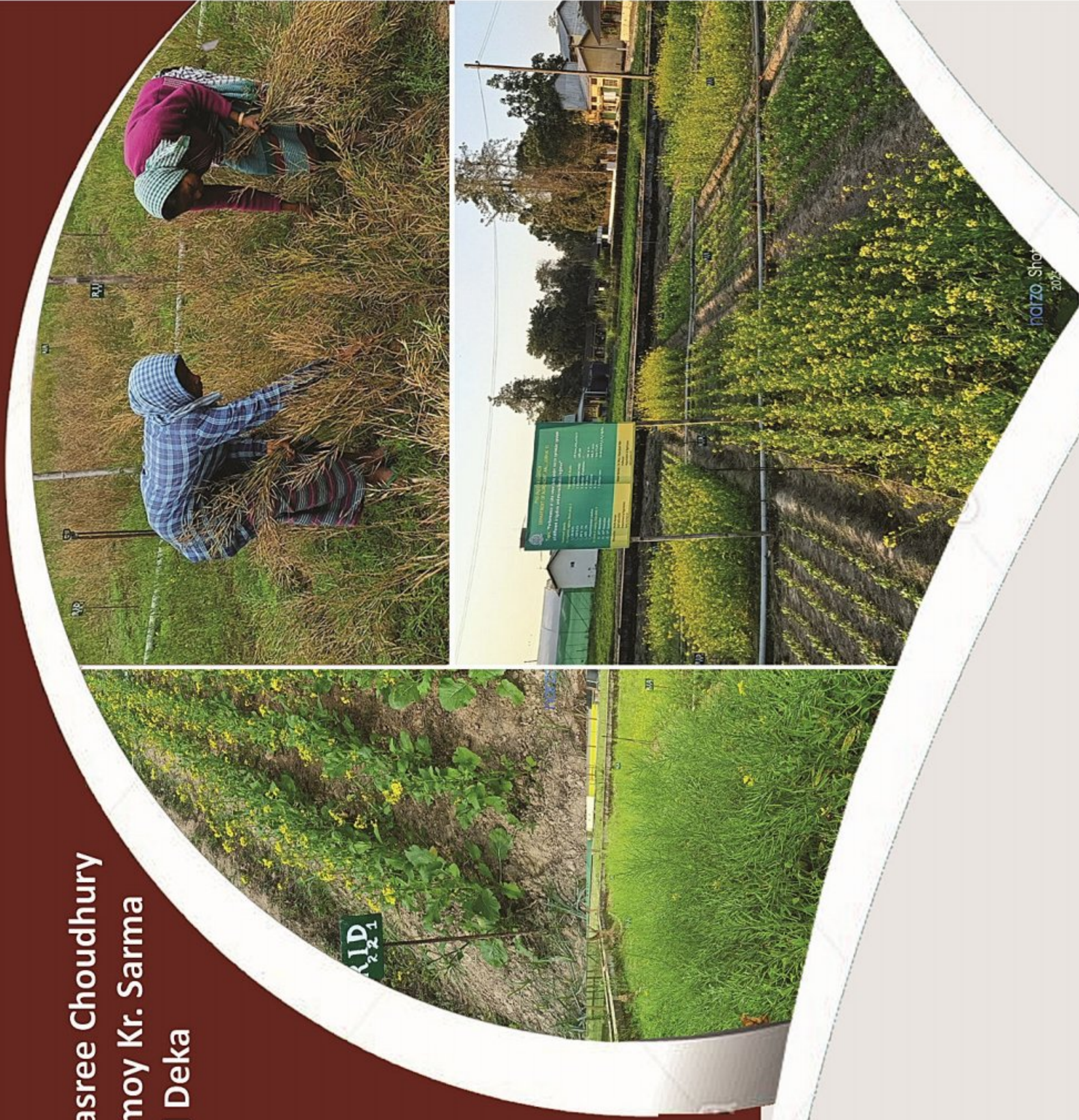


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Micro-Sprinkler Irrigation: A Low-Pressure, High Efficiency System for Toria and Beyond

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Assam Agricultural University



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Micro-Sprinkler Irrigation: A Low-Pressure, High Efficiency System for Toria and Beyond

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Preface

Efficient water management is vital for sustainable agriculture, especially in regions like Assam where rainfall is unevenly distributed. After the monsoon, farmers often struggle to establish Rabi crops such as Toria due to the quick depletion of soil moisture. Micro-sprinkler irrigation, a low-pressure and water-efficient technology, provides a simple yet effective solution to these challenges. This technical bulletin, prepared under AICRP on Irrigation Water Management, Assam Agricultural University, Jorhat presents a practical guide on micro-sprinkler irrigation system design, installation, operation, and performance. It aims to help farmers, extension officers, and students adopt this efficient irrigation system for better productivity and resource conservation.

