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RESEARCH ARTICLE

MOUNTAIN SPECIFIC RURAL TECHNOLOGIES FOR SUSTAINABILITY OF RURAL LIVELIHOODS IN HIMACHAL PRADESH, INDIA

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ABSTRACT

Lack of mountain specific technologies have proven less efficient in earning good income for the people of the rural areas. The traditional rural technologies in the state practiced from ages are at an edge of extinction due to high encouragement to the modern technologies. Himachal Pradesh being a rich state in traditional knowledge have many such technologies which can prove rewarding to the rural people for income generation. Due to higher unemployment rate in the state, policy makers and the government should help in implementing traditional rural technologies in the villages by providing financial aids and improving existing technologies, making them more competent. It is a need of an hour to implement these technologies as they are region specific, eco friendly, sustainable and climate resilient which makes them more robust in their implementation and for livelihood generation.

INTRODUCTION

The India Himalayan Region (IHR) is a region which is rich in biodiversity, natural resources, culture and traditions. The Himalayas are the most fragile and eco-sensitive geographical regions of the world formed by young fold mountains. The complete Himalayan region has seen a growth of 3.305% annually in the last 50 years (1961-2011), which is 3 times higher than the world average (1.096%) (Apollo, 2017). If this growth still continues at the same rate of 3.30 % the whole Himalayan population will exceed 260 million by 2061, though recent decades have shown a slower growth rate (Apollo, 2017). This trend in population growth has revealed a threat to the carrying capacity of the Himalayan ecosystem which will directly affect the lives of people living in this region. This growth can be a big challenge for the Himalayan region, especially when coinciding with the quality of life of the inhabitants of this region (Apollo, 2017). Maintaining this cultural diversity is one of the chief tasks for Himalayan society (Zurich and Pacheo, 2006).

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Himachal Pradesh located in the western Himalayan region is among one of the fastest developing Himalayan states. It has a population of 6864602, of which 89.97 % is comprised of a rural population (ENVIS Centre MoEFCC, 2020). The percentage of the rural population was 90.2% during the census year 2001(ENVIS Centre MoEFCC, 2020 and Census 2011) which is slightly higher from 2011 census data for the rural areas. The urban population has increased from 9.79% to 10% from the census data of 2001 to 2011. Change in rural and urban populations during this decade could be possibly due to the migration of people from villages to the cities (Apollo, 2017). The main cause of migration from rural to urban areas is to get employment and other basic facilities such as education and health.

Status of Livelihood in Himachal Pradesh: According to data published by a think tank, Centre for monitoring Indian Economy (CMIE), Himachal Pradesh was ranked on third position in unemployment rate (20.2%) after Tripura (28.6%) and Haryana (27.6%). This rate is higher than the national average which is 7.7%. Each year more than 60000 young people are added in list of people seeking job, while the vacancies in government and private sectors remain low as compared to the number of people in search of jobs. (Hindustan Times February 03, 2020). Agriculture is the main occupation of the people of Himachal Pradesh.

Out of total land holdings 75.3% of land is available for cultivation. Agriculture, Horticulture, Livestock, Forestry & Logging, Fishing, mining and quarrying sub-sectors which comprises of Primary sector with allied sector supports 60% of population. In 2018-2019 they have registered a negative growth of 1.7 percent. Industry sector broadly comprises of Manufacturing (Organised & Un-Organised), Electricity, Gas & Water Supply and Construction registered a growth rate of 8.0 percent in 2018-19 over the previous year. The Services sector which is mainly comprised of Trade, Hotels & Restaurants, Transport by other means & Storage Communications, Banking & Insurance, Real Estate & Professional Services and Community, Social & Personal services registered a growth rate of 8.6 percent in 2018-19 (FRE) over previous year (Economic Survey Himachal Pradesh, 2019-2020). These figures give us basic idea of the economic situations prevailing in the state. The primary sector which is majorly seen as a contribution of rural areas has seen a negative growth rate in the recent year pointing towards serious issues faced in these sectors.

