CHAPTER 9: SUMMARY
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Summary

The Adis, a major tribal community inhabiting the central part of Arunachal Pradesh, which is strategically important and ecologically significant region in Eastern Himalaya that sustain high biodiversity and provide ecosystem services to low land region. The community has been divided into two broad categories viz. the Padam-Minyong and the Galos based on some minor differences in material culture, hair dress and social institutions. The former has been divided in to ten sub/minor groups viz. the Minyongs, Padams, Panggis, Pasis, Ashings, Milangs, Komkars, Shimongs, Karkos and Boris whereas the Galo group consists of four subgroups viz. the Galos, Pailibos, Ramos and Bokars. The community belongs to the mongoloid stock and is factual and not philosophical in nature (Nyori, 1993). They inhabits on the tropical and subtropical belts of the state that are largely dependent on shifting agriculture. However, in recent past they have been developing terrace and valley rice cultivation in selected villages, which are within the reach of developmental agencies, particularly the Department of Agriculture, Government of Arunachal Pradesh. In addition to the various Government initiatives, majority of the Adi villages still rely on traditional farming systems that evolved with nature.

The study was conducted in three districts targeting to the Adi inhabited areas i.e Upper Siang, East Siang and West Siang of Arunachal Pradesh extending between 93.57° to 95.23° E and 27.69° to 29.20° N, bordering by Tibet (China) in the North, Dibang valley and Lower Dibang Valley districts in the East, Dhemaji district of Assam in south and Upper Subansiri and Lower Subansiri districts of Arunachal Pradesh in the Western part. It covers an area of 18,116 km² that has been divided in to 37 circles under 13 subdivisions (Anonymous, 2005) having a total population of 246,580 (Census 2011, Gol) with the sex ratio of 966 female against 1000 male in East Siang, 946 in West Siang and 880 at Upper Siang district respectively.

Like any other Himalayan highlanders, the Adis also maintain agrarian culture. Shifting agriculture is the prominent type of cultivation practice on which food, fodder and socio-economic life of the tribe depends. Recent research findings reported that the traditional farming communities living in the margin of forest at high hill region with continuous practice of shifting agriculture, farmers conserve huge amount of genetic resources at both on farm and off farm
level and hence the Eastern Himalayan region is acknowledged widely as hub of biodiversity. Without using mechanized agro tools also the highlanders have been able to maintain this type of age old farming practice in sustainable way through their time tested sound traditional ecological practices. In another sense, the failure of finding of an appropriate alternative to replace the practice by any agencies, it remains prevalent and becomes only the means of economic mainstay for this highlander since time immemorial although number of adverse affects of the practice have been fostering by both Government and non governmental agencies in the region. However, in recent past few more types of agro practices are getting popular such as cash crop cultivation in orchard garden, Wet rice or valley rice cultivation etc. among few sections of farmers of the tribe but the ratio is still negligible as compare to the traditional farming practitioner. Therefore, in order to understand the sustainable maintenance of agro-practices of the tribe a study was conducted in the Siang districts with focus on crop diversity and their maintenance and tested following hypotheses:

Hypothesis: I

_Upland agriculture is known for its high agro-biodiversity_

Objective to the hypothesis: I

➢ To assess crop diversity of upland agriculture

Hypothesis: II

_Agriculture is the principal livelihood sustenance for majority of the upland communities and it is known for ecologically efficient cultivation practices, when involving innovative TEK in agro-ecosystem management._

Objective to the hypothesis: II

➢ To estimate the agronomic yield and biomass productivity of selected crop(s)
➢ To analyze the economic and energy efficiency of the agro-ecosystem.

Hypothesis: III

_Soil is an important component for better agronomic yield and biomass productivity in agriculture. Nutrient optimizations in upland agriculture manage the temporal nutrient requirements of the crop species._

Objective to the hypothesis: III

➢ To analyze the nutrient optimizations practices and temporal variation in physico-chemical properties of soil.

