Indian Journal of Science and Technology Vol. 3 No. 7 (July 2010) ISSN: 0974- 6846

Demonstration and dissemination of simple eco-friendly technologies for natural resource management in central Himalaya

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Abstract
We present the outcome of innovative action research as capacity building for marginal and smallholder farmers and other stakeholders of Central Himalaya through strengthening social organization and entrepreneurial initiatives. By this, GBPIHED (Garhwal unit) established rural technology demonstration and training and capacity building centre (RTDTC) at three different locations equipped with 13-15 simple and specific technologies. About 41 on site training, capacity building and skill development programme were organized since 2000 in which 3860 participants were trained. The participants were provided on site demonstration, training and technical know-how about various technologies, which enable better understanding of problems faced by the farmers as well as sustainable management of natural resources. Consistent monitoring during and after the programme, feedback from people after adoption of technologies and income earned by each households from individual or grouped of technologies adopted were evaluated and analyzed. The documentation and analysis of action research (quantitative & qualitative) and data related to cost benefit analysis of the technologies adopted by farmers generated through this study has created room for wider sharing of farmer training outputs both at the farm level, and amongst the scientific communities and policy makers. Furthermore, the programme has shown that there is a need to develop and update location specific modifications in technologies has already been introduced /developed so as to maximize the sustainable use of local natural resources and reduce the cost use of external inputs.

Keywords: Himalaya, sustainable management, rural development, farmers, natural resources, India, economy

Introduction
The central Himalayan Mountains (CHM) is well known for its rich and diverse natural bioresources. However, during recent past due to increased population pressure from within the mountain region, largely exacerbated by external pressures from the industrial societies from the plains, has contributed to major changes in the environment and the associated rapid depletion of natural resources. All these factors force rural poor and marginal communities of this region to migrate and explore better options of livelihood earning in the urban and semi-urban centres located in the plains (Rao *et al.,* 1999; Rawat *et al.,* 1996; Maikhuri *et al.,* 2005). Technology change is considered an important instrument in the continuous process of socio-economic development but due to poor access to suitable technologies is one of the main causes of poverty, drudgery and natural resources degradation in the central Himalaya. So, to minimize the existing rate of migration, introduction of promising technologies in most of the sectors of 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,b).

Of late, development planners and extension workers have realized the importance of promising technologies, and therefore, strongly emphasized the need for a large scale demonstrations and establishment of technology resource centres 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.,* 2007 a, b). These centres 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 Centre (RTDTC) in rural setup has been perceived an action that could provide viable options for improving the yield potential of farm produce, income generation from off-farm activities as well as conservation and efficient management of existing natural resources through implementation of appropriate technologies for sustainable rural development in central Himalaya.

The major objectives of the participatory action research include: a). Demonstrations of improved/alternative and already available hill specific technologies in the RTDTC and at selected field sites. b).

Development of a framework and participatory action research approaches for achieving self-sufficiency within the system in the short and long term basis c). Capacity building through training/live demonstrations/field exercise of 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 scale, and e). Guidance and support for field implementation of technology packages and subsequent monitoring, evaluation, follow-up and adoption. The overall goals of these participatory action research centres are to train and build capacities of local farmers and other user groups and to make them adopt some of the promising, low cost, hill specific rural technologies in participatory mode. It was done with the hope that the improved capacities of local farmers help widespread adoption of rural technologies and thus expand the existing limited livelihood earning opportunities in remote and far flung isolated areas of this part of Himalayan region.

Methodologies

Before initiating the programme (Table 1), an in-depth rapid rural appraisal survey was carried out in few selected cluster of villages of the region in order to identify and select progressive farmers interested to receive sustained training and exposure at demonstration sites. Participants were selected in consultation with village leaders/elders those having some elementary knowledge and interest in learning new technologies. In addition, village councils preferred to select participants belonging to economically weaker sections of the society to be provided training. Participatory learning and sharing of knowledge was the process adopted during the present field based capacity building programme. A total of 42 training programmes (30 training programme each of 3 days & 12 training programme each of 2 days) were organized at demonstration sites for different stakeholders including farmers, students, NGOs and officials of government line departments for capacity building and skill development. Effective monitoring and evaluation mechanism was developed to measure the successes of the programme. The extent of skill development of each technology and resources availability formed the basis for the maintaining and technology transfer, replication/adoption strategies.

