

Water-saving through gravity based

Favarra system in the hilly region of Uttarakhand

Utkarsh Kumar, Jitendra Kumar, Sher Singh, J K Bisht and Lakshmi Kant

ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand 263 601

Water scarcity in mountain agriculture is increasing due to climate change, rapid urban expansion, deforestation, forest fires and adverse topographical characteristics. The water availability for agriculture during the lean period (March-June) is a serious challenge to the farmers of hills. In this context efficient utilization of stored rain-water during monsoon season and water harvested from spring may play an important role in combating the water scarcity during the lean season. Due to adverse undulating topography, water application to small size terrace field in hills is a challenging task. In the present study, gravity based low cost favarra system was installed at farmers field to evaluate water saving efficiency compared to traditional irrigation system (syphoning) under the Scheduled Caste Sub-Plan (SCSP) programme of ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand. The result showed that water productivity is increased from 33 to 46% by adopting gravity based low cost sprinkler in comparison to traditional syphon system in the hilly region. Therefore, gravity based low cost sprinkler can be used for irrigation on a highly sloping topography.

Keywords: Climate change, Efficiency, Hilly region, Irrigation

MOUNTAIN agriculture is predominantly a rain-fed ecosystem with about 90% of cultivable land in hilly districts of Uttarakhand being rainfed. Adverse topography combined with climate change makes agriculture unsustainable in mountainous region. The average annual rainfall of Uttarakhand is about 1550 mm. The average rainfall of Uttarakhand is much higher than average rainfall of the country as well as from many states, but the distribution of rainfall as well as rainy days are uncertain. Despite having good rainfall, these areas face water scarcity problem during the lean period. Hence, water harvesting structure and gravity based low cost sprinkler (Favarra) is an alternative for reducing water scarcity. Now a day's rainfall is becoming more intense as a result major portion of rainfall goes as a runoff. Major sources of water resources in these

regions are natural springs, small streams which apart from domestic need of the people also provide irrigation for agriculture. Due to climate change and anthropogenic activities, majority of these water resources are drying and mostly have become seasonal in nature from perennial. Furthermore, uneven distribution of rainfall over the year that's leads to moisture stress and crop failures. Water availability is the key component of crop production system. One of the major reasons for decreasing crop yield in the hills may be attributed to impact of climate change and reduced water availability. Water availability is the key component of the crop production system.

Site Description

To mitigate the problem of water shortage in hilly areas, ICAR-VPKAS, Almora implemented step

by step intervention under Scheduled Caste Sub-Plan (SCSP) programme during 2019-2020 in the Darima Village of Nainital district. The Darima village of Nainital district is situated in Kumaon division of Uttarakhand, between the latitudes of 29°28'33.20" N to 29° 26' 44.16" N and longitudes of 79° 37' 9.07" E to 79°39'15.46"E. The total area extent is 806.57 ha out of which 406 ha is under forest. The topography of the area varies between 1793 and 2123 m above mean sea level. The major crops grown in the area include vegetables and fruits viz. potato, vegetable pea, cauliflower, cabbage, pear, peach, apple, apricot, plum, etc. According to census 2011 of India, the total human population of Darima village was 2173, total number of houses was 407 with female population of 49.7% (1079). Total literacy rate of village was 77.2% (1677), in which female

literacy rate was 36.2% (787). The Scheduled Caste Population of village was 38.8%. Summer months i.e., May and June are the hottest with the maximum temperature ranging between 23.5 to 23.7 °C while temperature falls to its lowest during January with minimum temperature ranging between -3.0 to 1.9 °C. The mean annual rainfall based on 118 years record (1901-2018) is 1277 mm. About 80% of the annual rainfall is received during monsoon (June to September) and some rainfall is also received during the winter season (December to March). The average relative humidity is 39.7 to 91.9% and average wind speed is 0.45 to 3.96 m/s.

Interventions

Development of water resources followed by their efficient use was the prime goal. By constructing the low cost polytanks (LCP) the goal of water resource development was achieved while using the integration

of gravity based low cost favarra (GLCF) fulfilled the goal of efficient water use.

Low cost Polytank

To increase the irrigation potential in hills, it is necessary to develop the water resources using LCP (capacity up to 100 m³). The criteria for the design of tanks should be such that it not only reduces the seepage losses but it is cost effective as well. The cement tank for instance is able to check the seepage losses but the cost becomes the limiting factor in the economic exploitation of water resources. The ponds were dugout and lined with plastic sheet which is multi-layered cross laminated, U.V stabilized 250 μ thickness. Approximate life of LCP is around 8 years if proper care is taken for plastic sheet.