Acknowledgement

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1. Introduction

In Assam, the Rice-Toria cropping sequence is one of the most widely adopted double-cropping system due to its short duration, low input requirement, and profitable returns. Farmers prefer this sequence because Toria fits well in the post-Rice period before the onset of pre-Kharif showers. However, the major limitation in this system is the rapid depletion of residual soil moisture following Rice harvest. This moisture stress often leads to poor germination, uneven crop stand, and ultimately, reduced yield of Toria.

Traditional surface irrigation method such as flooding or basin irrigation are commonly practiced in the region. However, these methods are inefficient, as they lead to non-uniform water distribution, excessive evaporation, deep percolation, and conveyance losses. Moreover, fragmented landholdings and undulating topography in many parts of Assam make it difficult to maintain proper water levels using conventional methods.

To address these challenges, micro-irrigation technologies, particularly micro-sprinkler systems, have emerged as a viable solution. Micro-sprinkler irrigation operates at low pressure and applies water in the form of fine droplets, ensuring uniform wetting of the soil surface and better control over application rates. It helps maintain favourable soil moisture conditions during the critical growth stages of Toria, promoting better crop establishment and higher productivity.

Additionally, micro-sprinkler irrigation is well-suited for small and fragmented farms, which are predominant in Assam. The system's flexibility, easy installation, and efficient water use make it an ideal option for sustainable intensification of rice-based cropping systems. The adoption of such water-saving technologies can contribute significantly to improving water productivity, reducing input costs, and enhancing climate resilience in the region's agricultural practices.

2. What is Micro-Sprinkler Irrigation ?

Micro-Sprinkler irrigation is a type of pressurized irrigation system that distributes water through a network of pipes and small sprinklers mounted on risers along the lateral lines. Each sprinkler delivers water in fine droplets over a circular or semi-circular area, simulating light rainfall. The system operated

effectively under low pressure (1-1.5 bar) and ensures uniform soil moisture distribution, which is vital for good germination, plant growth, and yield.

Unlike traditional surface irrigation methods that often waste water through runoff, deep percolation, and evaporation, micro-sprinkler systems deliver precise and localized irrigation, optimizing both water and energy use. The system is particularly beneficial in regions where:

- Water availability is limited,
- Soils have low water-holding capacity, and
- Landholdings are small and fragmented (as in most parts of Assam).

The system can be operated with small electric motors or solar-powered pumps, making it a cost-effective and sustainable irrigation option for smallholder farmers.

Advantages of Micro-Sprinkler Irrigation

- Provides uniform water distribution and maintains consistent soil moisture.
- Reduces evaporation and percolation losses compared to surface irrigation.
- Enhances seed germination and early crop establishment, especially for Toria and vegetables.
- Allows fertigation (application of fertilizers through irrigation water).
- Requires low operating pressure, saving energy.
- Suitable for light soils and undulating terrains.
- Reduces soil erosion and surface crust formation.

Main Components of a Micro-Sprinkler System

Component	Specification/Function
Water Source	Farm pond, shallow tube well, or borewell used as the main source of water.
Pump	3 HP centrifugal or equivalent low-pressure pump to provide required discharge and pressure.
Mainline	63 mm HDPE pipe-carries water from the pump to the submains.
Submains	40 mm LDPE pipe-distributes water evenly to the lateral lines.
Laterals	16 mm LDPE pipe-fitted with micro-sprinkler, typically spaced at 3.5 × 3.5 m intervals.
Micro-Sprinklers	1 mm nozzle size, with an average discharge of 40 LPH at 1 bar pressure
Filter Unit	Screen or disc filter to prevent clogging of sprinkler nozzles.
Fittings and Accessories	Valves, tees, elbows, grommets, and take-off connectors to assemble and regulate the system.

