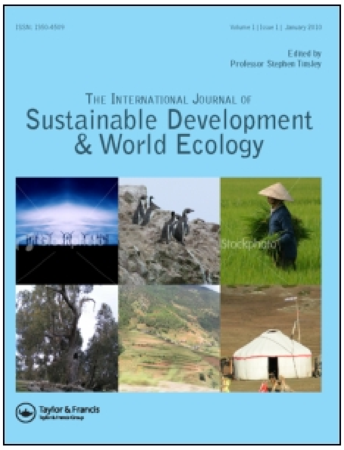

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L. S. Rawat[a]; R. K. Maikhuri[a]; Vikram S. Negi[a]; Abhay Bahuguna[a]; K. S. Rao[b]; Sunil K. Agarwal[c]; K. G. Sexena[d]
[a] GB Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar Garhwal, Uttarakhand, India [b] Center for Interdisciplinary Studies of Mountain and Hill Environment, University of Delhi, Delhi, India [c] Science and Society Division, Department of Science and Technology, New Delhi, India [d] School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India

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Managing natural resources with eco-friendly technologies for sustainable rural development: a case of Garhwal Himalaya

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[a]*GB Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar Garhwal, Uttarakhand, India;* [b]*Center for Interdisciplinary Studies of Mountain and Hill Environment, University of Delhi, Delhi, India;* [c]*Science and Society Division, Department of Science and Technology, New Delhi, India;* [d]*School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India*

Traditional Central Himalaya societies face a range of socio-economic and environmental problems. The potential of science and technology has not yet been adequately and appropriately harnessed to overcome the development constraints posed by the fragile Himalayan environment. Thus there is a need for large-scale establishment of technology resource centers. The Garhwal Unit of GB Pant Institute of Himalayan Environment and Development established rural technology demonstration and training centers in three different agroecological zones between 550 and 2200 m asl and in 13–15 locations, with suitable technologies based on appropriate use and management of locally available bio-resources that ensure people participation. About 35 on-site training courses were organised for about 2329 participants. The participants were given on-site demonstrations, training and technical know-how on various technologies, to enable farmers to better understand problems faced during implementation of new technologies for sustainable management of natural resources. An action research framework and training manuals were also developed in consideration of local socio-economic condition. The documentation and analysis of research (quantitative and qualitative) and data related to cost–benefit analysis of the technologies adopted by farmers generated through this study has created wider sharing of farmer training outputs, at farm level, amongst the scientific communities and with policy planners.

Keywords: sustainable livelihood; capacity building; rural development; technology adoption

Introduction

The Central Himalayan region is well known for its rich and diverse natural bio-resources. However, recently population pressure within the region has been exacerbated by external pressures from the industrial societies in the plains, leading to major changes in the environment and associated rapid depletion of natural resources. A large section of the population of this region depends upon agricultural activities for their livelihood, consisting of crop husbandry, animal husbandry and forest interlinked production systems. Terraced slopes covering 85% of total agricultural land are largely rainfed, while the valleys (15%) are irrigated (Palni et al. 1998; Maikhuri et al. 2001). Agricultural development is poor because of a lack of appropriate technology, proper policies, inaccessibility, varied topography and extreme ecological conditions. In addition, small and scattered landholdings are another common feature of low agricultural production (Maikhuri et al. 1994, 1996, 1997).

All the above factors compel the local poor to migrate and explore better livelihood options in urban and semi-urban centers in the plains (Rawat et al. 1996; Rao et al. 1999; Maikhuri et al. 2005, 2006). Technology change is an important instrument in the continuous process of socio-economic development but, due to poor access to suitable technologies, this is a major factor of poverty and natural resources degradation in Central Himalaya. So, to minimize migration, introduction of promising technologies to the rural economy is urgently required, which would not only provide livelihood and food security locally but also contribute towards minimizing existing pressure on natural resources (Maikhuri et al. 2007a, 2007b).

