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Low-cost Environment Friendly Interventions Under Rural Technology Complex (RTC): A Precursor of Sustainable Health-Based Management of Rural Resources in the Himalayan Region

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ABSTRACT

A range of technological applications are being developed through various R&D institutions working in Himalayan region that include different kind of natural resources and their utilization potential such as energy (for lighting, cooking, transportation, and agriculture), water (for domestic consumption and cultivation), agriculture (better seeds, practices, and equipment), manufacturing (micro and small scale, agro-based, etc.), sanitation, health, transportation, communication, environmental conservation, and rural employment. For the enhancement of rural resources, RTC

(Rural Technology Complex) of the GBPNIHE is continuously conducting the Capacity building, demonstration and dissemination programs since its inception in 2004. The present study is focused on the outreach and impact of these technological interventions on the rural community across the RTC's interventions in rural areas of IHR (Indian Himalayan Region) and reports the adoption and capacity building of various stakeholders towards the various low-cost, environment friendly, easy-to-use technologies and package of practices being demonstrated through RTC which are helpful in holistic improvement of human beings.

Keywords: Environment friendly rural technologies, natural resources, capacity building, rural stakeholder, nutritional security, RTC (Rural Technology Complex).

Introduction

Intervention of technological procedures can hardly be suggested as a panacea for all social and environmental dependent issues of Indian Himalayan region, although it can help to reduce the prevalence and severity of many developmental problems, be it environmental issues or the social-ecological aspects. Low cost technological intervention can help in improvement of the quality of life, especially for the poor and disadvantaged groups of native population in the region, through permitting more and better managed services, transforming economic activity and reducing inequalities based on factors like geography and natural resources. These appropriate technologies might be something as elementary as a strategically placed hole in the ground to harvest rainwater or it may be a sophisticated satellite-based system for tracking infectious diseases. The technological requirements are basically the solutions that are affordable to the dependent community, sustainable in approach and acceptable to the people who end up using them and can be utilised in the long run.

In the rural landscape of the Himalayan region, livelihoods of the people depend heavily on agriculture, animal husbandry and forestry sectors and they are inextricably connected with each other. The role of forest goods and services in sustaining the productivity of the agriculture and animal husbandry is immense^{1,2,3}. Livelihoods of majority of the poor/marginal and traditional societies are heavily dependent on natural resources particularly in the hilly region.

A range of technological applications are being developed through various R&D institutions working in Himalayan region that include different kind of natural resources and their utilization potential such

as energy (for lighting, cooking, transportation, and agriculture), water (for domestic consumption and cultivation), agriculture (better seeds, practices, and equipment), manufacturing (micro and small scale, agro-based, etc.), sanitation, health, transportation, communication, environmental conservation, and rural employment.

Based on the past experiences^{4-5,6} and others have identified a number of problems (including socio-economic) prevalent in the Himalayan region from time to time; these include (1) weak economic structure and male out-migration leading to women being overburdened, (2) preponderance of rainfed agriculture which depends on traditional Farm Yard Manure (FYM)/absence of irrigation and chemical fertilizers, (3) scattered and small land holdings result in longer working hours for women, (4) predominance of waste land due to undulating topography, (5) growing human and livestock population and ever increasing demand for food, fuel and fodder (3 F needs), etc., (6) less efficient livestock maintained mainly for FYM, (7) lack of advanced technological inputs because of poor transportation and lack of other infrastructural facilities resulting in low crop production, (8) low education level -leading to minimal employment opportunities; agriculture and allied activities being the only practical options (9) deforestation—resulting in soil loss, fertility reduction and increased time needed for collection of fuel, fodder, etc., (10) lack of available water for drinking as well as irrigation along with human-wildlife conflict presents a formidable problem all over the mountains—it consumes at least 2-3 hours per day.

In view of the problems discussed earlier, the G.B. Pant Institute of Himalayan Environment and Development has identified and demonstrated some technology packages^{1,2,3,4, 5,7,8,10} with the active participation of local inhabitants in various watersheds of the Himalayan region and at the technology complex in the premises of its Head Quarters located at Kosi-Katarmal, Almora. These packages are location specific and based on the topography, climate, soil fertility status, crop production, needs and demands of the local people.

