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Elderly Adi Women of Arunachal Pradesh: 'Living Encyclopedias' and Cultural Refugia in Biodiversity Conservation of the Eastern Himalaya, India

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Abstract: Elderly women of a particular socioecological system are considered to be 'living encyclopedias' in biocultural knowledge systems. These women play a pivotal role in retaining and passing on biodiversity-related traditional knowledge (TK) to the next generations. These women serve as 'cultural refugia'. Our study on the importance of these women in the conservation of indigenous biodiversity was conducted in 14 randomly selected villages dominated by the Adi tribe of East Siang district, Arunachal Pradesh, northeast India. Data were collected from 2003 to 2008 using conventional social science methods and participatory rural appraisal. One innovative method using 'recipe contest' was devised to mobilize Adi women of each village and to explore knowledge of elderly women regarding traditional foods, ethnomedicines and conservation of indigenous biodiversity. Fifty-five plant species used by elderly women in food systems and 34 plant species in ethnomedicinal practices were documented. These women identified different plant species found under diverse canopies of community forest, and applied appropriate harvest strategies. Elderly women were particularly skilled in preparing traditional foods including beverages and held significantly greater knowledge of indigenous plants than younger women. Cultural diversity was found to influence the significance of biodiversity. Women elders' knowledge is complex and location specific, and the conservation of biodiversity occurred in three different habitats: jhum lands (shifting cultivation), morang forest (community managed forests) and homegardens. This knowledge contributed significantly not only to food, nutritional and livelihood security of the Adi, but also to conservation of a number of rare, endangered and threatened indigenous plant species. We identified a need to develop holistic approaches and policies to recognize and support the knowledge of these women and integrate this knowledge with policies for sustainable conservation of biodiversity, including community based adaptive practices to climatic changes with due recognition of elderly women.

Title

Elderly *Adi* Women of Arunachal Pradesh: 'Living Encyclopedias' and Cultural Refugia in Biodiversity Conservation of the Eastern Himalaya, India

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Introduction

The northeastern region of India, occupying 7.7 % of the total geographical area of the country, is a recognized biodiversity hotspot (Myer and others 2000). It harbors about 50% of the Indian flora [(8000 species) (Rao 1994) of which about 30 % (2526 species) is endemic (Nayer 1996). Arunachal Pradesh, with an area of 83 743 km^2, is the largest state of the northeastern region of India. It includes five climatic zones (tropical, sub-tropical, sub-temperate, temperate and alpine) and supports three forest ecosystems: mixed wet evergreen, dry evergreen and deciduous. A total of 26 tribes and 110 sub-tribes reside in close proximity of these forests. The *Adi*, a dominant tribe, is widespread, residing in over 80% of the state's districts.

Adi communities depend on forest resources and for generations have practiced jhum (slash and burn) cultivation (Ramakrishnan 2007). They are culturally diverse in their food habits, social practices and languages. Almost every *Adi* festival and social occasion is linked with their forest resources and jhum cultivation, and their traditional ecological knowledge (TEK) and social institutions for use and maintenance of natural resources create unique biocultural diversity (Singh and others 2010a).

Adi women and men have separate roles and responsibilities, with males responsible for physical tasks such as ploughing, digging, cutting the forest for slash and burn agriculture and hunting (Singh and others 2007), and women playing a pivotal role in child care, collection of firewood, harvesting foods such as small insects, fish and other forest products, as well as medicinal plants, and crop management (Singh and *Adi* Women 2010).

Elderly women of the *Adi* tribe, although often little valued in the ever changing *Adi* society, play a critically important role as holders of TEK. In this way, they are metaphorically similar to ecological refugia, and can be considered as cultural refugia. Ecological refugia are areas that remain intact after major environmental disturbance such as forest fires, floods or glaciers, and following such disturbance can serve as source of genetic material for repopulating the disturbed sites (Turner 2005; Turner 2006a,b). In a parallel way, cultural refugia are knowledge holders – in this case *Adi* women – who are able to teach and revive original cultural practices, knowledge, and grassroots creativity for biodiversity conservation at times when this knowledge has been threatened or eroded due to environmental loss, economic development sand globalization process (Gupta 2002; Singh 2004; Turner 2006a,b; Turner 2007).

Especially over the past three decades, significant social and environmental changes have occurred among tribes of Arunachal Pradesh, India (APHDR 2005; Singh *et al*. 2011), compelling *Adi* and other local tribes to change their agricultural practices and lifestyles from subsistence to commercial. Extended families are dividing up into nuclear families; and community ownership of bioresources is being converted into private and individual ownership. Along with these changes, the TK systems of the *Adi* – particularly of elderly *Adi* women – are at risk. It has now become imperative to preserve their knowledge and practices which once were assets for the community's survival and biodiversity conservation. This will be assisted by a mission mode program on exploration, documentation, validation and conservation of the women's knowledge systems. This is possible only if the program is implemented in a participatory mode (Singh and others 2009), and any benefits accruing are shared equitably and ethically with the communities, which has not been in the usual practices in the region (Singh 2008; Singh and Srivastava 2010).

The objective of this study was: (i) to document the knowledge of cultural refugia *Adi* women relating to species used in food and ethnomedicine; (ii) to learn methods by which elderly women conserve indigenous biodiversity; (iii) to document the women's knowledge about the canopies of tree species; (iv) to better understand various social, cultural and ecological dynamics of indigenous biodiversity that are part of people's food and livelihood security; and (v) to study the mechanisms of knowledge transfer of cultural refugia women.

Study Areas and Research Methodology

The study was conducted in East Siang district (4,005 km^2) (27^0 30' to 29^0 42' N lat. and 94^0 42' to 95^0 35' E Long.) of Arunachal Pradesh. According to the latest census (2001), the total population of *Adi* tribes is about 87,400, with about 45,300 males and 42,100 females; with the female: male ratio is around 9. The rural population is about 65,400 and urban population 22,000.

The *Adi* community (also known as *Abor)* is a major collective tribe of the state. It comprises four major ethnic groups, *Minyong*, *Padam*, *Pasi* and *Pangi*. Other than the East Siang district, *Adi* live in sub-tropical and sub-temperate regions of West Siang, Upper Siang, Upper Subansiri and Dibang Valley districts. Living in remote villages, the *Adi* are subsistence farmers, practicing *jhum* cultivation and depending heavily on forest resources. Rice, meat of wild animals (deer, bear, porcupine, squirrel, rates, boar, etc., trapped and

hunted) and large number of ethnobotanicals (more than 60 species) (Singh and Adi Women 2010) collected from forest and *jhum*-land serve as staple foods.

Several *Adi* seasonal festivals are celebrated, including *solung* (September), *etar* (May) and *aran* (March). Village level community feasts are organized collectively. The cultural refugia women hold the major responsibility for celebrating festivals and collecting ethnobotanicals to prepare a variety of foods, while men hunt the wild animals (Singh and *Adi* Women 2010). They also hunt mithun, a semi-domesticated, high altitude species of cattle (*Bos frontailis*), which is widely used for sacrifice in *Solung* festival and during marriages. The young men perform butchering mithun and distributing the meat among community members during the festivals. The young women perform *ponung* (folk dance), receiving gifts of roasted *kebung* (Himalayan giant squirrel), wild rat and a local rice variety *amkel*. These products are also an integral part of the *Adi* dowry system, offered by the groom to his bride during the marriage ceremony.

Almost every member of *Adi* tribe and its ethnic groups consumes meat of wild animals and *mithun* along with boiled wild food plants. Throughout the *Adi* communities, there are social institutions (i.e. religious taboos, customs and beliefs) that regulate exploitation of these natural resources (APHDP 2005; Singh and Sureja 2006). Communal land ownership, an informal tribal institution called '*kebang*', and informal public forums to resolve disputes over resource use are examples of such institutions. Today, these sociocultural complexes are in a transitional state, but they are still working in supporting the subsistence survival of the tribes (Mishra and others 2011).

Sampling of Villages and Population

After several reconnaissances of the study areas, 14 villages were selected randomly from the east Siang district for the study: Ayeng, Pangin, Poglek, Sole, Kebang, Zarku, Mirbuk, Mirku, Balek, Kelek-Mirmir, Rasam, Gune, Sibut and Napit. Ethnicity, percentage of forest cover, distance of villages from town and dependency of rural women on agriculture and forest resources were taken into account during this selection. In each village, a list of cultural refugia women was prepared with the help of Village Panchayat, elders and school teachers. Negligence of these elder women by their community and family members and lack of attention to their suggestions in household decision making are common characteristics, helping to define them as "cultural refugia women". A total of 300 these women (>60 years old) along with 81 women selected through 'recipe contest', thus, total 381 were chosen to interview. In addition, 150 younger women (<40 years old) were selected randomly from

these villages in 2:1 ratio to assess how the knowledge of cultural refugia women is different from that of younger women. Thus, a total 531 women respondents from these villages were studied over a five-year period (2003 to 2008), using 14 different steps (**Table 1**). Since the majority (about 65%) of the elderly cultural refugia women were illiterate, their age was estimated using life history analysis and synchronicity of personal life events with the historical occurrences – such as the earthquake of 1952 or the Indian freedom movement in 1945.

Application of Participatory Rural Appraisal in Community Mobilization and Data Collection

To assess the current status and bio-resource use patterns of the villagers, group discussions [(FGD, a participatory rural appraisal tool (PRA) (Begossi 1996; Mayoux and Chambers 2005; Chambers 2009)] were organized in the selected villages, and widely known firsthand information on community knowledge (CK) about biocultural resources (plants and related cultural resources) among the women were recorded (Singh and others 2010a). In each village, the women were invited to draw a CK map of plants being used as foods and ethnomedicines. The plants used for other purposes, such as for handicrafts, domestic items, etc., were also recorded as other dimensions of the biocultural resources.

