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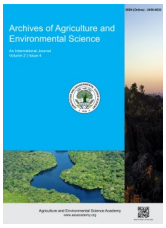

CASE STUDY

Crop diversity in jhum cultivation: A case study of Upper Siang District of Arunachal Pradesh, India

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ABSTRACT

Crop diversity is a source of food, medicines, and fodder; it provides a proximate composition including carbohydrates, proteins, minerals, vitamins, fats, essential elements, and nutraceuticals for healthy growth and development of a body. Jhum cultivation is a source of multiple crops and study on multiple sources of nutrients help in the dept understanding of diet and also framing of food policy; Present work was carried out to study the multiple cropping in Jhum agriculture field of the Upper Siang District of Arunachal Pradesh. To fulfill the objectives, field visit, open-end questionnaires and purposive samplings methods were used. A total of forty-three (43) crops were recorded to be cultivated in the Jhum field. Crops varieties of the study site could be classified into leafy vegetable crops, cereal crops, oil crops, pulses, spices crops, fruit crops, medicinal food plants, tuber crops and fiber crops.

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INRODUCTION

Plant is one among pre-requisite life-supporting system, the environment around has been influencing the culture of man since antiquity and he started to make use of available natural resources around him as food, medicine, and shelter (Cox, 1994), Balunas and Kinghorn, 2005; Gurib-Fakim, 2006). During the course of agricultural history, some 7,000 plant species have been used as food, but only around 2000 species have been domesticated and only 150 crops are commercially cultivated (FAO). Interestingly, only 30 species of plants have been reported to provide about 90% of world's nutrition needs and only three crops (wheat, rice, and maize) account the 60% of world's food supply (DePasquale, 1984; Kinghorn *et al.*, 2001; Payyappallimana, 2010). The genetic diversity within each crop has also been eroding fast. Agricultural intensificationthatisreferredtoas thegreen revolution results in a homogenous environment and eliminated natural crop diversity 9 (Butlet, 2004; Haridasan and Bhuyan, 2002). The resulting extensively grown monocultures become susceptible to disease and pest epidemics (FAO). In the various pockets of the world over, tribal people still practice jhum cultivation in which various crop varieties are cultivated, and there is a need of crop diversity study in such rural areas, particularly in remote villages, where crop diversity is high and modern hybrid seeds and technology advancement is low (Farnsworth *et al.*, 1985; Fabricant and Farnsworth, 2001). In jhum cultivation practices, many crops are cultivated in the same plot of land, such multiple cropping contributes in a multiple-way including minerals, vitamins, cereals, vegetables, etc for a healthy food habit (Mukheerje, 2001; Payum *et al.*, 2014). As opposed to monoculture, multiple cropping is significant in jhum agriculture practices and has a significant contribution to the understanding of food composition and food values including proximate and nutraceuticals of the tribal food baskets (Van Breemen *et al.*, 2008).

The study was carried out in Upper Siang District of Arunachal Pradesh (Figure 1a). Upper Siang district is of paramount significance from the crop diversity point of view; the district is

boarded by China in North, East Siang district in South, Upper, and Lower Dibang Valley districts in East and by West Siang district in West. The Dehang-Debang Biosphere Reserve is situated in the study site and a part of Eastern Himalayas that fall under the biodiversity hotspot list- among ten threatened biotas "hot spots" in tropical forests in the world (Myers, 1988) and also among the 25-hotspot biodiversity in the world (Myers, 2000). The district is in habitat by Adi, Memba, Khamba, and Idu Mishmi tribes and the culture, custom, and Traditional knowledge on eatable plants are very distinct and rich. The altitude of the area ranges from 300 m to 4000 m. The natural vegetation consists of mixed deciduous trees, grasses, and bushes of sub-tropical species (Tilbert and Kaptchuk, 2008). The vegetation of the area is represented by sub-temperate mixed forest and pine forest. The average annual temperature of the area is 18.4 ˚C and the annual rainfall is about 2646 mm, this zone also receives high rainfall during the months of May-September and the relative humidity is also very high providing an ideal environment for the growth of a luxuriant vegetation cover and orchids in particular. The temperature of the area reaches a maximum in the month of June - July (27˚C) and the lowest is in the month of January (-3˚C). The name of the district is given in the name of the mighty Siang River that drains through the district (Figure 2). And literature survey reflects that a few workers have carried out Botanical exploration of the region (Kagyung *et al*., 2010; Gajurel *et al*., 2015; Srivastava, 2018; Baruah *et al*., 2013) they have carried out some sporadic reports on the culture, medicinal plants but there are no such records on crop diversity of the region

