# Application of Gravity-drip Irrigation Technology for Vegetable Production

The Learning and Practice Alliance (LPA) approach is used with farmers who are engaged in water harvesting efforts. Groups of stakeholders come together to innovate, share experiences, and scale-up good practices using a common platform. The groups are usually composed of different stakeholders: implementers, policy and decision makers, researchers and private sector actors, operating at various levels, who would normally be working in isolation from one another, but have joined hands through a joint platform to address common sector challenges. The premise of the LPA approach is that addressing complex sector problems in a sustainable manner requires the involvement of all the stakeholders in the problem-solving process and focus on developing local knowledge to support local solutions.

# Implementation approach

Farmers who have water harvesting structures at Aliyu Amba area in Ankober District, North Shewa administrative zone were consulted to request their participation in demonstrating the gravity-drip irrigation side by side with the can application method during the dry season of 2004 and 2005. Five volunteer farmers were selected. Including those farmers, a Farmers Research Extension Group (FREG) composed of 20 farmers (6 were women), development agents in the kebele, and researchers as facilitators was established.

The FREG members were trained on the concept and procedures of FREG and the characteristics and application of the gravity-drip irrigation technology. To facilitate wider promotion and enhance group learning, the FREG members came together during seedbed preparation and the laying out of the drip system, seedling stages, development stages, and maturity stages to learn from each other on the application and utilization of the technology. Farmer-managed demonstrations and promotion of the drip technology was carried out on five farmers' plots. On the other hand, other farmers who cultivated tomatoes and onions were advised to use cans so that the outputs could be compared with those obtained from the drip application methods. Finally, field days were held to share the lessons and introduce the technology to other farmers and experts in the nearby kebeles.

Drip laterals (60 m length) having either 60 cm or 30 cm emitter spacing manufactured by Selam (a private enterprise in Addis) were provided to the five farmers. The spacing of the emitters can vary, depending on the type of vegetables raised. For example, tomatoes require an emitter spacing of 60 cm, while onions need only 30 cm or below. The number of laterals varied from farmer to farmer based on the area under irrigation. Locally made water storage tanks or, in this case study, oil barrels having a 200-liter capacity, were used to store water extracted from the water-harvesting ponds. The storage barrel was placed about 1 m above the ground surface in order to gain sufficient gravitational energy for drip emitters to discharge the required amount of water uniformly along the laterals. The laterals were directly connected to the barrels. One drip lateral can be used alternatively for different rows of tomatoes and onions. The farmers were required to fill the barrels before starting irrigation, to check the uniformity of water discharged by emitters, and to clean clogged emitters.

Since the variation in plant spacing requires different numbers of drip laterals, onions and tomatoes were purposely selected and used as test crops on each plot of the participant farmers. The plot sizes varied from farmer to farmer. Sandy clay soil was the dominant type of soil in the demonstration sites.

The amount of water applied per irrigation was determined by the soil water available prior to irrigation using the feel method. Initially,

***Table 1.*** *Amount of water and labor required for drip and can methods of application.*

| Vegetable | Replication | Volume of water applied (m³/ha) | | | Labor (person-days/ha) | | |
|---|---|---|---|---|---|---|---|
| | | Drip | Can | Difference (Drip-Can) | Drip | Can | Difference (Drip-Can) |
| Tomato | 1 | 53.33 | 70.41 | 17.07 | 82.38 | 98.85 | 16.48 |
| | 2 | 77.58 | 113.27 | 35.69 | 108.95 | 181.76 | 72.81 |
| | 3 | 83.64 | 103.57 | 19.93 | 100.45 | 247.66 | 147.22 |
| **Average** | | **71.52** | **95.75** | **24.23** | **97.26** | **176.09** | **78.83** |
| Onion | 1 | 142.55 | 177.86 | 35.31 | 255.21 | 245.54 | -9.67 |
| | 2 | 256.25 | 267.86 | 11.61 | 368.31 | 358.63 | -9.68 |
| | 3 | 244.37 | 265.00 | 20.63 | 293.90 | 602.68 | 308.78 |
| **Average** | | **214.39** | **236.90** | **22.51** | **305.81** | **402.28** | **96.48** |

the participant farmers demonstrated the shape of the squeezed moist soil under different soil moisture content. They were oriented to apply water when they obtain the similar shape of sample moist soil squeezed at critical water content. All farmers who used drip and can methods were told to record the amount of labor and water applied and the yield obtained from their plots, so that costs and benefits can be compared.

# Water and labor requirements

Evidence on farmer-managed on-farm demonstrations (Gizaw and Tegenu, 2008) indicated that using low-cost gravity-drip irrigation reduced the total amount of irrigation water required, by 24.23 $m^3$ and 22.51 $m^3$ per hectare of land for tomatoes and onions, respectively, compared with the can irrigation method (Table 1). The amount of water saved could have been used to irrigate tomatoes on an additional area of approximately one-third of a hectare using drip systems. Moreover, using the drip irrigation system, 79 and 97 person-days per hectare labor on average was saved over the can method for tomato and onion production, respectively. Sometimes, depending on the condition of water availability and lift from water-harvesting structures, the labor requirement for the drip method was slightly more than that of the can method. The tomato and onion producers would thus reduce labor cost per hectare by 3,000–4,000 birr and 3,800–4,800 birr, respectively. As a result, the opportunity cost of labor for drip-using households increases.

