ROLE OF TRADITIONAL ECOLOGICAL KNOWLEDGE IN NATURAL RESOURCE MANAGEMENT AMONG MONPAS OF NORTH-WESTERN ARUNACHAL PRADESH

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Introduction

The State of Arunachal Pradesh extends from lat. 27°N to 29°N and long. 92°E to 97°E. It is a sprawling mountainous territory in the Eastern Himalayas spread over 83,743 km^2, bounded by Bhutan in the West, China to the North and North-East, Burma to the East and the plains of the Assam to the South. It is the home of more than 30 major tribes and is considered to be one of the most splendid variegated and multilingual tribal areas of the world. It is situated in the overlapping zone of Oriental and Palearctic realms and thus has unique floral and faunal diversity. The traditional wisdom of tribal communities is based on the realization that man and nature form part of an indivisible whole and therefore should live in partnership with each other. This eco-centric view of traditional societies is widely reflected in their attitudes towards plants, animals, rivers and the earth. The traditional ecological knowledge is a cumulative body of knowledge, practices and beliefs, evolving by adaptive processes and handed down through generations by cultural transmission about the relationship of living being (including humans) with one another and with their environment. The present study was carried out to investigate the traditional ecological practices of the Monpas, an aboriginal Buddhist tribe of Mahayana (Tibetan - Lamatist) Gelukpa Sect pertaining to the management of water, agriculture and forest resources of the region. Studies have been conducted on the traditional practices and tribal culture of North-eastern region by Chib (1984), Sen (1986), Gangwar and Ramakrishnan (1990), Jodha *et al.* (1992) and Singh (2002).

Study area

The Monpas have three main centres of habitation in and around the administrative headquarters of Tawang, Dirang and Kalaktang. The language used by Dirang and Kalaktang Monpas is different from that of Tawang Monpas. The former use Bhutanese dialect whereas Tawang Monpas use Tibetan dialect. However, all other aspects of their life are quite similar. In Tibetan dialect, the name Mon and Pa signify the 'Man of the Lower Country'. The present study was carried out at two valleys viz. Namshu and Sangthi situated at Dirang administrative circle of West Kameng District. Namshu is situated 40 km North-West from Bomdila and 11 km from Munna camp. Sangthi is situated 75 km North-West from Bomdila and 15 km from Dirang town. The altitudes of Namshu and Sangthi are near about 7,000

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and 4,500 feet (2,133 m and 1371 m), respectively. The main forest types of this area are East Himalayan wet temperate forest, East Himalayan moist temperate forest and East Himalayan sub-alpine birch/fir forest (Champion and Seth, 1968; Kaul and Haridasan, 1987). The area comes under the Lesser Himalayan range. The main rocks are schist, magnetite, quartzite, amphibolites, dolomite, sandstone, siltstone and granite. The soil on hills is shallow with underlying boulders, sand and rocks. At some places on hills, soil is moderately deep and moist and have fertile loamy layer stained with humus. The sub-soil at lower elevation consists of mostly boulders and pebbles superimposed by a layer of sandy loam of various depths. The soil in valley is alluvial with sandy loam. The climate is humid cold. The temperature varies from –5°C to 20°C. The moisture varies from 30% to 95%. Dirang Circle receives 2,000-2,500 mm rainfall every year. The dry months are December, January and February. Pre- monsoon rainfall starts from the end of March. The highest rainfall is observed in June, July and August. Huge rainfall, tremendous cold and high relative humidity are the main factors for formation of diverse forest habitats.

Material and Methods

Reconnaissance survey was conducted in the study area to get an idea of the situation and plan the strategy for future work. A questionnaire was developed and tested with the local people and necessary modifications were made in it depending on the perception and knowledge of people. Surveys were carried out with the assistance of local guides, herders, hunters, villagers, farmers, village headmen (Gaoburas), Buddhist priests (Rinpoches) and Monks (Lamas). Extensive interviews and informal discussion were carried out with them to gather information on traditional knowledge and practices. Participatory transect walk was also made with the people in their agricultural fields, forests, grazing lands, mountain areas and riverbanks. The distance of walk ranged from 2 km to 15 km. A total of 21 transact walks were conducted during the entire study. Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques were used for collection of the data regarding socio-economic and socio-cultural aspects of the tribal people. Soil samples were also collected and analyzed at the Soil Science Laboratory of F.R.I., Dehra Dun.