Salient findings of the study are summarized as follows.
The upland agroecosystems of the Adi areas can be categorized into four broad categories viz. Shifting agroecosystem; Wet Rice Cultivation (WRC) agroecosystem; Homestead garden and orchard garden respectively. Among the four agroecosystems, the shifting agroecosystem was found highly diverse in terms of crop genetic resources. As many as 73 numbers of crop species under 49 genera and 23 families were documented from the study sites during survey period. The entire crop profile can be divided in to eight major categories based on their utilization, where number of crop species and their proportion were cultivated vegetable with 19 species (26.02 %), wild edible vegetable with 14 spp (19.18 %), legumes and pulses 12 spp (16.44 %), tuber, root, stem etc. with 8 spp (9.59 %), both cereal crops and fruits, latex, yarn etc. have 6 spp (8.22%) each and the least shared by oil seeds with single species (1.37%) respectively.

Crops are cultivated in mixed type with varied sequential sowing and harvesting time frame and each category of crops play pivotal role in managing upland agroecosystem. Significantly, crops remain available all most round the year that ensures the food security of farmers. Number of crop species remain available in a calendar year vary from time to time. The highest species remain available in the month of June (40), while the least number of crops found in December (7). The degree of diversity of crops appears to have at the peak in the middle of the year i.e. in May to June.

Similarly, the intra species diversity of crop is also very high. As many as 147 landraces or varieties have been documented from 24 crop major species at shifting agroecosystem where rice is the principal crop having 31 landraces or farmers variety. Other significant landraces were taro *Colocasia esculenta* (L.) Schott. with 18 no.s, foxtail millet (*Setaria italica* (P.) L. Beauv.) with 15 no.s, chilli (*Solanum annuum* L.) with 14 no.s, both finger millet (*Eleusine coracana* (L.) Gaertn.) and maize (*Zea mays* L.) with 9 each, brinjal (*Solanum melongina* L.) with 6 no.s, tapioca (*Manihot esculenta* (L.) cassava) with 5 no.s, Indian mustard (*Brassica juncea* (L.) Czern. subsp. rugosa (Roxb.) Prain) with 4 no.s etc. Significantly, sugarcane species although it is very rare in shifting agriculture has also two landraces being maintained in Siang districts.

27 samples of important crop species with economic and socially valued were deposited for germplasm conservation at NBPG, New Delhi and availed indigenous collection number (IC No.s).
Generally a plot is being used maximum of three years for cultivation in shifting agriculture. The opening year is locally called as *Amlek* where the Jobstear (*Coix lacryma-jobi* L.) plays the role of the keystone species while in the next two successive years (*Amlek*) the role is being played by the rice (*Oryza sativa* L.).

Ecological quantification of crop community interaction shows the highest value of IVI for jobstear was 74.9751 at Riga village under East Siang. Since Riga is the only sampling site under study at East Siang district where jobstear is cultivated during first year. It is the most dominant species recorded from entire sites under West Siang district where crop species prevailed almost in uniform pattern of interaction in the given composition of reported agroecosystem. The IVI values ranging from IVI=25.90621 lowest at Yosing village to IVI=74.040299 at Rumgong in highest range among the dominant species. On the other hand, rice has the highest IVI value with IVI=94.4036 at Panggo village for first cropping year. Meanwhile, the lowest range of IVI values in different agroecosystems was recorded for *Vitis repens* (Lam.) Wright & Arn IVI=2.0001241 at Rumgong. It was followed by *Allium sativum* L. (IVI=2.600948) at Jomo, *Momordica charantia* L. at Molom (IVI=2.718856) and *Solanum* sp. at Mopung (IVI=3.441963) respectively accounted in upland agroecosystem.

Rice remain as dominant and most importantly valued crop species in the second year cropping phase in study sites except at Sibuk village where Mirung (*Eleusine coracana* (L.) Gaertn.) was accounted with higher value of IVI (43.14385).

Two indices of diversity assessment namely Shannon –Weaver Index (H') and Simpson’s Index of diversity (1-D) have used. The more of Index value the less in diversity and vice versa. District wise analysis revealed that the highest number of diversity possesses by East Siang (H'=7.14±2.81) and Upper Siang districts (H'=10.64±5.41). The least value possesses by West Siang district (H'=15.97±4.25) in the first phase of cultivation. On the other hand, in the second phase i.e. in the second consecutive year of cultivation yield highest diversity in Upper Siang with H'=4.35 (±2.73) and it is followed by West Siang with the representation of H'=5.56 (±0.97). The least diversity was represented from East Siang district H'=9.18 (±3.85) in the second successive year.