# Productivity of the drip system

Using the gravity-drip irrigation method, applying 214 $m^3$ and 72 $m^3$ irrigation water to 1 ha during the growing season provided 20 and 27 tons of onion and tomato marketable yields in that order. However, using the can method, the equivalent to total yields of 18.4 tons for onions and 20.5 tons for tomatoes per hectare were obtained by applying the respective amounts of 237 $m^3$ and 96 $m^3$ irrigation water. In addition to the amount of water saved by the drip system, a considerable yield advantage was obtained using the drip system compared with the can irrigation method. The mean yield advantages by using drip irrigation were 6.29 tons for tomatoes and 1.43 tons for onions in a hectare of land (Table 2). The drip method has also shown better water productivity than the can method. Under the on-farm situation, average water productivity of tomatoes was 0.38 kg/L and 0.21 kg/L while that of onions was 0.09 kg/L and 0.08 kg/L for drip and can applications, respectively.

# Benefits

Partial cost and benefit analysis was done by considering only variable costs such as labor and value of water in the locality between drip and can methods. Costs related to fertilizer and seed varieties were uniform for both methods. The results indicated that the benefit obtained from the drip system was much better than the can method (Table 3). Despite the low price of onions (1.50 birr/kg) and tomatoes (1.00 birr/kg) during the harvesting season, the drip marginal rate of return, which was 451.18% for tomatoes and 138.27% for onions, was higher. Users of the drip technology would obtain a return of 4.5 birr and 1.4 birr from tomatoes and onions by investing 1 birr. From the partial budget analysis, one can easily realize that tomatoes can give smallholder farmers a much higher return than onions, in a short period of time, if they apply gravity-drip technology packed with local water storage.

# Lessons learned

Drip irrigation is a very simple technology to use. Often, farmers do not allocate large sizes of plots (e.g., not more than 1,000 $m^2$) for vegetables as the labor costs are higher compared with costs of other field crops. As a result, the labor required for cultivating vegetables on small plots was less and its drip investment cost was affordable to the average farmers. Producing vegetables that demand less labor for cultivation using the drip system pays back quickly. Both its direct benefits and the amount of water and labor saved by using it make the drip technology far preferable to the can method. Therefore, drip irrigation system needs to be considered in household irrigation programs and should be scaled out among smallholder vegetable farmers, along with the development of a market in the supply of drip laterals and technical skill support from experts to facilitate application.

*Table 2. Yield of tomatoes and onions and water-use efficiency for both irrigation systems.*

| Vegetable | Replication | Total yield (tons/ha) | | | Water productivity (kg/L) | |
|---|---|---|---|---|---|---|
| | | Drip | Can | Difference | Drip | Can |
| Tomato | 1 | 23.50 | 17.20 | 6.30 | 0.44 | 0.24 |
| | 2 | 16.05 | 10.31 | 5.74 | 0.21 | 0.09 |
| | 3 | 40.92 | 34.08 | 6.84 | 0.49 | 0.33 |
| **Average** | | **26.82** | **20.53** | **6.29** | **0.38** | **0.21** |
| Onion | 1 | 8.04 | 10.00 | -1.96 | 0.06 | 0.06 |
| | 2 | 35.71 | 29.64 | 6.07 | 0.14 | 0.11 |
| | 3 | 15.89 | 15.71 | 0.18 | 0.07 | 0.06 |
| **Average** | | **19.88** | **18.45** | **1.43** | **0.09** | **0.08** |

*Table 3. Partial budget analysis for drip irrigation technology compared with the can method.*

| Variable | Tomato | | Onion | |
|---|---|---|---|---|
| | Drip | Can | Drip | Can |
| **Labor cost (birr/ha)** | 778.05 | 1,408.72 | 2,446.44 | 3,218.27 |
| **Drip material cost** | 1,860.20 | --- | 1,860.20 | --- |
| **Total cost (birr/ha)** | 2,638.25 | 1,408.72 | 4,306.64 | 3,218.27 |
| **Benefit, yield (birr/ha)** | 26,819.67 | 20,527.33 | 29,821.50 | 27,678.50 |
| **Benefit, water (birr/ha)** | 484.62 | --- | 450.29 | --- |
| **Total benefit (birr/ha)** | 27,304.29 | 20,527.33 | 30,271.79 | 27,678.50 |
| **Net benefit (birr/ha)** | 24,666.04 | 19,118.61 | 25,965.15 | 24,460.23 |
| **Marginal rate of return (%)** | 451.18 | --- | 138.27 | --- |

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## Reference

Desta G., Ashagrie T. 2008. Testing low-cost gravity drip irrigation technology suitable to the current water harvesting structures. In: Selassie, Y.G. (ed.). Proceedings of the 2nd Annual Regional Conference on Completed Natural Resources Management Research Activities, 18-19 September 2007, ARARI, Bahir Dar, Ethiopia.