Results and Discussion

The study revealed that Monpas had prioritized the use of traditional knowledge and wisdom for the management of natural resources like water, soil and forest. The details of water resource management practices and traditional system of agriculture and forest management are discussed below.

Traditional water management system

Wet paddy cultivation : The philosophy behind this system is to use gravitational force for the purpose of irrigation. The main objective was to divert water to the agricultural fields through small channels. It minimized soil erosion and checked surface runoff. In Sangthi, land management practices revealed that terraces in the main valley were quite broad, perfectly leveled and provided with strong bunds. These bunds were made up of soil and supported by wooden planks at

the base. The size of bunds vaired from 1 to 2 m in breadth and 0.5 to 1 m in height depending on the gradient of land and the size and shape of terrace. The slope of land in the main valley ranged 1 to 10 degree while in the foothills it varied from 6 to 25 degrees. Perfect leveling of plots and well managed irrigation cum drainage channels reduced the soil erosion to negligible level. Plot size varied from 250 m^2 to 1500 m^2 at Sangthi.

It was observed that every stream from the surrounding hills had been tapped soon after it emerged from the forest. These have been channeled at the rim of the valley and diverted by a network of primary, secondary and tertiary channels. Short tertiary channels occurred above the terraces after the first and second diversions from the stream. Usually small quantity of water was deflected in the feeder channels while the stream continued its course. The feeder channels while branched of at angles lead water through a series of terraces so that by blocking or opening the connecting ducts, any field could be flooded or drained as and when required. The cross section of main channels ranged from 1 to 2 m in width and 0.5 to 1 m in depth, while of feeder channels (sub channels) ranged from 0.5 to 1 m in width and 0.5 to 1 m in depth. These channels were pitched with boulders at the entry that checked erosion of channels due to very high flow of water. People managed water in such a way that it always kept water layer on the soil surface at the permissible depths, which was the most important aspect of scientific water management.

Ghatta System (water mills) : This system has been developed for using the force of water for various local uses such as grinding of grains, alarm device for landslides and flash floods, and for the purification of water. Streams are first diverted into channels with piled up stones and brushwood wires. The last part of the channel leads into a chute (3 m - 4.5 m long, radius 10-15 cm made from *Pinus wallichiana*) inclined at an angle of about 45°. This is followed by a small two storey house. In the lower storey, a fan shaped wheel is there that has eight blades. The water generates the force to rotate the wheel. Due to this, the cylindrical poles that hold the wheel also rotate. At the upper storey, two millstones are attached with that pole. The upper millstone can be raised and lowered, while the lower one rests on mill floor. It is provided with wood bearings inserted into a centrally drilled hole. Materials to be grounded are fed into conical hopper that has adjustable feeding spout made of wood at the lower outlet. Grains fell into the eye of millstone in a regular succession with the aid of an agitator. Flour is collected around the stone in a square box. Grinding capacity of such Ghatta varies form 100 to 250 kg a day. This system is made of locally available material, environmentally sound, socially and economically acceptable, could be installed by local craftsman. The milling technique has higher extraction efficiency as compared to the traditional manual technique. The milled products contain bran as well as husk that is used for livestock feed.

Another interesting use of Ghatta system was its use as an alarming device. Instead of millstones, a drum of 30-90 cm diameter was fixed with the poles that are rotated by the force of water. 'Om Mane Pame Hung' was encrypted on this cylinder. A wooden stick of 60-75 cm length was attached with the wooden drum at the top.

