Indian Journal of Extension Education
Vol. 49, No. 3 & 4, 2013 (72-79)

Strengthening Transfer of Technology Among High Altitude Community of Ladakh

Dorjey Angchok[1] and R. B. Srivastava[2]

ABSTRACT

Different socio-cultural environment requires different method of technological interventions, so is true of cold-arid high altitude communities (HACs). In India, cold-arid HAC like Ladakh (J&K) and Lahoul Spiti (HP) has been neglected in this respect because of their lack of representation at national level due to their meager proportion in terms of population size. Though there has been considerable interest shown by social scientists in understanding the socio-cultural environment prevailing in these parts of the world, but there has been lack of interest among researchers to understand and contrive a model of technology intervention among such communities. This has resulted into the adoption of '*copy and paste*' model of technology intervention modalities, where models adopted for lowlanders were/are applied for HAC at various policy decision making platforms. Therefore an effort has been made through this paper to understand the various factors (both local and contextual) whose understanding would help extension workers and policy makers in increasing the efficacy and rate of technology transfer among HAC. Emphasis has been given to understand the prevailing local institutions, local wisdom and resource management practices and how these understanding could be applied in various extension activities for an effective technology transfer and intervention. The present study limit itself to Ladakh region due to accessibility constraints and the familiarity of the results.

Key words: Strengthening linkage; high altitude community

INTRODUCTION

In India, the risk prone high altitude area constitutes the easternmost trans-Himalayan part of Ladakh and Zanskar range (Jammu and Kashmir State) and some parts of Lahoul Spiti (Himachal Pradesh State). Truly described as cold desert with low population density, Ladakh constitutes the easternmost trans-Himalayan part of Jammu and Kashmir State of India comprising of two districts viz. Leh and Kargil, bordering Pakistan and China (figure 01). Geographical area of Leh covers an area of 82665 Sq.Km. and 51786 Hect. of reporting area, situated along the valleys of the Indus river, with an estimated population of 117232[1] (figure 02). Leh is India's highest and one of its most arid, coldest and sparsely populated high altitude districts[2]. Geographically Leh district is sandwiched between two Himalayan ranges Zanskar on its west and Ladakh on its east. Across the eastern range are the great highlands of Leh district Chang Thang which extend along the south of Ladakh and west, over the Indian-Chinese border, into Tibet. To the north of Leh district is the district of Kargil and beyond it is the Karokoram Range. The Indus River runs through Leh district from its south to its north, collecting the water of melting glaciers and straddling several high-lying villages along its banks. Geoecologically Leh district is divided into almost halves a cold, arid desert with minimal precipitation in the northern half, and high altitude grassland (Chang Thang) with perennial grasses in the southern half.

The cold desert region of Ladakh lying at an elevation varying between 8500 to 16500 ft. MSL is characterized by low relative humidity (20-40%), low atmospheric pressure (493 mm Hg), low partial pressure of oxygen, high wind velocity (8-10 km/hr), very low annual precipitation (80-300 mm), and sub-zero temperature (up to -40 ˚C) during winter months. Intensive sunlight, high evaporation rate, strong winds and fluctuating temperature (30C to -40C) characterize the general climate. It is generally said that a man sitting in the sun with his feet in the shade can have sunstroke and frostbite at the same time. With spare vegetation there is little moisture in the atmosphere. Rains are very rare, though it may even snow during July-August, the hottest months. Because of high mountains all round, the area remains landlocked to the outside world for nearly six months in a year.

The concept

The cold-arid high altitude area like Leh is characterized by its unique socio-cultural and environment accompanied by harsh and inhospitable climatic conditions. In such a condition we cannot 'copy and paste' the various Transfer of Technology (TOT) models (most of them developed for conditions prevailing

Defence Institute of High Altitude Research, Leh-Ladakh, India 194 101

in developed countries) "*as it is*". Therefore, there is a need to evolve strategies and action plan, appropriately suited to the conditions prevailing among the High Altitude Communities (HACs).

