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Low Cost Drip Irrigation System: An Appropriate Technology for Rural Women

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ABSTRACT

Despite contributing 80% of the food production in developing countries, women receive only partial support for their efforts. There has been, however, a significant shift in the approach towards well being of women from “welfare during fifties”, to “development during seventies” to “empowerment during nineties” and to “participation during 2000”. Women are also expected to face challenges in food security due to the lack of access to technology. This is because men are more likely to look for work and women have to manage their farm as well as homes. Drip irrigation technology is not only suitable for large farms but also for kitchen gardening. It is also appropriate for operation by women as it does not require use of spade etc as in conventional irrigation. The development of reliable low cost drip system that fits the needs of women farmers in India has long been recognized as a critical need. Three low head drip systems were designed and standardized for vegetables cultivation covering area of 50 to 600 m² area. Developed systems having bucket, drum, main pipes, portable laterals, and drippers. The drip system operates by gravity from a bucket of 25 litre capacity placed at 1 to 1.5 m height, a drum of 200 litres capacity placed at 3-meter height and drum of 1000 litres capacity placed at a height of 4 meter. About 25 to 50 plants of vegetables can be irrigated by using the single system. This technology is very ideal for rural conditions and small scale agricultural production besides back yard vegetable cultivation in village houses. The management of the bucket kit system is very easy and requires no special skills. Forty (40) family low cost drip systems were installed in the backyards of homes in selected villages especially in those houses where farm women were keen to maintain. Results of these family drip systems are very encouraging. Different bucket kits produced 150 kg of bottle gourd, 90 kg of bitter gourd, 75 kg of okra in one season (March to June). Vegetables production through low cost family drip system and conventional drip system will help achieve nutritional security at village level at nominal cost besides empowerment of rural women.

Key words: Drip Irrigation, Low Cost, Rural Women Friendly, Bucket Kit Technology, Vegetables

Introduction

The importance of water as a gender-sensitive resource has never been greater. Various national and international initiatives and government services have been launched to address this issue. Some of these include the establishment of the World Water Forum and the Gender and Water Alliance. This contributes to the well-being of both women and men. The judicious use of water and land resources

is very important for agricultural growth. The World Bank defines a participatory approach to irrigation management as the involvement of both the users and the management team at all levels. This concept implies that water users are involved in the design, construction, maintenance, and operation of irrigation systems. They also have a say in the setting of rules and regulations, as well as in the evaluation and monitoring of such systems.

Agriculture in India remains fundamental to eco-

conomic growth, poverty alleviation, and environmental sustainability. Declining natural resources, increasing input costs and rising food prices are reminders of the need to focus on food security and agriculture for development. Agricultural growth, a key means of poverty alleviation, relies on improving the productivity of women farmers since women form the majority of farmers and labourers in India (GDPRD, 2010). There is an increasing realization that challenging gender empowerment and investing in addressing the barriers that woman face, will increase efficiency and productivity in the agricultural sector and thereby contribute towards growth and poverty reduction (World Bank, FAO, IFAD, 2009).

World Bank, FAO and IFAD, 2009 suggested that accounting for the different roles of women and men and gender equality in access to resources, technologies and opportunities is a necessary condition for gender empowerment. Gender inequalities in technology development and adoption limit agricultural productivity and efficiency, undermine development agendas. Failure to recognize the different roles of men and women is costly because it results in inappropriate technologies and programs, forgone agricultural output and incomes, and food and nutrition insecurity. It is time to take into account the role of women in agricultural production and to increase concerted efforts to enable women to move beyond production for subsistence and into higher-value, market-oriented production through innovative technologies.

The importance of engendering the innovation process has also been emphasized recently and these discussions call for moving from gender analysis to gender learning and a shift in women's empowerment to empowering innovation system capacity. This indicates that, technologies have to move away from the traditional technology to new technological approach that often doesn't meet the needs or requirements of rural communities, especially women, which influences and impact the social development process.

State of Women in Agriculture

Women are key players in the farming sector; their role in agriculture self-employment is notable. Women's role in food production within agriculture is even greater. In many societies women supply most of the labor needed to produce food crops and often control the use or sale of food produce grown

on plots they manage. However, the asymmetries in ownership of, access to, and control of livelihood assets (such as land, water, energy, credit, knowledge, and labor) negatively affect women's farm productivity. Women are less likely to own land and usually enjoy only use rights, mediated through a man relative. Compromised land access leads women to make suboptimal decisions with regard to crop choices and to obtain lower yields than would otherwise be possible if household resources were allocated efficiently (Galina, 2015).

