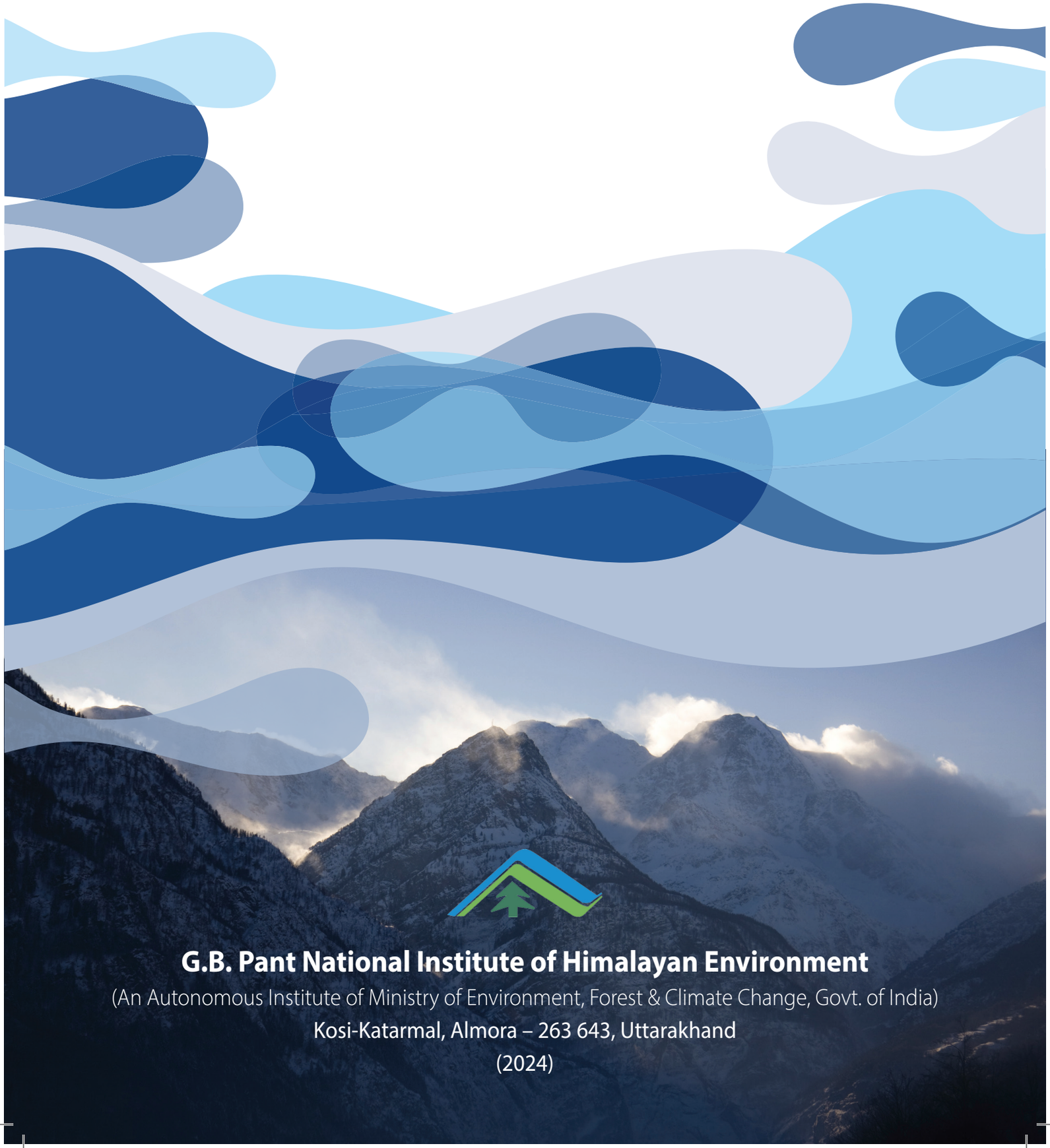
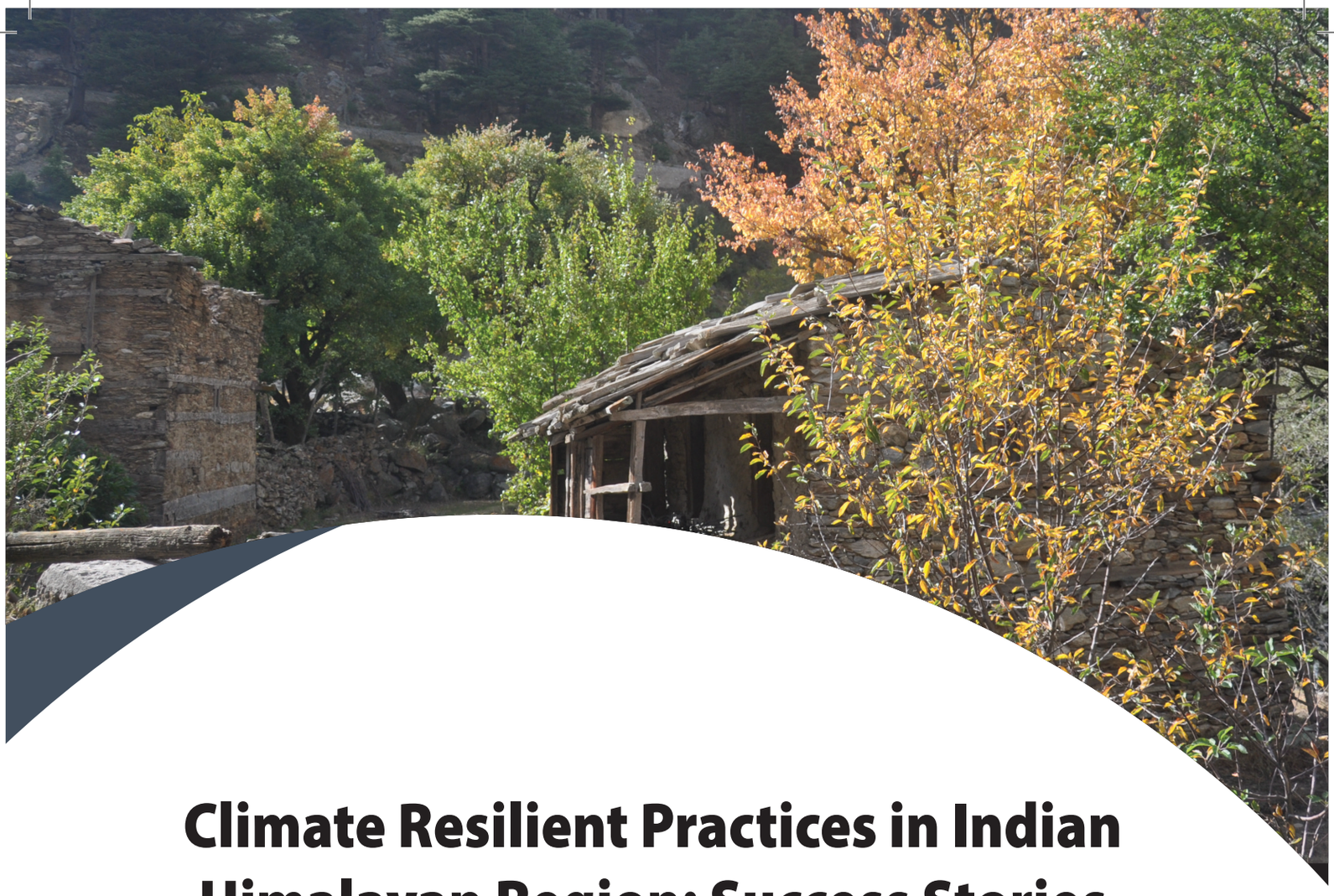
Climate Resilient Practices in Indian Himalayan Region: Success Stories



G.B. Pant National Institute of Himalayan Environment
(An Autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of India)
Kosi-Katarmal, Almora – 263 643, Uttarakhand
(2024)



Climate Resilient Practices in Indian Himalayan Region: Success Stories

Editors
J.C. Kuniyal | Kapil Kesarwani |
Sumit Rai | Mithilesh Singh

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Foreword

The Himalayan is considered to be one of the most fragile and diverse geographical entity of India. It harbours a variety of natural resources such as glaciers, glacier-fed perennial rivers, flora and fauna, rich biodiversity, and many others. The livelihood options and economic activities of the Himalayan communities are dependent largely on these locality available natural resources. However, the major economic activities of the Indian Himalayan Region (IHR) are hill agriculture, hydropower and tourism, which together represent limited livelihood options and higher marginalization because of inadequate infrastructure support. The Himalayan region is experiencing a higher degree of climate change. This would result in a variety of severe impacts on both the biophysical and socio-economic systems. Any impact in the Himalaya would not mean a direct effect on millions of people within India, but its far-reaching effect would also be experienced on the entire Asian sub-continent.

Under the future climate change scenarios and the stresses faced by the Himalayan ecosystem and its living communities, there is a need to preserve its traditional knowledge base and to adopt the climate smart practices, particularly in the high-altitude regions of the Himalaya. The present effort made by G.B. Pant National Institute of Himalayan Environment Almora, Uttarakhand in compiling and documenting the climate smart practices adopted over the entire Himalayan region will advocate fostering climate smart communities in the IHR through prioritization of adaptive practices as a part of remedial and sustainable management initiatives. The documented adaptive and resilient practices emphasize in view of suggesting alternatives for various livelihood options which are threatened or being threatened because of climate change. This effort will not only help the mountain communities to inculcate the spirit of climate smart activities, but will also be helpful in the utilization of available local resources for improving the livelihood options. This will eventually reduce biotic pressure on local but limited natural resources. Further, this will enable to develop a self-reliant system for the vulnerable Himalayan communities in pandemic situations like COVID-19. In addition, this document will also provide a roadmap for fostering climate-smart resilient practices for local level regulatory institutions, not only within the Himalaya but also other similar mountainous regions of the world. I am sure that this document would help in developing a strategy for site-specific adaptive and resilient practices for marginal communities of the Himalayan region.

(Sunil Nautiyal)
Director, NIHE

CONTENTS

Subhash Palekar Natural Farming (SPNF): an alternative of green revolution method

Sumit Rai[1]*, Nidhi Kanwar[1] and Kapil Kesarwani[2]

[1]Centre for Environmental Assessment & Climate Change, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

[2]Centre for Cryosphere & Climate Change Studies, National Institute of Hydrology, Roorkee - 247667, Uttarakhand, India

***Corresponding E-mail:** sumit.nihe@gmail.com

1.Climate Vulnerability Sector - Agriculture

2. Location (Lat. & Long.) - Himachal Pradesh (Latitude 31°49'51.24"N, longitude 77°16'59.88"E)

3. Key Summary - The idea of an alternative method for green revolution was developed by Maharashtra based agriculturist, Padma Shri Subhash Palekar in the mid-1990s. He noticed that impact of chemicals on long-term soil fertility and the environment is devastating. He keenly observed that how natural forest system works and nurtures them, while maintaining a healthy ecosystem. He also mimicked same technique in his farm and after six years (1989 - 1995) he verified and promoted technique of natural farming widely in Karnataka as zero budget natural farming. Nomenclature of Zero Budget Natural Farming (ZBNF) has now been changed to Subhash Palekar Natural Farming (SPNF). Subhash Palekar Natural Farming (SPNF) is a farming practice that believes in natural growth of crops without adding any fertilizers and pesticides or any other foreign elements. It is different from organic farming. This means that farmers need not to purchase any fertilizers and pesticides in order to ensure the healthy growth of crops. The input used for seed treatment and other inoculations is cowdung and cow urine.

4. Existing Practices - Research shows that poisonous chemicals and fertilizers used on crops leave undissolved and poisonous substances in grains, vegetables, fruits, and grasses. When eaten by humans and other living organisms, these cause a wide range of illnesses and harm to health. However, excessive use of fertilizer especially nitrogen fertilizer can lead to water pollution, acidification, and can contribute to greenhouse gas emission. In view of overcoming the ill effects of fertilizer and chemical-based farming, introduction of Subhash Palekar Natural Farming (SPNF) was advocated.

5. Resilient Practices / Technologies - The idea behind Subhash Palekar Natural Farming (SPNF) is to provide an alternative to chemical fertilizers and pesticides and return to a pre-green revolution style of farming. SPNF also has a positive effect on the environment. It tells people to avoid farming with a lot of chemicals, which is hurting the soil and the environment. Also, it suits all crops in all agro-climatic zones.

Subhash Palekar Natural Farming (SPNF) is based on the following four pillars:

- Jiwamrita: It is a mixture of fresh cow dung and aged cow urine with irrigation water that can be applied on farmland.

- Bijamrita: it is a treatment for plants and seedlings. It is effective in protecting young roots from fungus along with soil-borne and seed-borne illnesses that frequently affect crops. It is prepared with water, cow dung, cow urine, lime and soil from farm or forest.

- Aachhadan (Mulching): Applying a layer of crop residues to the soil surface in order to prevent water evaporation and to contribute to soil humus formation.

- Waaphasa: It means the mixture of 50 % air and 50 % water vapours (because roots take only molecules of water vapour not the water) in the cavities between two soil particles.

Satya Devi, a resident of a Lafughati village, Shimla, Himachal Pradesh grows apple, cash crops like peas, tomatoes, potatoes and cereals. She has her own success story as one of the pioneers of the natural farming in Himachal Pradesh (H.P.). She hasn't used any chemicals since 2018. Apples grown in her orchards are 100 per cent organic, highly nutritious and healthy. Another example is of Shakuntala Sharma, an apple grower from Theog in Shimla district, grows apples in her orchard with natural farming technique. She fetched an unexpected price of over Rs 100 per kg during recent pace . She is practising SPNF on land measuring 10 bigha, including an apple orchard in 5 bigha. Yashe Dolma, who belongs to Spiti district are setting an example of replacing the use of chemicals with "goumutra" or cow-urine. They don't use any medical sprays. A 'gomutra' (cow -urine) based product has been recommended by the agriculture department (H.P.). Dolma has expanded cultivation to at least five to six crops like broccoli, peas, spinach and radish which have high demand in the market since they are free from the chemicals (www.outlookindia.com). Jasvinder Kaur's family from Paonta block (H.P.) has adopted the organic farming and growing vegetables and cereals on almost seven bigha land. Sohan Lal from Dharampur block of district Solan, (H.P.) has adopted the natural farming of cauliflower and garlic. By just investing Rs. 1490, Sohan Lal has earned a profit of Rs. 60 thousand. Almost 28 horticulturists from the Banjaa valley of district Kullu (H.P.) have transformed their orchards into organic farming fields (http://himachalpr.gov.in/).

6. Impact / Interventions of GBP-NIHE or any other Organizations - Department of Agriculture Himachal Pradesh has implemented Subhash Palekar Natural Farming (SPNF) under a scheme called, "PRAKRITIK KHETI KHUSHHAL KISSAN".