The stick struck the bell with its each round. Therefore, the interval of the sound of bell was directly proportional to the velocity of water. It was a fascinating indigenous device of Monpa people that is used as an alarm for the detection of flash flood and landslides. If the interval of bell-sound increased, people thought of the possibility of flash floods due to the heavy rainfall at higher ridges. People then remove all installations along the bank of river and streams. There were some rare incidents that were informed by the villagers. Sometimes the interval of the sound of the bell decreases too during heavy rainfall. The main reason, as informed by the village elders, was that due to heavy rainfall sometimes streams and rivers were blocked by the landslide. A temporary water reservoir is formed at the site of landslide. Thus the sound of bell decreases due to the shortage of water. These types to situations generally lead to devastation by flash floods as soon as the temporary reservoir gets ruptured. However, due to this indigenous device, people were being alerted so the effect of such flash floods was always less in this area.

Villagers usually drank the water collected through a small chute from the ground storey of the water house. The impurities of water get precipitated due to the rotational motion of wheel and people use only upper layer of water for the purpose of drinking.

Traditional Highland Farming Systems

Four traditional farming systems were noticed in the study area, i.e.

(i) Crop dominated,
(ii) Horticulture dominated,
(iii) Livestock dominated, and
(iv) Mixed farming.

In the crop-dominated system cereals, wheat, maize or rice occupied the main place. It includes multiple cropping and intercropping. In livestock-dominated system priorities were given to livestock grazing and pasture management. In horticulture-dominated system priorities were given to the horticultural species and in mixed farming an integrated approach by combining all these systems was followed.

Wet Paddy Agricultural System

In Sangthi, people cultivate Rhitang variety of paddy with Kodu (Finger millet, *Eleusine coracana*). Nursery of rice is raised during February and seedlings become ready for transplantation in 60 to 80 days. Fields are prepared in April and all the operations were done manually with indigenous wooden tools. Fencing, maintenance of channels and terrace rising, nursery raising, manuring, land preparation, transplanting, weeding, fish culture (at Sangthi valley), harvesting, thrashing, drying and storage required approximately 320 to 350 man days. Single rice seedling was transplanted at a spacing 20-24 cm. Terrace risers were used for finger millet cultivation through trans-planted seedling. The yield varied from 8 to 12 qtls/hectare for the finger millet and 45-55 qutls/hectare for paddy. The variables and processes responsible for affecting wet paddy agricultural system of Monpa villages are mentioned in Table 1.

Maize-Finger Millet-Pea-Bean-Buck wheat-Soybean intercropping system

It is a unique intercropping system

Table 1

Variables and Processes affecting Wet Paddy Cultivation

Variable	Impacts	
	Positive	Negative
1	2	3
(i) Productivity	● Highly productive due to sufficient irrigation, drainage, and utilization of terrace riser/bunds. ● Fish production 80-100kg/ha/year. ● Use of organic manure increased productivity as well as improved soil.	● Traditional variety of paddy susceptible to fungal attack. ● Difficulties in using chemical plant-protection measures in case of paddy-cum-fish culture system.
(ii) Sustainability	● Natural streams provide sufficient irrigation through gravitational force ● Streams supply nutrients rich water to crop fields ● System is multi-faceted. The bio-terracing helps in maintaining soil fertility	● Cropping intensity was low.
(iii) Stability	● Locals satisfied with agricultural productivity. They never wanted to migrate to plains for better livelihood ● The physiographic features of the valley helped perennial water sources with gentle slopes (0-15%) covering large area ● Use of local resources, traditional low cost tools made of wood for irrigation and agriculture provide strong support to the system ● Subsidiary source of income from cattle, poultry and fishery	● Gradual erosion of social cementing force in the community due to urban influence. It infiltrated from nearby towns like Dirang, Bomdila and Tezpur. It may have impact on the socio-economic dynamics of the traditional agricultural system in future.
(iv) Equitability	● A well marked division of labour within the family and the community as a whole. Men engaged themselves for building terraces, irrigation channels, fencing, planting trees, while women looked after nursery, transplanting seedlings, weeding, fishery, poultry, harvesting, threshing of crops, drying and storage ● Community understanding of river maintenance and release of water for irrigation was equal among men and women	● The social turbulence and imbalance due to various interventions like religious shift from traditionalistic Buddhism to so-called modernistic Christianity. The juxtaposition between two cultures may have negative impact on the present bondage of man and nature.

Contd...

