United Nations University
Institute for the Advanced Study of Sustainability

POLICY BRIEF

No. 30, 2022

Scaling up Microirrigation Technology to Address Water Challenges in Semi-arid South Asia

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Highlights

Water resources in semi-arid regions are under severe pressure, causing reduced agricultural production and loss of ecological flows. Large scale expansion of microirrigation can increase productivity and economise scarce water resources. In South Asia, challenges include lack of awareness about the technology, the high cost and complexity of maintenance, and the non-alignment of government incentives with farmers' interests, which have resulted in underutilisation of installed systems.

Recommendations:

- Implement spatial mapping for microirrigation technologies and strengthen agricultural management practices to support diversification into high-value crops and improve yields.
- Promote farmers' collectives to manage community water resources and encourage cooperative farming.
- Provide incentives to increase production and installation of low-cost microirrigation technologies and assist farmers in maintenance.
- Promote coherent irrigation policies to increase water availability and adoption of microirrigation.

Microirrigation for Sustainable Agriculture

Sustainable agricultural development depends on the efficient use of water resources and favourable climatic conditions. Climate change has increased the frequency and intensity of droughts, particularly in semi-arid zones (Srinivasan et al. 2017) and rainfed areas that are highly dependent on monsoon rains. Increasing the sustainability of semi-arid agriculture in terms of water use requires climate change adaptation and mitigation solutions that build long-term resilience.

One such innovative solution is microirrigation, which incorporates frequent application of water in small amounts that only wets a portion of the soil surface. It applies water at low rates and pressures to discrete areas, reaching the root zone of crops with minimal losses. Microirrigation technologies reduce water losses to below 10% during application, compared to about 50% for surface irrigation where water is applied and distributed over the soil surface by gravity (Bjorneberg 2013). There are three methods: (i) drip irrigation, in which emitters are pre-installed within polyethylene pipes at regular intervals; (ii) bubblers, which discharge water with low energy to essentially flood a small area; and (iii) microsprinklers or microsprays, which apply a fine spray or mist with similar flow rates and wetted areas as bubblers. As well as improving water use efficiency, microirrigation helps to reduce fertiliser application rates through the drip fertigation method, in which fertiliser is added to the irrigation water. This achieves an efficiency of 80%–90%, compared to only 50% under conventional methods — decreasing fertiliser use by up to 25%. It also reduces adverse environmental impacts, labour expenses, and other input costs, while maintaining soil health and increasing yields by 30%–80% (Narayanamoorthy 2006).

In South Asia agriculture mainly comprises dryland or rainfed agriculture. Water shortages are expected to intensify in these areas of India, Nepal, and Pakistan, which are particularly vulnerable to climate change due to high dependence on agriculture for livelihoods, with low productivity. Adopting efficient irrigation techniques (sprinkler and drip) in these regions would increase the resilience of crop production to climate change, enable a greater range of crops to be grown, and increase yields. In recent decades, there has been considerable interest in expanding the area under microirrigation in South Asia. However, implementation is limited due to lack of awareness about its uses, the high cost and complexity of maintenance, and non-alignment of government incentives with farmers' interests, which have resulted in fewer farmers installing microirrigation systems and underutilisation of installed systems. Microirrigation is also considered unsuitable in local conditions that are economical for close-grown crops like rice.

This policy brief identifies the main challenges in scaling up microirrigation in the region, and offers recommendations for providing extension services and developing coherent policies to address agricultural sustainability as part of global efforts to achieve the SDGs. It focuses on goal 2 (zero hunger) and goal 6 (clean water & sanitation), linking higher agricultural production and better water resource management in agriculture.

Challenges & Policy Recommendations

Considering the current water stress in South Asia and the generous subsidies provided by governments for the initial setup costs of microirrigation technologies by small and marginalised farmers (45%–55% of the total installation costs, and in some cases up to 80%), it would be reasonable to expect widespread adoption (MAFW 2017). Yet recent literature (Bell et. al. 2020) suggests that although microirrigation technologies are expanding rapidly in India, adoption remains low in other South Asian countries. The following sections outline the key challenges and provide recommendations to address specific problems in scaling up microirrigation.

1. Sustainable Agricultural Management Practices & Water-saving Technologies

Promote No-tillage Sustainable Agriculture Practices

Tillage — the preparation of land for cultivation — is the main challenge in the installation of drip irrigation sets in farms (Mohan et al. 2019). No-till practices slow evaporation, which not only leads to better absorption of rainwater but also increases irrigation efficiency, resulting in higher yields even during hot and dry weather (Mitchell et al. 2017). A study in Andhra Pradesh, India, showed that drip irrigation had a significant positive impact on no-till maize production (Bhimireddy et al. 2017). One drawback of no-till production is the increased use of herbicides. However, harmful impact on the environment can be minimised through the use of modern non-toxic and residue-free herbicides. National and sub-national governments should promote the adoption of no-tillage practices together with microirrigation to support installation of drip irrigation sets and increase overall irrigation efficiency and soil health.

Implement High-value Cropping Systems, Reflecting Soil & Agroclimatic Conditions

Microirrigation, specifically drip irrigation, is particularly effective for irrigating individual plants or trees in orchards or row crops such as vegetables and sugarcane. Mapping out drip irrigation areas allows spatial planning for better and more diversified choices in cropping patterns and the cultivation of high-value crops. Promoting drip irrigation along with diversification of agriculture into staple and cash crops such as horticultural products provides dual benefits — high returns and food security for farmers and their families, along with maximum irrigation efficiency. In semi-arid regions of South Asia, once water is available for irrigation farmers grow mostly cereal crops, which are water-intensive. Local administrations should identify alternative high-value cropping systems with limited water demand that are suited to local agro-ecological conditions, and promote them through crop diversification incentives. For example, supplying improved seed varieties or developing market linkages through private participation, coupled with installation of microirrigation sets, can both increase farmers' revenues and improve water use efficiency.