To raise awareness among the *Adi* women of the importance of the biodiversity, biodiversity contests were held in each village as a participatory action-oriented event (Singh 2010). Selected women, tribal chief of the village (*Gaon Burha*), school teachers, extension workers and members of Village Panchayat (democratic unit at village level) participated in these biodiversity contests. The objective was to generate supplementary information and enhance and test the validity of information under study within a short period of time. For this event, the women were given seven days time to collect a maximum number of indigenous plants (both cultivated and non-cultivated) and animal resources – such as local fishes and wild animals from the locality – and present them before the judges. A team of judges was comprised of sociologist, ecologist, nutritionist, herbal healers and elder *Adi* villagers. The women were asked to present these resources according to their usage in food and ethnomedicine. The women were instructed to demonstrate their culinary knowledge of foods and medicinal plants through dishes made individually and displayed in the village community hall, together with live ingredient plant samples, along with information on their use, source of collection, source of learning about them and modifications, if any, they did to the original recipes. The contestants were assessed by the participatory team of judges and

those gaining the highest score were rewarded publically in a village level function as well as at regional events specially organized to promote conservation of indigenous knowledge, and related biodiversity of Arunachal Pradesh.

Before conducting the study, a collection of local plants was prepared with the help of recognized village traditional healers, food experts, hunter and gatherers of the each selected village and deposited in a herbarium. The plants were identified by the plant taxonomist of BSI (Botanical Survey of India), Itanagar, Arunachal Pradesh. The herbarium was then used as a knowledge catalyzer to interact with each respondent.

Using a combination of informal and formal ways, the respondents were encouraged to record their TK about biodiversity use and conservation. Open ended and objective types of questions were prepared within an interview schedule to question each respondent about the names of naturally growing local plants and crops in their locality and their uses as food and medicine and for other household purposes.

Pilot Testing of Interview Schedule

A pilot testing of framed questions in interview schedule was made in order to improve reliability. The pilot testing was done in two non-sampled villages adjacent to selected villages of study. The ambiguous questions were further rectified and improved with bilingual language (*Adi* and Hindi). About 25 % questions after pilot testing have been reframed. While making pilot test, two local guides who were acquainted well with local dialect, culture and customs of *Adi* tribe were the part of research team.

Measurement of Variables

Personal attributes

The personal attributes of the women participants (used as independent variables) were measured using indicators and the appropriate continuum, using social sciences research methodologies (Edwards 1957; Hunn 1982; Pieroni 2001; Reyes-Garcia and others 2004, 2007). Participant observations, distant learning (a PRA tool) and biodiversity contests (discussed in detail in the results part) were also adopted to validate our findings (Begossi 1996).

Cultural Significance Index

We measured the cultural significance index (CFSI) of the plant resources following the method developed by Pieroni (2001) with slight modifications according to socioeconomic and cultural conditions of *Adi* women. The availability of a crop or plant, frequency of plant utilization, the plant part used, the multifunctional use of plant, taste score appreciation and the ethnomedicinal role or health value of the plant were kept as the indicators in the CFSI index.

Diverse Knowledge System

The diverse knowledge system was measured in terms of the indicators developed on various biophysical and sociocultural aspects of plant biodiversity (**Table 3**). Indicators of this composite variable were developed during the community knowledge map and biodiversity contests in selected villages. Diverse knowledge of women about biophysical and socio-cultural aspects of local plant species was measured using the percentage and mean knowledge values.

Reducing Redundancy and Increasing Accuracy in Observations

Accuracy in observations of plant species, related knowledge, conservation and other aspects was maintained with the help of local experts from the *Adi* community who recorded the information with first author in the local dialect. Assistance from local experts from the selected communities was sought to avoid error and reduce redundancy in measuring the personal attributes of women. However, the first author of this article along with his research assistants again verified these variables through random visits to a selected number of the respondents' houses [(300) (250 elder women and 50 younger women)] on a specific day when a particular cultural occasion (celebration of festivals), social event (marriage and community feast), spiritual activities (death ceremony, worships, etc.), agricultural activity, healing practices or formation of *reglep* on agricultural food and forest, were going on.

Measurement of Biodiversity Conservation

Based on a food frequency questionnaire (Singh and others 2007), the use and conservation of indigenous crops and ethnobotanicals comprising local food and medicines were measured. The total numbers of plants used as food in combination with ethnomedicines were recorded from the study areas and were fixed as the benchmark value of plants biodiversity

conservation analysis. Knowledge of all 450 women respondents was measured against this value to assess the conservation status among and between the women's groups. The extent of use of these plants as food and ethnomedicine along with their cultivation (conservation) in different land use systems was considered as an indicator of conservation.

Women's Knowledge on Vegetation Stories (Canopies*)*

The objective of measuring the rationality of women's knowledge on vegetation stories was to assess their ecological knowledge of plant vegetation in different categories of the forest canopy other than the food and ethnomedicinal plants. From the herbarium, 50 percent of plants from each vegetation component (top, middle, lower and ground cover) were chosen randomly to incorporate in the interview schedule. Knowledge scores were assigned to each plant and to the respondents after comparing the response with the information from the village herbarium and CK map.

Knowledge Blending and Microecosystems

Biodiversity knowledge integration was defined as a skill of women who could use two or more plants from varied land use systems/sources/ecosystems to meet a particular need. "Microecosystem" was defined as the extent of variability in the biophysical indicators of landscape and availability of a specific plant (Singh and Sharma 2004). Cultural diversity was considered as the variability in types of sub-tribes of *Adi* community (*Padam, Pasi, Pangi* and *Minyong*).

Obtaining Prior Informed Consent (PIC) from Women

The women participants were contacted to obtain their PIC before their personal and community held knowledge on food, ethnomedicines and conservation techniques was recorded. The great majority (over 95 percent) of the women consented to have their knowledge used as part of our research, and for teaching and educational purposes other than commercial use. The PICs for the women's knowledge and practices which were the part of knowledge in the public domain were further obtained from *Gaon Burha* (community chief of each village) in order to secure consent at the community level.

Statistical analysis

The data were subjected to coefficient of variations, 'Z' test and Spearman correlation. Since the sample size was large, to test the significance of differences between selected variables of

elder and younger women, the 'Z' test was applied (Chandel 1978). The statistical analyses were carried out using SPSS statistical packages (Norusis 2000).

Results

Personal Attributes of Women

The mean age of the elderly women was 77 years with minimum of 62 and maximum of 103 years. The majority (about 78%) were in the range of 70-80 yrs. The mean age of the younger women was about 34 years, with minimum 30 and maximum 40 years, most (about 75%) being 32-35 years. Over 42 % of the elder women were illiterate; some were able to read signs (46.7%) and only few had primary school level education (3.9%). The majority (52.6%) of the young women were educated up to junior school level and above (up to high school and in some cases to post secondary), followed by primary school education (38.2%), those who could read and write (7.9%), and a small minority (about 3%) who were illiterate. The elder women were living mostly (75.8%) in traditional rural environment. Some lived in a semi-rural environment (23.5%) and only few in towns (about 2 %). In contrast, most of the young women lived in rural-urban environments (60.2%). A comparison of some promising personal attributes of elder and younger women showed that elder women were superior in all the aspects that are required to enhance conservation of biodiversity and sustain related TK (**Table 3**).

Recipe Contest and Social Validation of Ecological Knowledge of *Adi* Women

The summary of 14 selected villages 'recipe contests' revealed very location-specific results on food and medicinal plant-based knowledge systems (**Table 4**). The highest number of plants used in traditional foods and medicines (67) was demonstrated by the women in a remote village, whereas the smallest number of local plants (20) used was by the women residing close to the town of Pasighat (headquarters of East Siang district). The mean number of plants used in traditional medicines and foods demonstrated by the women in all the villages during these contests was about 34, with a coefficient of variation of about 46.

An assessment of the variability of food and medicinal plants revealed that *Kebang* and *Ayeng* villages (situated at high altitudes: 330 m and 220 m, respectively) had the highest diversity of plant resources, with 45 varieties of traditional foods and medicinal plants. The lowest diversity in plants documented during the contests was 28, in Kelek-Mirmir village at 170 m altitude. The overall mean variability in these biocultural resources was about 33, with

a coefficient of variation of about 30%. The women living in remote villages [(e.g. Sole (88.2%), Balek (87.5%), Kebang (85.7%), Pangin (83.3%) and Ayeng (80.9%)] demonstrated their culinary skills in using the forest-based ethnobotanicals in traditional foods and medicines more than cultivated crops. The overall mean percentage of using wild ethnobotanicals in such remote villages was 72.3 with a coefficient of variation of 27.5 per cent. While, women living near to town (semi-rural villages) used local land races only for preparing foods (e.g. Mirbuk- 40.0%, Paglek-33.3 % and Napit-31.0, Mirku-28.5%, Kelek-Mirmir-28.0%).

A total of 54 elderly women from 14 villages showed exceptional culinary skills with demonstrated traditional foods and received awards from the judges. On average three woman in each village, and in some villages, four women, were honoured, in these 'recipe contests'. These awards were intended to inspire other members of the respective villages, to promote lateral and vertical networking of knowledge chains relating to traditional knowledge of biocultural resources.

Traditional Foods and Ethnomedicines Used by Adi Women

Effort was made to record data on food and ethnomedicines from elder and younger *Adi* women *about commonly used species* in food and medicines. We found that elder *Adi* women used traditional foods prepared from a larger number (55) of local plant species than the young women, and these included both cultivated and uncultivated plants (**Table 5**). Various parts of these plants (seeds, leaves, fruits, tubers, etc.) were utilized, and their availability was seasonal, with cultivation and conservation undertaken in jhum-land, community forest and homegardens.

The elderly *Adi* women were documented as using 34 ethnomedicinal plants species (**Table 6**). Over 47.1% of these plants were used for their leaves. A number of ailments and diseases are treated using these species. These women used 54-100% ethnomedicinal plants in their healing practices, whereas, among younger aged women, no one ethnomedicinal plant could qualify even the level of 29.2 % of limit, thus difference of minimum and maximum use of ethnomedicinal plants percentage among this group was about 25.7.

Overall average use and conservation value for the food plants by older women was observed 76.7 % (**Tables 5**), whereas for the younger women, this value was 24.9 %. On

average the overall 82.5 % elderly women use ethnomedicinal plants for various ailments and disorders, whereas, this value among younger women was only 14.0 % (**Table 6**).

