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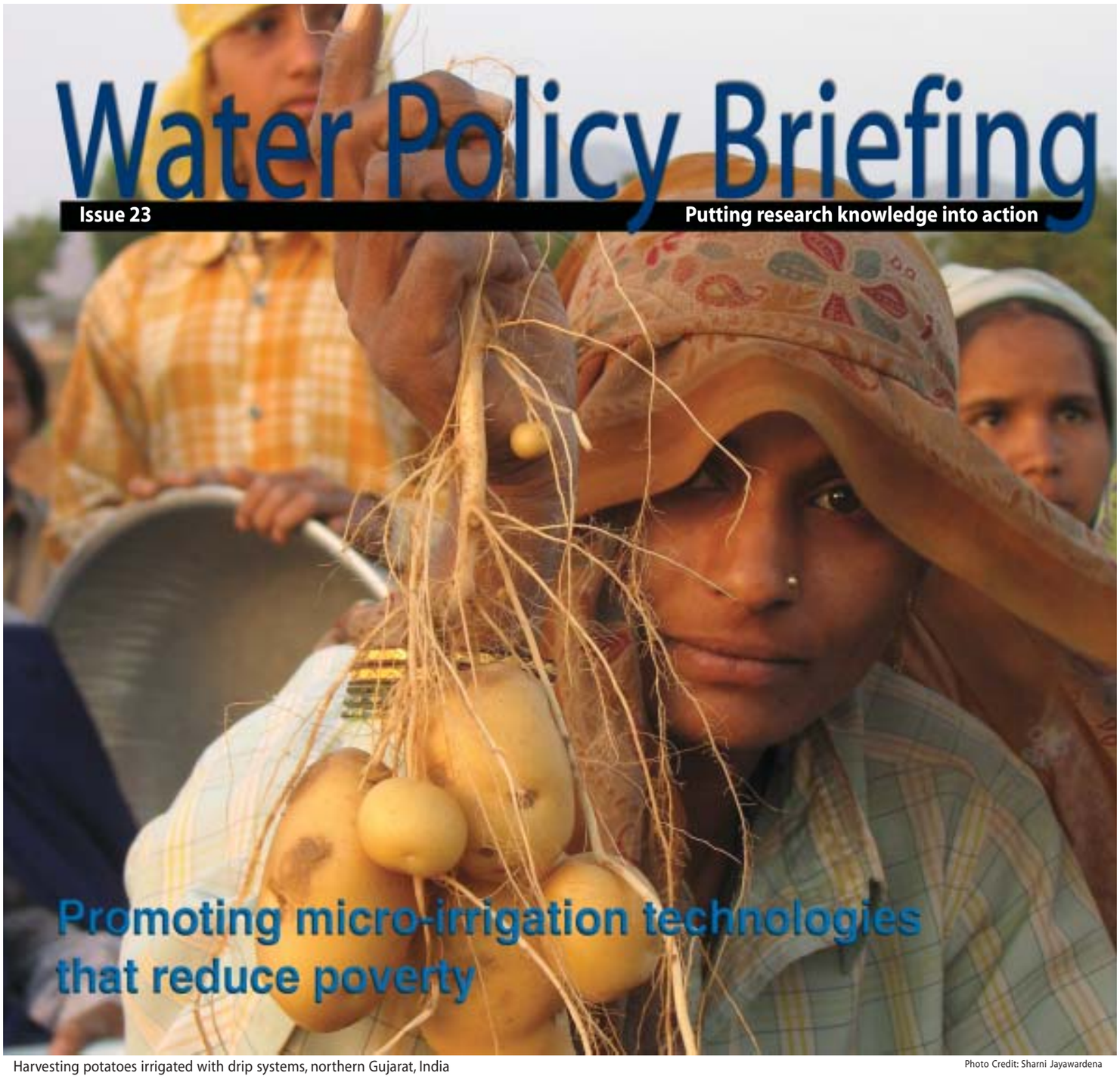
Putting research knowledge into action



Promoting micro-irrigation technologies that reduce poverty

Harvesting potatoes irrigated with drip systems, northern Gujarat, India

Photo Credit: Sharni Jayawardena

International Water Management Institute

Micro-irrigation technologies are increasingly seen as a means of addressing the growing competition for scarce water resources. Appropriate low-cost drip systems have shown to have positive effects on yield, incomes, and food security. With the right institutional support, these systems can help poor farmers improve water productivity and incomes.