Whatever limited TOT activities been carried out by various governmental and non-governmental organisation has been based on the classical diffusion model, where it is assumed that once a technology is diffused and adopted by a farmer (mostly progressive and resource rich), the technology in a social system will diffuse of its own like a contagious disease. The major assumption behind this approach was it is a matter of time that all farmers will adopt the technology. But in reality it is not the case and consequently we call those farmers (who have not adopted the technology) as laggards/ traditional/non-progressive/ non-innovative/ disadvantaged *etc.*, without assessing, whether the technology is compatible (or fit into) with the farmers' socio-cultural environment, skill, and the resources available with them. In other words the poor farmers are blamed for technology non-adoption and we generally ignore the technological incompatibility with the prevailing environment and available resources.

TOT among HACs

In contrast to the above mentioned assumption there is a need to look into the nature of the technology its appropriateness in terms of needs (both felt and unfelt) of the farmer (both small and big); socio-economic condition; resource availability, and the prevailing environmental conditions. For overall development of the region, research output has to reach at the grassroots level, but adoption of a technology (apart from appropriateness of the technology) is dependent on many other factors like the sociology of HAC, their economic status, resource and infrastructure available, and also on the psychological make up of the individual. It is argued that a chronologically arranged activity is necessary for efficient execution of a 'plan of work' and for success of any TOT being carried out by an organisation. In this regard a conceptual framework provides us the basic outline which helps in linking together the theoretical orientation and practical aspects of the service[4]. Therefore, a conceptual framework based on the learnings from Ladakh region is put forward to help development workers in HACs to improve upon their TOT activities.

Socio-cultural environment of HACs

Demographic pattern: In HACs there is low population density (in case of Leh district it is only 3 individual/Sq.Km[1]) and it has been found that the communication pattern is dominated by the lateral networking accompanied by more of personal interaction. This network act as a platform for sharing information and acknowledging the various creative and innovative endeavors made over time and space by various individuals. In general, for any TOT approach the vertical system of communication is preferred over because of its wide coverage and easy accessibility, but in a HAC it will be much more effective if the lateral networking is also used as a communication channel in the TOT approach.

Cultural environment : Among the Buddhist community in Ladakh the old generation used to follow the polyandry system of marriage whereby brothers live with a single wife. This system of marriage is not being followed by the new and younger generation because of which each sibling establishes his/her own nuclear family, and thus there is fragmentation of land (and other resources) holdings. The breakage of polyandry system has also affected the in-house labour availability status because of which every household now act as an independent entity and thus has to depend on hired labours to carry out the farming activity. Nowadays it is a very common practice in Ladakh that we find hired labours from other states like Bihar and Nepal, carrying out the various agricultural practices like the harvesting of fields etc. Therefore it is necessary that we chose our TOT approach in such a way that it suits the small nuclear family also.

Social institution: One intriguing features of HAC is high level of social security, even though with limited resources. It is even more intriguing to find sustainable agriculture in a region where the individuals household are not self sufficient in itself in terms of resource required to practice agriculture. The answer lies in local institutions, observed high in HAC. A single household, or a village may not be self sufficient (self possession of resource) of its own in terms of the resources required to make a living by subsistence type of farming, but the household enjoy assurances (both vertical and horizontal) that the deficient resources will be available, when required. For example, a HAC household does not possess his own irrigation source (unlike the individual tube wells in LLC). In HA there are glaciers, whose melted water is carried through *khuls* (channels) into the villages for distribution in a village (somewhere distributed among more than one village) and further among different householders. Though the system of distribution is complex, but exploitation is rare. The equitable distribution of this scarce resource to every stakeholder (those who contribute in community work) is ensured by the strong institutional network[5]. The

institutions allow (within a limited scope) to contribute in a way where a household (household is the social unit in HA institutional system) is capable of, e.g. I help you in sowing and you help me in harvesting.