Diverse Knowledge of Adi Women about Biophysical and Socio-cultural Aspects on Local Plants

Elderly *Adi* women had comparatively more knowledge on the various aspects of plant biodiversity and the socio-cultural values than the younger women (**Table 7**). In all aspects of plant biodiversity, the elder women showed greater associated local knowledge, among all the listed indicators, than younger women. Overall, the elder women had higher ('Z' value = 34.59 <p, 0.01 %) diverse knowledge systems as reflected in the indicators of plant resources (38.7±3.6) than their younger counterpart (21.4± 5.5).

Women's Knowledge about Vegetation Classification of Community Forest and Homegarden Canopies

The dominancy of 40 plant species in different stories (10 indentified in the top story, 8 in middle story, 8 in lower story and 14 in ground cover and climbing species) was observed in the community forest and homegarden while making village herbarium of plant biodiversity (**Table 8).** The elderly women's knowledge of the nature of vertical distribution of 40 plant species across the four canopies in community forest and homegardens was high (**Table 8**). They could readily place plant species in a particular story (level of forest canopy), and this difference was statistically higher as compared with the younger women. With respect to ability for overall placement of the plants species in one of four identified forest canopies, again the elder women had significantly higher scores (2.39±0.24) than their younger counterparts (0.91±0.093) ('Z' value 92.50 <*P*, 0.01 %).

Correlation of Personal Attributes with the Plant Biodiversity Conservation

Personal attributes of women (i.e., age, family type, living environment, altitude level, food habits, types of healing practices, types of agriculture, forest dependency, divers knowledge systems on biophysical and socio-cultural aspects, spiritual and cultural attachments with the plant resources and participation in the *reglep*) were found to be positively correlated with plant biodiversity conservation among the elder women (*P*< 0.01) (**Table 9**). Only the education level (r = -0.117, *P*<0.01) and market dependency (r = - 0.125, *P*< 0.05) were negatively correlated with the plant biodiversity conservation. In contrast, the correlation of these variables with conservation of plant biodiversity among younger women was either

weak or non-significant. The types of agriculture they follow, their market dependency and participation in the informal institution *reglep* were all found to be negatively correlated. Although, these relations were weak. Family types, living environments and types of healing practices were found negatively correlated with conservation of plant species, but non-significant among the younger women.

The level of market dependency correlated negatively with plant biodiversity conservation across both elder and younger categories of women (**Table 9**). The pooled values of personal attributes for the entire sampled respondents of women showed a positive correlation with the plant biodiversity conservation, whereas education and market dependency still revealed negative correlations.

Microecosystem Diversity and Biocultural Resources Availability

Women were found to have TEK of plants and their distribution. A majority (about 60%) of the cultural refugia women held the view that ecological location plays a decisive role in determining diversity in biocultural resources related to ethnomedicines and food. The tribes who lives in the East Siang district (155-250 m), where the landscape is uneven or flat, depend more on *apongs* (traditional alcoholic beverages) made of a local variety of ice called *amkel*, can only be cultivated in water-logged conditions. The relatives of the same peoples living in *Maryang* region (530 m) depend more on *apongs* made of *mirung* (finger millets) and *angyat* (foxtail millets), which are grown in rainfed conditions of hilly terrains.

Use of green leaves of *onger* (*Zanthoxylum rhesta*) as a vegetable was found to be very popular among the elderly women (94.3 %). Fresh *onger* leaves also serve as food and medicine (for constipation, dysentery and diarrhoea). This plant grows best (88%) in the uneven and steep sloping landscapes of the villages of Kebang, Pangin, Sibut and Balek than on the plains. Women of the plains either exchange *onger* for cereal crops and other ethnobotanicals or purchase it from the upper regions of the mountains. In return, cultural refugia women make dried meat of mithun (*Bos frontailis*) available to lower altitude communities from the upper montane (Maryang) areas for exchange with *mirung* (finger millet), *angyat* (foxtail millet) and *emo* (*Aconite ferox*, used in hunting).

Knowledge of Blending Biodiversity in Food System

Blending of two or more ethnobotanicals was one of the criteria use to compare the biodiversity use skills of the two groups of women. The cultural refugia women were

comparatively more competent (76.8%) than the younger women (18.5%) in blending more than two plant products. The elderly women mixed sometimes 8-10 different plant products to make a special dish, using taste, palatability, nutritional security, cultural preference (offerings to guest) and some time medicinal usage of plants species in determining these mixes. The criteria of selecting a plant for its use in a food or particular medicine are drawn from inherited knowledge accumulated through generations. For example, the cultural refugia women determine the edibility of forest ethnobotanicals from watching the grazing behaviour of *mithun*. If this animal grazes a plant, it is then considered safer for human consumption. Using *mithun* as a tester, the women have identified a number of wild plants (e.g. *Diplazium esculentum, Bauhinia variegate, Solanum torvum, S. spirale, S. indicum, Urtica parviflora* and *Fagopyrum esculentum*) for human consumption.

The ethnobotanicals products are mixed with other green leaves of 12 plant species (**Table 10**), collected from shifting agricultural lands. The relative quantity of each plant is decided based upon the age of the plant, occasion of its use, and the season and availability. These plants are mixed together, and boiled to make a local dish called *Adi mixed sabji*. Some of these plants are cooked alone, and some used in combinations to improve the taste / aroma or neutralize the bitterness/astringency. For example, bitterness of *Solanum torvum* and *S. spirale* fruits is neutralized after boiling with the green leaves of *onger* (*Xanthoxylum rhetsa*). Small fresh or smoked fishes are cooked with dried bamboo shoots or the slices of *champa* fruit (*Dillenia indica*) to avoid fragmentation and improve the taste of the fish and cooking of leafy vegetables like *oyik* (*Pouzolzia bennettiana*) with small grains of *amkel* rice to improve the taste. Cooking of fishes like *ilisha* (*Tenualosa ilisha)* and *ngopi machh* (*Garra naganensis*) with the green leaves of *Adi dhaniya* and *bamboo tenga* (fermented bamboo shoots), etc. is considered to produce a culturally and nutritionally rich food. These dishes need special culinary knowledge and experience accumulated over generations. Such culinary attributes of the traditional food preparation were found to be substantially greater (77.9%) in older than younger women (29%).

Cultural Variability and Their Significance in Food and Ethnomedicinal Knowledge

The cultural differences among *Adi* ethnic groups play a key role affecting knowledge level of medicinal plants and food systems. As stated earlier, there are four major *Adi* ethnic groups (*Minyong, Padam, Pasi* and *Pangi*), and the women of these groups have different dialects, traditional dress and food habits. Women of each group had varying levels of

knowledge and cultural significance index values related to local plant resources being used in their ethnomedicines and foods (**Fig. 1**). The women of the *Minyong* and *Pangi* ethnic groups who reside amidst rich floras of forest in remotely located villages (58.7%) had greater knowledge and higher levels of cultural significance index values on food and medicinal components of local plants than the *Padam* and *Pasi*.

Informal Leaching on Traditional Knowledge

Elder women teach local knowledge to their grandchildren so that it would be available for forthwith generations. But, interest of younger generations for learning from the cultural refugia women appeared very low (with just over 13 % expressing interest). A young girl was traditionally taught to make traditional alcoholic beverages (*apong* and *ammin,* made of local rice landraces), making *siye* (yeast tablets, prepared from local fern, solanacious plants, local rice and other botanicals by the elder members of only selected tribe or sub-tribe), processing of local tea leaves, smoking fishes and wild games, fermentation of *bamboo-tenga* (bamboo shoots), making basketry, storage of surplus food materials, boiling of local foods using ethnobotanicals and weaving of traditional dresses called *gale* and *galuk*. They were taught with special stories, songs, and proverbs, and this kind of learning was an effective learning by elderly women in the joint family system.

Up to the 1980s, there was an indigenous institution called '*Dere*' among *Adi* peoples, formed by elders of a clan. The *Dere* functioned to look after the children during off hours and peak hours when the parents were working in jhum lands for agricultural operations. During this period, the elders used to narrate folk stories, sing the songs and teach children about how to live in the mountains and forests. The children were also taught various informal techniques and practices employed for conservation of plant and animal diversity. However, with the passage of time and introduction of new developmental policies by the state and central governments, there has been rapid erosion in *Dere.* The impact of sociocultural changes and erosion in ecological ethics among new generation has further aggravated the problem of existence of *Dere.*

Learning ethnobotanical and conservation knowledge by younger children traditionally occurs from various sources such as the grandmother, mother, family, *Gaon Burha* (village customary chief), neighbor, community, social (marriage) and cultural institutions (e.g. *regelp* and community feasts) (**Fig. 2**). However, there is a difference in such sources of learning between the women of semi-rural (transformed) and traditional

villages (**Fig**. 2). The traditional sources of learning, where the grandmother, informal food networks, family and others are major sources of transmitting ideas to younger generation, are more functional in traditional villages than the semi-rural communities.

Discussion

At least 55 different plant species (55) have been documented as being cultivated in either jhumland or home gardens or naturally grown in the community forests (Singh and *Adi* Women 2010). These plant resources, used year-round, are conserved mainly by elderly women either through domestication or *in-situ* conservation. The optimal conservation of indigenous plant species is achieved by women adding 'utilitarian value' to the plants in their food systems. Selection of species and its mode of conservation are determined by use values, livelihood dimensions, ecology and compatibility of local climate (Singh and others 2011).

Elderly women of any society are major, but often unrecognized, stakeholders in use of plants, including: harvesting (plant food, medicinal plants, basketry materials, firewood, etc.); processing (foods and medicines); storing; manufacturing; provisioning (food for family meals, food for feasts; managing land and plant resources (clearing, selective harvesting, weeding, pruning; gardening of food plants, management, trimming, etc. of plant material); bearing and nurturing the children with care, story-telling; and educating children and contributing to cultural life of family and community (Anderson 2005; Turner 2003; 2005; Singh and others 2007a,b; Singh and others 2011). All of these are accompanied by considerable skills and practical knowledge for plant conservation and propagation of the various species of plants and animals important to their lives (Singh 2012). To keep learning continue and sustainable, and enhance further conservation rewarding elderly *Adi* women could inspire other members of their respective villages. This ecoliterary tool can activate the lateral and vertical networking of chain on TK and biocultural resources among society members (Singh 2008).