Promoting micro-irrigation technologies that reduce poverty

According to research done by the International Water Management Institute (IWMI), one-third of the world's population will face absolute water scarcity by the year 2025. Among the worst hit will be regions in Asia, the Middle-East and Sub-Saharan Africa, home to some of the largest concentrations of rural poverty in the world. Policymakers, researchers, NGOs, and farmers are pursuing various technical, institutional and policy interventions to meet this challenge.

Micro-irrigation technologies, commonly in use in water scarce areas of developed countries, constitute one such intervention with the ability to use water more efficiently in irrigated agriculture. These technologies can improve productivity; raise incomes through crop yields and outputs; and enhance food security of households. Numerous studies have established the gains from micro-irrigation adoption and several government and non-government organizations are engaged in actively promoting the technologies.

In India, micro-irrigation technologies have been marketed for more than three decades. The main vehicle of government policies to promote micro-irrigation systems are product subsidies—in certain cases up to 90 percent. However, there has been a lukewarm response to such initiatives from farmers, especially smallholders. This can be attributed to several causes: lack of access to groundwater, lack of cash, crop specificity of the available micro-irrigation technologies, lack of know-how, poor product quality and absence of adequate credit facilities (Narayanamoorthy 1996). Studies show that despite active promotion, the appeal of these technologies has remained confined to "*gentlemen farmers*"—wealthier farmers who produce commercial crops (Shah and Keller 2002).

Despite these constraints, in certain pockets of India, these technologies have become a popular choice among farmers. It is notable that, in some of these cases, the technologies have been adopted in the absence of government subsidies. However, IWMI's work shows that in general special efforts are required to market cost appropriate technologies to the poor and smallholder farmers. Drip irrigation is often promoted for reasons that do not match with the farmers' main concerns. While the government promotes drips as long-term investments for water saving and sustainable agriculture, the farmers look for more immediate and assured benefits, such as lower costs and increased incomes.

Micro-irrigation technologies

Micro-irrigation technologies can be broadly categorized into two types based on their technical and socioeconomic attributes: low-cost micro-irrigation technologies and the commercialized, state-of-the-art micro-irrigation systems. Low-cost systems include the *Pepsee* easy drip technology, bucket and drum kits, micro sprinklers, micro tube drip systems and others that have been designed by organizations such as the International Development Enterprises (IDE), along with innovative farmers. The more sophisticated, capital intensive systems are conventional drip and sprinkler systems.

This policy briefing is primarily based on IWMI Research Report 93: "Adoption and Impacts of Micro-irrigation Technologies: Empirical Results from Selected Localities of Maharashtra and Gujarat states of India" by Regassa E. Namara, Bhawana Upadhyay and R.K. Nagar.

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The technical, economic and social attributes that distinguish the low-cost irrigation systems from commercial state-of-the-art irrigation systems are as follows:

Criteria	Micro-irrigation systems	
	Low-cost systems	**Conventional systems**
Affordability	Require little initial capital	Require high initial capital
Local manufacturing capacity	Based on local skills and materials	Require relatively sophisticated facilities
Payback period	Usually covers investment cost in one or two seasons	Require several years
Compatibility to the farming system	Available in a range of small packages and expandable	Generally adopted by large farms, but small versions of high-tech systems are also being marketed
Pressure requirement	Require low pressure	Require high pressure
Ease of technical understanding by users	Simple and easily understood	Sophisticated and need technical expertise
Operational convenience	Low operational conveniences	High operational conveniences
Compatibility with local micro-entrepreneurship	Compatible with local micro-enterprises and require limited skill and capital to design, service and maintain	Require special skill

Low-cost micro-irrigation technologies are largely promoted to poor farmers, hence their competitive pricing and compatibility with smallholder farming systems. Farmers can generally recover their initial investment capital between one and three years, although the extent of economic gains from investment depends on the type of crop. Subsidies and options for financing from organizations and government schemes like IDE, the AKRSP and the Gujarat state government in India (Namara, Upadhyay and Nagar, 2005) can further increase the profitability of investing in micro-irrigation, which makes a crucial difference in adoption by poorer farmers.