7. Scope for Upscaling - Subhash Palekar Natural Farming has a lot of scope in India. Apart from being a sustainable agriculture practice for farmers, there are a multiple benefits to the environment. Given the nature of products (cow dung and urine of domestic Indian cows) used, the soil will be doubly enriched with organic matter. It is also environmentally sustainable as it facilitates soil aeration, topsoil mulching, intercropping, and less irrigation. Further, the practice of Subhash Palekar Natural Farming is applicable across climate zones, over a multitude of crops and cropping patterns, making it universal in its application.

8. Number of Persons / Communities Benefitted in the Region, if any- A total of 53,951 farmers have adopted SPNF Model in all the 12 districts of the Himachal Pradesh during 2019-20.

9. Name of Climate Smart Leader/ Society/NGO, etc. - Ghaini village of district Shimla is the first Panchayat where eighty women have formed Village Organization Himalaya Institute for growing organic vegetables. Satya Devi in Shimla and Yesha Dolma in Spiti, Himachal Pradesh are the pioneer to introduce new farming techniques to boost quality and prices at low cost. (fig.1)

Fig.1 Women farmers from (a) Ghaini village Panchayat, (b) Satya Devi in Shimla and, (c) Yesha Dolma in Spiti, Himachal Pradesh, adopted new farming techniques (Source: https://thenewshimachal.com; Outlook Photos)

Night Soil Composting (NSC) in Lahaul &Spiti district, Himachal Pradesh

Sumati Rathore and Sarla Shashni*

Himachal Regional Centre, G.B. Pant National Institute of Himalayan Environment, Mohal, Kullu- 175126, Himachal Pradesh, India.

*Corresponding email: sarla.shashni@yahoo.co.in

1. Climate Vulnerability Sector - Waste management

2. Location (Lat. & Long.) - Lies between Longitude 76° 46′ 29″ & 78°41′34″ E and Latitude 31° 44′ 57″ & 32° 59′ 57″ N.

3. Key Summary - Night soil compost (NSC) is a century old practice of managing human excreta in the cold desert area of Lahaul & Spiti district, Himachal Pradesh. The structure or technique used is locally known as Ghop or Khikong. These are mainly dry toilets in which no water is being used and manages the human excreta from open defecation. These are further used as manure in the agricultural fields after its decomposition. The current scenario of NSC is gradually decreasing in Lahaul sub-division of the district as compared to the Spiti sub-division. The reason is modernisation (use of modern toilets), hygiene and easily accessibility in the area of Lahaul as compared to Spiti. Instead, this technique is still in use because of unsuitability of the modern toilets in harsh climatic condition during winters. In the cold desert area of Lahaul & Spiti where long term snow deposit and avalanches continuously have washout effect on the nutrients from soil. The uses of these night soil compost are highly beneficial for maintaining the soil nutrients while managing human faeces. The nutrients are also beneficial for many cash crops of the region such as potato (Solanum tuberosum), pea (Pisum sativum) and hop (Humulus lupulus) which requires higher nutrients from compost.

4.Existing Practices - The high demand for manure in the agricultural field in the district is also met by recycling human waste into night-soil besides FYM/cow dung. With the increase in usage of modern toilets and maintaining hygienic practices, the use of traditional toilets is steadily declined in the region. But during harsh winters, these are the only substitutes for managing the human waste. Night soil composting takes around 6 to 7 months for complete decomposition and units are cleaned and emptied twice a year. Previously, women in the family used to manage all the night-soil composting work. However, as the village economy improved due to cultivation of cash crops and other salaried works, the rich households began to hire outside labour to manage the work.

5. Resilient Practices / Technologies - Natives of Lahaul & Spiti district used to build these two storied traditional toilets in the first floor through separately attaching the unit with their houses. A rectangular hole is made in the first floor through which the excreta drops down to the ground floor, where composting takes place. Some used also to make a separate unit away from the houses. The use of water in these traditional toilets is strictly prohibited as the moisture slows down, the decomposition process. To avoid the foul smell and flies, the faeces are covered with the material locally called as fot. Fot is a mixture of dry leaves, wood ashes, dry cattle dung, etc. which also make the compost nutrient rich. Every time, after defecation the faeces are covered with the fot. For making a good nightsoil compost,in general two chambers are made which give enough time for composting six months period to the compost in an alternate basis. The chamber has a special door for the removal of compost which is generally covered by wooden planks or some metal sheet. The resting period of minimum six month also eliminate the various pathogens which can cause the health risks if not treated well. The nightsoil

compost is being emptied from the chamber twice a year during the months of October/November and March/April. Due to social reasons and avoid contact with others, the work is generally carried out during night time when there is a full moon and are completed by morning. The compost is transported to the fields in a wooden basket called 'Kilta' and the tools used for the same is generally kept separate and used for this purpose only. These nightsoil composts are taken to agricultural field and dumped in a series for some time and after that evenly spread all over the field and mixed well with soil. The nightsoil composting technique in the region is a century old practice for manage human excreta and using it as agricultural manure. The technique is dose only managing human waste but it also fulfils the nutritional requirement in the agricultural fields. In the tribal district of Lahaul &Spiti, the agricultural fields remain snow covered during the winter for around 4 to 5 months. When snow melts, it also washes out the top nutrient layer of the soil. It, also nourishes the soil and this traditional night soil composting techniques is being used in the region.

6. Impact / Interventions of GBP-NIHE or any other Organizations - Night Soil Composting (NSC) is being practiced by the people of Lahaul & Spiti district, Himachal Pradesh to manage the human excreta as well as use it as a resource. In modern times, unhygienic practice involved in the technique, it is depleting fast from the region. But still it is in use particularly during winter in which modern toilets are non-operational due to below zero temperature. For the improvement and conservation of the technology CSIR-Institute of Himalaya Bioresource and Technology, Palampur (HP) extracted a cold tolerant bacterial consortium from the NSE to further speed up the degradation process of the compost. These bacteria with plant growth promoting characteristics plays a role in boosting the products are very user friendly with the use of only handful material after defecation. The technology also saves water, increases the productivity of crops with production of quality compost from the human waste and at the same time provides opportunities for local start ups. Currently, the technique is being given to the farmers in the cold desert area of Lahual&Spiti where it is being used by the locals and also getting good results.

7. Scope for Upscaling - One of the major points which need to be addressed in the traditional toilets is proper sanitation techniques. As per the current situation of modernisation, educational improvement, social status, these traditional toilets need a great scope of scaling up. These traditional nights soil composting can be one of the techniques for composting if personal hygiene of the users is ensured. The practice is very simple, affordable and environmental friendly. With upscaling the technique, this can be taken as a model to use the waste as resource to other similar cold desert mountain regions of the world in presence of vegetation.

8. Number of Persons / Communities Benefitted in the Region, if any - All native communities of Lahaul & Spiti district.

Fig 1.1(a) Traditional dry toilets, (b) Dry toilet in Spiti valley, (c) Construction of dry toilet, and (d) Small chamber to emptied the compost from the room

9. Name of Climate Smart Leader/ Society/NGO, etc.: All native communities of Lahaul & Spiti district.

Fostering Climate Resilient Practice in Upland Farming Systems in the North East (FOCUS) India

Kesar Chand*

North East Regional Centre (NERC), G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Itanagar-Arunachal Pradesh, India

*Corresponding email: kesar1982@gmail.com

1. Climate Vulnerability Sector - Agriculture, Livelihood

2. Location (Lat. & Long.) - Mizoram (Mamit district (23°38'59"N, 92°20'66"E), Kolashib district (24°13'26"N, 92°40'33"E), Serchhip district (23°20'30"N, 92° 51'02"E), Champai district (23°26'43"N, 93°10'40"E); Nagaland (Kohima district (25°40'30"N, 94°06'31"E), Wakha district (24°46'16"N, 94°59'26"E), Mokokchung district (26°19'72"N, 94°49'11"E), Longleng district (26°29'22"N, 94°49'11"E), Mon district (26°43'21"N, 95°01'52"E), Kiphire district (25°52'08"N, 94°47'07"E), Phek district (25°44'33"N, 94°26'26"E).

3. Key Summary - North East Region (NER) part of Indian Himalayan region of India has ecological and traditional values which helps to stabilize socio-economic status of the indigenous communities. However, most of the areas are critical to regional climate change perspective. It is because majority of the communities or rural population have economy based natural resources and climate sensitive sectors like, forest, agriculture, horticulture, water, biodiversity and traditional agricultural practices. Climate change adaptation for NER is critical as more than 81% of the population in the region is residing in rural area is dependent on climate sensitive production natural resources. This region is not well equipped to deal with the impact of climate change. Therefore, vulnerabilities of traditional communities need to develop the strategies for adaptation and mitigation. This part of the country have a large dependency on the natural products for food, hill agriculture livelihood which make NER more vulnerable to climate change. Deforestation, jhum and cultivation, and natural disasters (flood and landslide) are the major reasons of vulnerability. Nagaland and Mizoram are two states among eight states of the North East India, where climate change adaptation practices are significantly critical for the indigenous population. Both states are seeking to restore the balance between the ecological imperatives and growing human needs with the help of modern scientific knowledge, and experience. With the unique geographical features identity like hilly terrain, low population density and high rainfall pattern, both the states are vulnerable to climate change. Farmers have adopted traditional method of cultivation that is known jhum. This practice fulfils the basic needs of local communities, like food and energy, but it is now getting retrograde due to increasing pressure of population, cash crop production and low soil fertility. Engaging with village communities towards sustainable intensification of jhum has to be end goal. This would promote climate resilient practices through the twin approaches of aligning jhum cycles to the natural regeneration cycles of forests. Simultaneously, this effort would encourag settled agriculture where possible.

4. Existing Practices - In both the states, livestock practice is the integral part of rural livelihood. Most of the villagers keep few pigs and chickens for their domestic requirement. Poultry contribute to household food security, household income, and reduce dependence on jhum cultivation. The approach Pashu Sakhi to livestock development has been introduced in both the states, and has given training to community animal health worker. This approach has focused on primarily on pigs and poultry. Later on, this practice was introduced on goats and (local buffalo) mithun and develop dairy production and marketing groups which create less pressure on the jhum cultivation practice in the states.

5. Resilient Practices / Technologies - Use of remote sensing to facilitate Village Councils to identify land have been appropriate for cultivation and to avoid using steep slop land for jhum cultivation, prevalent. Introduction

of fertility management practices us both biological measures and possibly the introduction of "nano-nutrient delivery systems". Use of traditional knowledge in erosion control for ensuring extension of cultivation period from currently one year to three years may be beneficial to the farmers. Use of better agronomic practices, introduction of agro-forestry, linear planting, cereal and pulse cultivation to build synergy between crops to maintain soil health on the one hand and improved farmer income on the other would again be viable for the farmesrs.

6. Impact / Interventions of any other Organizations - The FOCUS addresses the issues facing in jhum cultivation through: (i) better jhum cultivation practices that enhanced productive and more sustainable, ecological balance; and (ii) gradually shifting jhumia households to stationary farming. Both of these approaches sustainably be important along with more productive wet rice fields, better plantation crops, improved livestock systems and increased off-farm income, enhanced farmers' income and reduce pressure on land and enhanced adaptation to climate change. As farmers seek to enhance their income by way of more market-orientated production, they got support for marketing, including orientation of production towards what the market needs in terms of volume, quality and price of produce. The project worked on jhum improvement and settled agriculture. In order to generate concurrent impact on data generation and to demonstrate the effectiveness of these approaches, the FOCUS scheme was engaged with ICAR, Regional Centre in Barapani and the Regional Agriculture Technology Application Research Institute (ATARI). Both these institutions come under the Deputy Director General (Extension), ICAR, GoI.

7. Scope for Up-Scaling - Both the states have demonstrated the effectiveness for a twin approach of promoting better management of jhum on the one hand and gradually shifting towards stationary agriculture on the other. In Nagaland, these are: (i) Nagaland Environment Protection and Economic Development through People's Action (NEPED), funded by the India-Canada Environmental Facility (ICEF),and (ii) Sustainable Land and Ecosystem Management (SLEM) in shifting cultivation areas of Nagaland for ecological and livelihood security project funded by UNDP-GEF. In Mizoram, the New Land Use Policy (NLUP) promotes stationary agriculture. Additionally, the North Eastern Region Community Resource Management Project for Upland Areas (NERCORMP), a scheme was supported by IFAD in hill districts of other north eastern states, demonstrated community planning and implementation for more sustainable land use systems.

8. Number of Persons / Communities Benefitted in the Region, if any - A total of 201,500 households (137,000 households in Nagaland, and 64,500 households in Mizoram) have directly been benefitted from this work.

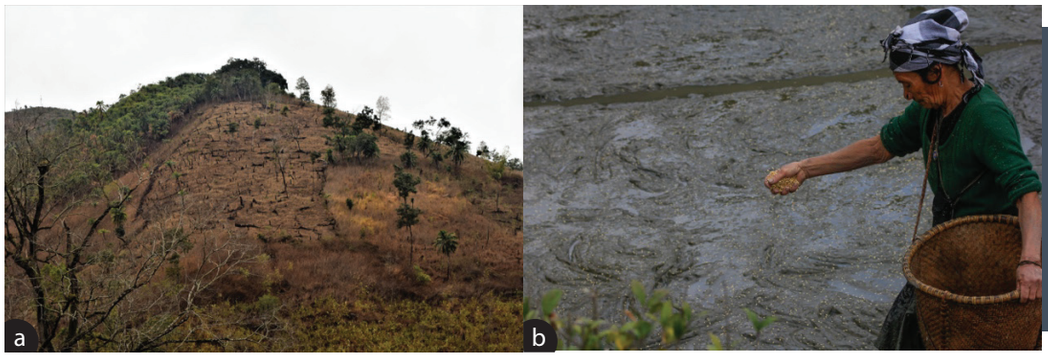


Fig 1 a) jhum cultivation land; and b) practices of settled agricultural

9. Name of Climate Smart Leader / Society / NGO, etc. - At the state level, the Agriculture Production Commissioner's (APC) office in Nagaland and Department of Agriculture (DoA) in Mizoram were the nodal agencies, with the implementing agency being the two states' Society for Climate Resilient Agriculture. The Chief Executive Officer/Secretary of the Society were the State Project Director (SPD), supported by a team of technical and administrative staff. The SPD was reporting to the APC in Nagaland and to the Secretary, Agriculture / Director, Department of Agriculture, in Mizoram. At the district level, a District Management Unit (DMU) was established within the office of District Agriculture Office. The District Agriculture Officer was the District Project Manager, with a small team of professionals to facilitate project implementation.

Climate resilient agroforestry model in the middle Himalaya through integrated multipurpose tree plantation and cash crop cultivation on community-degraded land

Lakhpat Singh Rawat and Soukhin Tarafdar*

Garhwal Regional Centre (GRC), G.B. Pant National Institute of Himalayan Environment (NIHE), Upper Bhaktiyana, Srinagar, Garhwal-246 174, Uttarakhand, India

*Corresponding email: tarafdar101s@gmail.com

1. Climate Vulnerability Sector - Degraded land restoration, livelihoods, agriculture, agroforestry.

2. Location (Lat. & Long.) - Bhiri-Banswara village (Latitude 30° 27′ N and Longitude 79°5′E) at 1200 m asl in Rudraprayag district in Garhwal region of Indian Himalaya.