Traditionally, the villages of India were self sustainable meeting their own demands by locally produced products but with shift on focus on urban areas and ignoring rural development the rural areas became more prone to the migration due to less basic facilities and degradation of living standards. The age old technologies which helped people to be self sufficient can be of great help to make rural self sufficient in many aspects chiefly providing livelihood generation through agriculture, horticulture, tourism etc. Improving income of people of villagers through these sectors can also mitigate the problem of migration. As the living standards of people increases basic facilities in the villages will be automatically improved. Therefore the main objective of the paper is to identify the different traditional mountain specific rural technologies in Himachal Pradesh and potential of these rural technologies which can further help in generating employment and livelihood to the people residing in the rural areas of Himachal Pradesh.

METHODOLOGY

Secondary data was collected from the census reports, ENVIS centres of state and central government, agriculture department, economic survey of Himachal Pradesh and articles published in newspapers. Different research papers related to population and demography, migration and sustainable rural technologies were referred. The results were compared and analyzed with Himachal Pradesh, India.

Study Area: Geology/Geography and Demography: The state of Himachal Pradesh is a Himalayan region lying in the north western part of India at 30°23'-33°13'N to 75°43'-79°4 E. Its altitude varies from 460m to 6600m amsl covering three ranges of the Himalayas i.e. Shivalik, lesser Himalayas and the greater Himalayas. The total geographical region covered by the state is 55,673 km² and administratively divided into 12 districts. Primarily five perennial rivers flow through the state which is Beas, Ravi, Chenab, Satluj and Yamuna. According to the census 2011, the total population of the state is 6,864,602 with 50.7% males and 49.2% females. A decrease in the total population growth to 12.94 percent in this decade was observed while in the previous decade it was 17.53 percent. In 2011, Himachal Pradesh formed 0.57 percent of total Indian population.

In 2001, the figure was 0.59 percent. At present, the rural population is 89.97 % of the total population while 10% makes the urban population (ENVIS Centre MoEFCC, 2020). The percentage of the rural population was 90.2% during the census year 2001 (ENVIS Centre MoEFCC, 2020) while the urban population was 9.79% in the last decade. Out of the total population of Himachal Pradesh, 82.08% is literate of which 89.53 % of male and 73.51 % are female literate.

Climate, Zones and Vegetation in Himachal Pradesh: The climate of northern part or the glacial region of this state is almost cool throughout the year. In winter, snowfall continues until March and could be as high as three meters on the average. The southern part has similarity with the plains and varies from hot to sub-humid. The state experiences cold season from October to middle of March, hot seasons from April to June, and rainy season begins from July and goes up to September. As per agro climatically zones, Himachal Pradesh has been divided into 4 zones on the bases of temperature, soil, rainfall, etc. (State Agricultural Plan, 2009)

Vegetation: The vegetation of Himachal is mainly classified into tropical (below 900 to 1000m), sub tropical (1000m - 2000m), temperate (2000m-3500m), sub alpine (3500-4000m) and alpine (above 4000m) vegetation (Thakur *et al.*, 2018).

Mountain Specific Sustainable Rural Technologies: There are already many known sustainable rural technologies which are being used by rural communities in the Himalaya's from ages. These techniques have been developed according to the needs and the availability of the resources. Some of techniques used by the people of Himachal Pradesh from ages are as:

Gharats / Water Mills: The traditional knowledge which has been gained over a period of time is passed from one generation to another generation from time immemorial. People living in mountainous regions are still using this traditional knowledge to fulfil their basic needs in their day to day lives. The techniques used from agricultural practices to daily household chores are performed with the help of this knowledge. Since ages, the Himalayan people have developed indigenous devices in the form of watermills, locally known as gharats to harness renewable hydro-energy. From a very long time the idea of using water energy by converting it into mechanical energy is known to people (Slathia *et al.*, 2018). In the mountainous regions where water is available throughout the year in form of perennial river and streams forms an important natural source of energy. The energy of flowing water is trapped and converted into mechanical energy which is further used in performing different tasks such as gridding and milling. It is assumed that about 20,000 gharats are present throughout Indian Himalayan Region (Slathia *et al.*, 2018). The watermill technology built indigenously has been designed locally. The materials used for building the gharats are available locally and are much cheaper than the modern machinery. The low running and maintenance cost make this technology further cost effective. Further from building till operation of the gharat the complete process is from natural resources and eco friendly further making this technique more robust.