It has also been noted that there is often a progression from low-cost to conventional systems—IWMI's study of micro-irrigation adoption in India found that farmers who have adopted low-cost micro-irrigation see it as a step towards modernizing their farming systems, and may go on to up-scale to more capital intensive systems later on.

Improving water productivity and yield

The use of micro-irrigation technologies generally results in a significant yield improvement over traditional irrigation practices such as flood irrigation (Table 1).

Table 1. Realized extra yield due to micro-irrigation over and above what's possible under traditional methods such as flood irrigation

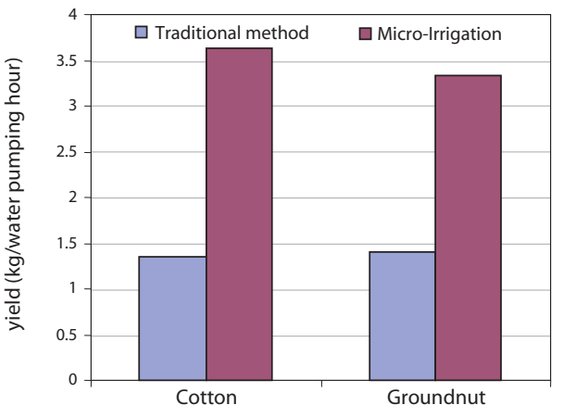
Micro-irrigation	Change in yield under micro-irrigation (t/ha)		
	Banana	**Groundnut**	**Cotton**
Low-cost drip	+14.2	-	+0.7
Micro-tube drip	-	+0.4	+0.5
Conventional drip	+18.1	-	+0.9
Micro-sprinklers	-	+0.7	-
Conventional sprinklers	-	+0.5	-

Source: IWMI RR 93

Research in Gujarat has shown that yield improvements from micro-irrigation technologies are dependent on the crops grown and the type of irrigation system used. Various studies have also shown that for many different crops, drip systems produce more per unit of water used, thus increasing water productivity. (Figure 1, Tables 2 and 3). When water is pumped for irrigation, savings in energy required for irrigation can also be significant.

It is notable that the magnitude of water productivity difference between the conventional and micro-irrigation systems is by far larger than the magnitude of land productivity differences between the two systems (Table 3). Hence, micro-irrigation technologies are even more appealing for water scarce environments.

Figure 1. Water Productivity



Source: IWMI RR 93

Table 2. Water productivity under different irrigation methods

Crop	Water productivity (kg/m^3)	
	Conventional	Drip
Cotton	3.1	11.6
Sugar beet	85.0	132.0
Sweet potato	6.7	23.4
Beetroot	0.7	5.0
Radish	2.25	11.0
Papaya	0.06	0.32
Mulberry	138.6	375.0

Source: Cotton: Sivanappan et al., 1987; Sugar beet: Agarwal and Goel, 1981; Sweet potato, Beetroot and Radish: Sivanappan and Padmakumari, 1980; Papaya: Sivanappan, 1977; Mulberry: Muralidhara et al., 1994

Table 3. Land and water productivity of selected crops under conventional and drip irrigation systems in India

Crop	Yield (t/ha)		Yield (kg/m^3)	
	Conventional	Drip	Conventional	Drip
Banana	57.5	87.5	3.3	9.0
Grapes	26.4	32.5	5.0	12.0
Sugar cane	128.0	170.0	6.0	18.1
Tomato	32.0	48.0	10.7	26.1
Watermelon	24.0	45.0	7.3	21.4
Cotton	2.3	3.0	0.3	0.7
Chillies	4.2	6.1	0.4	1.5
Papaya	1.3	2.4	0.1	0.3

Source: NCPA, 1990

Changes in cropping patterns

An interesting outcome of micro-irrigation adoption in the study area is its impact on cropping patterns. Farmers who adopted alternative technologies in the study locations changed their crops and also the extent of cultivation. More specifically, micro-irrigation adoption proved to encourage farmers to increase their overall cropping intensity or to shift their cropping patterns to high-value, water intensive crops (Table 4).