Methodology

For the assessment of prioritized technologies by the rural stakeholders, detailed documentation was conducted on the basis of technological packages and capacity building programs conducted at the RTC of the institute. The technological dissemination was started in 2001-02 since the inception of RTC and hill farmer friendly technologies and package of practices were provided to the farmers after the survey, SWOT and need based assessment of natural resources. The farmer selection process which was kept in practice is as follows:-

Before initiating the training program, an in-depth rapid rural appraisal survey was carried out in and around the selected villages to identify the priorities and perceptions of local farmers for the issues impacting their livelihood generation practices. The prime issues which have been identified through this procedure are as follows:-

After the identification of issues the farmers were provided with briefing of low-cost environment friendly technologies demonstrated at RTC of the Institute. Than experiences from various regions/ organizations individual farmers, farmers groups, etc., was shared through interactive learning sessions and the need based technological dissemination was conducted.

Since the demonstration and dissemination activities are being conducted since 2001, the monitoring and feedback from farmers have been received at regular intervals. Timely consultation and particular suggestions regarding the technological interventions and up-scaling of package of practices is continued and inputs were addressed. The stakeholders were also linked with the state and village level schemes for the sustainable continuation of the activities and time to time visits were also being conducted.

Result and Discussion

To overcome the problems related to the livelihood, a number of on-farm and off-farm R&D based natural resource management (NRM) and mountain-specific package of practices are reportedly available. These technologies are not only simple, cost effective and eco-friendly but also helpful in reducing the drudgery of women, out- migration and environmental degradation^{6,7,8}. However, location specific package of practices and their effective implementation for NRM is still a need of the hour in the IHR. In this context, capacity building of rural people, particularly women is urgently required for sustainable utilization of available resources to provide alternatives for livelihoods and employment and help reducing drudgery and out migration^{9,10,11,12}. Therefore, keeping into consideration the complexity of bio-physical set-up and socioeconomic dimensions the process of technology transfer need to be accomplished in systematic steps (i) site selection, (ii) resource survey, (iii) development of an operational framework, (iv) establishment of demonstration, (v) consideration of the specificities of peoples' participation, (vi) capacity building and skill development, (vii) implementation/adoption, (viii) monitoring and evaluation, and (ix) feedback for further up scaling and improvement of the technology. On the basis of these technologies it was also reported¹³ that the rural communities are much inclined towards the adaptation of low-cost environment friendly rural technologies for their income generation

and its enhancement and these packages of practice can be up scaled for the sustainable approach of holistic management of natural resources in the region.

Under the present study thirty promising low-cost environment friendly and farmer friendly technologies were reported which have been disseminated through the RTC of the institute (Table 1). These technologies are as follows:

Table 1- List of prioritized technologies and package of practice being disseminated through RTC since 2004.

<i>SN.</i>	<i>Name of technology</i>	<i>SN.</i>	<i>Name of technology</i>
1.	Protected cultivation (Polyhouse, Polypit, Polytrench etc)	16.	Traditional food items
2.	Bio-composting	17.	Medicinal plants cultivation
3.	Vermi-composting	18.	Silvi-pastoral system
4.	Vermi-Wash	19.	Multipurpose tree plantation
5.	B.D. Heap	20.	Sewing and Knitting
6.	NADEP Compost	21.	Bio-fencing
7.	Green manuring	22.	Traditional Art
8.	Vegetable cultivation	23.	Decorative items from household materials/biomass
9.	Integrated fish farming	24.	Nursery development
10.	Cash crop cultivation	25.	Improvement and Management of waste land
11.	Mushroom cultivation	26.	Water harvesting tank technology
12.	Floriculture	27.	Multiplication technology for bamboo
13.	Apiculture	28.	Zero energy cool chamber
14.	Horticulture	29.	Bio-briquetting
15.	Fruit and vegetable processing	30.	Drip irrigation/Handi (Pitcher) irrigation

Till date total 829 low-cost technological demonstrations have been adopted by farmers in Uttarakhand (Table 2), which have been disseminated by RTC at Kosi-Katarmal, Almora, these technologies have been widely accepted by farmers. Main parameters of success are easy learning and easy-to-do approach, low cost input and high out-put and optimal land use. Total 2490 people have adopted these

technologies and 21033 people have been trained for these technological adoptions (Table 3) at the RTC premises.