3. Key Summary - The agroforestry model with people's participatory approach was developed in the year 1990 on 14 hectare (8ha village community abandoned agricultural land (AAL) and 6 ha highly degraded forest land (HDFL) at village Banswara (1200 m asl) of Rudraprayag district in Garhwal hills (Uttarakhand). The tree species for plantation were selected based on the priority of local people (especially women) to cater to the need for fuel wood, fodder and other products. The species like Boehmeria rugulosa, Grewia optiva and Ficus glomerata were considered to be best quality fodder trees, whereas Albizzia lebbek, Celtis australis and Dalbergia sissoo were the best quality timber trees, and Pyrus pashia and Sapium sebiferum were the best quality fuelwood species. Ten-to-twelve-months-old seedlings were planted at regular intervals at two sites: 8 ha degraded land and 6 ha abandoned agricultural land in July 1991. During the first two years after plantation, vegetables including spinach (Spinacia oleracea), radish (Raphanus sativus), Brassica juncea (Rai), lady's finger (Hibiscus esculentus), brinjal (Solanum melongena), french bean (Dolichos spp.), cucurbits (Cucurbita maxima), bitter gourd (Momordica charantia), sweet gourd (Cyclenthera pedata) and sponge gourd (Luffa cylindrica) were grown. the third year onwards when considerable shade was created by the canopy of planted trees, mustard (Brassica campestris), wheat (Triticum aestivum), lentil (Lens esculenta), adjuki bean (Vigna angularis), cow pea (V. unguiculata) and pigeon pea (Cajanus cajan) were grown. Thus, a total of 8 ha degraded land was transformed into a well-developed agroforestry model. This model is now contributing in reducing drudgery of women by supplying fuel, fodder, timber on. The one hand and strengthening food security on the other through hand growing cereals, cash crops, spices etc. Average survival at the abandoned agricultural land (AAL) site was 87% compared to 51% at the highly degraded land (HDL). This was evaluated in terms of economic and ecological costs and benefits, which built was on people's traditional knowledge and active participation.

4. Existing Practices - At the time of initiation of the model development in 1990, the village community comprised of 1400 people in 256 families, with mean farmland holding size of 0.45 ha. Two crops were harvested from a field every year. Fingermillet, foxtail millet, paddy, pigeon pea, soybean, horsegram and beans were grown during warm rainy season (June-October) and wheat, mustard and lentil during winter season (November-May). Livestock comprising bullocks, cows, buffaloes and goats (mean holding: 4 livestock units) are fed partly with biomass obtained from farm land (crop residues, weeds and fodder of agroforestry trees) but largely with biomass from forests (grazing and stall-feeding of grass/tree fodder). Forest leaf litter was used as bedding material in livestock-sheds and litter-livestock excreta mixture, the traditional farm yard manure, was used in crop fields at an average rate of around 25 t ha-1 year-1.

5. Resilient Practices / Technologies - Tree planting has formed a component of land rehabilitation strategy

built on indigenous knowledge, local needs and through people's participation. The species selected for plantation were chosen by the village community from a wider list of traditionally valued and naturally regenerating tree species identified in a survey of a cluster of villages across an altitudinal range of 800-2500 asml. Boehmeria rugulosa, Grewia optiva and Ficus glomerata were considered to be on of the best quality fodder trees; While Albizzia lebbek, Celtis australis and Dalbergia sissoo were the best quality timber trees. In case of Pyrus pashia and Sapium sebiferum were the best ones. As the best quality fuelwood species. Pyrus pashia is used as a stock for grafting Pyrus commune. Pyrus pashia and Prunus cerasoides had a wider altitudinal range of distribution compared to the other species. Development of agroforestry model on degraded land was based on the common decision of the entire village community where in their views and preference were given due respect and implemented accordingly. Social fencing around the plantation sites was adopted as decided by the community instead of barbed wire fencing to protect the planted tree seedlings from wild animals. Soil improvement by adopting organic compost was adopted for better growth of the planted species. Species for biofencing and plantation in agroforestry model were identified with participatory discussion and by valuing the priority of the people.

Ten-to-twelve-months-old seedlings were planted at regular intervals of 3 m in 45 x 45 x 45 cm size pits, providing 2 kg of farm yard manure in each pit. There was a Random mixture of above mentioned 10 tree species (in equal proportion) at two sites: a degraded community forest land site and an abandoned agricultural land site (1.5 ha area of each site). During the first two years after plantation, crops were grown. Both sites were protected from grazing and other human disturbances. Survival rate was assessed based on complete census of all planted individuals at the end of one, three and five years of plantation. Crown depth, width and number of branches were observed after five years of plantation. Biomass per ha was obtained by multiplying mean biomass per tree and number of standing trees. Soil of both degraded and abandoned land was analyzed to determine the nutritional status before and after plantation. Carbon accumulation by each plantation species was calculated to determine the total carbon sequestrated by the planted species. People's participatory approach especially the involvement of women in developing framework and implementation of the activities in the field was ensured where the preference and need of the local people particularly women was given due priority. The rehabilitation framework comprised of (i) a survey of local perception and indigenous knowledge related to degraded land rehabilitation, (ii) analysis people's perceptions from the perspectives of other stakeholders and their concerns, (iii) discussed these perceptions with the people and identified possibilities for improvement based on scientific knowledge, and (iv) facilitated consensus for an enhanced rehabilitation framework and its implementation. The planting tree species were selected based on the priority and response of the local women where the drudgery of women because of fuel, fodder and health can be reduced through maximization of the benefits from the rehabilitation models as well as habitat conservation. This step would help in mitigateng the impact of climate change through carbon sequestration. The model was integrated with some economically valuable cash crops and traditional crops to make the model more sustainable in meeting the livelihood of the people/women in the long run.

A total of 8 ha of degraded land was transformed into a well developed agroforestry model. The developed model is contributing in reducing drudgery of women by supplying fuel, fodder, timber on the one hand and livelihood security through generation of cash crops, medicinal plants, spices etc On the other hand. Average survival at the abandoned agricultural land (AAL) site was 87% compared to 51% at the highly degraded forest land (HDFL) site, with 970 trees ha-1 in the former and 564 trees ha-1 in the latter site which have been surviving more than 20 years after planting. Annual height increment rate across species, growth phases and sites varied in the range of 0.01-2.41 m year-1, with rates > 2 m year-1 observed only in A. nepalensis all through 1-5-year period and in C. australis during the first year after planting at the AAL site. At the age of 20 years, F. glomerata had the largest girth (85 cm) followed by B. rugulosa and A. nepalensis (77-79 cm) at the AAL site and P. cerasoides (70 cm) followed by A. nepalensis and A. lebbek (57-65 cm) at the HDFL site, while P. pashia (25-28 cm) had the lowest values at both the sites (Figure 2). At the HDFL site, farmers cut grass during the dry season serving three purposes: better growth of transplants as a result of reduction in competition, avoidance of mortality due to fire and availability of some fodder for stall-feeding. Biomass of grass is taken out of the site and fed to livestock amounted to 14.4 Mg ha-1 over the entire period. Farmers did not lop trees

at the HDFL site as they did not think it sustainable under highly stressful conditions. Over 20-year period, above ground C pool increased by 15.6-times at the AAL site compared to 8.0- times at the HDFL site, with the mean rate of 2.09 Mg C ha-1 year-1 at the AAL site and 0.95 Mg C ha-1 year-1 at the HDFL site (0.95 Mg C ha-1 year-1). Over 20-year period, the HDFL site accumulated below ground C at a rate (1.37 Mg C ha-1 year-1) 210% faster compared to the AAL site (0.44 Mg ha-1 year-1) (Figure 1). The successful action research and trials turned out to be role models often used as practical demonstration sites in training programme sponsored by different development agencies and Govt. line department for universities students, individuals/grassroot NGOs, etc. The impact assessment study revealed that more than 80 stakeholders (individuals/women/village institutions/Forest Department'etc.) adopted the approach. Framework developed by Garhwal Regional Centre (GRC) indicates conversion of about 120 ha degraded land was rehabilitated. The model is also contributing in mitigating adverse impact of climate change through sequestration of atmospheric carbon. Women are saving their valuable time that is spent on traveling a long distance for meeting their daily demand of fuel, fodder from natural forest in far flung areas from the developed model.

6. Impact / Interventions of GBP-NIHE or any other Organizations - This successful action research and trials turned out to be an agroforestry model that is used as practical demonstration sites during training programme sponsored by different development agencies and Govt. line departments, universities students, individuals/grassroot NGOs, etc. The impact assessment study reveals that more than 80 stakeholders (individuals/women/village institutions/Forest Department' etc.) adopted the approach and framework developed by GRC about 120 ha degraded land was rehabilitated based on. The model is also contributing in mitigating adverse impact of climate change through sequestration of atmospheric carbon. Now women are saving their valuable time that is spent on traveling a long distance for meeting their daily demand for fuel, fodder from natural forest in far flung area from the developed model.

7. Scope for Up Scaling - Village development scheme like MNREGA could be linked to plantation programme and awareness may be created among the farmers regarding financial assistance available at block, and district level with govt. line departments. Introduction of non-timber forest product yielding species provide monetary benefits over short periods of time. Medicinal herbs, together with trees could be another viable rehabilitation option easily acceptable to the people. Considering the diversity in ecosystem biophysical attributes, indigenous knowledge, market potential and socio-economic conditions in the mountains, rehabilitation strategy has to be location specific. There is a need to facilitate training and impart knowledge about plantation at local level to develop skill among the stakeholders while demonstration of rehabilitation models suited to diverse sets of ecological and socioeconomic conditions in the region through research and people participatory approach.

8. Number of Persons / Communities Benefitted in the Region, if any - 80 people

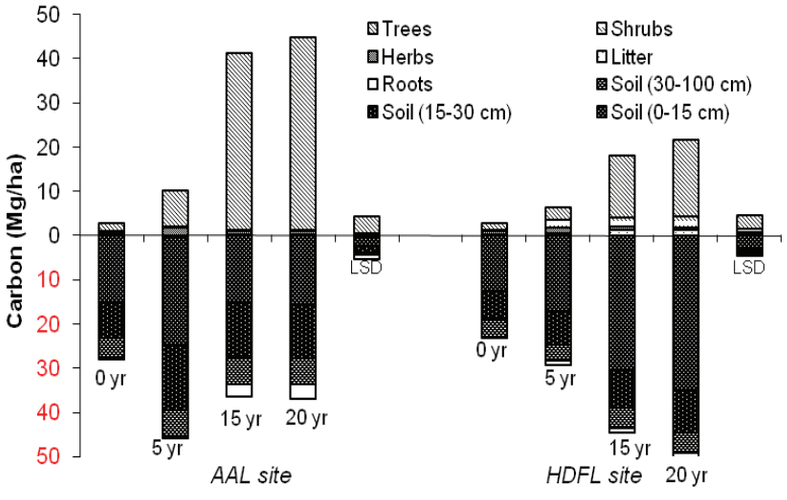


Figure 1. Carbon stock accumulated by the plants after twenty years of plantation at both the sites AAL and HDFL of Banswara, district Rudraprayag

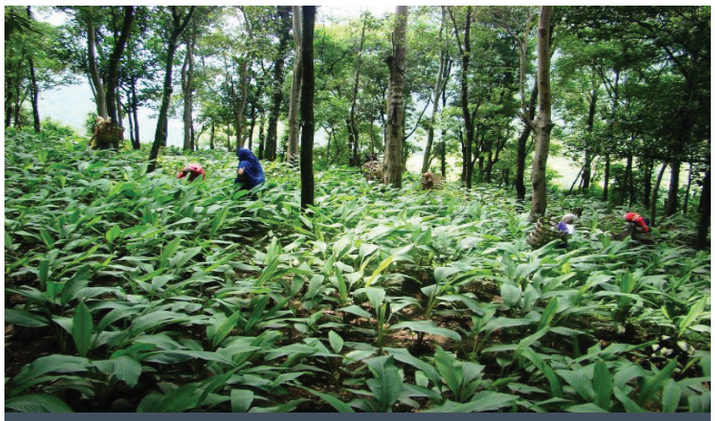


Photo 1. Agroforestry model integrated with cash crops in 6 hectare village community degraded land

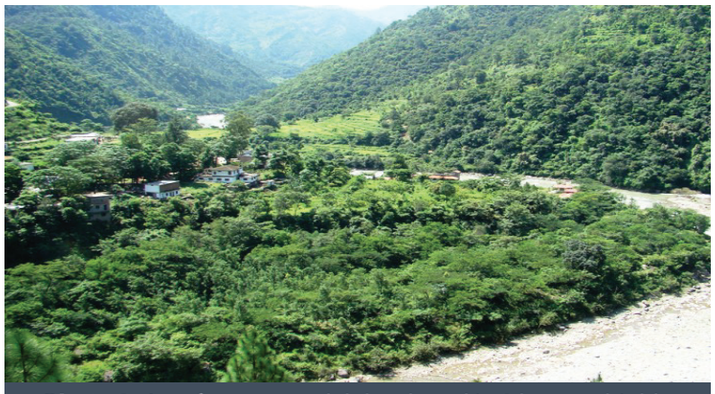
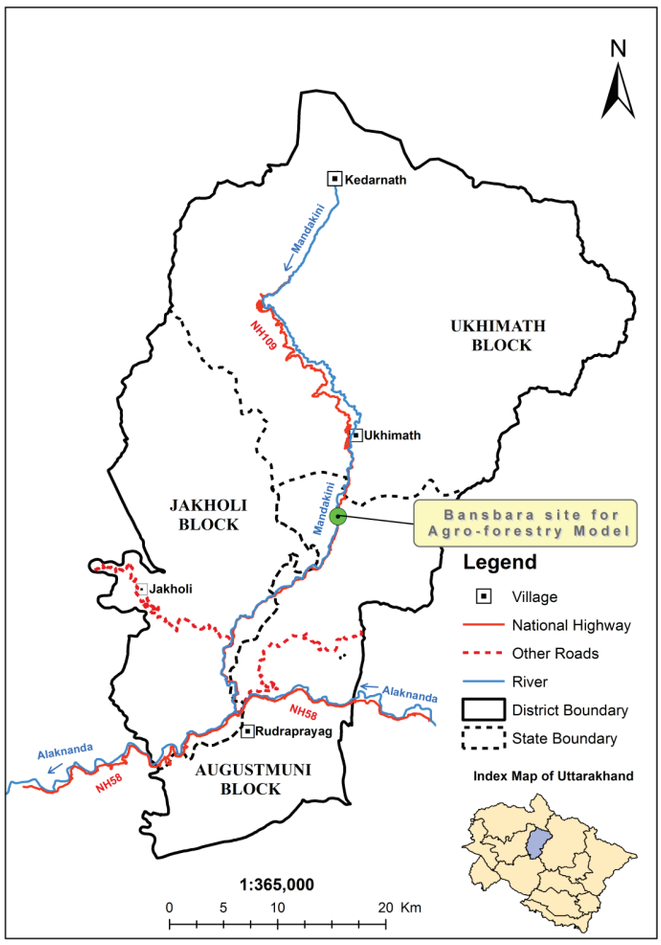


Photo 2. Agroforestry model developed in 8 hectare highly degraded forest land



9. Name of Climate Smart Leader/ Society/NGO - Bimla Devi and Bhiri-Banswara village

Climate resilient organic ways of agriculture beneficial for farmer's personal well-being and planetary well-being

Renu Lata*

Himachal Regional Centre, G.B. Pant National Institute of Himalayan Environment, Mohal, Kullu- 175126, Himachal Pradesh, India.