For example, in Maharashtra, the main change in cropping pattern observed was a shift from groundnut and oil seeds to high-value, water intensive crops, such as banana. In Gujarat, an increase in vegetable production was observed. If the result is an increase in total water use, there could be conflict between the positive impact on poverty and food security and the sustainability of water resource use, especially groundwater, when micro-irrigation is adopted.

Studies have shown that crop yields improve when drip irrigation is used. Yields are higher because the systems allow for multiple crops to be grown; for crops to be grown under circumstances where it was not possible when there is an early withdrawal of the monsoon; and for cropping to be intensified in the same field. Farmers who adopt the system also have the possibility of extending irrigated or cultivated area on their land. This has a significant effect on the incomes of farmers, as higher yields bring higher earnings.

Drip systems have the potential to improve the quality of the harvest because it is a form of precision irrigation, and applies water directly to the root zone. Each plant is able to receive the right amount of water at regular intervals, and less water is lost due to conveyance. When farmers use traditional irrigation methods, such as flood irrigation, they often tend to over irrigate or under irrigate their crops depending on the amount of water they are able to pump and not necessarily on the amount that their crop requires.

Table 4. Comparison of the cropping patterns of micro-irrigation adopters and non-adopters.

Crop	Gujarat		Maharashtra	
	Adopters (%)	Non-adopters (%)	Adopters (%)	Non-adopters (%)
Groundnut and other oil seeds	54.7	63.7	1.2	7.1
Cotton	20.1	6.7	31.1	48.8
Cereals	9.7	15.5	28.7	25.0
Fruit crops	7.6	10.3	25.0	3.6
Vegetables	6.0	2.9	4.8	4.8
Sugar cane	0.9	0.7	0.8	1.2
Pulses	0.3	0.0	8.2	9.6

Source: IWMI RR 93

Increasing incomes and reducing poverty

Low-cost drip systems increase income for poor farmers by enabling more efficient use of water resources, improving yield, improving quality, and reducing labour costs.

Drip systems have a particular niche in monsoonal climates. They allow farmers to plant earlier so that the crop is already established at the onset of rains and can make efficient use of rainwater. This helps to avert a crop loss, or a decline in yield that could arise from a dry spell or the early withdrawal of rain. One of the key advantages of using such technologies is that it helps to extend the use of water during times of drought or water scarcity, and mitigates the risk of losing a crop. Micro-irrigation can thus improve livelihood security to poor farmers vulnerable to rainfall variability.

In addition to quality and yield, farmers may choose to use drip systems because it reduces labour. Micro-irrigation allows for early harvesting of the crop, which reduces the labour costs of farmers. Weeds, insects and other plant diseases have also proven to occur less frequently with the adoption of this technology, cutting down the efforts that farmers have to make to protect their crop. The lower energy expended when micro-irrigation is used in cultivation has an effect on the overall cost of production, making this one of the main reasons why farmers switch to the technology. Interviews with mulberry farmers in Kolar, India recorded that the labor requirement reduced drastically from using drip irrigation over flood irrigation (Shah and Keller 2002).

Drip kits provide women with opportunities to earn incomes from homestead plots, enhancing household food and nutritional security

The impact of micro-irrigation adoption on rural women differs depending on whether they are small or large cultivators, primarily because the systems adopted are different. In IWMI's study women from small cultivator households used drip kits for vegetable farming in their homesteads, while women from large cultivator households used customized systems. Micro-irrigation was able to benefit both cultivators. It provided the women smallholders with an income generating opportunity and they received revenue from the sale of their produce. The women from larger farms benefited from the technologies as it led to a reduction in the labor requirement.