The cost-benefit analysis of each technology demonstrated at the sites was worked out and was mainly depends on the nature of intervention, materials/items required for infrastructure development, land area treated/covered and other monetary inputs, yield of the products (agro & others) and their monetary equivalent. The major monetary inputs for the technologies tested/demonstrated mainly includes materials/items such as iron rod, UV polythene, naisal, rope, bamboo poles, sand, cement, brick/stone, honeybee colony and rearing box and kits (i.e. swarming bag, wax comb, queen guards), vegetable seeds, mushroom spores, sugar, preservative, plastic containers, barbed wire, etc. The monetary output includes yield of the produce/products and their monetary equivalent based on the current market rates. The manpower required for different activities/operations under each technology was calculated based on the prevailing daily wage labour rates (Table 2).

Results and discussion

The research framework of stakeholders training programme

Though capacity building and training programme was initiated mainly to provide technical inputs to local farmers and local institutions in rural technologies, a number of new issues began emerging during initial interactions with local communities. This led to redesigning, testing and development of modified approaches for making the programme more effective and successful (Fig. 1). Thus it had been learned that constructing any R & D framework, it was useful to consider how different sets of local socio-economic and ecological issues interdependent and inter-related with each other (Maikhuri *et al.,* 2005). It was realized that inter-disciplinary team (one involving both practioners & researchers) need to be constituted to employ different methodologies and approaches simultaneously in order to address the complex issues related to technology completion (Palni, 1996). It was observed that each trained member of an inter-disciplinary team strengthen the developing approaches by integrating the sheer diversity of perspectives and experiences into the framework that is to be implemented. In order to achieve effective implementation of eco-friendly and hill specific technologies it is essential to ensure that partners and stakeholders acquire and constantly improve their capacities and provide relevant practical skills (Rawat *et al.,* 1996; Joshi *et al.,* 1998). Training needs to be "put into practice" in the context of different target audience. Thus approaches that make training process more flexible, adaptive, responsive and applicable were considered important.

The integrated framework developed taking into account the experiences and expertise of different disciplines was able to provide the most effective way of understanding the issues and solving the problems related to rural technology adoption. Transfer of technology (TOT) requires high levels of planning, management and evaluation skills to ensure clarity of purpose, focused partnerships and assessment of effective progress. The level of knowledge, skills, enthusiasm and values of the user groups were considered key factors in stimulating the learner's interest and appreciation of implementation of rural technologies. In addition, it was considered that a number of other factors including policy and regulatory environment, nature of resource base, local capacities, external support, and prevailing natural resources management

Indian Journal of Science and Technology Vol. 3 No. 7 (July 2010) ISSN: 0974- 6846

Table 1. List of simple hill specific technologies (grouped under different categories) introduced & demonstrated in demonstration centre at different locations