Of late, development planners and extension workers have realised the importance of promising technologies and emphasized the need for large-scale demonstrations and establishment of technology resource centers in rural and marginal areas of the mountains (Palni 1996; Joshi et al. 1998; Purohit 1988; Rawat et al. 1998; Vyas et al. 1999; Maikhuri et al. 2007a, 2007b). These centers are expected not only to develop location-specific technologies and suitable intervention mechanisms but also play a catalytic role to bridge the information gap between technology developers and the local resource users. Therefore, establishment of rural technology demonstration and training center (RTDTC) could provide viable options for improving the yield of farm produce, income generation from off-farm activities and conservation and efficient management of existing natural resources while developing appropriate technologies for sustainable rural development in Central Himalaya.

The major objectives of the participatory action research were: (a) demonstration of improved/alternative and already available hill-specific technologies in the RTDTC and at other selected field sites; (b) developing a framework and participatory action research approaches

*Corresponding author. Email: rawat_lakhpat@rediffmail.com

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for achieving self-sufficiency within the system in the short and long term; (c) capacity building through training/live demonstrations/field exercise for target groups, and training of trainers (TOT) on a regular basis through the process of learning by doing; (d) cost–benefit analysis of different technologies tested/experimented/demonstrated on smaller scales and (e) guidance and support for field implementation of technology packages and subsequent monitoring, evaluation, follow-up and adoption. The overall goals of these centers are to train and build capacity of local farmers and other user groups and motivate them to adopt promising, low cost, hill-specific rural technologies in participatory mode.

Study area

Uttarakhand, the 27th state of India, came into existence in November 2000, by carving out the hill regions from the state of Uttar Pradesh. It comprises 13 districts, covers 53,483 km^2, or 1.67% of the country's total area, contains 8,479,562 people or 0.83% of the total population of India. It is situated between 28°53′24″–31°27′50″N and 77°34′27″–81°02′22″E, with altitudes from 300 to 7,817 m asl. The region contains diverse vegetation types, ranging from tropical deciduous to temperate, subalpine forest and alpine forest. Forest is one of the most important natural resources in Uttarakhand.

For successful replication of eco-friendly technologies among local farmers and other user groups, field demonstration and training centers were established in three regions with diverse climatic conditions and agro-ecological zones with altitudinal gradients: Maletha village at 560 m asl (district Tehri Garhwal), Triyuginarayan village at 2300 m asl (district Rudraprayag) and Tapovan village at 1900 m asl (district Chamoli). These centers are 10 km, 100 km and 200 km, respectively, from the GB Pant Institute, Srinagar Garhwal. About 13 potential rural technologies were successfully introduced/designed/demonstrated in these locations (Table 1).

Methods

Before initiating the program, an in-depth rapid rural appraisal survey was carried out in eight clusters of villages in the region to identify the priorities and perceptions of local farmers on selected technologies and their interest in receiving sustained training and exposure to the technologies demonstrated at RTDTC. Over the last 8 years (2000–2008), the Garhwal unit has been involved in organising capacity building programs for local farmers and other user groups. A total of 35 training programs were organised at all three demonstration centers for different stakeholders, with 2915 participants trained. The program facilitated regular interactions and discussions among scientists and primary stakeholders. The interaction was continued till the farmers acquired adequate knowledge about the technologies in which they were interested. In addition, contact addresses of both farmers and scientists were obtained for future consultation, in case farmers had problems during implementation of the technologies. There were regular visits of scientists/researchers during field experiments. At the same time, farmers were provided opportunities to make detail observations of scientists in the field, analyse them, and communicate their observations to the scientists through group discussions and presentations. This regular interaction between scientists/researchers and farmers differed from formal training programs generally delivered through lectures to the user groups for transfer of appropriate technologies.