Table 2- Technologies disseminated through RTC in Uttarakhand region

<i>Technologies</i>	<i>Number of demonstrations</i>
Protected cultivation	385
Bio-composting	170
Bio-briquetting	135
Vermi-composting	97
Water-harvesting	53
Integrated fish farming	30
Waste-land development	11
Total	881

Improved productivity under protected cultivation systems and cash-crop/ waste land development have been reported while involvement of line agencies and social empowerment through awareness raising, involvement of local institutions and users, encouraging women involvement, user committee formulation and technical backstopping has proven beneficial for long term management. Active promotion of knowledge sharing and encouragement of cross-discussions about ideas and traditional knowledge is being conducted continuously through various intervention packages. These socially validated best practices can make a tremendous difference in people's livelihoods particularly in hill regions. Though there are some situations such as lesser adoption and subsequent failure leads to disbelief in institutional programs and technical intervention. Some stakeholders provided different reasons of failure such as leakage in water tanks, issues of insect infestation in poly-houses, failure of crop due to climatic factors which suggests a thorough monitoring and technical back dropping along with MOU with line agencies for ensuring successful outcome. These issues can be identified and sorted after the proper technical and institutional support.

Similarly the outreach of RTC at regional centres was also recorded after the interaction with co-workers and extensive literature review and following details were obtained which indicate the adoption of low-cost technologies by the stakeholders located near regional centres or disseminated through the centres. The technologies and package of practices are as follows:

Table 3. Year wise capacity building of various stakeholders at RTC and income generated by rural people through adoption of various environment-friendly rural technologies

Year	Title of the programme/workshops/meeting	Venue (RTC/village)	Total participants			Income generated by RTC	Technology adopted (No.)	No of people who adopted (Village name/address)	Income generated from given technology /H.H./Year	Total people visiting RTC annually (Visitors)
			Male	Female	SC/ST					
2001-02	Soil Conservation, Horticulture,	RTC & Field site	838	886	224	1724	05	115000	15000.00-	89
2002-03	Vegetable cultivation, protected cultivation,		1203	938	236	2141	07	247600	3,000000.00	43
2003-04	Integrated fish farming, Mushroom cultivation,		798	758	178	1556	09	194000		19
2004-05	Organic farming,		706	683	136	1389	05	559500		70
2005-06	Cash crop cultivation, Bio-broquetting,		421	1035	205	1456	06	389815		112
2006-07	Multipurpose tree plantation, Nursery development, etc.		570	1010	305	1580	05	1106630		119
2007-08			384	587	194	971	05	677100		71
2008-09			583	506	203	1089	05	377800		71
2009-10			334	594	173	928	04	402070		32
2010-11			491	769	206	1260	05	252085		20
2011-12			155	459	94	614	05	258265		30
2012-13			166	315	81	481	04	533500		44
2013-14			309	432	111	741	05	106410		18
2014-15			259	207	61	466	06	568710		22
2015-16			299	565	134	864	05	410160		13
2016-17			515	481	208	996	13	366800		28
2017-18			362	409	114	771	12	160900		61
2018-19			445	282	132	727	07	150000		32
2019-20			219	227	72	446	11	82000		18
2020-21			141	520	108	461	09	584573		32
2021-22			235	137	40	372	08	275167		48
TOTAL			9433	11600	3215	201033	141	7818085		944

1. Garhwal regional centre (GRC)

- Protected cultivation (Preferably poly-house and shade-net).
- Vermi-composting.
- Bio-composting.
- Bio-prospecting (value edition of wild edibles).
- Medicinal plant cultivation.

2. North-East regional centre (NERC)

- Vermi-composting
- Protected cultivation (Polyfilm/Polymulch technology)
- Poly-house (Green house).
- Shade-net (Orchid cultivation)
- Bio-briquetting (weed species).
- Trellis technology
- Bio-processing and local food product development.

Himachal regional centre (HRC) and Sikkim regional centre (SRC) are in initial phase of development of RTC, through various demonstration technologies such as bio prospecting of wild rose and product development such as rosehip tea and lip balm, along with waste paper based recycling at Himachal regional centre and cultivation and bio-prospecting of wild-edible species, development of eco-trails and medicinal plant cultivation for communities at Sikkim regional centre.

As per the change in long-term needs of stakeholders at present some of the new demonstrations are being implemented and demonstrated at the RTC of the Headquarters for which an updated list is provided (Table 4). These technological packages of practice are beneficial for the rural stakeholders for the livelihood enhancement especially during the pandemic times of COVID-19. During the pandemic times the trained stakeholders particularly women have earned around Rs. 16,000 from the preparation and sale of bio-briquettes and sustained their livelihood. More of the stakeholder analysis is being continuously conducted and will be beneficial for the institute for the long term monitoring. Moreover the produce such as organically cultivated vegetables and fish produced through the IFF has played a significant role in enhancing the nutritional values of the food consumption in the marginalised sections of the hill communities.