Technologies	Functions	Advantage
(A) Protected cultivation		
Polyhouse	The polythene sheet (150gsm thick) used in the construction of a polyhouse prevents the entry of the ultraviolet rays and conserves green house gases, enhance the efficiency of plant growth and development. The temperature and moisture inside the polyhouse is greater as compared to outside environment, which enhances the rate of photosynthesis and helps in better and uniform growth of plants (Palni, 1996; Palni & Rawat, 2000).	It is used for enhancing the production of quality vegetables, flowers and ornamental plants etc. and also provides protection to crops from severe effect of frost and cold and diseases. It is very useful in high altitude areas for vegetables cultivation round the year. The per unit area productions can also be enhanced. It is particularly useful for farmers having small landholding in which multi-tiered cultivation in trays with the help of racks is possible. The size of polyhouse depends upon the need and resources available with farmers.
Shadenet house	A nethouse that protects the crops grown inside from harmful ultraviolet rays as well as from 60% infrared radiation. Thus a nethouse saves the plants from extreme summer temperature and help in maintaining required air and soil moisture (Maikhuri *et al.,* 2007a).	It is useful for the farmers with small holding and can be used effectively like polyhouse. Off seasonal vegetables cultivation and nursery raising of medicinal plants provide better yield under net house.
Polypit	Polypit technique is used for cultivation of off- season vegetables, tree and growing other crops. It is equally beneficial as polyhouse. The polypit trench helps in the buffering of temperature inside resulting into increased CO_2 fertilization effect, and also minimizes the water requirement (Palni, 1996).	It is a simple, low cost, practicable and effective technique for raising and protecting plant materials from severe winter temperature. It is equally beneficial as polyhouse.
(B) Organic compost & biofertilizer		
Bio composting	The compost prepared through traditional methods usually takes 8-10 months to fully decompose. However, compost prepared through improved techniques in which weeds/dry leaves, mixed with cow dung and is placed kept inside the pit. Pit is covered with polytheen sheet over a bamboo frame to chek the entry of rain water and heat loss during the process of decomposition. Through this method compost gets ready for use between 30-45 day depending upon the materials used (Palni, 1996; Maikhuri *et al.*, 2007a).	The compost prepared through this technique is richer in nutrients as compared to the compost prepared traditionally. Through this technique, the decomposing time as well as loss of nutrients can be minimized considerably.
Vermi composting	Vermicompost is a simple technique in which biodegradable waste i.e. agricultural and vegetable residues, weeds, excreta of animals etc are converted into organic manure with the help of earthworms. In this process the earthworms (*Eisenia foetida* species used at demonstration sites) are bred in a mixture of cow dung, soil and agricultural residues (Maikhuri *et al.*, 2007a).	Vermicompost provides the necessary ingredient for optimum growth of cultivated plants. Continuous use of vermicompost replenishes soil fertility quickly by improving physico-chemical and biological properties of the less fertile soils. Its application also reduces the use of pesticides.
Vermiwash	Vermiwash is a liquiform biocompost, applied on vegetables and horticultural crops through sprinkling. The compost consists of necessary ingredient useful for plant growth and development including nitrogen, potassium, and phosphorus. Thus it is an excellent source of nutrients for plant growth and could also be used as pesticide in leafy vegetables (Maikhuri *et al.,* 2007a).	It helps in enhancing the number of macro-micro organisms and essential elements in soil for plant growth and development. It acts as pesticides and also improves soil fertility.
Azolla culture	Azolla is an aquatic fern that floats on water surface of flooded rice fields, small ponds and canals. By the process of nitrogen fixation the blue green alga is capable of full filling the nitrogen requirement of the association and it can fix about 3-5 kg N/ha/day. The plant is highly productive with the ability proliferate rapidly doubling its biomass in every 7 days (Maikhuri *et al.*, 2007a)	It fixes nitrogen, grows rapidly, and ensures quick coverage of the areas and suppresses weed growth. Azolla can accumulate nutrients from water and provide these after decomposition.