The approach used involved: (i) multi-stakeholder consultations to gather wider perspectives; (ii) analysis of administrative, technical, policy and financial implications and (iii) visioning of the future sustainability. Using this approach, farmers were able to understand how their social and individual behaviors affect their livelihoods. During implementation of the program, training and related material was developed in Hindi and English and even translated into local dialects. Scientists, field/extension workers from local NGOs, officials of government departments and local knowledgeable people were invited to deliver lectures or share their views/ideas on various rural technologies. All selected farmers and user groups worked together with scientists and rural technology experts at the demonstration sites on technologies and experiments related to: (i) yield improvement of vegetables; (ii) bio-composting; (iii) rainwater harvesting; (iv) protected cultivation (application of polyhouse, shade nethouse and polypit) and (v) bioprospecting of wild and agricultural produce. Farmers and user groups were encouraged to generate new ideas, facilitated through on-site demonstrations, participatory and action research, exchange of knowledge, exposure visits, organising farmer-to-farmer training programs, capacity building and organising expert lectures.

Strategic framework for stakeholder training

New issues began to emerge during initial interactions with local communities, which led to redesigning, testing and development of modified approaches to make the program more effective and successful (Figure 1). The level of knowledge, skills, enthusiasm and values of the user groups were considered key in stimulating the learner's interest and satisfaction. The approach initiated and steps followed had well-defined criteria, indicators and purposes, developed by a multi-disciplinary team of experts for rural technology transfer, and was completed in nine steps: (i) appropriate site selection; (ii) resource survey; (iii) development of operational framework; (iv) planning and management; (v) people's participation; (vi) capacity building and skill development; (vii) implementation/adoption; (viii) monitoring and evaluation and (ix) feedback. A set of analytical and critical thinking skills was developed and shared, leading to understanding and sharing socio-economic, cultural and environmental relationships in the context of rural technology transfer. The framework was considered successful by

Table 1. List of rural technologies (grouped into categories) introduced and demonstrated, with their functions and advantages.