The lower production reduces not only women's potential income, but also the availability of food for household consumption. Legal reforms need to take into account multiple-use rights to land, particularly women's rights, as well as the different means by which women gain access to land. Agricultural technology transfer capacity development is one of the prime policy levers to increase agricultural productivity. But often women are not targeted because it is assumed that their husbands or fathers will share the knowledge with them, and often they are supplied with technologies that do not meet their needs. However, adoption of new technology depends on many things, including the availability of required assets to implement the technology, how local women and men view the perceived benefits, the way information is shared, and local gender roles and other socio cultural constraints. Even when women have access to land for food production and access to improved technologies, they face more constraints than men in accessing complementary resources for success. They have less access to credit and less access to inputs such as fertilizer, seed etc.

Women are a vital agent in Indian economy, even as studies points towards 'statistical purdah' (World Bank, 2009) or 'economic invisibility' (Radhadevi, 1981) manifest in selective under- documentation of their endeavours, in a society with strong traits of patriarchal norms. In Indian population 48.27 % are women, 72.72 % of the women live in rural areas and 45.84 % of the female population is illiterate. As per Census 2011, workers constituted 39.79 per cent of total population whereas the ratio of female workers was 25.51 per cent. At All-India level the percentage share of females as cultivators, Agricultural laborers, workers in the household industry and other workers stood at 24.92, 18.56, 2.95 & 47.20 respectively. The percentage of female main workers to total female population stood at 25.5 which shows an increase as compared to 14.68 reported in

the 2001 Census. Literacy rate amongst females was reported at 65.46 per cent which was less than the male literacy rate i.e. 82.14 per cent in the 2011 census. Work participation rate of female workers in rural areas was higher which stood at 30.0 as compared to the work participation rate of 15.4 per cent in urban areas. The State of Himachal Pradesh had the highest female work participation rate (44.8 %) whereas the lowest was reported in case of Delhi (10.6 %). Percentage of female main workers, female marginal workers and female other workers to total female population was 59.6, 40.4 and 29.2 respectively (Labour Bureau Ministry of Labour & Employment, 2012-13).

Inferences drawn that women are critical to the well-being of farm households. It further suggests that perhaps, ironically, it is because women have so many responsibilities that they have been overlooked by agriculturalists and policy makers. Yet, women are involved in all aspects of agriculture, from crop selection to land preparation, to seed selection, planting, weeding, pest control, harvesting, crop storage, handling, marketing, and processing. Hence, the development of farming technologies relevant to women is reasoned to be of significant importance.

Women's lack of access to appropriate technology will have an adverse impact on food security, especially as men migrate to seek work and women have to do all the farm work as well as managing their home. It can be argued, therefore, that low-cost, reliable, less labour intensive, practical and socially accepted technologies can help reduce women's drudgery and meet their practical needs, improve health and save time. To accommodate female farmers' needs, it is *necessarily* to identify who will be using the technology and for what purpose therefore gender participation in technology design is crucial. After all, farmers are the ultimate adopters and lack of gender involvement will have an adverse impact in technology adoption.

Drip irrigation as a tool to empower women in Agriculture

The drip irrigation is one of the most efficient methods of water application for crop production. Drip irrigation technology is not only suitable for large farms but also for kitchen gardening. It is also appropriate for operation by women as it does not require use of spade etc as in conventional irrigation. The development of reliable low cost drip system

that fits the needs of small farmers in India and other developing countries has long been recognized as a critical need. Participation of rural women and their access to affordable low cost drip system can revolutionize in the availability of good quality vegetables in rural India.

Methodology

Sample area: In Rajasthan state of India, five villages of district Alwar namely Tilwar, Gujuki, Salpuri, Tikri and Sunehra were selected to understand the perception of the farmers including farm women, about the drip system. These villages do not have any canal network for irrigation and are totally ground water dependent for irrigation. The normal rainfall for the district is 657 mm. The rainfall distribution in the district is uneven and scattered which results in occasional flood problem and occasional draught situation which affect the agriculture production both in kharif and rabi seasons. Farm women were being encouraged to use these drip systems through different capacity building programs organized by WTC, Indian Agricultural Research Institute, New Delhi.

Drip technology improves irrigation efficiency by reducing evaporation from the soil surface, reducing or eliminating runoff and deep percolation, and eliminating the need to drastically over-irrigate some parts of the field to compensate uneven water application. The application of fertilizer and other chemicals can also be optimized through the use of drip irrigation, weed growth can be reduced, and salinity problems can be mediated.