A major transition is occurring, due in part to conversion of ethnic cultures to Christianity, which hinders continuance of customs and rituals relating to conservation of plant biodiversity (Yumnam 2008). In northeastern Indian, after the 1980s, a major emphasis was given in the state to promote commercial cultivation of oranges, pineapples and ginger in order to improve agrarian economy of various tribes including *Adi*s. A major contribution in agronomic practices is assured by women to promote cultivation of these commercial crops. These changes occurred more among younger women who were attracted to the commercial

economy and thus resulted in erosion of the traditional practices of conserving plant biodiversity through integrated farming systems.

Isolated and '*top-to-bottom*' inappropriate government policies such as promoting horticulture in *morange* forest (community forest) areas have affected the status of indigenous species wild-growing plants and conservation of indigenous varieties of crops such as rainfed paddy, millets (finger millet, foxtail millet and jowar) maize, and some fruit and vegetable species (*Allium* spp., amaranths, root and rhizome species, etc.) being conserved by elderly women. The shift from 'community ownership' to private ownership land and forest resources, and erosion in group dynamics of '*kebang*' (indigenous institution of *Adi* that regulate and sustain community land and forest resources) has further aggravated the problem of degradation on indigenous resources among *Adi* community (Singh and others 2010a,b).

In last 30 years, erratic rainfall and weather anomalies are being noticed in the state at community and broader levels (Singh and others 2011; Bhattacharya and others 2007; Panda 2009). The elderly women noticed some changes in plants' phenology (*Gymnocladus burmanicus* and *Aconitum ferox*) and wild animals' behavior, and their availability pattern in last 40 years. These women have perception that changes in behavior and availability of biodiversity is caused by climatic changes and eroded after compounded impact of anthropogenic factors. The anthropogenic factors including increasing population pressure, economic policies of central and state governments, soil and water erosion due to changes in landscape for commercial cultivation of fruit crops in transitional villages, making communal land resources into private, and heavy landslides in the mountainous region caused by extraction of boulders and stones by private property dealers and contractors have affected natural resources base. These problems further compelled local community to reduce jhum cultivation cycles from 15 years to 8-10 years (Ramakrishnan 2007). This reduction has adversely affected energy flow in the ecosystem, practices of conservation of indigenous plant and animal biodiversity (Datta and Goyal 2008) in homegarden by women folk, and in *morang* forest by *kebang*.

Cultural refugia women act as knowledge carriers for traditional foods and ethnomedicines for entire villages. In case of any cultural occasion (festivals, marriage, worship, etc.), the presence of these women is important, to instruct younger women in performing these events and activities and also in preparing the appropriate dishes. Rich in

knowledge and cultural capital, such as folk songs, proverbs, folktales and folk stories, these women also act as living libraries and discharge their duties as community teachers on many occasions, such as marriages, festivals, baby deliveries and deaths. These women generally also provide first medical aid and give instructions to new mothers related to childcare in remote villages where allopathic drugs are rarely available. They suggest to the mother appropriate foods for better health of both baby and mother (Singh 2004; Singh 2006, Singh and others 2009). As some 400,000-500,000 examples of social capital in the forms of social groups have been established world over since the early 1990s for forests, wildlife, fishery and microfinance management (Pretty 2003), the knowledge, social capital and cultural capital available from elderly women could be of great importance in planning and executing natural resource conservation activities.

The cultural refugia women elders maintain a wide knowledge network within their own groups and cultures and with like-minded women of a similar age group from other *Adi* communities (*Minyong* or *Pasi*, or *Padam* or *Pangi*) living in neighbouring regions. This networking provides a substantial foundation for cross-cultural transfer of knowledge, accelerating, for example, the process of refinement in knowledge on ethnomedicines and food plants (Singh and others 2008).

Marriage as an institution helps in the reciprocal exchange of knowledge of biocultural resources, including conservation methods of plant and animal resources, between culturally and ecologically distinct areas. It also facilitates the flow of genetic resources from one biome to another through the networks and cultural interchange of women, and thus promotes a wide, simultaneous distribution of knowledge and practice of biodiversity conservation. For example, when a girl of the *Minyong* ethnic group is married to a *Padam* boy, she learns more about the diversity of traditional foods such as roasting kebungs meat, making *apong* (alcoholic beverage), mixture of fish and leafy vegetables, fish roasting, making mixture food from namdung (*Perilla ocymoides*) seeds, etc. prepared on festivals like *etar, aran* and *solung*. This cultural grafting nurtures the knowledge systems of two cultures simultaneously and allows the development of new relevant knowledge and

Elderly women were observed to have greater competence in caring for motherless children as compared to younger *Adi* women. For example, they feed the grains of *amkel,* an indigenous variety of rice, well ground and cooked into a semi-liquid food, to newborn infants who have no source of mother's milk.. The ripe fruits of a local banana (*Ensete*

glaucum), collected from the forest, are also mashed and given to these infants. In addition, a traditional beverage called *pongkang* prepared from *amkel* rice (fermented, but with a lower percentage of alcohol) is given to infants to quench their thirst. These babies are also given a soup made from *lai patta* (mustard greens, *Brassica* sp.), which is considered to have a meaningful amount of vitamins and minerals. For effective treatment of diarrhoea and dysentery, the infants are given an extract of rhizomes of *kekir* (indigenous ginger, *Zingiber officinale*)

Knowledge and practice relating to biocultural resources are most prevalent among elderly women speaking their native languages and incorporating this knowledge in their day-to-day lives (Singh *et al*. 2012). Studies conducted in the region and elsewhere indicate that the younger generation is losing their native dialect/languages and cultures which are the basic foundation for nurturing and transferring biodiversity knowledge systems intergenerationally (Anderson 2005; Singh 2006; Turner and Turner 2007; Singh and others 2012). The rate of loss/disappearance of local cultures and languages, along with associated traditional ecological knowledge systems among various Indigenous communities of the world has become a serious issue internationally. There is a threat that some 250 local cultures and languages, which are available with world Indigenous Communities including *Adi* elders also, will be lost in the coming century and as a result an immense amount of biodiversity knowledge will vanish (Nettle and Romaine 2000; Deacon and others 2004; Turner 2005; Maffi and Woodley 2010).

Elder women are the ones who know practices related to ecosystem structure and function, such as setting fires in the hills of degraded bamboo to clear patches of ground for growing the roots of *Colocasia*; leafy vegetables such as *oyik* (*Alternanthera philoxeroides*), *ongin* (*Clerodendrum colebrookinanum*), *onger* (*Zanthoxylum rhetsa*); and mushrooms in sloppy land near community forests. They also have experience in modifying garden habitat, using local plant resources such as the branches of the *sisar* tree for natural mushroom cultivation. This practice activates the percentage of germination and increases the production of local mushrooms by 3-4 times. The local practice of using the excreta and dung of wild animals – such as elephant, wild pig and deer – was once a unique practice, not only for improving the germination rate of mushrooms but also in promoting forest succession. As in other parts of the world, such as Canada, the Indigenous women do burning of the forest to enhance the growth of edible roots, fruits and leafy vegetables (Turner 1999; 2003).

To be effective in promoting their resources, they need to have an intimate knowledge of the complex life cycles of plants, animals and insects; and to know the biological indicators needed to predict the weather and seasonal and landscape changes. They need to understand biometeorology (effect of weather on plants and animals) for sustainable harvesting and processing of resources (e. g. food preservation, drying of meat, preparation of traditional alcoholic beverages). They must also know what kinds of firewood to use in cooking, and how to dry, or otherwise process their foods effectively to provide the best possible nutrition for their families even during the winter (Singh and others 2012; Singh 2012).

Some of the wild animals such as rat, squirrel (Himalayan giant squirrel), deer, bear, porcupine, *mithun*, buffalo, and wild hens; and local fishes (*nagopi, singhi, jhinga*, etc.) were also identified along with plant resources during the community knowledge map preparation, and organizing biodiversity contest in the villages in this study. These resources provide food, nutritional and medicinal security for *Adi* communities. The elderly women in particular were found to be very concerned about the decreasing populations of ethnobotanical products and wild animals. They considered that the reduction in these bioresources was due to a decline in natural habitats because of deforestation for commercial agriculture.

Three types of biocultural knowledge for foods and ethnomedicines based on local plants resources were observed: (i) individual (a knowledge of identifying and using a particular plant first time by a woman in a particular village was called individual knowledge) (ii) community (a biocultural knowledge/practice if known and used widely at village level by the women was called community knowledge on traditional food or medicinal resources) and (iii) refined-community knowledge (a knowledge or practice which if is developed after the refinement in already established community knowledge/practice with an intention to improvise the efficacy or increase the benefits, then was called refined-community knowledge) (Singh and others 1010a). Women were found to adopt two types of basic strategies at inter and intra household levels, for coping with the crisis they are experiencing in food and healthcare management using local plant resources, within these knowledge categories. The women living in remote locations were particularly rich in community-level knowledge and practices, revealing a co-evolution of knowledge with the plant resources themselves (Singh and others 2010). Here major concern is that despite considerable extent of potential, such knowledge typology could not become the part of learning (education system) and conservation policies in the state. However, fortunately

the new state climatic change action plan of 2011 endorses values of indigenous practices in adaptation measures, and inclusion in monitoring of biodiversity and climate change (Government of Arunachal Pradesh 2011). But, the emphasis given in this policy is general, and there is need of paying more attention to gender specific knowledge- especially of elderly women under the mission of greening India (Government of Arunachal Pradesh 2011).

The knowledge of traditional foods and ethnomedicines among elderly *Adi* tribal women revealed the extent of their interactions with nature. Most of the women (over 72%) living amidst rich floras in remote locations had strategies at both inter and intra level of crisis management on food and health, whereas only about 18% of the women living in transformed (semi-rural) villages had such experience. This difference could be due to the developmental factors in lesser and more developed villages for example commercial agriculture and horticulture by converting natural forest into plain land, making availability of modern foods and other resources from outside the social system with developed roads and communication facilities. However, knowledge and practices around plant-based foods and ethnomedicines within the individual and refined knowledge categories was higher (nearly 65%) among the women of semi-rural villages than among the women living in remote located villages (about 39 %).