So as to the Simpson’s diversity Index possesses similar trend of index values. Among all the district the East Siang maintains the highest degree of diversity with (1-D) =
0.63(±0.13) whereas the district Upper Siang has bit higher range of diversity with (1-D)= 0.76(±0.16) than that of West Siang with (1-D)= 0.87(±0.06) in the very first year of cultivation. Contrastingly in the second successive year of cultivation reflected highest in the case of West Siang district with the average range of diversity include (1-D)= 0.57(±0.06) in West Siang; Lowest in East Siang with (1-D)= 0.70(±0.11) whereas the Upper Siang possesses the medium range of diversity with (1-D)= 0.64(±0.15) respectively.

- Unlike plain land agricultural practices, the Adis maintains mixed cropping type of WRC agroecosystem. The present study unfolded as many as 51 species under 38 genera and 19 families of crop genetic resources in WRC field from three Siang districts. Among the districts, 47 was recorded from Upper Siang showed the highest number of crops and was followed by the West Siang districts nearly maintained half of the total diversity. Interestingly, at East Siang district, rice is the only crop being used by farmers at WRC agroecosystem.

- Rice is the principal crop being maintained in WRC agroecosystem. Altogether 48 landraces of rice have been collected from Siang districts that are conserved by the Traditional Adi Farmers. District wise survey revealed that Upper Siang maintains 16 landraces; West Siang (14 landraces) and East Siang district with 12 landraces. Among the collected rice landraces 26 are indigenous 22 are exotic or high yielding variety (HYV).

- Both homestead garden and orchard garden are newly emerged agroecosystems observed in Siang districts where considerable range of diversity exists. In the case of homestead garden, only very few numbers of households maintained this practice in very limited unit of landuse. Further, there were only two villages namely Rungong village at West Siang with 9 households and Rengo village at East Siang districts were observed where mostly women farmer involved actively in managing this rich source of genetic resources. Because of the limited unit of landuse (0.03h/HH) in the study site, the occurrence of species in this system were counted and listed out therefore no ecological quantification phyto-sociological studies could possible. As many as 39 species under 34 genera and 12 families were documented from homestead garden agroecosystem in two of the aforesaid villages at Adi areas.
Following crops, the weeds occurred in upland agroecosystems also possess wide range of floristic diversity. As many as 74 species under 70 genera and 35 families of weeds have been recorded from all four studied upland agroecosystems at Siang districts. Details screening of weed diversity revealed that 52 species occurred in shifting agroecosystem, 37 species in WRC, 15 in Orchard garden and 13 species in homestead garden respectively.

Agroecosystem wise quantification revealed that six species weeds are most abundantly occurred and play the role of keystone species in shifting agroecosystem. They are Biedens biternata (Lour.) Merr. & Sherff.; Phlogacanthus thyrsiflorus (Roxb) Nees.; Strobilanthes sp.; Dichrocephala crepidioides (Benth.) S.Moore.; Anelima sp. and Youngia japonica etc. respectively. In the case of WRC, four species namely Elephantopus scaber L.; Equisetum debile Roxb.; Ageratum conyzoides L. and Alternathera sessilis (L.) R.Br etc. are occurred as keystone species, whereas Centella asiatica (L.) Urban has been reported as dominant species at Homestead garden and the Strobilanthes sp. has been recorded as keystone species of weeds at orchard garden.

The species Sporobulus diander (Retz.) P. Beauv has been recorded as the most significant weed species in over all upland agroecosystem which secured the highest position with 12 points. It is found to be distributed uniformly in all agroecosystem irrespective of location and habitat conditions.