World is running increasingly short of water because of the growing competition between farmers who need to irrigate their crops and the world's rapidly expanding cities, water saving modes of irrigation are at a premium (Postel, 1992). The drip irrigation technology enabling farmers to cultivate all the year round, grow a wide variety of crops, have higher cropping intensity and do priority farming.

Drip irrigation is in practice since 1970s in India to improve agricultural water productivity, creating more output with less water. Its high capital cost per ha for vegetables and fruits crops makes installation of drip systems prohibitive for the great majority of farmers in developing countries like India who cultivate less than five acres. Existing drip irrigation technology is not "divisible," and cannot be divided into very small functional units. As per Agriculture

Census 2015-16, the average size of operational holding has declined to 1.08 hectare in 2015-16 as compared to 1.15 hectare in 2010-11. The small and marginal holdings (<2 ha) now constitute 86%, while the large holdings (>10 ha) are merely 0.57% of the total land holdings. However, HYV seeds and fertilizer technologies are divisible because they can be split into small affordable packets that fit tiny plots. But drip irrigation systems are difficult to customize to meet the needs of the small plots of poor farmers, and they are too expensive to be affordable. The key contributors to cost for a standard drip irrigation system are laterals and drippers used for delivering water to each plants and filter system at the head works. Therefore, a low cost drip system which utilizes gravity as the force to push water through the pipes is one of the sustainable solutions (Karlberg *et al.*, 2007).

Drip irrigation maximizes returns by increasing the agricultural production per unit of land and water through increasing cropping intensity by growing a crop during the dry season. The development of low head drip systems uses simple filtration has reduced much of the initial capital investment necessary, making small-scale drip irrigation systems affordable to smallholder farmers. Small holder drip irrigation systems are being used in some parts of Africa; for example, the Chapin bucket kits are being used in Kenya, Tanzania, Malawi, Zambia and Uganda. The Water boys bucket has mainly been used in Uganda, although a number of kits are in use in Kenya and Tanzania. Elsewhere in the world, for example, in India, resource-poor farmers have used drip irrigation systems with reported success.

Bucket Kit: An appropriate technology for women

The Bucket Kit is ideally suitable for kitchen gardens for women or landless farmers, and with urban gardens. It consists of a 20-liter bucket and one 10-meter long lateral fitted with 26 micro tubes (Fig. 1). It can irrigate 104 plants, (around 25 m²) with four plants placed around each of the micro tubes. The bucket is placed at a height of about 0.5-1 meters and is filled 3 to 4 times a day (depending on environmental conditions and plants grown). The kit costs around US\$ 5.00 in India. It reduces the labor burden of hand-watering each plant and fetching precious water often carried from sources up to a mile away.

In countries as diverse as India, Israel, Jordan,

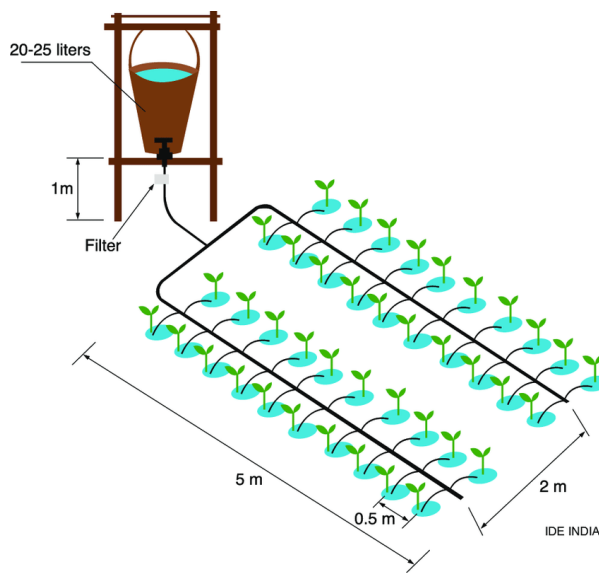


Fig. 1. A simple bucket kit for irrigating a small vegetable garden plot

Spain, and the United States, studies have consistently shown drip irrigation to reduce water use by 30-70% and to raise crop yields by 20-90%. In India, trickle irrigation has been introduced for high value crops (vegetables, flowers, spices) in some of the more arid parts of the country where water is scarce. Over 50,000 ha were being irrigated by trickle irrigation earlier, this has now risen to over 2,25,000 ha. This substantial increase in the use of trickle methods is not so much a result of market demand but the low-cost of the systems, which are heavily subsidized by the Indian Government. Drip irrigation's combination of water savings and yield increases typically produces at least a doubling of water productivity—yield per unit water—and makes it a leading technology in the global challenge of boosting crop production in the face of serious water constraints (Postel, 1992). Even with subsidies the systems were too expensive for small farmers. Trickle systems were also thought to be too complicated to operate and maintain and not easily divisible to fit small plots (Polak and Sivanappan 1998, Key, M. 2001).