In terms of technology adoption, institutions play a major role in regions of high social networking. Adoption of a technology takes place within the institutional framework. Before a technology is adopted, it has to fit within the institutional framework of the community. In other words, technology is like the '*word'* and institutions the '*grammer'*[6]. An efficient technology, if it does not fit into the institutional framework, is not adopted by the community. E.g. trench greenhouse. It being one of the most economical and affordable greenhouse technologies, is not well adopted by the farmers of Ladakh. The reason being, conversion of private property into common property during winter, due to which these greenhouses are not feasible where there is encroachment of free roaming grazing animals. These greenhouses are only feasible where a household has its own boundary walled compound, thus limiting the adoption of this technology by household who are devoid of such facility.

Increased importance of the role of local and grass root level institutions cannot be overruled. Therefore when formulating and implementing plans, priority should be given to relevant institutions on a continuing basis. In addition to this, instead of creating new institutions the existing institutions e.g. the *goba* system (village administrative system), *chhurpon* (water supervisor), *Kutual* (messenger) - (for detail about this functionaries see Angchok 2006[3]) should be effectively used and involved in various extension programmes. It will not only help in reducing the exante and ex-postfacto cost, but will also helps in obtaining credibility (a major factor for success of any technology intervention) among the local people.

Nature and availability of resources

The property regime in HAC in respect to natural resources is such that many of the resources are held in common (common property resource - CPR) and even private property held by an individual household are spread over different altitudes and consolidated holdings are rare to find. Today, the development policies generally recommend consolidation of holdings which overlooks the advantage of this property regime.

Altitude variation is the major factor deciding the type of agro-climatic region in high altitude areas like Ladakh. Such variations are found even within a single village. Since a single altitudinal level and econiche does not have the potential to provide the subsistence need of the villagers, all farmers require access to different econiches[7]. To solve this problem many of the resources, which are necessary for survival, are held in common, where the rule of subtractability and excludability is followed. The availability of CPR helps people living in high-risk environment, to fulfill this need. Netting[8] argues that access to different microenvironment reduces the risk of bad years and effectively schedule labour, particularly for such activities as haymaking, at different altitudinal level in successive stages. Although small agricultural plots can be effectively exploited when owned individually, higher pasture can be more effectively utilised when owned in common. In the same way a single altitudinal level is not capable of providing subsistence needs, a single econiche activity of crop or animal raising alone cannot provide such needs either. Most importantly, the diversity in holdings act as a buffering agent against the high rate of entropy (a common feature in HA area) thus helps minimize the risk of failure.

Due to single cropping season in HA it has been found that the consequences of perceived risk takes a major factor in decision making process, especially when it comes to adoption of a new technology. Therefore except for a very few early adopters, a new technology is adopted by majority of the farmers only after they have personally identified and experienced the positive outcome of the new technology. In extension terminology, the proportion of late majority occupies the major share.

Figure 01: Leh at a glance

Description	Ref. Year	Unit	Magnitude
Geographical Area	2011-12	Sq. km.	82665*
Reporting Area	2011-12	Hect.	51786
Number of Tehsils	2011-12	Number	03
Number of Blocks	2011-12	Number	09
Number of Panchayats	2011-12	Number	93
Number of Villages	1981 Census	Number	113
Number of Inhabited Villages	1981 Census	Number	112
Population	2011 Census	Number	147104
Households	2001 Census	Number	24147
Average Household Size	2001 Census	No./Hh	5
Cultivators	2001	Number	22149
Net Area Sown	2011-12	Hect.	9824
Gross Area Irrigated	2011-12	Hect.	10319
Net Area Irrigated	2011-12	Hect.	9824
Number of Land Holdings	2000-01	Number	16999
Area of Land holdings	2000-01	Hect.	11933
Average Holding Size	2000-01	Hect.	0.70
Livestock Population	1997 L/S census	Number	333759
Average Livestock per Household	1997 L/S census	Number	14.3
Forest Area	2004-05 Est.	Sq.Km.	29.00

* Includes 37555 sq. Kms. under illegal occupation of China.
Source: Statistical Hand Book, Ladakh Autonomous Hill Development Council, Leh, 2011-12.