Gravity based low cost sprinkler (Favarra)

A gravity based low cost sprinkler

(Favarra) (GLCF) irrigation system is a cheap and effective way to provide irrigation for a smaller sized crop area. It would be especially cost effective if the climate of the area can provide enough rainfall (natural spring in the context of hilly areas) to consistently keep a tank filled using rain or spring water harvesting techniques. The basic system is very simple consisting of an elevated tank (LCP) with a pipe coming out the bottom that feeds water into a basic GLCF system that is all controlled either by on/off valve that controls the rate at which the crop is watered.

Shri Navin Chandra Arya a small farmer from Darima village of Nainital district Uttarakhand used to grow vegetable crops during the monsoon season. He was unable to cultivate off-season vegetable crops due to the lack of water availability during Rabi season. He comes in contact with ICAR-VPKAS, Almora, subsequently got training under SCSP programme and discussed the



Fig. 1. Step by step (1 to 4) for Construction of LCP



Fig. 2. Step by step (1 to 4) process for installation of GLCF

problem of water scarcity in his farm. He was advised to construct a LCP and integrate it with GLCF intervention. Keeping these points in mind, Shri Navin Chandra Arya decided to go for the above said interventions in his field. He followed step by step approach for the construction of LCP as shown in Fig. 1.

After construction of LCP, he also adopted GLCF as per the suggestions given by the scientist of the institute for efficient water use. The step by step process for installation of GLCF is shown in Fig. 2. The Construction of LCP having the dimension of (7m × 4.5m × 1.5 m) with a capacity of

storage volume (47.25 m³) helped in the harvesting rainfall water, while GLCF helped him in using the harvested water more efficiently. For implementing the above intervention, a suitable site was selected at high reaches of crop land keeping in mind the use of gravitational force in the favarra system. The size of LCP was decided based on the area of field to be irrigated and type of the crop to

be cultivated e.g., vegetable pea in this study.

Benefits of GLCF over conventional syphon (CS) system

- Water saving up to 80%
- Useful for undulating area especially mountainous region.
- Optimum moisture availability in the root zone thereby higher crop yield.

Table 1. Description of discharge of different GLCF and syphon system

Type	Volume (l)	Time (Sec)	Discharge (l/sec)
3 Arm sprinkler	11	95	0.115
4 Arm sprinkler	4	30	0.133
Syphon system	7	30	0.233



Fig. 3. a. 3 Arm GLCF,

b. 4 Arm GLCF

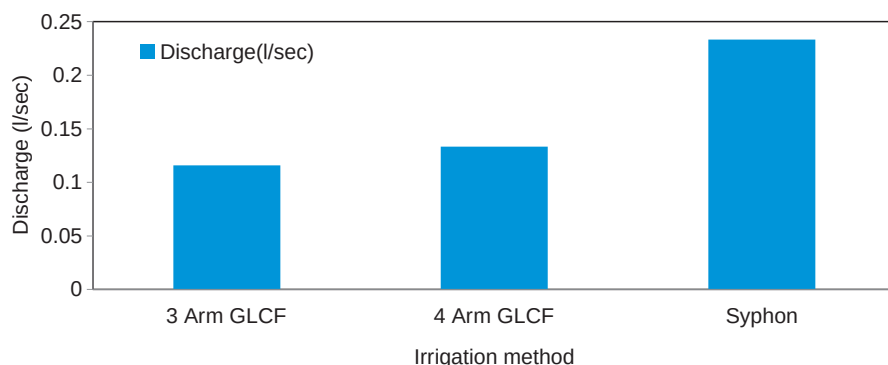
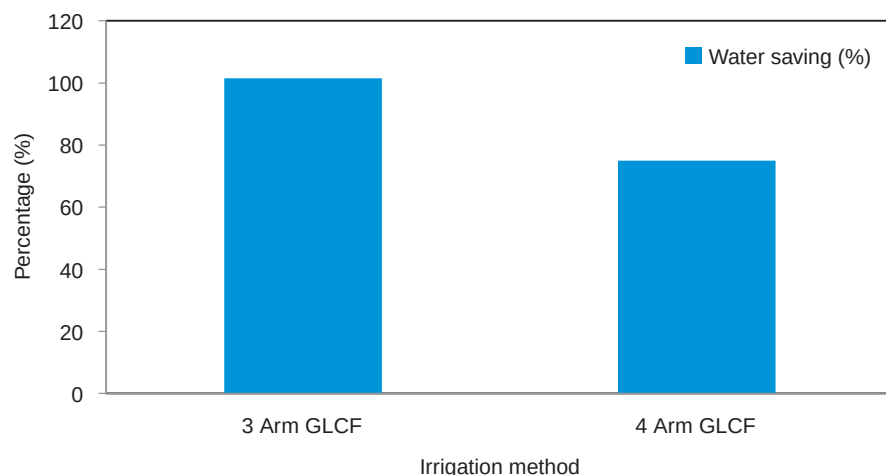


Fig. 4. Discharge rate of different irrigation method.