Technology	Function	Advantage
	(A) Protected cultivation	
Polyhouse	Polythene sheet (150 gm thick) used in construction prevents entry of ultraviolet light, conserves CO_2, and enhances plant growth and development. Temperature and moisture inside the polyhouse is higher than the outside environment, which enhances photosynthesis and uniform plant growth (Palni 1996; Palni and Rawat 2000).	Enhances production and yield of vegetables, flowers and ornamental plants, and protects crops from frost, cold and diseases. It is very useful in high-altitude areas for vegetable cultivation throughout the year. Particularly useful for farmers with small landholdings in which multi-tier cultivation in trays is possible. The size of the polyhouse depends on need and resources available to the farmer.
Shadenet house	This protects crops from harmful ultraviolet and some infrared radiation. Thus it protects plants from extreme summer temperatures and helps maintain air and soil moisture (Maikhuri et al. 2007b).	Useful for smallholdings, with similar properties to a polyhouse. Better for yields of off-season vegetables and medicinal plants.
Polypit	Used for cultivation of off-season vegetables, trees and other crops. The trench helps in buffering temperature, increasing CO_2 and minimizing water requirements (Palni 1996).	Simple, low cost, practicable and effective for raising and protecting plants from severe winter temperatures. It is equally beneficial to a polyhouse.
	(B) Organic compost and biofertiliser	
Biocomposting	Traditional compost usually takes 8–10 months to fully decompose. Compost is prepared by mixing weeds/dry leaves with cow dung in a pit covered with a polythene sheet over a bamboo frame to check entry of rainwater and reduce heat loss during decomposition. This compost is ready for use in 30–45 days (Palni 1996; Maikhuri et al. 2007b).	Compost contains more nutrients. The decomposing time as well as loss of nutrients is minimized.
Vermicomposting	Biodegradable wastes, i.e. agricultural and vegetable residues, weeds, manure, converted into organic manure with the help of earthworms (*Eisenia foetida*s used at demonstration site) (Maikhuri et al. 2007b).	Provides nutrients necessary for optimum plant growth, replenishes soil fertility quickly by improving physico-chemical and biological properties of less fertile soils and reduces the use of pesticides.
Vermiwash	A liquid biocompost applied to vegetables and horticultural crops. Contains all necessary nutrients for plant growth and development and can also be used as pesticide on leafy vegetables (Maikhuri et al. 2007b).	Increases macro- and microorganisms and essential elements in soil, acts as a pesticide and improves soil fertility.
Azolla culture	Azolla is a nitrogen-fixing aquatic fern found on the surface of flooded rice fields, small ponds and canals. It can fix 3–5 kg N/ha/day, is highly productive, doubling its biomass in every 7 days (Maikhuri et al. 2007b).	Fixes nitrogen, grows rapidly, and ensures quick coverage of areas and suppresses weeds. Accumulates nutrients from water and returns them on decomposition.
	(C) Off-farm technologies	
Mushroom cultivation	Oyster mushroom (*Pleurotu*s sp.) contains protein, can be grown at 10–30°C to an altitude of 2600 m. It is grown on straw (wheat/paddy), first soaked in water at 70–80°C for about 1 h then excess water removed before adding spawn (mushroom spore) (Palni 1996; Maikhuri et al. 2007b).	Good substitute/source income source for landless farmers and the unemployed. Production can be started at little cost. Considered the best food for diabetics and heart patients.
Honeybee rearing	Because of rich flora, the mountains of Uttarakhand are suitable for bee keeping. Most flowering plants require insects for cross-pollination (Maikhuri et al. 2007b).	Honey is used as a medicine; bees are good pollinators and improve agricultural production.
Bioprospecting of wild/semi-domesticated fruit	Wild edible plants are underutilized and could play a significant role in development, poverty alleviation, livelihood and nutritional security using appropriate technological interventions (Maikhuri et al. 1994, 1999, 2007a).	Income generation through value-added products, e.g. juice, jam, pickles, sauces prepared from about 25 wild plant species for household consumption and sale.
	(D) Other supporting technologies	
Biobriquets	An improved traditional practice for conversion of weeds and waste biomass into low cost, energy efficient, nonhazardous fuel (Purohit 2007).	Used in winter for warmth and room heating. It is smokeless and can be prepared very easily. May help in forest conservation.
Zero energy cool chamber	Cost-effective, simple, eco-friendly and easily adoptable technique that works on the principle of evaporative cooling. The chamber can maintain a temperature 10–12°C less than the outside temperature.	No need for electricity. Small farmers can keep agro-products and vegetables fresh for longer. May be used to preserve domestic food, e.g. milk, curd, ghee, water.

(Continued)

Table 1. (Continued).

Technology	Function	Advantage
Water-harvesting tank	Low cost tank to store rainwater, spring or wastewater for irrigation and other purposes. Valuable for areas lacking water for livestock and minor irrigation (Maikhuri et al. 2007b; Sah et al. 2007).	Can retain water for a year in areas lacking water for minor irrigation, and thus saves time and minimizes labor.
SWEET technology	Slopping Watershed Environmental Engineering Technology (SWEET) is cost-effective to rehabilate/restore sloping wasteland in the Himalaya. Uses low-cost bioengineering with people participation to check environmental degradation and provide income (Rao et al. 1999).	Based on traditional knowledge supplemented with scientific innovation to substantially reduce rehabilitation cost, speed up rehabilitation and mobilise local participation.