2. Optimising Community Resources through Participatory, Cooperative Approaches

Efficient use of water through rainwater-harvesting structures in arid and semi-arid areas can be enhanced by integrating them into microirrigation technologies. This requires involvement of the local community in construction of water harvesting infrastructure such as small- or medium-scale check dams or large watersheds, water tanks, ponds, and dug wells connected to microirrigation systems at a larger scale. However, afforestation and catchment area development upstream that brings no direct benefits to local households, while harvested water is used by downstream farmers in hilly areas, may lead to conflicts within watersheds and limit the adoption and expansion of microirrigation. Developing and maintaining community water resources, and connecting them to the distribution network and drip irrigation systems, guarantees maximum irrigation efficiency through the supply chain and new fully pressurised irrigation systems that can be drawn from available water resources and deliver water on-demand to farmers.

Some of the main barriers to adoption of microirrigation technologies in small farms are the high capital investments needed, and a lack of knowledge about the systems. Indeed, the majority of farmers in South Asia are small and marginalised farmers; it is estimated that the actual area cultivated (operational holdings) averages only 0.5 to 3.0 hectares (Thapa and Gaiha 2014). These farmers often lack the technical know-how and initial investments that are needed to adopt microirrigation. Furthermore, farmers do not have easy access to institutional credit due to the lengthy procedures and documentation required by formal lending institutions (Chandio et al. 2020). An effective solution to these challenges is cooperative or collective farming — a model that enables small and marginal farmers with common socio-economic needs to pool their land and other resources for joint cultivation under a single management unit. It brings some of the benefits of large-scale farming, such as reducing the cost of cultivation, and enables use of farm machinery including microirrigation technologies. Cooperative agriculture — land pooling and leasing to commercial entities — not only enables better production but also improves the skills of participants, their livelihoods, and their access to institutional credit, while increasing their backward and forward bargaining power.

Due to widespread poverty and high illiteracy rates in semi-arid regions of South Asia, there is a need for training and easily accessible extension services staff — including agricultural officers and microirrigation technicians — to encourage farmers to adapt to more technology-friendly services and mechanised agriculture. Governments and the private sector need to provide farmers in the region with demonstrations and support services such as technical assistance for installing and maintaining microirrigation sets. Sub-national governments should collaborate with private microirrigation companies to build state capacity to provide such services through special programmes, for example the National Mission on Microirrigation (NMMI) implemented by the Government of India (MoA 2010). Rapid improvements could be achieved by incentivising private companies to produce, sell, and deliver post-sale extension services for low-cost microirrigation sets provided by the governments.

3. Coherent Irrigation Policies & Good Governance

There is also a need to adopt more coherent policies in order to expand microirrigation. In India and Pakistan, for example, the governments support microirrigation without considering the infrastructure required — such as available groundwater and low-cost microirrigation sets — resulting in lost opportunities to advance adoption. In Nepal, groundwater schemes are mostly implemented by large-scale farmers due to their high capital costs and the lack of sufficient financial support from the government (Singh 2017). The situation is similar in Sri Lanka, which also has a large proportion of small and marginalised farmers in resource-poor conditions.

For farmers in Andhra Pradesh, India, the unavailability of subsidies in borewell and cost-effective pumping systems are significant challenges to the installation of drip irrigation in the field (Mohan et al. 2019). Due to incoherence between microirrigation schemes and ground water schemes of the state government, sometimes the benefits for the farmer are not optimised. Such a lack of coherence in policies, often with numerous piecemeal policies narrowly focused on specific areas of agriculture, can impede the holistic utilisation of water resources and efforts towards realising sustainable agriculture (OECD 2019).

A successful example of self-sustaining, integrated irrigation management systems has been developed by the Barind Multipurpose Development Authority (BMDA) in a highly water-stressed area in north-west Bangladesh. Predominantly, underground pipeline water distribution systems were developed in deep tubewells control areas to prevent significant water loss during distribution and improve cropping intensity — from single-cropping to double- and triple-cropping. Moreover, the authority undertakes cost recovery for operations and maintenance, and generates income by charging farmers affordable prices to access the water (Rashid et al., 2019).

Coordination between multiple stakeholders is a difficult task. However, a coherent policy approach like establishing Special Purpose Vehicles on mission mode, which many developing nations have recently introduced, is needed to engage multiple stakeholders in a single platform. These approaches can address multidimensional problems such as sourcing water, improving legal frameworks for water, developing groundwater, supplying energy for pump sets, installing microirrigation sets, changing cropping patterns, and expanding areas under microirrigation to increase water use efficiency and farm productivity.

Further research is required on delivering cost-effective microirrigation technologies suitable for small landholdings. Governments should also focus on developing new innovations like permanently buried pipelines connected with microirrigation systems, and implementing pre-paid smart card irrigation management to make each scheme financially self-sustaining. The installation of microirrigation sets should be combined with subsidies for solar energy to power their operation, and expansion of solar-powered water pumping systems that are suitable for agricultural uses in remote villages with limited access to electricity.

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ISSN: 2409-3017

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Publisher
United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS)
Tokyo, Japan