*Corresponding author: renunegi15@gmail.com, renu15_negi@yahoo.co.in

1. Climate Vulnerability Sector - Agriculture

2. Location (Lat. & Long.) - Sidhbari, Dharamshala (32.1793901°N' 76.3779831°E)

3. Name of Climate Smart Leader/ Society/NGO, etc. - Chinmaya Organisation for Rural Development (CORD)

4. Key Summary - With the aim of Grow Organic: Go Resilient, Chinmaya Organisation for Rural Development (CORD) has been interacting with villages in the Kangra district, in view of Himachal Pradesh building a knowledge base for using organic substances as inputs for agriculture. These organic practices are not only for aimed benefits in production, but also for the surrounding environment. This would climate resilient also become which would help agricultural practices positively related to farmer's gains and environmental conservation. CORD's approach toward agriculture is to create an integrated, humane, environmentally and economically sustainable agricultural production system. CORD has been working on climate resilient agricultural practices; with around 200 families in 48 villages during the past 3 years. They have significantly impacted farming practices and resulted in flouring implications :

- Increased use of organic pest control techniques, organic based agricultural practice.
- Farmers have been trained to use the best suitable seed in the market.
- Reduced impact of rains on the crops by increasing their resilience, by feeding organic manure to crops, instead of pesticides.
- Reduced health issues in this region, related to skin and lungs, wherein fertilisers and pesticides had potential to aggravate.

5. Existing Practices - In the past one decade, Himachal Pradesh has been witnessing huge negative impacts of global warming which has started to affect people's lives, livelihoods and hill agriculture. The production of cash crops like potato, apple that were grown extensively in this region has substantially declined as a result of which the farmers started using chemical fertilisers and pesticides to increase the in production . The new high yielding varieties of seeds were also tested by the farmers which gave decent outputs. However, due to high cost of inputs including pesticides, fertilisers, the substantial profit decreased out of total produce.

6. Resilient Practices / Technologies - Chinmaya Organisation for Rural Development (CORD) has been interacting with the villages in the Kangra district in view of using organic substances as organic inputs in place of chemical pesticide have been in frequent need and fertilisers. These organic practices will not only give a boost to the production, but will also save the environment because of its climate resilient nature, thus making agricultural practices positively related to farmers' and environmental gains. They started to discover and scale up the use of organic materials and suitable seed variety available within households as agricultural

inputs in the region.

The volunteers regularly visit and interact with the villagers; they build village groups, which meet monthly for discussing their concerned issues of agriculture. The volunteers share their experiences, try to mobilise few volunteers in the village; to start seed selection and organic practices of manure and pest control. All the villagers, who volunteer for starting organic practices, are then assisted with popular successful organic practices by the CORD volunteers. A village resource person is also appointed in all the village groups, who can facilitate and mobilise the group towards transitioning to organic practices. Thus, a chain of farmers is made within the village; which keeps growing as more villagers get influenced and join the circle of organic practices. Various farmer groups; women groups, youth mandals, farmers children groups are also formed for effective engagement.

There are various natural pest control and manure generating techniques initiated by CORD across the region. CORD has introduced Azolla as a bio-fertilizer and cattle feed. It is a water fern and increases milk and calcium content in the milk. This provides farmers with better quality milk and improves cattle health.

Another introduction is "Panchagavya", a bio-pest control measure produced by mixing cow dung, cow urine (Gomutra), milk, ghee and curd along with banana, vinegar and coconut in fixed proportion. Another practice that CORD volunteers have successfully initiated and spread across scale is seed testing practice. Taking a part of the field on volunteer basis from a farmer, all kinds of varieties of grains that are available in the market are sowed in small number. Regular meeting on the field is organised for farmer to check the status of the crop. In this way, farmers are able to decide the best variety of seeds for their trial, based on climatic conditions that they should sow in their own villages. This practice is done with an aim to bring the element of self-reliance, where farmers can evaluate on their own, which seed variety is best suitable in the present conditions. The overall approach that CORD

Figure 1. (a) Azolla: a biofertilizer and cattle feed (b) Panchgavya for pest control in the field (c) Six varieties of seeds of same grain in a farm plot to assess the best variety.

e-Arik (e-agriculture): using Information & Communication Technology (ICT) to Facilitate "Climate-Smart Agriculture" among Adi farmers of East Siang District, Arunachal Pradesh

Wishfully Mylliemngap*

North East Regional Centre (NERC), G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Itanagar-Arunachal Pradesh, India

*Corresponding author: wishm2015@gmail.com

1. Climate Vulnerability Sector - Agriculture, climate-smart agriculture, information & communication technology (ICT)

2. Location (Lat. & Long.) - East Siang District, Arunachal Pradesh (28°7'25.644" N and 95°9'48.204 E)

3. Key Summary - The East Siang District in Arunachal Pradesh, northeast India is dominated by the Adi tribe whose main livelihood is agriculture. Due to the difficult mountainous terrain coupled with erratic rainfall pattern, agricultural productivity is mainly subsistence in nature. Since the farmers are living in remote areas of the state with limited or no facilities for transport and communication, majority of the farmers do not have access to information pertaining to agriculture including disease and pest management.

The *e-Arik* (e-agriculture) project ('Arik' means 'agriculture field' in Adi dialect) was initiated to provide better information about "climatesmart agriculture" in order to increase awareness regarding for climatesmart agricultural practices, ultimately leading to adoption of those practices". The Climatesmart farm practices were seen as those that were sustainable, low input and reliant on organic technologies. The project focussed on two crops, paddy (*Oryza sativa*) and Khasi Mandarin orange (*Citrus reticulata*). Under this initiative, 'Village Knowledge Centres' (VKCs) with computer and internet facilities, phone and TV were set up in the project villages. The local farmers can access ICT-based agricultural information from these VKCs with assistance from Project facilitators consisting of agricultural professionals, a computer instructor and farmer-facilitators.

4. Existing Practices - The Adi community practise mainly rain-fed Jhum (slash-and-burn) cultivation and very less area under terrace or wet rice cultivation. The main crops include rice, maize, millets, leaf and tuber crops and horticultural crops such as orange, banana, pineapple. Agricultural practice was based on traditional knowledge and methods due to lack of access to agriculture extension services to address their problems. Mountainous terrain, lack of transport and communication facility, frequent natural disasters and irregular monsoons has been few of the several reason for this lack of access to information which, in turn, translated to low productivity. These factors posed a threat to the livelihood and food security of the people which may be worsen in future by climate change events.

5. Resilient Practices / Technologies - Since lack of access to agriculture-related information was the main drawback to agriculture, especially in remote villages, it was felt that there is a need to establish a single platform which will bridge the existing knowledge gap between the agricultural experts and the farmers. The e-Arik project demonstrated the use of ICT to channelize the required information from the experts to the primary stakeholders, i.e., the farmers. At each village, Village Knowledge Centres (VKC) were established and Project Facilitators (consisting of agricultural professionals, a computer instructor and farmer-facilitators) were appointed to assist the farmers in accessing the information. The VKCs were equipped with a variety of ICT tools such as computer and internet facilities, phone, printer, scanner and television set. The ICTs tools were used in different ways for collecting, interpreting and disseminating information. Thus, mobile technologies

were used to record from the field. Radio and TV were used as a channel for raising general awareness about climate and agricultural issues but not for specific guidance. Video was used to communicate specific details of new agricultural technologies - sometimes shown via laptop actually in the field. Physical publications and physical display of organic farm inputs at the VKCs were used when power failures prevented the use of ICTs.

The project focussed on two crops, viz., rice (*Oryza sativa*) and Khasi Mandarin orange (*Citrus reticulata*). A number of sustainable farm practices, such as vermi-compost, using leguminous crops for nitrogen fixation, bunds and ridges for water retention; stone contour bunds, agroforestry, crop rotation, indigenous pest and disease management etc were demonstrated under the project.

A low methane emitting and water-conserving technology of rice cultivation known as System of Rice Intensification (SRI) was also introduced by the project. However, only two out of the 40 farmers trained in this technology had adopted it by 2010. The reason for it may be because the farmers were reluctant to try this new technology as it is completely different from their traditional cultivation methods which they have been practicing since many generations. Therefore, there is a need to educate and sensitise the farmers on this technology so that more farmers can be convinced to take up this agricultural practice.

6. Impact -

- The *e-Arik* has covered 12 remote villages of East Siang district and 500 farmers have been registered in the *e-Arik* system.

- Till 2011, 44 % and 92 % of farmers have adopted climatesmart farm practices on rice and mandarin crops respectively as demonstrated through *e-Arik* (Drishti 2011).

- Forty-two (42) per cent and 29 % of *e-Arik* beneficiaries reported increased production of rice and khasi mandarin crops, respectively.

- 55 % farmers have permanently converted their shifting cultivation fields to Khasi Mandarin orchards.

- Among the 500 *e-Arik* beneficiaries, the increase in average seasonal income per farmer was reported to be Rs.1,689 (US$37.50) and Rs.5,251 (US$117) for rice and mandarin respectively.

- This system had an edge over the conventional agricultural extension system where a farmer has to travel long distances to the agricultural extension offices to access the information which consumes a lot of time and money. In the *e-Arik* system, farmers can gain access to the same information through the VKCs located at their respective villages or the nearest village. It was estimated that this approach is 3.6 times cheaper and access to information and services is 16 times faster than in a conventional agricultural extension system (Saravanan 2008).

7. Scope for Up Scaling - The *e-Arik* project has demonstrated the use of ICT tools to facilitate transfer of information on climate-smart agricultural practices to farmers in the remote villages of East Siang district. Lack of access to information and communication facilities is a common issue affecting the remote villages in the Indian Himalayan region due to the difficult terrain and frequent natural calamities. Therefore, this concept has a great scope for adoption and scaling up in other villages of the IHR to facilitate better and faster access to information and knowledge among the rural farmers, especially those residing in remote villages and out of the reach of agriculture extension services run by the respective states/districts.

8. Number of Persons / Communities Benefitted in the Region, if any - The *e-Arik* project has benefited 500 farmers belonging to the Adi tribal community residing in 12 villages of East Siang district of Arunachal Pradesh.

9. Name of Climate Smart Leader/ Society/NGO, etc.- The project entitled "Application of ICTs for Agricultural Extension Services Provision and its Impact among the Tribal Farmers of Arunachal Pradesh State of North-East India (*e-Arik*)" (2007-2009) funded by DSIR, Ministry of Science & Technology, Govt. of India, was implemented by Dr. Saravanan Raj (Principal Investigator), Central Agricultural University (CAU), College of Horticulture and Forestry, Pasighat, Arunachal Pradesh.

Literature Consulted -

Drishti, D.M. (2011) The *e-Arik* Initiative: Weaving ICT into Farming. *Dataquest (India),* February, http://dqindia.ciol.com/content/spotlight/2011/111021401.asp

Saravanan, R. (2015) *e-Arik* Center: Using ICT for educating farmers. *Leisa India,* https://leisaindia.org/e-arik-center-using-ict-for-educating-farmers/

Saravanan, R. (2008) *e-Arik*, Arunachal Pradesh, In: Bagga, R.K. and Gupta, P. (eds.), *Transforming Governments: eGovernment Initiatives in India,* ICFAI Publications, Hyderabad, 260269.

Saravanan, R. (2011) *e-Arik*: Using ICTs to Facilitate "Climate-Smart Agriculture" among Tribal Farmers of North-East India. ICTs and Agricultural Adaptation to Climate Change Case Study, 2011, Centre for Development Informatics, University of Manchester, UK. www.niccd.org/NICCD_AgricAdapt_Case_Study_*e-Arik*.pdf

www.niccd.org/NICCD_AgricAdapt_Case_Study_eArik.pdf

https://saravananraj.in/category/research-projects/

Koti Banal: an earthquake resilient architecture of Uttarakhand

Nidhi Kanwar*

Centre for Environmental Assessment & Climate Change, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

*Corresponding E-mail: nidhib100@gmail.com

1. Climate Vulnerability Sector - Vulnerability Sector- Earthquake Resilient (an adaptive measures for exposure element)

2. Location (Lat. & Long.) - Rajgarhi, Uttarkashi district, Uttarakhand (30°49'39.86"N 78°14'45.80"E)

3. Key Summary - Koti Banal is the name of a village in the Yamuna Valley which represents the traditional knowledge and understanding of earthquake effects on buildings and their earthquake resistant design. This magnificent earthquake-safe construction style belongs to 1,000 years before present. The performance of these structures has also been eye-witnessed during the 1991 Uttarkashi earthquake which had a magnitude of mb 6.6 in an epicentral distance of 30 km during which many new buildings collapsed while these structures did not suffer any damage. The salient design features are such as regular plan shapes, the sensible use of locally available building materials, the integration of wooden beams over the total height of the building as well as small openings and the arrangement of shear walls. Similar structures are however also present in the valleys of the rivers Sutlej and Tons of the Himachal Pradesh.

4. Existing Practices - Koti Banal Architecture reflect an agrarian lifestyle. Many houses still follow the Koti Banal style, but others have evolved into a cemented style, which utilizes concrete, brick and other new materials. The disappearance of such native dwellings and increase of concrete designs can transform a distinct cultural environment into a common place. The major reason for its disappearance is the unavailability and scarcity of timber, inconvenience in regular maintenance. Moreover, traditional masons (stonecutter) are being forced to switch over to new construction practices due to a lack of business.

5. Resilient Practices / Technologies - The Himalayan topography is extremely vulnerable to a variety of calamities due to its complex geomorphic evolutionary history and continuous tectonic activity. Increased population pressure and anthropogenic intervention in fragile terrain, have led to devastating disasters which is a major concern for the people who resides in this terrain and have witnessed the devastation caused by earthquakes on a regular basis. The fear of such disasters has stopped inhabitants from building multistorey homes in the region, so people began to explore and develop an architectural style that was distinct and resilient to disasters. It shows that people of Uttarkashi region developed a sophisticated system for earthquake-safe structures, approximately 1,000 years before the present in the form of unique architectural style (Koti Banal). These architectural styles (Koti Banal) are typically found in flat, sloped and hilly terrain. It is characterized by simple rectangle plan of two-unit construction with lengths and widths ranging from 4 to 8 metres. Generally, the building rest on a dry stone-filled platform. The height of platform is 2-4 or 7-12 m high. The architecture is made up of locally available building materials such as long thick wooden logs, stones and slates. These structures are observed to have four (Chaukhat) to five (Panchapura) stories. People have given different names to the floors of the house (ground floor, kholi; first floor, manjua; second floor, baund; third floor, baraur). The thickness of the walls is defined by the two parallel logs, which are usually 50- 60 cm thick. The construction is reinforced by perpendicular wooden beams attached to the logs in the midst of two parallel exterior walls and are mostly rectangular in shape. These beams support the floors of each storey. They restrict earthquake vibration effects on the superstructure. There is only one major entrance on the ground floor. Upper floors are only accessible via single wooden ladders. The ground floor is used for cattle or grain

storage, the upper floors are used as living and bed rooms. The kitchen is generally on the top floor. Some buildings have dry toilets on the fourth storey cantilevering balcony. Corrosion of the stone and wood used in the building is indicative of the antiquity of these structures. Beside good aspect ratio of the buildings and the use of lighter timber construction overturned the effects of earthquakes.