The weed biomass dynamics varied greatly between the seasons in the first year of cropping in shifting agroecosystem. The highest amount of biomass for above ground was accounted during first weeding season which was decreased from 0.978 (±0.15) to 0.438 (±0.21) t·ha⁻¹·yr⁻¹ during the second weeding. The amount of biomass increased little bit than that of the second phase i.e. during last and final phase of weeding season where it was accounted 0.608 (±0.02) t·ha⁻¹·yr⁻¹. Meanwhile different trend of biomass accumulation was accounted for below ground level where the highest was recorded at the third weeding period with 1.082 (±0.05) t·ha⁻¹·yr⁻¹ which decreased gradually from first (0.297 ±0.15) t·ha⁻¹·yr⁻¹ to second weeding seasons (0.100 ±0.02) t·ha⁻¹·yr⁻¹ respectively.

Altogether the total amount of weed phytomass return to the soil system accounted was $3.5 ± 0.3$ t·ha⁻¹·yr⁻¹ (P < 0.001) in a typical shifting agroecosystem at Siang district, where
the above ground phytomass was 57.71% (2.03±0.02 t ha⁻¹ yr⁻¹) while the below ground phytomass was accounted 1.48 ± 0.16 t ha⁻¹ yr⁻¹ which is nearly 43% of the total weed phytomass for the first cropping year.

- In second year of cropping phase, the amount of weed phytomass estimated was 5.07 ± 0.77 t ha⁻¹ yr⁻¹ (P <0.001) as standing crop. The total above ground level of phytomass accumulation estimated was 4.32 ± 0.64 t ha⁻¹ yr⁻¹ which is 85% of the total phytomass while the below ground level estimated was 0.75 ± 0.13 t ha⁻¹ yr⁻¹ per anum.

- The total annual (Above ground + Below ground) biomass accumulation for wet rice cultivation system was estimated 2.4405 ± 0.24 t ha⁻¹ yr⁻¹ as standing crop. The annual accumulation of above ground biomass (1.7384 ± 0.08 t ha⁻¹ yr⁻¹) of weeds was more than double of below ground weed phytomass (0.7021 ± 0.15 t ha⁻¹ yr⁻¹).

- The annual returns of phytomass of seven major crop species have been estimated. Individually, the Perilla (Perilla frutescens (L.) Britton) has the highest accumulation of phytomass with 49.95±(9.43) g followed by jobstear (Coix lacrymal jobi L.) with 41.91±(10.61) g, (Zea mays L.) with 23.52±(2.29) g, Millet (Eleusine coracana (L.) Gaertn. with 12.99±(1.58) g and rice (Oryza sativa L.) with 6.64±(1.68)g excluding the grains and panicles in a given year in shifting agroecosystem. Significantly, ginger (Zingiber officinale Roscoe) possesses the least account of phytomass accumulation that is return to the soil ecosystem among the selected crop species under study. In case of WRC field the rice has possesses an average of 7.52±(0.61) g phytomass accumulation in a given cropping year.

- The average biomass accumulation in the first cropping year of shifting agroecosystem was estimated at 2.243 t h⁻¹ yr⁻¹ which returns as net biomass to the crop field for next cropping year. The average above ground biomass estimated for shifting agroecosystem was 175.951 g/m² of which the stem portions contributed the lion share with 121.741 g/m². Further, other two important portions of above grounds phytomass of both roots and litters were contributed 26.364 g/m² and 24.641 g/m² respectively in typical first year cropping. Meanwhile the below ground phytomass estimated for the same was 54.484 g/m².

- In the second year of consecutive cropping phase, similar trend of phytomass accumulation was observed in shifting agroecosystem. The average accumulation of total
Phytomass was estimated at 1.545 ±0.21 t ha⁻¹ yr⁻¹ in the study site. Significantly here also the stem of above ground part contributed the major share with 68.726 (±11.74) g/m² while the contributions of leafy masses and litter were 33.615 ±4.51 g/m² and 22.769 ±3.43 g/m² respectively and hence the total above ground biomass estimated at 125.027 (±17.86) g/m² in a typical agroecosystem of Siang districts. The below ground phytomass for the second year was estimated at 29.636 ±3.88 g/m². Therefore the total phytomass accumulation (Above ground + below ground) in second year was estimated at154.52 (±21.15) g/m².

- From the analyses it is revealed that the amount of crop phytomass accumulation in second year is fairly advance than that of the first year. The total increment estimated from first year to second year was 0.649 t ha⁻¹ yr⁻¹ (P<0.01).