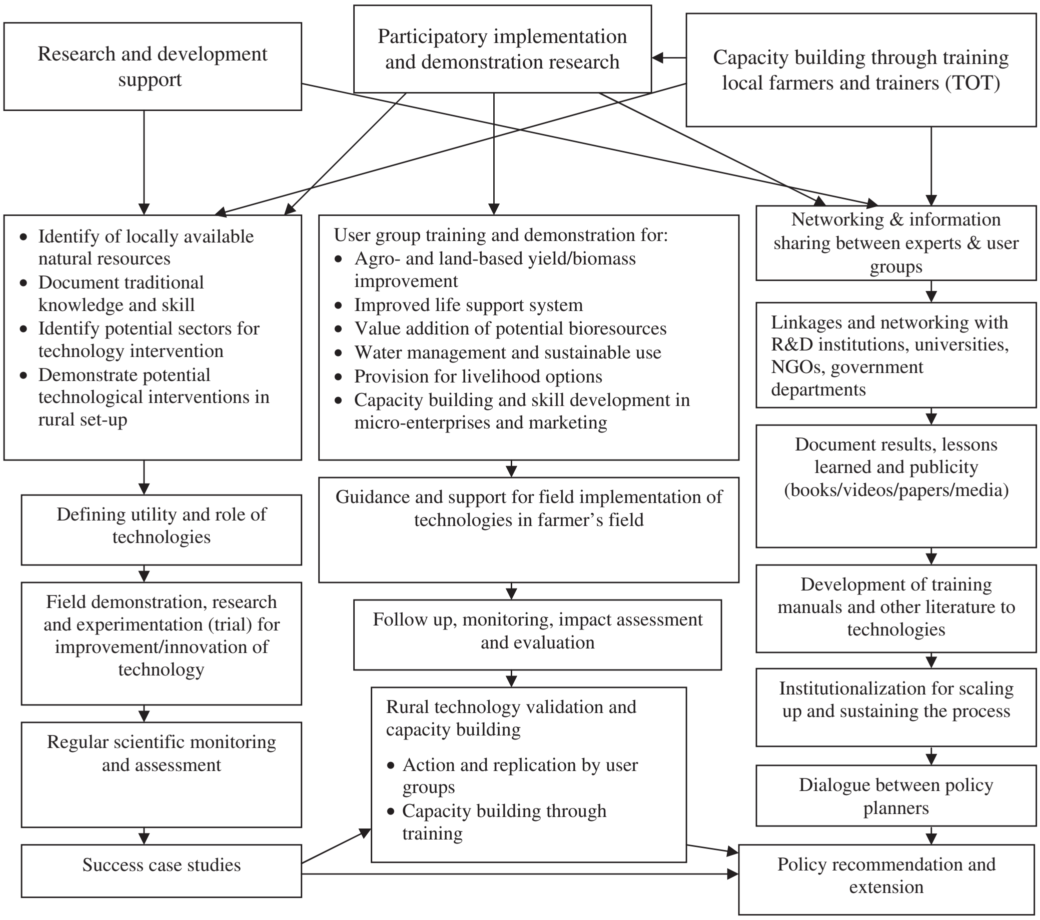

Figure 1. Promoting adoption of rural technologies among user groups through capacity building, participatory research and demonstration.

the stakeholders as it brought ecologically sound, economically viable, socially acceptable and institutionally enforceable outputs.

Cost–benefit analysis

The cost–benefit analysis of each technology demonstrated at rural technology demonstration and training centers was calculated in Rs/day, which includes manpower required for different activities/operations in each technology and materials/items required (e.g. iron bars, UV polythene, saisal, rope, bamboo poles, sand, cement, bricks/stones, honeybee colony and rearing box for swarming, wax comb and queen guards, vegetable seeds, mushroom spores, sugar, preservatives, plastic containers, barbed wire) was calculated based on the prevailing daily wage labor and market rates. The monetary output includes yield of the products and monetary equivalent based on current market rates.

Results and discussion

Community outreach, mobilization and improving access

An understanding of the relationship between existing capacities and human resource development is critical for cost-effective technology transfer to minimize poverty. Enabling access to hill-specific technologies was partly about making more productive, useful technologies available and partly to provide opportunities (institutional, financial, social, micro-credit, skill, etc.) and access to marginalised communities. Building community capacity/skill means not just bringing new technologies to their doorstep, but addressing organizational capacities and opening new channels of information. This is particularly important in the Himalayan Mountains where local communities have very limited access to modern facilities or to secure external help for solving local problems.