MATERIALS AND METHODS

The present study was conducted in the Upper Siang District of Arunachal Pradesh covering entire villages and towns (Figure 1b) *viz:* Geku, Jengging, Katan, Mopom, Palling,Yingkiong, Migging, Tuting, Gelling, and Singa administrative block (Figure 3) in which 110 Farmers/Cultivators from Adi tribe, Memba tribe, Idu Mishmi tribe, and Khamba tribe participated which was carried out. The species taxonomic identification was carried out by following standard flora of Arunachal Pradesh and related floras (Materials for the Flora of Arunachal Pradesh, 1996, 1997, 1998) published by Botanical Survey of India, Kolkata, (Flora of Assam, 1997), and online botanical the database was consulted from the plant list (http://www.theplantlist.org/) and encyclopedia of Life (https://eol.org/). The study was carried out by following extensive fieldwork in the villages to reach out the farmers of the study area. In order to achieve the objectives, open-ended interviews were used; In open-ended questions processes, there is a good chance of capturing the full range of possible responses, since the survey is administered to a random sample of the target population (Singer and Couper, 2017); it allows researchers to take a holistic and comprehensive look at the issues by permitting respondents to more options and opinions. And often, Open-ended questions are used alone or in combination with other interviewing techniques to explore topics in-depth, to understand processes, and to identify potential causes of observed correlations (Susan *et al*., 2018), Interview with the farmers were carried out by using a semi-structured questionnaire and the guided field-walk method (Martin, 1995) and (Louise, 1998). Purposive sampling was also used to interview elderly farmers of the study site by using methods given in (Bowling, 2002). Purposeful sampling allows identifying and selecting the information-rich cases related to the phenomenon of interest (Palinkas, 2015).