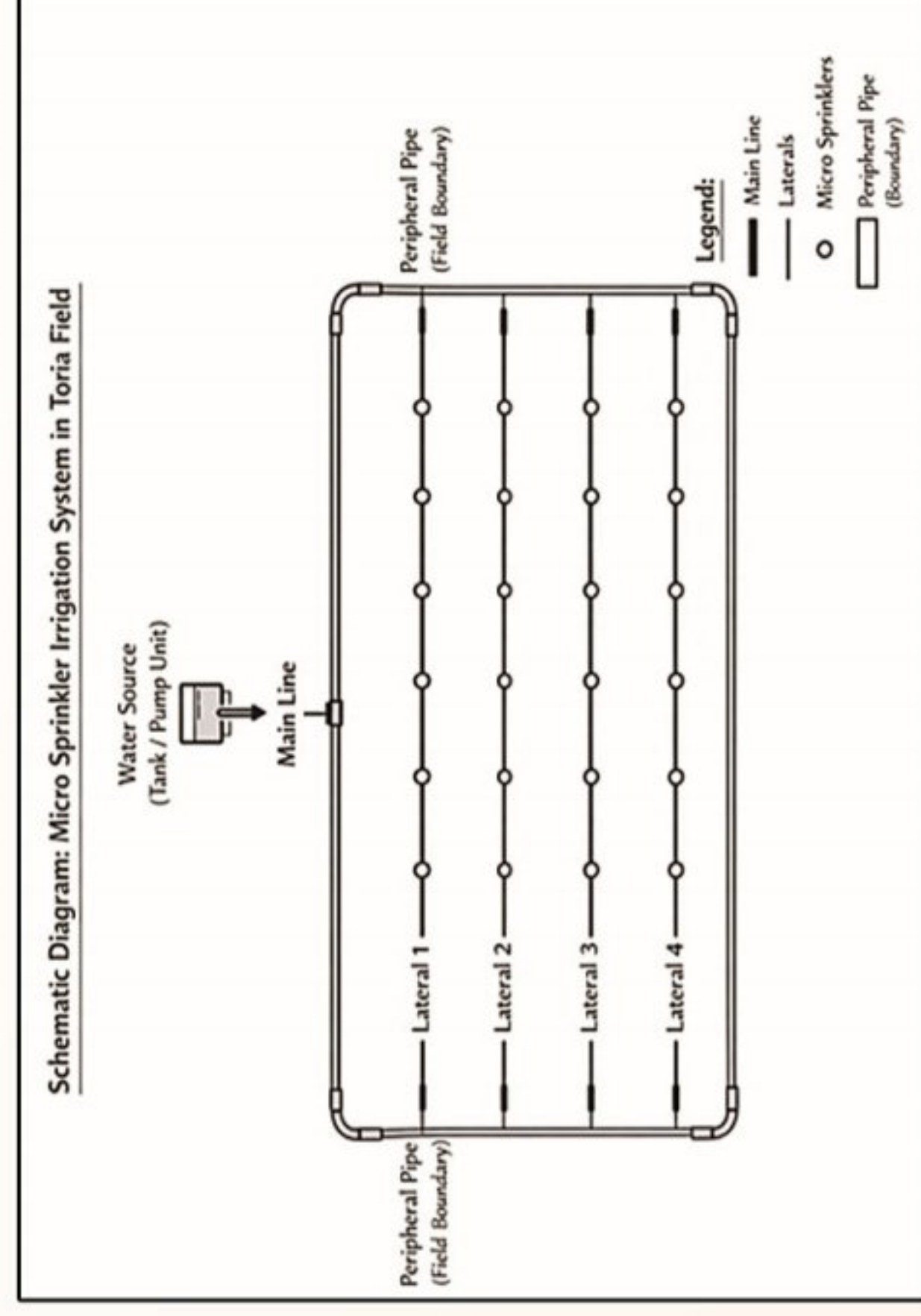


Fig. 1. Schematic layout of micro sprinkler irrigation system showing main line, peripheral pipe and laterals in Toria field.