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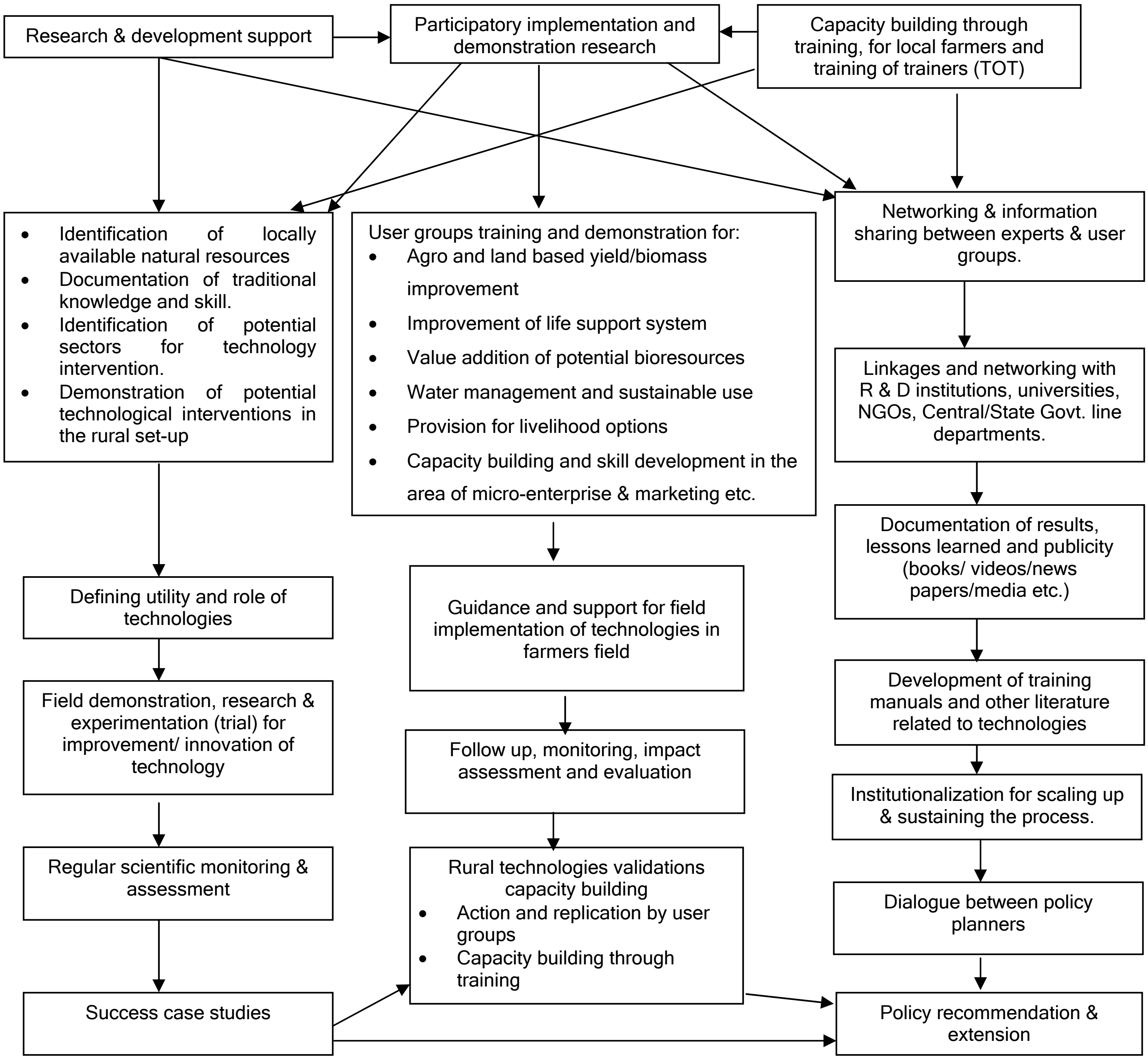
(C) Off-farm technologies		
Mushroom cultivation	Oyster mushroom (*Pleurotus* sp, locally known as dhingari) offers a protein rich diet, which can be grown with in a temperature range of 10-30°C up to an altitude of 2600 m. Its cultivation requires straw (wheat/paddy), soaked in the water at 70-80°C temperature for about one hour and kept aside so as to remove excess water. Thus the straw gets ready for spawn (mushroom spore) cultivation (Palni, 1996; Maikhuri *et al.*, 2007a).	It is a good substitute /source of employment for landless farmers and unemployed people. Its production can be started in a room at low cost. It is considered as the best food for diabetic and heart patients.
Honeybee rearing	Because of diversity of rich flora, the hills and mountains of Uttarakhand are suitable for bee rearing. Majority of the flowering plants require honeybees for cross-pollination for higher quality yields (Maikhuri *et al.*, 2007a).	Honey is used as a medicine and bees are known to be a good pollinator and improve the agricultural production.
Bioprospecting of wild/wemi-domesticated Fruits	Wild edible bioresources are being viewed as untapped or underutilized resources that could play a significant role in hill area development, poverty alleviation, livelihood and nutritional security of local communities through appropriate technological interventions and local value addition (Maikhuri *et al.*, 1994, 1999; 2007b; Dhyani *et al.,,* 2007).	Farmers have adopted this as small household activity for income generation. The various local value added products i.e. squash, juice, jam, pickle, sauce etc. are being prepared from about 25 wild plant species by the people for their household consumption and also for marketing.
(D) Other supporting technologies		
Biobrequetting	Biobrequetting is an improved traditional practice for conversion of weeds and waste biomass for making low cost, energy efficient, non hazardous fuel (Purohit, 2007).	Biobriquette is utilized in winter for warming and room heating. It can be used in room since it is smokeless and can be prepared very easily. Its application may also help in forest conservation.
Zero energy cool chamber	It is cost-effective, simple, eco-friendly and easily adoptable technique which works on the principle of evaporative cooling, i.e. cooling effect due to evaporation of water. The chamber can maintain the temperature 10-120°C less than the outside temperature and conserve about 90% relative humidity.	There is no need of electricity for its operation. In this chamber, small farmers can keep their agro-products and vegetables for longer duration in fresh and preserved condition. This structure may be utilized to preserve the domestic food item like milk, curd, ghee, water etc except cooked food.
Water harvesting tank	Low cost water harvesting tank store rain water/unused spring or waste water for irrigation and other purpose during lean period. This technique is of great value for areas having paucity of water for livestock and minor irrigation needs (Maikhuri *et al.*, 2007a).	The water harvesting tank technology is easy and cost- effective. It can retain water for a year in water deficient areas for minor irrigation and thus helps save the time and minimize drudgery.
Sweet technology	Slopping Watershed Environmental Engineering Technology (SWEET) is a cost-effecting mostly designed to rehabilate/restore sloping waste lands belongs to village community and private owner in the Himalaya. It involves use of lowcost bioengineering measures with active people's participation to check the environmental degradation and provide opportunity for income generation (Rao *et al.*, 1999).	Capitalizing upon the positive aspect of traditional knowledge and supplementing it with appropriate scientific innovation, could substantially reduce rehabilitation cost, speed up the rehabilitation process and mobilize local participation so crucial in inaccessible Himalayan region.