Geographical factor: Because of the different geographic location and mountainous region this region has become a major tourist destination. It has helped local people to improve upon their economic sector via

involving themselves into the tourism business. On the other hand because of labour shifting into tourism sector due to higher opportunity cost and instant return in tourism sector, it is becoming difficult to get labour for agricultural sector, and the limited availability is also at a very premium price (manual labour for, weeding, harvesting etc charge around Rs. 350 per day (including food and transport), though the Government official rates are quite low).

Figure 02: Geographic Location of Ladakh

Fuzzy Government policies

Most of the policies are following a top-down approach, formulated by cosmopolitan people sitting far away and not identifying themselves with the grassroots environment. The general trend is the 'copy and paste' model, where, a model successful in one region (lowlander community) is implemented in a HA region (highlander community). This approach of development does not take into account the wide diversity in terms of sociology and resource available in a single econiche in HA regions.

Leh district is spread across 82665 Sq Kms of geographic area constituting of 112 settled and 1 nomadic village[1]. The district consist of valleys, uniquely differentiated and characterized in terms of resource available and livelihood opportunities e.g. Changthang valley- pasturelands, animal husbandry; Nubra valley- floral diversity, agriculture; Leh valley- agriculture, tourism, Govt/Pvt. jobs. Therefore it is argued that different development models have to be evolved according to these characterizations. A single umbrella model would not be successful for the whole region. In a HA area after every kilometer the shades of mountain differs, so does the sociology and ecology of the region. This aspect is generally absent in the various developmental policies.

To illustrate this - In Leh district plan, first priority is given to agriculture sector[10]. On the other hand because of the higher discount rate (high opportunity cost) in sector like tourism, many of the common property resources are being privatized. The result is, farmers are not finding it feasible to keep animal, for the grazing lands are now being lost to privatization and public goods.

On the other hand, the development policies recommends for organic farming in Leh. It's a paradox that without generating farmyard manures how the concept of organic farming is going to succeed. E.g. in phey village a decade ago every household kept 30-40 sheep and goat, and presently no one keeps them. Though there could be many factors behind this change, but the policies leading to shrinking of grazing land and labour scarcity is the major factor.

In this context it is argued that extension personnel should be aware of such changes and the causes of those changes, so that in future development activities the effect of those changes can be manipulated and directed towards a desired change.

Local Knowledge System:

Its intriguing to find people inhibit such a hostile regions, and even more intriguing is the practice of agriculture in a sustainable basis before the intervention of modern techniques and practices. In this connection, the role of local knowledge system (LKS) plays a major role.

- It is the knowledge prevalent overtime among the living community and transferred from one generation to the next. They play a major role in sustaining the livelihood in harsh and inhospitable environment.

- In the early 1990's considering the potential of LKS, initiative were taken to understand and integrate them into the mainstream scientific knowledge system but majority of the work in this field has been limited to the exploitation of the tangible aspects of LKS like the use of medicinal plants. Little effort has been made to make use of the intangible (e.g. the traditional cultivation practices) aspect of this system.

- There is tremendous scope for integration of this old age system into our mainstream development practice. Out of this effort, various new sustainable and appropriate techniques and practices can be evolved, suited to the local environment.

- To achieve this end it is imperative to document LKS and kept in a form of digital library to help easy accessibility of this knowledge for various R&D activities, and moreover any unathorised outside agencies cannot take stakehold of this knowledge and develop products based on this knowledge system without paying back (material/non-material) to the owners of these LKS.

Market availability:

- Before the intervention and influence of the modern world, HAC were self sufficient and their livelihood were based primarily on traditional agriculture on a subsistence basis, which is clearly evident in their belief system and folk sayings[11].

- With changing time market, or the clients for consumption of produce, is one of the major force which (in the recent few decades) has a very significant effect on the adoption of a technology by local farmers.

- Consumers/market has to be identified and make known to the growers before they adopt a technology. In today's world scenario, producer and consumers can be linked together irrespective of time and space barrier. In this regard the concept of golden triangle[12] is quite useful (see figure 03). Generally the activities of growers are limited within a particular area, but now with the improvement in communication (both virtual and real) the physical distance has been shortening to a great extend. These days, an entrepreneur sitting in Ladakh can invest in an enterprise at Delhi, producing products for the consumer of Mumbai. This linkage chain can be established at intra and inter regional level also.