It was also confirmed that local people and institutions not only adopt technologies but also strengthen their capacities to further upgrade/renovate/redesign the introduced technologies based on the ecological set up and resource availability. Some new approaches were initiated and developed while integrating on-site experimentation through participatory approaches and facilitating multi-stakeholder capacity building training programs with various stakeholders (Table 2). A total of 35 training programs (each of 2–3 days) were organised in three districts (Tehri, Rudraprayag and Chamoli) between 2001 and 2008. A total of 2915 participants (1086 farmers, 280 extension workers from NGOs and 49 government officials, 1436 students) of various standards from different educational institutions were trained. These programs had wide popularity, created awareness in the region and also tempted and motivated farmers, school children, university students, NGOs and officials of financial institutions, particularly the National Bank for Agriculture and Rural Development (NBARD), Alaknanda Gramin Bank and other interested people, to visit the demonstration sites on their own.

Cost–benefit analysis of each technology

The technology demonstrated and economic activities performed was assessed as per the function and usefulness in terms of creation or development of infrastructure (high cost/low cost) (Table 3). The net monetary return varied depending upon the area treated, materials applied and time spent. Where high-cost materials were used for creation of infrastructure under each intervention (e.g. rehabilitation of degraded land through SWEET technology, construction of polyhouses and shade-net houses) the monetary return was negative in the first year but increased significantly in the following 2 years (Table 3). On the other hand, where low-cost materials were used, monetary return was better from the first year onwards, but after a certain period (5 or 6 years), the structures required repair and maintenance and thus reduced the margin of benefit as compared to high-cost structures. Based on cost–benefit analysis, technologies such as traditional small-scale vermiwash, *Azolla* culture, honeybee rearing as part-time off-farm activities gave a less attractive monetary return compared to technologies such as bio-brequetting, mushroom cultivation, protected cultivation, etc.

Adoption and follow up

Efforts developed over a period of technology transfer were successful in helping farmers to adopt useful eco-friendly technologies. Farmers adopted many of the technologies, with different degrees of success, which enhanced their livelihood significantly (Table 4). Organic compost and biofertilisers were well adopted by farmers (185 households), as was off-farm income generation options (177 households), through which they earned Rs. 5747 and Rs.10,460 per household per year, respectively. Seventy-one families adopted other supporting technologies and 57 took up protected cultivation, earning Rs. 12,048 and 8214 per household per year, respectively. Among the technologies adopted, the net monetary return was higher under protected cultivation, followed by biobrequetting, mushroom cultivation and vermicomposting. Income increased gradually from the second year onwards because, in the first year, net monetary return was low and in some cases negative due to higher costs involved in purchasing materials for creating/developing infrastructure (i.e. polyhouse, shadenet, water harvesting tank, honey bee rearing, SWEET).

Table 2. Capacity-building/skill development and on-site training of stakeholders in eco-friendly hill-specific technologies at three rural demonstration sites.

	Capacity building/Skill development			
Category of participants	Tehri (Maletha)	Rudraprayag (Triyuginarayan)	Chamoli (Tapovan)	Total
Farmers	885 (398)	79 (102)	122 (89)	1086 (589)
NGOs	166 (87)	35 (36)	12 (23)	213 (146)
Students (secondary to PhD)	689 (564)	23 (25)	11 (19)	723 (608)
Students (junior)	456 (486)	201 (156)	56 (149)	713 (791)
Ex-army personnel	47 (89)	7 (15)	9 (16)	63 (120)
Government officials	49 (75)	11 (16)	7 (11)	67 (102)
Academics/policy planners/officials from financial institutions	37 (49)	9 (19)	5 (7)	51 (75)
Total	2329 (1748)	365 (369)	222 (314)	2916 (2431)

Table 3. Cost–benefit analysis (Rs ± SE) of mountain-specific rural technologies used at the training center at Maletha.