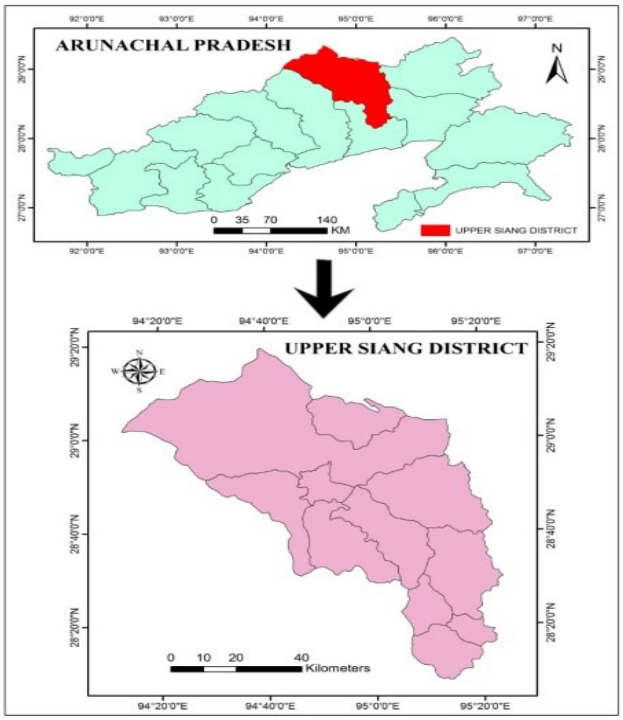

Figure 1(a). *Political map of Arunachal Pradesh.*

Figure 1(b). *Map of Upper Siang: Circles and Blocks.*

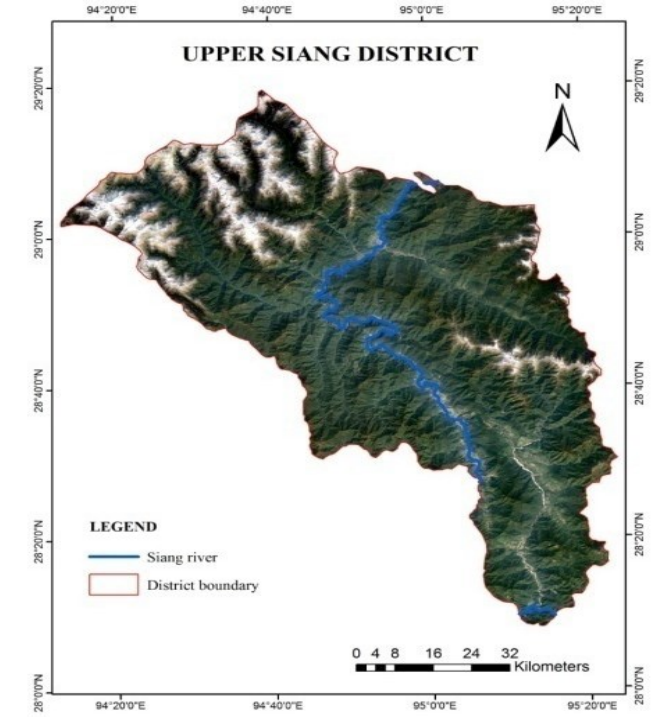

Figure 2. *Rivers, Hills and Mountains of Upper Siang District.*

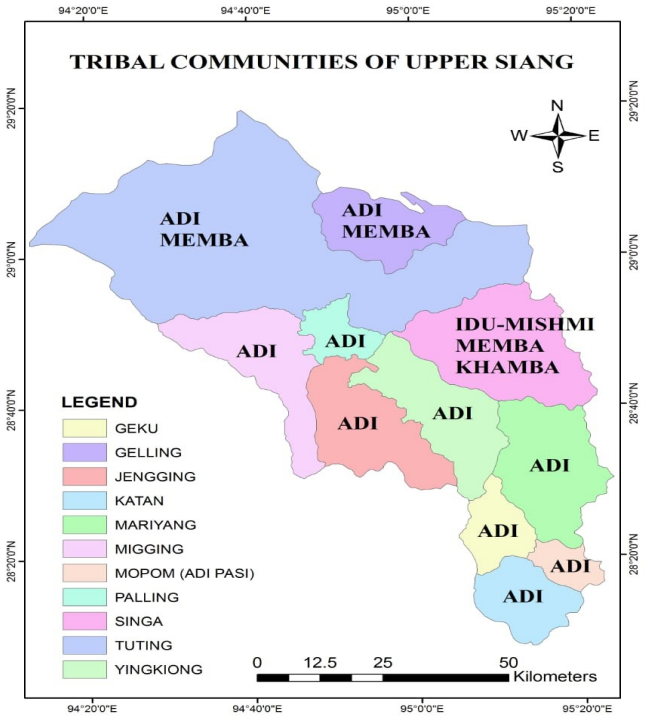

Figure 3. *Upper Siang District: Tribal Community Habitat.*

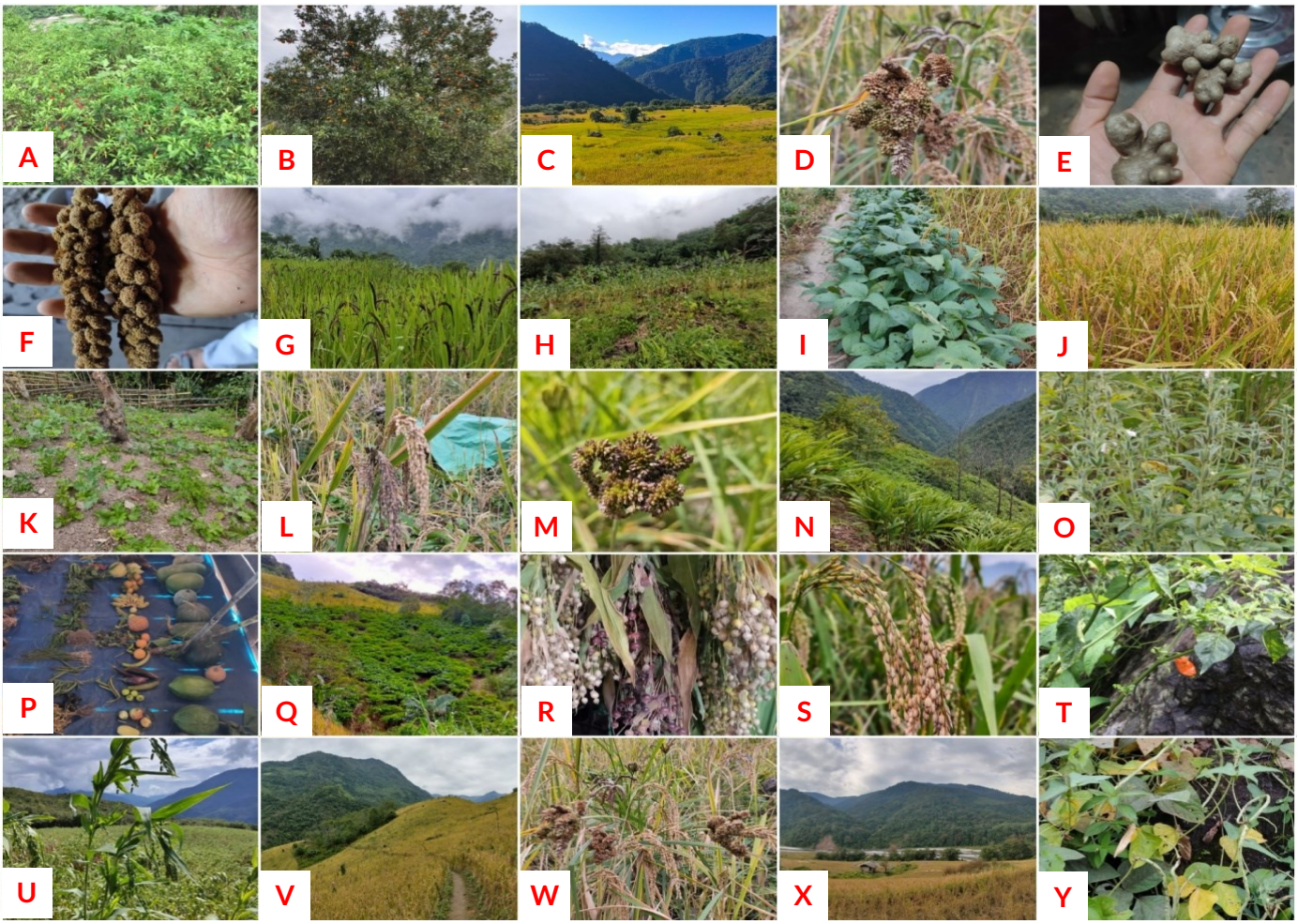

Plate 1. **A**-*Capsicum garden at Komkar village.* **B**- *Citrus orchard at Pugging village.* **C**- *Terrace filed at Likor Village.* **D**- *Eleusine corocana of Peki modi village.* **E**- *Dioscorea bulbifera.* **F**- *Setaria italica.* **G**- *Purple Oryza sativa field Mayung Village.* **H**- *Zea mays field at Mayung Village.* **I**- *Glycine max at Ningging village.* **J**- *Terrace paddy field at Kopu village.* **K**- *Lactuca garden at Damro village.* **L**- *Purple Oryza sativa jhum field at peki modi village.* **M**-*Eleusine corocana of Damro Village.* **N**- *Cardomom garden at peki modi village.* **O**- *Sesame indicum of Singing Village.* **P**- *Exhibition of cultivated crop variety by Damro women.* **Q**- *Cardomom garden.* **R**- *Different variety of Coix lacryma.* **S**-*Jhum Oryza sativa.* **T**- *Capsicum chinense.* **U**- *Coix lacryma filed at Sibum village.* **V**- *Jhum field of Peki modi.* **W**- *Inter cropping of Eleusine and Oryza.* **X**- *Terrace field at Damro village.* **Y**- *Vigna spp.*

Table 1. Plant varieties cultivated by different tribes in the Upper Siang district of Arunachal Pradesh.