Working Principle

Water is pumped through the mainline and submains to the laterals, where micro-sprinklers distribute water in fine droplets over the crop root zone. The wetted area from each sprinkler overlaps slightly with its neighbour, ensuring uniform coverage. Operating under low pressure, the system minimizes energy consumption and can be easily automated or operated manually as per crop water needs.

3. Step-by-Step Installation Guide

Installing a micro-sprinkler irrigation system is simple and can be done with basic tools and field measurements. A well-planned layout ensures uniform water distribution, efficient operation, and minimal maintenance. The following steps outline the procedure for field installation:

Step 1: Planning the Layout

- Measure the total field area and mark the boundaries clearly.
- Based on the shape and slope of the field, plan the alignment of the mainline, submains, and laterals.
- Maintain a 3.5×3.5 m spacing between sprinklers for uniform overlap and coverage.
- Prepare a layout map on paper before actual installation to avoid errors.

Step 2: Setting up the Water Source

- Select a reliable water source such as farm pond, shallow tube well, or borewell.
- Install a 3 HP centrifugal pump (electric or solar-powered) depending on discharge and head requirements.
- Fit a screen or disc filter at the pump outlet to prevent debris and sand from entering the system.

Step 3: Laying the Mainline

- Use a 63 mm HDPE pipe as the mainline from the water source to the field.
- Place it along the boundary or centre of the field for efficient distribution.
- Install gate valves or control valves at suitable points for regulating flow.

Step 4: Installing Submains and Laterals

- Connect 40 mm LDPE submains to the mainline using suitable fittings (tee or reducer).
- Lay 16 mm LDPE laterals perpendicular to the submains at 3.5 m spacing.
- Keep laterals straight and secure them with plastic stakes if needed to prevent movement during operation.

Step 5: Fixing the Sprinklers

- Use a hole punch to make openings on the laterals at marked intervals.
- Insert take-off connectors and attach riser pipes (30-45 cm height).
- Fix micro-sprinkler heads on top of each riser.
- Check that each sprinkler rotates freely and is positioned vertically for uniform spray.

Step 6: Testing the System

- Run the pump and observe water flow through all lines.
- Check for leakages, blockages, or uneven spray patterns.
- Adjust riser height or nozzle directions if needed.

Step 7: Irrigation Scheduling

- Operate the system every 3-4 days, depending on soil texture, crop stage, and weather.

- Each irrigation should wet the root zone (10-15 cm depth for Toria).
- Avoid over-irrigation to prevent nutrient leaching and waterlogging.

Step 8: System Maintenance

- Clean filters weekly and flush laterals and submains once in 15 days.
- Inspect connectors, risers, and sprinklers for leaks or clogging.
- Replace worn-out nozzles promptly.
- Before storing the components of sprinkler system after the season, flush the entire system with clean water and coil laterals properly.

4. System Design and Operation

Micro-sprinkler irrigation systems can be designed for 1 hectare or smaller farm holdings under Assam conditions to ensure efficient water application and uniform crop growth. Proper design ensures high distribution uniformity and water-use efficiency.

For Toria cultivation:

- Recommended sprinkler spacing: 3.5 m × 3.5 m
- Throw radius: approximately 2.5 m
- Operating pressure: 1.0-1.5 bar
- Average discharge: about 40 LPH per sprinkler

Field evaluations under Assam agro-climatic conditions have shown:

- Christiansen's Uniformity Coefficient (CU):87-90%
- Distribution Uniformity (DU): around 80-85%

Uniformity above 85% indicates excellent irrigation performance, ensuring:

- Even soil moisture distribution
- Uniform crop stand
- Better nutrient availability

Irrigation recommendation for Toria

- Irrigation duration:1-1.5 hours per application
- Maintain soil moisture at 70-80% of field capacity

- Apply approximately 20-25 mm water per irrigation
- Irrigate every 3-4 days, depending on soil type and weather Avoid over irrigation to prevent:
 - Nutrient leaching
 - Waterlogging
 - Increased weed growth

5. Advantages of Micro-Sprinkler System

Micro-sprinkler irrigation provides several benefits over traditional surface irrigation:

- Ensures uniform water distribution and better germination.
- Saves 35-40 % water and reduces energy costs.
- Operates efficiently under low pressure.
- Portable, flexible, and easy to install.
- Reduces labour and ensures timely irrigation.
- Minimizes soil erosion and nutrient loss.
- Enhances yield and oil content in Toria.
- Reduces weed growth by avoiding waterlogging.