Figure 03: The Golden Triangle

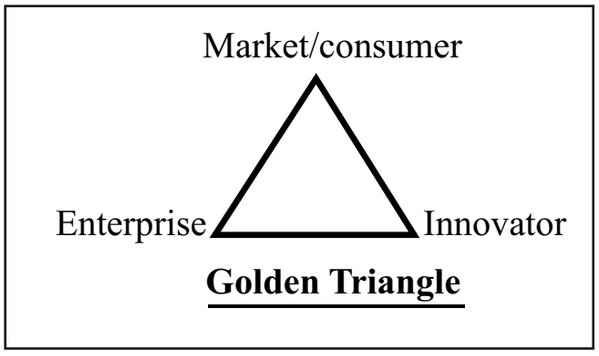
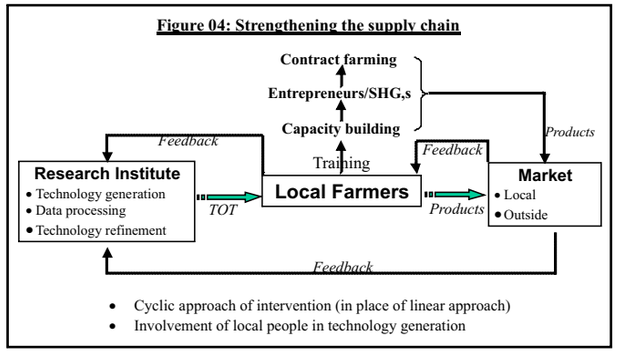


Figure 04: Strengthening the supply chain



Coordination among research and development agencies

A HA region is considered to be one of the interesting fields for researchers around the world due to its unique sociology and environment. The far-flung district of Leh is one of them where there are many organizations (governmental and non-governmental) involved in research and development. A R&D organization like Defence Institute of High Altitude Research (DIHAR) develops many agro-animal technologies, which are further disseminated among the local farmers via the widespread networks facilities of state departments of agriculture, horticulture, animal husbandry and various NGO's. These networks are spread at various grassroots level with different functionaries like the village level worker (VLW). These functionaries are engaged in direct supply of inputs to the local farmers and they also help in dissemination of know-how gained/released from the R&D organization like DIHAR.

The viable functioning of this network plays a very important role, but unfortunately at several occasions the same network itself creates barriers for adoption of technologies.

Because of fear of "*losing status-quo*" an organization does not freely shares their know-how with their counterpart line departments. And whenever there are some successful case studies to be highlighted they again clash (many of the times covertly) with each other to take the credit for the success. Though these differences are not discussed at open platforms, but the grapevine in a HA community is so high that the message reaches at the grassroots (local farmers) anyway. These differences result in harvesting of benefit (various schemes and subsidies) by the cosmopolitan and upper layer of the society only and makes a windfall profit. Thus the benefits arising out of the rural development schemes are not reaching the majority of intended clients.

Moreover, it has been observed that people (marginalized and remote) are not aware of the various schemes which are meant for them. The fear inherited from the zamindari (landlord) system is still being carried along by the communities, which stops them to "*dare to ask*". In contrast to this, compared to the high altitude communities (HAC) such behaviour (the fear) is generally not observed in lowlander communities (LLC). Assumption for this difference in behavior, is higher exposure and awareness among LLC compared to HAC. This difference can even be found in the behavior among HAC also, one residing in proximity and other remote to the district/block headquarter.

In summary, it is the lack of countervailing capacity of the people which hinders people to ask and take benefits from various developmental policies. Therefore, increasing only the awareness level will not help to counter this problem, all the agencies engaged has to work in collaboration with each other with no overlapping of activities. Because, it is the overlapping of activities which creates differences among agencies, and confusion in the mind of farmers.

