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Traditional Knowledge of Water Management in Himalayan Region–Innovative Technological Interventions

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Abstract The hydrological problems of hills are different from those of plain areas due to variation in topography, climate, land use, soil type. Majority of soils are loamy in texture and 40% soils have steep slope greater than 15% . Rainfall is erratic and the reliability of receiving the lowest assured weekly rainfall is very low in the later part of monsoon. The critical challenges the mountain agriculturists face include soil crosion, drought and floods, dwindling irrigation resources and lack of risk bearing ability of resource-poor hill people. In this paper attempt is made for implementation of up-take of innovative technological interventions of water management with traditional water management practices by stake-holders and end users for achieving improved water use efficiency and water productivity under bill agro-ecology. The said approach will lead to improve cropping intensity from present 100 to 200% as well as enhancement of agriculture productivity from present average 1.0 t/ha to 4-5 t/ha per annum and restore environment and ecology of the Hill States.

Keywords Traditional knowledge of water management, Hydrological problems of hill states. Innovative technological interventions.

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Introduction

The Indian Himalayan region encompasses the area between $21^0 57'$ to $37^0 5'$ N latitude and $72^0 40'$ to $97^0 25'$ E longitude. The total area is 5.31,250 km^2, spread over 12 states of India, constituting about 16% of the total geographical area of the country. The hydrology in the Himalayan region is undergoing a significant change as a result of climate change. It is reported that from last 50 years there is 19% retreat in glaciated area and 23% in glacier volume (Kulkarni 2007). The melting of the glaciers and ice sheets has two major repercussions : Devastating floods followed by severe water shortages. Flow in snow-fed rivers would increase temporarily in short term cusing flash floods, but would decline in the long term. Estimates predict a reduction in river flow to the tune of 30% of its current level over the next 50 years. Decreased flow in rivers would increase irrigation dependency on groundwater which is already scarce in the Hill States. In many areas rainfall is decreasing and becoming more erratic in amount, frequency and distribution. Hill States are identified as most vulnerable under the climate change regime and farmer communities are already facing numerous challenges to adapt with the uncertainties in the weather pattern exacerbated by the changing regime (Anonymous 2016).

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Materials and Methods

Traditional wisdom of water management of Himalayan farmers

Different Hill States are following age old practice of community managed water conveyance, management and conservation practices. The system generally involves diversion of water from streams, nallahs and springs. However, it is observed that due to climatic variations there is great impact on water regimes available in local streams, nallahs and springs. This phenomenon has impacted traditional water management methods adopted by farmers and resulted in resource degradation as well as high volatility in yield/returns (Singh and Gupta 2002, Gupta and Tiwari 2002). Scenario of traditionally adopted water management methods with down sliding trend of water productivity (WP) within Hill States of Himalayas is presented in Table 1.

Modern techniques of water management

Integration of the traditional methods of water management and modern day water management technologies helps in aligning the technology to local requirements (Nanda and Ambast 2016). Water resources can be sustained, water use efficiency (WUE) can be increased and deficiencies in the traditional water distribution systems can be removed to a greater extent is presented in Table 2.

Results and Discussion

Expansion and up-scaling of rainwater harvesting

Construction of micro water harvesting structures (e.g. small farm ponds, such as *jalkunds*) on individual farmers' fields should be preferred over the community based watershed approach tanks and taken-up

Table 1. Summary of traditional eco-zone-wise water harvesting structure in Himalayan region.

Eco-zone	Traditional water harvesting system	Description	Location
1. Trans-Himalayan region	Zing	Tanks for collecting water from melted ice,for irrigation	Ladakh
	Artificial Glaciers	Arrificial formation of ice stupas ; for irrigation	Ladakh
2. Control-Western and Western Himalayas	Kul/Kuhl/Gubl	Water channels in mountain areas; Headwall across a ravine to divert water from a natural stream for irrigation; guhls are contour channels, for irrigation and operating watermills (*gharats*). Seepage control will improve by lining with different sealents from 1.4 to 36% Practice of UFI is still prevalent WUA at farmer level is not practised Participatory irrigation management (PIM) needs to be legislated.	Jammu (J&K), Himachal Pradesh, Uttar Pradesh
	Chappris	Shallow dug ponds without any masonry work, for livestock and irrigation	Hgimachal Pradesh, Jammu & Kashmir
	Panihars/Nahuns/ Chharedus	Spring/stream water flows through a carved/uncarved stone; used for household/livestock/irrigation	Himachal Pradesh, Jammu & Kashmir
3 Eastern Himalayas	Apatani	Terresed plots connected by inlet and outlet channels; for irrigation and pisciculture	Arunachal Pradesh
4. North-Eastern Hill Ranges	Zabo	Impounding runoff; for irrigation and pisciculture	Nagaland
	Cheo-oziihi	Chananels from rivers for irrigation	Nagaland
	Bamboo drip irrigation	Water form streams in the hills is brought to the plains via bamboo pipes for drip irrigation	Meghalaya

Table 2. Summary of innovative technology interventions on water management in Hill States of Himalayas.