- Total biomass accumulation of both shifting and WRC agroecosystems were estimated and compared. Interestingly, in the very first year of cropping, the total amount of weeds phytomass was exceeded the crop biomass production where weeds was estimated at 3.504 t ha⁻¹ yr⁻¹ while the estimated amount of crop was 2.244 t ha⁻¹ yr⁻¹. Hence the total annual biomass production was 5.748 t ha⁻¹ yr⁻¹ in shifting agroecosystem. Meanwhile, in the second year, the amount of phytomass accumulation of weeds was nearly more than thrice than that of crops. The total amount of production estimated for weed was 5.070 t ha⁻¹ yr⁻¹ whereas it was 1.545 t ha⁻¹ yr⁻¹ for crops. Therefore the annual production for both weeds + crop was 6.615 t ha⁻¹ yr⁻¹. These results, together with those of crops and weeds composition seem to suggest that weed proliferation is higher at later year while it is reverse in the case of crop phytomass accumulation, hence it may be stated that weed phytomass plays a pivotal role in managing shifting agroecosystem at Siang belt of the state.

- Similar pattern of phytomass accumulation calculated from WRC field as well where the accumulation of weed phytomass was greater than crops. The total amount of production of phytomass calculated for WRC agroecosystem was 2.52 t ha⁻¹ yr⁻¹ where the weed contributed an amount of 2.44 t ha⁻¹ yr⁻¹ while contribution of crop biomass was calculated just 0.08 t ha⁻¹ yr⁻¹.

- The involvement of labour varies greatly from location to location. The highest mandays involvement was accounted from West Siang district with 295.22(±8.48) mandays ha⁻¹ yr⁻¹.
which was followed by Upper Siang district with 213.50(±7.09) mandays ha\(^{-1}\)yr\(^{-1}\) whereas the lowest was found in East Siang at 170(±6.73) mandays ha\(^{-1}\)yr\(^{-1}\) in a calendar year. Similarly the monetary values possess the same trend as in mandays engagement. The labour input in terms of monetary value ranges from Rs. 25100(±1083.02) in lowest at East Siang whereas Rs. 39391.67(±1408.39) highest in Upper Siang district.

Seed input is another important invested component in shifting agroecosystem. Altogether 12 major crops were considered for present analyses which act as keystone crop species in the studied shifting agroecosystem of Adi areas. The selected crops were namely rice, maize, millet (both Finger & foxtail millets), jobstear, chilli, mustard, taros, tapioca, bean, brinjal and ginger etc. On farm quantification revealed that the average input of rice seed grain ranges from 15 Kg to 29 Kg ha\(^{-1}\)yr\(^{-1}\), Jobstear 10.33(±0.8) to 31.47 (±3.63) Kg ha\(^{-1}\)yr\(^{-1}\), Colocasia esculenta (L.) Schott. & Alocasia sp. 3.22(±2.77) to 9.28(±0.62) Kg ha\(^{-1}\)yr\(^{-1}\), Tapiocas (Manihot esculenta (L.) cassava) 7 Kg ha\(^{-1}\)yr\(^{-1}\), Ginger (Zingiber officinale Roscoe) 0.39(±0.29) to 11.00(±1.52) Kg ha\(^{-1}\)yr\(^{-1}\), Maize 1.48(±0.25) kg ha\(^{-1}\)yr\(^{-1}\) unit area.

Conversion of farm input into monetary values revealed for rice between Rs. 375.00(±24.44) to Rs. 604.17(±66.93) ha\(^{-1}\)yr\(^{-1}\), Jobstear from Rs. 179.67(±12.74) ha\(^{-1}\)yr\(^{-1}\) to Rs 227.33(±17.62), Taros from Rs. 64.44 (±55.40) to Rs.185.56 (±12.41) ha\(^{-1}\)yr\(^{-1}\), Tapioca from Rs. 105.00 (±82.46) to Rs. 148.89 (±14.76) ha\(^{-1}\)yr\(^{-1}\), Ginger from Rs. 105.33(±10.92) Rs. 132.00(±18.24) ha\(^{-1}\)yr\(^{-1}\) unit area in a typical shifting agroecosystem.