Outside intervention into Ladakh:

William Moorcroft, a veterinary surgeon traveling in the 1820's, was the first Englishman to give a detailed account of Ladakh[13]. Moorcroft describes three meals a day. First: tea, which would be salt not sweet; second: porridge, made with *tsampa* (roasted barley flour) and water and probably allowed to ferment slightly, or tea; third: meat, rice, vegetables and bread for the upper classes or soup, porridge and bread for the lower classes.

G T Vigne[14], traveling in the 1830's, tells us about items that passed through Ladakh on the trade routes from Yarkand to Hindustan and vice versa. These traders colony from Central Asia will also have influenced the people of Ladakh.

David Fraser[15], in his amusing account of travels around the turn of nineteenth century, found eggs, fowl and vegetables as part of the diet in *Lamayuru* (West of Ladakh).

Then came the Moravian missionaries to Ladakh in the last quarter of the nineteenth century and they brought with them vegetables such as potatoes, spinach, cauliflowers, radishes, green beans, brussels sprouts and tomatoes[13]. These were probably the first significant additions to the Ladakhi diet for many years turnips, swedes and peas having predominated until then. It was probably also the Moravians who demonstrated that root vegetables could be stored in pits in the ground[13], thus improving the variety of foods available in the winter.

Recent initiatives:

Regarding the interventions made by various research and developmental institutions like Defence Institute of High Altitude Research (DIHAR), State Department of Agriculture and Horticulture, there has been a tremendous improvement in the diversity, quantity and quality of cultivated crops (especially vegetables). It has been demonstrated (on field conditions) that around 64 different kinds of vegetables (both European and Asiatic type) can be successfully grown in Ladakh. Presently, local farmers in Ladakh are successfully growing newly introduced crops like kale, parsely, celery, summer squash, okra, and various cucurbits also. The increase in crop diversity has helped them to increase their income and improve the nutritional uptake. At present 51% of Army's (a major market for local produce) fresh vegetables requirement is fulfilled by the local farmers (local farmer's cooperative is supplying 23 different kinds of vegetables to army). It not only provides income to the local farmers but also saves a large chunk of expenditure on part of the Government exchequer (carriage charges incurred on transport).

Suggestion:

Considering the above statements, the authors put forward the following suggestions for research institutions and development agencies/workers engaged in the agriculture development among the HAC:

- Similar to the strategy adopted by the product marketing ventures, development agencies have to approach and reach out the selected segment of the society for a particular technology, in a segment targeting way of approach.

- Increase awareness (individual/group/mass) through various media (see figure 04).

- Increase the countervailing power of the farmers through capacity building (see figure 04).

- Involve local farmers at every stage of technology generation process, so that they identify themselves with the developed technologies, thus increase rate of dissemination and adoption (see figure 04).

- Develop a flexible extension model (approach) for effective intervention at the grassroots level among HAC.

- Develop and maintain a digital library of the local wisdom related to agriculture prevalent among HAC, and endeavour to scientifically validate them for further value addition and integration into the mainstream technology development process.
- Strengthen the linkage between all the stakeholders for efficient supply chain of agricultural products (see figure 04).
- The fragile environment of HA does not allow for mass production in a sustainable manner, therefore effort should be made to produce high quality (unique and appropriate) products in low quantity rather than going for bulk, which fetches premium in the market. In other words produce in '*grams'* instead of '*kilograms'*.

CONCLUSION

In Ladakh region greenhouse technology is quite popular among the masses. Among the various types of various passive solar greenhouses, the trench type is the cheapest of all. It involves digging of a trench (preferably of 09x04 mts size) under which cultivation is practiced and during winter it has to be covered with a UV stabilised polythene sheet. For detail see Narendra Singh etal 2011[16].

Common property resource (CPR): A well-defined resource, consisting of a definite group of authorized users that will manage and set institutional rules of use for the resource in question (Bromley, 1992)[17]. It can also be defined as a resource system that makes available to a group of users a flow of subtractable resource unit over time (Ostrom: 1988)[18].

