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LOW-COST DRIP IRRIGATION KITS FOR SUSTAINABLE RAINFED AGRICULTURE

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Abstract: *Drip irrigation provides good water control by delivering water near the plant, enabling the farmer to grow crops with much less water compared to the other irrigation methods. The use of low-cost drip irrigation systems in India goes back to the 1995 when International Development Enterprise (IDE) introduced drip irrigation kits in India. The range of drip kits in India now includes bucket, drum, eighth acre and orchard drip irrigation systems. Experience with the drip irrigation kits has shown that small-scale farmers especially women are able to adopt and use them successfully. The potential for the technology is vast. In monetary terms, at the farm level, a farmer investing in a drum drip kit of 1000 m^2 costing Rs. 23847 and inputs worth Rs. 5000 can generate an extra income from Rs. 96,153 to Rs.1,36,153 in rabi season from the high value vegetable crops. Studies have shown that even when market prices are low, it still pays the farmer to grow vegetables using this kit.*

Key words: *Drip kit, smallholder farmers, vegetable garden.*

Introduction

In India, despite the impressive gains in national food production over the last half century, an estimated 148 million people remained hungry as per the survey conducted by World Bank in year 2014. Total 36.4% agriculture households have qualified for the Below Poverty Line (BPL) ration cards. Many of the poor farming families are living in rainfed areas, who have neither the means to produce the food they need nor sufficient income to purchase it. For them, access to irrigation water and the means to use the limited quantity of water they have more productively, is a key to increasing their crop production, their incomes, and their household food security. Ironically, a technology like drip irrigation is typically associated with wealthy farmers. The conventional drip irrigation technology that was developed in Israel, Denmark and the United States of America (Sijali, 2001; Bresler & Yasutomi, 1990; Dorenbos, J. & Kassam, A.H., 1986) is estimated to meet initial investment of Rs 65,000 to Rs 95,000 for the adoption on one hectare cropped land. The investment costs and the inherent risks of conventional drip irrigation in view of the unreliable water supply are too high for most smallholders. Keeping this in view, a new spectrum of low cost drip irrigation systems, namely drip kits, addressing low income levels, seasonal water source and marginal farm sizes now exists aimed specifically at the poor farmers.

The drip kits provide good water control by slow application of water near the plant, enabling the farmer to grow crops with much less water compared to other irrigation methods. In drip kits water is applied by gravity pressure to the soil through emitting tapes or coiled micro-tubes. The basic components of a drip kit are water emitters, water distribution lines/laterals, filter, tank and a treadle pump/solar pump to fill the tank. Drip kit usually have a raised reservoir/tank to create the pressure, which may be only 0.1-1 kg/cm^2. Emitter discharge usually ranges from 0.2 lph to 2 lph. The area covered by single unit ranges from 15 m^2 to 2000 m^2 for vegetables and fruit trees.

Where adequate technical and agronomic training and support are given drip kits can offer technical and financial benefits. However, the degree of benefit varies greatly according to the type of kit

used, types of crops grown, the attitude and skills of the user, their current wealth status and the wider commercial and agricultural context in which their farming takes place. The smallest bucket drip kit may offer some improved family nutrition and food security during the dry season to a poor household. Larger drip kit, combined with a high value crop offer the greatest visible impact on livelihoods through an improved cash income that may contribute as much as 60% of the total annual income of a household.

In order to assess the potential and impacts of drip kits in semi-arid areas of Maharashtra a study was undertaken by the Rashtriya Krishi Vikas Yojana, entitled, "Rain-runoff water harvesting storage tanks for smallholder farming systems" M.P.K.V., Rahuri. In this paper, the potential and impacts of drip kit are analysed considering the marginal land holdings of tribal farmers at Thakarwadi located in Rajgurunagar tahsil of Pune district in Maharashtra.