6. Performance Results with Toria

Research findings under Assam conditions indicate that micro-sprinkler irrigation significantly improves crop performance and water productivity in Toria compared to conventional surface irrigation methods.

Traditional flooding methods often result in:

- Uneven water distribution
- High conveyance loss
- Excess evaporation
- Deep percolation losses

In contrast, micro-sprinkler irrigation ensures:

- Controlled water application
- Uniform soil moisture distribution
- Improved crop growth and yield

Key Observed Benefits

- Water saving approximately 35-40%
- Increase in grain yield: about 15%

- Average yield under micro-sprinkler: ~9-10 q/ha
- Yield under conventional method: ~8 q/ha
- Higher net returns per hectare
- Benefit-Cost Ratio (BCR): around 1.7-1.8
- Payback period: about 1.5 years

These results clearly indicate that micro-sprinkler irrigation enhances both water productivity and farm income, making it highly suitable for small and medium farmers of Assam.

Key Performance Indicators

- Average yield under micro-sprinkler irrigation: 9.8 q/ha
- Yield under traditional irrigation: 8.0 q/ha
- Water saving: 40 %
- Increase in yield: 15 %
- Net return: Rs 16, 458 /ha (micro-sprinkler) vs Rs 3,800/ha (traditional method)
- Benefit-Cost Ratio (BCR): 1.78
- Payback period: 1.5 years



Fig 2: Micro-sprinkler irrigation system installed at Toria field

These findings demonstrate that micro-sprinkler irrigation not only enhances crop productivity but also ensures more efficient utilization of available water resources, making it a

sustainable and profitable irrigation technology for Toria cultivation in Assam's agro-climatic conditions.

7. Maintenance and Troubleshooting

Routine maintenance ensures system longevity and efficiency.

Common Issue	Possible Cause	Suggested Solution
Uneven water spray	Blocked nozzle or low pressure	Clean nozzles and check pressure (1-1.5 bar)
Dry patches in field	Misaligned sprinkler or leak	Reposition sprinkler, fix leaks
Reduced discharge	Clogged filter or emitter	Clean screen filter and flush laterals
System shutdown	Pump suction issue	Check foot valve and suction line

8. Broader Applications

Micro-sprinkler irrigation is highly adaptable for crops beyond Toria, including mustard, pulses, vegetables, flowers, and fruit crops. In horticultural crops such as citrus, banana, and guava, it maintains soil moisture around the root zone, improving yield and fruit quality. In vegetable cultivation, it supports uniform germination and growth by maintaining a humid micro-climate.

9. Role in Climate-Resilient Agriculture

Micro-sprinkler irrigation contributes significantly to climate-resilient agriculture by enabling controlled water use and reducing crop stress during dry spells. Its low-pressure operation reduces energy demand, and integration with solar pumps enhances sustainability. By optimizing every drop of water, it strengthens farmer's capacity to adapt to erratic rainfall patterns and water scarcity.

Key Recommendations for Farmers

- Adopt micro-sprinkler irrigation for small fields (up to 1 ha).
- Maintain sprinkler spacing at 3.5 × 3.5 m for effective overlap.
- Operate system at 1-1.5 bar using 3 HP pump.
- Clean filters and flush laterals regularly.
- Integrate solar or low-head pumps for energy savings.
- Use the same system for Toria, Mustard, Vegetables and Floriculture.

10. Conclusion

Micro-sprinkler irrigation is a low-pressure, water-efficient and farmer-friendly irrigation technology suitable for small and fragmented landholdings of Assam. The system ensures:

- Uniform water distribution
- Improved germination and crop establishment
- Water saving up to 40%
- Increased yield and profitability
- Reduced labour and energy cost

Adoption of micro-sprinkler irrigation in Rice–Toria cropping systems can significantly improve water-use efficiency and promote climate-resilient agriculture in Assam.

Farmers are encouraged to adopt this technology with proper layout planning, regular maintenance, and scientific irrigation scheduling for sustainable crop production.

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