Micro-irrigation technologies can improve the food and nutritional security of small cultivator households that have adopted the technology. In the study, there was a marked improvement in household food security and nutritional intake for women small cultivators who adopted bucket and drip irrigation for homestead vegetable cultivation. The adoption of drip and bucket irrigation helped farmers to grow vegetables for household consumption that were otherwise missing from their daily diets, often using land that had been bare. Diets improved also due to the additional income from surplus produce being sold in the market.

This additional income remained mostly in the hands of women who were responsible for bringing it in. It was observed that this particular factor had an impact on food security for the family, as women tended to prioritize spending on household food items. Research from an IWMI study on micro-irrigation in Nepal (Upadhyay and Samad, 2004) corroborates these findings from Gujarat and Maharashtra. They found that in Nepal where the NGO IDE has worked to promote livelihoods, women farmers once introduced to drip kits, were able to increase vegetable production in their homesteads. They also grew vegetables over a larger area and their crops were of better quality and size. Vegetables became a part of the daily diet of these families, and the women were able to increase their incomes from selling a portion of their produce.

Poverty Outreach of Micro-irrigation technologies

Socioeconomic variables influence micro-irrigation adoption

When the poverty outreach of micro-irrigation technologies was assessed it was revealed that the largest group of adopters were farmers that fall into the wealthier categories on one poverty index. In Gujarat, the distribution was somewhat even, amongst the middle, rich and the very rich farmers—whereas in Maharashtra, the highest proportion was represented by the richest farmers in the sample. The difference between the pattern of adoption in the two states can be attributed to the activities of NGOs operating in Gujarat, whose policies included subsidizing the cost of the technology and providing other forms of support (such as credit and training) as well. These efforts have helped middle and lower income farmers in the state to make the change to drip systems.

- In Gujarat, the current micro-irrigation adopters are somewhat evenly distributed among the middle, rich and very rich groups.
- Currently, the largest proportion of micro-irrigation technology adopters in Maharashtra belongs to the relatively very rich group.
- The slight difference in the poverty outreach of micro-irrigation technologies between Gujarat and Maharashtra is due to differences in the support system: there are many NGOs operating in Gujarat.
- In both Maharashtra and Gujarat, the poor and the very poor categories are the least represented.

Influencing micro-irrigation technology adoption

Institutional Support systems for Micro-irrigation Technology Dissemination

Direct Marketing vs. Government Extension

In the study areas, NGOs, governmental organizations and private businesses are involved in promoting micro-irrigation technologies. In Gujarat, the NGO most prominently involved is the Aga Khan Rural Support Program (AKRSP), while International Development Enterprises (IDE) works in both Gujarat and Maharashtra. These organizations have different approaches to promoting technologies. IDE engaged in designing the actual technology to be more easily accessible to poor farmers. They concentrate their training and other support activities on disseminating information on how new designs actually work. This is done by holding events such as video shows, field demonstrations, exhibitions in village markets, and meetings with farmers. IDE does not provide financial support to acquire the technology but links farmers to financial institutions and output markets.

The AKRSP on the other hand, takes a slightly different approach. They undertake training for 'Assemblers' and Village Extension Officers on micro-irrigation technology who are mainly private entrepreneurs. The extension officers function as the marketers of the technology and are responsible for disseminating the information to the farmers. Once they meet and interact with a farmer who is willing to 'volunteer' to try out the technology the assemblers prepare a proposal based on the feedback of the volunteer. This proposal is then reviewed by AKRSP's technical staff, and once approved, the system is installed in the farmer's field

and a subsidy is given directly to the farmer. AKRSP also deals directly with farmers who may want to interact with the organization or the assemblers directly.

In the case of Gujarat, the state government has also played an active role in promoting micro-irrigation technology among poor farmers. It has done this through a subsidy scheme that has different rates depending on the socioeconomic status of the farmer. For example, small, marginal, backward, tribal and female farmers may receive a 50% subsidy for installing drip, sprinkler and pipeline systems. Large cultivators may avail of a 35% subsidy for drip systems, and 40% for pipelines. There are also centrally administered programs that give subsidies to farmers for micro-irrigation technologies, but the rate is set at 25% for all farmers irrespective of their socioeconomic standing. Although these opportunities are available, actually procuring a system using one of these subsidies is a long and painful process. Farmers are often reluctant to engage state or central government subsidies for this reason. **However, the result has been an more even distribution in economic status amongst adoptors than occurred in Maharashtra where no such government subsidies existed.**

The direct marketing approach taken by NGOs has shown to be more effective in bridging the gap between the supply and demand of micro-irrigation technologies than the traditional government extension approach. Through activities that disseminate information, raise awareness and most importantly demonstrate the use and benefits of the technology, they seek to create a market for the product amongst farmers.