Table 4- List of prioritized technologies and package of practice being disseminated through RTC at present

SN.	Name of technology	SN.	Name of technology
1.	Protected cultivation (Polyhouse, Polypit, Polytrench etc.)	9.	Fruit and vegetable processing
2.	Bio-composting , Vermi-composting, Vermi-wash, B.D. Heap, NADEP Compost, Green manuring	10.	Traditional folk art, sewing and knitting
3.	Vegetables and other cash crops cultivation	11.	Decorative items from waste materials
4.	Floriculture, Apiculture, Horticulture	12.	Pine needle (Pirul) based items (file covers, file folders, envelops, carry bags, wedding cards)
5.	Integrated fish farming (Poultry+ Fish+ Kitchen garden)	13.	Bio-briquette preparation using Pirul
6.	Nursery development and wasteland plantation	14.	Experiments for improved farming / technology improvement
7.	Post harvest technology / storage (Zero energy cool chamber)	15.	Soil and water conservation (SWC) using Pine Leaf litter (Pirul)
8.	Drip irrigation/Handi (Pitcher) irrigation		

Importance in Health and Nutritional Enhancement

Most of these technologies are being adopted by the stakeholders for the improvement in nutritional values of existing food crops/vegetable crops and relevant food products, while some of the technologies have been adopted for the food product enhancement and quality improvement. The results have also been reported in the improvement of nutritional health of women and children of the weaker sections particularly those who have adopted protected cultivation (enhancement of food availability and nutritional enhancement), integrated fish farming (benefits accrued in form of chick birds, eggs, fish and vegetables) and backyard poultry farming (benefits accrued in form of chick birds and eggs). A detailed study by Bisht (2011; 2020) had also reported that these activities such as IFF had provided a security of protein rich food for the household consumption, and an average net gain of Rs 36,823 which was obtained annually by the practicing household. Current ongoing studies on these technologies have reported that in an average 40 households have been benefitted of Rs.1, 20,000 from the earning of 19 vegetable crops cultivated under protected cultivation, while the backyard poultry had earned Rs. 6, 95100 to 85 households which is inclusive of bird and egg selling, while the self-consumption of these commodities have not only provided economic benefits but also enhanced the nutritional and health benefits for these households (Negi et al, 2022).

Importance in Livelihood Generation and Holistic Development

The study showed that the interventions conducted for the marginalised and weaker community had been beneficial for their holistic

development as well as for the livelihood enhancement and employment generation for the unemployed and marginal, sub-marginal stakeholders. Moreover these interventions have also helped the communities to understand the positive implications of the low-cost, environment-friendly technologies which not only enhance their living standards but also enrich their platter with nutrient –rich and health-considerate food items. As most of the stakeholders were dependent on the market based commodities consumption, the interventions of these technological packages of practice have enhanced their capability of purchasing while it significantly contributed to the benefits in sector of organic food consumption. It can also be stated that these interventions are highly beneficial in the long run for the community based natural resource management and holistic development of communities in hill regions.

Conclusion

In the present study it was also documented that under the training programs, participation of women stakeholders is higher and similarly certain technologies are being highly adopted by women farmers such as bio-briquetting, backyard poultry farming, protected cultivation and integrated fish farming. The present results also showed that the most prioritized technologies adopted by farmers have benefits in aspect of low cost inclusiveness, higher outcomes and long term sustainability and replication potential for the sustainable utilization and regular livelihood sustenance. Moreover it is ascertained that in the long run these technological interventions will also be beneficial for the food and nutrition security in the region and act as a key towards the nature based solutions for the holistic development of the local communities.

Acknowledgement

The authors are thankful of Dr.(Prof.) Sunil Nautiyal, Director GBPNIHE, Er. Kirit Kumar, former Director In-charge GBPNIHE, Late Dr. Ranbeer Singh Rawal, former Director, GBPNIHE for the work support. The authors are grateful of Dr. D.S. Rawat and Dr. R.C. Sundriyal and Dr. G.C.S. Negi (Former Scientists, GBPNIHE) for providing their valuable suggestions for this work. The authors would also like thank all the stakeholders who had participated in the documentation work and provided their valuable inputs and the regional centre's faculty for their valuable inputs.

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Photo-plate 1- Technical demonstrations and package of practices demonstrated at farmer's field



Protected cultivation in polyhouse



Cash crop cultivation in wasteland



Bio-briquette preparation from dry chir-pine needles



Integrated fish farming (fish and poultry inclusive with water harvesting)



Water harvesting poly tank



Vermi and bio-composting