The Himachali gharat has remained technically unchanged for centuries, using ancient technique developed around 100 B.C.E. to grind wheat into flour (Bunch and Hellmans, 2004). The water from nearby water bodies is guided by canal to chute, which is placed above gharat where it gains momentum as waterfalls towards turbine. A funnel located on top of grindstone slowly releases grain in its centre. The grinded flour is released through the edges of the grindstone which is later collected. Chiefly the turbine and chute in gharat is mostly constructed of wood which in recent years have been replaced by metal ones (Vashisht, 2012). This technology is so simple and extensively known that every person including children and women can operate gharat even in the absence of the owner. Sustainable source of energy in food production and processing plays a crucial role in economic and social development of mountainous region worldwide therefore gharat still plays a very important role especially in remote villages where modern technology is still not very popular due to its backwardness.

A natural resource is harness into energy and income for families with the use of this simple technology and is also considered to produce higher quality of flour than modern alternatives (Ghosh, 2008). With the introduction of the modern substitutes for milling techniques among the rural communities, has greatly reduced demand for the gharats services. Some of reasons for the decrease in the popularity in gharats are decrease in water flow, low output in grinding, tough terrain of the gharats, lack of electricity decreasing working hours and high cost of maintenance due to lack of technical knowhow (Leiro *et al.*, 2015). Technical improvements have been imitated by Alternate Hydro-Energy Centre (AHEC), Rorkee under UNDP –GEF project one for mechanical outputs and other for mechanical and electrical outputs (Sharma *et al.*, 2008). The ministry of non conventional energy sources has also started promotional incentives schemes for development/ upgrading of gharats under which it is giving financial support of 75% of the actual cost to the owners. 30-40% efficiency can be increased by modifications in the gharats (Sharma *et al.*, 2008). While some gharats with good water flow can also produce 5.0kW which is sufficient to meet the electricity demand of 20-50 households (Sharma *et al.*, 2008). So With some minor upgrades and adaptations to their business model, the gharats of Himachal can be preserved, providing millers with locally important and financially viable businesses.

Kulh: One of the traditional methods of water irrigation used in Himachal is Kulhs. These are the diversion channels made by diverting small streamlets from parent water streams or springs by dugout. This system dates back to 16th century is used best post-monsoon when the abundant rainwater runs off through diversion channels (Payret *et al.*, 2013). Due to the availability of perennial water in the hills from the glaciers and rain, the Kulh provide the most efficient water irrigation system in the mountainous terrain. Traditionally kulhs are temporary and permanent types in which depends upon its construction material used to build them. Temporary structures are preferably built using boulders, rocks, and bamboo and tree branches which have been replaced by concrete recently. A site that has a concrete foundation and has a depth of at least eight inches is required to construct kulhs where different other factors like slope area of land and the availability of rivers are also considered (Bhaduri, 2013).

Different distribution points are created by the diversion of water at different points (The people's science institute, 2003). This system can range from hundreds to thousands of kilometers long to allow water (primarily floodwater) to be diverted to farmlands. The Kulhs have a trapezoidal cross section and are one to two tenths of a square meter in areas (CE IIT Kharagpur, 2011). The water used for irrigation is supplied to terraced field land typically situated on hillsides where water flows due to gravity that transverses the contours of a mountain slope (The people's science institute, 2003) (Sengupta, 1985; CE IIT Kharagpur, 2011). These diversion channels are successfully managed by local government forming sustainable, cost effective community based systems (Bhaduri, 2013).