Technology	Land area covered/treated or material used	Total monetary input (Rs ± SE)	Total monetary output (Rs ± SE)	Net monetary return (Rs ± SE) Year 1	Year 2	Year 3
(A) Protected cultivation						
(a) Polyhouse	10 m × 5 m × 2.5 m					
• Iron (high cost)		10680 ± 540	4230 ± 120	−6450 ± 170	4720 ± 125	4990 ± 130
• Bamboo (low cost)		3250 ± 85	4230 ± 120	980 ± 25	4720 ± 125	4990 ± 130
• Control (no polyhouse)		360 ± 18	1710 ± 74	1350 ± 55	1350 ± 55	1350 ± 55
(b) Shadenet house	10 m × 5 m × 2.5 m					
• Iron (high cost)		9830 ± 510	4150 ± 215	−5680 ± 325	4610 ± 253	4780 ± 259
• Bamboo (low cost)		3050 ± 124	4150 ± 215	1100 ± 56	4610 ± 253	4780 ± 259
• Control (no nethouse)		360 ± 18	1710 ± 74	1350 ± 55	1350 ± 55	1350 ± 55
(c) Polypit	3 m × 2.5 m ×1 m	1025 ± 54	1810 ± 79	785 ± 35	1980 ± 85	2235 ± 106
(B) Organic composting and biofertilizer						
(a) Biocompost	5 m × 2 m × 1 m	1300 ± 65	1800 ± 78	500 ± 40	1920 ± 81	2133 ± 98
(b) Vermicompost	5 m × 2 m × 1 m					
(i) With pit (high cost)		4550 ± 278	4710 ± 295	160 ± 15	5110 ± 302	5321 ± 310
(ii) Without pit (open condition)		461 ± 25	1340 ± 54	879 ± 45	879 ± 45	879 ± 45
(c) Vermiwash	50 L	1460 ± 68	326 ± 25	−1134 ± 55	452 ± 210	452 ± 210
(d) Azolla culture	10 m × 2 m × 0.1 m	810 ± 45	600 ± 36	−210 ± 22	710 ± 40	710 ± 40
(C) Off-farm income generating technologies						
(a) Oyster mushroom						
(i) With infrastructure (high cost)	120 kg base material	2890 ± 135	6800 ± 312	3910 ± 185	7200 ± 385	7200 ± 385
(ii) Without infrastructure (low cost thatch)		840 ± 52	2845 ± 120	2005 ± 85	2005 ± 85	2005 ± 85
(b) Honeybee rearing						
(i) With improved wooden box	Single box	1500 ± 70	600 ± 38	−900 ± 45	1100 ± 56	1800 ± 85
(ii) Traditional technique		250 ± 20	200 ± 15	−50 ± 5	250 ± 20	250 ± 20
(c) Bioprospecting of wild/semi-domesticated fruit species	Potential plant species	1725 ± 86	3520 ± 124	1795 ± 90	4826(± 265)	4826(± 265)
(D) Other supporting technologies						
(a) Zero energy cool chamber	2 m × 1 m × 1 m	1900 ± 75	2500 ± 112	600 ± 35	2960 ± 120	2960 ± 120
Water harvesting tank (a) Cement structure (high cost)	6 m × 3 m × 1.5 m	9000 ± 450	2350 ± 105	−6650 ± 375	2660 ± 112	2980 ± 122
(b) Temporary polythene lined (low cost)		1750 ± 90	2350 ± 110	600 ± 30	2660 ± 112	2980 ± 122
(c) Biobriquet/bioglobule	1 m × 1 m × 1 m	1820 ± 85	5460 ± 280	3640 ± 180	8645 ± 355	11880 ± 385
(d) SWEET technology##	1 ha	11400 ± 585	1806 ± 70	−9594 ± 455	3655 ± 215	4756 ± 355

Note: ##SWEET – Sloping Watershed Environmental Engineering Technology.