1	2	3
	● Prevalence of community labour in various operations based on the principle of reciprocation ● Landless people were engaged respectfully in agricultural works and paid wages.	

found in Namshu valley. Intensive intercropping is done by the farmers using five major varieties of crop i.e. maize (*Zea mays*), finger millet (*Eleusine coracana*), pea (*Vigna cylindrica*), bean (*Phaseolus vulgaris*), buck wheat (*Fagopyrum cymosum, F. esculentum*) and soybean (*Glycine max*). It was observed that four traditional varieties of maize and three varieties of soybean were used in the cropping system. The maize varieties were (a) Bhamphinam, (b) Phinam, (c) Kashmiri Phinam, and (d) Nersaphinam. Three varieties of soybean were: (a) Lave Tang-Po, (b) Lave Injan Za, and (c) Lave Chang Nu. The last one is a rare and black variety of soybean that is grown by Monpas (Table 2). This intercropping system is followed on 20-25%terraced land where soil moisture content was low.

Cropping Mechanism : Land is prepared for cropping in May and June. Maize is sown in the first row while in second and third rows catzang pea and cowpea is sown, respectively. Maize is again sown in the forth row and yardlong bean/soybean and rajma in the fifth and sixth consecutive rows, respectively. In the seventh row again maize is repeated. The spacing between the two maize rows was 1.22 m (4 feet) and spacing between peas or bean row was 30 cm (1 foot). Organic manure made from leaves of *Quercus pachyphylla* and *A lemellosa* is collected from nearby forests and used in agriculture land. Maize crop took minimum five months for ripening, while catzang pea, cowpea, yardlong, bean, rajma and soybean matured within three and half months. Due to this, a continuous gap was formed between the two maize rows. As soon as other crops are harvested they plant two verities of buckwheat at these gaps. The latter took one and half months for ripening and farmers harvested both buckwheat and maize at the same time. The leguminous plants (bean, pea, and soybean) help in nitrogen fixation. Productivity as well as energy efficiency of this system was quite high.

Traditional Forest Management System

It was observed that Monpa community manages the forest areas by using age-old traditional methods. The village headman divides the forest area into several compartments. Each compartment is then allotted to a household. The average holding of the forestland is 4 acres. The decision taken by the village headmen (Gaoburas) is final. There are many customary laws that are strictly followed in the village regarding the use of forest products like medicinal and aromatic plants, dye yielding plants and fuel wood etc.

Medicinal and Aromatic Plants

Medicinal and aromatic plants have an important role in the traditional

Table 2

Details of the crops being grown by Monpas

Local Name	Common Name	Scientific Name	Family
1. (a) Yaeoung (b) Rhitang	Paddy	*Oryza sativa*	Poaceae
2. (a) Bhamphinam (b) Phinam (c) Kashmiri phinam (d) Nera Phinam	Maize	*Zea mays*	-do-
3. Kodu/Kompu	Finger Millet	*Eleusine coracana*	-do-
4. Tsang Lee Bee (i)	Catzang pea	*Vigna cylindrica*	Papilionideae
5. Tsang Lee Bee (ii)	Cow pea	*Vigna angulicata*	-do
6. Tsang Lee Bee (iii)	Yardlong Bean (Pale brown variety)	*Vigna sesquipedalis*	-do-
7. Tsang Lee Bee (iv)	Yardlong Bean	*Vigna sesquipedalis*	-do-
8. Tsang Lee Bee (v)	Rajmah/Bean	*Phaseolus vulgaris*	-do-
9. Lave Tang Po	Local Soybean (large)	*Glycine max*	-do-
10. Lave Injan Za	Local Soybean (small)	*Glycine max*	-do-
11. Lave Chang Nu	Black variety Soybean	Not identified	-do-
12. Jum	Barley	*Hordeum vulgare*	Poaceae
13. Brasum	Buckwheat (variety one)	*Fagopyrum cymosum*	Polygonaceae
14. Geuergon	Buckwheat (variety two)	*Fagopyrum esculentum*	-do-

system of medicine that exists in this area. The village headmen and monasteries are the authorities to decide the species and quantity to be collected from forests. Some species like *Illicium griffthi* and *Swertia chirayata* had an open access to all the people of village, while a few species such as *Meconopsis grandis*, *Aconitum ferox* and *Fritillaria cirrhosa* were allowed only to the Buddhist priests who practiced traditional healing.