Here, a major concern arises concerning how best food and medicinal security, and conservation of indigenous biodiversity, can be assured using women's knowledge in location specific conservation strategies (**Fig**. 3). The development and conservation practices in mountainous ecosystems, as in the study areas, need a critical understanding of the difference of developmental processes in traditional and transitional villages. The types of knowledge (private, publically held, and refined) of elderly women of different social systems (traditional and transitional) could be determining factors for assuring food, medicinal security and biodiversity conservation. In particular, community knowledge, most often held by cultural refugia women, has tremendous potential in conservation of biocultural resources (**Fig. 3**). The United Nations and other international organizations, through various conventions and agreements on biodiversity, have recognized women's knowledge, culture and contributions to biodiversity conservation (United Nations 1992). A woman who has retained significant traditional ecological knowledge and wisdom (including language) in the face of major sociocultural change, can help her community to retain its cultural identity and to build sustainability in the era of environmental and socioeconomic restructuring (Maffi and Woodley 2010).

Conclusion and Policy Implications

We concluded that 'recipe contest' could be an important eco-literary participatory approach for mobilizing rural communities about learning and conservation of indigenous biodiversity. Elderly women, often considered to be less important in society, actually play a key role in a communities ability to maintain food security of families, healthcare practices and overall conservation of biocultural diversity. Elderly women have very detailed and accurate knowledge about plant types, their habitats and canopies, for example, allowing them to develop sustainable harvesting strategies and assure food, nutritional and medicinal security for their communities year round. The rich experiences of these elderly women relating to plants, animals and other resources have been the guiding principles for conservation of local biodiversity at the village level in Arunachal Pradesh. Their knowledge of species and related conservation techniques enable them to secure sustainable food, nutrition and cultural resources. In this study, cultural diversity among the *Adi* peoples has been identified as one of the major factors that determine the diverse traditional values of indigenous biodiversity. Knowledge of *Adi* women elders about species, access levels and conservation practices has been found to vary across different locations, depending upon ecosystem diversity and degree of association with the market economy.

Elderly women, who in changed social system, though are considered to be less important for society, play a key role in food security of family, healthcare practices and overall conservation of biocultural diversity. The knowledge of elderly women about plant types, their habitats and canopy helps them to decide sustainable harvesting strategies and assure food, nutritional and medicinal security year round. The rich experiences of these elderly women on plants, animals and other resources have been the guiding principles for conservation of local biodiversity at village level. This knowledge held by elderly *Adi* women on species and related conservation techniques also secure associated cultural resources of indigenous biodiversity.

Social bonds among *Adi* women, developed through socio-cultural structure developed through generations, serve as a social capital and provide critical inputs for learning on biodiversity and conservation practices. In the present changing socio-cultural scenario, when the extended family is disintegrating into nuclear family groups, and materialistic culture is dominating, with globalized agriculture and economy, the elder

women of *Adi* society are facing insecurity from various sources in the recognition of their important knowledge and creativity.

Considering the cultural refugia elder women as source of "social capital" and "living encyclopedias of biocultural resources", they now need to be acknowledged by the environmental and forest agencies, so that their knowledge can be applied appropriately in location specific conservation. A national level mission mode programme is required to form associations of such women. Before they pass away, the biocultural knowledge base these women hold should be recorded, characterized, validated and protected through various mechanisms being recognized. Simultaneously, we need to reward these elderly tribal women who add value to plant resources and biodiversity. This can be done in a participatory and integrated mode with the help of research and educational institutions, NGOs and government bodies, with the active participation of community members. Always maintaining the ethical approaches of prior informed consent (PIC) and IPR, after completion of such a project, the findings within the public domain but known only to the elders of a society and its extension among societies members, must be incorporated into school curricula to develop a formal chain of learning biodiversity-based knowledge systems and protecting them from erosion. The knowledge capital of biocultural resources of 'living encyclopedia' women must be taken into account as one of the foundations for sustainable management of biodiversity in India, and in this way, it can contribute significantly to conservation and community based adaptive practices to combat climate change in fragile ecosystems and disadvantageous social systems.

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Table 1 Steps and activities of study with culturally refugia elderly women from 2003 to 2008

Steps	Activities	Period
One	Selection of villages	January 2003
Two	Exploring key communicators and outstanding traditional knowledge holders (TKH)	February to April 2003
Three	Developing rapport with key communicators and TKHs	May to July 2003
Four	Obtaining prior informed consent (PIC) from key communicators and TKHs	August to October, 2003
Five	Preparing a list of women interested to participate in recipe contest	November 2003
Six	Awareness campaign about the recipe contest	December 2003 to February 2004
Seven	Conducting recipe contest with the help of key communicators and TKHs to select recipe contest winners and rewarding them	March 2004 to September 2005
Eight	Organizing focus group discussion (FGD) to develop village knowledge map	October to December 2005
Nine	Conducting transect walk to verify/measure rationality of plant species being used in food and medicines, and random verification of plant species conserved in various habitats	January to March 2005
Ten	Study of personal profile of rewarded women	April to December 2005
Eleven	Continuing data collection through interview, FGD, participant observation	January to December 2006
Twelve	Sending back the results obtained from study to women for social validation	January to March 2007
Thirteen	Organizing participatory village workshops to incorporate feedback from women into result	April to December 2007
Fourteen	Data analysis and result writing	January to July 2008

Table 2 Score techniques used in measuring independent variables

Variables	Scoring techniques
Education	Illiterate= 0, can read and write= 1, primary= 2, secondary= 3 and junior high school & above= 4
Family types	Joint family= 2 and nuclear family= 1
Living environment	Rural=3, semi-rural=2 and town= 1
Food habit	Quite traditional= 3, traditional with modern commercialized foods= 2, purely commercialized foods = 1
Types of healing	Pure ethnomedicines= 3, ethnomedicines with allopathic drugs= 2, allopathic drugs alone= 1
Types of agriculture	Traditional= 3, traditional with somewhat modern= 2, quite modern and commercial= 1
Forest dependency	Very highly dependent (>75%) = 4, Highly dependent (>50 & < 74%) = 3, moderately dependent (>25 & < 49%)= 2, less dependent (>3-24%)= 1, negligible dependent(<3.0)= 0
Market dependency	Very highly dependent (>75%) = 4, Highly dependent (>50 & < 74%) = 3, moderately dependent (>25 & < 49%)= 2, less dependent (>3-24%)= 1, negligible dependent(<3.0)= 0
Diverse knowledge systems	Complete knowledge with score value 3, partial knowledge = 2, least knowledge=1 and no knowledge= 0
Spiritual attachment	Fully= 3, partially=2, least= 1, nil= 0
Cultural attachment with society	Fully= 3, partially= 2, least=1, nil= 0

Table 3. Comparison of some promising personal attributes of elder and younger

Attributes	Elder women (%)	Young women (%)
Food habit (using traditional foods)	85.4	69.0
Use of ethnomedicines for healthcare	87.7	37.8
Use of allopathic drugs	8.9	42.6
Practicing slash and burn agriculture	82.4	46.7
Dependency on forest ecosystems	75.0	32.5
Access level of marketed foods	18.7	59.4
Degree of spiritual and cultural attachments with plant resources	80.0	19.7
Participation in *reglep* institution	69.0	21.4
Practice commercial agriculture (growing orange, pineapple and ginger)	11.5	30.3

* Figures indicating multiple percentages

Table 4 Summary of women's wisdom on traditional foods and medicinal plants demonstrated ruing recipe contests

Villages	Descriptive statistics of traditional foods and medicinal plants resources demonstrated by women in the biodiversity contests held in each village									
	Sampled women (1)	Mean age (2)	RW (3)	HN MP (4)	TND MPF (5)	PCPTF MP (6)	PWE TFH NH (7)	PWG FMF (8)	PSFT FLCP (9)	PTBP LCSD (10)
Ayeng	29 (12)	70	5	60	45	19.0	80.9	10.5	07.3	04.2
Pangin	28 (12)	65	5	44	40	16.7	83.3	12.4	06.5	03.3
Poglek	18 (10)	68	2	30	36	27.8	72.2	10.4	05.6	04.9
Sole	16 (12)	62	3	21	34	11.8	88.2	12.2	04.3	04.5
Kebang	40 (18)	98	3	67	45	14.3	85.7	14.5	07.4	05.6
Zarku	25 (10)	68	4	37	40	23.8	76.2	08.2	04.5	03.4
Mirbuk	18 (11)	64	4	23	30	40.0	60.0	07.7	04.4	03.4
Mirku	20 (12)	67	4	20	25	28.0	72.0	06.5	03.5	03.3
Balek	21 (7)	70	4	27	32	12.5	87.5	09.3	05.8	04.4
Kelek-Mirmir	19 (9)	63	4	42	28	28.6	71.4	06.4	04.5	04.3
Rasam	16 (8)	62	4	36	38	21.1	78.9	06.3	05.2	05.3
Gune	12 (10)	69	4	40	43	14.2	85.7	10.4	04.2	04.2
Sibut	20 (9)	71	4	27	30	33.3	66.6	07.5	03.2	03.4
Napit	18 (10)	69	4	33	29	31.0	68.9	05.3	04.3	04.5
Total	300 (150)		54							
Mean	--	--	54	34.06	33.3	21.8	72.3	09.1	05.4	04.6
CV (%)	--	--	--	46.3	30.2	43.3	27.6	29.1	03.3	35.9

Total sample from contest 81

1. No of women respondents in the case study (300) and young aged relatives (150) are placed in the parenthesis who helped in this study
2. Mean age (in years)
3. No of women rewarded for their outstanding knowledge on medicinal plants and traditional foods
4. Highest No. of medicinal plants and traditional foods shown by the elderly *Adi* women
5. Total no of distinct medicinal plants and foods
6. Percentage of cultivated plants used in traditional foods and medicinal purposes
7. Percentage of wild ethnobotanicals used in traditional foods used in human and animals' healthcare
8. Percentage of wild games and fishes used in medicines and foods
9. Percentage of semi-fermented and fully fermented traditional foods made of local crop plants
10. Percentage of traditional beverages (diversities in local alcoholic beverage called *apong*) prepared from local crops species (rice, finger millet, foxtail millet, tapioca and maize) demonstrated by the *Adi* women