Since agriculture and horticulture mainly contributing to the primary sector therefore traditional water harvesting system forms a backbone in the mountainous terrain of Himachal Pradesh. Traditional technologies are highly relevant particularly for smallholding farmers, as these are being implemented and maintained by farmers at their own cost (Sethi, 2011). A typical community Kulh serves six to 30 farmers; irrigate an area of about 20 ha. As compared to the high cost modern water irrigation system, this traditional system forms the most efficient way to irrigate the farmlands situated in difficult terrains of the Himalayas. Hindrances such as limited finance, labour shortage, improper demarcated field boundaries, lack of a proper mechanism for their maintenance, difficulty in facilitating group action among neighbouring farmers, low level of motivation, etc. (Sethi, 2011) adversely affecting the adoption of these technologies should be removed by common efforts of local community and government.

Kath Kunni Designs/Houses: Traditional construction techniques vary from region to region depending on weather, material efficiency, and the seismic zone just like Kath-Kunni, Dhajji-Diwari construction, Dry stone construction, Mud construction, and wood construction (Singh and Sharma, 2019). But the Kath-Kunni house construction forms are most popular and peculiar in some regions of Himachal Pradesh. This type of architecture is well established in districts of Kullu, Mandi, and part of Shimla and Solan which are situated in central Himachal Pradesh (Singh and Sharma, 2019). A combination of wood and stone is used in the construction technique. In the Kath Kunni construction timber logs are alternately arranged with stones without any use of mortar.

A pair of wooden beams runs along the entire length of the wall, and another pair of the wooden beams in alternate directions placed perpendicular to each other. The space between the wooden beams is then filled with dry stones. The absence of vertical members in construction is the main considerable part of this type of construction. Long and well dressed flat stones are used in construction (Singh and Sharma, 2019). The thickness of walls ranges from 400mm to 1000mm in some cases, which provides insulation from the cold and hot climate. The traditional construction techniques of Himachal Pradesh are the outcome of its typical climate conditions, landscapes, availability of raw materials, and other natural resources (Singh and Sharma, 2019). Kath Kunni construction is mainly popular in Himachal Pradesh due to their seismic resistance. The absence of cementing material and the wooden angles and

corners during seismic activities distribute the stress evenly in the structure making it resistant to fall and destruction. Design efficiency, energy efficient configuration, structural resilience, low maintenance cost, Biodegradable resources for construction and ease of construction are some of the reasons for the popularity of this architecture. Due to the popularity of cemented houses and shortage of skilled labour and forest wood for Kath Kunni construction had decreased the number of traditional buildings. In recent times these traditional houses have again gained popularity among people. New temples, some houses hotels etc in the region are being constructed through this architectural technique. This architectural technique is unique to this area so skilled labour who can build them also comes from here; therefore, this can be a good source of income to some people who gets involved in learning this age-old technique of constructing these buildings.

Bee Keeping: Beekeeping is one of the ancient practices in India which provides sustainable livelihood to many people. In Himachal Pradesh, the rearing of honey bees as part of normal day to day practices. In different parts of Himachal Himalayas, several types of hives such as hollowed logs, wall recesses, and boxes of various dimensions and designs are in use even today for beekeeping. The remnants of ancient bee knowledge are reflected by these beehives and are the vestiges of honey-collection techniques being practiced by mountain farmers through the centuries (Verma and Attri, 2008). With the introduction and rearing of *A. mellifera*, the most honey yielding species in the Kangra district, Himachal Pradesh became the first pioneer state in beekeeping. Modern beekeeping practice was started in 1934 in Kullu and in 1936 in Kangra valley. Till 1961 only the Indian honeybee *Apis cerana indica* was reared in the State (Kumar and Kumari 2017). It was in 1960s that Commercial beekeeping in Himachal Pradesh was started. *Apis mellifera* adapted so well and did so well that it encouraged presently nearly 1500 unemployed educated youths have taken up *Apis mellifera* beekeeping as full time profession. Beekeeping is a sustainable income generation for rural people even people without land can take up it as a profession. It is socio-economic venture that plays an important role in sustainable agriculture & bio-farming (Kumar and Kumari 2017). Punjab, Haryana, Himachal, Uttar Pradesh, Bihar, and West Bengal are the main honey producing states (Kumar and Kumari 2017). Beekeeping as a traditional sustainable technique with some modifications has immense potential for income generation as there is a minimum investment (Patil 2019). As a state with rich natural resources especially bee flora, Himachal Pradesh has an enormous scope for further expansion of beekeeping as a profession for many rural unemployed educated youth of the state to promote self-employment.