History of Low Cost Drip kit Systems in India

Low-cost drip irrigation was introduced in India in 1995, when forty two month research project funded by the Knowledge and Research programme of DFID's Department for Infrastructure and Urban Development was implemented. The project ran from April 1999 to December 2002 with fieldwork occurring in India and Zimbabwe. The project undertook an action research focused on the work of the International NGO, International Development Enterprises (IDE). The drip kits were experimented mainly in East India (Jharkhand and West Bengal) and West India (Maharashtra, Gujarat and Himachal Pradesh). Quantitative data from sustained field records were collected in India. Farmers in the East India study reported that the water use dropped from 8 to 10 buckets applied twice daily, under conventional irrigation, to 2 buckets three times per day with the drip kit, during peak summer demand. Sustained over a season this represents a 66% reduction in water use. In the West India study, where many farmers use pumps to draw water from wells, farmers estimate that the pumping hours required to irrigate an acre of pomegranate using the customised drip kits (3-4 hrs) was only half the time required when using the same source and irrigating by surface furrows. The diffusion of drip kits to the poorest was almost entirely achieved through subsidies provided by local NGOs.

Characterization of Drip Kits:

The drip kit system in India has following characteristics which differentiate it from rest of the irrigation methods.

- Drip kit systems are aimed specifically at smallholders having seasonal or temporary water source.
- Drip kits are designed specifically for small plots from just 15 m^2 up to 1 000 to 2 000 m^2, which can be added to as and when the farmer chooses.
- Drip kits use low pressure (or head). A raised bucket, oil drum or other storage tank may provide enough pressure and could be filled manually.
- In order to overcome the effect of low operating pressure on flow rates the lateral lengths are kept short.
- Simple emitters, such as coiled micro-tubes or holes punched into the lateral (Tapes) are used .
- Drip kits use simple cloth or wire mesh filters to prevent large particles entering laterals. In addition, the systems using simple holes in the lateral rely on the farmer using a pin or fine wire to clear any emitter that becomes blocked.
- Movable laterals are often used.

Typology of Drip kit irrigation systems in India

India, has established national manufacturing capacity and placed emphasis on 'simple' micro-irrigation systems that do not rely on automatic control or other labour-saving devices. The range of drip kits now includes bucket, drum, eighth acre for vegetable gardens and orchard drip irrigation systems. The brands namely IDE/KB, Netafim and Jain Irrigation systems limited are available in Indian market.

IDE Drip kits / KB Drip kits

International Development Enterprises (IDE) has produced various drip kits to meet the different needs of marginal farmers (Polak et al., 1997):

- **Bucket kits**. These are for home gardens and were based on the Chapin Bucket System and cost approximately US$5. Each comprises a 20 litre household bucket installed on a pole at shoulder height. The bucket is fitted with a 10 m lateral line and is filled two to four times a day. The single lateral line has 26 micro-tubes attached and each waters four vegetable plants, irrigating 50 m^2, enough to provide vegetables for a family.
- **Drum kits** use a 200-litre drum made of steel or plastic and costs around US$25 and irrigates a 125 m^2 plot. Water is supplied through a simple filter and supplies five 10 m-laterals each fitted with 26 micro-tubes.

Netafim Family kits

Netafim, an Israeli trickle irrigation manufacturer, has developed Family Drip System that can be adapted to variable plot sizes. The kit comprises standard emitters, pipes and filter equipment, works at low head and is pressurized from a tank rather than by pumping. The costs of the system range from US$150-240 for 1000 m^2 (US$1500-2400 per ha).

Drip kits developed by Jain Irrigation Systems Ltd.

The systems are manufactured mainly by focusing on small farmers having seasonal/ temporary water source and land-holding less than 1 acre. Drip kit systems are available in six models or sizes of : 30m^2, 100m^2, 250m^2, 500m^2, 1000m^2 & 2000m^2. These systems are operated on gravity pressure of 0.1 to 1 bars and maximum discharge of 0.95 to 1.6 lph. It is available in three types of lnline tubing options: i) Thickwall - 12mm J-Turbo Excel® (JTE 1.6 lph, 30 cm spacing & 0.6-0.7 mm thickness) ii)Thinwall - 16mm Jain Turbo Slim® - TE(JTS-TE 1.6lph, 30 cm spacing & 6 mil (150 micron)) and iii) Thinwall - 16mm Chapin™ Deluxe (0.95 lph, 20cm & 6mil (150 micron)). Very suitably these systems can be used for cultivation of vegetables, cereals, pulses, cotton and other closely spaced crops in open fields, green house/ net house and nurseries. The kits are useful as a survival irrigation tool in rainfed area or water scarcity region or when there is a prolonged gap between rains and or electricity is not available.