The Challenge – bridging the gap between farmers and policy

Economic efficiency is only one of the many factors that influence farmers' decisions to adopt micro-irrigation. The successful adoption of micro-irrigation requires, in addition to technical and economic efficiency, some additional preconditions:

- The target beneficiaries need to know about the technical and economic advantages of using these technologies which may be achieved through extension services.
- Creating a market for new technologies is slow and expensive. It takes sustained effort and resources to raise awareness on and demonstrate the effectiveness of a product.
- The technologies need to be accessible to the potential users. Awareness or knowledge does not guarantee actual adoption unless the technologies are made accessible to the farmers through institutional support systems such as credit provisions and subsidies.

Strategic recommendations

The low cost and compatibility of micro-irrigation systems for small cultivators lends itself to targeting the poor, but without specific institutional support and strategies a market for this technology cannot be created, and its uptake will be slow. Hence the most important aspects that influence the adoption of micro-irrigation are the efforts of policymakers and organizations in long-term service provision and training. Policies must have a strong poverty focus that emphasizes the potential to improve incomes and outputs for poor farmers, while building awareness and demonstrating the potential of micro-irrigation technologies in accordance with their priorities and concerns.

- **Shifting Water Saving Technologies from Investment Mode to Input Mode:** If smallholders and poor farmers are to be targeted, policymakers must understand that promoting micro-irrigation technologies through capital investments that offer returns over 8-10 years is not the way forward. Even when they are convinced about the returns, poor farmers might not be in a position to incur the huge capital costs due to poor access to credit facilities. Poor farmers are more likely to experiment with options such as *Pepsee* systems that cut initial capital costs by having lower recurrent input costs promising returns within a year. Although these innovative low-cost systems have a shorter lifespan, once the returns start flowing in, farmers may decide to shift to the more durable varieties.
- **Creating 'First Mover Advantage':** Micro-irrigation is seen as a high risk venture, and farmers tend to wait for others in the neighbourhood to try out and test new technologies first before they adopt their own systems. Some programs have tried to overcome this obstacle by providing special incentives to 'first movers'. In IWMI's North Gujarat Initiative in Banaskantha, demonstration plots let the farmers see for themselves what works and what does not in their immediate context. These also help educate the farmers about a variety of micro-irrigation technologies. The AKRSP (I) in Saurashtra, Gujarat is providing greater support to initial adopters which it gradually reduces over the years.
- **From Custom-Solutions to Package Solutions to Farmer-Assembled Systems:** The market for micro irrigation products is experiencing its second major shift today. From the sophisticated custom built drip irrigation solutions for the commercial farmers, the technology has shifted towards package solutions provided in the form of drip kits popularized by organizations such as IDE. Today, there is a need to transfer the technology into the hands of the users. Farmers are demanding components of drip kits like pipes, drippers etc., which they can assemble locally and the biggest example of this shift is the popularity of *Pepsee* systems. Similar trends can be seen in the grey drip markets in Kolar district in India. AKRSP (I), which is promoting micro irrigation in Saurashtra, Gujarat have supported private entrepreneurs to set up manufacturing and assembling plants locally. AKRSP's experiment with 'assemblers' and village extension officers is also a step in this direction.

The diversity of conditions and situations in which micro-irrigation has proved successful shows that no single technology or practice can be a panacea. However, participatory approaches that encourage and support the creativity and innovation of farmers, by offering options that can be adapted and combined as needed, can help farmers improve their outputs and escape from poverty.

Sprinkler irrigated alfalfa crop, northern Gujarat.

Photo Credit: Sharni Jayawardena

Water Policy Briefing Series

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