practices that significantly influence the effectiveness of the integrated framework during field implementation. The approach initiated had well defined criteria, indicators, and purposes that were developed by a multi-disciplinary team of scientists and experts involved in this rural technology transfer programme. The framework developed was successfully adopted/implemented by farmers in several villages in the region that has generated ecologically sound, economically viable, socially acceptable, and institutionally enforceable outputs.

Community outreach, mobilization and improving access

An understanding of the relationship between existing capacities and human resource development was

Fig. 1. Participatory action research and framework for appropriate rural technologies demonstration, dissemination, capacity building, education and communication



considered critical for making cost-effective technology transfers that help minimize poverty. Enabling access to hill specific technologies was partly about making more productive, useful technologies available and partly providing opportunities (institutional, financial, social, micro-credit, skill etc.) that support access to marginalized communities to these technologies. Building community's capacity/skill to make these choices means not just bringing new rural technologies to their doorstep, but addressing their organizational capacities and opening new channels of information and knowledge. 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 the local problems. It has also verified that local people and institutions not only adapt and adopt technologies but also strengthen their capacities to further upgrade/renovate/redesign introduced technologies based on the ecological set up and resource availability. Some new approaches were initiated and developed by GBPIHED, Garhwal unit while integrating on-site

Indian Journal of Science and Technology Vol. 3 No. 7 (July 2010) ISSN: 0974- 6846

Table 2. Capacity building/skill development & onsite training & exposure visit of different stakeholders (user groups) in the field of eco-friendly, hill specific rural technologies at three rural technology demonstration sites. Values in parenthesis for exposure visit.

Category of Participants	Tehri district (Maletha)	Rudraprayag district (Triyuginarayan)	Chamoli district (Tapovan)	Total
Farmers	923(423)	259(255)	133(102)	1315(780)
NGOs	184(97)	52(47)	19(32)	255(176)
Students (From Secondary to Ph.D)	787(627)	144(41)	23(28)	954(696)
Students (Junior level)	598(539)	389(254)	74(207)	1061(1000)
Ex- Army personnel	64(94)	19(22)	13(24)	96(140)
Official of Govt. line depts.	69(88)	23(26)	13(19)	105(133)
Academicians/policy planners/ and officials from financial institutions	49(53)	16(24)	9(12)	74(89)
Total	2674(1921)	902(669)	284(424)	3860(3014)

experimentation through participatory approaches and facilitating multi-stakeholders concerted efforts in organizing capacity building training programme in which various stakeholders were involved (Table 3). A total of 42 training programmes (each of 2-3 days) on rural technologies were organized in three districts of the Uttarakhand (i.e., Tehri, Rudraprayag & Chamoli) between 2001 to 2009. Through these training programmes a total of 3060 participants (1315 farmers, 255 extension workers from NGOs and 105 Officials of the government, 2015 students of various standard belonging to different educational institutions. Among the three training centres, Maletha in Tehri district received maximum participants (2674) as compared to two other centers. The participatory action research and demonstration centres on rural technologies developed wide popularity and created awareness among the masses of the region. It has oriented and motivated school children, university students, farmers, NGOs and officials of the financial institutions particularly national bank for agriculture and rural development (NBARD), Among others, Alaknanda Gramin bank performed short exposure visit to the demonstration sites through their own support (Fig.2). About 3014 participants benefitted with maximum number belongs to student category followed by farmers, NGOs, etc. (Table 2).