Table 5 A general summary of local foods' crop and plant species conserved by elderly and younger *Adi* women in their shifting land, kitchen garden and community forest

Local name (*Adi*)	Botanical name	Seasonal availability	Mode of conservation	Part used	Use % (Elder women)	Use % (young women)
Adi lychee	*Nephelium lappacium* L.	Summer season	Community forest	Fruit	47.8	12.3
Angi tare	*Beta vulgaris* L.	Winter to summer	Shifting land & homegarden	Seeds	64.5	14.4
Ankari	*Vicia sativa* L.	Winter	Shifting land & homegarden	Stem & seeds	42.3	17.4
Asi tapa	*Cucurbita maxima* Duchesne. L.	Rainy season	Shifting land & homegarden	Fruits	54.5	13.2
Ayak	*Paspalum scrobiculatum* L.	September-October	Shifting land	Seeds	59.7	19.4
Bagodi	*Zuzuphus jujuba* Mill.	Winter	Near shifting land used as living fence	Fruits	60.3	32.37
Bakla	*Vicia faba* Linn.	Winter	Shifting land & homegarden	Seeds	69.6	11.2
Bambotenga	*Bambusa indica arundinacea* (Retz,) Willd.	Rainy to winter season	Shifting land &forest lands	Shoots	76.5	68.9
Bayum	*Solanum melongena* L.	Rainy to winter season	Shifting land & homegarden	Fruits	98.3	22.5
Belang	*Artocarpus heterophyllus* Lam.	Summer	Community forest	Fruits	78.9	08.2
Choulai badi	*Amaranthus tricolo*r L.	Rainy to winter season	Shifting land & homegarden	Leaf	59.4	24.3
Choulai chhoti	*Amaranthus viridis* L.	Rainy to winter season	Shifting land & homegarden	Leaf	75.7	26.2
Dilap	*Allium cepa* L..	Rainy season	Shifting land & homegarden	Bulb and leaf	74.7	44.89
Engi	*Colocasia esculenta* L. *var.* esculenta	Rainy season	Shifting land, homegarden & community forest	Tuber	65.5	10.2
Engin	*Amorphophallus campanulatus* Blume.	Rainy to winter season	Shifting land, homegarden & community forest	Tuber	68.7	09.4
Gobar oying	*Amaranthus spinosus* L.	Rainy to winter season	Shifting land & homegarden	Leaf	79.8	25.5
Jhikka	*Luffa cylindrica Linn.*	Rainy season to winter	Shifting land & homegarden	Fruits	62.3	22.2
Kaon	*Setaria italica* L.	September-October	Shifting land	Seeds	50.2	16.8
Karela	*Momordica charantia* L.	Year round	Shifting land & homegarden	Fruits	93.4	41.2
Kharbooz	*Cucumis melo* Linn. var. *momordica*	Summer	Shifting land & homegarden	Fruits	60.2	12.3
Kekir	*Zingiber* spp Roxb.	Rainy season to winter	Shifting land & homegarden	Rhizome	98.8	57.8
Kompe perong	*Emblica officinalis* Gaertn.	Winter to summer season	Found in forest areas	Fruits	80.3	18.9
Kopak	*Musa paradisiaca* L.	Year round	Domesticated in homegarden	Fruits	67.8	14.8
Koppir	*Solanum* spp.	Year round	Shifting land &community forest	Fruits	95.5	32.3
Koppy	*Solanum* spp.	Year round	Shifting land &community forest	Fruits	97.7	40.4
Laipatta	*Brassica campestris* Hook f. & Thoms.	Year round	Shifting land &community forest	Leaf	98.9	45.3
Maitikolai	*Vigna mungo* L.	Winter to summer	Shifting land & homegarden	Seeds	70.5	38.9
Makoy	*Solanum nigrum* L.	Year round	Shifting land &community forest	Fruits	60.4	12.3
Mangra	*Ipomoea batatas* L.	Winter	Shifting land & homegarden	Tuber	85.4	34.5
Marsang	*Spilanthes acmella Murr.*	Year round	Domesticated in homegarden	Leaf	95.6	47.8
Mayang	*Luffa acutangula* L.	Rainy season to winter	Shifting land & homegarden	Fruits	54.4	18.7
Mirung	*Eleusine coracana Gaertn.*	Rainy season	Shifting land	Seeds	89.9	09.8
Morshi	*Piper mullesua* L..	Year round	Conserved in shifting land	Fruits	80.5	16.4
Mula	*Raphanus sativus Linn.*	Year round	Domesticated in homegarden	Stem	84.3	55.5
Namdung	*Perrila ocymoides* L.	October to April	Naturally grown &reared in shifting land	Seeds	87.6	22.3
Onger	*Xanthoxylum rhetsa* D C.	Year round	Shifting land & homegarden	Leaf and	94.3	32.4

				fruits		
Ongin	*Clerodendrum colebrookianum* L..	Year round	Shifting land & homegarden	Leaf	98.9	38.3
Ori	Coriandrum sativum L.	Summer and rainy	Shifting land & homegarden	Leaf	90.3	39.4
Peron	*Vigna unguiculata* L.	Rainy season	Shifting land & homegarden	Seeds	89.5	40.4
Ritsar chili	*Capsicum spp.*	Winter to summer	Shifting land & homegarden	Fruits	97.5	38.9
Ronyang	*Vigna radiate* L.	Winter to summer	Shifting land & homegarden	Seeds	76.5	31.2
Ronyang	*Glycine max* Merrill.	October-December	Shifting land	Seeds	88.3	15.3
Samak	*Echinocloa crusgalli* Beauv.	Rainy season to winter	Shifting land & homegarden	Seeds	89.9	16.5
Shamula	*Echinocloa frumentacea* Roxb.	Rainy season to winter	Shifting land & homegarden	Seeds	85.5	11.2
Shapa	*Zea mays* L.	May to December	Shifting land & homegarden	Seeds	87.7	24.2
Shinkanga	*Solanum torvum* Sw.	Rainy to winter season	Shifting land & homegarden	Fruits	57.5	11.9
Singiengin	*Manihot esculenta* Crantz.	Year round	Shifting land	Tuber	90.8	19.5
Sirang	*Castanea* sp. Mill.	Winter to summer	Found in forest areas	Fruits	89.9	27.7
Sutri	*Vigna umbellate* L.	Rainy season	Shifting land & homegarden	Seeds	80.8	09.3
Takeng	*Zingiber officinale Rosc.*	Year round	Shifting land	Rhizome	89.8	19.8
Tang chili	*Capsicum* spp.	Winter to summer	Shifting land & homegarden	Fruits	60.5	14.3
Tatum tai	Pennisetum typhoides (Burm. f.) Stapf & C. E. Hubbard	Rainy season	Shifting land & homegarden	Seeds	59.4	14.5
Yaimu	*Zingiber zerumbet* L.	Rainy season	Shifting land & homegarden	Rhizome	65.4	11.2
Yokshik peron	*Lablab purpureus* L.	Year round	Shifting land & homegarden	Seeds	54.3	10.9
Overall average use value					76.7	24.9

Season= summer from February to May; Rainy from June to September, Winter from October to January

Table 6 Use of ethnomedicinal plants species by elderly and younger *Adi* tribal women

Local name of plants	Scientific name	Fruiting & flowering time	Family	Part used	Medicinal usage	Elderly women (%)	Young women (%)
Akirokmi	*Ricinis communis* L.	March-Nov	Euphorbiaceae	Green leaves	Muscles pain, bone fracture	54.2	14.5
Apatare	*Paederia scandens* (Lour.) Merrill.	July-Jan	Rubiaceae	Green leaves	Hypertension, stomach pain, inflammation, cut & wound	86.2	11.1
Boku	*Begonia roxburghii* Miq. DC.	March-Nov	Begoniaceae	Petioles	Toothache, gum swelling, chronic indigestion, excessive flatulence	57.6	03.5
Dumkur	A*esculus assamica* Griff. A.	August	Sapindaceae	Bark	As purgative and fish poison	79.4	16.6
Ekkam	*Phrynium pubinerve* Bl.	May-Oct	Marantaceae	Rhizomes	Mental stress, chest pain	98.2	27.3
Emo	*Aconite ferox* Wallich ex Seringe	August	Ranunculaceae	Dried roots	Scorpion and snake bites, rheumatic swelling	99.1	06.2
Gaam oying	*Glochidion multiloculare* Voigt	April-May	Euphorbiaceae	Green leaves	Abortifacient, indigestion, chest pain	95.6	22.3
Gandhi tar	*Mikania micrantha* Kunth, M. scandens	Oct-Feb	Asteraceae	Green leaves	Mild stomach pain, diarrhoea	69.3	08.9
Hathiphal	*Dillenia indica* L.	July-Dec	Dilleniaceae	Fruits	Piles, indigestion, dysentery, dandruff, sexual debility in male	88.9	07.3
Hoven yuar	*Eupatorium odoratum* L.	Nov-March	Asteraceae	Green leaves	Cut & wound, blisters and skin irritation	67.8	09.9
Jepo	*Ammomum subulatum* Roxb.	August	Zinziberceae	Rhizomes	Skin allergy and body tonic, fever	75.4	08.7
Kopitang	*Solanum viarum* Dunal	Year round	Solanaceae	Fruits	Toothache	98.3	18.9
Loglin	*Artemisia indica* Willd.	Aug-Sep	Asteraceae	Green leaves	Asthma, nose blockade, skin allergy	66.7	14.3
Loma-Losut	*Pothos scadens* L.	Feb-July	Araceae	Stem & leaves	Fractured bones, cut and wounds	91.2	17.8
Mat pepereng	Dendrocnide sinuate (Bl.) Chew	July-Dec	Urticaceae	Green leaves	Infection	90.2	13.2
Namdung	*Perrila ocymoides* L.	Sep-Nov	Laminaceae	Seeds	Abdominal distension, morning sickness and threatened abortion	91.2	23.2
Namsing eang	*Ageratum conyzoides* L.	Sep-Oct	Asteraceae	Green leaves	Conjunctivitis and cut & wound	87.2	29.2
Nebi nilam	*Kalanchoe pinnata* (Kurz.) Persoon	Feb-March	Crassulaceae	Green leaves	Skin burn, cut & wound, sensational urination	97.6	27.8
Nupuk	*Fagopyrum esculantum* Moench.	March-May	Polygonaceae	Green leaves	Liver problems to alcoholic, constipation, increasing appetite	92.4	24.5
Ogen	*Gynura crepidioides* Bentham	Oct-Jan	Asteraceae	Green leaves	Headache, insomnia, constipation, in pregnancy for easy delivery	90.9	23.4
Oike	*Pouzolzia hirta* Wight	Sep-Nov	Urticaceae	Leaves	Lactation in women	95.6	09.2
Ongin	*Clerodendrum colebrookianum* Walp.	June-Dec	Verbenaceae	Green leaves	High blood pressure, liver pain & viral fever	98.9	08.3
Oyik	*Pouzolzia bennettiana* Wight	Jan-Dec	Urticaceae	Green leaves & stem	Burning sensation, indigestion, constipation	98.2	12.2
Piwaj ekkum	*Oxalis griffithii*	May-July	Oxalidaceae	Green leaves	Digestive and stimulant, cough and chest congestion, liver	97.6	16.5