Combining treadles and solar pumps with Drip kits

The treadle pumps and solar pumps are often combined with drip kits. Once water has been lifted from the water source to the tank, there is every incentive to use it as effectively as possible. Treadle or solar pump is not directly connected to drip kit as the flow tends to be intermittent which reduces the uniformity of water application.

Materials and Methods:

Thakarwadi is a small settlement of 13 tribal farmers possessing total 15 ha cultivable land. It is located in *Jaulake* village (Tah. *Rajgurunagar*, Dist.-*Pune*) which is characterized by moderate to low rainfall (550-650 mm) distributed in a single rainy season of around four months with a subsequent dry season of eight months duration. Water shortage particularly at the end of the dry season is severe. The annual income of the farmers from agriculture is less than Rs. 2000. The farming is practiced only in rainy season. In dry season due to lack of irrigation water farming is not practiced. The household food security is hampered since no vegetables and fruits are available for consumption in dry season. During this period the tribal farmers work as labourers on daily wages in nearby irrigated farms of rich farmers.

In the study area, the agriculture department has constructed the earthen embankment across the rock catchment to collect the water in rainy season especially for the tribal settlement of *Thakarwadi*. The embankment retains water till the end of *rabi* season. This water is not enough to irrigate the entire 15 ha land owned by the farmers using flood irrigation method. However, it is possible to cultivate vegetables on up to 5 ha land in *rabi* season if drip kits are made available to these farmers. Electricity for agricultural use is not yet available in the tribal

settlement. However, solar pumps can be installed for pumping water in the raised tank of each drip kit. The local market is available at 3 km distance from *Thakarwadi* while the main market is available 15 kms away at *Chakan*. All the three prerequisites of adaption of drip kits such as market for vegetable products, reliable and adequate water source and adequate land available for future expansion are fulfilled in the selected location.

The drum type drip kits manufactured by the JISL are considered for the assessment of potential impacts on the livelihood of marginal farmers (Fig.2). The detailed map of the agricultural land of the tribal settlement in *Thakarwadi* is shown in Fig. 1. The group of tribal women farmers is thought to be operating this drip irrigation project. Each woman farmer is considered to have a drum type of drip kit to irrigate 1000 m^2 of vegetable garden (Fig.2). Total thirteen vegetable gardens are delineated potentially covering area of 3.25 acres. The cost of each drip kit is Rs. 10000/- . The total cost installing drip kits is 1,48,005. The cost of 1 hp solar pump (Jain make) is 1, 62,000. The cost of vegetables in local market is considered to be Rs. 20 per kg.

In monetary terms (Table 1), at farm level, a farmer will invest Rs.23,847 in a drum kit and use Rs.5000 for crop inputs to generate an income of Rs. 96,153 to Rs.1,36,153 in *rabi* season depending on the type of crop cultivated in vegetable garden. Similar field reports (Nyakwara *et al*., 2000) for the various low-cost drip irrigation systems in Moiben showed gross returns from the sale of tomatoes, cabbages and traditional vegetables amounting to US$ 56, US$ 245 and US$ 990) for bucket, drum and eighth acre systems respectively. Experience with the drip irrigation kits has shown that small-scale farmers are able to adapt and use them successfully (Nguluu *et al*., 1999; Nyakwara *et al*., 2000).

Conclusions

Low-cost systems such as drip kits have the potential to raise productivity and enhance rural livelihoods. As the cost of this technology is relatively low it is still accessible to farmers who cannot afford to buy expensive conventional systems, Farmers can grow cash crops such as vegetables, fruit and flowers that provide sufficient returns to pay for the investment. These systems are likely to be taken up by poor farmers with or without appropriate financial and technical support. The main impact of drip kit was the conservation of water resources in semi-arid areas where water supplies are scarce. Field reports indicate that farmers are irrigating 1-3 mm per day in areas where the crop water requirement is 4-5 mm per day and still making profit (Nyakwara *et al*., 2000, Postel et al.2001; Shah et al., 2000).