DISCUSSION

Out of the total geographical area of India, only 18 percent of the area is covered by the Indian Himalayan region while it constitutes 50% forest cover of the country. This feature of the Himalayas makes this region rich in biodiversity and natural resources (Anonymous, 2005) (Saxena et al., 2001). Himachal Pradesh covers 1.69% of the total geographical area of the country (Indian State of Forest Report 2019). The total area covered by Forest is 15,433.52 sq km that is 27.72% of the State's geographical area (India State of Forest

Report 2019). The majority of 89.97% of the rural population depends on agricultural, horticultural, and forestry based practices for livelihood generation. The trend observed from the last two censuses shows changes in urban and rural populations which can be caused by migration from rural to urban areas. Though people reside in natural resource rich regions they themselves are underprivileged due to limited economic development activities leading to migration from rural to urban or industrial areas (Maikhuri et al., 2011). There are many modern technologies introduced in rural areas by the government in different sector to improve their production and efficiency. This top down approach has failed to gain the desirable objectives due to deficient knowledge and capacity building (Maikhuri et al., 2009) (Agarwal and Joshi, 2006). Due to varying geographical and environmental settings, variation in economic and social conditions these technologies do not perform up to their full potential proving them less proficient for this region. As suggested by different researchers bottom up approach is needed to be followed which includes building technologies on indigenous knowledge, making people aware of scientific knowledge, linking indigenous knowledge for environmental development, during technology development implementation and evaluation there should be involvement of people throughout (Maikhuri et al., 2011).

The indigenous rural technologies developed before many generations are the product of many trials and errors and are in their refined form according to their utility. But today due to an increase in needs and changes in the demands these technologies are not able to perform according to the needs of people therefore becoming less popular. These indigenous rural technologies are based on scientific principles that are now known to people through research studies. These practices are robust when implemented in these areas of their origin. All the technologies discussed above in this paper are in common use in Himachal Pradesh for ages. These all technologies are made up of locally available biodegradable materials which can be reused, are efficiently designed according to needs and local environment, are energy efficient, have low building cost maintenance cost, are based on community participation, and most importantly are Climate-resilient sustainable.

These all attributes of these technologies qualify them to be given first preference over modern complementary technologies. Himachal Pradesh is a Himalayan state situated in an eco fragile zone rich in natural resources and indigenous knowledge. This knowledge can be utilized for livelihood generation from these resources in a sustainable manner. In a state with literacy of 82.80%, it is difficult to accommodate so many people in government and private service sectors causing an increase in the unemployment rate of the state. This problem can be solved by implementing different rural indigenous technologies at the village level so that people start earning their livelihood without migration. The rural technologies discussed in this paper can greatly help in improving the income of rural people. Most of the Himalayan villages depend on monsoons for irrigation which increases their dependency on rains. The modern irrigation system is expensive due to mountainous terrain; therefore Kulh irrigation which is a community-based system can increase agricultural and horticultural outputs.