Monitoring and evaluation mechanism

Effective monitoring and evaluation mechanism was developed which was diverse and flexible enough to adopt at any geographical and climatic conditions using similar vocabularies, related to professions/economies etc. The extent of implementation, research outputs and validation, extent of adoption, usefulness of technology, cost-benefit analysis and resource availability formed the basis for the monitoring and evaluation of technology transfer, replication/adoption strategies. Over a period of

Table 3. Rural technology adoption (impact assessment) by farming communities & other stakeholders

Technologies	Size of land treated/covered & plant species used	Adoption (no. of villages)	Adoptions (no. of families)	Average income/ family/yr (Rs±SE)
Protected cultivation				
Polyhouse (low-cost)	10mx5mx2.5m	13	105	6223(±285)
Nethouse(low-cost)	10mx5mx2.5m	3	16	3958(±135)
Organic composting and biofertilizer				
Biocomposting	5mx2mx1m	13	64	1260(±98)
Vermicomposting	5mx2mx1m	16	100	3645(±148)
Azolla culture	10mx2mx.1m	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 of Wild/ Semi-Domesticated Fruit species	Five** potential plant species used	15	75	4826(±265)
Other supporting technologies				
Biobrequetting	1m x 1m x1m	11	39	6845(±212)
Sweet technology	1 ha	5	7	2630(±132)
Water harvesting tank	6m x 3m x1.5m	8	19	1443(±120)
Zero energy cool chamber	3m x 1.5m x 1m	5	6	1130(±90)

*One US $ = Rs. 46; * Wheat straw of about 80 kg was used as raw (base material) (on dry wt. basis) for mushroom cultivation; **Spondias pinnata, Hippophae rhamnoides, Aegel marmelos, Ficus ariculata & Rododendron arboretum* time while imparting continuous training, it was observed that the experts themselves sharpen their interactive skills and was able to convert a field problem into learning opportunity. Thus, it was a two way learning process, where experts (trainers) and local farmers and other user groups (trainees) helped improve their respective capacities. A number of trained farmers and user groups became master trainers who subsequently took the responsibility for wider dissemination of rural technologies (Maikhuri *et al.,* 2005). The capacity building programme essentially seeks to empower farmers so that they themselves are able to move forward from a marginal to a stronger socio-economic position. The skills developed during training helped local farmers self-confident and capable of addressing to the problems they encounter. Experts and trainers facilitated farmers to carry out these activities in their rural setup. The way farmers were trained at demonstration sites is thus radically different from the formal training programmes in which generally experts deliver lectures to the trainees/beneficiaries or the extension workers to transfer rural technologies in a conventional way. As evident, a top-down approach in the past of pushing new technologies for sustainable rural development without transfer of adequate knowledge and building capacities to local communities mostly failed to achieve the desired objectives. Therefore, formal institutions have to ensure effective people's participation applying bottom up approaches during any intervention (Maikhuri *et al.,* 2005). The present approach was participatory since the beginning and therefore remained a continuous process of learning for both trainers and trainees. They jointly tried developing appropriate technologies for sustainable development by bringing in diverse livelihood earning options and at the same time ensuring conservation of surrounding natural resources.

Adoption and follow up

The above approach was considered successful in effectively helping farmers to adopt more productive and useful eco-friendly technologies. As a direct result of these efforts, there are now numbers of farmers have adopted many of these technologies with different degrees of success which enhanced their livelihood significantly (Table 4). The organic compost and biofertilizers was adopted by farmers to the large extent (201 families) followed by off farm income generating options (177 families) through which they earned on an average of Rs. 5747 and Rs.10,460/family/year respectively. About 119 families adopted protected cultivation followed by supporting technologies (71 families) and earned on an average of Rs. 8214 to 12048/family/year respectively. Among the technologies adopted by farmers, the net monetary return was obtained higher under protected cultivation; followed by bio-brequetting, mushroom cultivation, vermicomposting etc. However it was observed that the income increased gradually after 2nd year onwards because during first year net monetary return obtained was low and even in some cases it was estimated in negative due to higher cost involved in purchasing the materials for creating/developing infrastructure (i.e., polyhouse, shadenet, water harvesting tank, honey bee rearing, sweet technology etc.).