S.N.	Botanical Name	Local Name	Family	Part Used	Food/ medicine	Vegetable/ fruit/Spice etc.
1	*Allium hookeri*	Dilap , Talap (A), Tsamgokpa (K), Alonpena (I)	Liliace	Bulb	Both	Spice
2	*Amomum subulatum*	Taje, Karbin (A)	Zingiberaceae	Seed	Both	Spice
3	*Ananas comosus*	Tako Belang (A), Janakongche (M, K)	Bromeliaceae	Berries / fruit	Food	Fruit
4	*Arthocarpus heterophyllus*	Belang (A)	Moraceae	Fruit, seed	Food	Food
5	*Benincasa hispida*	Par, War (A), Chubumsa (M, K)	Cucurbitaceae	Fruit / pepo	Food	Vegetable
6	*Capsicum annum*	Mirsi, Marhi (A), Inchi (I), Sepey (M, K)	Solanaceae	Fruit	Food	Spice
7	*Capsicum chinense*frutescens*	Bongal, Sibol (A), Bau Sepey (M, K), Inchinbu (I)	Solanaceae	Fruit	Food	Spice
8	*Carica papaya*	Omir, Omri (A)	Caricaceae	Fruit, flower	Food	Vegetable
9	*Citrullus spp*	Pumrung (A)	Cucurbitaceae	Fruit/pepo	Food	Vegetable
10	*Citrus sinensis*	Kinturang ,Umtir (A), Tselum (K), Kapur (M),	Rutaceae	Fruit	Food	Fruit
11	*Coix lacryma*	Anyat,Anget (A), Neh (I)	Poaceae	Seed/grain	Food	Food Grain
12	*Colacasia esculenta*	Enge,Enyi(A) , Bojong (M, K), Sona (I)	Araceae	Tuber	Food	Vegetable
13	*Coriandrum sativum*	Ori(A), Washu (K)	Apiaceae	Whole plant	Both	Spice
14	*Cucumis sativus*	Makung (A) Manjing (K), Amjipu(I)	Cucurbitaceae	Fruit / pepo	Food	Vegetable
15	*Cucurbita pepo*	Asi Tapa,Tapo, Tapo (A), Aungpu (I), Sher Bumsa (M, K)	Cucurbitaceae	Fruit / pepo	Food	Vegetable
16	*Dioscorea bulbifera*	Latik (M,K), Urun, Uli Lagli (A)	Dioscoreaceae	Fruit	Food	Food
17	*Eleusine corocana*	Mirung (A) Menja(K) Pongpu (M) Yamba (I)	Poaceae	Seed / grain	Food	Food grain
18	*Glycine max*	Rontung, Ronsing (A), Adulu (I), Libi (M, K)	Fabaceae	Seed	Food	Food grain
19	*Gossypium arboreum*	Sipyak Hopat (A)	Malvaceae	Floss	NA	Fibre
20	*Ipomea batatas*	Geja (I) ,Engin (A), Joktang Chalo (M), Inchagong (K)	Convolvulaceae	Tuber	Food	Food
21	*Lactuca sativa*	Pettu (A), Tuna (I) , Tsema (M, K)	Asteraceae	Whole plant	Food	Vegetable
22	*Lablab purpureus*	Ronjep (A), Ado Korbo (I), Lepe Sepe (K)	Fabaceae	Seed pod / seed	Food	Vegetable
23	*Lagenaria siceria*	Giri, Geri (A), Ujuk Mk, Ekapu (I)	Cucurbitaceae	Fruit / pepo	Food	Vegetable
24	*Luffa cylindrical*	Tokkit (A)	Cucurbitaceae	Fruit	Food	Fruit
25	*Manihot esculenta*	Singio, Hingjo (A)	Euphorbiaceae	Tuber	Food	Food
26	*Momordica charantia*	Kerelang (A)	Cucurbitaceae	Fruit	Food	Vegetables
27	*Musa spp*	Kopak (A), Ajebru (I), Tala Opa (M, K).	Musaceae	Fruit	Both	Vegetable
28	*Ocimum sanctum*	Tasing Ori (A), Papi (K)	Lamiaceae	Leaves, fruit	Both	Spice
29	*Oryza sativa*	Aam, Ammo (A), Keba (I), Dri (K), Bara (M)	Poaceae	Seed / grain	Food	Food
30	*Phaseolus spp*	Orsa (M) ,Jepying (A), Ado (I)	Fabaceae	Seed pod / seed	Food	Food