Table 1. Demography of Himachal Pradesh, India

Description	2011	2001
Approximate Population	68.65 Lakh	60.78 Lakh
Actual Population	6,864,602	6,077,900
Male	3,481,873	3,087,940
Female	3,382,729	2,989,960
Population Growth	12.94%	17.53%
Population Density	123 per sq km	109 per sq km
Percentage of total Population	0.57%	0.59%
Sex Ratio	972	970
Child Sex Ratio	909	957
Density/km ²	123	109
Density/mi ²	319	283
Area km ²	55,673	55,673
Area mi ²	21,495	21,496
Literacy	82.80 %	76.48 %
Male Literacy	89.53 %	85.35 %
Female Literacy	73.51 %	65.61 %
Total Literate	5,039,736	4,041,621
Male Literate	2,752,590	2,278,386
Female Literate	2,287,146	1,763,235

Source: <http://www.hpenvs.nic.in>

Table 2. Agro-climatic zones of Himachal Pradesh, India

S.N.	Particulars	Sub-montane low hills zone (Zone-I)	Mid-hills high humid zone (Zone-II)	High hills temperate wet zone (Zone-III)	High hills temperate dry zone (Zone-IV)
1.	Geographical area (000 ha)	913.2 (16.4)	1183.2 (21.3)	1280.9 (23.0)	2190.0 (39.0)
2.	Total cropped area	355.1 (38.0)	383.4 (41.0)	171.8 (18.4)	24.0 (2.6)
3.	Elevation)	Below 650 metres (above mean sea level)	650-1800 metres (above mean sea level)	1800-2200 metres (above mean sea level)	2200 metres and above (above mean sea level)
4.	Soil pH	Neutral, coarse texture	Acidic, coarse texture	Acidic in reaction shallow in depth and sloppy	Neutral reaction, coarse texture
5.	Rainfall	About 1000 mm	1500-3000 mm	About 1000 mm	250 mm
6.	Field crops	Rice maize, wheat and pulses	Rice, maize, wheat barley, pulses	Maize, potato and wheat, off-season vegetables	Barley, potato, wheat and off-season vegetables
7.	Fruits	Sub-tropical fruits	Apple, other temperate fruits, stone fruits, nuts and sub tropical fruits , particularly mango and litchi	Apple, other temperate fruits and nuts	Nuts, dry fruits and apple
8.	Percentage of irrigated area	16.6	17.5	7.8	40.6

Source: National Agricultural Research Project, Report of the ICAR Review Committee, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi.

The traditional watermills or gharats, after some modifications, can prove to be very useful in providing healthy natural milling options for locals as well as a source of electricity for small hamlets or villages. The traditional architectural buildings are gaining their importance in modern times so there is a demand for skilled carpenters for building temples, houses, hotels, etc. There is a high demand in the tourism industry for such skilled efficient workers. The traditional honey bee hives can be further modernized for more production of honey as this market has a good scope of income generation, especially small scale farmers. There is a lot of scope for income generation through the implementation of rural technologies but gaps in scientific data, inadequate knowledge of rural technologies, more promotion of modern technologies, and less financial aids and promotion of rural technologies are some of the reasons for the failure to appreciate these indigenous technologies. To make these rural technologies a success story for earning a good living before implementation stakeholders should be taken into consideration. They should be involved throughout the development and till implementation. According to Maikhuri *et al.*, 2011 for successful technology transfer, nine steps should be followed i.e. site selection, resource survey, development of

an operational framework, planning, and management of demonstration crystalizing the specificities of people's participation, capacity building, and skill development and feedbacks. Before the implantation of these technologies the cost-benefit analysis and Strength, weakness, opportunity, and threat (SWOT) analysis should be done for their successful implantation.

Conclusion

All the rural technologies which are used traditionally by the people from ages have a good potential to generate livelihood directly or indirectly. Little transformation or addition to the old techniques can help in increasing the efficiency of output given by these techniques. The traditional techniques are sustainable, area specific in use and construction material and eco friendly. The efficiency of these techniques is high as they are best suited for area specific and are best product of trial and errors. Also the materials used for the construction of these are available locally and hence the construction cost is low and also construction is eco friendly. Traditional systems provide an opportunity for the people to be involved. Therefore government and private sectors should come forward and

help rural people to upgrade old technologies by giving them economic and technical assistance. The help from such institutes can help these rural areas become self-reliant and sources of higher income generation, hence decreasing migration, the problem of urban overpopulation and unemployment.

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