Water management for sustainable mountain agriculture

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Agriculture in Uttarakhand state has 10 % irrigated area and rest 90 % is rain fed, which supports 65 % population. Most of the land holdings are small and marginal, fragmented and scattered. Despite of sufficient rainfall water scarcity is major problem due to light shallow soils with very low retaining water capacity and rolling topography that leads to generate 30 to 70 % rainfall as runoff. This leads to massive soil and water erosion. The drying of springs in hills is a serious problem, which will further deepen water availability in future. Also climate change is reality now that may lead to reduction in crop productivity.

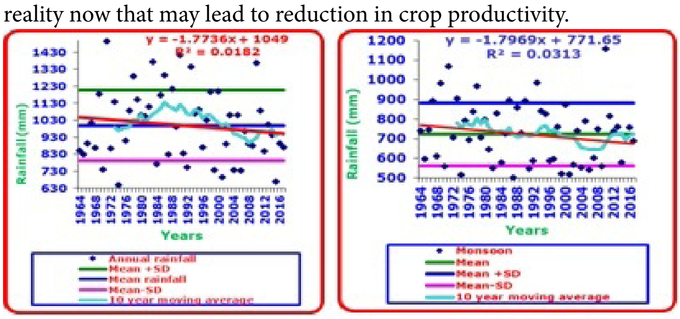
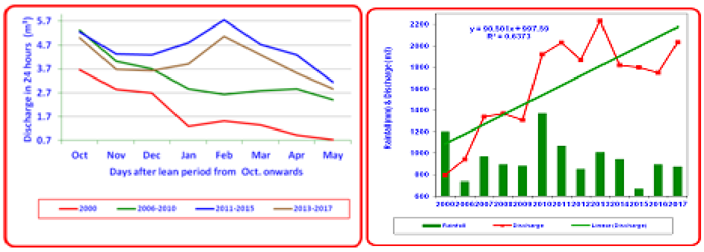


Fig. 1. Annual and monsoon rainfall variation at Hawalbagh (Almora)

An analysis of five decades data of Hawalbagh (ICAR-VPKAS Almora) agro-met eorological observatory revealed decreasing trend in annual and monsoon rainfall, increase in extreme events and increasing trend of maximum temperature during post monsoon and winter season. These changes could be fatal and detrimental to crop productivity. Thus increasing water availability will not only offset climate change affects but also increase productivity, and sustain mountain agriculture.

These alarming water scarcity situation and multiple problems need immediate attention of researchers, policy makers and community to act hand to hand to resolve the problems. Therefore, intensive research programmes were undertaken at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora under AICRP-Irrigation Water Management project to develop, test and refine technologies for recharging of springs, harvest rainfall/ runoff in-situ and ex-situ and appropriate structure for water storage and efficient management of harvested water (Fig.1). The brief account of technologies and management practices develop by ICAR-VPKAS is discussed in this paper.

A drying spring was recharged by harvesting roof water in trenches and planting of *Alnus nepalensis* on trenches banks. These interventions enhanced annual water discharge of 2017 by 156.3 % in comparison to discharge recorded before the interventions (794 m^3) in 2000 (Fig. 2a). The daily discharge increased by 37 to 291% during the lean period of October to May in comparison to discharge that was recorded before the interventions (Fig. 2b).



a b

Fig. 2. Annual rainfall and discharge (a) Before and after the interventions and discharge (b) During lean period

A simple runoff farming model was developed by dividing terrace in two parts. One part made as sunken bed by shifting 30 cm soil to other part to make other part as raised bed. The runoff water of upper catchment harvested 10 times of water in sunken bed. The rice and wheat was grown in sunken bed and pulse, vegetables millets barley were grown on raised beds. It was observed that 30 to 50 % increase in crop productivity. This technique and catches 100 % silt and runoff generated by the upper catchment. This system helps to recharge the soil profile and shallow water aquifers of springs and provide many opportunities for crop diversification (Fig. 3).

Fig. 3. Runoff farming models for small-scale farmers

In the hills mostly cement tanks are constructed on soil surface for storing of water. These tanks are very costly (Rs. 7 to 15 / litter cost of storing of water) and very prone to damage in earth quake and land sliding, and mostly function one to 15 years. In view of this, the poly lined tank technology was developed for storing the over flowing water of a spring/ roof water, runoff water and stream water. The poly lining of tank fully protected by covering poly film with locally made bricks. These tanks are low cost (one litre water storage is only Rs 1.0 /litre), long life (>30 years) and suitable for fish cultivation. The tanks of 20 to more than 500 m^3 water capacity can be made by using 250 GSM multi-layers cross-laminated polyfilms (Fig. 4). The surface runoff water can be harvested by passing through catch pit to avoid siltation in main tank and spring. The harvested water is delivered with gravity fed drip or sprinkler irrigation system. It was advised that the scheduling of the irrigation should be based on the water requirement of vegetable crop and rest surplus water can be diverted towards irrigating *rabi* crops at critical stages. The area of crops under irrigation as well as choice of crops can be increased or decreased as per the availability of water in the tank / discharge of water sources tapped for tank filling. The supplementary irrigation for crops in both the seasons (*kharif* and *rabi*) and vegetables in *kharif* during stress period is most appropriate strategy to optimize profit and production under limited water supply.

Fig. 4. Polylined tank with locally made bricks pitching Repaired cement tank with silpaulin

The multiple water use model thus not only solve water problems but it will also ensure livelihood security of small and marginal farmers and to combat climate change and sustain livelihood of the hill farmers.

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