Table 1. *Contd...*

31	*Perilla ocimoides*	Namdung (A), Eno (I)	Lamiaceae	Seed	Food	Oil
32	*Pueraria tuberosa*	Lodor, Rodol (A)	Fabaceae	Tuber	Food	Food
33	*Saccharum spp.*	Tabat (A)	Poaceae	stem	Food	Food
34	*Sesame indicum*	Totok (A)	Pedaliaceae	Seed	Food	Oil
35	*Setaria italica*	Ayak (A), Yah (I), Teh (M, K)	Poaceae	Seed / grain	Food	Food
36	*Solanum aethiopicum*	Kopi (A), Setekala K, Seteka (I)	Solanaceae	Fruit	Both	Vegetable
37	*Solanum lycopersicum*	Tumpuluk (A)	Solanaceae	Fruit	Food	Vegetable
38	*Solanum melongena*	Bayom (A), Bapa (M, K), Pradibu (I)	Solanaceae	Fruit	Food	Vegetable
39	*Spilanthes acmella*	Marsang (A), Marsena (I), Jangema (M, K)	Asteraceae	Whole plant	Both	Spice
40	*Vigna spp.*	Rondol ,Rondong (A), Tema (M, K), Adumpu (I)	Fabaceae	Seed pod / seed	Food	Vegetable
41	*Zea mays*	Sapa,Sappe, Sepa (A), Assam (M, K) , Ambo (I)	Poaceae	Corn/ grain	Food	Food
42	*Zingiber officinale*	Kalita (I), Takeng, Take , Kedang (A), Chago (M, K)	Zingiberaceae	Rhizome	Both	Spice
43	*Zingiber zerumbet*	Kalita (I), Kekiir (A), Chago (M, K)	Zingiberaceae	Rhizome	Both	Spice

Note: (I-Idu Mishmi, A- Adi, M-Memba, K-Khamba).