In field trials in Madhya Pradesh, India, with adjacent 2,000 m² plots of seed cotton, the field irrigated by a low-cost stationary drip system yielded 670 kg/ha compared with 500 kg/ha for the flood-irrigated field—a 34% yield gain. Water use was estimated to be 55% less with the low-cost drip system (IDE, 1998). Previous studies in Coimbatore in

southern India comparing cotton irrigated by conventional drip versus flood systems showed water savings ranging from 43% to 79% and yield increases ranging from 25% to 40% (Polak and Sivanappan 1998). Tests in Rajasthan, India, of the micro tube system on sugar cane showed lower gains in yield (14%) than more expensive conventional drip systems (29%) when each was compared with flood irrigation methods (IDE, 2004). In both the cotton and sugar cane trials, low-cost drip resulted in a substantial increase in water productivity—output per unit water—due to both the yield gains and water savings.

In early 1999, the Swiss aid agency, Swiss Development Cooperation, sponsored a study of low-cost drip systems used by a small sample of farmers in the Indian state of Maharashtra. The farms ranged in size from 100 m² up to 0.2 hectares and included a mix of drip system types. A variety of crops were irrigated on these plots, including beans, vegetables, papaya, and flowers. Compared with flood irrigation methods, the study found average water savings of 55%, labour savings of 58%, and reductions in expenditures on fertilizer and pesticides averaging 16%. With the drip systems, some farmers obtained cash profits for the first time, while others saw substantial increases—50% to more than 300%—in their net profits. In addition, household consumption of fresh vegetables increased—from occasionally to almost daily—suggesting improved variety and nutrition in the diet. Finally, because drip-irrigated fields had fewer weeds, the work load on women and children was reduced.

So far, small farmers have purchased approximately 13,000 micro-irrigation systems, including about 8,000 in India, 2,300 in Nepal, and 1,700 in Sri Lanka. In addition, 60 systems are being field tested in Vietnam and another 60 in Bangladesh. At the initiation of Fideicomiso de Riesgo Compartido (FIRCO), a technology transfer organization within the Ministry of Agriculture of the Government of Mexico, some 50 test plots have been established in four states in Mexico. In China, International Development Enterprises has established 160 demonstration plots in Gansu and Shanxi provinces. Moreover, a rapidly expanding array of low-cost drip systems is now available to small farmers in different parts of the world. The Israeli firm Netafim, the largest international drip irrigation company in the world, is now marketing a high-quality, 1000-m² system in China, India, and Africa. It is still too expensive,

however, for very poor farmers. For the past several years, the New York-based non-profit Chapin Watermatics has distributed thousands of bucket kits for irrigating kitchen gardens to poor rural families in Africa and elsewhere. Affordable/low-cost drip systems are being installed in the hills of Nepal and northern India, where water from community tanks is scarce and cropland is terraced and prone to erosion. Drip systems have great potential as a feature of watershed projects in South Asia, sub-Saharan Africa, and elsewhere. In these areas, very labor intensive efforts go into capturing and storing rainwater runoff, for example, by constructing check dams or tanks, but then that water is often applied very inefficiently to fields (Postal *et al.*, 1992).

Estimates show that over 100,000 IDE low-cost drip systems have already been purchased in India, Nepal, Sri Lanka and Zimbabwe. In India alone sales to this date exceed 85,000 kits (IDE, 2004). The drip system is also expanding in countries such as China and Africa where Israeli firm Netafim, the largest International drip irrigation company in the world, is marketing their systems. The non-profit Chapin Watermatics along with IDE is also distributing thousands of bucket kits for irrigating kitchen gardens to poor families in Africa and elsewhere (Postal *et al.*, 2001). The low-head drip was successfully implemented in countries of sub-Saharan Africa region.