					problems		
Pumrol	*Parabaena sagittata* Miers ex Hook. F. & Thoms.	May-Nov	Menispermaceae	Milky sap and leaf	Cut and wounds, throat infection, skin allergy	69.49	19.24
Rinko	*Coptis teeta* Wall.	Feb-May	Ranunculaceae	Leaves, stem	Fever, headache, and gastric	76.45	14.34
Roram	*Houttuynia cordata* Thomb	Dec-Jan	Saururaceae	Green leaves	Insomnia, dysentery, diarrhoea, jaundice	93.21	09.89
Rukjii	*Cyclosorus parasiticus* (L.) Farewel	Fern, year round	Thelypteridaceae	Leaf	Gout rheumatis, microscopic insect in chickens, fishing	99.67	07.61
Rumdum	*Blumea fistulosa* Kurz.	Aug-Sep	Asteraceae	Green leaves	Diarrhoea	77.47	11.21
Sibutulpii	*Gynocardia odorata* R. Br.	Dec-Jan	Flacortiaceae	Dried pericarp	Gonorrhea, chest distension, cut & wound	68.89	08.98
Singger	*Alstonia scholaris* L. R. Br.	Jan- July	Apocynaceae	Bark	Indigestion	65.69	07.86
Tangam	*Bidens pilosa* var minor (Bl.) Scherff.		Asteraceae	Green leaves	High blood pressure, infection, insomnia, jaundice, asthma	59.88	06.54
Yadukh	*Abroma augusta* L.	July-Aug	Sterculiaceae	Stem bark	Dysentery and vomiting	60.23	05.65
Yaing	*Chenopodium album* Bosc. Ex Moq	Aug-Dec	Chenopodiaceae	Green leaves and seeds	Indigestion, constipation an chest pain	64.36	08.92
Overall average use value							

Table 7 Diverse knowledge of women about biophysical and socio-cultural aspects of local plants

Indicators of biophysical and socio-cultural aspects	Percentage and mean score of knowledge		Difference of %	'Z' Statistics
	Elderly women (%)	Young women (%)		
Managing land and plant resources	57.8 (813.3)	23.5 (213.3)	34.4	85.9**
Selection of plants	78.5 (850.4)	36.4 (309.1)	42.1	94.5**
Maintaining populations of important local plants	76.4 (810.1)	18.9 (270.3)	57.5	83.1**
Identifying appropriate stage for harvesting	88.9 (790.1)	09.4 (298.8)	79.6	36.9**
Using sustainable method of harvesting plants from community forest for various purposes	83.2 (812.2)	19.2 (323.8)	64.0	92.8**
Collecting plants from community forest for medicines	78.7 (789.4)	26.4 (239.6)	52.4	99.1**
Processing the food products and beverages from forest plants	95.3 (790.5)	08.1 (310.1)	87.2	87.4**
Storage of surplus amount of local plants	89.6 (698.3)	14.2 (197.3)	75.4	98.9**
Manufacturing of domestic items from forest plants	65.4 (680.4)	17.7 (168.9)	47.7	82.1**
Adding local value to forest plants for meeting social demands	69.3 (645.4)	09.1 (178.8)	60.2	80.6**
Provisioning of using plants for risk management	48.9 (590.3)	11.2 (178.4)	37.7	71.6**
Coordinating household activities on culturally important plants	84.5 (850.2)	25.5 (311.1)	59.0	88.7**
Maintaining socio-cultural values on local plants	90.1 (790.3)	31.2 (245.3)	58.9	95.91**
Maintaining knowledge network on use of local plants	94.5 (689.5)	23.3 (289.4)	71.2	67.5**
Supervisory role on local plants to ensure sustainability through making informal institutions *reglep*	81.8 (768.5)	19.7 (223.2)	62.1	93.7**
Overall the difference of diverse knowledge score in between elder and younger women	38.67± 3.6	21.41± 5.6	17.26	34.6**

Data presented in parenthesis is indicating mean knowledge score.

** Indicating 'Z' values significance at 0.001 % cent of probability level.

The knowledge score was measured using four point continuums at complete knowledge with score value 3, partial knowledge with 2, very less knowledge with 1 & for no knowledge with score value 0.

Table 8 The rationality of women's knowledge about classification and placement of local vegetation of community forest and homegarden in different stories (canopies)

Knowledge of vegetation	Local name	Botanical name	Mean rationality score			'Z' values
			Elderly women	Young women	Difference	
(A) Top story canopy (10 plant species)	*Hollock*	*Terminalia myriocarpa* Heur	2.7	1.1	1.5	27.5**
	Khokan	*Duabanga grandiflora* Roxb. Es DC.	2.9	1.0	1.9	24.0**
	Bogipoma	*Chikassia tabularizes*	2.5	1.0	1.5	18.0**
	Hatipoila	*Pterospermum acerifolium* Willd	2.8	1.0	1.7	27.1**
	Poma	*Toona ciliate* M. J. Roem	2.3	1.0	1.2	20.1**
	Simul	*Bombax ceiba* L.	2.4	1.0	1.3	23.7**
	Borpat	*Ailanthus grandis* Prain	2.6	1.0	1.6	23.4**
	Dhuna	*Canarium resiniferum* Brace ex. King	2.8	0.9	1.8	23.9**
	Sopa	*Magnolia* spp.	2.7	0.8	1.8	41.5**
	Hillika	*Terminalia belerica* (Gaertner) Roxb	2.4	0.8	1.5	30.0**
(B) Middle storey canopy (8 plant species)	*Hingori*	*Castanopsis indica* Roxb. ex Lindl. A. DC	2.7	0.9	1.8	27.6**
	Pichola	*Kydia calycina* Roxb	2.6	0.7	1.1	30.2**
	Banderdima	*Dysoxylam binectariferum* (Hook. f. ex Bedd.)	2.56	0.8	1.7	24.8**
	Paroli	*Stereospermum chelonoides* L. f. DC. Paroli	2.6	1.0	1.6	35.4**
	Urium	*Bischofia javanica* Blume	2.7	0..9	1.8	25.0**
	Outenga	*Dillenia indica* L.	2.8	0.8	2.0	23.6**
	Koroi	*Albizia procera* Roxb. Benth.	2.7	0.7	2.0	24.8**
	Moj	*Albizia lucida* Benth.	2.6	0.8	1.8	26.8*
(C) Lower story canopy (8 plant species)	*Jamuk*	*Syzygium cuminii* L. Skeels	2.9	0.74	2.1	23.8**
	Poreng	*Olea dioica* Roxb.	2.9	1.1	1.7	22.6**
	Dimuru	*Ficus lepidota*	2.6	0.9	1.7	22.2**
	Boramthuri	*Talauma hodgsonii*	2..9	0.8	2.1	25.3**
	Selleng	*Sapium baccatum* Roxb	2.7	1.1	1.6	25.5**
	Morhal	*Vatica lancaefolia* Blume	2.4	0.6	1.7	20.8**
	Kako bans	*Dendrocalamus hamiltonii* Nees & Am. ex Munro.	2.6	0..8	1.9	21.6**
	Bohal bans	*Pseudostachyum polymorphum* Munro	2.8	0.9	1.9	21.5**
(D) Ground cover climber (14 plant species)	*Kaupat*	*Phrynium imbricatum* Roxb	2.8	0.8	2.0	21.3**
	Bhat	*Clerodendron infortunatum* L. GGP.	2.2	0.8	1.4	30.2**
	Tora Tenga	*Citrus* spp.	2.2	0.9	1.3	21.2**
	Dhopatia	*Clerodendron viscosum* Vent.	2.3	0.8	1.4	20.9**
	Bogitora	*Slopina molluccenisis*	2.1	0.7	1.4	21.5**
	Khagri	*Saccharum spontaneum* L.	2.2	0.8	1.4	20.0**
	Kolgoch	*Ensete glaucum* W. Roxburgh	2.2	0.9	1.3	19.76**
	Ikra	*Erianthus ravanas*	2.1	1.0	1.1	17.6**
	Ghila lata	*Bauhinia vahlii* W. & A. ; F.B.I.	2.2	1.0	1.1	16.9**
	Kachai	*Acacia pinnata* L. Willd.	2.4	0..9	1.5	21.4**
	Pani lata	*Vitis planicaulis* ex. Lind	2.4	0.9	1.4	21.7**
	Mikania	*Mikania micrantha* L. Kunth.	2.1	0.8	1.2	18.6**
	Dhekia lata	*Stenochina palustre* L.	2.1	1.0	1.1	18.6**
	Kumaric lata	*Dioscorea indica* L.	2.1	0.9	1.1	19.4**
	Overall mean rationality value		2.39±0.2	0.91±0.09		
	Overall rationality significance at 'Z' statistics					92.5**

** Significant at <p=0.01 probability

The rationality of women's knowledge about types of vegetation was measured using 4 point continuum scale. Most rational knowledge of women on a particular plant species found in a respective vegetation story was assigned the score value 3 followed by 2, 1 and 0 for rational, least rational and irrational.