Agronomic yield in terms of accurate economic return to the farmers of aforesaid major crops were ranging from 3466.44(±120.68) Kg ha\(^{-1}\)yr\(^{-1}\) to 5029.17 (±278.45) Kg ha\(^{-1}\)yr\(^{-1}\).

The monetary value in terms of output as agronomic returns to the farmers of those major crops varies greatly from plot to plot. The yield of rice was exceeding anywhere in all the sampling sites of the study area however, the cash values was ranging from Rs. 35277.78 (±2051.39) ha\(^{-1}\)yr\(^{-1}\) to Rs. 64200 (±7456.76) ha\(^{-1}\)yr\(^{-1}\). The trend of monetary return is similar with that of the total crop yield where more agronomic yield results more monetary return. Analogous statement made for other crops also. In the case of maize the cash value was calculated in between Rs. 1955.56 (±638.17) ha\(^{-1}\)yr\(^{-1}\) to Rs. 5888.89 (±378.47) ha\(^{-1}\)yr\(^{-1}\) while for millet it was accounted from Rs. 12650.00 (±1484.35) to Rs. 5300.00 (±2028.99) ha\(^{-1}\)yr\(^{-1}\) in a typical shifting agroecosystem management practice at
Siang districts. The overall cash value return from major crops revealed highest at East Siang district with Rs. 111932 (± 4135.16) ha\(^{-1}\)yr\(^{-1}\) followed by upper Siang with Rs. 92006.67 (±2984.09) ha\(^{-1}\)yr\(^{-1}\) and the lowest at west Siang district with Rs. 91316.67 (± 5458.09) ha\(^{-1}\)yr\(^{-1}\) respectively.

- For one hectare of land, the requisite number of labour in typical WRC agroecosystem ranges from 236.71 (±8.43) to 314.74 (±29.25) Mandays ha\(^{-1}\)yr\(^{-1}\). During cropping phase of a calendar year 54-103 number mandays for weeding and 58 mandays that translates monetarily to Rs. 8657.14 (±2087.82) ha\(^{-1}\)yr\(^{-1}\) to Rs. 15457.89 (±953.7) ha\(^{-1}\)yr\(^{-1}\) and Rs. 8778.95 (±1134.99) ha\(^{-1}\)yr\(^{-1}\) respectively are spent. In transplanting the number of labour investment ranges from 46.00 (±16.24) ha\(^{-1}\)yr\(^{-1}\) to 52.63 (±1.37) mandays ha\(^{-1}\)yr\(^{-1}\) whose monetary values accounted between Rs. 9200.00 (±3247.28) ha\(^{-1}\)yr\(^{-1}\) to Rs. 10526.32 (±273.40) ha\(^{-1}\)yr\(^{-1}\). The total labour input in WRC of Adi agroecosystem is ranging from 236.71 (±8.43) to 321.16 (±11.66) mandays ha\(^{-1}\)yr\(^{-1}\) with monetary values from Rs. 39707.14 (±1317.52) to Rs. 56157.89 (±2260.96) for managing one hectare land unit. The total amount of Rs. 53241.20 ha\(^{-1}\)yr\(^{-1}\) to Rs. 89048.2 ha\(^{-1}\)yr\(^{-1}\) as total farm input including seed and farm manure, fertilizers etc. is being invested for managing WRC agroecosystem by the Adi farmers at Siang districts.

- In WRC agroecosystem for a calendar tear, the output ranges from 1730.56 (±546.71) to 5000 (±547.93) Kg ha\(^{-1}\)yr\(^{-1}\) as seed grain or other agronomic product. The monetary values of the output crops accounted from Rs. 57108.33 (±18041.29) to Rs. 165000 (±18081.85) ha\(^{-1}\)yr\(^{-1}\) in Siang districts respectively.