Results and discussion

A low head bucket drip system was designed and standardized for kitchen gardening (25 to 50 m²). The system consists of a bucket, portable laterals, and drippers. The drip system operates by gravity from a bucket of 25 litre capacity placed at 1 to 1.5 m height. About 25 to 50 plants of vegetables can be irrigated by using the single system. This technology proved to be very ideal for rural conditions and small scale agricultural production besides backyard vegetable cultivation in village houses. The management of the bucket kit system is very easy and requires no special skills. Farmers can install and maintain it on their own. The cost of this system varies from Rs. 750 to Rs. 1000 per unit. Forty (40) family low cost drip systems were installed in the backyards of sample households in selected villages especially in those houses where farm women were keen to maintain. The results of these family drip systems were encouraging. Different bucket kits

produced 150 kg of bottle gourd, 90 kg of bitter gourd, 75 kg of okra in one season (March to June). (Fig. 2).

These family drip systems helped in motivating the farmers to install drip system in regular fields. Consequently, in a span of just one year, twenty-one farmers adopted drip irrigation in the village bringing about 25 ha area under drip irrigation mainly for vegetable crops namely tomato, onion, brinjal and cotton. Increasing area in the villages under vegetables production generated secondary employment for land less women in picking, sorting and grading of vegetables. Vegetables production through low cost family drip system and conventional drip system will help achieve nutritional security at village level at nominal cost as most farm women workers may get the vegetables in the form their wages. For example, 0.25 ha tomato cultivation under drip irrigation provided employment of 100 woman days, besides saving 50 % irrigation water and 60 % enhancement in yield.

Impact on Agricultural Productivity

Despite the various factors that have affected the development of rural economies, the emergence of social relations has been able to improve the productivity of women farmers. While pre-capitalist production relations were not ideal for the marginalized farmers, they were able to benefit from the social relations that were brought about by economic growth.

Women's lack of knowledge about the technical aspects of irrigation technology and land ownership were some of the factors that contributed to the late adoption of this technology by women. According to studies, the increase in women's access to revolving funds boosted overall investment. However, small farmers who fell below a certain landholding threshold had to make do with less credit available from the revolving fund.

Increasing incomes and reducing poverty

Besides providing high yield and quality, drip sys-



Fig. 2. Bucket kit in bottle gourd, ridge gourd and other vegetables

tems can also help farmers reduce their labor costs. This technology allows them to harvest their crops early, which can help them save money on their labor. In addition, the presence of pests and diseases such as weeds has also decreased with the use of this technology, which means that farmers no longer have to spend a lot of time and effort to protect their crops.

The lower energy used by micro-irrigation systems when compared to traditional methods can help decrease the overall cost of production. This is one of the main reasons why many farmers choose to use the technology instead of traditional methods.

Women can earn a living from their homestead plots with the help of drip kits, which provide them with the necessary tools and resources to improve their household food security and income. Most of the additional income that came from the drip kits went to the women who brought it in. This factor has an impact on the family's food security. They tend to prioritize buying household food items. They were able to grow vegetables in a larger area, which resulted in better quality and bigger crops. Because of this, they were able to increase their income by selling vegetables.

The Challenge – bridging the gap between women farmers and policy

Aside from the technical and economic efficiency, there are also various other factors that need to be considered before micro-irrigation can be successfully implemented. This includes the knowledge of the women farmers and the market for new technologies.

It takes a lot of resources and effort to raise awareness about a product or a technology. Without proper access to these resources, women farmers will not be able to adopt the technology. This is why it is important that the various support systems are made available to the farmers.

Conclusion and policy implications

This paper aims to introduce a woman of rural India to transform their local economy by establishing a commercial vegetable farming operation. Through this technology, they were able to improve their well-being. The sustainability is ensured by the training and supervision of the community people who are involved in the operation of the irrigation system.

A couple of important points should be pondered on this bucket technology for women. First, irrigation technology developers should be aware of the need of gender sensitive technologies together with considering socio-economic and cultural scenarios of the region where diffusion of the technology takes place.

Besides economic benefits, positive impact could be felt on household. There is a need to revisit irrigation policies and technology development strategies. Technology developers and policy makers should understand the productive roles of women in using drip-irrigation technologies. Secondly, government should shy away from its conventional habit of introducing larger farmer friendly subsidies and rather facilitate tie-ups with non-government sector so that poor friendly technology becomes available at affordable prices for a broader population. Offering mortgage-free loan to landless farmers to enable them to lease the land and subsidy to install the technology will be an appropriate policy response to the problems of poorest of the poor, usually women. It may be useful to launch such packages in conjunction with local micro-finance schemes.

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