It was also found that majority of the families (87 families) adopted 6 to 7 technologies and earned about Rs.24,404/family/year, 62 families adopted 4 to 5 technologies and earned a total of Rs.20, 615 and 57 families adopted 2 to 3 technologies from which they earned an average of Rs.7616/family/yr. The number of farmers adopted vermicomposting and bio-composting is higher since organic manure required for sustaining agricultural productivity is directly linked to the livelihood of the people. Besides, the resources needed for composting is locally available, less costly and easy to maintain the structures required for it: whereas, in case of other technologies resources are to be purchased from distant market places at a higher cost. The participatory impact assessment, follow up, monitoring and evaluation of rural technologies showed many of the constraints still faced by the majority of the marginal farmers while implementing and developing the infrastructure etc. The limitations commonly experienced by users/farmers include (i). Inadequate methodologies, demonstrations, capacity building and training programme (ii). Inaccessibility of research areas (iii). Lack of facilities and resources (IV). There is a lack of overall communication and coordination between government programme, NGOs and farmers (v). Field testing and trial of rural technologies are not enough at grass root level and there is a gap between institutions and farmers, financial limitations etc. The other constraints which is considered important that affect adoption of rural technologies is that hills/mountain agriculture has not been given any priority in the agriculture policies of Govt. at state and central level. However, a number of constraints are mainly related to external factors, which is especially relevant to action, participatory and development oriented research. It was reflected through the number of training programmes organized, participants trained, exposure visit of the individual and group of people and the level and magnitude of adoption in the initial stages of the programme. It has stimulated financial institutions of the state government (national bank for agriculture and rural development) to provide support through its various line departments for training and extension of technical advice to the user groups/rural people and has improved substantially during recent past. It is hoped that such interventions will lead to reduce the gap between R & D institutions from farmers on the one hand and between the policy planners, extension workers, NGOs, GOs and the implementers (local people) on the other hand.

Indian Journal of Science and Technology Vol. 3 No. 7 (July 2010) ISSN: 0974- 6846

Fig. 2. a& b: On site demonstration on protected cultivation & adoption by farmers c: Demonstration on water harvesting tank technology; d: Demonstration & training on vermicompost; e: Training on honeybee rearing; f: People participation on land rehabilitation programme; g: Value addition of Spondia pinnatta & its product; h: Capacity building of women farmers on mushroom cultivation; i: Demonstration & training centre at Triyuginarayan; j: Demonstration and training center at Maletha

Conclusions and suggestions

These simple rural technologies were introduced, redesigned and developed with the goal of bringing change over a period of time, leading to socio-economic improvement, generation of employment opportunities and promotion of sustainable use of bioresources. In order to ensure this, one must think about appropriate and effective mechanism with system approach in development and transfer of appropriate and eco-friendly technologies as per user needs in the Central Himalaya. Training programme need to be developed for specific target audience, in ways that reach beyond awareness rising. Thus, various approaches such as inquiry based, practice based, community based, need based, critical and collaborative approaches to be tested and applied. In this endeavour, institutional linkages and active participation amongst voluntary agencies/science and technology based field research groups, research and development institutions, financial agencies and above all people who are the primary stakeholders become crucial for improving the quality of life in remote and rural areas to achieve short and long term sustainability. Therefore, the technologies demonstrated/introduced, tested implemented/adopted and described here can play crucial role in building up local capacity to devise solutions for tackling the identified problems to improve the livelihoods of the rural people by improving their surroundings environment. Besides, they will be empowered with skill and critical thinking which will fosters a sense of self- reliance, self-confidence and ability to evaluate what is beneficial and which will improve their access to affordable, environmentally sound technologies and generate meaningful employment based on locally available natural resources of the region.

Acknowledgments

The authors thank the Director G.B.Plant Institute of Himalayan Environment and Development, Kosi Katarmal, Almora for facilities and SSD, DST (TIME) Govt. of India, New Delhi and TSBF/GEF/CIAT/UNEP for financial support.

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