The majority of families (87) adopted six to seven technologies and earned about Rs. 24,404 per family per year, 62 families adopted four to five technologies and earned Rs. 20,615, and 57 families adopted two to the technologies and earned Rs. 7616. More farmers adopted vermicomposting and biocomposting since organic manure is required to sustain agricultural productivity, which is directly linked to their livelihood. Besides, the resources needed for composting are locally available, less costly, with easily maintained structures, whereas some technologies required purchase of resources from distant markets at a much higher cost. The participatory impact assessment,

Table 4. Rural technology adoption (impact assessment) in farming communities and for other stakeholders.

Category of technology	Land treated/covered and plant species used	Adoption (no. of villages)	Adoption (no. of families)	Average income/family/yr (Rs ± SE)
Protected cultivation				
1. Polyhouse (low cost)	10 m × 5 m × 2.5 m	8	41	4256 (± 185)
2. Nethouse (low cost)	10 m × 5 m × 2.5 m	3	16	3958 (± 135)
Organic composting and biofertiliser				
1. Biocomposting	5 m × 2 m × 1 m	13	64	1260 (± 98)
2. Vermicomposting	5 m × 2 m × 1 m	16	84	3645 (± 148)
3. Azolla culture	10 m × 2 m × 0.1 m	9	37	842 (± 82)
Off-farm technologies				
Mushroom cultivation	120 kg base material*	15	78	3856 (± 172)
Honeybee rearing	Single improved wooden box	7	24	1578 (± 123)
Bioprospecting for wild/semi-domesticated fruit	Potential species used	15	75	4826 (± 265)
Other supporting technologies				
Biobriquets	1 m × 1 m × 1 m	11	39	6845 (± 212)
SWEET technology	1 ha	5	7	2630 (± 132)
Water harvesting tank	6 m × 3 m × 1.5 m	8	19	1443 (± 120)
Zero energy cool chamber	3 m × 1.5 m × 1 m	5	6	1130 (± 90)

Notes: US$1 = Rs 46. *80 kg dry wheat straw used as base material for mushroom cultivation.

follow up, monitoring and evaluation of rural technologies showed many of the constraints still faced by the majority of farmers while implementing and developing infrastructure and other activities. The limitations commonly experienced included (i) inadequate methodologies, demonstrations, capacity building and training programs; (ii) inaccessibility of research areas; (iii) lack of facilities and resources; (iv) lack of overall communication and coordination between government, NGOs and farmers; and (v) field testing and trials of rural technologies are not adequate at grassroots level and there is a gap between institutions and farmers, as well as financial limitations. The other important constraints that affect adoption of rural technologies are related to the lack of priority for hills/mountain agriculture in government and state policies. However, constraints are mainly related to external factors, which are especially relevant to action, participatory and development-oriented research. It is necessary to stimulate financial institutions of the state government to provide support through its various departments for training and extension of technical advice to the user groups/rural people, which have improved substantially in recent years. It is hoped that such interventions will reduce the gap between R&D institutions and farmers, on the one hand, and between policy planners, extension workers, NGOs, government departments and the implementers (local people), on the other hand.

Capacity building and outreach programs in appropriate technologies have had a significant impact in this region. They have stimulated state and central government financial institutions to provide support for training and extension of technical advice to user groups/rural people. A few institutions, district level departments and local NGOs have incorporated these technologies into their action plans for wider dissemination and adoption. But due to the absence of adequate dialogue between government agencies, researchers and farmers, including their participation in determining research priorities, there remains a lacuna in most R&D institutions in the region. While government has an important role in promoting support services, mountain farmers cannot be sustained by the government alone, and requires involvement of the private sector in coordination with village institutions. Policies applied to mountain people have long been questioned, as in most cases these policies were forced upon them without their consent. Generally, such policies failed to consider the unique features of mountains and their inhabitants. This requires specific policies to support implementation of appropriate technologies that consider the needs of the people in different agro-climatic zones and available bioresources in these areas. Part of the solution requires increased efficiency, effectiveness, sustainability, as well as political will and commitment of the various government agencies in pursuing rural development and natural resource management policies in a Himalayan Mountain context.

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