Fuelwood

Fuelwood is the main source of energy. In winter, fuelwood is essential to burn the fire-places (Bukhari) for 24 hours. These traditional fireplaces are made of tin, have multipurpose uses, and optimized the heat energy. People could cook; boil water and heating up the rooms simultaneously that decreased the fuelwood consumption. The per capita fuelwood consuption by the households in the survey areas was 6 tonnes per annum. Species having high calorific value like oak, alder and maple are mostly used as fuelwood. They did not prefer coniferous woods. They only used small quantity of pinewood for initial lighting up the fire because of its high combustion value due to the presence of resin. People never burnt wood of *Cupressus* because it was considered to be a sacred species. There are some customary laws for collection of fuel wood too. Every household is allowed to collect fuelwood only from their specific forestland that was allotted to them by village headmen. People were not allowed to cut good trees for this purpose. They could only cut crooked, diseased, and moribund and wolf trees for this purpose. If any one cut a healthy tree without prior permission from the village headmen, he/she would be fined up to Rs. 5000/- as an offender.

Collection of Leaf Litter

Dry oak leaves are collected from the forests during January. Every household collects it from the respective forest area, which is allotted to them. The stand density of *Quercus pachyphylla* and amount of liter produced per 100 sq ft area was around 57.6 kg and on an average the weight of leaves left on the forest floor was 17 kg. Therefore, it can be concluded that around 30% of dry leaves were left on the forest floor for maintaining the fertility of the soil.

The litter is piled up in the agricultural fields and allowed to decay for around five months. Cattle dung is also mixed with it. Maize and beans are sown in June and by July end maize and beans gain a height of 0.5 to 0.75 m. During that time farmers apply this bio compost. They usually made a 10cm to 15 cm (4-6 inches) layer of compost on the soil. It helps in controlling the weed growth. It was a unique indigenous technique for weed control that was noticed in Namshu valley.

Traditional silvicultural practices

The most important silvicultural practices were tending operations. It included thinning, pollarding, pruning, cleaning and weeding. Thinning operations are usually undertaken where the stand density was greater than 0.75. The philosophy behind it was to open the canopy to enhance the lateral growth of trees. They also did pollarding for the purpose of coppicing. Trees of 2-3 ft diameter class were selected for coppicing. However, the success rate was low. Cleaning and weeding operations were generally undertaken during winter. Moribund, crooked, diseased and malformed trees were always cut for the purpose of fuel wood.

It was observed that the villagers only allow to grow the seedlings of *Quercus pachyphylla* and *Q. lamellose*. It was difficult to find other species like *Acer campbelli, Magnolia campheli and Castanopsis triblodes* in a managed forest

area. This practice is not ecologically sound and may be disastrous in case of disease. It was observed that succession at southern aspect was badly affected due to this practice.

Sacred landscapes

All hilltops were named as "phu". People never practiced any hunting or felling operations in these areas. The total area of landscape was protected from human interferences. People believed that "phu" are the abode of local deities whom they have been worshipping before the arrival of Buddhism. Thus it could be inferred that traditional wisdom is helpful for biodiversity conservation. That might be a reason for the high-density of mountain ungulates viz. goral and blue sheep on the hilltops.

SUMMARY

This paper describes the role of traditional ecological knowledge and wisdom of the Monpa tribe in the management of natural resources like water, soil and forest in the high altitudes of the Eastern Himalayas. The traditional water resource management practices are highly diversified and have multipurpose uses. People have developed irrigation system using gravitational force that check surface runoff and maintain the water table throughout the year. They have unique technique for pre-detection of the flash flood using water force. The traditional highland farming system is highly productive, sustainable and environment friendly. The wet paddy cultivation in high altitude valley and intercropping system in terrace cultivation has been described in detail. Both these systems ameliorate soil fertility and have no negative impact on environment. The forests are owned and managed by the community. People follow customary laws and traditions regarding collection of forest products. They follow traditional silvicultural practices for management of their forestland. They have strong religious belief on conservation of plants and animals. The sacred groves concept plays a significant role in this aspect. All these systems have been discussed in detail in present paper.