6. Impact / Interventions of GBP-NIHE or any other Organizations - Disaster Mitigation and Management Centre, Department of Disaster Management, Government of Uttarakhand, researchers from different institutes, World Housing Encyclopedia etc. are studying this architectural style of Uttarakhand in detail.

7. Scope for Up Scaling - There is a need of community involvement and combination of new materials with ancient structural design for construction of heritage structures 'Koti Banal'. So that it will ensure that the landscape continues to reflect the community's identity and local skills. It will also lead to opportunities for culturally sustainable livelihoods and enterprises. Local crafts, wood carvings, and weaving can also be used to create functional and vibrant interiors. It is also suggested that to new government policy or initiatives are required preserve such architectural style.

8. Number of Persons / Communities Benefitted in the Region, if any - local people of Uttarkashi who are involved in the Koti Banal architecture construction, also people living in these types of traditional houses and home stays.

Fig. 1. Traditional *Koti Banal* architecture houses in Uttarakhand (source; Rautela and Joshi, 2008)

9. Name of Climate Smart Leader/ Society/NGO, etc. - Native of the Uttarkashi District, Uttarakhand.

Kath Kuni Architecture of Himachal Pradesh

Usha Thakur and Sarla Shashni*

Himachal Regional Centre (HRC), G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Mohal, Kullu- 175126, Himachal Pradesh, India.

*Corresponding email: sarla.shashni@yahoo.co.in

1. Climate Vulnerability Sector - Earthquake resistant, Climate resilient, Sustainable and Environment friendly

2. Location (Lat. & Long.) - Kullu Valley (31°20'N to 32°25'N 76°56'E to 77°52'E)

3. Key Summary- 'Kath Kuni' is the environment friendly, sustainable, vernacular architecture of hilly regions of Himachal Pradesh especially Kullu district (Fig. 1). Kath kuni word has its genesis from Sanskrit word Kath (Kashtth) means wood and kuni means kona, angle or arm corner. About the origin of this architecture there is no such written information available but the knowledge has been passed down orally from one generation to another. It evolved with time according to climatic conditions, culture, resource availability and people's need. Traditionally, readily available wood in nearby forests e.g. deodar (*Cedrus deodara*), because of its strength, tensile and other properties) along with stone (as easily available in hilly areas) are used to construct this vernacular architecture. Stone layers and wood beams alternate with each other from base upward. In these layers, two horizontal wooden beams runs parallel to each other forming a cavity which is filled with the smaller stones and at the corner (common point) of two adjacent walls, wooden beams alternate with each other resting one above the other. Himachal Pradesh is under seismic zone IV and V where earthquakes more than 8 can also occur. There are a number of other natural calamities viz. flash floods, cloudbursts etc. that occurs in the area beside earthquake. The characteristics of this architecture viz. strength, stability (due to stone and wood), flexibility (due to fillers and no cementing agent) make it earthquake resilient.

4. Existing Practices - Traditionally all the rural households in the area were built in Kath kuni architecture. However, nowadays only temples of local deities are constructed in this architecture. It varies from one storey (local deity temples) to 2-3 storeys (common people house) to 7-9 storeys (temples e.g. Chaini kothi). In recent times, there has been a sharp decline in the construction of the Kath kuni architecture houses. This is mainly due to the shortage of the resource material such as wood, stones etc (legal ban on felling of trees), its high cost (availability of cheaper alternatives) and moreover the knowledge holders of the architecture. Except the local temples, no new construction in this architecture can be seen in the areas of its existence whereas very few buildings have been renovated owing it mainly to tourism industry and insignificantly to historical values and ritual beliefs.

5. Resilient Practices / Technologies - Generally, the building of kath kuni design is rectangular but can be more close to square in case of temples. The basic theme of the kath kuni design is alternate stone (2-3 layers) and wood (1 layer) layers with horizontal parallel beams with filler stone and no nails. The no of stone layers to wood is more at the base and it decreases with height towards the upper end. The wall is almost 2 feet thick which acts as thermal insulator due to the air in between the filler stones. Most of the time wall is plastered with mud on the inner side which also provides insulation. The structure mainly consists of base i.e. plinth made up of hard stones only. On plinth, low height floors are made with small windows and doors to prevent heat loss. Mostly mud is used on plinth for flooring. The floors are divided as per the requirement of the family. The ground floor is mostly dedicated for cattle locally called khudh. First floor dedicated for storage of grains and other agricultural crops locally called kathar. Sometimes

underground storage rooms are also constructed in some houses. Above that, rest of the floors are for residential purpose with kitchen. In top floors cantilevered (beams locally called kariyaan arising from the walls) balconies locally called poada are made mainly of wood (within the main building) with open windows locally called birgunu for light and warmth from sun. The cantilevered balconies without windows are used for drying of crops and storage of dried grasses. The top most structure is attic which is generally dedicated to the deity and locally called taala which have and sometimes don't have gables for light. Most of the times, a part of it is also used as kitchen. A big long wooden pole placed horizontally at the middle of pent roof called sirwansa for roof construction. Rest of the wooden rafters are placed on it at some degrees for roof construction. Roof is made of metamorphic rocks called slate in hindi and pouts in local, which are frost resistant, trap more heat, easy to maintain and a lot more. Roof always have some slope for proper drainage of rain and snow. The most common practice is of 2 floors but sometimes 3 to 4 floors locally called char bhuin ra ghor (4 storey house). Staircase is within the building but outside all the rooms connecting all the floors except in the top floor where it is inside the room connecting the attic. Wood carving is the main component especially in temples. The use of no cementing agent with fillers and airspace within the frame provide this structure flexibility. Whenever the earthquake occurs, this structure resonates with the energy and comes back to its shape. Its flexible structure and resonation helps in dispersing the energy without collapsing it and making it earthquake resilient. The pointed structure or gradual tapering also helps to avoid collapsing.

These houses are warmer in winter and cooler compared to outside in summer due to many reasons viz. mud used on inner walls (insulating effect of mud), stone walls and thicker walls around 2 feet, air space in between acting as insulation, wood (warmer character), small windows and low height of floors (saving energy) and cattle living on the ground floor (giving warmth to the above floors) etc.

6. Impact / Interventions of GBP-NIHE or any other Organizations - NORTH, a centre for Himalayan craftsmanship and design innovation is working on revival of Himalayan architecture esp. Kath Kuni architecture which is on the verge of extinction. Environmental consciousness and sustainability are the main thought for reviving this old architecture design. Constructions of new buildings based on Kath Kuni architecture beside restoration of old traditional houses of this design are the main work of this group. They convert these restored buildings in homestays as per demand of the owner of the building/ clients e.g. NORTH Estate. There are now, very few in numbers, buildings of this architecture (compared to none earlier) in Kullu region which are now converted to homestays which is generally left as such to rot or considered difficult to maintain, if not linked with any traditional ritual as people are shifting from Kath Kuni to RCC buildings. This concept (Homestay) is giving the local people the reason to maintain their old property for getting extra income. Efforts are made in this direction for creation of livelihood of people which is sustainable and environment friendly based on traditional knowledge of architecture besides protecting the indigenous knowledge, craft and skill.

7. Scope for Up Scaling - The resources such as wood and stones which were easily available earlier are not the case now. There is ban on felling of trees now and stone queries are also regulated by government in Himachal Pradesh. These structures are also highly prone to fire and termite attack. Staircases are also very difficult to climb for older people. Most of the people (more than 85%) of the area have now shifted to the RCC constructions from this traditional architecture due to low cost and time. High end maintenance of the building is also one of the reasons. So there is need for innovation and upscaling while retaining the main character for which it is known or beneficial. Bamboos can be one of the alternatives for the wood in future which is still a subject of research. There is need for balance between Kath kuni and RCC structure due to resource availability, fire hazard and many more reasons.

8. Number of Persons / Communities Benefitted in the Region, if any - Approximately 2000 people of Kullu valley who are elderly or are involved in the Kath Kuni construction are the main beneficiaries besides the local people living in these types of traditional houses and local people who converted their old houses into BnB (Bread and Breakfast) or homestays.

Figure 1. Traditional Kath-kuni architecture houses in Kullu Valley

9. Name of Climate Smart Leader/ Society / NGO, etc. - Kullvi People/ Himachali People

Knowledge holders of Kath Kuni design

Rung Radio: Community Driven Radio (CDR) as innovative climate resilient practice

Priyanka Maiti and J.C. Kuniyal*

Centre for Environmental Assessment & Climate Change, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

*Corresponding E-mail: jckuniyal@gmail.com

1. Climate Vulnerability Sector - Disaster management and community development

2. Location (Lat. & Long.) - Nayabasti(29°47'49.02"N, 80°29'33.31"E), Dharchula, Pithoragarh, Uttarakhand

3. Key Summary - Pithoragarh district of the Uttarakhand state is considered as one of the most fragile area in the central Himalaya. The district lies in the high seismic zone V. Current days, the area is observed to be affected by frequent climate extreme events including cloudburst, landslide, heavy localized precipitation etc. responsible for severe losses of lives, properties and infrastructures along with natural resources. In view of these disaster-prone areas, Community Driven Radio (CDR) setup is a community based innovative technology that establishes a local area network among communities reducing the cost of access to information. It is useful in the remote villages of the Indian Himalayan Region, where mobile network is still not available or other network problem exit. It uses Wi-Fi and other low-cost deregulated media to share content locally. Therefore, implementation of such practice in the remote Himalayan villages may play tremendous role in disaster management as local communities are the first responders during the initial hours of disaster. These radio stations will help in broadcasting live information for local administration to reach directly to the disaster affected families. The radio will also help in audio documentation of Runglwo language, recognised as endangered language by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Simultaneously, establishment of CDR Cafeterias, the tourists and locals will both enrich the CDR by availing the services and promote local livelihood options. The work is jointly implemented by the Asian Disaster Preparedness Center (ADPC) and the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) under Climate Adaptation and Resilience (CARE). The TechEmerge Resilience India Challenge is part a of the CARE project, being administered by ADPC under the overall framework of the World Bank's Program for Asia Resilience to Climate Change Multi Donor Trust Fund (PARCC TF Grant).

4. Existing Practices - In the current era of fast communication, the remote Darma-Byans, valley of Pithoragarh district, Uttarakhand still don't have basic communication infrastructure due to lack of Indian mobile towers. On the other hand, the area is also under high pressure of climate extreme events, e.g., extreme rainfall, heavy load of sliding lands, frequent cloud burst, etc. Lack of communication during these events creates the situation more vulnerable. The situation also affects the education system of the area in present time of COVID-19 pandemic, where online classes become essential. Localities of the area mainly belong to the Rung community and speak the language Runglwo. According to UNSECO, documentation of the endangered language and indigenous culture of the Rung community through folklore (folk songs and folk stories), rituals, traditions, attire and food is a matter of concern. It will increase a sense of self-respect and confidence when the Rung children realize that they are Rungmung and belongs from a community with vast wealth of knowledge and culture.

5. Resilient Practices / Technologies - Resilient practices / technologies (500 words)
At present, a pilot project of CDR has been implemented in three villages of the Darchulla block of Pithoragarh district, namely Talla Nayabasti, Malla Nayabasti and Charchum, together known as Nayabasti.

The Innovator, Mr. Vedanthi Giri from Pragathi Foundation, Karnataka has initiated the work under the project CARE. According to the innovator, the project is mainly focused on the development of the Rung community, a high mountainous community enriched with vast cultural ecosystem services. The unique and diverse culture of the community have their own identity. Therefore, establishment of a CDR system for such heritage community living in environmentally challenged area will be helpful initiative for the audio documentation of the culture and disaster mitigation. In the initial phase of the work during August 2021, audio contents are produced involving the frontline workers ASHAs and Anganwadi Workers, community members, women and youth. The audios will be relayed to the relevant on or off line media platforms for awareness and redress. Villagers were also trained regarding technical and non-technical aspects of the CDR. Network feasibility has been successfully tested in the area. Devices like Raspberry Pi recording, Public Pi, Backpack Pi, Pi -TV for collecting stories have been successfully installed. Recordings were made on COVID-19, daily health reports, the government schemes, general information and disaster updates along with the implementation of Open Mike Systems in the area. Accompanied by the innovator and local partner Renu Thakur from ARPAN (NGO), Mr. Vinay Taragi (network engineer), Mr. Karan Joshi (software developer), and four other members were found to work efficiently in the villages. Along with the community people, the government stakeholders like the Department of Health, Education, Panchayat, Women Empowerment & Child Development (WECD) and Uttarakhand State Disaster Management Authority (USDMA) are also part of the work. They will participate in disseminating the programs and schemes. During the work, old panchayt ghar of the village was found to be used as CDR Cafeteria. The innovator tried to involve the skilled and newly trained community women to run the CDR through a Cafeteria. Along with the communication facility, the cafeteria will also have variety of food option, local handicrafts and other local products. Through generating income, the CDR cafeteria concept will untimely promote the suitable establishment of the practice among the community.

6. Impact / Interventions of GBP-NIHE or any other Organizations - The work has been implemented collaborating with Uttarakhand State Disaster Management Authority (USDMA). For the Technical Support, the project has been executed in collaboration with Janastu (https://janastu.org/). The main role of Janastu is annotation and archiving of the stories. For the local Community participation, collaboration has been done with Pithoragarh based NGO, ARPAN (http://arpanuk.in/) and national level organization, ENVIRONICS Trust (https://environicsindia.in/).