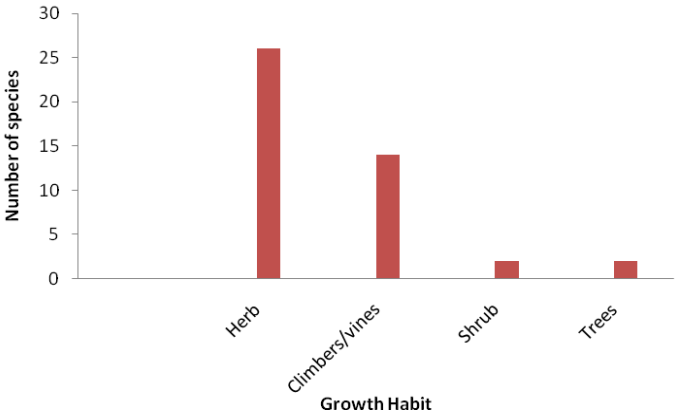

Figure 4. *Growth habit of cultivated plants of the study area.*

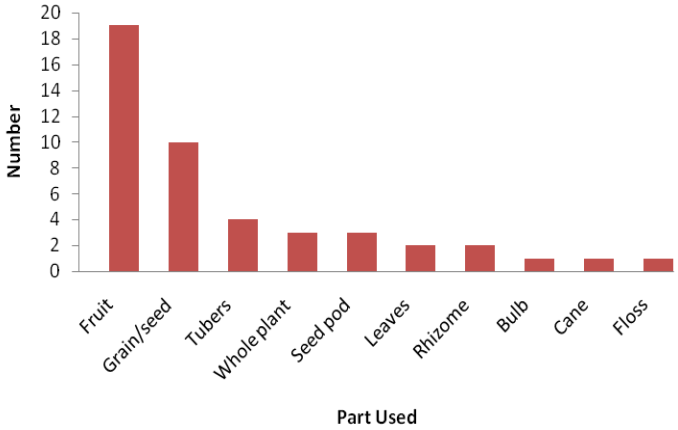

Figure 5. *Plant part used for food and medicine.*

RESULTS AND DISCUSSION

In the present study, numerous cultivated crop varieties were recorded from the Upper Siang District of Arunachal Pradesh indicates the significant role of the locally cultivated plant variety in meeting the basic needs of the tribal people. A total number of 110 cultivators/farmers interacted during the study, and forty-three crop varieties were recorded (Table 1). It was found that nineteen (19) crops were cultivated for fruits, followed by ten (10) for grain/seed crops, nine (9) crops for medicine as well as food, four (4) tubers crops, three (3) each of whole plant and seed pod crops, two (2) each of leaves and rhizome crops and one (1) each of bulb crop, cane and floss respectively (Figure 4). Twenty- six (26) crops were herbs, followed by fourteen (14) climbers/vines, two (2) shrub, and 2 trees respectively (Figure 4). In the family-wise category; seven (7) crops were Cucurbitaceae, six (6) Poaceae crops, five (5) Solanaceae crops, five (5) Fabaceae crops, three (3) Zingiberaceae crops, and two (2) Asteraceae crops (Figure 6). In the category of vegetables and spices, twenty-four (24) variety of Vegetables and pulses were recorded, eleven(11) varieties of condiment and spices were recorded, five (5) variety of cereals, one (1) species of oilseed, and one (1) species of fiber crop (Figure 7).

The present study reveals more diversity in multiple cropping in Jhum agricultural practice as reported by various workers including Tangjang (2009) who reported 20 species in the shifting(jhum) field of Nocte tribe of Arunachal Pradesh. Similarly, Bhuyan *et al.* (2012) reported 39 species of crop plants belonging to 14 families among 'Adi tribe of East Siang District, Arunachal Pradesh. Dikshit and Dikshit (2004) reported only 22 important crops species from North-East India.

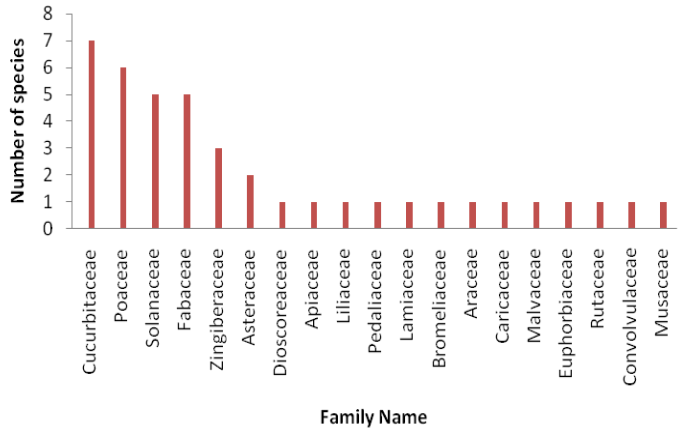

Figure 6. *Cultivated crop plant family.*

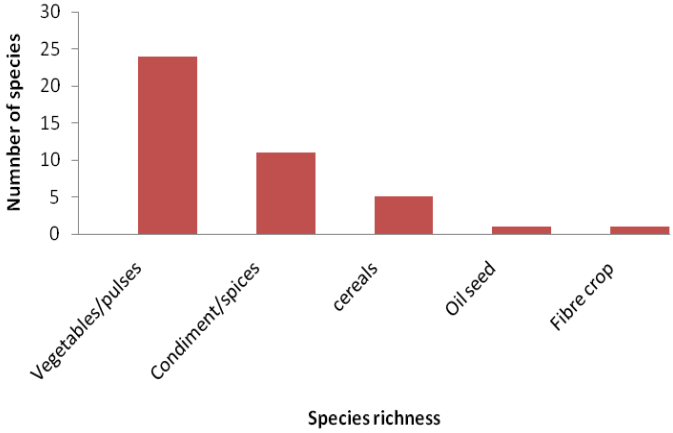

Figure 7. *Species richness of cultivated crop plant.*

Conclusion

The Jhum agricultural practices have the potential in the conservation and preservation of multiple crop varieties and GenBank as opposed to monoclonal agriculture, multiple cropping also mobilize balanced nutrient cycles among, naturally protects from pests and crop diseases and also provide food, medicine, fodder, vitamins and minerals. The Jhum agriculture practice in the Upper Siang District of Arunachal Pradesh sustains as many as forty varieties of crops that provide leafy vegetable, cereals, pulses, oilseed, fodder, fiber crops, medicinal food, and spices in a single plot of land. There is a need of dept study on the jhum cultivation on the line of nutrient cycle, soil health, and nutritional profile and soil use patterns.

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