उत्तर–पश्चिमी अरुणाचल प्रदेश के मोंपाओं में प्राकृतिक संसाधन प्रबन्धनार्थ पारम्परिक पारिस्थिकीय ज्ञान की भूमिका

सौमिध साहा व एन०एस० बिष्ट

सारांश

इस अभिपत्र में पूर्वी हिमालय प्रदेश की अधिक ऊंचाइयों पर प्राकृतिक संसाधनों जैसे जल, मृदा और वन के प्रबन्धन में मोम्पा जनजाति के पारम्परिक पारिस्थिकीय ज्ञान और बुद्धिमत्ता की भूमिका का वर्णन दिया गया है। ये पारम्परिक जल संसाधनों की प्रबन्धन रीतियां अत्यधिक विविधिकृत है और इसके बहु प्रयोजन उपयोग हैं। लोगों ने गुरुत्वाकर्षण शक्ति उपयोग में लाकर ऐसी सिंचाई प्रणाली विकसित की है जिससे भूतल पर जल अपवाह रुकता है और भुमि के अन्दर का जलस्तर पूरे वर्ष ठीक–ठाक बना रहता है। उनके यहां जल शक्ति को उपयोग कर एकाएक बाढ़ आने का पहले से पता लगा लेने की भी विलेक्षण विधि है। उनकी पठारी भूमि पर पारम्परिक खेती करने की प्रणाली अत्यधिक उत्पादक, टिकाऊ और पर्यावरण–संपोषण है। अधिक ऊंची घाटियों में सिंचित धान की खेती और जीनेदार खेतों में सहरोपण खेती प्रणाली का वर्णन विस्तार से दिया गया है। इन दोनों प्रणालियों से मृदा उर्वरता में परिष्कार आता है और इनसे पर्यावरण पर हानिकर प्रभाव नहीं पड़ता। वनों पर स्वामित्व और उनका प्रबन्धन समुदाय के हाथ में हैं। वनोपजों का संग्रह करने में लोग–बाग रीतिरिवाजों से बने नियमों और परम्पराओं का पालन करते हैं। अपनी वनभूमियों का प्रबन्ध करने में वे पारम्परिक वनसंवर्धन रीतियों

का अनुसरण करते हैं। पेड़ पौधों और पशुओं के संरक्षण के बारे में उनके दृढ़ धार्मिक विश्वास हैं। पावन निकुंजों की अवधारणा इस बारे में सार्थक भूमिका निबाहती है। इस सभी प्रणालियों को प्रस्तुत अभिपत्र में विस्तार से विवेचित किया गया है।

References

Berlin, B. (1992). *Ethnobiological Classification: Principles of categorization of plants and animals in traditional*. Princeton University Press, New Jersey.

Champion, H.G. and S.K. Seth (1968). *A revised survey of forest types of India.* Manager of Publications, GoI, Delhi.

Chib, S.S. (1984). *Caste, Tribes and Culture of India*, *Vol 8 : North Eastern India.* Ess Ess Pub., New Delhi. pp. 278-299.

Gangwar, A.K. and P.S. Ramakrishnan (1990). Ethnobiological notes on some tribes of Arunachal Pradesh, Northeastern India. *Economic Botany*, **44** : 18-21.

Jodha, N.S., M. Banskota and T. Pratap (1992). *Sustainable mountain agriculture and issues*, ICIMOD. Oxford and IBH Pub. Co., New Delhi. pp. 18-21.

Kaul, R.N. and K. Haridasan (1987). Forest types of Arunachal Pradesh - a preliminary study. *J. Econ. Tax. Bot.*, 9 (2) : 379-389.

Sen, S., (1986). *Arunachal Pradesh and the tribes*. Gian Pub. House, New Delhi. pp. 26-27.

Singh, K.A. (2002). *Resource management perspective of Arunachal agriculture,* ICAR, NEH Region. pp. 235-238.