- Saving of labour charges.
- Reduction in weed intensification.
- Initial investment is very low.
- No requirement of maintenance and technical expertise
- Since, less water is applied, as a result nutrient leaching and soil erosion is reduced.
- Reduces pest problem as there is no waterlogged condition.
- Flexibility in amount of irrigation water applied.

- It applies the water to the plant just like rains thus favouring the plant growth.

Comparison of GLCF (3 arm sprinkler and 4 arm sprinkler) and syphon system

Discharge rate (l/sec)

Discharge of different GLCF (3 arm GLCF and 4 arm GLCF, Fig. 3) and syphon system were calculated using volume time technique for estimating discharge for a head of 35 m (vertical distance between polytank and GLCF was installed). The head was measured by recording the elevation at source (LCP) and the point of discharge (GLCF) using global positioning system. The discharge is measured using volume time approach for all the three systems as shown in Table 1.

The discharge rate of syphon was almost 75% higher than 3 arm sprinkler and 100% higher than 4 arm

sprinkler systems (Figure 5). In addition to this, the area covered by GLCF is more in comparison to syphon system. The infiltration rate of the soil was more than the discharge rate of irrigation system practised by the farmer. Hence by adopting the GLCF system provided by VPKAS, Almora, Now Naveen Chandra Arya has increased the water saving more than 75% but also increased the cultivated area.

Impact

The farmer realised a significant increase in the water saving with the help of gravity based low cost Favarra irrigation system fed from low cost polytank. There was a significant increase in water saving (>75%) by adoption of the intervention suggested by the scientist of ICAR-VPKAS, Almora. This water saving was increased due to balance discharge rate given by the irrigation system equal to the saturated hydraulic conductivity of the soil. Because of this, extra water compared to syphon system was saved and optimum moisture availability in the root zone was maintained. The availability of irrigation water at the critical growth stages of vegetable pea crop (pre-flowering, pod development) is the major factor for yield enhancement. The water productivity was increase from 33% in syphon system to 46% by adopting gravity based low cost favarra system. Through enhanced vegetable farm income Shri Navin Chandra Arya restored his self-confidence and better livelihood. Now he is known as a successful vegetable growing farmer (Fig. 4) in the village and the neighbouring villages are coming to see the GLCF irrigation technology at his field.

This has raised enthusiasm of the farmers of the area and the generally reluctant farmers have come forward to adopt GLCF system on their fields in coverage with ongoing Scheduled Caste Sub-Plan (SCSP) Programme. This successful case has demonstrated the value and usefulness of GLCF technology for judicious use of rainfall harvested water in the undulating topography and importance of convergence of



Fig. 6. Field view of vegetable crop under gravity based low cost favarra system

Research & Development of institution. The above success story of use of technological intervention may be replicated in other hilly areas of the country. We acknowledge ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand, India for providing financial support and necessary technical facilities during the above work under SCSP programme.

Testimonial

Name of Farmer: Mr. Navin

Chandra Arya, Fathers's Name: Shri. Brij Mohan Age: 38 years, Experience: 18 years, Village: Darima, District: Nainital, State: Uttarakhand

किसान के शब्दों में:- “कम लागत वाले GLCF से फायदा ही फायदा है। इससे मेरे खेतों में बढ़िया तरीके से सिंचाई हो पा रही है। पहले मैं खेती के लिए वर्षा के पानी पर ही पूरी तरह से निर्भर था जो अनिश्चित था। मैं उस वर्षा के पानी को कम लागत वाले पॉलीटैंक में संचय कर लेता हूँ। और इसका गर्मी के समय में फसलों की सिंचाई में उपयोग कर अधिक मुनाफा कमा रहा हूँ।

Words of farmer:- “There are many benefits from GLCF. There is efficient irrigation from this system in my field. Before this intervention I was dependent on rainfall, which is uncertain. Now I conserve that rainfall water in the low cost polytank and use this water for irrigation during summer season to get extra income”

Kumar, V., Shanu & Jahangeer Statistical distribution of rainfall in Uttarakhand, India. Appl Water Sci 7, 4765–4776 (2017). <https://doi.org/10.1007/s13201-017-0586-5>



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