Drip irrigation kits will provide an opportunity for farmers in semi arid *Thakarwadi* area to grow vegetables in small gardens of 1000 m^2. With a relatively small capital investment of Rs.65,000, a group of thirteen women farmer can invest in a bucket kit and expect net benefits of Rs.13,29,000 in a single *rabi* season where previously no cropping was possible. The production costs will be reduced during the second and later seasons for better net income. The drip irrigation kit saves water to the account of 40% to 80 % and provides higher income which makes the technology attractive in semi-arid and dryland agricultural production.

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Table 1: Costs and Projected Benefits on Drip kit with solar pump in first *rabi* season in Thakarwadi

Sr. No.	Name of Woman Farmer	Area, m^2	Crop	Cost of drip kit+ solar pump on sharing basis, Rs.	Approx. Cost of inputs, Rs.	Yield Kg	Net profit, Rs. (Selling price Rs. 20/kg)
1.	Alka Lakshuman Mengde	1000	Tomato	23847	5000	3000	96,153
2.	Sindhubai Kesu Mengde	1000	Broad bean	23847	5000	2500	76,153
3.	Durga Luma Mengade	1000	Brinjal	23847	5000	4000	1,36,153
4.	Yashoda Laxuman Mengde	1000	Tomato	23847	5000	3000	96,153
5.	Sarsabai Yashwant Mengde	1000	Broad bean	23847	5000	2500	76,153
6.	Sulabai Sitaram Mengde	1000	Brinjal	23847	5000	4000	1,36,153
7.	Sonabai Rakhama Mengde	1000	Tomato	23847	5000	3000	96,153
8.	Kausabai Barku Mengde	1000	Broad bean	23847	5000	2500	76,153
9.	Parubai Mahadu Mengde	1000	Brinjal	23847	5000	4000	1,36,153
10.	Dhondabai Saga Mengde	1000	Tomato	23847	5000	3000	96,153
11.	Phulabai Chimna Mengde	1000	Broad bean	23847	5000	2500	76,153
12.	Rakhmabai Manu Mengde	1000	Brinjal	23847	5000	4000	1,36,153
13.	Indubai Kisan Mengde	1000	Tomato	23847	5000	3000	96,153
	Total	13000	---	3,10,011	65000	---	13,29,989

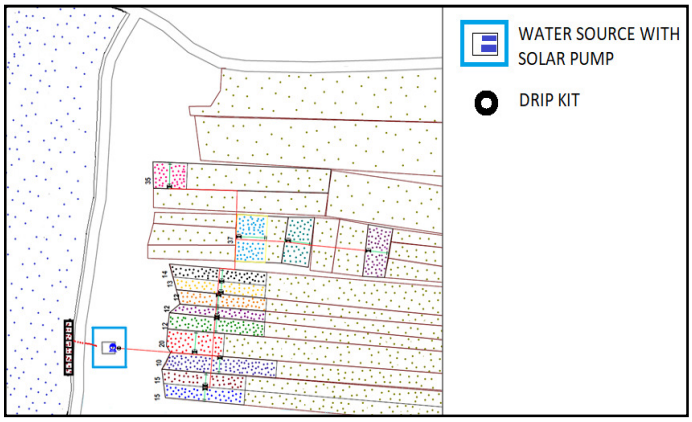

Fig. 1: Layout of cultivable area in Thakarwadi showing the position of solar pump and drip kits

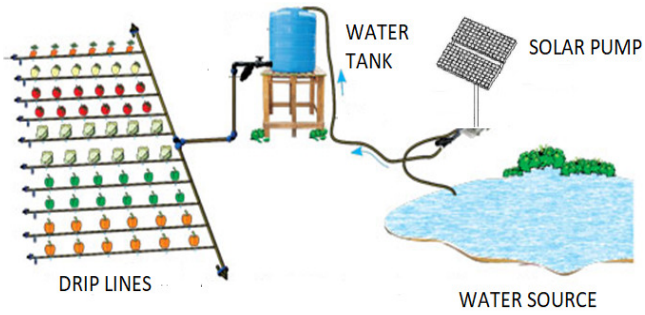

Fig. 2: Schematic diagram of solar powered drip kit