Sl. No.	Name of the technology	Description of technology	Requirement of scalability	Water saving (%)
1	Low cost covering material for protecting LDPE/Silpaulin pond lining in Hills (50 to 250 m^3 capa-city-(Almora)	Liying of Silpaulin sheet (250 GSM/1/7:2/1:14:2, CC to cover sides & bottom of tank	Life of tank 40 years/cost Rs 1/lit	40 years of life
2	Micro-rainwater harvesting structures (Jalkund) suitable for Hilly condition. (Shillong)	Jalkund of 7 m* 6m* 1.25 m would harvest 52 m^2 of water during monsoon	Low cost technique	Used for irrigating irrigating vegetable strawberry
3	Micro-irrigation for high value crops (Strawberry and Cauliflower) under mulched condition-(Shillong)	Drip irrigation at 1.0 PE with black polythene or paddy straw	Khasi-hills strawberry yield achieved was 20.124 kg/ha	Benefit 2.39.1 Water saving 80%
4	Fertigation technology for enhancing the crop and water productivity in vegetable crops crops in Hills- (Palampur) (Vegetable crops like. Cauliflower/ Broccoli/Capsicum)	In venture system, 1/10 part of total water soluble is dissolved in 4 litres of water and applied in 6-8 minutes commercially available water soluble fertilizers 19:19:19, 12:61.0, 17:44.0 etc	Yield increase compared to conventional is 21.3%, 21.4% and 15.1% respectively	40%
5	Evaluation of drip irrigation layout and irrigation effect on Tomato-Jammu	Under open field condition paired row along lateral	The yield increase is 35.9%	80%
6	Modified drip system for small terraces/kitchen gardens of Hills-Almora	2.0 m terrace risers give pressure of 2.90 m head using 16 mm laterals	Costs Rs 825 for 200 m^2 area of vegetables	70 to 80%
7	Alternate wetting and drying irrigation regimes management in basmati-Jammu	Irrigation after 7 cm drop of water level below surface from 7 DAT to 10 days prior to harvest	28.0 q/ha at par with conventional	18.73%
8	Laser leveling for improving yield and saving water inrice-wheat sequence under ir rigated/lift/Sirowal conditions (2.0 lakh ha)-Jammu.	Water use efficiency 10.32 kg/ha-mm as compared to FP 8.37 kg/ha-mm for rice-wheat sequence	Costs 8500/ha for 5 years with additional benefit of Rs 20000/ha	21%
9	Direct seeded basmati rice under sprinkler irrigation-Jammu	Applying sprinkler irrigation with depth of 150% PE on 2 days frequency	Slight yield reduction by 15 to 16%	67.5%

in a mission mode presented in Table 2 (Sidhu et al. 2000, Rawat and Shah 2009).

Efficient water conveyance and distribution system

All water conveyance systems (viz. *kuls/kuhls/guhls*) need to be lined with appropriate sealant materials,such as LDPE sheet, rubber sheet, stone pitching, concrete lining. The average seepage loses will improve from 1.4% to 36% as compared to no lining. Implementation of water users association (WUA), participatory irrigation management (PIM) is essential for achieving equity of water distribution in farmers fields presented in Table 1 (Rawat and Shah 2009).

Use of water conservation techniques

Promoting construction of earthen/rubble barriers (traditionally called *Johads*) across the contour of a slope to arrest/conserve rainwater. Land levelling, field bunding, use of mulches and conservation tillage requires to be up-taken presented in Table 2 (Rawat and Shah 2009).

Effective utilazation of harvested water

Need of the hour is to judiciously follow recommended irrigation schedules. Practice of modern irrigation systems, viz.drip and sprinkler/micro-sprinkler system and fertigation technique presented in Table 2 (Thakur et al. 2007).

Conclusion

India has a rich tradition of water harvesting systems since time immemorial. India also has a basket full of innovative water management technologies. If traditional wisdom of water management is blended with modern technologies, the natural water resources can be sustained and the predicted water crises situation in the country can be addressed.

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