- The energy input in shifting agro-ecosystem is human labour and seed only while in settled agro-ecosystem, the energy input included farm yard manure (FYM) and fertilizer besides, human and bullock labour etc. The output ratio of twelve major crop cultivated in shifting agroecosystem were estimated. As such the output ration estimated for foxtail millet was calculated as 292.68 Kg; finger millet 346.4 Kg, maize 388.51 Kg, rice 83.57 Kg to 110.46 Kg against 1 Kg input ha\(^{-1}\)yr\(^{-1}\) among major cereal crops. The agronomic return of brinjal was calculated in between 102.91 Kg to 718.75 ha\(^{-1}\)yr\(^{-1}\), for bean from 29.8 Kg to 106.87, tapioca from 9.57 Kg to 18.25 Kg against 1 Kg input ha\(^{-1}\)yr\(^{-1}\).

- Monetary values of farm output was recorded highest from the district East Siang with Rs. 4.2/ ha\(^{-1}\)yr\(^{-1}\) from investment of Rs.1/.

273
111932 (±4135.16) from the total cash input of Rs. 26591.03 (±1601.07). The second return was recorded from West Siang district where the output was found Rs. 91316.67 (±5458.09) from total input of Rs. 30554.72 (±1450.33) ha⁻¹ yr⁻¹. The least output ratio was recorded from Upper Siang with Rs. 2.27 ha⁻¹ yr⁻¹ from the investment of Rs.1/.

- The farm output analysis revealed that the highest output was recorded from upper Siang district with 330.9 Kg ha⁻¹ yr⁻¹ from 1 Kg of input for WRC. Next two districts were namely East Siang with 218.3 Kg ha⁻¹ yr⁻¹ and West Siang with 139.22 Kg ha⁻¹ yr⁻¹ respectively from 1 Kg unit of input.

- Similar trend was also seen in the overall monetary values of the system. The highest agronomic return in terms of cash from entire system was recorded from Upper Siang district again with Rs. 3.09/ from input of Rs.1/. On the other hand the district West Siang was found second in position among three studied districts where the total economic return was accounted with Rs. 1.41/ ha⁻¹ yr⁻¹ from input of Rs.1/. The least economic return was accounted from East Siang district where the output ratio corresponding to the input was Rs. 1.39/ against in input Rs. 1/ha⁻¹ yr⁻¹.

- Screening of soil physico-chemical properties possess better at Shifting agroecosystem than WRC. The water holding capacity (WHC) for first cropping year ranges from 66.43 (±2.06) to 109.22 (±7.45). On the other hand in the second cropping year, there has been changing significantly where, the holding capacity decreases from the previous year in almost all the seasons.

- Bulk Density accounted from lowest (0.69 ±0.03) to the highest (1.01 ± 0.24) at upper depth with 0-10 cm depth. Meanwhile in the lower depth i.e. from 10-20 cm the range showed between 0.62 ±0.04 to 1.01±0.02 whereas an intermediated range showed just after burning. On the other hand in the successive second year cropping phase the range of BD accounted between 0.64 ± 0.001 to 0.94 ± 0.006 g/cm³ at upper depth while it ranged from 0.51± 0.006 to 0.93 ± 0.004 g/ cm³ lower depth.

- Soil Moisture Content (%): The moisture content accounted the highest for 109.22 ± 7.45 and lowest for 44.09 (± 0.39) % in entire cropping phase of the first cultivation year. The moisture content gradually increases from before slashing to reach at peak stage during cropping in both levels of soil depths. However, it is interesting to note that the trend of higher accumulation of moisture content in upper depth is significantly better than that of
the lower depth. In the second year of cultivation, the lowest accumulation (43.18 ± 2.05 to 68.26 ± 3.29) was recorded during cropping in both levels of soil depth. The moisture accumulation rate has been decreased drastically in second year than that of the first cropping year at shifting agroecosystem.

- Countering the ethics of maximal optimization, traditional farming system adequately maintained in north eastern region of the country through mixed and multiple cropping type in hilly landscape which could be a model for germplasm maintenance among farmers which not only ensure the food security additionally restore the already existing fragile ecosystems in mountain region people.

- Among the chemical parameters the pH and conductivity of soil remain acidic that ranges from highly acidic to moderately acidic stage during cultivation period. The acidity is more in first cropping year than that of the second year. The range of conductivity showed higher in the second year than that of the first cropping year.