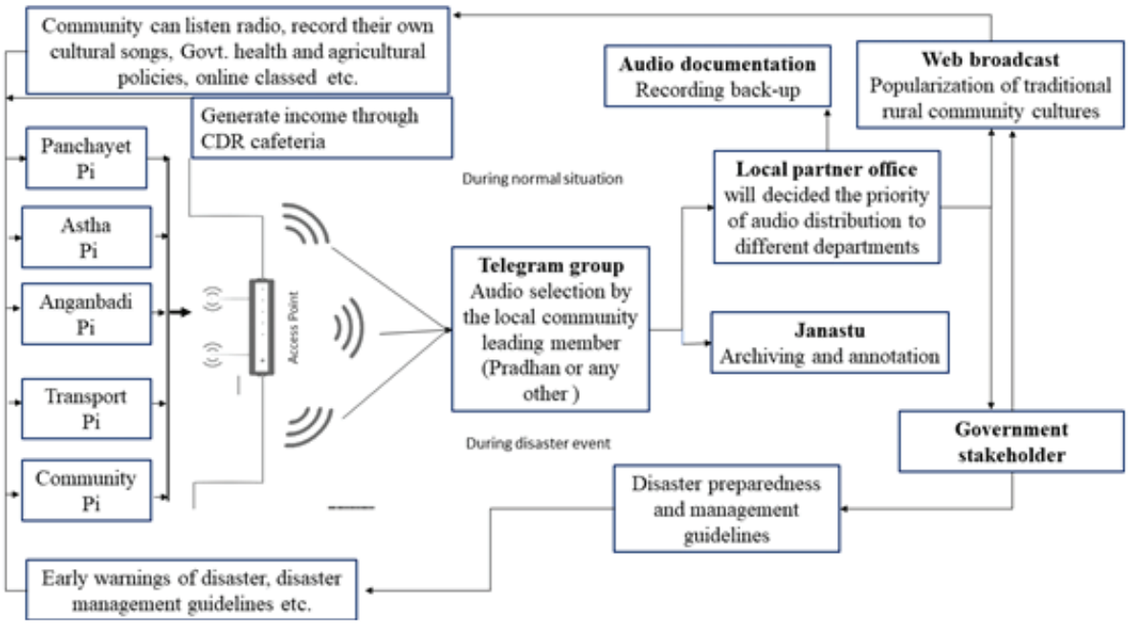


Figure 1. Working principle of the CDR

Fig. 2 Establishment CDR in Nayabasti, (a)Traditions of the Rung community, (b) Rungmungs using CDR, and (c.d) Use of open mike and CDR in Charchum (Photo credit: Dr. Ravi Pathak, Vinay Taragi and Niji)

7. Scope for Up Scaling - CDR, has tremendous role in disaster management and communication. Therefore, such innovative technology could be promoted in the other areas of the Darma-Byans and Chaudas valley and other no network areas of the IHR. Through this technology, the hilly communities will be able curate content for their needs and utilise a hyper-media archive architecture for their story telling, publishing and navigation needs or for online classes during the present COVID-19 situation. During disaster, the system will act as lifesaving hand by communicating warning of hazards; information transmission about affected areas; alerting the officials, relief NGOs and the public to specific needs. Hence, promotion of such low-cost technology in other no network disaster prone areas of the IHR is highly recommended.

8. Number of Persons / Communities Benefitted in the region, if any - 600-700 villagers of Nayabasti, Dharchula, Pithoragarh, Uttarakhand.

9. Name of Climate Smart Leader/ Society/NGO, etc. - Technical- Mr. Vedanthi Giri, Pragathi Foundation, Karnataka. Non-Technical - ARPAN, Pithoragarh, ENVIRONICS TRUST (https://environicsindia.in/)

‘Hamam’- An institutional set-up for dissemination of energy-efficient device

Kapil Kesarwani[1]*, Arushi Sharma[1] and Sumit Rai[2]

[1]Centre for Cryosphere & Climate Change Studies, National Institute of Hydrology, Roorkee - 247667, Uttarakhand, India

[2]Centre for Environmental Assessment & Climate Change, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

*Corresponding E-mail: kapilnih@gmail.com

1. Climate Vulnerability Sector - Energy-efficient cooking (pressure cookers and liquefied petroleum gas stoves) and traditional water heaters (water-heating devices) for Women Empowerment.

2. Location (Lat. & Long.) - Remote villages of Kullu, Mandi and Shimla districts, Himachal Pradesh, India (31°57’29.61”N, 77° 6’31.64”E; 31°42’29.10”N, 76°55’53.69”E & 31°6’16.73”N, 77°10’3.37”E)

3. Key Summary - Jagriti is a community-based organisation which is working for women empowerment in rural areas. Main aim of organization is to empower women by giving them chance for livelihood development. The majority of women’s daily routines are often dedicated to collecting wood for cooking, which can be a time-consuming and physically demanding task. Recognizing this challenge, Jagriti organization is actively advocating for the adoption of energy-efficient and time-saving cooking devices. By embracing these innovative technologies, women can have some time from their daily schedules, offering them the opportunity to explore and consider various livelihood options. Moreover, Energy-efficient devices are a necessity these days in order to adapt to climate change and various vulnerabilities, so the NGO decided to start a project that included the dissemination of traditional water heaters, pressure cookers and liquefied petroleum gas stoves in the state’s Kullu District. The program was implemented with the help of women group. The NGO made women’s savings and credit groups at the village and hamlet level so that they could afford the expenditure of these devices. This programme is making energy services available to women, it has become a platform for women’s empowerment and social transformation. With the help of this program 1,000 household have been benefitted till now and the demand for the devices is still growing.

4. Existing Practices - India is one of the fastest growing economies in the world and home to over 1.4 billion people (17% of the world’s population). Since in India population is expanding rapidly, its energy demand will grow in coming days. However, the energy consumption and electricity generation are still dependent on fossil fuels, coal accounted for 42% of India’s primary energy consumption in 2008, oil at 23% and natural gas at 6% with renewable energy (RE), mainly hydropower, wind and solar at 31%. Electricity generation in India is mainly coal-based (70%). However, hydropower accounts for 14%, though its share has declined over the last 35 years. But the remote areas are still not energy efficient and they urgently need climate smart practices to cope with climate changes. (Source: UNDP, Women’s Power: Energy Services for Rural Women in India).

5. Resilient Practices / Technologies - Women are the primary gatherers and providers of fuelwood in rural areas, and hence they suffer a lot. Progressive deforestation has meant that women have to walk farther for fuelwood. Delivering subsidized fuels and technologies to the poor can be a challenge. About 90% of Himachal Pradesh’s population lives in rural areas. Since fuel wood is still the primary source of energy that is used for cooking, there is a need to empower women by easing the burden of daily chores by introducing energy efficient devices along with that creating a pathway for personal growth and economic independence. Jagriti works with the help of more than 1200 poor rural women that are divided in to 100 women’s saving and credit groups. In 2001, Jagriti began work on empowering poor women in the Lag Valley of Kullu District

in Himachal Pradesh. Jagriti organized women into WSCGs to improve their economic and social status. Consultations with WSCGs revealed that women were solely responsible for managing the energy needs of the household, so they had little time to attend participate in training or economic activities. In order to make women participate in program organised by Jagriti first step that was needed was to reduce time spent on meeting energy requirement and household chores. Improving women's access to household energy was thus identified as a key for improving the status of women. As the temperature remains cool in Himachal Pradesh hot water is a required throughout the year. An average household needs roughly 50-60 litres of hot water every day during the six winter months. During the study, it has been found that heating 20 litres of water requires 10-12 kg of hardwood in a traditional cookstove, while a Hamam requires just 02 kg of household waste, crop residue or twigs. Hamam is made up of a simple tin structure. A hollow cylinder is made in which the inner cylinder is open from the top, and a mesh is used in the bottom. In the inner cylinder some twigs or small wood are used, they are burnt and covered with a chimney cover. The water is filled with the help of funnel shaped inlet connected upwards that fills water in the space between the outer and inner cylinder. The water gets heated, and it comes out of the outlet pipe connected at lower height than the inlet pipe. When cold water is poured in the inlet funnel-shaped pipe, the hot water comes out of the outlet pipe. This device provides improved fuel-use efficiency, that means that fuelwood collection trips to the forest, which formerly had to be made daily, are reduced to between one and four trips per week. With the use of time and energy efficient devices like LPG stove and pressure cooker now women have 1-1.5 hours of extra time daily. The free time can be used to participate in training programs in order to generate extra income. (Source: UNDP, Women's Power: Energy Services for Rural Women in India)

6. Impact / Interventions of GBP-NIHE or any other Organizations - The work has been implemented with the collaboration of United Nations Development Programme: Women's Power: Energy Services for Rural Women in India UNDP. Other partners who have made financial and other contributions to the energy sector programme were Norwegian Agency for Development Cooperation (NORAD), SN POWER (Norway), the Global Environment Facility (GEF) and the GEF Small Grants Programme. For the local community participation, collaboration has been done with the help of NGO, Jagriti.

7. Scope for Up Scaling - Some methods need to be introduced in order to avoid appropriation of programme benefits by the relatively affluent households. Local communities should be made aware about their rights that will allow them to monitor beneficiary selection and hence improve programme transparency. The high cost of energy-efficient devices is a barrier to their adoption by the poor. In the programme by jagriti- introduction of Hamams and pressure cookers are good but not all households can afford LPG gas stove instead of that they should be made aware about the rocket stove that can be used. This will not help them cook safely but also help to keep their room warms in winter.

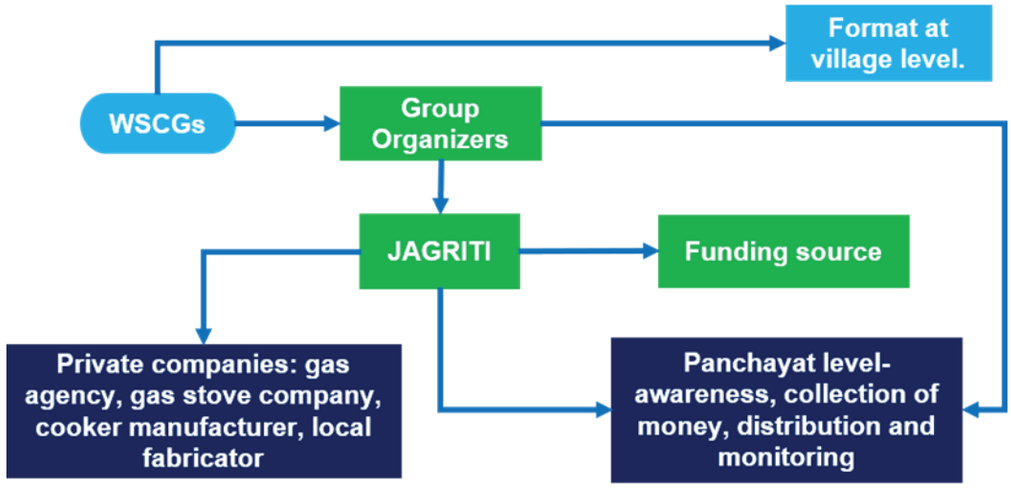


Fig. 2 Institutional setup for dissemination of energy efficient devices (Source: United Nations Development Programme: Women's Power: Energy Services for Rural Women In India)

Fig 2(a) Women using a hamam
(Source: UNDP/Energy Access for Poverty Reduction)

Fig 2(b) Women in Lag valley using pressure cooker
(Source: UNDP/Energy Access for Poverty Reduction)

Fig 2(c) Women learning to operate LPG gas stove
(Source: UNDP/Energy Access for Poverty Reduction)

8. Number of Persons / Communities Benefitted in the Region, if any - Poor women in the Lag Valley in Himachal Pradesh's Kullu District.

9. Name of Climate Smart Leader/ Society/NGO, etc. - Jagriti, a community-based organization (registered as a Society) operating in the hilly state of Himachal Pradesh, India. The Norwegian Agency for Development Cooperation (NORAD), SN POWER (Norway), the Global Environment Facility (GEF) and the GEF Small Grants Programme, UNDP

Himalayan Rocket Stove: More fire, less wood and saving a million trees

Arushi Sharma[1], Kapil Kesarwani*[1] and Sumit Rai[2]

[1]Centre for Cryosphere & Climate Change Studies, National Institute of Hydrology, Roorkee - 247667, Uttarakhand, India

[2]Centre for Environmental Assessment & Climate Change (CEA&CC), G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

*Corresponding E-mail: kapilnih@gmail.com

1. Climate Vulnerability Sector - Energy Efficiency and Women Empowerment, No smoke gas stoves plus heaters for rural people.

2. Location (Lat. & Long.) - Himachal Pradesh & Ladakh in India (32°5'55.60"N, 77°33'35.61"E & 34°13'30.98"N, 77°33'41.23"E)

3. Key Summary - There are almost 10 million people living in the north Indian Himalayas, and it has been estimated that each house consumes almost 1,000 kg of fuel wood per year. According to the data of state wise fuel wood consumption report of the Environment and Forest Ministry's 2011, the fuel consumption in Himalayan state is as follows- Assam uses 114.21 lakh tonnes of fuel wood, Uttarakhand uses 25.66 lakh tonnes, Jammu and Kashmir uses 13.94 lakh tonnes and Himachal Pradesh uses 12.14 lakh tonnes of fuelwood per year. Generally, women and children are the one who gathers the fuel wood, so Russel Collins sees his innovation not only as ecological but it saves time and labour also. An expense they'd rather not pay, given an efficient option. With the invention of the Rocket Stove, the usage of wood is reduced. The usage is reduced to 20 per cent of Bukharis (Traditional stove). (Source: DNA, dated 27 March 2017)

4. Existing Practices - Himalayan Rocket Stove looks like a big metal box with a small, pull-out tray. To those of us living down south or in west India, it won't seem like 'rocket science', but people living in hilly region will find it similar to traditional bukharis they use in winters. It is similar to their traditional methods since it also plays the dual role. It used as stove and as well as room heater but it is more fuel efficient. Collins first saw the rocket stove when he visited Ladakh to meet Wangchuk. There the Himalayan scientist have built that stove for his students that inspired Collins to innovate and make something similar to help Himalayan communities. After three years hard work and many failed attempts he finally got successful in making a working prototype. Test production began in 2017 at the LEDeG (Ladakh Ecological Development Group) in Leh.As he didn't have access to the high-tech insulation, he innovated using clay and puffed rice. Though commercial version is available but it can be made with the help of clay, rice and straw at home.