Table 9 Correlation[a] of personal attributes with plant biodiversity conservation.

Independent variables	Conservation of plant biodiversity[+]		Conservation of plant biodiversity (pooled values of elder and younger women)
	'r' value Elder women	'r' value Younger women	'r' value
Age	0.84**	0.05 ^{NS}	0.77**
Education	-0.12**	0.02 ^{NS}	-0.82**
Family types	0.45*	-0.15 ^{NS}	0.35**
Living environment	0.616**	-0.04 ^{NS}	0.70**
Altitude	0.13*	0.142^{NS}	0.14**
Food habit	0.87**	0.05 ^{NS}	0.73**
Types of healing	0.91**	-0.03 ^{NS}	0.74**
Types of agriculture	0.72**	-0.39**	0.61**
Forest dependency	0.38**	0.15*	0.76**
Market dependency	-0.13*	-0.25*	-0.81**
Diverse knowledge	0.50**	0.28*	0.87**
Spiritual attachment	0.69*	0.07 ^{NS}	0.70**
Cultural attachment	0.76**	0.04 ^{NS}	0.59**
Participation in *reglep*[€]	0.34*	-0.25*	0.74**

[a] Pearson correlation coefficient.
Significance levels *$p < 0.05$, ** $p < 0.01$, ^{NS}= non-significant
N =450 (n_1= 300, n_2= 250)
[+]Dependent variable conservation was defined as the total number of crop and ethnomedicinal plants conserved (in home-garden, shifting land and community forest) and used by the women).
[€]*Reglep*: It is an informal institution of *Adi* women. It is formed on the basis of mutual understanding and helps in reducing the drudgery and time management while collecting agricultural and forest based resources

Table 10 Species used as mixture in food and securing livelihood and being conserved by women in different habitats

Species	Habitat of conservation	Use
Brassica juncea var. rugosa	Jhum land	Food and income
Chenopodium album	Jhum land	Medicinal foods for anemic patient and income
Eryngium foetidum	Jhum land and homegarden	Food and income
Xanthoxylum rhetsa	Homegarden and jhum land	Food and medicines for stomach disorders, and income in local market
Xanthoxylum. Nitidum	Jhum land	Food
Gynura crepidioides	Jhum land	Food and income in local market
Pouzolzia benettiana	Homegarden and jhum land	Food and income in local market
Mormordica cochinchinensis	Homegarden and jhum land	Food and stomach disorders and income in local market
Spilanthes acmela	Homegarden and jhum land	Food and income in local market
Clerodendrum colebrookianum	Homegarden and jhum land	Food and use in diabetes
Murraya koenigii	Homegarden and jhum land	Food and income in local market
Amaranthus tricolor	Homegarden	Food and income in local market

Note: Jhumland and homegarden are actively managed by *Adi* women including soil preparation, modification in micro-ecosystem, plant domestication to conservation through cultivation of species using traditional practices

1
2
3

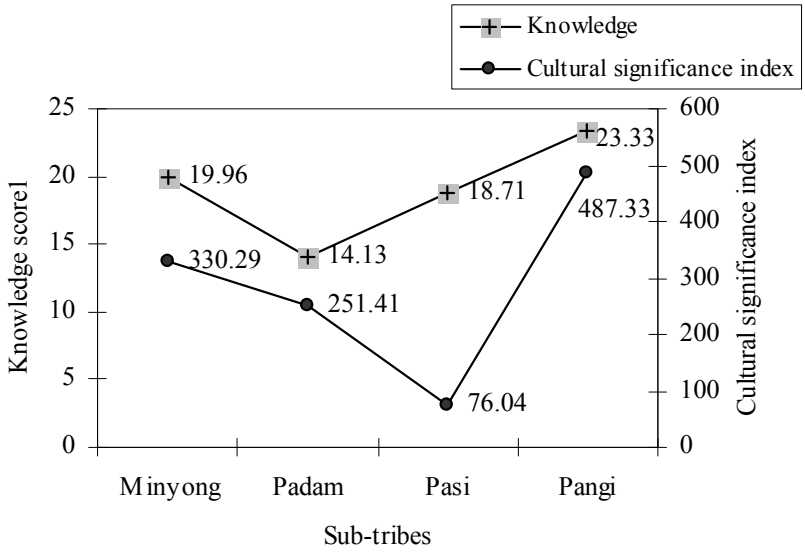

Fig. 1 Trend of traditional knowledge systems on foods and ethnomedicines and their cultural significance among different *Adi* communities

Knowledge score were generated upon the following indicators:

Plant collection, plant use, harvesting techniques, plant domestication, plant conservation, local processing techniques, food preparation, ethnomedicine preparation, preservation of plants surplus, cultural usage, social usage and spiritual usage.

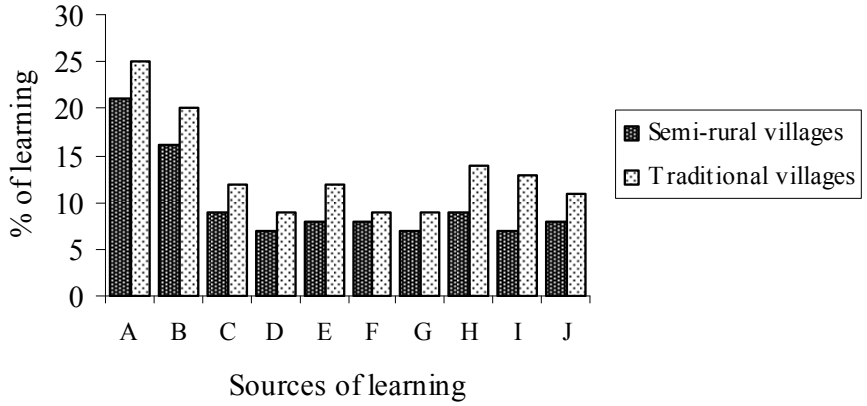

Fig. 2 Sources of traditional learning on biocultural resources

Sources of learning. (*A*)= Grandmother, (B)= Mother, (C)= Family, (D)= Neighbour, (E)= *Gaon Burha*, (F)= Community, (G)= Relatives, (H)= Social institutions, (I)= Cultural institutions, (J)= Food networks

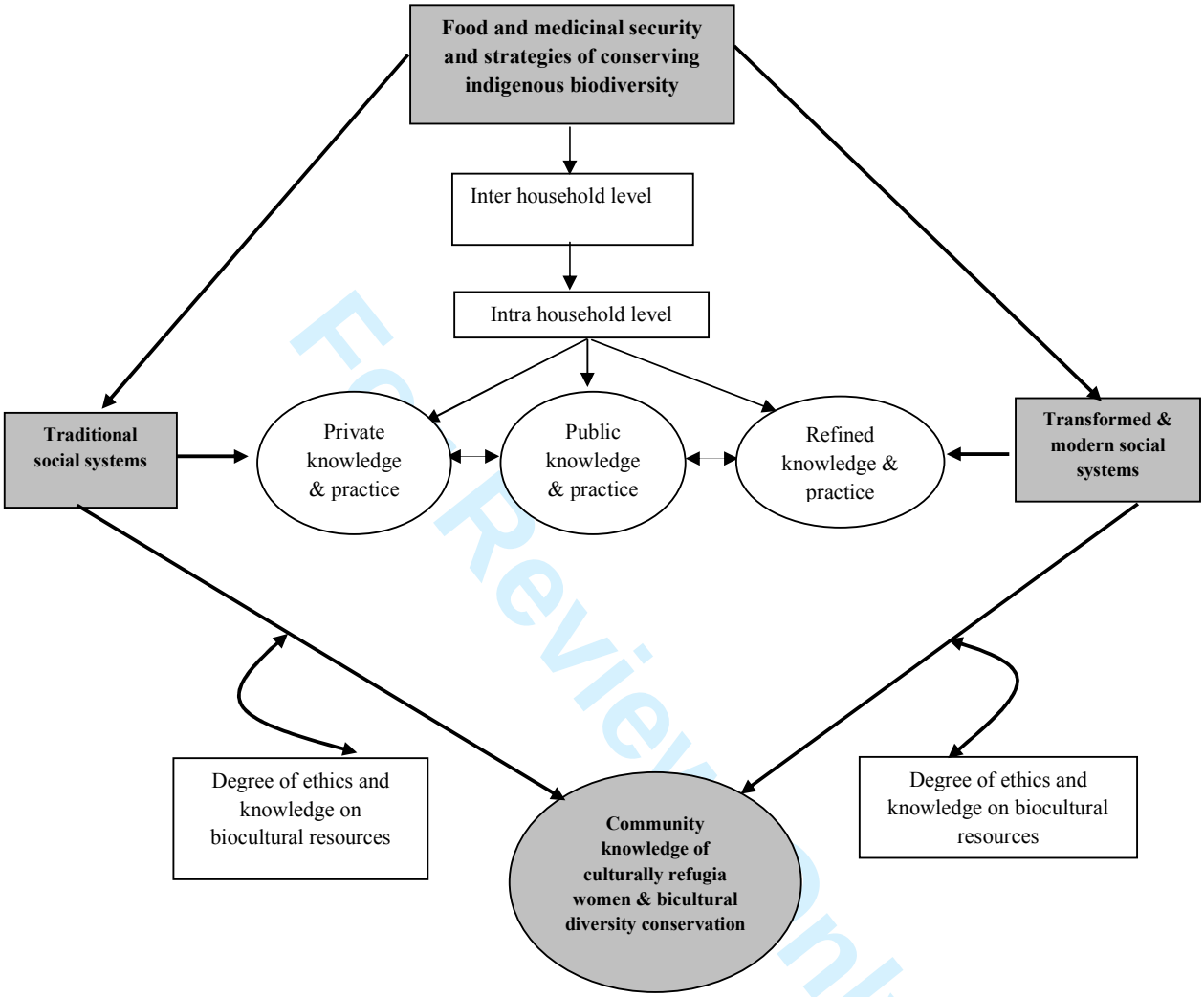

Fig. 3. Location specific conservation strategies using women's knowledge to secure food and medicinal security, and conservation of indigenous biodiversity