CPRs differ from public goods in that public goods are indivisible and jointly consumed. Public goods cannot be divided among users and consumption of a public good by any member of the user group does not reduce the amount available to other users. In CPRs on the other hand, the flow of benefits is subtractable that is, consumption of resource unit by any member from the flow of benefits from a CPR reduces the amount available to other members. This is especially true of pastures, fisheries or irrigation water. CPR differs from private goods by the attribute of excludability (Olson, 1965)[19]. It is difficult to exclude people from using the CPRs once it has been provided. Thus public goods are indivisible and non-excludible and their consumption is characterized by jointness. Private goods are divisible and excludible, and their consumption is subtractable. On the other hand, CPRs usually exhibit differing degree of divisibility and excludability, and subtractability in the flow of units from the resource, depending upon the characteristics of the resource in question, and features of the institutions that govern the use of the resource.

REFERENCE

Anonymous. Statistical handbook, Ladakh Autonomous Hill Development Council, Leh, 2011-12.

Humbert-Droz and Sonam Dawa (ed) (2004), *Biodiversity of Ladakh: Strategy and Action Plan*, Sampark, New Delhi.

Dorjey Angchok & Premlata Singh, *Traditional Irrigation and Water Distribution System in Ladakh: Folk Tradition and Belief System*, Indian Journal of Traditional Knowledge, Vol. 5(3), July 2006, pp. 397-402. NISCAIR, CSIR New Delhi 12.

Dorjey Angchok etal. Agriculture Extension through Local Institutions in High Altitude Region of Ladakh, In: Advances in agriculture environment and health (Eds. Shashi Bala Singh and OP Chaurasia et.al) SSPH Publ., 2009. pp 259-272.

Dorjey Angchok, Stobdan & SB Singh, *Community-Based Irrigation Water Management in Ladakh: A High Altitude Cold Arid Region*, In: Proceedings of 12th Biannual Conference on CPR Management, 2009. Available online at website of digital library of commons (www. iasc2008.glos.ac.uk).

Gupta, Anil K. (1991). Building Upon Peoples' Ecological Knowledge: Framework for Studying Culturally Embedded CPR Institutions. Paper Presented at the *Second Annual Conference of the International Association for the Study of Common Property*, Winnipeg, Manitoba, 26-29 September 1991.

Buzdar, Nek (1988). Property Rights, Social Organization, and Resource Management in Northern Pakistan. *Working paper No.5.* Environment and Policy Institute, Honolulu, Hawai.

Netting, Robert McC (1972). " Of Men and Meadows: Strategies of Alpine Land Use". *Anthropological Quarterly*, 45.

Executive Councilor (Agriculture), Ladakh Autonomous Hill Development Council, Leh, India. Personal communication

Dorjey Angchok, Appeasing spirits, protecting nature, honey bee Vol 15 (4), Oct-Dec 2004).

Gupta, A. K. (1997). *From Grassroots to Global: Linking Innovations, Institutions, Investors and Entrepreneurs*. *Honey Bee*, IIM, Ahmedabad, 8 (2): 1-2

Reifenberg G, *Ladakhi Kitchen,* (Melong Publication of Ladakh, Leh), 1998.

Vigne G T, *Travels in Kashmir, Ladakh*, Iskardo, II (1842) 344-45.

Fraser D, Transhimalaya unveiled (originally *The Marches of Hindustan*, ca. 1906), I (reprint), 1986, 106.

Narendra Singh *et. al.* 2011. Greenhouse technology for cold arid region. Extension bulletin No 10, Publ. Defence Institute for High Altitude Research, Leh, India.

Bromley, D. W Ed. (1992). Making the Commons Work: Theory, Practice and Policy, ICS Press, San Francisco.

Ostrom, Elinor (1988). In Ostrom, V; Fenny, D & Picht, H (Eds.) Rethinking Institutional Analysis and Development, 101-139. Institute for Contemporary Studies, San Francisco.

Oslon, M (1965). The logic of collective action: Public Goods and the Theory of Groups. Harward University Press: Cambridge, MA.