5. Resilient Practices / Technologies - The idea to design highly efficient, rocket stove, came to Collins when he went to see school of Sonam Wangchuk, and there he was introduced to a "big" rocket stove that Wangchuk had built for his students and that inspired him to make one that would meet the needs of Himalayan homes. After trying hard on the prototype, test production began in 2017 at the LEDeG (Ladakh Ecological Development Group) in Leh. The basic Himalayan Rocket stove costs from Rs. 10,000 to Rs. 15,000. In the regions where people don't have access to the fuel, they can use small sticks or dried animal dung for combustion. In many regions these materials are easily available and thus no felling of mature trees is required. He's received feedback that when it's "-10°C outside, the Himalayan Rocket Stove is able to maintain the heat inside homes at 25°C". Since this is still out of reach of some rural communities living in the Himalayas. They experimented to make this stove from material that is readily available and cheap. In his normal stove he uses a metal box, but if instead of using the metal box some rudimentary materials like straw (to give strength to the structure of clay

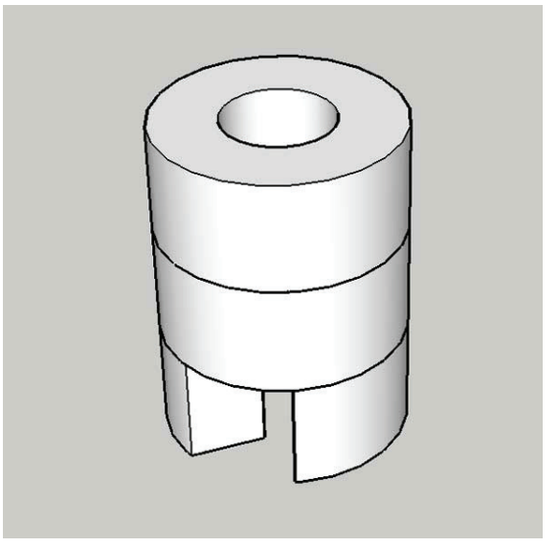
donuts that we use) and puffed rice are used, that makes it more affordable for everyone. In the improvised version basic materials like clay, straw and puffed rice are used. All materials are need to be mixed, and clay donuts are prepared from the mixture. To prepare clay donuts, a tin structure is used. Four clay donuts are stacked upon each other and one clay donut is cut for an opening, this donut is cut in a particular way so to make fire swirl inside. One small iron pipe is also inserted in this clay donut. A large cardboard pipe is attached to half-cut clay donut. This pipe is than covered with clay and another full clay donut. The design could work as a smokeless stove. Something that would tackle the problem of household air pollution, which as per the World Health Organisation (WHO), kills about 4 million globally and 1 million in India. The materials used also have their own significance - clay soaks up heat, but puffed rice creates air pockets, making it insulating that enables us to burn the smoke itself. Burning smoke is the science behind all smokeless stoves, but it is incredibly accessible using cheap, easily available materials. Hence, it's viable even to teach people how to make the smokeless stoves for free. According to the Himalayan scientist Wangchuk, rocket stoves are really needed at current times. He said that 70 % people in Ladakh use LPG but 30 % still use wood and dung. Since the cost of LPG is increasing day by day, if the locally available material like wood and dung are combined with the efficiency of rocket stoves than they can be quite cost effective.

6. Impact / Interventions of GBP-NIHE or any other Organizations - The work was carried out by taking inspiration from Sonam Wangchuk's award-winning school Student's Education Movement of Ladakh (SECMOL) and the production was started at Ladakh Ecological Development Group (LEDeG) in Leh.

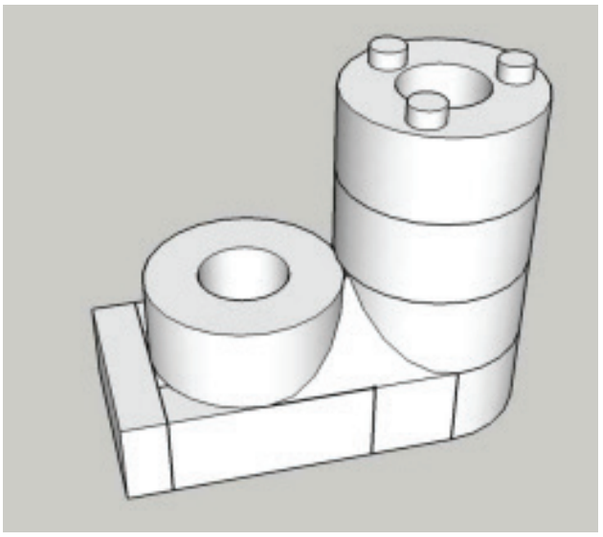
7. Scope for Up Scaling - The commercial version of Himalayan Rocket Stove is costly and that can be purchase by the rich people. The stove is locally available at cheap rate of Rs 800 also but they are not that efficient. Since it would be affordable by poor people, they will tend to purchase this inefficient version only. People can make their own stove that may be more cost effective and the required material to make them is readily available. There is a need to adopt innovative ideas like training some local entrepreneurs to make the smokeless stoves and sell them for a small price. Some training programmes can be initiated that will enable people to learn how to make these stoves at home.

8. Number of Persons / Communities Benefitted in the Region, if any
The stakeholders were locals communities of high-altitude villages of Himachal Pradesh & Ladakh (approximately 200 families).

9. Name of Climate Smart Leader/ Society/NGO, etc. - Russell Collins, LEDeG (Ladakh Ecological Development Group), Leh



a. Clay donut stacking



b. Final shape of the stove
(Source: himalayanrocketstove.com)

c. Collins demonstrating his cost-effective version of smokeless stove
(Source: himalayanrocketstove.com)

d. Different versions of Himalayan Rocket stove (Eco-1-2-3-soft-focus-1200)
(Source: himalayanrocketstove.com)

Integrated Solid Waste Management

Smriti Thakur and R.K. Singh*

Himachal Regional Centre, G.B. Pant National Institute of Himalayan Environment, Mohal, Kullu- 175126, Himachal Pradesh, India.

*Corresponding email: rksingh@gbpihed.nic.in

1. Climate Vulnerability Sector - Waste Management

2. Location (Lat. & Long.) - Aima Panchayat of Palampur in Kangra district of Himachal Pradesh (32.1255837 N, 76.5332075 E)

3. Key Summary - In the present times with the fast pace of development, increasing demand for goods and socio-economic status has caused in generation of huge amount of waste in both urban and rural habitations. The non-availability of efficient scientific disposal method for waste has led to escalation of the problem. The disposal of the unsegregated mixed waste in the landfill sites has drastically contaminated the soil, air, water and land resources. Also, the toxic gases from the landfill sites and incineration plants are immensely contributing towards the climate change. Impacts related to waste disposal have magnified role in the eco sensitive zone of Himalayas where the impact get far more adverse than the other areas. But Aima Panchayat of Palampur in Kangra district of Himachal Pradesh has come up as a model Panchayat for integrated waste management. It has come up with an idea of local solution to the local problem of disposal of the generated waste. It is the first Panchayat in Himachal Pradesh to initiate practice of segregation of waste and its collection at rural level. Also, it has become first model Panchayat to set up a waste management plant for wet and dry waste.

4. Existing Practices - The segregated waste collected from all the households, shops and hotels/dhabas is brought to the waste management plant where it is treated according to its nature after its secondary segregation. The wet kitchen waste is put into bio composter machine which converts this waste into compost. This compost is distributed to the local residents according to their needs for the agricultural purposes. The dry waste such as sanitary pads and some biomedical waste from households are disposed of in the incinerator. The plastic bottles and polythene is converted into small granules by granulators or crushed down to be sold to the recyclers.

5. Resilient Practices / Technologies - Aima panchayat became the first panchayat in Himachal Pradesh to promote door to door collection of the waste from households. They fixed a user fee for the waste collected and it was collected from every household. Later for more efficient and eco-friendlier disposal of waste more feasible options using modern cleaner and greener techniques were adopted. The segregated waste from the households is brought to the garbage disposal plants where the plastic waste is converted into construction material while organic waste is converted into compost with help of composting machines. The hazardous household waste such as sanitary pads, diapers, bandages, infected cotton roles, syringes etc are disposed inside incinerators. The total cost for set up of waste treatment plant came out to be Rs 15 lakh, while the Panchayat is now earning Rs1.20 lakh every month which is utilized to meet operational cost of plant as well in the developmental activities of the area. The Panchayat waste treatment plant is also catering to the needs of solid waste management from surrounding areas, hotels and Palampur Municipal Council. Governmental officials from within the state as well as from other states of India are visiting this Panchayat for studying the model and for its replication in their areas. Aima panchayat has come up as a successful model especially at village level where modern ecofriendly techniques are used for efficient waste disposal.

Figure 1. Bio composter set up in waste management plant in Aima Panchayat

These techniques used in this set up for waste disposal are ecofriendly and a step of technology towards climate resilience. Uncertainty of weather conditions and temperature fluctuations with change in climate causes disruption in decomposition of mixed waste and causing pollution and health hazards. But these scientific methods of waste disposal provide effective management of waste produced by converting into resource for reuse. During extreme weather conditions such as flooding due to excess rainfall makes the regulation of landfill sites difficult increasing vulnerability towards pollution and health effects. These technological implications are small step towards reducing impacts of climate change on waste management practices.

6. Impact / Interventions of GBP-NIHE or any other Organizations - The government of Himachal Pradesh has encouraged the efforts of the Panchayat. Certain funds under (MPLAD) scheme has been provided and utilized for this practice by the Panchayat authorities by themselves. Also, elected representatives of the Panchayat along with community participation have resulted for a proper segregation at household level and its dissemination by workforce to the waste treatment site. This coordination and awareness among the local residents has enabled this model to become a proper example of the need of community role in the waste management at rural level.

7. Scope for Up Scaling - The (ISWM) approach of Aima Panchayat should be taken as a pilot project for further waste management crisis in the state of Himachal Pradesh and other scales of Himalaya Also, certain technologies such as product development from waste material, eco-bricks from plastic and others can be a game changer in the near future. The economically viable setup should be installed by the government or other agencies in rural areas those have population above certain limit and those looking for immediate waste management plan. Also, community awareness at ground level can help in better outcome of results.

8. Number of Persons / Communities Benefitted in the Region, if any - More than 7000 people comprising local residents and people from adjacent areas of Panchayat are being benefitted.

9. Name of Climate Smart Society - Aima Panchayat, Palampur, Kangra Himachal Pradesh

Urtica tea: A wild edible Product For uplifting livelihood and building adaptive capacity to climate change

Nisha Bisht and Mithilesh Singh

G.B. Pant National Institute of Himalayan Environment, Kosi-katarmal, Almora-263643, Uttarakhand, India

1. Climate Vulnerability Sector - Livelihoods

2. Location (Lat. & Long.) - Almora (29.594189, 79.653893) Pithoragarh (29.582861, 80.218185), Nainital (29.380304, 79.463570) ,and Pauri Garhwal (29.453015, 78.24,7923) districts of Uttarakhand.

3. Key Summary - Urtica grass, locally known as 'Bichchu' and 'Kandaali' is a type of perennial wild herb of the family Urticaceae. In the Himalayas, it grows in forests, thickets, grasslands, stream banks, floodplains, and newly disturbed moist areas at altitudes of 1200-3000 m. Urtica is often considered a weed or a useless plant. But due to its merits, it has fascinated the attention of the scientific and commercial communities.It is an important source of many value-added natural products as well as traditionally used as food, fibre, and medicine. Nettle tea contains many nutrients which can boost the body's immunity. In scientific studies it has been proved that vitamins A and C are found abundantly in this herb, therefore, it is beneficial in colds. It has many medicinal properties such as arthritis, diabetes, etc. As Urtica species has many medicinal properties and components that are beneficial for health, therefore interest from NGOs, youth, and women groups is growing in the production of Urtica/nettle tea. Many rural people from Almora, Nainital, Pauri Garhwal and other remote areas of Uttarakhand state have started nettle tea cultivation at their locality for income generation. Now, nettle tea is one of the most popular products of various villages of Uttarakhand.

4. Existing Practices - In recent years, with the growing interest towards health-related benefits of tea, organic tea is becoming a special niche product globally. Local people from Almora, Pithoragarh & Pauri Garhwal of Uttarakhand state have taken this idea of nettle tea cultivation from traditional knowledge of healthcare. Nettle is a wild plant and its cultivation does not require much care. In addition, its production takes place with less investment while people are selling its tea products at very good price, and earning good profit due to its high demand in India and also in foreign countries. Therefore, in Uttarakhand, its production played crucial role in building up capacity of local communities to improve economic conditions.

5. Resilient Practices / Technologies -

Tea processing involves the transformation of green leaves into dried leaves for brewing tea. In the process of making tea from nettle grass, selection of good leaves is the foundation of the quality of tea. Production of tea includes three phases:

- First, nettle grass is washed with hot water then placed for drying in the bright light of the sun. Next day, after careful examination of the leaves, they are hung in the air as separate bunches using thread. While hanging the bunch of nettle grass, special care is taken that it does not touch the ground and the wall. Leaves are checked repeatedly from time to time to find that the leaves do not turn black. Simultaneously, if the amount of moisture in the season is high, then the temperature of the room is fixed by artificial method heater and the room is disinfected by giving smoke of neem leaves in the morning and evening. Moisture is provided by sprinkling water to stabilize the colour of the leaves, as well as the taste and quality of the tea. In this way, this process takes about fourteen days.

- In the second stage, bunches of dried leaves are stored in another dark place for next five to six days.

- The third stage involves grinding of dried nettle leaves and packaging the resulting tea powder. Glass and plastic bags are used for long-term safe packaging. In addition, other ingredients such as lemongrass, ginger, rhododendron flowers, and basil leaves are mixed with nettle leaves to improve the taste of tea. After packing, it is ready for sale in the market.

Impact/Interventions of GBP-NIHE or any other organizations: Kothari Hill Development Committee, Self-help group and SOS organics are supporting and uplifting local people of small area to scale up their nettle tea production and livelihood.

6. Scope for Up Scaling - Various leaders from different area of Uttarakhand have revolutionized nettle tea cultivation in his locality. Their success has been turned out to be inspirational for many rural youths to accept farming as a source of livelihood. Under their leadership, many rural youths of their locality and also from neighbouring villages formed groups to start tea cultivation in commercial scale. These groups adopted nettle tea cultivation technologies. Now, nettle tea is one of the most popular products of various villages of Uttarakhand. Many govt. organizations, NGOs, farmers groups are supporting them for suitable marketing and promotion. After one to two years of nettle tea cultivation, the farmers/leaders are earning good amount of profit. They are producing this tea at a low cost and selling it under different names likeMountain Tea, Himalayan tea, Natural Nettle tea, Herbal tea, Pahari wellness tea in the market and through online medium.A leader ofNawara village of Almora district is producing this tea at a low price and selling it on Amazon for Rs 1000 per kgand earning a profit of up to Rs 60,000 per month. A 'Kothari group' from Dwarikhal village of Pauri Garhwal district working at local and producing tea 20-30 kg/month, earning profit up to 40,000 Rs/month. Furthermore, group of women associated with 'AajivikaSamooh' is working hard in free time to produce tea and earning little profit. 'Pahari Wellness Tea' produced in Nainital is also very famous, showing a great impact in livelihood promotion of the local people (Table 1).

7. Number of Persons / Communities Benefitted in the Region, if any - More than 200 villagers in major districts such as Almora, Nainital, Pauri Garhwal in Uttarakhand.

Table 1. Profit earned by local people of various districts of Uttarakhand.

Sr. No.	Village	District	Name of product	Selling price	Investment	Profit
1	Nawara	Almora	Mountain tea	1000 Rs/kg	40,000 Rs/ month approx.	60,000 Rs/ month approx.
2	Pant village, Chitai	Almora	SOS organics	110 Rs/50gm	30,000 Rs/ month approx.	50,000 Rs/ month approx.
3	Dwarikhal	Pauri Garhwal	Natural Nettle tea	120 Rs/kg	15,000 Rs/ month approx.	40,000 Rs/ month approx.
4	Hawalbagh	Almora	Herbal tea	200 Rs/Kg	20,000 Rs/ month approx.	50,000 Rs/ month approx.
5	Jeolikot	Nainital	Pahari wellness tea	399 Rs/50gm	35,000 Rs/ month approx.	70,000 Rs/ month approx.