- Total Soil Organic Carbon (SOC) content recorded higher in second year (3 ±0.13) of cropping than those of first year and while it is significantly more in the early state of cropping than the burning and lowest was recorded just after burning. A slight variation of total soil organic carbon (SOC) content was recorded after burning. The amount was decreasing from 3.0±0.13 to 1.57± 0.14 at before slashing, 3.34± 0.14 to 1.82±0.005 at just after burning and 2.86± 0.06 to 1.88 ± 0.15 during cropping period respectively, at 0-10 cm soil depth. Similar trend was recorded in the 10-20 cm depth level where it reduced from 2.2± 0.2 to 0.98± 0.04 in three seasons at lower depth.

- In Total Phosphorus (TOP %) also the similar trend was observed for total phosphorus as was recorded for nitrogen. The highest level of phosphorus was seen in 0-10 cm soil depth during cropping (1.94± 0.05) and lowest at 0.59± 0.04 % during first cropping year while in lower depth level it was accounted between 0.51± 0.04 to 0.72± 0.05 % at 10-20 cm soil depth. Meanwhile in the second year of cultivation the range showed on an average of 1.45±0.05% at 0-10cm soil depth. The highest phosphorus was seen during cropping with 2.71±0.05% while the lowest was recorded with 0.59 ± 0.005% during cropping itself in 01-10 cm soil depth.

- Total Nitrogen (%): Just before slashing, the amount of total nitrogen content increased from top to bottom level in upper organic rich layer of the shifting agricultural land use in
the very first year ranged from $0.56 \pm 0.001$ to $0.2 \pm 0.001$ respectively at 0-10 cm soil depth. The nitrogen content was recorded almost unchanged in two year cropping system. This reason behind there may be due to higher intensity cultivation of leguminous crops in those localities.

- The amount of Potassium (K) content recorded during study period varies in all sampled landuses. Before slashing of the cultivation field, the highest amount of potassium was found in case of field with Slashing, followed by after burning and during cropping. However the maximum K was recorded from top ($22.25 \pm 1.1$) to bottom level ($13.93 \pm 0.69$) in 10-20 cm soil depth.

- In Wet rice cultivation (WRC) agroecosystem the fire impact is not applicable to this so only two phases before sowing to transplanting stage and another phase on during cropping were considered for laboratory quantification. The physical parameters analyses revealed that soils are moderately acidic in nature while the conductivity is higher during cropping than that of transplanting. Holding capacity of water is higher during cropping while less during transplanting. The same was found for moisture content.

- As such Nitrogen (N) content remains highest during cropping while least was recorded from during transplanting. Likewise the Total Organic Carbon shows higher at transplanting stage along with Total Phosphorous content. However, the Potassium (K) content was more at transplanting stage.

- Validation of indigenous technology possesses positive impact in maintenance of shifting agroecosystem. The Panpeng, an indigenous soil water conservation practice employed in shifting agroecosystem is highly effective and helpful in sustainable management of shifting agroecosystem at Siang districts.

- Farmers maintain well designed fallow management system through the Patat which influence the productivity in shifting agroecosystem. Thereby the farmers at Siang districts maintain 13 to 41 years of fallow cycle which indicate the sustainable maintenance of agro-practice.

- Phytomass of both weeds and crops are utilized for fertility maintenance in all selected agroecosystems. However, chemical fertilizer has been using in Orchard garden.

- Shifting agroecosystem management among the Adis is good source of collecting non timber forest produces. The secondary forest developed after cultivation remain potential
for income generation and can be an option for livelihood as well.

Among the social institutions, the Ke'bang played important role in managing shifting agroecosystem but is gradually weakening which may in days to come will impact in adverse state of affairs in sustainable maintenance of shifting agroecosystem. More so, there is an urgent need in revitalize the function of Ke'bang to keep sustainability of the traditional farming practice.

Developmental activities such as mega dam construction for power generation, construction of road through crop field etc. may alter the rich crop diversity in the region which needs an urgent intervention. More so, the quality of soil status may also change if not executed properly. In the name of development, the area under cultivation shall marginalize and gradually this will lead to disintegrate the established civilized culture of the Adi tribe since agriculture in the region is intricately linked with the ethnic culture. Therefore, the implementing agencies need to adequate measures to promote sustainable development of the location.