8. Name of Climate Smart Leader/ Society/NGO, etc. - Women villagers

Fig. 1. Sun drying of Urtica leaves and packaging of leaves for marketing by SHG members of Hawalbagh, Almora

Ringal (Dwarf bamboo):A bioresource blooming robust green economy to adapt climate change in Uttarakhand

Nisha Bisht and Mithilesh Singh

G.B. Pant National Institute of Himalayan Environment, Kosi-katarmal, Almora-263643, Uttarakhand, India

1. Climate Vulnerability Sector - Livelihoods

2. Location (Lat. & Long.) - Pithoragarh (29.582861, 80.218185), Chamoli (30.2414.778, 79.19543684), Uttarkashi (30.434800, 78.27.000), Rudraprayag (30.284414, 78.981140), Bageshwar (29.51000, 79.461200), Joshimath (30.550552,79.565964) and Almora (29.594189, 79.653893) districts in Uttarakhand.

3. Key Summary - In Uttarakhand, a number of communities are involved in dwarf bamboo (Ringal) and natural fibre crafts work for their survival. Ringal, locally known as Ningav, is a potential resource available in different villages and adjoining forests in state Uttarakhand. It is a woody member of the grass family, fast growing, versatile and able to thrive on sloping, degraded soils. It grows on steep mountain slopes, at an elevation of 1800-2400m in the Garhwal and Kumaon Hills under-story of oak and rhododendron forests. Furthermore, ringal is usually tufted, gregarious with erect small culms which are conical in shape. The culms attain an average height of 12ft with a diameter of 10-20 mm, with internodes approx. 20 cm apart. Although, it is known as "poor man's timber" and have long been considered a valuable source of income for communities. especially socially backward communities of the Himalaya, besides supplementing their nutritional requirements. Owing to its fast growth and easy availability in the region, ringal is preferred by the rural people for construction, handicrafts, furniture and cottage industry. Realizing the potential of this resource, local people of Uttarakhand took a major initiative to use it for making different produces to improve livelihood status of marginal communities of IHR and to enhance their adaptive capacity.

4. Existing Practices - Ringal has commercial application and offer an income generation opportunity to marginalized communities of Himalaya. In such districts, Pithoragarh, Chamoli, Uttarkashi, Rudraprayag, Bageshwar, Joshimath, Almora of Uttarakhand, traditional artisans (Rudhiya) have set good employment due to abundant availability of rich quality and variety of ringal species in local forest. Approximate 300 bamboo artists from these areas are working on ringal craft & earning good profit by selling their products in market. In addition, ringal consumes less energy for processing, which reduces manufacturing costs and is economically more beneficial. Its modern use has become a popular alternative to products made from rapidly decaying wood and other more expensive materials, as products made from ringal last longer without any damage. Many new products which were previously made using wood are now made of dwarf bamboo, and this list is growing rapidly.

5. Resilient Practices / Technologies - Ringal weaving is an age-old craft of Uttarakhand with almost every family directly or indirectly involved in ringal weaving work in the regions of Chamoli, Bageshwar, Khalijhuri, Almora, Rudraprayag, Joshimath and Pithoragarh. All five species of ringalDrepanostachyum falcatum(Goluringal), Thamnocalamus spathiflorus (Dev ringal), T. jonsarensis (Thamringal), Arundineria falcate (Sarauringal) and Bhatputra (locally identified) are used by the villagers or weavers for making various items. Drepanostachyum falcatum, Thamnocalamus pathiflorus are popularly considered species of ringal, highly distributed in lower altitude range (1000-2000m) and high altitudinal region (above 2000m) respectively. Due to easy distribution and availability, these two species arehighly usedto make puja thalis, roofs and coverings for their grass houses, hookah pipes, table lamp, flowerpot, walking sticks and other products. However, Arundinaria falcata (Sararuringal) and Bhatpura are used for making handicraft and agricultural items. Due to less availability of T. jonsarensis (Thamringal) it is use comparatively less in high altitudes.

Weaving pattern differs from place to place and as per the quality of ringal and skills of the weavers. The style of weaving also helps for the durability and gives strength and stiffness to the product. Generally, ringal is collected between October - November from the forests. The barks are lightly peeled and dried in the sun for 3 - 4 days and then cut into 4 -12 parts as per the requirements (weaving or crafting domestic implements). The whole ringal is split into small strips with different lengths for warp (lengthwise yarns) and weft (crosswise yarns) as per the product requirement. The excess fibre of the ringal splits is removed before the weaving commences. (Fig. 1).

6. Impact/ Interventions of GBP-NIHE or any other Organizations - Uttarakhand Bamboo and Fibre Development Board is mainly serving as out-reach to roughly 20-30 existing bamboo artisans as well as potential artisans- women and unemployed youth from marginalised communities who are interesting in learning new skills to supplement their incomes.

7. Scope for Up Scaling - Now-a-Days, the usage of bamboo products is growing due to its good decomposable characteristics and also due to craze towards modern life style products that are introduced in the current market.Products like fruit and vegetable baskets, pen stand, flower vases, vessels and tea trays are beautifully weaved in attractive design patterns like plane weave, basket weave and twill weaves. Some other products like basket, Big basket, Shallow baskets/ Porridge, Grain baskets, Double walled baskets, Winnowers, Hand basket, Mat, Broom, and Dustbinare used by rural people for daily activities, agricultural support and selling in market with good price. (Table1).

Bamboo is proving to be superior alternative to wood and plastic for many uses. Bamboo being a versatile material could help us to reduce our dependence on hardwood and plastic in a much bigger way and thereby help to save the trees and eradicate plastic from our living space. Furthermore, products made from bamboo are durable and strong in comparison to plastic containers.

8. Number of Persons / Communities Benefitted in the Region, if any - Approximate 300-400weavers in major districts such as Almora, Nainital, Pithoragarh, Chamoli, and Uttarkashi in Uttarakhand.

Table 1. List of traditional products made byRingal weavers, their market value and uses. (Source: D'source, Kumar, 2009)

Sr. No.	Local Name	English Name	Used for	Price
1	Tokri	Basket	For keeping Chapati, fruits and flowers etc.	80-100 Rs
2	Solta	A big basket	Used for fodder and litter collection	180-250 Rs
3	Dalia	Shallow baskets/ Porridge	Used for fodder, fuel & crop residue and manure collection	120-150 Rs
4	Puthuka	Grain baskets	For storage of grains.	100-150 Rs
5	Dvak	Double walled baskets	Used for crop residue and manure collection	200-250 Rs
6	Suppa	Winnowers	Winnowing grains	150-200 Rs
7	Hathkandi	Hand basket	For shopping goods	250-300 Rs
8	Mothi/ Dan Chatai	Mat	Used for drying grains like paddy, wheat etc in the sun	200-300 Rs
9	Jhaaru	Broom	For sweeping and cleaning floors	70-100 Rs
10	Kudadan	Dustbin	A container for keeping household rubbish	150-200 Rs
11	Fooldan	Flowerpot	For decorating rooms and keeping flowers	50-100 Rs
12	Kalamdan	Pen-rack	Keeping pens	40-50 Rs

Fig. 1. Making of ringalcrafts by rural people (weavers)of Uttarakhand. (PC: D'sourceHimantarpatrika, Nisha Bisht)

Honeybee keeping: dual benefit in change and poverty mitigation

Priyanka Maiti[1], J.C. Kuniyal[1], Sumit Rai[1]* and Kapil Kesarwani[2]

[1]Centre for Environmental Assessment & Climate Change, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora -263 643, Uttarakhand, India

[2]Centre for Cryosphere & Climate Change Studies, National Institute of Hydrology, Roorkee - 247 667, Uttarakhand, India

*Corresponding E-mail: sumit.nihe@gmail.com

1. Climate Vulnerability Sector - Livelihood and forest management

2. Location (Lat. & Long.) - Dhari village, Almora, Uttarakhand Latitude (29°36'29.38"N, longitude 79°36'29.38"E)

3. Key Summary - Honey beekeeping is one of the traditional practices in the Indian Himalayan Region (IHR) and local people have been aware of the worthwhile profits to be gained from bees. Along with the primary harvested product honey, other earnest materials of the practice include beeswax, pollen, propolis, royal jelly and bee venom, and the use of bees in apitherapy. In ecosystem point of view, bees are important pollinators, helps in ecosystem maintenance that promotes quality and quantity of cropping system. Consequently, honey beekeeping could be promoted as dual benefit worthy practical tool for climate change resilience. In one hand it is an efficient livelihood option with high market demand of original honey and other way it will make community level efforts to maintain forest land and biodiversity for their own benefit, which will ultimately benefit the global climate change mitigation.

4. Existing Practices - In the IHR, honey beekeeping has special significance as livelihood for the poor and landless farmers and women. The practice could be adopted in own house with very small start-up investment and profit generates within one year. Traditionally, Mr. Prem Ballabh Pandey, a 67 years old farmer and bee keeper from Dhari village, learnt the method of beekeeping from his father and grandfather. In this method, wall hive is left during construction of house in a height of 200-250 cm from floor. Apis cerana indica descends naturally and settles in this hive and make combs. Honey is collected from the hives in months of April-June in a year. Nearly 5-8 Kg honey is extracted from each hive and twice in a year.

5. Resilient Practices / Technologies - Presently, Mr. Prem Ballabh Pandy is used to with both traditional and modern bee keeping practices. He has 15 traditional beehives in wall and 55 in boxes. He has also taken training from the Uttarakhand, State Apiary Board Jeolikote, District Nainital. Now he gets 10-15 Kg honey from each box in season and extract in the months of February to June. 80-90 Kg honey is produced per year in his home. According to him, selection of site for the placement of boxes is a major issue behind establishment of successful bee colonies. Hives close to the flowers effects the flavour of the honey and its production. Therefore, placement of the box should made with in one mile from the flowers and quarter mile from the fresh water source. Plenty of sunshine is also necessary for place selection as it helps the bees to find the queen and eggs in the comb. It is recommended to have no more than four beehives on a quarter acre or less. Apis cerana indica, species is found in the hill regions. Present days, basic bee keeping equipment are also used by Mr. Pandey including hive tool, smoker, frames and foundation, feeders, bee hive components like hive body, hive stand, queen excluder, inner/outer cover etc. For extraction of honey, he uses cotton/poly coverall with attached zipper veil, mesh helmet and vented leather gloves. Smoke and chase technique for cutting the comb. The freshly collected honey contains wax and sometimes the young bee from the hive.

After that, honey is sieved properly and preserved in glass bottles. He also mentioned that, nowadays he has started growing mustard in his fields which has increased the amount of honey and he get nearly 15

Kg honey from a box in growing season. With addition to the above, a floral calendar may be maintained to record the availability of bee flora around the year in for individual area. The calendar should consist the sources of nectar and pollen, the strength of the sources along with flowering time and duration of nectar and pollen availability. It shows the availability of bee flora as well as the dearth period, when pasture and feeding management can be carried out (ICIMOD, 2012). The price of honey varies from ₹ 1000- 3000/kg depending on the verity and the other by products include, beeswax (₹ 650 -900/ kg), pollen (₹550 -700/gm), royal jelly (₹ 19000 -27000/ kg) and bee venom (10,000 - 12,000/gm).

6. Impact / Interventions of GBP-NIHE or any other Organizations - In Uttarakhand, agencies like Uttarakhand, State Apiary Board Jeolikote, District Nainital, ENVIS centre, G.B. Pant National Institute of Himalayan Environment, Kosi, Katramal, Almora provide training in Wild Beekeeping and Processing.

7. Scope for Up Scaling - Starting up with few resources, honey bee keeping is an excellent climate resilient livelihood practice with very low labour and time involvement. It is necessary to provide training and awareness to other villagers for adopting the practice. Participation of women in the practice should be promoted as it requires less time involvement and women can easily adopt the practice with their household work. Beekeepers can establish themselves in local beekeeping associations, improve their techniques, increase production and strengthen their position on the market. However, this type of practice should be coupled with some local government agencies which will help to improve market chain of the products and promote sustainable establishment of the practice in the area.

8. Number of Persons / Communities Benefitted in the Region, if any - Two-three families in the Dhari village, Almora.

9. Name of Climate Smart Leader/ Society/NGO, etc. - Mr. Prem Ballabh Pandey

Fig. 1. Traditional wall and modern hive honeycombs

G.B. Pant National Institute of Himalayan Environment (NIHE) established in 1988-89, is an autonomous Institute of the Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India. NIHE identified as a focal agency to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound development in the entire Indian Himalayan Region (IHR). The Institute attempts to maintain a balance of intricate linkages between socio-cultural, ecological, economic and physical systems that could lead to sustainability in the IHR. To achieve this, the Institute follows a multidisciplinary and holistic approach in all its Research and Development programmes with emphasis on interlinking natural and social sciences. In this effort, particular attention is given to the preservation of fragile mountain ecosystems, indigenous knowledge systems and sustainable use of natural resources. A conscious effort is made to ensure participation of local inhabitants for long-term acceptance and success of various programmes. Training, environmental education and awareness to different stakeholders are essential components of all the R&D programmes of the Institute. The Institute functions in a decentralized manner having 30+ scientists. R&D programmes of the institute are majorly based on the stakeholder needs and is carried out by 05 Regional Centers across the IHR – i) Ladakh Regional Centre (Leh, Ladakh), ii) Himachal Regional Centre (Kullu, Himachal Pradesh), iii) Garhwal Regional Centre (Srinagar-Garhwal, Uttarakhand), iv) Sikkim Regional Centre (Pangthang, Sikkim), and v) North-East Regional Centre (Itanagar, Arunachal Pradesh) along with headquarters at Almora (Uttarakhand) and Mountain Division at MoEF&CC, New Delhi.

Dr. J.C. Kuniyal
Scientist 'G' & Head: CEA&CC
G.B. Pant National Institute of Himalayan Environment (NIHE)
Kosi-Katarmal, Almora - 263 643, Uttarakhand, INDIA
jckuniyal@gmail.com

Dr. Kapil Kesarwani
Scientist 'D', C4S
National Institute of Hydrology (NIH)
Roorkee - 247 667, Haridwar
Uttarakhand, INDIA
kapilnih@gmail.com

Dr. Sumit Rai
Scientist 'D', CEA&CC
G.B. Pant National Institute of Himalayan Environment (NIHE)
Kosi-Katarmal, Almora - 263 643, Uttarakhand, INDIA
sumit.nihe@gmail.com

Dr. Mithilesh Singh
Scientist 'D', CEA&CC
G.B. Pant National Institute of Himalayan Environment (NIHE)
Kosi-Katarmal, Almora - 263 643, Uttarakhand, INDIA
singmithilesh@gmail.com

Centre for Environmental Assessment & Climate Change (CEA&CC)

G.B. Pant National Institute of Himalayan Environment (NIHE)

(An Autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of India)
Kosi-Katarmal, Almora-263643, Uttarakhand, India
www.gbpihed.gov.in